

world energy
we

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THE
WORLD
TO
COME

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by Moisés Naím



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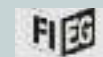
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Scenario/

The role of energy companies

The Inevitable transition

COVID-19 has provided the most significant economic challenge of the past 75 years. Engineering a recovery that does not make the world safer for all by meeting the needs of all would be a historic abdication of our responsibilities

A

BY RACHEL KYTE

She is the 14th (and first woman) dean of The Fletcher School at Tufts University, the US's oldest school of international affairs. Prior to joining Fletcher, Kyte served as special representative of the UN secretary-general and chief executive officer of Sustainable Energy for All (SEforALL), an international organization that works to drive faster action towards the achievement of Sustainable Development Goal 7. She previously was the World Bank Group vice president and special envoy for climate change.

At the beginning of 2020, the world's focus was on the ten years left to achieve the sustainable development goals (SDGs). A decade of urgent climate action was necessary to put the world on track to reach net-zero emissions by 2050. When the SDGs were being crowd-sourced and negotiated, the then-UN Secretary General described sustainable energy as the golden thread that pulled all the other goals together or enabled them. The goal of reliable, affordable, and in the context of climate action, clean energy, lay then at the heart of realizing other SDGs.

But then, despite specific and stark warnings of the risk of a zoonotic disease pandemic, to which no country paid proper heed and adequately prepared, COVID-19 rocked the world.

The need for a new world

Now, we have only one challenge. We must recover from a global pandemic and the economic destruction in its wake by positioning ourselves for net- →

zero emissions by mid-century, which necessitates deep decarbonization this decade, and at the same time, beginning to reverse the drastic rise in inequality of the past decades. As Margrethe Vestager, Vice President of the European Commission, noted, “why rebuild the old world when we want a new one.”

The energy transition is now not so much a golden thread to the SDGs, but a golden pathway through pandemic response and enabling use to change the trajectory to one in line with the Paris Agreement.

The immediate impact of COVID-19 was to shut down large parts of the industrialized world and, in so doing, disrupt global supply chains, investment flows and commodity prices. In the shutdown, energy demand collapsed. Within days images of clean skies above polluted cities and nature encroaching on urban life flooded our screens.

When governments lifted shutdowns, emissions rose again. COVID gave us a glimpse of the impact of simultaneous behavior change by millions of people. But it also illustrated the extent to which fossil fuels are the arterial system of our present-day economies. If there ever was any real argument of whether we needed system change or whether individual decisions at the consumer level should focus on climate action, COVID-19 clarified the urgency of system change.

In those early days of the pandemic, we also saw images of queues at foodbanks and disruptions of food supply from Texas to Tanzania. The pandemic brought home our lack of resilience. We are only safe if our neighbor is healthy, an important lesson in an era of expected intensifying climate impacts.

The search for balance between nature, economy and health

Now, countries are working through different stages of recovery. Of course, the first stage has focused on relief, on getting support to the most vulnerable, both as individuals and businesses. The second phase has been marked in many countries by an increasingly partisan political struggle over how to re-emerge—precisely, how to balance public health against the broader impacts of economic weakness. To move too fast to reopen the economy risks dying from the pandemic; to move too slow risks dying from hunger. The third phase, rebalancing, is the most critical if we use the recovery to pivot to a more sustainable pathway. In this third phase, countries have the opportunity to rebalance between nature, the economy and health.

There has been an outbreak of vio-

lent agreement among economists, international organizations and think tanks that we can and must use the recovery from the pandemic for course correction towards decarbonization and greater inclusion. However, governments are struggling to put this in place. The EU has been heralded for cojoining recovery with plans to green the economy. While success will depend on member states’ actions, it is a significant statement of intent and has impacted European institutions, from the European Investment Bank to the European Central Bank. Beyond the EU, some countries have indicated green elements of recovery, such as Chile’s commitment to green hydrogen, while others, such as New Zealand, continue to pursue wellbeing budgets and other forms of more inclusive wealth measurement. In Canada, public funds to support companies through recovery include climate conditionality with a requirement to publish their business strategy in line with the Task Force on Climate-Related Disclosures. But in the main, countries have yet to turn this crisis into an opportunity.

At the heart of a green and inclusive recovery lies the energy transition. The collapse in oil prices, the comparative resilience of investment in renewable energy, and the growing investor exodus from fossil fuels have seen the transition gather pace through the pandemic. The transition gained impetus from commitments to net-zero from major economic powers in the fall of 2020. First came the EU’s announcement that by 2030 it would reduce global warming emissions by 55 percent over 1990 levels. Then, in a deft diplomatic move, China announced at the UN that it would achieve carbon neutrality by 2060. The announcement exposed the US and nudged Japan to announce a 2050 carbon neutrality commitment and the Republic of Korea to do the same. The majority of the world’s economy has now joined a race to zero, the phrase used by the UK in its presidency of the critical climate talks postponed from November 2020 to 2021.

Transition and recovery, a virtuous relationship

How then can recovery speed the transition and transition support recovery? In the summer of 2020, the International Energy Agency (IEA) and the International Monetary Fund (IMF) published their Sustainable Recovery Plan. It demarcated a sweet spot where government support would meet short-term needs for job creation and income generation, with medium and long-term emissions reduction and growth objectives. Their plan singled out investments in



buildings efficiency, clean transport infrastructure and smart energy infrastructure as three win-win-win measures.

In the US, for example, despite some of the rhetoric in a hard-fought election, clean energy accounted for three times as many jobs as the fossil fuel industry. Energy efficiency employs almost 2.5 million people. Both are growing faster than in other energy sectors. Clean energy jobs are higher waged and include blue-collar as well as white-collar jobs—the perfect component of any recovery package

An “energy efficiency first” approach works everywhere—from the most advanced to the lowest income economy. No country in the world has yet optimized its regulatory environment for energy productivity. Some were moving fast, some slower, but all countries had room for improvement to attain and maintain a three percent improvement in energy efficiency year on year, necessary to reach the energy sustainable development goal by the end of the decade. Setting standards, revising them, educating the financial sector to recognize and value savings, and gains,



finding ways to reward performance, are some of the no-regrets measures available to spur progress.

Energy access is essential for resilience

Closing the energy access gap is also essential. Apart from the apparent drag on development without access to energy, health systems and safe vaccines depend on reliable, affordable energy. Energy access is a key to resilience not just for its role in supporting health systems but also for its role in access to food, water, internet connectivity and financial services.

This resilience is within reach due to decentralized renewable energy. International oil and gas companies have a potentially vital role to play in transition and recovery. However, as we enter a new post-fossil fuel era, the strategic conversation has shifted from operations' energy intensity to phase out. While some leading companies have pledged to become energy companies; in reality, companies have to become carbon molecule management companies. If companies wish to continue exploring and exploiting fossil fuels, they must use or capture and store any emissions.

Meanwhile, financial regulators, investors and trade rules will increasingly treat carbon as "bad." The transition for heavily carbonized growing economies is more complicated where public funds to support COVID recovery from the IMF and multilateral development banks flow into budget support and where budget support will flow to state-owned fossil fuel companies. These countries and their national oil companies may need assistance in making the transition. In the 1980s, states created the European Bank for Reconstruction and Development to ease the transi-

tion as the Iron Curtain fell. We need a similar response to secure the brown to green transition of carbon-intensive economies, either cut from the existing multilateral institutions or a new fund or special purpose vehicle.

For low-income countries, indebtedness was a growing problem before the need for recovery. And so, the challenge is to solve for indebtedness and a green recovery at the same time. Possible solutions include debt for climate swaps, a repurchase of African debt by European central banks in return for investment in green infrastructure, and sovereign performance bonds. What is clear is that we need guardrails for recovery to work for people and the planet.

An unprecedented challenge

We are at an inflection point. The world must come together initially within imperfect global coordination structures and governance to ensure that recovery packages needed now can steer investment into green and more inclusive growth. But we also need to take this moment to pause and hit the reset button—to build the cooperation we need for the unprecedented challenges of the next decades. Our flatter world means that we need to set the table for different actors than we did when we founded our current institutions more than seven decades ago. China and India are creditors now; we need private equity as well as banks around the table. And who represents nature at the table? Each one of the compound crises we face has, at its core, our disregard for nature and its laws. We will need new measures of success. GDP, always a blunt instrument with which to measure progress, fails us spectacularly when we need to invest more in health and education and social welfare and when we need to value nature and decarbonize rapidly. Alongside GDP (if not to replace it), we urgently need to use other forms of wealth and wellbeing accounting. At the United Nations, more than 75 years ago, the nations represented agreed on its charter. The charter opens with the phrase "We the peoples...". Today we understand this to mean, not just a few, in the city, connected to the grid, with the means to buy their resilience with a generator and access to a safely cooled vaccine. But, through advances in technology and business models, we the peoples are a legitimate aspiration for all. COVID-19 has provoked the most significant economic challenge in the past 75 years. Engineering a recovery that does not make the world safer for all by meeting the needs of all would be a historic abdication of our responsibilities.





Analysis/The pandemic and the future of decarbonization

The Dress Rehearsal

COVID-19 has produced shocking changes in the valuation of companies. But greater change looms in the form of climate change, which well may make COVID-19 seem like a mere harbinger of the events that follow it



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How will the world look once the COVID-19 pandemic is contained? This question is as urgent and important as it is difficult to answer. Every day, we are surprised by news of important and unprecedented developments in politics, the economy, society, culture, business, science and more. Many of these changes were unimaginable even a few months ago. Yet, while it is impossible to reliably project what the world will look like in a decade or two, we can probe the present to find changes that are harbingers of things to come.

Market valuations help predict the future

Take the bike boom, for example. Worldwide demand for bicycles has soared to hitherto unseen levels. The surge in demand took manufacturers, mostly in China and Taiwan, by sur- →

AUTOMOTIVE Tesla experienced a boom and was among the leading companies on Wall Street during the pandemic. Thanks to its leading position in the electric and high-tech car sector, the company managed to cope with crises and recessions caused by coronavirus.



STREAMING Netflix achieved a significant increase in subscribers thanks to the lockdown that forced people to stay home. The streaming platform closed the second quarter with 193 million subscribers worldwide. This year, its market capitalization has therefore grown by USD 70 billion.



FITNESS Fitness startup Peloton, which produces exercise bikes and also offers online fitness classes, recorded a 66% increase in sales in its third quarter. In April, Peloton held the most attended online lesson ever, with over 23,000 people taking part from home.



VIDEOCONFERENCING Zoom became a fundamental tool for work and school during the lockdown. At its peak, the teleconferencing company attracted more than 300 million users (April 2020), up from 10 million in December, despite some issues related to privacy and security.



Growing Sectors

prise and shortages ensued. The sudden, global appetite for bikes was due to people trying to mitigate the risk of COVID-19 contagion by avoiding public transportation and biking instead. Also, to the fact that there are more unemployed people with the time to enjoy a bike ride. Streets and roads with dramatically lower automotive traffic are also more wel-

coming for cyclists. Once the pandemic abates, bicycle use will surely decline from the current levels, but it is reasonable to expect that the number of regular bikers will be greater than it was before the outbreak. The growing appetite for “green” transportation options is also a component of the new demand for bikes. And, not just for bikes: a soaring market for

electric cars, buses and trucks has emerged. One small, but revealing, recent event is that Tesla is now the world’s most valuable carmaker. This ten-years old company boasts a market capitalization that is higher than those of Toyota and Volkswagen combined. Just in the past year, the price of Tesla’s shares has increased almost fivefold. While stock markets



GAMING Online games like Call of Duty attracted tens of millions of players. The latest game, Nintendo's popular Animal Crossing franchise, sold over 13 million units in the first six weeks after its launch in March. Nintendo and other consoles, including Xbox and PlayStation, have also seen demand rise in recent months.



STREAMING MUSIC Spotify has been a great success as well. The Swedish music streaming company saw its paid subscriber base rise to 130 million in the first quarter of 2020. In particular, there was an increased use of it on video game consoles like Xbox and PlayStation.



FOOD Closed schools and home working increased food consumption at home to the point that, in the early days of the pandemic, retailers like German Rewe and the French Carrefour saw their supermarkets stormed and shelves emptied. Online retailers like Amazon are also experiencing strong demand.



HEALTH Manufacturers of face masks, hand sanitizers and sanitary wipes are seeing a huge increase in demand as buyers around the world look for ways to protect themselves from the rapidly spreading virus. 3M Corp, which also creates face masks, is one of the major beneficiaries.

value Toyota at 16 times its profits, Tesla's is valued at a whopping 220 times earnings. Even Elon Musk, Tesla's CEO was surprised by his company's extravagant valuation. Indeed, it is safe to assume that Tesla's skyrocketing stock market performance was also driven by speculative behavior. Stock markets valuations are driven

by many factors—including market bubbles—and may not accurately reflect the true value of a company. But they do suggest how investors are valuing not just its current performance, but also its future potential. From this perspective, it is interesting to realize that Zoom, the video-conferencing company, is valued by the markets four times higher than

Delta Airlines. In fact, buying the world's entire US airline industry would be substantially less costly than acquiring Amazon. Another interesting signal is that Netflix is now 25 percent more valued by the markets than ExxonMobil. These two companies are iconic examples of two important global trends: cocooning and decarbonization. Cocooning

refers to protective behavior, the preference to stay inside one's home, insulated from perceived danger, rather than going out. Netflix epitomizes this preference, while the decline in the value of ExxonMobil reflects the drop in the world's demand for hydrocarbons. The lower demand for oil and gas has a cyclical component and price fluctuations are normal. But the currently depressed price of oil, for example, is not only driven by a weak global economy that consumes less crude.

Decarbonization still accelerating

Prices are also being pushed down by the widespread expectation that decarbonization—the movement towards phasing-out the carbon dioxide emissions that result from the use of fossil fuels—will be an accelerating trend. Most analysts expect global demand for oil to peak around the year 2030 as renewable sources of energy continue to grow at a fast pace and the mass adoption of electric vehicles becomes a reality. Fossil fuels will continue to be the main source of energy in the foreseeable future, but increasingly severe climate emergencies will create enormous social and political pressures to accelerate efforts towards decarbonization. Scientists, policymakers and the public continue to be surprised by the speed at which climate is changing and creating extreme weather events. Most recently, Siberia was the location of these unprecedented climate accidents. In June, the temperature in the town of Verkhoyansk reached 100.4 degrees Fahrenheit, the highest temperature ever recorded anywhere north of the Arctic Circle. Siberia has experienced an unprecedented heat wave. In the first semester of 2020, the region's temperature was nine degrees Fahrenheit warmer than the average temperature recorded between 1951 and 1980.

Antarctica, the earth's other pole, is also warming up. Scientists are concerned that the enormous Thwaites Glacier, also known as the doomsday glacier, is melting at a quick pace and perhaps becoming unstable. The *Financial Times* reports that if the glacier, which is the size of Britain, actually melts, global sea levels are estimated to rise by 2 to 3 meters. Among all the uncertainties about the world after the pandemic, there is a certitude that looms large: in the future, climate change will change the world more than COVID-19. Will this coronavirus pandemic be remembered just as a dress rehearsal for a global and unprecedented climate accident that alters civilization as we have known it?



Countercurrent/COVID-19's questionable implications for the future of energy

All is not as it Seems

The 2020 pandemic will not accelerate the global energy transition. Economies, both advanced and emerging, still need oil and gas. But we can, and must, change consumption patterns

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have no illusions about the depth of historical perspectives in a world whose attention span has become circumscribed by tweets. But even so, I did not expect that the still unfolding pandemic will be perceived, almost universally, in such an ahistorical fashion, with the only relatively common references made to the 1918 pandemic (due to its record mortality).

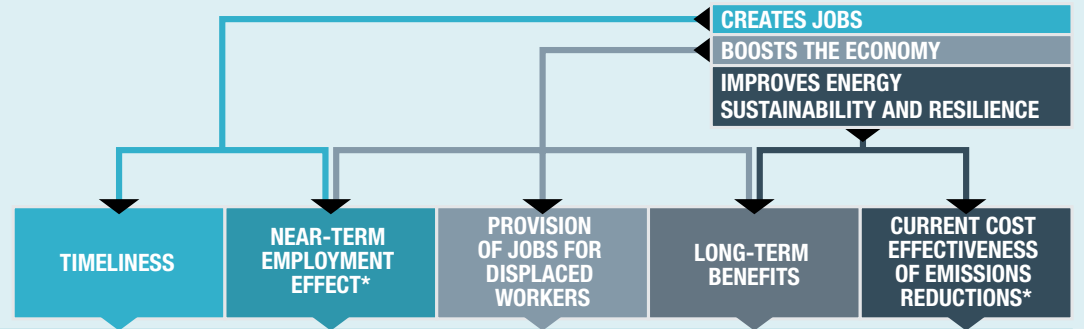
Comparisons with past pandemics

Exclusion of the 2009 pandemic can be explained by its short duration and limited impact, but that was not the case with its two most notable predecessors, the pandemic of 1968-1969 (caused by the H3N2 virus that began to spread in July 1968 in China) and the pandemic of 1957-1958 (caused by the H2N2 virus, also originating in China). As comparisons with 2020 SARS-CoV-2 show, both of these pandemics were protracted and serious events and their impact and aftermath should be considered when appraising COVID-19. →

The IEA's "Sustainable Recovery" report sets out a global sustainable recovery plan for the energy sector that has three objectives: to maintain and create jobs, to promote economic growth and to improve sustainability and energy resilience. An estimated total annual expenditure of approximately 1 trillion US dollars is required for the plan over the next three years. For the IEA, this plan would make energy systems more resilient: investing in better electricity grids and ensuring greater efficiency would improve electrical security.

ASSESSMENT OF MEASURES FOR THE SUSTAINABLE RECOVERY PLAN

■ GOOD MATCH
■ NEUTRAL MATCH
■ POOR MATCH



	TIMELINESS	NEAR-TERM EMPLOYMENT EFFECT*	PROVISION OF JOBS FOR DISPLACED WORKERS	LONG-TERM BENEFITS	CURRENT COST EFFECTIVENESS OF EMISSIONS REDUCTIONS*
ELECTRICITY					
EXPAND AND MODERNIZE GRIDS	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
WIND AND SOLAR PV	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
LIFETIME EXTENSIONS OF NUCLEAR AND HYDRO POWER	GOOD MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
NEW UNABATED GAS	GOOD MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
NEW UNABATED COAL	GOOD MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
TRANSPORT					
NEW ELECTRIC AND HIGH EFFICIENCY CARS	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
HIGH SPEED RAIL	POOR MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	POOR MATCH
URBAN INFRASTRUCTURE	GOOD MATCH	GOOD MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH
BUILDINGS					
RETROFITS AND MORE EFFICIENT NEW BUILDINGS	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
APPLIANCE EFFICIENCY	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
CLEAN COOKING	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
FUELS					
REDUCE METHANE FROM OIL AND GAS OPERATIONS	GOOD MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
REFORM INEFFICIENT FOSSIL FUEL SUBSIDIES	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
BIOFUELS	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	POOR MATCH
INDUSTRY					
EFFICIENCY	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
MATERIAL EFFICIENCY	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
INNOVATION					
HYDROGEN	GOOD MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	POOR MATCH
BATTERIES	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
CCUS	POOR MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	GOOD MATCH
SMRs	POOR MATCH	POOR MATCH	GOOD MATCH	GOOD MATCH	POOR MATCH

* Based on relative levels of jobs created per unit of spending and dollars per tCO₂-eq avoided.
CCUS = carbon capture, utilisation and storage; **SMRs** = small modular nuclear reactors; **tCO₂-eq** = tons of carbon-dioxide equivalent.
 Suitability of the various measures will vary across different regions; levels shown provide a global perspective.



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Even when using the conservative estimates of the total excess deaths caused by the viruses (1.5 million for the 1957 and 1.1 million for the 1968 event), the implied mortalities were, respectively, 52 and 30/100,000. This means that COVID-19 would have to cause as many as four million and no fewer than 2.3 million deaths in order to match the toll of those two events. But COVID's deaths reached 600,000 on July 17, 2020 and hence even their tripling would still leave this pandemic well short of the less virulent event of 1968-1969 and more than 50 percent below the 1957-1958 mortality.

And yet, in a profound contrast to 2020, there was no worldwide lockdown of economies either in 1957 or in 1968, schools remained opened (with some localized declines in attendance), theater performances and sporting events were not cancelled (the Olympic Games were held in Mexico in October 1969), and expansion of global travel continued unabated. Reviews of economic and travel statistics for 1957 or 1968 do not reveal any notable declines followed by difficult recoveries. During the late 1950s, *World Economic Surveys*, published annually by the United Nations (every issue about 300 pages long), do not contain a single reference to pandemic, virus

or influenza. In 1957, while Europe experienced significantly higher excess mortality than the US, GDP kept on increasing in all of the continent's major economies.

A decade later, the World Bank's database shows the global economy growing by about 6.3 percent in 1968, higher than in both 1967 and 1969. The world's airlines showed continued increase in annual passenger-kilometers both in 1957-1958 and in 1968-1969, and, moreover, 1958 had marked the beginning of jet-powered flight between North America and Europe and the first wide-body jet, Boeing 474, flew for the first time in 1969. And global energy consumption kept rising, up by 3.6 percent in 1957, by 5.4 percent in 1958, by 6 percent in 1968 and by nearly 7 percent in 1969.

Clearly, the world's economic growth and energy demand continued without any notable disruptions, global connectivity was intensifying rather than declining, and neither pandemic marked any departure from established growth patterns. Countries did not need any reopening and any return to normal as lives and economic activities coexisted with temporarily excessive mortality. In contrast, SARS-CoV-2, the virus responsible for COVID-19,

brought not only mortalities clearly in excess of expectations but led to the great global shutdown (economic lockdowns, school closures, bans on gatherings and drastic reductions in travel frequency). And this has not been the only distinction when comparing the unfolding pandemic with its two predecessors during the second half of the 20th century.

No warning signs of impending changes

We are now told that this prolonged and costly misfortune that has, inevitably, reduced global energy consumption represents a welcome opportunity and that it should be used as a providential point of departure for accelerated transition to non-carbon energy supply. A temporary 17 percent drop in CO₂ emissions has been seen by some as something to celebrate and to be turned into a permanent trend leading to complete decarbonization in just three decades. That logic eludes me: should not a drop that has deprived hundreds of millions of people of their earnings, imperiled the stability of the global energy and food supply, disrupted manufacturing and put many services (retailing, eating out, tourism) on a perilous trajectory toward permanently reduced employment be reversed as rapidly as

possible to resume normal lives? In any case, even a slight familiarity with the imperatives of modern energy use would have dictated a bit of prudence before seeing a significant temporary drop of energy use as a harbinger of imminent changes.

Waiting for just a few weeks would have shown that the energy consumption declines that were forced by economic lockdowns and by shutdowns of transportation can be reversed fairly rapidly. Crude oil demand in China, the first country into the pandemic and the first one out of it, rebounded to pre-COVID-19 levels before the end of May 2020, when nearly 120 very large crude carriers, possibly the largest-ever procession of supertankers traveling to the world's largest oil importer at one time, brought cheap crude to China's expanding economy. US diesel fuel and motor gasoline consumption data are also examples of rapid recovery. In February 2020 gasoline sales were 2.3 percent higher than in February 2019, in April they declined by 36.5 percent compared to a year earlier—but by the end of June they were less than 10 percent below the June 2019 level and at that time diesel fuel consumption was less than 3 percent below the demand during the last week of June 2019. →

These are just two of many examples showing that the latest pandemic will not accelerate any shift of the global energy use onto a new trajectory. Most imminently, it could not do anything of the kind because simply having more solar or wind-generated electricity would be of no use to deliver billions of pieces of personal protective equipment for hospitals (done since March 2020 by unprecedented frequency of intercontinental cargo flights) and to transport food from fields and slaughterhouses to housebound populations. Only aviation kerosene, diesel fuel and gasoline could have done that, and this dominance will not (the scale makes it obvious that it cannot) disappear in a matter of years. But, as some have argued, that should change in coming months and years as the economic recovery is deliberately tilted toward accelerated embrace of renewable energies.

The International Energy Agency's (IEA) latest *Energy Technology Perspectives* (published in June 2020) presents yet another sustainable development scenario (how many of those smoothly declining curves have we seen during the past decade?) that sees major carbon emission reductions coming from the accelerated electrification of heating and transportation and from large-scale production of low-carbon hydrogen and hydrogen-derived fuels, but the IEA admits that such transformations face many challenges before becoming commercially viable. I would qualify and stress the enormity and the unprecedented nature of these challenges. To give just one example and leave out hydrogen, the ideal fuel whose near-term mass-scale commercial embrace remains as elusive as ever, the sustainable recovery plan would boost spending on the grids which would receive a third of the proposed USD1 trillion in three years. But new high-voltage lines are perhaps the least likely candidate for any sudden massive investment as their planning and permitting periods are long and countries repeatedly fall behind in their plans to extend transmission grids.

Germany has seen years of delays in the construction of north-south transmission links that are essential for the further progress of *its energy transition*. Without new long-distance high-voltage direct current (HVDC) links it will be impossible to take full advantage of America's enormous potential for renewable electricity generation. The Great Plains are the country's windiest and the Southwest its sunniest region, while the major load centers are hundreds and thousands of kilome-

ters away. Clean Line Energy, the company that planned to develop five large US transmission projects, folded in 2019, and the Plains & Eastern Clean Line that was to become the backbone of a new US grid by 2020 (its environmental impact statement was already completed in 2014) lost the participation of the US Department of Energy in the project, which may not be built even by 2030.

Emissions must be cut, regardless of climate change

As for the commitment to finance such accelerated transformations, the latest (five-day) round of the EU's obligatory Brussels wrangling produced new fiscal stimulus that may be "pivotal" and "unprecedented" (what else are its exhausted architects supposed to say?)—but that, as Reuters immediately reported, came at the cost of cuts to proposed investment in climate-friendly funds. But making the rich world's energy use less carbon-intensive is a goal that we should be pursuing even if there were no problem with global warming, mainly because it still remains excessively wasteful and systemically irrational. What is the rationale of producing biofuels (whose carbon intensity is only marginally lower than that of gasoline) and then using them in monstrous SUVs? What is the point of a two-ton Jeep Cherokee (one of the best-selling vehicles in the US) driven by a 60-kg woman on her shopping errands? Do we need fresh greenhouse tomatoes in January (at 50 times the energy cost of a summer field crop) and what is the energy return on airlifting green beans (91 percent water content) from Kenya to the EU during winter?

These excesses and irrationalities of the rich world's energy use should not have been introduced in the first place. There was nothing inevitable about displacing sedans by SUVs and there is nothing existentially imperative about not getting vitamin C from fresh tomatoes in January. And why have we not adopted one of the easiest efficiency measures—to have all cold-climate construction with superinsulation and triple windows—decades ago? Mass-scale elimination (or at least substantial moderation) of such waste should go some way toward making the rich world's energy use more rational and less carbon-intensive. In that sense, the latest IEA perspectives are correct that the single largest gain can come from higher efficiencies.

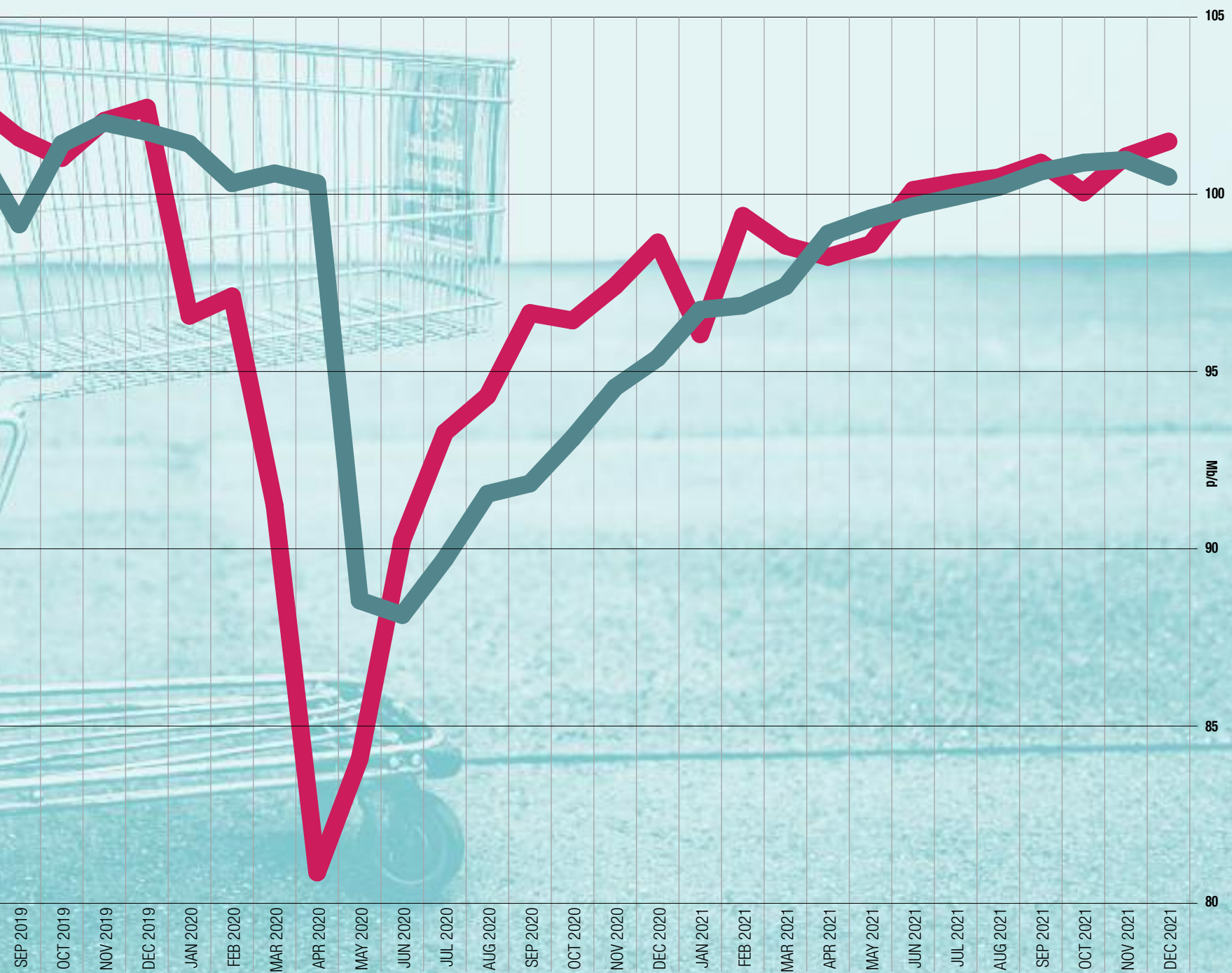
But there is another world at the opposite end of the quality-of-life continuum descending from affluent countries. In 2020 half of humanity lives in countries with an annual per



capita primary energy supply of less than 50 gigajoules (GJ) and 40 percent of the world's population (3.1 billion people) have access to less than 25 GJ a year per capita, the rate achieved in both Germany and France by 1860. In order to approach the threshold of a dignified standard of living, those three billion people need to at least double or triple their per capita energy use, and while they need to multiply the electricity supply they need, above all, to produce more food and build their essential infrastructures. These tasks are impossible without the massively increased synthesis of nitrogenous fertilizers (average applications in sub-Saharan Africa are

less than a quarter of the EU level), production of primary steel (the EU's per capita consumption of finished steel is more than ten times the African mean) and cement (the EU's per capita supply is more than six times that of African nations) required for buildings, dams, transportation infrastructure, industrial production and electricity transmission. All of these outputs depend on large-scale inputs of fossil fuels—natural gas for Haber-Bosch ammonia synthesis; coke for blast furnace iron or natural gas for direct iron reduction; various liquid and solid fuels for cement production—and none of these industries has at its disposal any non-carbon

Source: U.S. Energy Information Administration



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alternatives that could be deployed immediately and on the requisite scales to produce the tens to hundreds of millions tons of products that the modernizing countries will require every year.

China's post-1990 rise has not been based on wind and solar but on fossil carbon: in order to bring its 1.4 billion people from about 25 GJ/capita in 1990 to about 100 GJ/capita in 2019, the country had to increase its coal use nearly four-fold, its crude oil consumption nearly ten-fold and its natural gas combustion nearly 20-fold and these gains resulted in more than quadrupling China's carbon emission increase from 2.3 to 9.8 Gt/year. And

that was for the current population of 1.4 billion which means that even if the 3.1 billion people in today's low-energy countries were to do only half of what China has done their combined demand for fossil carbon would surpass that of post-1990 China!

Feasibility, not wishful thinking, is what matters for the future

Wishful thinking is never the best guide to any effective public policy, especially not in matters that concern the very fundamentals of modern civilization. Carbon-free energy supply might be highly desirable—but those who claim that we can

completely transform the global energy system in two or three decades must do better than present just another hypothetical smooth-curve scenario driven by arbitrarily placed targets for years ending in five and zero. They must first convincingly explain how they would eliminate the rich world's dependence on fossil fuels (now 80 percent of their primary energy supply) by 2050 and, even more importantly, they have to demonstrate how they would elevate (even just to half of today's Chinese level) the living standards of the poor half of humanity without fossil carbon.



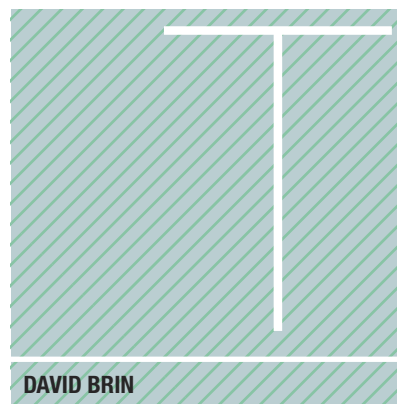




The point of view/Trends over the next 10 years

Postcards from 2030

New technologies could help resolve some of today's most pressing crises, such as water scarcity, and build a better and more sustainable world. But we mustn't let our guard down on the potential pitfalls of technology—it will be essential to build in accountability for all



DAVID BRIN

An astrophysicist and writer, Brin sits on the advisory board of NASA's Innovative and Advanced Concepts group and advises companies and government agencies: from Google to the CIA. His most recent science novels include *Heart* (1990) and *Existence* (2012).

These have been boom times for “futurists,” a profession without credentials, in which anyone can opine about tomorrow's Undiscovered Country. Ever since the turn of the century, a whole spectrum of corporations, intel and defense agencies, planning councils and NGOs have expressed growing concern about time scales that used to be the sole province of science fiction (SF). In fact, all those companies and groups have been consulting an ensemble of “hard” SF authors uninterrupted by the pandemic's travel restrictions.

New technologies: solution or threat?

One question always pops up; can we navigate our way out of the current messes, helped by new technologies? The news and prospects are mixed, but assuming we restore the basic stability of the Western Enlightenment Experiment—and that is a big assumption—then several technological and social trends may come to fruition in the next 5-10 years.

- Advances in the cost effectiveness of sustainable energy supplies will be augmented by better storage systems. This will both reduce reliance on fossil fuels and allow cities and homes to be more autonomous.
- Urban farming methods may move to industrial scale, allowing even →

VISIONS of

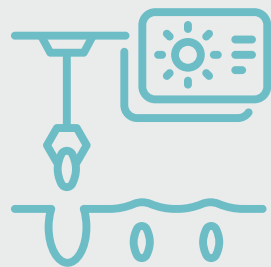


Energy

Falling sustainable energy procurement costs due to better storage systems will reduce dependence on fossil fuels.

Agriculture

The methods used in urban agriculture could also be applied on an industrial scale, allowing giant steps towards achieving local autonomy.



Transport

All over the planet, transoceanic transport will find itself with surplus capacity that could partly be used to improve severe water shortages.

greater moves toward local autonomy, although a decade or more may be necessary to show significant impact. Meat use will decline for several reasons, ensuring some degree of food security.

- Local, small-scale, on-demand manufacturing may start to show effects by 2025, altering supply chains and reducing their stretched networks.
- If all of the above take hold, there will be surplus oceanic shipping capacity across the planet. Some of it may be applied to ameliorate but not solve acute water shortages. Innovative uses of such vessels may range all the way from hideaways for the rich to refuges for climate refugees—possibilities I describe in my novels *Existence* and *Earth*.
- Full scale diagnostic evaluations of diet, genes and micro-biome will result in micro-biotic therapies and treatments utilizing the kitchen systems of the human gut. AI appraisals of other diagnostics will

both advance detection of problems and be distributed through hand-held devices cheaply available to even poor clinics.

- Hand held devices will start to carry detection technologies that can appraise across the entire electromagnetic spectrum, allowing NGOs and even private parties to detect and report environmental problems. Socially, this extension of citizen vision will go beyond the current trend of applying accountability to police and other authorities. Despotisms will be empowered, as predicted in 1984. But democracies will also be empowered, as described in *The Transparent Society*.
- I give odds that tsunamis of revelation will crack the shields protecting many elites from disclosure of past and present torts and turpitudes. The Panama Papers and Epstein cases—and the more recent FinCEN spill—exhibit how much fear propels some oligarchs to combine efforts at repression.

But a few more cracks may cause the dike to collapse, revealing networks of extortion, cheating and blackmail. This is only partly technology driven and hence is not guaranteed. If it does happen, there will be dangerous spasms by all sorts of elites desperate to either retain status or evade consequences. But if the fever runs its course, the more transparent world will be cleaner and better run.

- Some of those elites have grown aware of the power of 90 years of Hollywood propaganda for individualism, criticism, diversity, suspicion of authority and appreciation of eccentricity. Counter propaganda pushing older more traditional approaches to authority and conformity are already emerging and they have the advantage of resonating with ancient human fears. Much will depend upon this meme-war. Of course, much will also depend upon short term resolution of current crises. If our systems remain undermined and sab-

the future

Diagnostics

Large-scale diagnostic evaluations of diets, genes and the microbiome will lead to microbiome-based therapies and treatments. AI evaluations of other types of diagnostics will improve problem detection.



Society

Despots will find increasing opportunities to increase their power, but democracies will also do the same.



Environment

Portable devices will begin to be equipped with detection technologies capable of capturing, analyzing and processing data across the entire electromagnetic spectrum, allowing private individuals also to detect and report any environmental problems.



otaged by incited civil strife and distrust of expertise, then all bets are off.

The risks to privacy

What about the role of technology and technology companies in individuals? Many fret about the spread of surveillance technologies that will empower Big Brother. These fears are well-grounded, but utterly myopic.

- First, ubiquitous cameras and face-recognition are only the beginning. Nothing will stop them and any such thought of “protecting” citizens from being seen by elites is stunningly absurd, as the cameras get smaller, better, faster, cheaper, more mobile and vastly more numerous every month. Moore’s Law to the nth. Safeguarding freedom, safety and privacy will require a change in perspective.
- Yes, despots will benefit from this trend. And hence the only thing that matters is to prevent despotism altogether. A free soci-

ety will be able to apply the very same burgeoning technologies toward *accountability*. At this very moment, we are seeing these new tools applied to end centuries of abuse by “bad apple” police who are thugs, while empowering truly professional cops to do their jobs better. There is no guarantee that this light will be used with broad effectiveness. It is an open question whether we citizens will have the gumption to apply *sousveillance* (the recording of an activity by a participant) upward at all elites. But Gandhi and ML King likewise were saved by crude technologies of light in their days. And history shows that assertive vision by and for the citizenry is the only method that has ever increased freedom and—yes—some degree of privacy. Oh, the hand wringers are totally right about the problem and the danger presented by surveillance tech! And they are diametrically wrong in the common prescription. Trying to ban technologies and create shadows

for citizens to hide within is spectacularly wrongheaded and disastrous. See my book *The Transparent Society: Will Technology Make Us Choose Between Privacy and Freedom?*

The ethical issue

Will AI mostly be used in ethical or questionable ways in the next decade? Isaac Asimov in his Robots Series conceived a future when ethical matters would be foremost in the minds of designers of AI brains—not for reasons of judiciousness but in order to quell the fears of an anxious public. No such desperate anxiety about AI seems to surge across today’s populace, perhaps because we are seeing our AI advances mostly on screens and such, not in clanking mechanical men.

Oh, there are serious conferences on this topic. I’ve participated in many. Alas, statements urging ethical consideration in AI development are at best palliatives. I am often an outlier, proposing that AIs’ “ethical behavior” be promoted the way it is in

most humans, especially most males—via *accountability*. If AIs are many and diverse and reciprocally competitive, then it will be in their interest to keep an eye on each other and report bad things, because doing so will be to their advantage. It is a simple recourse, alas one seldom even discussed.

Will quantum computing make IA empathetic?

Quantum computing has genuine potential. Roger Penrose (recently awarded the Nobel Prize) and associates believe it already takes place, in trillions of sub-cellular units inside human neurons. If so, it may take a while to build quantum computers on that kind of scale. The ethical matter is interesting, though totally science fictional, that quantum computers might connect in ways that promote reciprocal understanding and empathy.

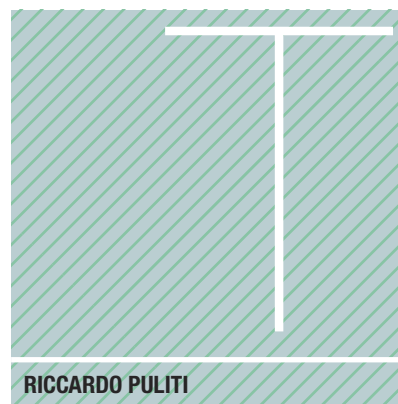




Economy/The importance of an immediate and collective action

Sparking a Green Recovery in

Mobilization of capital, optimization of technologies and the creation of favorable conditions for private sector investments will be essential for the recovery phase, especially in countries with limited tax margins and poor access to energy



RICCARDO PULITI

He joined the World Bank Group as Senior Director, Head of the Energy and Extractives Global Practice in November 2016. On 1st July 2020 Puliti has been appointed Regional Director and assumed responsibility for all operations in energy and infrastructures in Africa.

The coronavirus has unleashed the greatest global disruption in generations. The pandemic represents a deep and enduring human crisis, with reverberating impact on lives and livelihoods across the entire world. Coping with the crisis reminds us of the critical role that energy plays in our daily life and in our response to hardship. Reliable energy services lie at the core of preventing and fighting COVID-19 by powering healthcare facilities, supplying clean water for essential hygiene, and providing sufficient refrigeration for the maintenance of food and medicine. These services are also critical to power the digital infrastructure needed to fight the spread of the pandemic, cope with social distancing measures and ensure service continuity for the government and essen-



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Developing Countries

tial businesses. While many of us rely on access to electricity to connect virtually and continue to work, such access and options are not available in many parts of the world; nearly 790 million people live without access to electricity, mostly in Africa and South Asia. The interconnected nature of an effective health response explains our interest in a well-functioning energy sector and reliable access in even the most remote corners of the world.

In addition to its visceral impact on health and survival, the pandemic is also a historic political and economic turning point. COVID-19 severely impacts the energy landscape by causing supply and demand shocks across the sector, rattling commodity markets and threatening the viability of public utilities and private sector suppliers. Maintaining the

sector's viability will be important during the immediate crisis, but also for economic recovery, building resilience against future shocks and eventually achieving universal access. The policy decisions and investments that are taken in response to the immediate crisis will have a major impact on the trajectory of the energy economy in subsequent decades, particularly in terms of locking in lower-carbon pathways to growth.

Peril in the energy sector: Supplier impacts and commodity price fluctuations

The effects of COVID-19 on the energy economy in developing countries are dramatic. In April, the International Energy Agency (IEA) estimated that countries in full lockdown experienced an average 25 percent decline in energy demand, with elec-

tricity consumption patterns making every day look like Sunday. Activity slowed substantially in transport, trade, and commerce, and the deep reductions in energy consumption caused knock-on payment crises from customers to service providers, utilities, generators and governments. The slowdown also impacted both supply and demand in global commodity markets, and the effects are likely to persist for months to come. New investments in energy and extractive projects were delayed, suspended or cancelled, while existing operations have been confronted with new challenges to logistics, supply chains and personnel management.

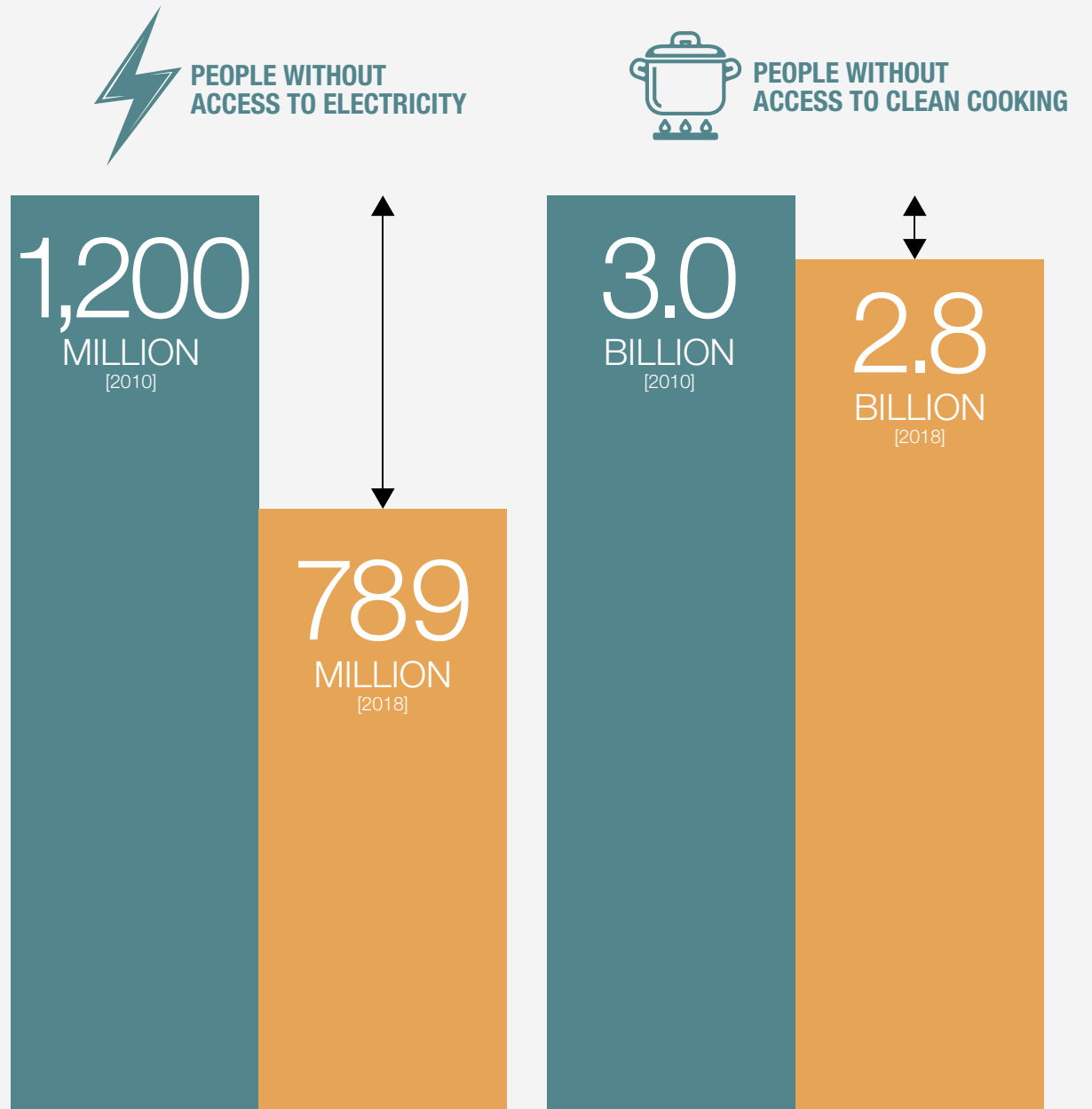
Overall prices for industrial commodities like copper, zinc, and other metals are expected to fall this year, but the effects have been most dra-

matic for commodities related to transportation. Oil prices have plunged since January and reached a historic low in April, with some benchmarks trading at negative levels. Declines reflect a sharp drop in demand and have been exacerbated by uncertainty around production levels among major oil producers. Oil demand is expected to fall by an unprecedented 9.3 million barrels per day this year from the 2019 level of 100 million barrels per day. Energy prices generally, including both natural gas and coal, are expected to average 40 percent lower in 2020 than in 2019—although a sizeable rebound is anticipated next year. These major disruptions to the extractive industry across the world are especially difficult for developing countries that lack essential fiscal revenues, forcing resource-dependent coun- →

Energy priorities in the wake of COVID-19

COVID-19 is intensifying the urgency to promote sustainable energy solutions around the world. As can be seen in the graph—taken from the latest Tracking SDG 7: The Energy Progress Report published by the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank and the World Health Organization (WHO)—significant progress was made in the various energy aspects related to Sustainable Development Goal (SDG) 7 (“Ensure access to affordable, reliable, sustainable and modern energy for all”) before the start of the crisis linked to COVID-19: a significant reduction in the number of people around the world without access to electricity, a significant spread of renewable energy for electricity generation and energy efficiency improvements. Despite these advances, the global efforts made in recent years remain insufficient to achieve the key goals of SDG 7 by 2030. And now, with the pandemic and the resulting global financial crisis, the fear is that the results achieved so far will be lost.

↑ Difference
 ■ Latest year ■ 2010



tries to assess and cope with the budgetary implications of commodity prices over the short and medium term.

Across regions at various stages of lockdown, the ongoing impact is uneven and dynamic, with consumer demand returning as restrictions are eased. In June, electricity demand (weather corrected) was still 10 percent below pre-crisis levels in most countries. While many countries reopened, successive waves of the pandemic threaten to return some jurisdictions to full lockdown. Overall, it is expected that the impact on energy demand in 2020 will be seven times greater than that of the 2008 financial crisis.

In the power sector, those demand shocks have led to liquidity crunches among both public utilities and off-grid electricity providers. Utilities are suffering from a sudden drop in sales to the most profitable industrial and commercial consumers (which can account for as much as 70 percent of revenues), as well as an affordability crisis among residential con-

sumers facing unemployment and declining income. The result is the significant deterioration of the financial positions of power utilities across developing countries and potential bankruptcies. Utilities in developing countries are already under fiscal strain and may struggle to provide basic services or pay their own bills. If utilities are unable to fulfill purchasing contracts and default on payments, independent generators (which account for 40 percent of power in sub-Saharan Africa) are jeopardized in turn. Indeed, liquidity shortages can rapidly become a solvency issue both for public and private electricity providers, with negative fiscal impacts on the states that are forced to step in. The ultimate pressure on governments to fill the gaps comes just as public revenue is falling, particularly among oil, gas and mineral exporters that face low commodity prices.

Utilities and grid-connected generators are not the only ones in trouble. In less developed regions, off-grid and mini-grid providers are particularly

important for energy access, including at critical healthcare facilities. But some mini-grid and off-grid companies will struggle to survive the triple shock being dealt by the pandemic—they are unable to subscribe new customers due to lockdown; they face defaults from existing customers; and supply chain disruptions affect importation, inventory and in-country logistics. An April SEforALL questionnaire found that solar-home-system companies expected a 27 percent decline in revenues and mini-grid companies almost 40 percent. Most of these companies had less than two months of available OPEX. In places like Africa that are still confronting the challenge of widening energy access, maintaining the solvency of private sector off-grid electricity providers is critical. A viable off-grid sector is key to keeping the lights on and also to growing the pie of sustainable energy access. Without them, many communities will rely on diesel generators that depend on an expensive and often unreliable fuel supply.

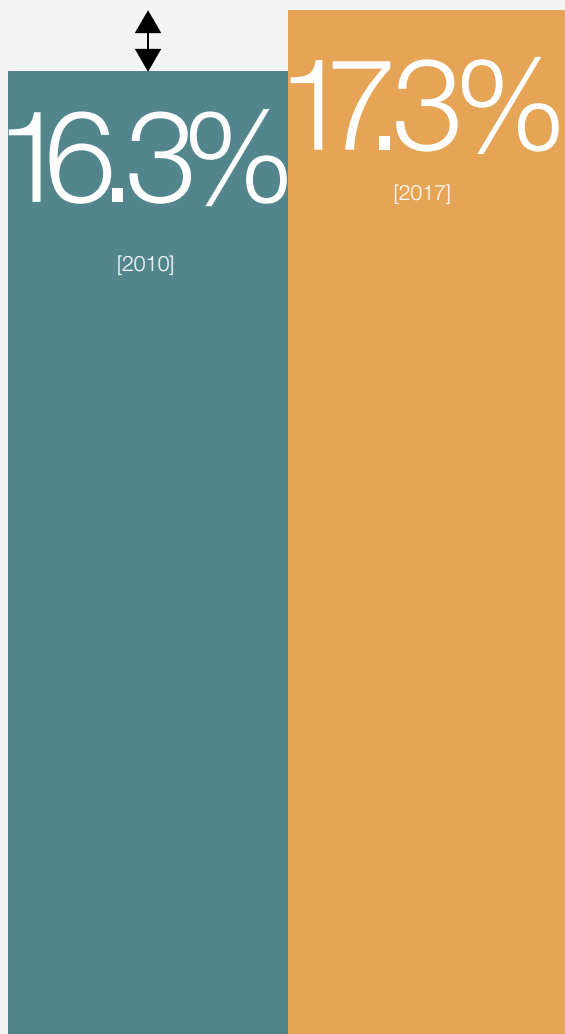
Supporting incumbents to avoid backsliding

If these issues are not properly and swiftly addressed, they can ultimately pare back sustainability gains in the domestic energy sector and reverse critical economic reforms. The effect would be to undermine a decade of progress toward open competitiveness, energy security, affordability and decarbonization. They also threaten the sector’s future trajectory, as planned energy investments are affected both by expected demand falls and the difficulty of raising equity in the current environment.

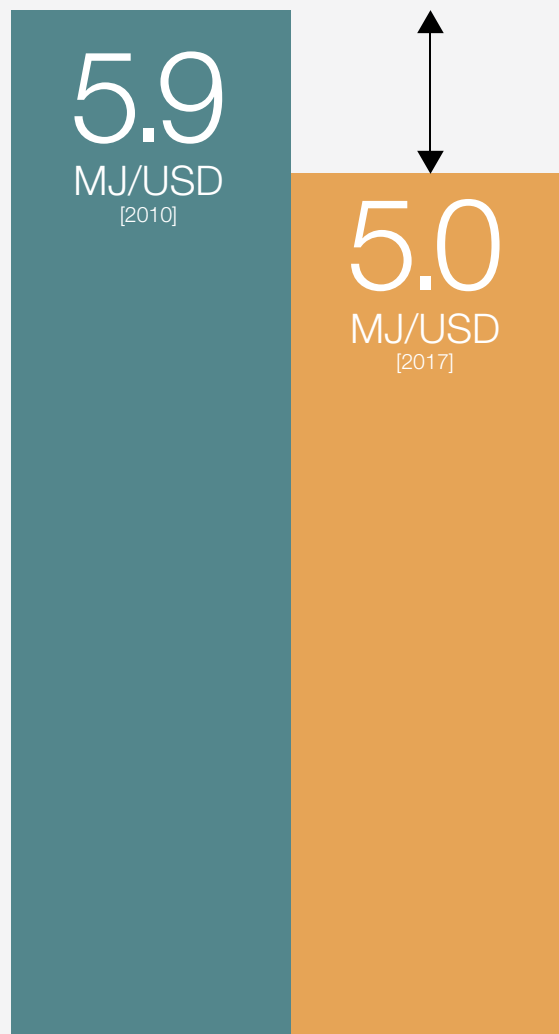
Immediate and collective action is needed to maintain the power sector’s viability, both in the context of the current crisis and the economic recovery to follow. Governments should fast track electricity connectivity to ensure business continuity of key government functions, especially health service delivery during the pandemic. Emergency financial support to both utilities and off-grid producers will also be necessary to ensure continuity of essential services



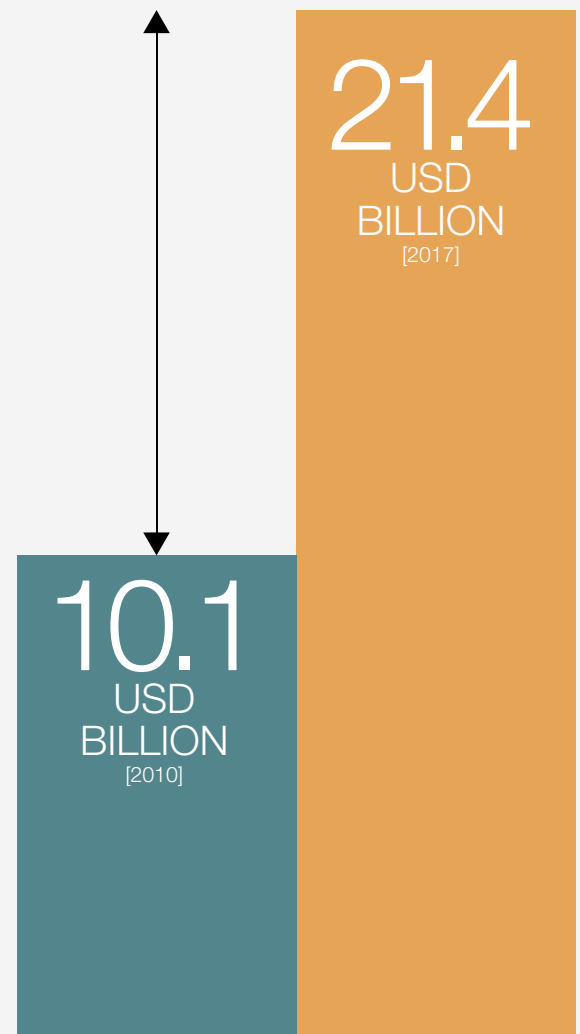
SHARE OF TOTAL FINAL ENERGY CONSUMPTION FROM RENEWABLES



PRIMARY ENERGY INTENSITY



INTERNATIONAL FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN ENERGY



and make sure that frontline workers can continue to lift their heavy burden during the crisis. It is crucial to fund contracts with local private sector producers (particularly small mini-grid and solar-home-systems) to deliver quality and reliable electricity in areas not connected to the main grid if those companies are to be kept solvent.

In the absence of long-term planning and effective policy, unreliability or service cut-offs will often be addressed by expensive and dirty rental power providers. Particularly in landlocked developing countries with weak institutional oversight and patchy exposure to energy supply chains, a flourishing temporary power generation and power rental market burns either diesel (at small scale) or heavy fuel oil (in larger plants) to deliver exorbitant electricity to some of the poorest consumers. Sector planning is a critical element for meeting growing demand in a coherent and sustainable manner, and it becomes especially important to adhere to positive and hard-won tra-

jectories in the face of major disruptions.

Successes achieved through several years of reform should be maintained, so that efforts towards a decarbonization of the economy can be sustained and quickly accelerated. In the longer term, the impacts of the pandemic are expected to reverberate, and it will be important to support investment in the clean energy transition as we emerge from the crisis. Depending on the fiscal space available to countries, investments contributing to clean energy and universal access goals represent a valuable proposition, particularly when they help create jobs and alleviate poverty.

For example, supporting labor-intensive energy investment programs, such as rural electrification or energy efficiency upgrades that could simultaneously contribute to fiscal stimulus and advance universal access goals while boosting employment is a no brainer. Another way to stimulate investment in clean energy would be to replace aging fuel

plants with renewable-plus-battery combinations, which can be packaged with concessional debt or debt guarantees.

At the same time, direct support to utility-scale renewable energy projects is unlikely to be the most effective way to spend stimulus money, particularly as cost curves make them increasingly attractive to private sector investors under the right conditions. Instead, addressing structural issues such as interconnections, storage, smart charging and demand response technologies to compete in the flexibility markets—as well as accelerating the electrification of heating, transport and industry—will be crucial to stimulating investment.

Enabling clean energy also means ensuring the supply of critical resources, yet the crises associated with COVID-19 could represent a risk to sustainable mining for the many minerals and metals used in renewable energy technologies. As economies start to reopen, governments and companies will need to strengthen their commitment to cli-

mate-smart mining principles and mitigate negative impacts, including through the increased deployment of renewables in the mining sector itself. In both the renewable energy sector and those that support it, there is a need for enhanced international cooperation that includes stronger public and private engagement in order to drive increased financial flow to those most in need.

Enabling the private sector to lead the recovery

With public sector funding stretched, the role of the private sector becomes increasingly important.

In recent years, private sector investment in developing countries has grown rapidly, thanks to new financing mechanisms as well as meaningful progress on policy and institutional reform. Fostering private participation by nurturing enabling conditions and creating attractive investment opportunities has played a major role in addressing near-term development needs such as energy access, infrastructure and public trans- →



port and has also supported the longer-term financial viability of low-carbon projects.

However, with the onset of the pandemic, the move of capital toward less risky markets has limited the availability of private sector financing in developing countries. In late April, Devex reported nearly USD 100 billion in private investment retreating from Africa. In the world of highly constrained public budgets that will persist for years after the heavy toll of COVID-19 emergency spending, it is crucially important to retain existing investors as a first step to attracting new ones. Yet retaining the private sector in higher-risk countries poses a challenge when global uncertainty feeds the temptation to revert to safer havens. Adjusting incentives and risk sharing will be key to maintaining private capital for innovation and effective management. The World Bank is working to bridge

the gap between governments and the private sector, helping to maintain payment schedules or, where necessary, to restructure deals to accommodate exceptional circumstances. The aim is to avert a downward spiral of defaults, legal disputes over credit and further inability to service debt. In some cases, that means providing necessary liquidity by extending concessions or access to new credit in order to alleviate the near-term pressure on public entities struggling to provide service to populations under crisis conditions. For example, in Guinea-Bissau the World Bank Group restructured a regional access project for USD 6 million to enable the Government to pay arrears and fuel, thus allowing the utility to cover its costs and avoid power cut-offs by the sole independent power producer.

However, support also entails fostering dialogue between the parties to

promote rational flexibility, so that lending arrangements can survive the discrete shock of COVID-19 and ultimately deliver better outcomes for both borrower and creditor. Every possible action should be taken to avoid defaults and the emergence of costly legal claims due to force majeure clauses. Costly disputes between public utilities and suppliers ultimately serve little purpose beyond ruining the credit rating of the state-owned entity or even the sovereign, and finally hindering the long-term return to investors on generation assets.

While short term mismatches may be resolved through dialogue and some supplementary liquidity, the most important component to maintaining investor confidence is still a strong commitment to sector reform and a conducive enabling environment. Engaging the private sector as a financier, operator, service provider or

innovator in the pursuit of Sustainable Development Goals requires efficiently functioning and competitive markets, as well as effective governments. Such markets only emerge when there is a framework that addresses market failures through policy reform, and also improves underperforming markets through demonstration effects—enhancing competition, innovation, integration and better skills through investments and advisory services.

That is why, in conjunction with concessionary financing, the World Bank also helps to provide enabling conditions such as sector reforms, regional trade, planning, regulatory transparency and demand creation through income-generating appliances. Such enabling conditions should address affordability, inclusion and poverty reduction.

The necessary market-driven reforms to de-risk the energy sector re-



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quire a forward-looking vision that recognizes the increasing attractiveness to capital of resilience, sustainability, social stability and thoughtful governance. Getting the generation mix right in terms of affordability and sustainability, while ensuring energy security and reliable service delivery, is a critical factor. That mix is increasingly tilted towards renewable energy, and requires significant investments in network technologies, grid management and storage to manage variability and integrate renewable energy at scale.

Supporting private investment in green development

Investment opportunities at the intersection of energy and development are immense. Before the COVID-19 outbreak, the World Bank estimated that the off-grid solar energy industry presented a USD 1.7 billion an-

nual market and would have to grow at an accelerated rate of 13 percent to reach the goal of universal energy access by 2030. This meant that up to USD 7.7 billion in private investment and up to USD 3.4 billion in public funding would be required to bridge the affordability gap.

Although falling renewable energy technology costs have significantly lowered the capital needed to invest in new systems, and even if renewable energy represents the cheapest option for 2/3 of the global population, financing renewable energy projects is still difficult in many parts of the world. Underlying market barriers and a perception of high risk constrain the development and financing of renewable energy projects. Identifying attractive projects and gaining access to capital often presents a major hurdle to realizing renewable energy investments. Project risk can take multiple forms. These include polit-

HURDLES TO INVESTMENTS

Underlying market barriers and a perception of high risk constrain the development and financing of renewable energy projects. Identifying attractive projects and gaining access to capital often presents a major hurdle to realizing renewable energy investments.

ical and regulatory risk; counterparty, grid and transmission link risk; currency, liquidity and refinancing risk; as well as resource risk.

Policy makers, financial institutions and investors can draw from a strong toolkit to help overcome such barriers, mitigate investment risk, and improve access to capital for renewables projects. Development finance institutions (DFIs) such as the World Bank can help countries implement enabling policies for stable and predictable investment environments and ensure predictable project revenue streams. Technical assistance and grant funding can be critical early on in the project lifecycle when preparing the ground for investment. We can also foster project development and strengthen documentation with the Energy Sector Management Assistance Program (ESMAP). Targeted non-financial interventions can play a facilitating role and help take projects forward to full investment maturity.

While non-financial interventions can create better enabling conditions for private investment, commercial banks and development finance institutions can also provide critical support with the long-term financing necessary for infrastructure (due to particularly enduring liabilities), as well as effective risk mitigation instruments. These include guarantees, currency hedging instruments and liquidity reserve facilities. Debt-based instruments, such as on-lending and co-lending structures, can help local finance institutions overcome key barriers, including limited access to capital and weak experience in lending to renewable energy projects.

Credit enhancement instruments can play an important role in de-risking projects and making them replicable. Credit enhancements aim to mitigate the specific risks of a project that ei-

ther weigh on its overall credit profile or decrease its appeal to the private sector. They can take various forms. Cash flow stabilization can prevent or delay potential distress and default; recovery enhancement can reduce losses in the event of default. Combined instruments provide both. Credit substitution is a guarantee that serves to fully transfer the risk of timely debt repayments from the project finance issuer to a guarantee provider. Partial guarantees for recovery can be an attractive feature for investors as they give enhanced visibility on recovery, while the experience and influence of a multilateral lending institution can be another significant draw. This is sometimes referred to as “the halo effect.”

The World Bank’s Mobilizing Finance for Development (MFD) strategy aims to deliver infrastructure projects by reducing the reliance on public funds (i.e., taxpayers’ money) and mobilizing greater amounts of commercial financing. One key metric of success is the MFD multiplier, defined as the ratio of commercial finance to public funds in the context of infrastructure finance.

To significantly scale up investment capital, renewable energy projects must become more accessible to mainstream investors. Structured finance can help increase investment volumes by reducing due diligence costs. Standardization of project documents and aggregation are important mechanisms allowing smaller projects to be pooled together. These mechanisms can also help securitize renewable energy assets for the purpose of trading in capital markets.

A functional sector for greener growth

To build resilient, equitable and sustainable economies in a post COVID-19 world, sustainable energy must be placed at the heart of economic stimulus and recovery measures. Mobilizing capital, optimizing technologies and adopting the enabling conditions for private sector investment will be crucial to the recovery phase, particularly in countries with limited fiscal headroom and existing energy access shortfalls. DFIs such as the World Bank can support with technical assistance as well as credit instruments that are important to de-risking particular projects.

However, the real de-risking must be a functional energy sector that is underpinned by efficient markets, dependable institutions and ongoing reform. Protecting progress to date, and establishing the right path forward, can ensure greener growth and a healthy recovery as the world emerges from this pivotal moment.



Response/Secretary General and CEO of WEC, Angela Wilkinson

Humanizing Energy

In many ways, the disruption to our normal lives caused by the global health crisis provided a glimpse of a better energy future. The World Energy Council’s agenda is inspired by a vision of the energy transition that puts its humanization at the forefront



ANGELA WILKINSON

Secretary General and CEO of the World Energy Council, she is one of the world’s leading global energy experts, an experienced energy executive and a published author. Angela Wilkinson has 30 years of experience in leading national, international and global multi-stakeholder transformation initiatives on a wide range of economic, energy, climate and sustainable development related challenges.

The world is in the midst of an existential crisis. As the COVID-19 pandemic swept across international borders, it had devastating impacts on human health, the world economy and energy systems all at once. Pre-conceptions and conventional wisdom have been thrown into doubt and our future vision is obscured by a fog of uncertainty. Is it still possible to see a brighter energy future? I believe it is if we work together to prepare post-crisis strategies that make more room for “greener” and cleaner energy pathways and incorporate the human cost of transition.

Since the start of the pandemic, the World Energy Council has been surveying its members drawn from more than 3,000 organizations around the world to see how energy leaders and businesses are managing the crisis and to share their expectations for the future. Our surveys indicate that the pandemic has impacted all energy industries and businesses, but with highly uneven effects.

COVID-19 offers a glimpse of a better energy future

In many ways, the disruption to our normal lives caused by the global health crisis provided a glimpse of a



better energy future. As roughly half the global population went into partial or total lockdown, the air was purer and waters ran blue as a large percentage of the workforce shifted from offices to homes, turning cities into spaces free from congestion and urban pollution, as road transport came to a virtual halt and aircraft were grounded.

We can seize the moment while

memories are still fresh to prevent a return to pre-COVID business-as-usual. We can build resilient societies and overhaul outdated economic systems and ensure that the global energy transition is not derailed by geopolitical and trade disputes and inward-looking national policies. When our 24th World Energy Congress was held in October 2019, it brought together 15,000 energy



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leaders, decision makers and experts from all sectors around the world. The discussions highlighted the risk of fragmentation and the need to address social and financial risks in accelerating the pace of transition. Ten months on, the world is reeling from the effects of COVID-19. The closure of shops, businesses and factories has resulted in massive job losses, bankruptcies and fiscal stresses.

Whether this crisis will lead to transformational actions is not yet clear. The responses to our surveys have enabled us to identify four alternative post-crisis scenarios, with a time horizon of 3-5 years. We are using this set of scenarios as a radar to detect and decode signals of change from around the world. We are also developing a scenario-based serious gaming platform that can be used to stress test and

design post-crisis strategies and make a contribution to the recovery efforts being considered by governments, energy companies and utilities.

No single pathway and no short cuts

There is no single pathway to net zero and all technologies, fuel sources and abatement measures will be needed if the targets are to be attained

by 2050. The drive to decarbonize must also take into account demand growth and societal affordability. It not possible to turn the global energy system around overnight. To move from 20 percent of the world's energy system that runs on electrical power to a 100 percent net zero carbon economy by 2050 is highly ambitious. To imagine this can be done without the use of more energy or →

More investments in digital technology

In the energy sector, COVID-19 is encouraging a reallocation of investments to digital transformation. A recent WEC survey involving energy leaders and experts from over 100 countries found that around 85 percent of companies plan to shift their investments towards digitalization, research and development, strengthening environmental, social and governance policies at the same time.

Smart working, which became necessary during the lockdown period, has contributed significantly to accelerating digitalization.

For companies, the crisis was also an opportunity to examine past strategies and lessons learned, evaluate the responses of others, and build resilience for the future. The graph shows the answers given to the survey question “How is your organization reallocating investments in order to prioritize the key functions of the company?”

with only renewable power and battery storage is pure fantasy.

While it is true that renewable energy sources grew their share of electricity generation during lockdown, total reliance on intermittent solar and wind would not have kept the lights on everywhere, nor provided sufficient heat, cooling, fuel or power to restart whole economies. The need for a broader resilience also came into sharp relief during lockdown. Electricity companies had to balance systems to cope with surging demand from households while industrial use declined, and all energy organizations had to manage people and supply chains, not just the flow of electrons or stocks of fuel.

The World Energy Council’s recently published Innovation Insights Brief on the role of transmission companies shows a growing trend to invest in enhancing system security and resilience as well as prepare for a more digital world. Until we find flexible, affordable and sustainable storage solutions, there can be no globally imposed exclusion on the use of existing energy technologies, so long as new solutions enable the overall carbon footprint to be reduced to levels that are compatible with the goal of climate neutrality by 2050.

With many expecting the worst is yet to come as economies around the world start to return to some kind of normal, attention in the energy sector has turned to balancing the needs of survival and recovery. So how should we plan for what’s next, and possibly the worst?

COVID-19 has magnified pre-existing stresses

The World Energy Council promotes a multi-dimensional approach which uses the “Energy Trilemma” framework to assess and rank the performance of a country on energy security, energy equity and environmental sustainability. It is difficult to get the balance right, especially considering the negative impacts of energy poverty in Africa, where hunger, poor sanitation and indoor pollution are leading causes of premature deaths. This crisis has magnified pre-existing stresses—from economic recession and climate change to deeper social inequality. It has come at a time when leadership mindsets are shifting to the

customer centric energy future, as value creation moves closer to the end-user. Corporate announcements across the spectrum point to expectations that the pandemic will stall demand for oil and gas for a prolonged period and hasten the shift towards cleaner power and fuels. Meanwhile, power sector executives highlight the fact that the crisis is accelerating digitalization opportunities and presenting challenges of resilience—for people and value chains, as well as cyber security.

Historic reallocation of capital

COVID-19 is also driving a historic reallocation of investment in energy systems. Responses to our survey from energy leaders and experts in more than 100 countries show that up to 80 percent plan to shift investments to digitalization, research and development while strengthening environmental, social and governance policies. Around 20 percent are considering more ambitious climate policies. To prepare a better exit from this pandemic we also need to ask: How and what does this fundamentally human health crisis teach us about the need to put humanity at the center of the global energy transition debates? Nearly 40 percent of respondents in our latest survey expect a “new normal” for energy systems, up from 15 percent a month earlier, but they have diverging views on what “new” looks like. More than 60 percent expect behavioral shifts and over 50 percent expect changes in social norms.

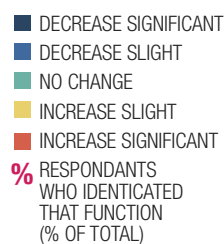
As we emerge from crisis, we must anticipate the “tsunami” of pent-up energy demand that may hit post crisis. The doubling of global energy demand by 2040 will fundamentally reshape an energy landscape that is ill prepared due to inadequate investment, largely because of previous volatility and crises, and exacerbated by COVID-19. According to our calculations, energy investment is set to fall by between \$200 and \$400 billion in 2020, putting at risk 350,000 jobs in the energy sectors of the G7 economies.

Inadequate access to energy, the circular economy and the Energy Transition

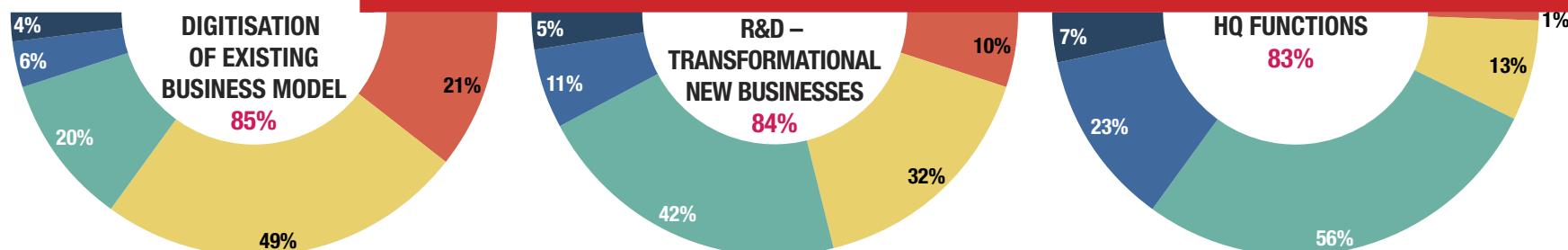
When we talk about accelerating clean, affordable and reliable energy transition, particularly in a post-crisis



era, we need to think about demand-side economics as part of the “new normal.” We can’t keep overlooking the problem of inadequate energy access everywhere—in addition to the lack of basic access to any modern energy source that affects more than 850 million people in non-OECD countries. We also need to reconnect price with value and cost to society: climate neutrality, which is not the same as an ideological war on carbon, opens up new solutions including a clean hydrogen vector, sector coupling and carbon removal technologies. Carbon Capture Utilization and Storage offers a decarbonization solution and, if deployed across energy and energy-intensive industries, could take us closer to a circular carbon economy, where carbon dioxide is removed, recycled and reused. Energy transition does not mean the end of oil but it does mean more responsible management of fossil fuels to reduce their impact on the environment. New pathways ex-



Source: WEC





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TECHNOLOGY IS THE PRIORITY FOR COMPANIES

Energy industry executives point out that the crisis is accelerating opportunities for digitalization. The Innovation Insights Brief published by the World Energy Council highlights that there is a growing trend for energy distribution companies to invest in improving the security and resilience of systems, as well as preparing for a more digital world.

In the photo, a girl uses a touch screen in Shanghai.

ist. Some fossil fuel infrastructure can be repurposed to carry net zero carbon fuels like clean hydrogen-based fuels, while depleted oil and gas fields offer space for storage.

Energy transition does not mean a future of only renewable power. Emerging from crisis there will be even greater attention to issues of affordability, social responsibility and environmental sustainability.

A big question facing the global energy industry is “how to” ensure its responses to and strategies for emerging from the pandemic can meet new and shifting energy demand, whilst advancing ambitions for climate neutrality.

Estimates suggest greenhouse gas emissions fell by between 8 and 9 percent as a result of the lockdown measures. Yet to achieve climate neutrality by 2050, that reduction would need to be sustained every year for 30 years. Of course, no society can stop breathing to save oxygen!

Similarly, the need to kick start globally competitive economies is redirecting attention to the energy investment gap and fueling the risk of more extreme polarization, e.g., clean vs. green energy, renewables vs. gas.

The notion of “humanizing” the energy transition has come of age

The technologies available for accelerating global energy transition and securing clean, affordable, reliable energy for all are the same as those that existed before the crisis. What has really changed—and could be the new force for change—is the social energy agenda. Issues of affordability, societal cost and acceptability and social license to operate are set to challenge all energy transition players. In effect, our humanizing energy transition vision agenda has come of age and reflects:

1 | The opportunity for whole societies to move faster and further to-

gether by engaging those impacted by energy transition in designing and managing the process;

2 | The increasing gap within countries in quality energy access, despite progress in closing the global gap on basic access;

3 | A new context of affordability and the need to reconnect price and cost and ensure adequate infrastructure investment planning—not just new build, also decommissioning and repurposing where it makes sense;

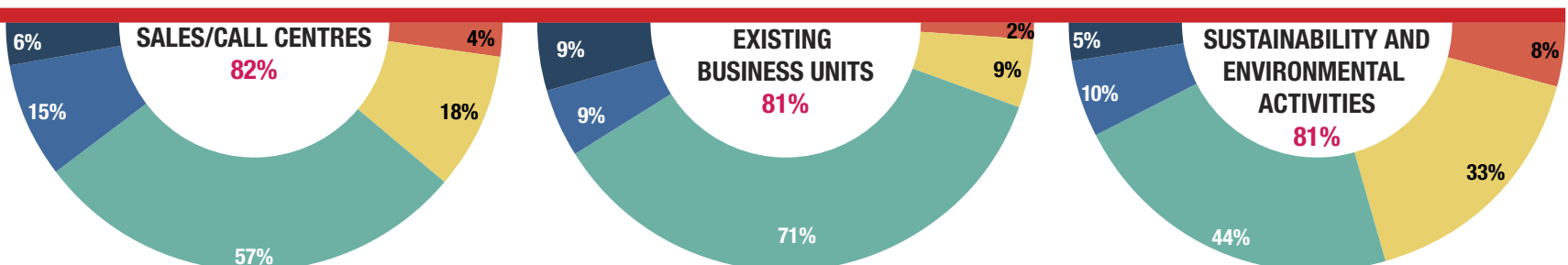
4 | The migration of value creation towards the end-user, the rise of digitally empowered prosumers and renewable communities and new demand for energy-plus services;

5 | New challenges for energy and power firms of all shapes and sizes in maintaining their social license to operate, recognizing also that no energy technology can assume social acceptability.

Now is the time to remember why the

World Energy Council was founded in 1923 as a community of energy expertise and practice and our responsibility to step forward as an inclusive and pragmatic community open to all. We are the modern equivalent of the cathedral builders of old. As architects of new energy futures, we are focused on the “how to” rather than “should do” of energy transition inspired by earthly dreams of better energy for all. We are open to learning by doing, by sharing experiences and through dialogue. Even at the regional level we work together with an agile approach to connect different societies, energy needs and solutions.

United in diversity, our community has pulled together in a time of crisis to provide practical insights and a value-added voice. Looking to the future we are well placed to make a valuable contribution to a human-centric Energy Transition agenda.



Renewables/IRENA's Director-General weighs in

It's Time to Make Strategic Choices

Our response to two crises—
COVID-19 and climate
change—must be mutually
reinforcing



It

is time to build a global energy system that is fit for the future. By making strategic investments and policy choices that focus on transitions to renewables, efficiency and greater electrification, we can strengthen the economic recovery, bolster sustainable development and set the course for a fully decarbonized system by the middle of this century.

FRANCESCO LA CAMERA

He is the Director-General of the International Renewable Energy Agency (IRENA). He has more than thirty years of experience in the fields of climate, sustainability, and international cooperation. He formerly served as Director-General of Sustainable Development, Environmental Damage, EU and International Affairs at the Italian Ministry of Environment.

While COVID-19 may be the most urgent threat today, we cannot forget that climate change remains the biggest threat facing humanity over the long term.

Our response to the two crises must be mutually reinforcing. Linking the short-term economic recovery to medium and long-term strategies is paramount to stimulate our economies and get people back to work—while simultaneously aligning →

FIGURE 1
ENERGY
TRANSITION
INVESTMENTS

The investments needed to support clean energy are expected to amount to approximately USD 2 trillion a year for the next three years, according to the IRENA Transforming Energy Scenario (TES). The biggest share of the investment would relate to energy efficiency.

Source: data processed by IRENA (2020), "Global Renewables Outlook: Energy Transformation 2050"

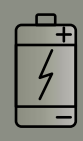
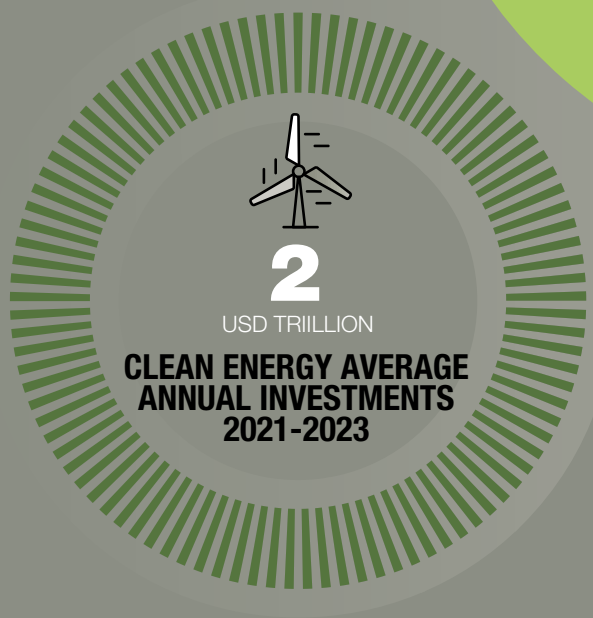
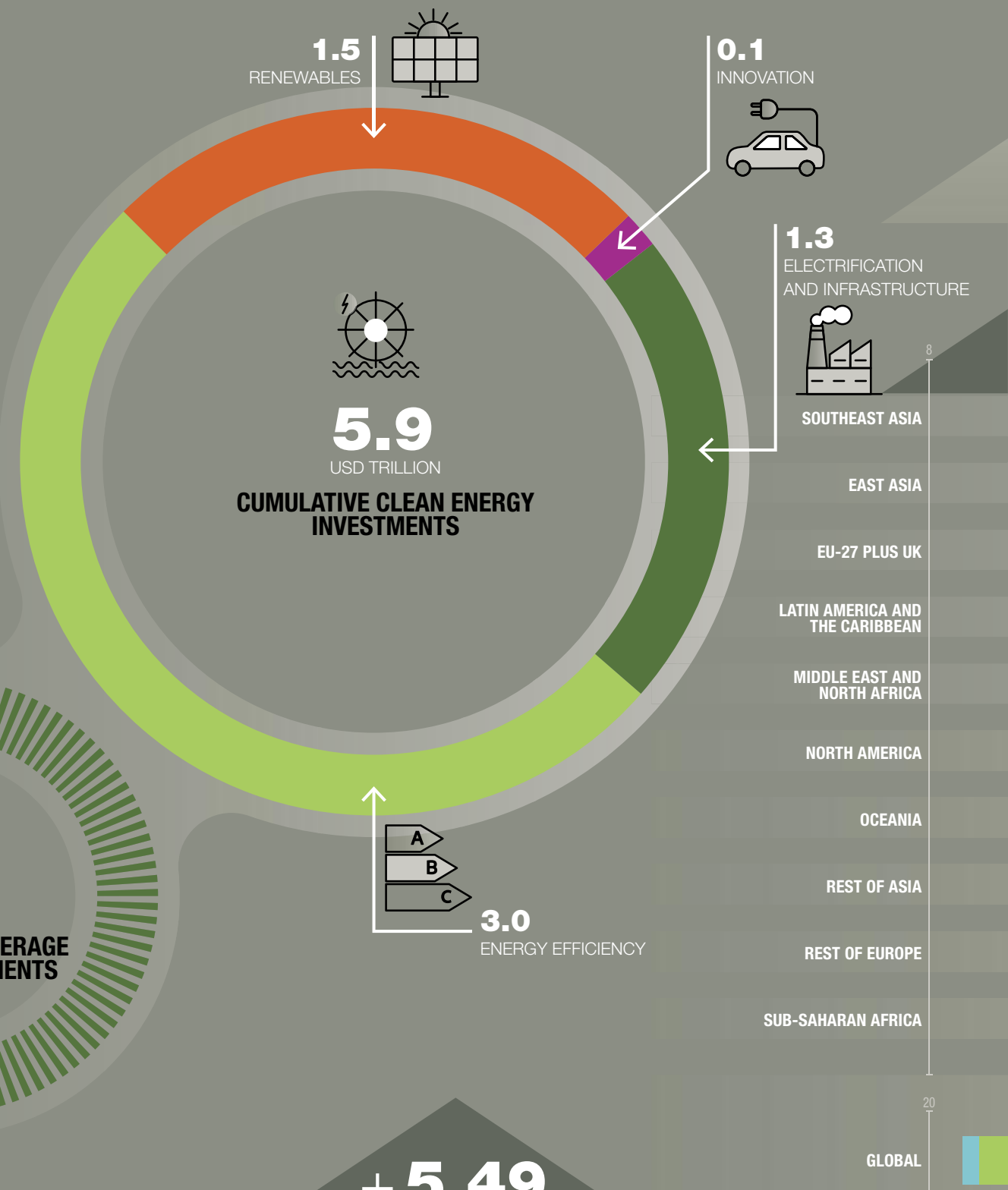
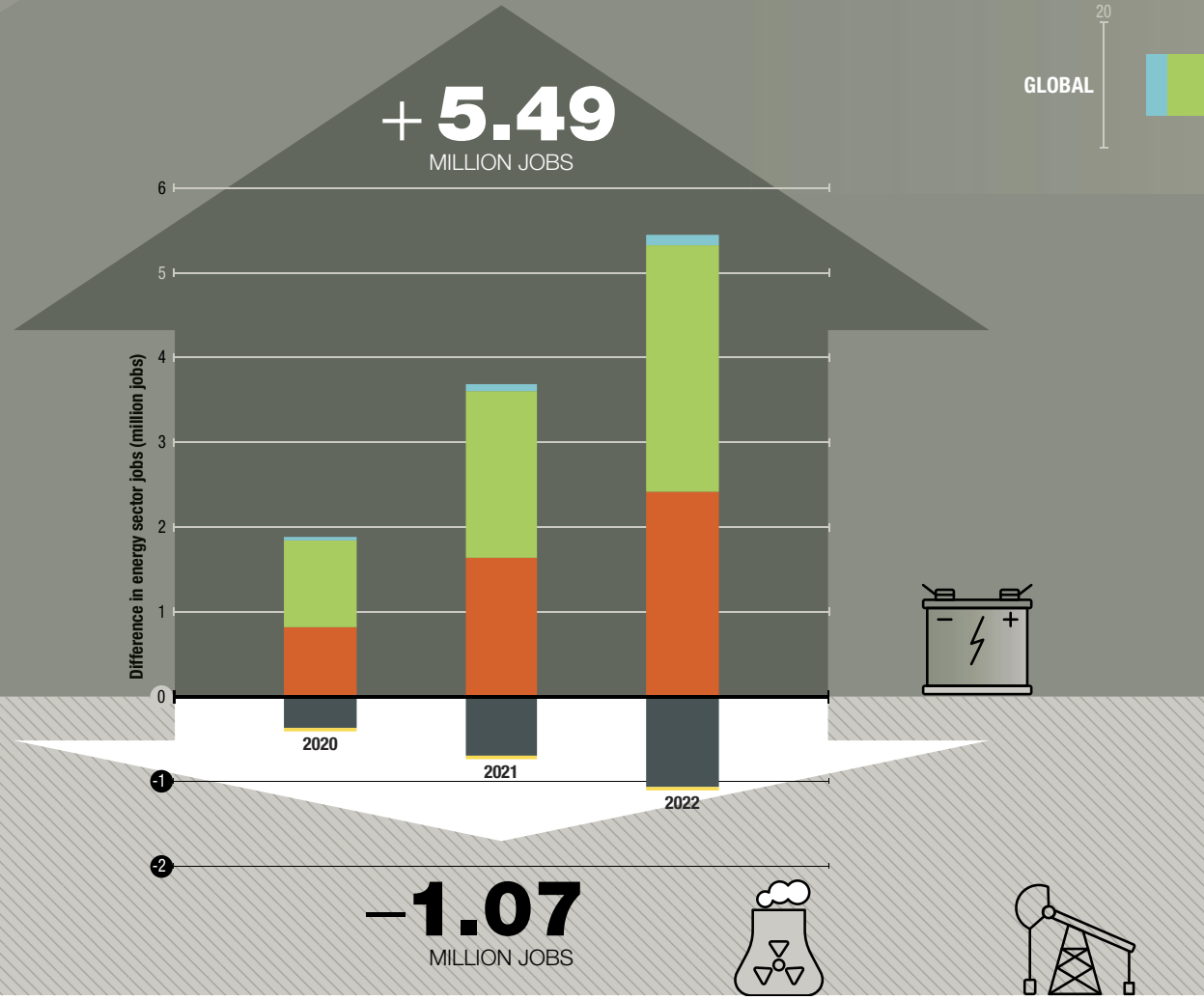


FIGURE 2
IMMEDIATE
EMPLOYMENT
AND GDP BENEFITS

With an immediate investment of USD 2 trillion in the energy transition, as predicted by the Transforming Energy Scenario (TES), by 2023 a further 5.5 million jobs would be created. This would lead to an average annual GDP growth of 1 percent in the years 2020-2023, compared to the Planned Energy Scenario (PES).

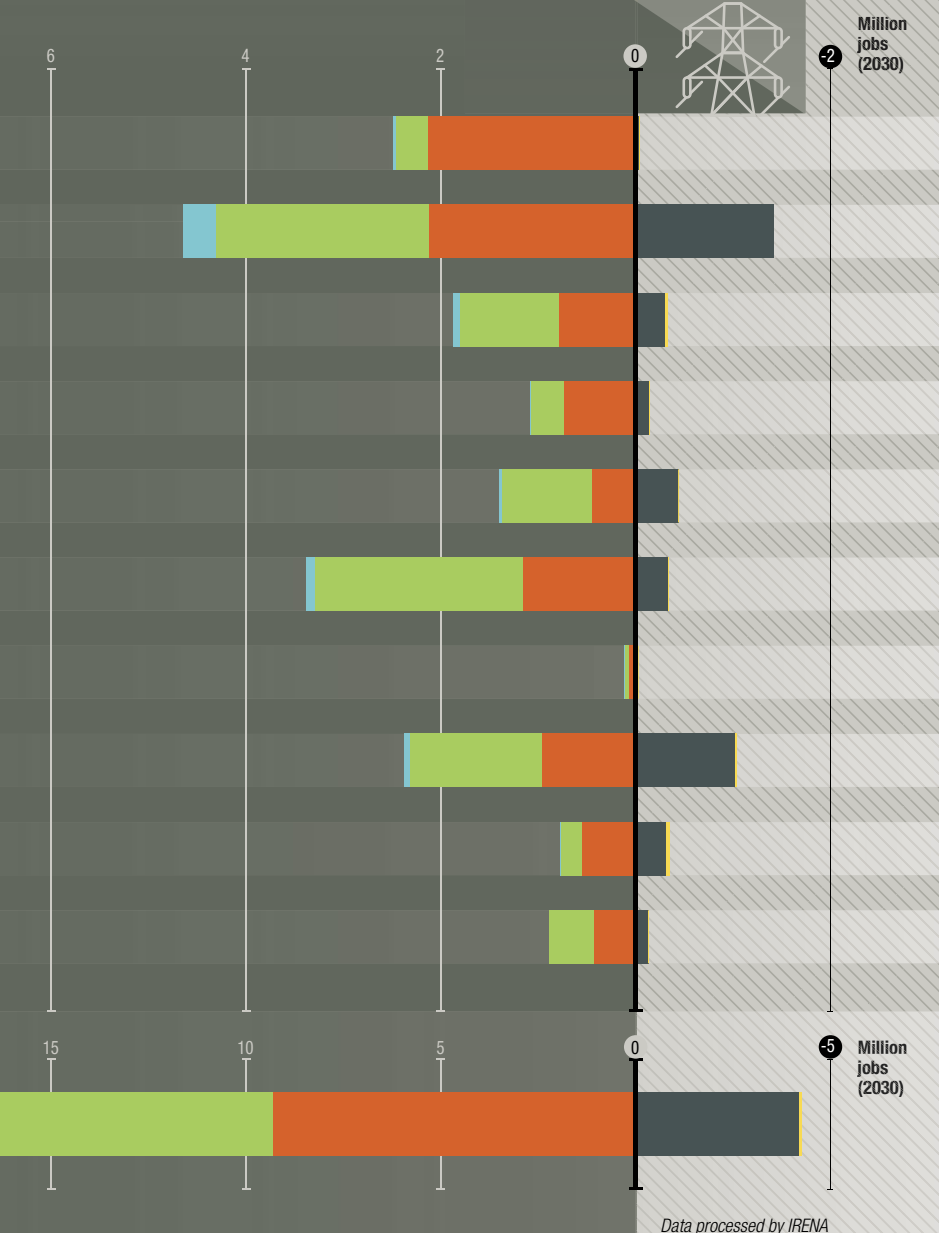


Data processed by IRENA

+1.3%
GDP ON AVERAGE
BETWEEN 2020 - 2030
COMPARED TO PES

+15
MILLION JOBS
COMPARED TO PES

**CUMULATIVE
GDP GAIN
OF USD 16 TRILLION**



**FIGURE 3
EMPLOYMENT AND
GROWTH BENEFITS
TO 2030**

Over the next decade, increasing public and private energy spending to USD 4.5 trillion annually could grow the world economy by an additional 1.3 percent and create 15 million additional energy transition jobs by 2030 compared to the PES Scenario.

KEY

Transforming Energy Scenario (TES)
Describes an ambitious yet realistic energy transformation pathway based largely on renewable energy sources and steadily improved energy efficiency. This would set the energy system on a path to keep the rise in global temperatures to well below two degrees Celsius.

Planned Energy Scenario (PES)
Provides a perspective on energy system developments based on governments' current energy plans and other planned targets and policies (as of 2019), including nationally determined contributions under the Paris Agreement, unless the country has more recent climate and energy targets and plans.

with the UN Sustainable Development Agenda for 2030 and the climate goals set out in the Paris Agreement.

What is needed to speed up the decarbonization process

We have entered a decisive phase in the global energy transformation. IRENA's (International Renewable Energy Agency) first definitive Global Renewables Outlook showed how to transform the global energy system over the long term in line with the Paris Agreement. It demonstrates how energy-related CO₂ emissions could be reduced by 2050, while driving broad socio-economic development, boosting GDP growth, creating more jobs and broadly improving people's welfare. This long-term vision also guided our Post-COVID Recovery Agenda. Today's government policies and investment choices can create the momentum to enact systemic change and deliver the global energy transformation. The word "investment" is meaningful—these are not simply costs, but investments in our collective future and key enablers of economic growth, much-needed jobs as well as social resilience and welfare.

The capital needed to invest and build the future is available. Around USD 10 trillion of unsustainable energy related investments are planned between now and 2030. UN Secretary-General Antonio Guterres said the recovery from the coronavirus crisis must not just take us back to where we were. I could not agree more and would add in my own words: Let's not retrofit the past, but instead design a possible and brighter future.

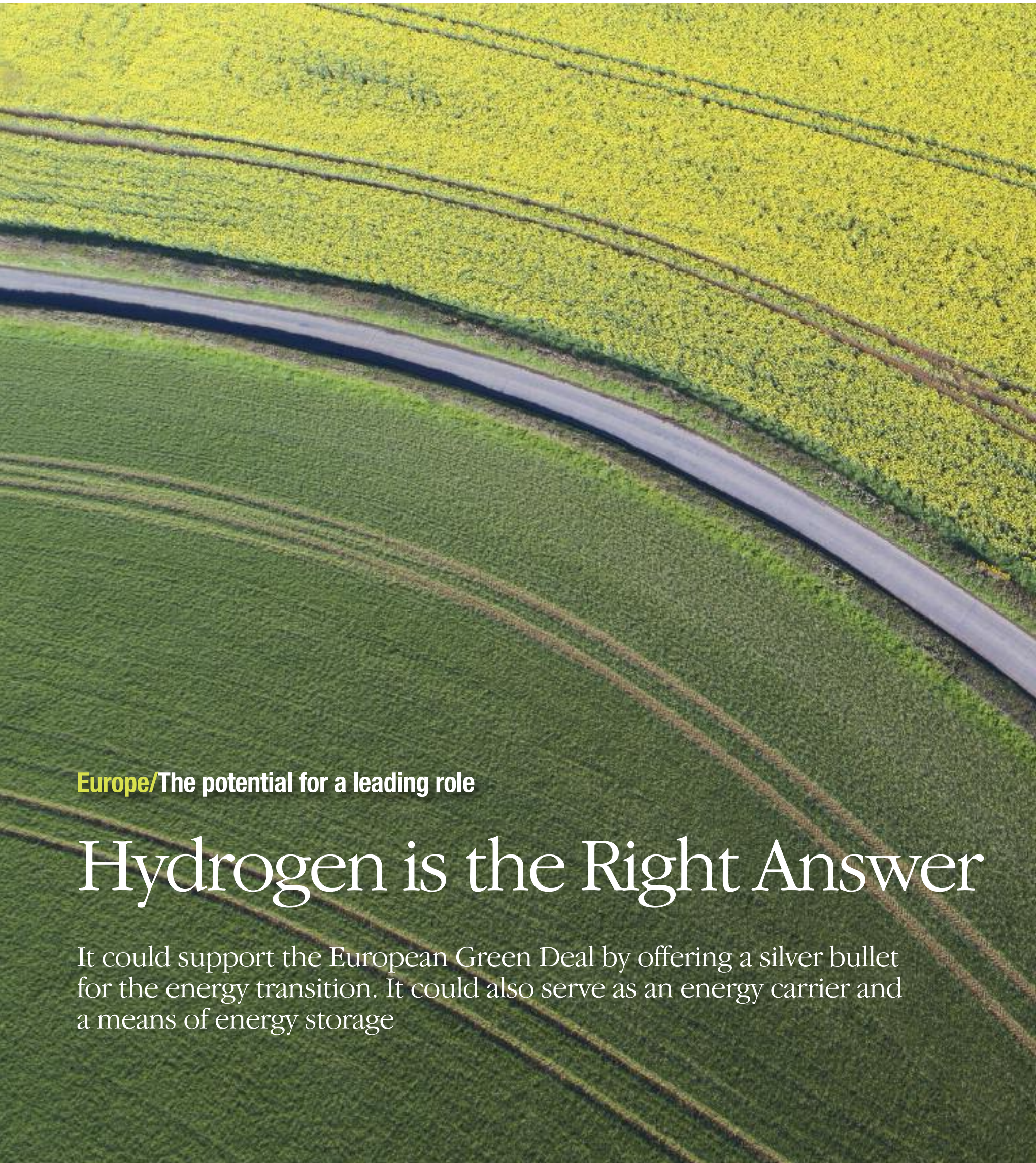
We believe that an energy transition investment worth USD 2 trillion can boost the economy over the 2021-23 recovery phase and create investor confidence to mobilize private sector funding (Figure 1). Innovation is key in this process and investments to foster innovation for the energy transition will bring substantial local as well as global benefits. Interesting new technologies now exist with the potential to lead us to a net zero energy system by mid-century. Green hydrogen for example, complementing renewables and bioenergy, represents one of the major strategic opportunities in the coming years. The burden would not fall on public finances alone. Government funds can leverage private investments by a factor of 3-4 and should be used strategically to nudge investment decisions and financing in the right direction. As technologies keep developing and renewable power costs fall further, renewable energy is increasingly the cheapest source of new electricity, offering tremendous potential to stimulate the global

economy. Similarly important, stimulus investments will directly result in rapid job creation. Today, over 11 million people work in the renewable sector worldwide, and with the immediate investment we have outlined, an additional 5.5 million jobs will be created by 2023 (Figure 2). In the next decade, annual public and private energy spending rising to USD 4.5 trillion per year could boost the world economy by an additional 1.3 percent and create an additional 19 million transition-related jobs by 2030 (Figure 3).

The pandemic shows that firm action can be taken

Stimulus measures can accelerate positive ongoing trends. The COVID-19 crisis has in some ways provided an unexpected foreshadowing of the mounting climate emergency. But it has also shown that collectively and with a common purpose, we are able to act decisively. We are at a crossroads, but the challenges are clear. It is not just a choice of various technologies. It is a choice in favor of an energy system that is surely cleaner, but also more resilient, prosperous, just and capable of tackling the challenges ahead of us.





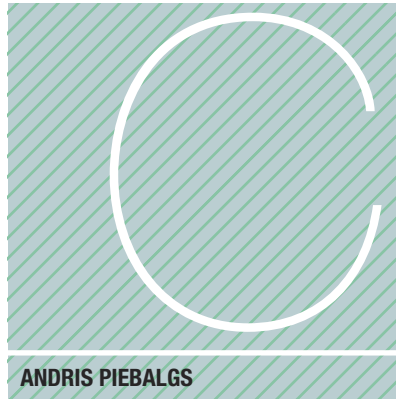
Europe/The potential for a leading role

Hydrogen is the Right Answer

It could support the European Green Deal by offering a silver bullet for the energy transition. It could also serve as an energy carrier and a means of energy storage



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ANDRIS PIEBALGS

He is a Professor at the Florence School of Regulation in the European University Institute. His work now focuses on the decarbonization challenges in the energy sector. He is the Chairman of the Board of Appeal of ACER. Before coming to FSR, he was EU Commissioner for Energy and EU Commissioner for Development.

Coronavirus represents an unprecedented challenge to humanity. It affects our way of life, our governance and our economies. Together with climate change, it creates a perfect storm. Recent power outages and their impacts on populations are a warning to urgently address climate issues. The Inter-governmental Panel on Climate Change (IPCC) believes that the world has only 10 years to reduce greenhouse gas (GHG) emissions by 50 percent. Unfortunately, we can see that international cooperation is failing to respond to these two challenges. Differences regarding the World Health Organization (WHO) and controversy about Russia's announcement that it has a coronavirus vaccine are good examples. The pandemic and its impact on economies has overshadowed the need for climate actions.

In times of uncertainty, leadership is crucial. The European Union (EU) could provide this leadership by building a successful pathway towards its goal of having a carbon neutral economy by 2050. As energy drives the economy and is also the largest source of GHG emissions, the energy transition is a key element in the Green Deal. The energy sector has been heavily impacted by the pandemic. The current fall in energy demand is the largest in 70 years, and the impact of the coronavirus is seven times greater than that of the financial crisis in 2008-2009. The International Energy Agency (IEA) estimates that in 2020 energy demand will be at least six percent lower than in 2019. Energy investment is down by \$400 billion, a 20 percent reduction. The EU electricity demand decreased by three percent in the first quarter of the year and the carbon footprint of electricity generation decreased by 20 percent, with renewable energy sources (RES) reaching a 40 percent share of the power mix. Increased flows of intermittent renewable energy in this low demand environment need to be managed. Electricity day-ahead prices and gas prices have plunged.

What is being done and what could be done to assist with the recovery

The growing numbers of infected people around the world and the time needed to successfully vaccinate populations remove the possibility of a full recovery in 2021. Even a U-shaped recovery is questionable, as in some areas there could be permanent shock. Governments are deploying massive recovery packages, and many people see them as a good opportunity to achieve three goals at the same time: boost →

economies, create jobs and improve the environment. The IEA suggests there should be public investments to improve the energy efficiency of buildings, to increase solar and wind electricity generation capacity and to modernize and digitalize grids. Without disputing the positive impact that recovery packages could have, we need to recognize that they are temporary measures and they will not necessarily make a sustainable change. During the financial crisis there was a substantial decrease in GHG emissions and recovery packages were implemented, but after a couple of years, GHG emissions started to grow faster than before the crisis. 2020 could see an eight percent drop in GHG emissions worldwide, but this drop will be unsustainable if there is not a structural change in the energy sector. Two elements are crucial: markets should reward lower GHG emissions; and more investment in decarbonized energy research is needed.

The EU Emissions Trading System (ETS) has responded reasonably well to the COVID-19 shock. After an initial drop in the price of emission allowances, it quickly recovered to the 2019 level. The EU ETS strengthened with the market stability reserve can substantially increase the price of allowances. As the mechanism is somewhat complex (including a cancellation policy and increases in the rate at which the emissions cap decreases) the challenge is to achieve predictability of prices. In addition, overlapping policies like renewables targets and phasing out coal now have a direct impact on cumulative emissions under the ETS. There is a good chance that the next revision of the EU ETS will consider increasing the linear reduction factor to put it in line with the 2050 target price floor/ceiling. More predictability of the price of emission allowances would encourage investment in clean technologies and innovation, and extension of the ETS to other sectors like buildings and transport could play an important role. The path towards the EU Green Deal goal will require new regulations, but these regulations should not replace the market but instead should focus on the correction of market failures.

R&D is crucial in the energy transition, and more and better targeted public and private financing is needed. Of the global public investment of USD 17 billion, nearly three quarters goes into renewables, nuclear and energy efficiency while storage, network development and hydrogen are under-funded. All the vectors of the energy transition need to be well funded; otherwise the

transition will not be complete. A commitment to change demands actions, and one of the most important actions is ambitious funding of energy-related research.

A growing share of electricity in final energy consumption is a trend in Europe and the world at large. According to Deloitte, by 2030, a third of new cars sold globally will be electric, and this change will require a substantial investment in grids. The European Network of Transmission System Operators for Electricity (ENTSO-E) estimates that an additional 93 GW of interconnection capacity will be needed in the EU by 2040, 50 GW of which must be operational by 2030. The share of electricity in final energy consumption could grow from the current 23 percent to 40-60 percent by 2050. This means that many industrial and transport sectors need to have other solutions. Steel, cement and chemicals have multi-decade investment cycles so new technologies should be applied by the next decade. Climate neutrality by 2050 requires investing in all the avenues that can us take us to this result: renewables; energy efficiency; storage; carbon capture, storage and utilization (CCSU); and grids. At the same time, the portfolio needs to be optimal to make the transition cost-efficient. This means that the use of the “Next Generation EU” recovery fund of EUR 750 billion and the EUR 1 trillion multi-annual financial framework for 2021-2027 should focus on the most difficult sectors to decarbonize, allowing markets and market players to reach for low hanging fruit. There is a serious change in corporate strategies in favor of investing in climate action in a sustainable way, as the license to operate sustainably demanded by civil society and climate change-related risks both lead to this approach. A good example is ENI's Long-Term Strategic Plan to 2050, as it announces fixed 2050 reduction targets of 80 percent of absolute emissions and strong growth of renewables in its portfolio. Recently BP also announced plans to develop 50 GW of renewable generation capacity by 2030 and to raise its low carbon investment ten-fold to USD 5 billion a year.

European ambitions need to be clarified

After agreement on a recovery fund and the next financial prospects, the EU now needs to give clarity to its ambition for 2030. Should it stay at 40 percent less GHG than the 1990 level, or should it increase the goal to 50-55 percent. Both approaches have merit. The current target is well covered by the legis-

A specific strategy

Through the Green Deal, the European Union is aiming to achieve a smarter, more integrated, and optimized energy system, in which all sectors can contribute fully to decarbonization. Hydrogen is an important element of this strategy, which is why, on July 8, 2020, the Commission adopted a new specific strategy on hydrogen in Europe, in line with the 2050 climate neutrality target set out in the Green Deal. In this plan, the European Commission sets intermediate targets for renewable hydrogen production in the EU, which it sees as a growth engine to overcome the economic damage caused by COVID-19.

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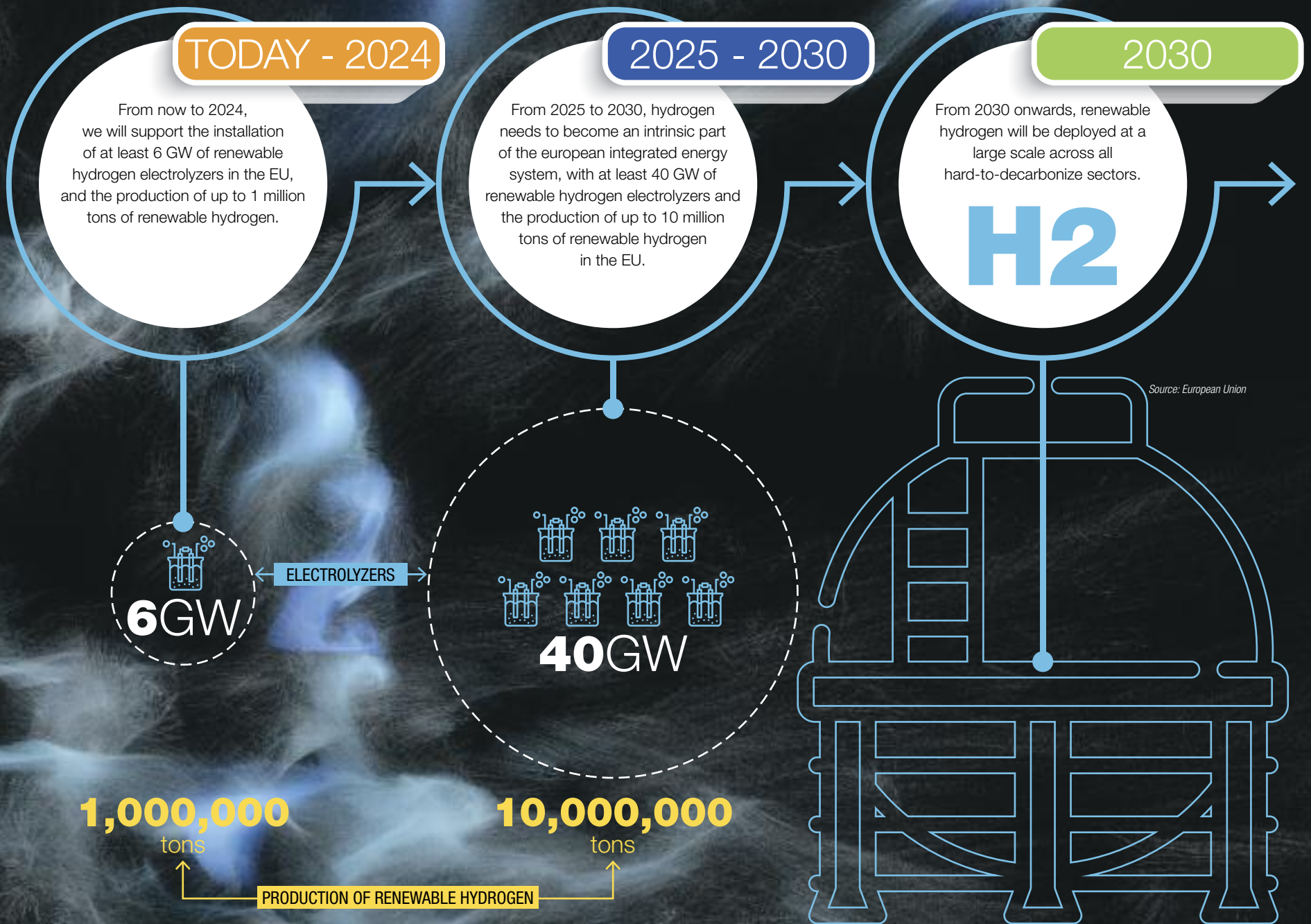
lation already adopted, and this decade could be used to prepare for the decarbonization of the most challenging sectors. This would allow the EU to be very ambitious from 2030 to 2040, leaving the last decade for addressing the most difficult issues. Increasing the target would send a signal for society to mobilize and quickly reach low hanging fruit like phasing out coal and achieving a nearly 100 percent decarbonized electricity supply by 2030. Whatever decision is made, it should be made quickly because it will influence investment priorities and the instruments used. Initially,

it could be more market-based instruments; later more regulatory approaches will be needed, like an accelerated phase-out of coal. Whatever the target chosen, one issue will need to be addressed urgently: scaling up the production and use of clean hydrogen.

Why is hydrogen so important for the EU Green Deal? In 1842, English scientist Sir William Grove developed the first fuel cell which combined hydrogen and oxygen into water and generated an electric current. While there were promising developments later, there has never been a real breakthrough.



THE PATH TOWARDS A EUROPEAN HYDROGEN ECOSYSTEM STEP BY STEP



Interestingly, the US House Democrats' climate plan mentions hydrogen but stops short of encouraging the necessary large-scale investments. Why will it now be different in Europe? One answer is obvious. To decarbonize industry, the fossil-fuel-based hydrogen mostly produced by reforming steam methane needs to be replaced. Globally, industry is responsible for 20 percent of fossil fuel emissions, and in the EU 70 to 100 million tons of GHG are emitted yearly. Basically, this means that grey hydrogen must be replaced with green hydrogen if the critical problem of

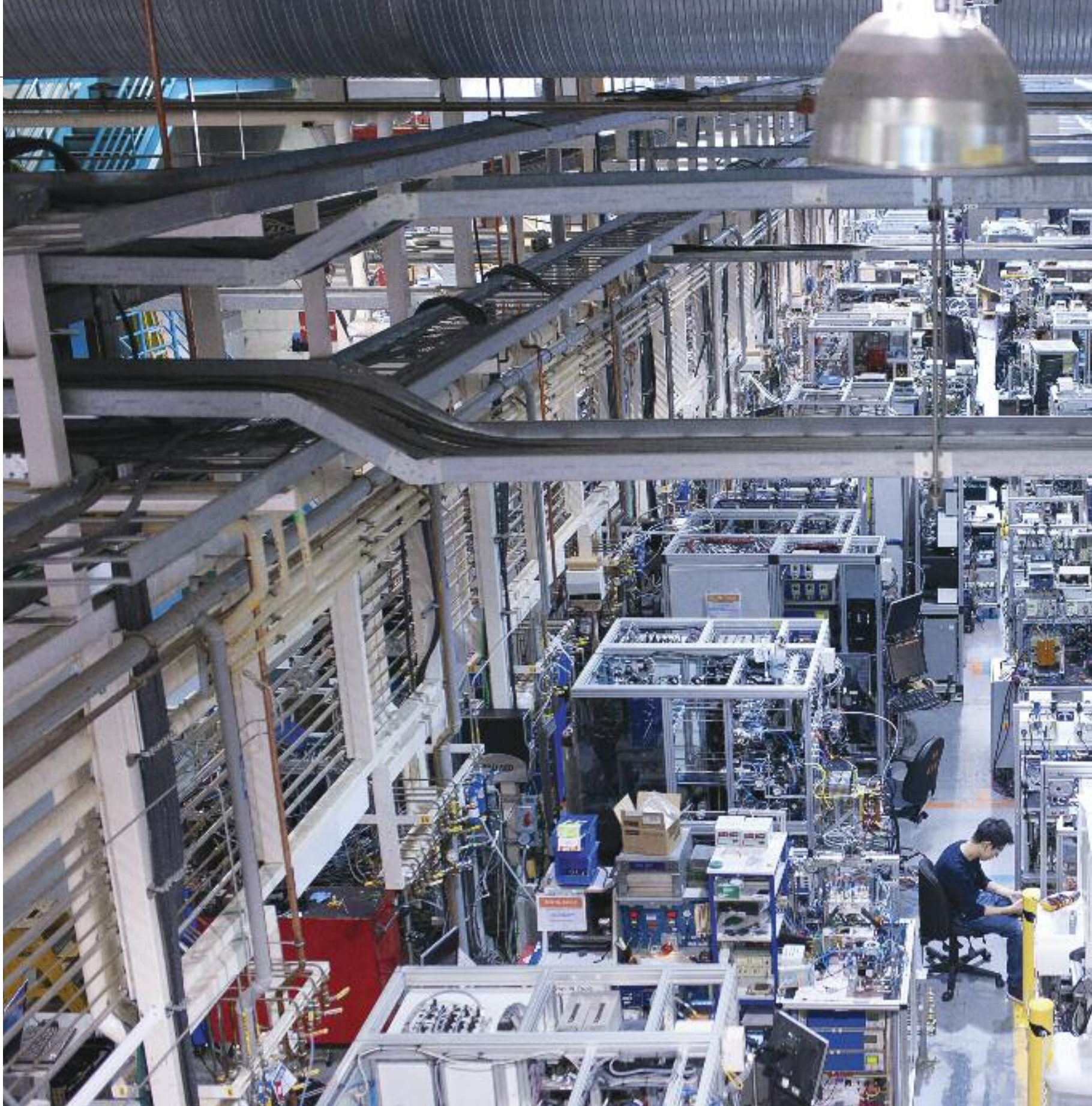
GHG emissions is to be resolved. The expectation is that renewable hydrogen could be a crucial feedstock for clean synthetic fuels like synthetic kerosene for aviation and synthetic diesel for trucks, and it could be used directly in shipping and long-haul transport. It could serve as a feedstock or a fuel depending on the demands of technology. Hydrogen seems to be the silver bullet for the energy transition. It could also serve as an energy carrier and a means of energy storage. A smart integration of the electricity and gas sectors is an important step

in responding to the sustainability and cost-effectiveness challenges in the energy sector. With hydrogen this is not only achievable but a clear necessity. In addition, the EU has a very well developed gas network and a first class gas industry. To neglect these strengths would be a big mis-take.

Potential, expectations, and difficulties

Producing renewable hydrogen is quite simple. Electrolysis of water using renewable energy and steam reforming sustainably produced biomethane produces renewable →





hydrogen. The real challenges are the cost and scale of production. The production of fossil-fuel-based hydrogen has an average cost of EUR 1.5 per kilogram; the production of renewable hydrogen using electrolysis costs EUR 2.5-5.5 per kilogram. Expectations are that the cost of electrolyzers will halve by 2030, renewable electricity costs will decline further and the price of carbon will substantially increase. These developments should help increase the competitiveness of renewable hydrogen in the coming years.

Because of hydrogen's lower volumetric energy density, transporting it will be more expensive than natural gas. For security, a strong retrofit of existing pipelines will be needed

and in some cases dedicated new hydrogen pipelines will have to be built. Scale is another headache. Achieving a 100 percent renewable electricity system would require at least a doubling of renewable energy system (RES) capacity, but the expected increase in the share of electricity in the final demand and dedicated capacities for renewable hydrogen production will create a huge demand for renewable electricity. Improved energy efficiency will help, but not enough, and while there are expectations that imports will help, this is still uncharted territory.

It is difficult to make any forecast at this stage. A helping hand could come from low-carbon hydrogen (blue hydrogen) produced from nat-

ural gas and using CCS. The technology is well known and the impact of the carbon price could make this a cost-efficient option compared with grey hydrogen. Hydrogen produced with pyrolysis from natural gas is also an interesting option. With improved methane emission regulation and voluntary actions on the part of industry, there is improved knowledge of the real GHG emissions in the natural gas value chain. Rigid regulation and technological development are decreasing fossil methane emission intensity. Increases in the price of carbon and a reduction in the cost of renewable hydrogen will mean that society is not locked into fossil fuels any more than necessary. It would be a mistake to ignore this option.



THE DECARBONIZATION OF TRANSPORT

Clean hydrogen is a key to the transformation of the global energy system, particularly in industry, transport and buildings. In the photo, the Ballard Power Systems Inc. facility in Burnaby, Canada. Ballard supplies hydrogen fuel cell technology and batteries used for back up power to major transportation companies around the globe.

Large scale production and use

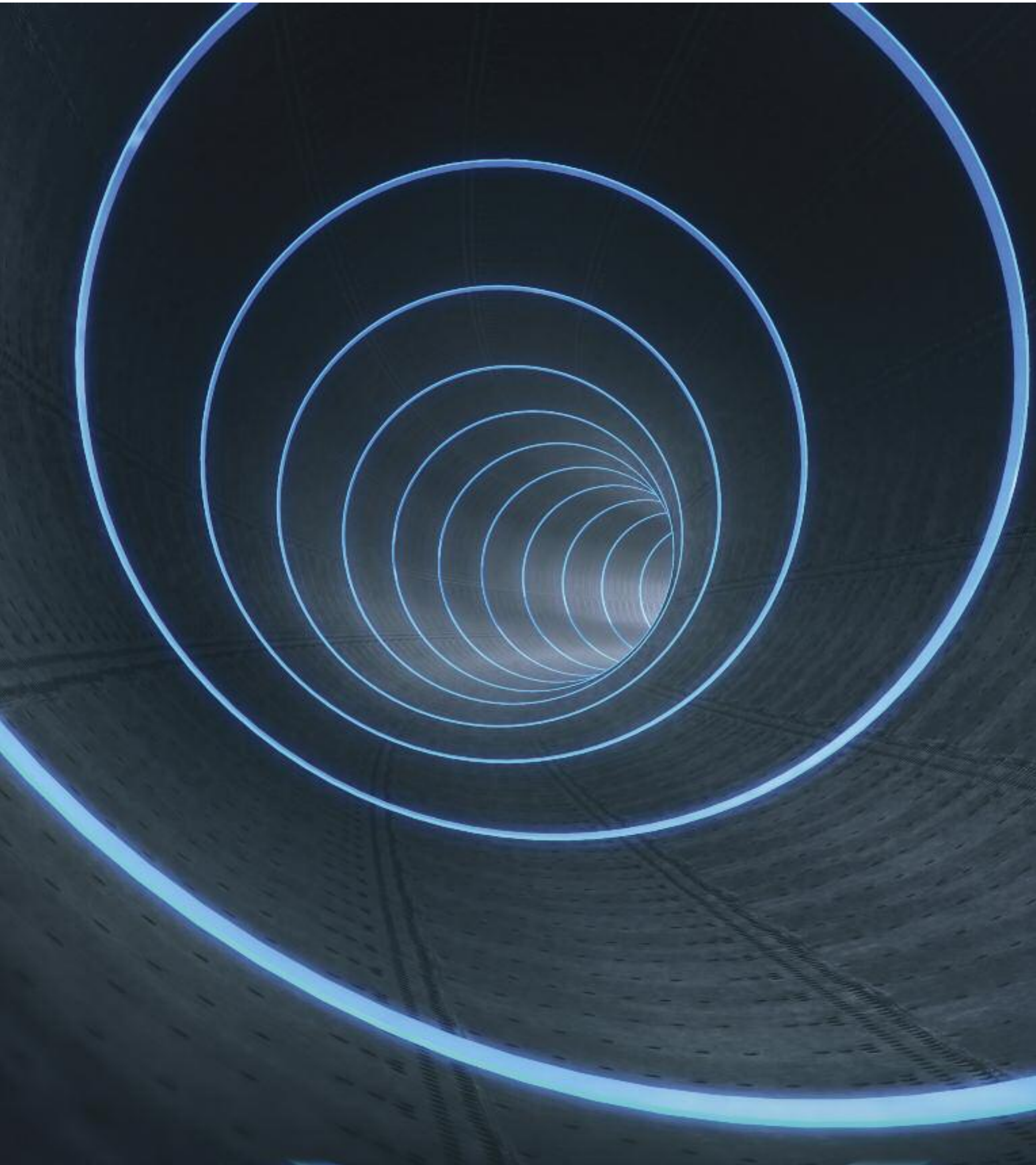
The EU's Hydrogen Strategy is attempting to find the right balance between the need to develop large-scale clean hydrogen production and use despite the current limited experience with hydrogen. There is a clear need for renewable and low-carbon hydrogen and for financial support to accelerate developments. The Carbon Contracts for Difference program, Horizon 2020 projects like developing 100 MW electrolyzers, and Invest EU's Strategic European Investment Window are important tools to accelerate such developments. International activities, in particular with the African Union and Ukraine, are envisaged as a first step towards having 10 million

tons of renewable hydrogen produced beyond the EU borders by 2030. The expectation is that the same amount will be produced in the EU by 2030, starting with one million tons already being produced by 2024. The main vehicle for further development is the European Clean Hydrogen Alliance, which was launched in July. The response from industry in the first month has been quite good, with 120 companies joining. Less pronounced have been the responses from public bodies and research institutions. Their active participation in the Alliance is of crucial importance because nearly all the EU Member States anticipate measures to promote the use and supply of clean hydrogen. Germany has adopted a very ambi-

tious hydrogen strategy, and the Alliance could multiply efforts at different levels in the EU to create a wave of innovations and investments to decrease costs and increase scale. Nevertheless, without market forces it is impossible to imagine a success. Germany's strategy expects the development of a clean German hydrogen market by 2023, but it would be better to have a European market. Integrating different markets is never easy and in this case many important issues, like definitions and guarantees of origin, need to be agreed to beforehand. It is also important to see the creation of the hydrogen market in the context of the development of the EU electricity market and technological development of the scale

of utility electricity storage. Without doubt, clean hydrogen is a key to the transformation of the global energy system, particularly in industry, transport and buildings, and it is also an accelerator of renewable power deployment. By committing itself to carbon neutrality by 2050, the EU has taken the lead in the fight against climate change. It is crucial that in the process of achieving its Green Deal goal, the EU creates technological tools and regulatory experiences that can be replicated in other parts of the world. The production and use of clean hydrogen could be a most important transformative experience.

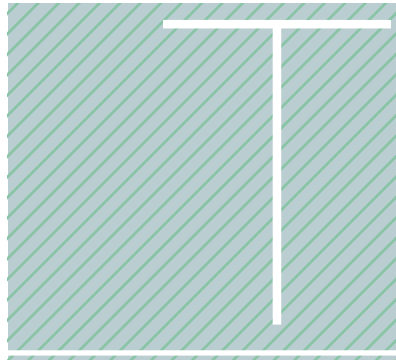




Gas/The impact of the COVID-19 crisis on global markets

How Long-Term Perspectives Change

In the short run, gas demand will be affected less by the COVID-19 crisis than that for coal or oil. The long-term outlook will differ significantly between countries and regions and depend on the pace of development of zero-carbon alternatives



TATIANA MITROVA AND JONATHAN STERN

Tatiana Mitrova is Director of the Energy Center of Skolkovo Business School, Senior Research Fellow in the Oxford Institute for Energy Studies, and Scientific advisor at the Energy Research Institute of the Russian Academy of Sciences.

Jonathan Stern, Distinguished Research Fellow of the Natural Gas Research Programme, founded the OIES Natural Gas Research Programme in 2003 and was its Director until October 2011 when he became its Chairman and a Senior Research Fellow. He became a Distinguished Fellow in October 2016.

The immediate impact of the COVID-19 crisis on global gas markets remains unclear, other than that it is likely to be less severe than for oil or coal. The International Energy Agency has projected that global gas demand in 2020 could fall by four percent (compared with nine percent for oil and eight percent for coal) before increasing at 1.5 percent per annum up to 2025. Prior to the crisis, the global gas supply surplus resulted in regional and international prices converging at historic lows.

By reducing demand, the crisis forced prices even lower, resulting in strong incentives for short-term switching from coal and oil to gas where possible, but in the power sectors of many countries, this will be tempered by gas-to-renewables switching.

To the extent that switching to gas is possible in non-power (especially industrial) sectors, where use of renewables may be more complicated, air quality improvement will be a powerful incentive. But widely anticipated national and global recessions means it is possible that any strong rebound of gas demand may be delayed.

The impact of the energy transition on gas is also likely to be less severe, because of its lower carbon dioxide emissions compared with other fossil fuels. But fuel switching is a longer-term option in only a few countries—mostly in Asia—and will depend on whether much larger gas and LNG imports are considered acceptable in relation to energy security, and whether gas prices remain affordable in rapidly industrializing countries. Moreover, until methane emissions from pipeline and LNG value chains are measured with greater accuracy and independently certified, the greenhouse gas (GHG) footprint of natural gas will remain open to question.

Gas prospects will be strongly related to the details of how individual countries and regions will be impacted by, and choose to adapt to, both the health crisis and the energy transition. This in turn will be determined by a combination of economic and policy impacts. The former will be principally governed by the price and availability of imported gas and LNG, and the latter by the priority which governments give to environmental issues: meeting net-zero carbon-reduction targets which are more stringent than those set at COP21 (the 2015 UN climate summit), as well as targets for improvement of urban air quality.

This article considers the crisis-related impacts on gas demand and international trade and investment, particularly in LNG projects, as well as longer-term transition impacts in →

relation to the major national and regional gas markets.

Crisis-related impacts on major gas markets

Since the COVID-19 pandemic began, the European Union Parliament and many member state governments have expressed continued commitment to the Green Deal, which dictates net zero emissions by 2050 and increases emission-reduction targets for 2030, and to the use of recovery funds to fulfill these aims. But Green Deal policies may encounter delays, and the immediate emphasis of recovery programs seems more likely to be on the power and transport sectors (acceleration of renewables and support for electric vehicles and associated infrastructure), which would have more immediate impacts on coal and oil demand. Retrofitting buildings for efficiency and lower-carbon energy would have a greater impact on gas demand, but probably on a longer time scale.

Prior to the crisis, natural gas was seen as part of the transition by many European governments, but it was to be progressively replaced by “green gases” (biogas, biomethane and hydrogen) as those technologies evolve and their costs fall. Investments in green gas, particularly hydrogen-related technologies, are likely as part of recovery packages, but will have no significant impact on energy balances before 2030 (and may still be modest even by 2040).

Increased carbon-based prices or taxes, which consumers may not resist (or may notice less) given current fossil fuel price levels, are likely to have a more immediate impact and become popular with governments needing additional revenues. The introduction of national, and eventually EU, border taxes on GHG (carbon and methane) content would create significant problems for gas imports with high methane emissions in the value chain (or which are unable to provide independent certification of their emissions).

Indigenous gas production (Norway excepted) has been in long-term decline, and Europe will become increasingly dependent on imports. Some countries have used low-cost LNG to accelerate their drive to reduce dependence on Russian gas imports for political and security reasons, but the majority are allowing commercial logic to dictate their supply choices. Prices in 2020 have created even more bad news for European gas producers, who were already under pressure following the 2018 price downturn. This will accelerate the decline of UK gas production. Norwegian gas production and exports will reduce somewhat

due to oil production cuts (as part of the OPEC+ agreement), and low prices will also delay new developments. In the Mediterranean, gas developments which looked marginal even at pre-2019 price levels will only progress if their destination can be regional countries (rather than European Union or global LNG markets).

Outside Europe and some other OECD countries (particularly parts of North America and possibly Japan), the policy focus of the energy transition in relation to GHG emissions will be significantly less urgent given the crisis-related fall in emissions. Immediate reactions will be based more on the historically low international gas prices in 2020, which look set to continue into at least 2021. There will be no change to the US energy dominance and self-sufficiency policy. However, with Joe Biden’s election, federal policy on GHG emissions could change. In any case, state and city initiatives to pursue GHG reductions will continue. Meanwhile, coal-to-gas switching, particularly in power, is supporting gas demand but, as elsewhere, this will be limited by growth in renewables. Investment in shale gas production has fallen sharply but will quickly pick up if gas and oil prices recover.

In China, low-cost gas imports are helping to accelerate market liberalization, raising the possibility of third-party access to pipelines and LNG terminals. Tensions with the US have prompted a greater focus on domestic gas production and clean coal, but the crisis will highlight security-of-supply concerns around import dependence and how to maintain domestic production at a time of very low import prices.

For India, low import prices are a particular benefit, since energy security is very much about minimizing fiscal deficits. In both countries, but especially in China, renewables are making significant progress, but coal development is also continuing, and the past two years have been negative for decarbonization. Indian private-sector gas production, which has been in long-term decline at low prices, is likely to collapse, while production by state-owned companies will fall, but not so dramatically. Air quality will also remain very important to promote gas, particularly for India, as coal-to-gas switching is already well advanced in China, and in both countries vehicle emissions may be an equally important focus.

In summary, COVID-19 will cause a significant reduction in global gas demand in 2020, but a return to a range of 1.5–2.0 percent for the next several years is possible. The key region on which gas demand recovery

Natural gas prices in 2010-2020

The fall in gas prices started well before the COVID-19 crisis and well before the fall in oil prices. Moreover, while it seemed possible by mid-2020 that the worst of the crisis’s impact on oil prices had passed, for the gas sector, 2020 price levels for US Henry Hub (HH), European spot (TTF) and Asian spot (JKM) could continue for several years.

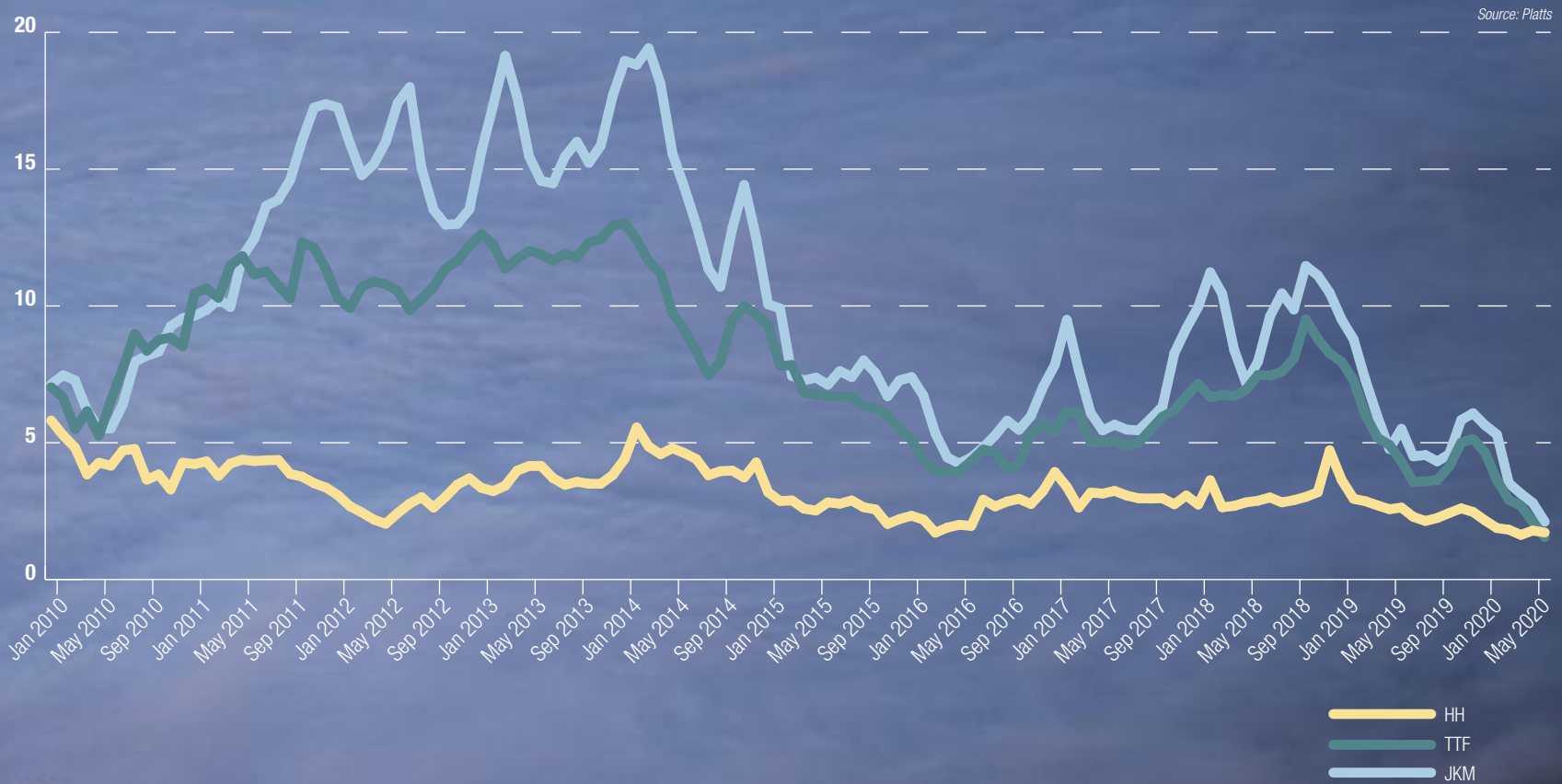
depends is Asia—not just China and India but also Southeast Asia, which will be the principal locations of most coal-to-gas switching, and the Middle East, where switching to gas will be from liquids. The main immediate impact has been coal-to-gas switching due to low prices, but this was already the case before the crisis. Some of this switching may be temporary, depending on relative coal and gas prices, but in countries where the coal-fired power fleet is very old, it may be permanent.

Shorter-term impacts on international gas and LNG exports and new project investments

The fall in gas prices and demand during the crisis means that all producing companies will have less money to invest in new developments. The fall in gas prices started

well before the COVID-19 crisis and well before the fall in oil prices. Moreover, while it seemed possible by mid-2020 that the worst of the crisis’s impact on oil prices had passed, for the gas sector 2020 price levels for US Henry Hub (HH), European spot (TTF) and Asian spot (JKM) could continue for several years.

This raises two interesting prospects: in Europe, that major suppliers (Russia, Norway, Qatar, and Algeria) may contemplate an informal arrangement to control volumes, particularly if European gas prices turn negative when storage becomes full; and in Asia, that a protracted global LNG surplus and very low spot prices could accelerate a move away from oil-linked long-term contract prices. The fall in prices combined with reduced demand expectations means that, Qatar excepted, investments in



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gas production and new projects will also fall, possibly very substantially, as projects are deferred. LNG projects which are under construction may be delayed for both logistical and financial reasons. Final investment decisions (FIDs) for new projects will be stalled until the demand and price outlook provides greater clarity. This is most likely to impact the many US (and some Canadian) LNG export projects, yet to reach FID, which may need to make significant changes to their business models to attract buyers and secure financing.

In Australia, the crisis has caused A\$80 billion of investments in gas and LNG projects to be deferred, although where there is co-production of oil or an expectation of selling LNG at oil-linked prices, some of these decisions may be more directly related to oil price

levels. Some existing Australian projects need additional gas to maintain current export levels, and consequently exports may decline modestly in the early 2020s. The government has stated that it will not support climate policies that harm the economy or put jobs at risk, and as a result, it has expressed support for the expansion of the domestic gas market.

Decarbonization has not been a significant policy driver in the Gulf countries. Although renewable-energy development is increasing (albeit from a low base in all countries other than the United Arab Emirates), the major impacts are likely to be seen after 2030. The crisis appears to have had little impact on Qatar's plans for a huge expansion of LNG export capacity, although delays, principally for logistical reasons, are possible. A protracted pe-

riod of low prices could create incentives to increase regional exports, but this would require improved regional political relationships, specifically a resolution of the rift between Qatar and its Gulf Cooperation Council neighbors. Other Gulf countries will reduce gas investments, with the possible exception of those building LNG receiving terminals to take advantage of low prices.

In Russia, the government may use oil and gas investment support as a driver of general economic recovery, and rouble devaluation will soften some of the financial impact. Pipeline gas projects under construction will be completed, but the crisis could delay new Russian pipelines to China, while US sanctions are having a similar impact on the Nord Stream 2 pipeline to Europe. Extremely low European

prices in 2020 resulted in sales to the Russian domestic market becoming more profitable than exports. But domestic prices have been frozen to support industry and prevent protests, and payment obligations for consumers have been relaxed as a way of absorbing excess domestic production. Although an official national strategy for low-carbon development to 2050 should be submitted to the Russian government later this year, the current draft suggests it will have minimal impact, and the economic and health crises will most likely further weaken any initiatives.

In Russia, India, and Qatar, national oil and gas champions are likely to maintain and even increase their importance as private-sector and foreign investors pull back, leaving national companies as the major gas project investors using their govern- →



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ECONOMIC INCENTIVES

By reducing demand, the crisis forced prices even lower, resulting in strong incentives for short-term switching from coal and oil to gas where possible, but in the power sectors of many countries, this will be tempered by gas-to-renewables switching.

ments’ reserve and stabilization funds. We can expect these governments to protect their national companies and use them to promote economic recovery. In China, new domestic private and international companies are likely to be allowed to enter the gas sector and may choose to do so given that demand is continuing to increase.

In relation to longer-term strategies, the share of gas in the reserve portfolios of many national and international oil companies (IOCs) has increased over the past decade, and both groups of companies may see future gas investments as less risky than oil (given the potentially less certain future of oil demand under the energy transition). This can be represented as diversification until large-scale investments in non-fossil energy sectors become attractive. Portfolio players with large balance sheets will be able to progress new LNG projects without reliance on external finance. But the current global surplus and a potentially prolonged period of low gas prices may change the perceived attractiveness of such investments, particularly for IOCs experiencing much lower than anticipated returns on very large LNG projects which started operation in the second half of the 2010s. Aside from investments by energy companies and governments, it is unclear whether banks and hedge and pension funds will still be interested, and have sufficient liquidity, to invest in gas projects. Their decision-making criteria in relation to

risk and return may favor expansion of existing, rather than new greenfield, projects. But it is possible that price volatility and politicization may increase the risk profile of projects to the point where the sector is no longer seen as an attractive future investment.

The strategy of global LNG purchase and sale, which was highly successful in a market with significant regional price spreads, has far fewer commercial advantages in a market where regional prices are uniform and low. Until it can be anticipated that prices will increase significantly, and unless regional differentials then re-emerge, there will be very limited arbitrage gains from moving LNG around the world. This means that companies will need to “trade smarter” using sophisticated financial instruments that are more usual in oil markets. However, it also suggests that the globalization of gas will slow down and international trade, particularly of LNG, will not increase to the extent anticipated before the crisis.

Longer-term energy transition impacts

Prior to the COVID-19 crisis, most models showed that under COP21 targets, global gas demand would continue to increase into the 2030s, and then fall increasingly rapidly to 2050. For countries that adopt net-zero targets, the decline of natural gas, unless it can be decarbonized with carbon capture utilization and storage (CCUS), would need to start

in the 2020s. In both cases natural gas could be considered a transition fuel, but net-zero targets dictate that the transition should start soon and have a much shorter duration. The question now is whether the COVID-19 crisis has changed the longer-term outlook. As we have already indicated, answers will differ significantly between countries and regions, and depend not just on gas but also on the development of zero-carbon alternatives and technologies. But the COVID-19 crisis will only significantly change the post-2030 outlook for gas if government recovery packages are directed towards the development of hydrogen or electrification at the expense of gas, to a greater extent than was already anticipated.

In countries that already have a gas market, most studies find that a mix of electrification and gas will be a much lower-cost option to achieve decarbonization targets than electrification alone. Lowest cost will probably mean maintaining gas network infrastructure even if this needs to be converted to carry hydrogen, which will need to be available at scale for use in the industrial—and in some countries the residential, commercial, and electricity—sectors. In order to scale up rapidly, hydrogen will need to be derived from reformed natural gas with CCUS, with the anticipation that these will be replaced by large volumes of hydrogen from electrolysis of renewable energy after 2040.

A key question is when the global

supply/demand balance will tighten and create signals for the next price cycle. With most new international gas and LNG projects having delivery costs of at least \$6/MMBtu (and a profitability comfort zone of closer to \$8/MMBtu), investments particularly in new greenfield projects will be a significant problem. In addition, with only 20–30 years before it needs to be phased out (depending on policy commitments), large new natural gas infrastructure may not be feasible unless it is hydrogen-ready. Initially this will be fossil-based hydrogen plus CCUS, but if it is to become a large-scale energy source, the majority of hydrogen will need to come from renewable electricity. This is particularly important for large-scale pipeline exporters to European countries committed to net zero emissions, where new infrastructure investments will need to be either amortized prior to phase-out or converted to decarbonized gas, a transition which needs to start by 2030. LNG exporters will have greater market flexibility, but those planning new projects need to be aware that an energy transition which meets even COP21 targets would mean that, by the 2040s, they would face similar demands from the majority of their customers.



This article was first published in issue 123 of the “Oxford Energy Forum” magazine.



What will our
future be like?

That's the question we'll be
asking ourselves in this issue.

The global crisis that humanity
is facing – primarily to do
with health care but,
as a result of the domino
effect, economic as well
– has changed us and will
continue to change us,
at a speed that only
emergencies can trigger.

The world of energy has also
been heavily hit, in terms of both
demand and collapsing prices,
but it is showing that it wants
to use this critical time
as a catalyst to accelerate
the energy transition and invest
in an increasingly
sustainable direction.

The crisis has therefore generated
resilience and new solutions that
move with the times.

The photographic project we present
on these pages is a snapshot
of everything that science, technology
and research are developing,
in different parts of the world,
particularly to achieve
this resilience, thinking about
the life to come.

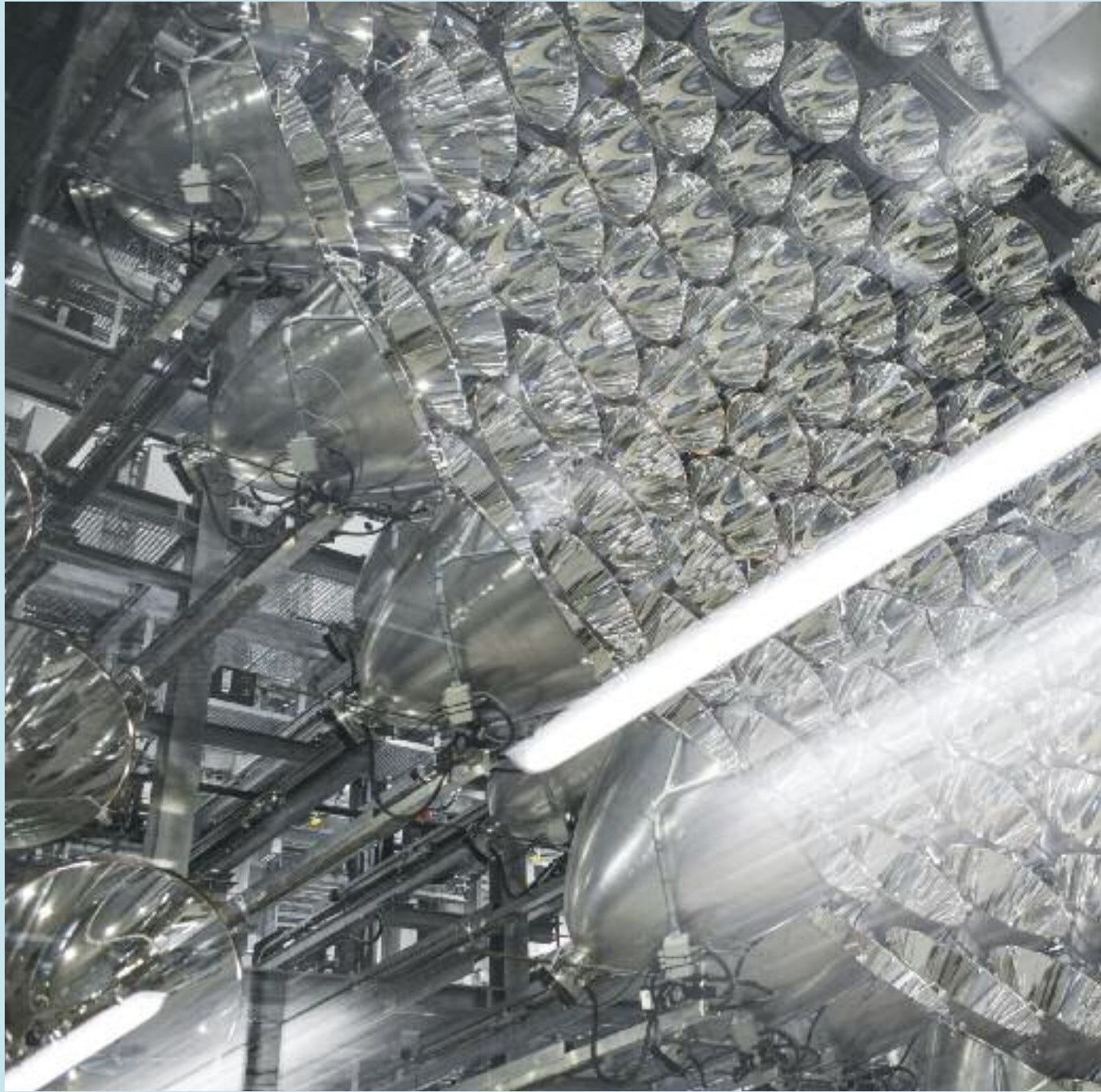
Surviving humanity

PHOTOSTORY BY ALBERTO GIULIANI

THE PROJECT

The portfolio published on these pages was created to explore the future of humanity. Our age is full of invisible threats: climate change, nuclear war, pandemics. Our development model is incompatible with the expected population growth in the coming decades. Huge challenges lie ahead. And, for the first time in history, we will have to defend our survival. This work explores what science is doing to cope with the future. The photographer met men and women whose stories, recounted here, tell us about places where human beings are developing their resilience.

📷 Alberto Giuliani is an Italian photographer and journalist, known in particular for his work on Italian mafias and health care staff during the COVID-19 pandemic in Italy. His photographs are published in leading newspapers around the world. In 2010, he founded and directed the LUZ agency (Milan). He is the author of the book *Gli immortali - storie dal mondo che verrà* [The immortals - stories from the world to come] (Il Saggiatore).



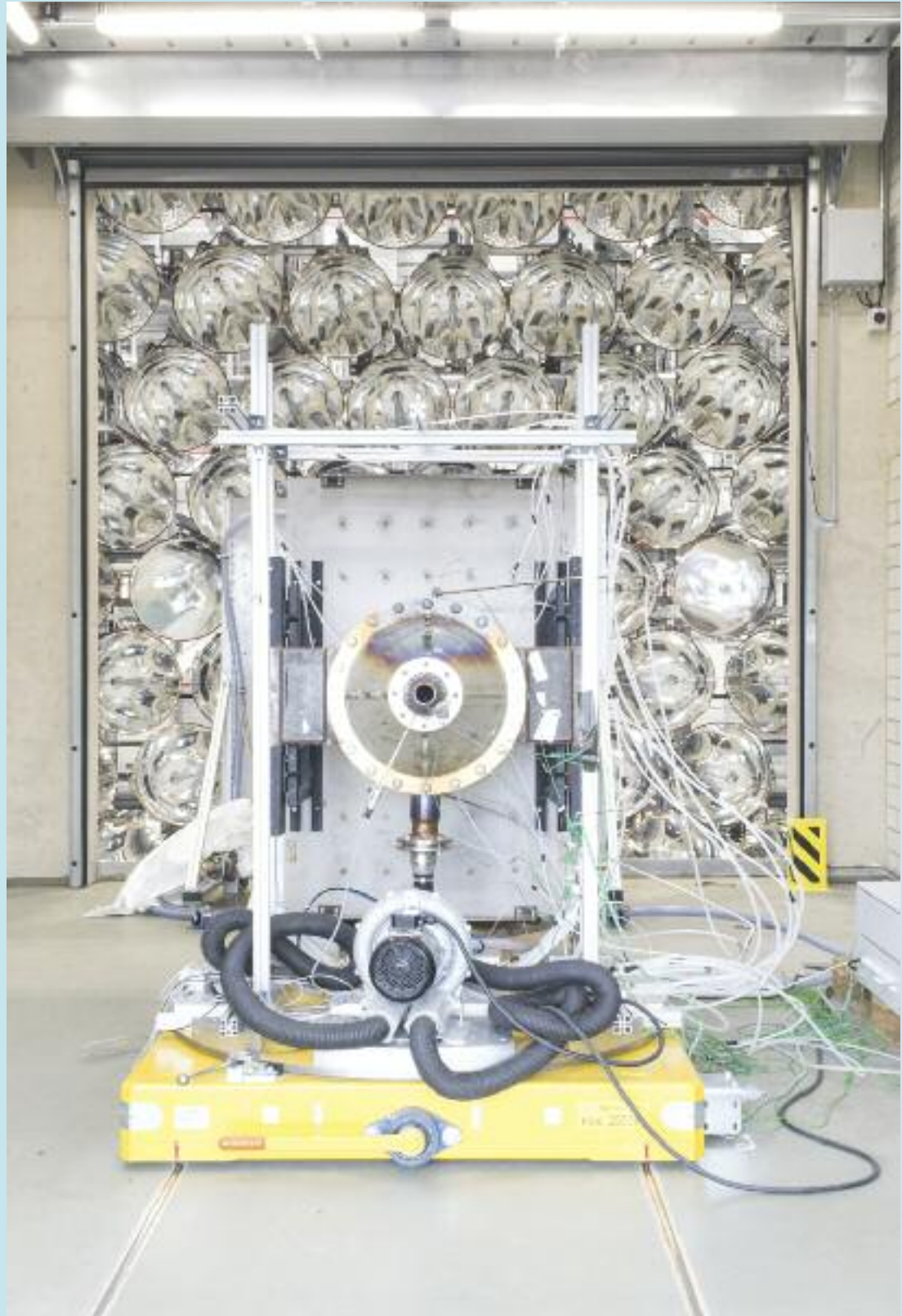
H energy

2

An artificial sun, the first in the world, from which energy and hydrogen can be obtained. Built in Jülich, in northern Germany, it consists of 149 short-arc Xenon lamps that together produce a light intensity 10,000 times stronger than is produced by sunlight hitting the Earth. In the two radiant chambers where the light converges, a concentration of over 11 megawatts per square meter is achieved. When all the lamps are oriented to concentrate the light on a single point, temperatures of about 3,500 °C are reached, about two or three times the temperature of a blast furnace. “With this artificial sun we will no longer need oil, gas or other renewable energies,” say researchers at the DLR Institute of Solar Research. Using this “synthetic sun,” in fact, German scientists have managed to develop a sustainable technique to extract hydrogen from the water vapor contained in the air.



Synlight, the world's first artificial sun, created in Jülich, Germany.



The 149 lamps that make up the artificial sun form a wall 16 meters high and concentrate their light on a single point, where the reactor used to generate hydrogen is located (photo above).

Inside the irradiation chamber, two researchers work on the reactor before an experiment.



Guardians of the climate

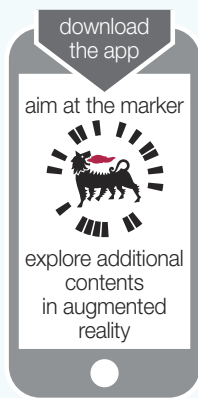


Above, the Global Space and Geodetic Research Antenna that points to the deepest sky. Scientists study how the earth's crust and atmosphere are changing by communicating with a quasar billions of light years away. Kai Shwaltenberg (left) is a German marine geologist and biologist. He dives into the Arctic sea to search for evidence of climate change.

Left, "Clock N.2" sets the exact time for the whole world. It loses one second every 65,000 years and is constantly connected with global satellites.



Ny-Ålesund is a settlement in the northwest corner of the island of Spitsbergen, the largest of the Svalbard archipelago, in Norway. It is a handful of houses scattered across the snowy terrain and inhabited mostly by researchers from all over the world. Scientists here study the ozone and collect data to monitor the climate and its changes. The researchers include René Bürgi from the University of Bern, renamed “Sky Walker” by colleagues after the famous character in the “Star Wars” saga, because René is the engineer who handles the laser beam. Every night, as soon as the stars appear in the clear sky, he turns on the laser and, with a noise like a puff of air, a beam of light rises straight up to the stratosphere. “We study the clouds, where a chemical reaction stabilizes molecules from human activity, increasing the hole in the ozone,” he explains showing a complex network of curves snaking across the control monitors. René and his colleagues spend the twelve months of their mission in front of these screens that chronicle the changing world, before being replaced from the mainland. The results of their research, translated into millions of data, are then processed by universities around the world. Meanwhile, on this stretch of land, which is a synthesis of the perfection of nature, scientists try to safeguard the survival of life. This is why the Global Seed Vault was built, a few kilometers south of Ny-Ålesund: a bunker under the ice, created to withstand nuclear and missile attacks, in which all the seeds of the world are stored. From the United States to North Korea, each country has sealed its biodiversity in a box and buried it in the Ark of the Apocalypse, as they call it in these parts, to preserve it over time and protect it.



Left, a laser beam shines through the atmosphere of the polar sky to study climate change.
Right, a French scientist shines a laser beam into the sky every night to study the clouds in the stratosphere, a new phenomenon due to terrestrial pollution.





The sixth day

The South Korean Sooam Biotech Foundation is the only organization in the world capable of cloning dogs. For a hundred thousand dollars, scientists extract DNA from a body and quickly blow it into the “black cells extracted from the mother that will provide the womb. We wipe their original DNA, thus transforming them into blank pages on which to write a new life,” explains Woo Suk, the biologist called “the Jedi” because, as in Star Wars, no one knows more about the power of cloning than he does. “It took thirty thousand tries to refine this technique. Cloning cats or other animals would be easier, but there is no market yet,” explains biologist Jae Wang, who is not coy about the commercial interest in the Foundation’s scientific research, and who explains that duplicating good DNA saves a lot of money. “Out of ten natural dogs trained for special operations, including counter-terrorism or rescue, only two prove to be up to par. Cloning the DNA of the best means we don’t waste time.” Thus the US government has asked for five copies of Trakr, the heroic German shepherd of the Twin Towers. These laboratories, however, clone not only dogs but also pigs and cows for human nutrition and experimentation, and a mammoth is also being brought back to life. Melting ice in the Arctic has revealed the intact remains of this animal that disappeared ten thousand years ago and Sooam is investing heavily in completing the map of its DNA and bringing it back to life, “to rebuild the ecosystem of the past and save Arctic biodiversity.”



In the large photo, three dogs cloned by the Sooam Biotech Foundation. Puppies have to spend 40 days in solitary confinement before being handed over to their owner. Left, in the waiting room, hang hundreds of images from all over the world portraying the cloned dogs with their owners. Above, the life of the cells to be cloned is preserved in liquid nitrogen at -196 degrees centigrade.

The race to take man to Mars began half a century ago. It is a challenge for which the US has invested seventeen billion dollars in space research in the past year alone. To prepare man for an essentially unlivable planet, without oxygen or atmosphere, NASA chose the Mauna Loa volcano in Hawaii. Here, six astronauts lived for a year enclosed in a space housing module, 2,800 meters above sea level, on the summit of the volcano. Under an 11-meter diameter white dome, the men and women in the crew spent their days eating only freeze-dried food, washing with powdered soap and sixty seconds of water a week, harnessing the energy of the sun, or pedaling on a bicycle to recharge the batteries and their muscles. Above all, they cut ties with the Earth, eliminating all external contact to simulate the perfect loneliness that will await them. "It is a planet very similar to Earth, there is a good chance that there is life. It is also a place where we will be able to survive if one day our planet should abandon us," explains Kim Binsted, director of NASA's Hi-Seas research project. For now, of course,

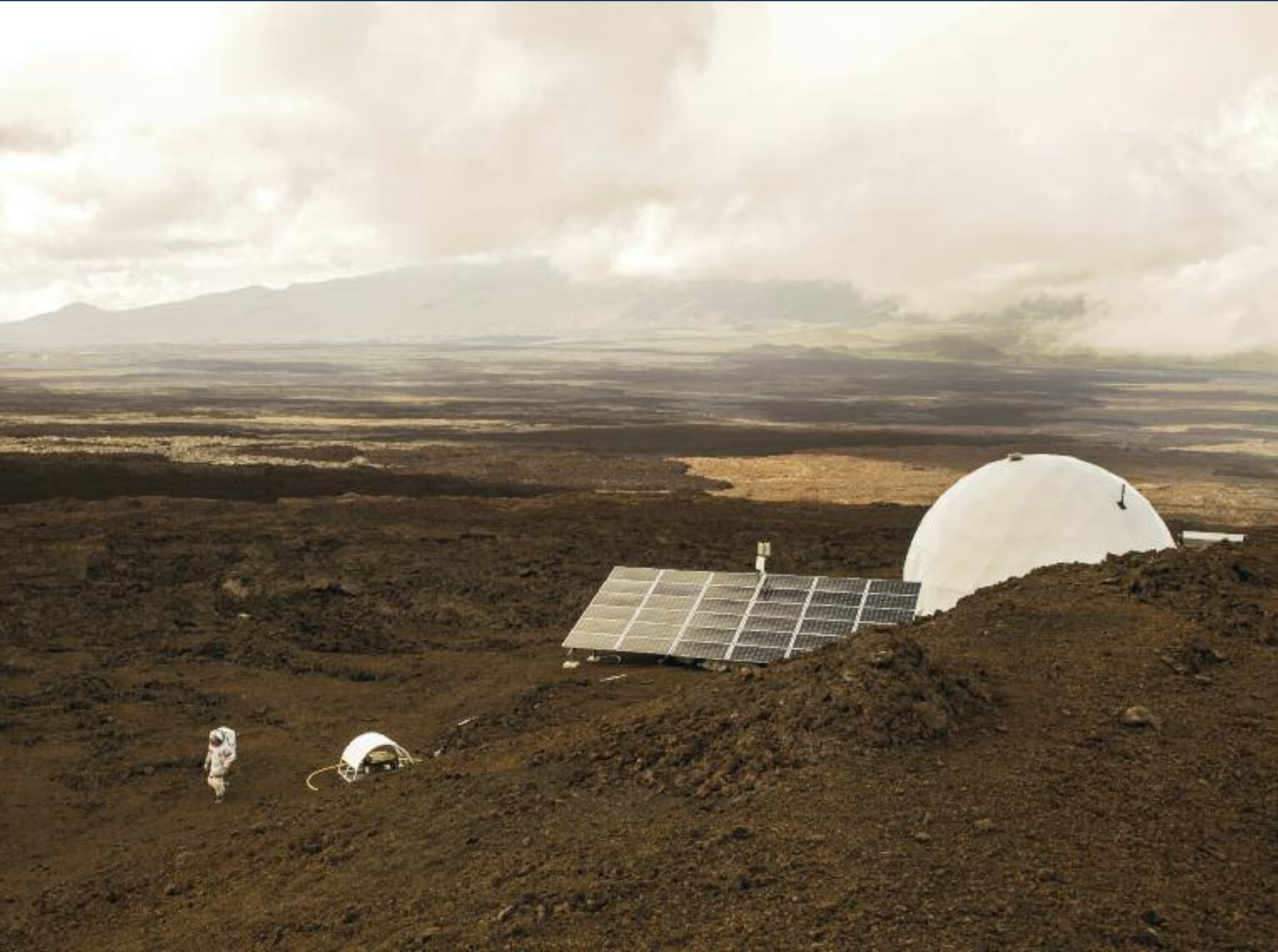
living conditions seem rather difficult. During the simulation year, the crew members came out of the white dome only twice a week for extra vehicular exploration (EVA) activities, but always locked inside the 20 kg spacesuit. "The first of us to go up there won't survive," says Carmel Johnston, 27, from Montana, crew commander. The outward journey will last seven months and once landed, the base will have to be built and an underground shelter quickly found to protect the crew from radiation, he explains. "And even if we manage to return to Earth, the exposure suffered will still be excessive and probably lethal. But my life will have had a meaning." On Mars, the daily temperature range can be up to 100 degrees, the wind blows at the speed of sound, the terrain is the most hostile desert that man can imagine, and, as on the slopes of the Mauna Loa volcano, the rocks are razor sharp. In the coming years, in any case, it is highly likely that robots that have evolved from Curiosity, the rover that has been trundling across the Martian lavas since 2012, will continue to set foot on the planet. But, according to Binsted, nothing can replace humans and their sensitivity: "If a researcher finds an interesting stone and thinks it might be useful to dissect it, he or she will do so immediately. Giving a robot the tools to do the same thing means imagining that action at least twenty years earlier."

New territories

French astronaut Cyprien Verseux shakes hands with his American colleague Tristan Bassingthwaighe during an Extra-Vehicular Activity (EVA). This is the term used to describe the work done by astronauts in space and outside their spacecraft.



French astronaut Cyprien Verseux shakes hands with his American colleague Tristan Bassingthwaighe during an Extra-Vehicular Activity (EVA). This is the term used to describe the work done by astronauts in space and outside their spacecraft.



Left, an astronaut explores a cave in the volcano. Center, Sheina Gifford is among the US astronauts chosen to colonize Mars. Above, the astronauts pantry. The food they ate for a year was mostly freeze-dried.



Survival scenarios



The market for family shelters and community bunkers has never been more prosperous. North Korean threats, international terrorism and climate change have been joined by fears about global epidemics and natural disasters, and those who can afford it have decided to save themselves, starting with the captains of industry and Hollywood stars. The most luxurious bunker in the world is already in operation. Named the "Survival Condo," it is located in Kansas, in the exact geographical center of the United States. It consists of 15 apartments built in the giant underground silos of a Cold War nuclear missile. It goes without saying that this is not a solution for everyone: each house costs five million dollars and the monthly condominium fees amount to twenty-five thousand dollars. Yet the bunker is already sold-out. Only seventy-five people in the world are admitted to the Condo, namely the owners of the apartments, who have a swimming pool with tropical ornaments to enjoy, plus an artificial lawn for dogs with the backdrop of the Colorado mountains, a cinema room and Google data backup. There is a supermarket, a hospital and private security armed to the teeth. Despite the effort to make it a normal place, there are many disturbing elements. One in particular is the absence of windows, replaced by screens that reproduce the view you prefer, among those captured by the cameras placed on the Kansas prairies.



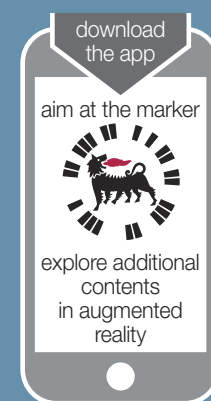
Opposite page, a bedroom in the super-luxury Europe1 family bunker, built in eastern Germany. Inside the Survival Condo there are swimming pools (above), supermarkets, a hospital and many other areas designed to accommodate residents for more than a year without ever having to leave. Left, the area dedicated to pets, 100 meters under ground.



Witnesses of creation



Restoring life to a place blasted by man and turning it into an enchanted garden. This was the “visionary” idea of the people who created the Eden Project: large geodesic domes housing over two million plants. We are in Cornwall, in southwestern England, in an area previously occupied by a china clay quarry used to manufacture ceramics. Tim Smit, a British man of Dutch origin, found himself on the edge of this open pit mine and realized that a tropical forest could grow on the barren stony ground. With the help of architect Nicolas Grimshaw, he created a structure using sustainable materials, self-sufficient in both energy and water. The floors are made of flax and corn, claddings created by recycling Heineken bottles and a system of overhead walkways was built. “I created this to display the beauty of nature and protect the biodiversity of our planet, but above all to show that nothing is impossible,” says Tim, strolling among the palm trees of his forest which welcomes a million visitors every year.



The biospheres of the Eden Project are the largest in the world. Experts believe the biosphere is an effective way to preserve forest biodiversity.

Top right, the domes of the Eden Project and the circular entrance structure, seen from the surrounding hills. Right, Tim Smit, founder of the Eden Project, in his tropical forest.



Immortality is the dream of every human being. And there are those who, since the seventies, have tried to make this dream a reality. Robert Ettinger, a visionary professor of physics and mathematics at Wayne State University, Michigan, invented cryopreservation. Today there are three companies in the United States and Russia that use this technology. One, the Cryonic Institute in Detroit, was founded by Ettinger himself, who hibernated history's first patients, including his wife, parents, and dog, at his institution, and ended up there too. Today, his son David Ettinger, a famous lawyer, explains the effectiveness of cryonics: "Our cells remain alive for a long time after we die. If we

Seeking immortality

intervene immediately by freezing the deterioration process, we will be able to return to life very soon". The academic world is skeptical about cryopreservation, because to date no living being subjected to these treatments has been successfully restored to life. Frozen patients are not considered dead, but simply have their lives suspended. "When science is able to rekindle life, each of us will be able to decide when to live in on or off mode, at any time and forever," says Hillary, who is in charge of freezing operations at the Cryonic Institute in Detroit. She studied Funeral Management after losing her mother in an accident.



Left, the waiting room of the Cryonic Institute of Michigan, in Detroit. It is the oldest center in the world for human cryopreservation. All the patient photos are framed on the wall of the Institute. Above, Max More, chief executive officer and president of Alcor Life Extension Foundation. In the room behind him is the area where 152 human bodies are frozen, looking forward to their next life.



Hillary, 24, is the funeral manager of the Cryonic Institute in Detroit. She is responsible for all the body cryopreservation operations.



The operating theater of the Alcor Life Extension Foundation cryopreservation company. This is where the patients' bodies are frozen. On the left is the sarcophagus

where the cooling process takes place for people who choose cryopreservation of the whole body. On the right is a machine for those who only require cryopreservation of the head.



Above, the China National Genebank sequencing room, where 150 machines are constantly working to map and archive the DNA of humans, animals and plants for scientific research purposes. Left, Dr. Shang, head of the team of scientists studying the possibilities of genetic modification in pregnant women. Right, the bank's data storage room.



In the hills of the Tai Pang Peninsula in southern China, stands a structure that is invisible to Google. Satellites in the sky see only meadows and woods, but the flickering shadows of the bamboo forests hide the China National Genebank, a 50,000 square meter structure commissioned by the Chinese government and built by BGI, the world's largest DNA research organization, to archive the life codes of every living being. Inside ten stories of raw concrete and glass, under its vegetation covered terraces, hundreds of machines map the genome, creating digital archives that touch the ceiling. The structure houses laboratories filled with light, where five thousand researchers rewrite the destiny of mankind. "Our mission is to create a better future," explains Professor Xun

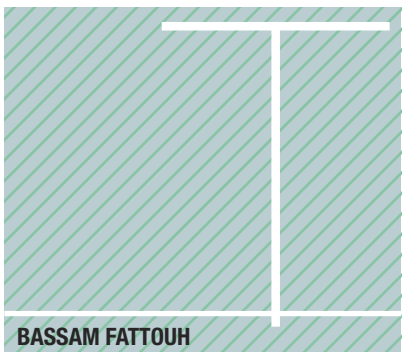
The map of life

Xu, a world-renowned scientist and vice-president of BGI. "Thanks to these studies, the day will come when genetic diseases are wiped out and treating a tumor will be like treating the flu. We will create new species and the cell phone will become our first doctor," he adds, serenely depicting a new world. "Homo sapiens is entering a new stage of evolution. This is where the Transomic Era is born, where humans decide on their evolution."

Oil/The price crisis and its impact on business models

The Recovery Will Be Driven by Demand

The revival of the oil sector is intricately linked to growth in demand, which will determine how prices recover. It remains to be seen how much the pandemic will speed up the energy transition, but regardless, the hydrocarbon sector must continue to invest in measures that align it with low-carbon scenarios



BASSAM FATTOUH

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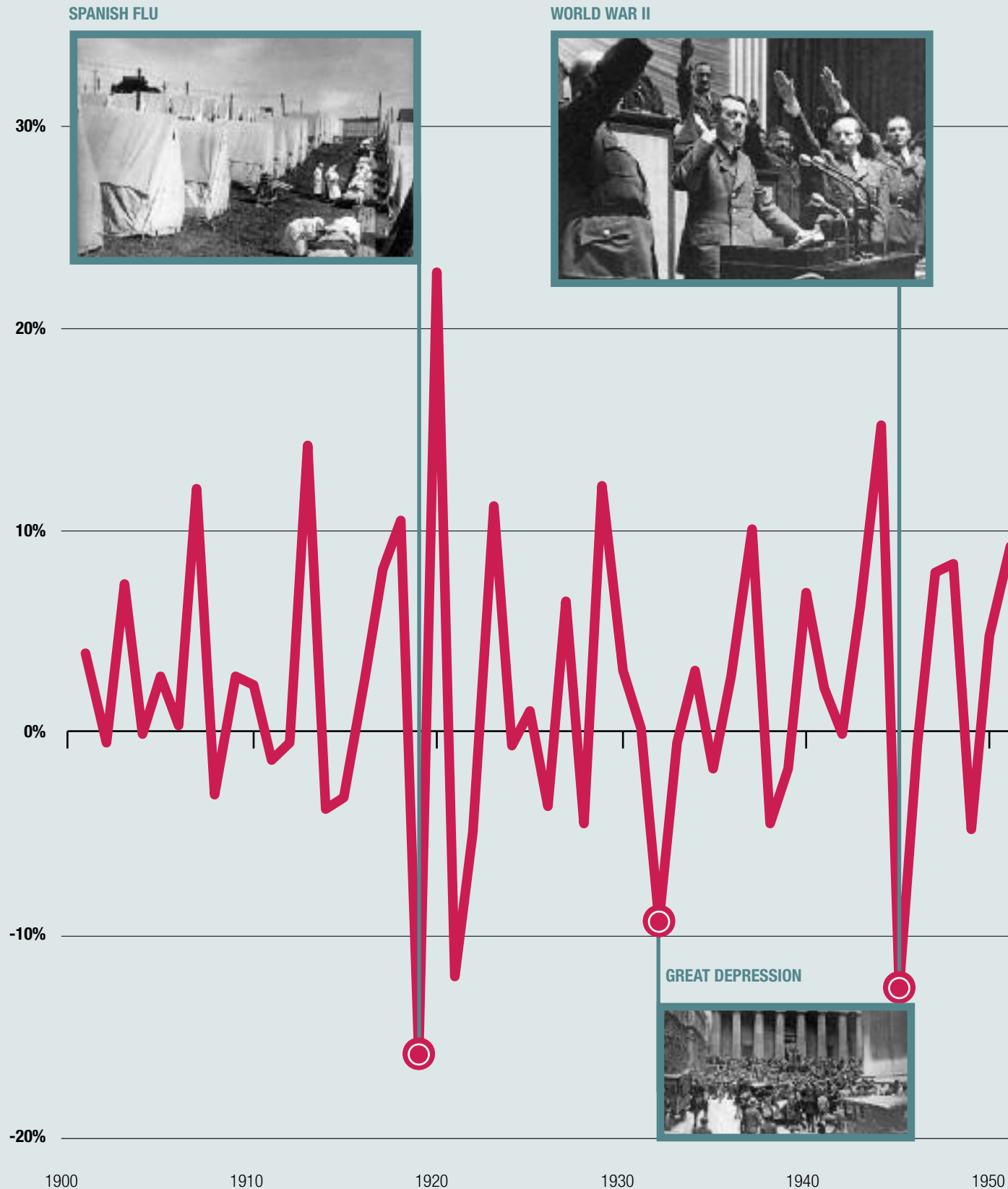
The spread of COVID-19 and the dissolution of the OPEC+ agreement in March have generated one of the largest shocks in the history of oil markets. While the increase in supply due to the breakup of the OPEC+ agreement contributed to the price fall and accelerated its decline in March and April, this is first and foremost an oil demand shock caused by the severe contraction in economic activity. In fact, recent analysis shows that even without the increase in supply due to the breakup of the OPEC+ agreement, oil prices would have reached their low at about \$20 per barrel. However, the severity of the price fall focused the minds of the world's largest producers and, unlike with the 1997-1998 and the 2014-2016 price cycles when it took years for the producers to reach an agreement to cut output, producers' response was much faster. OPEC+ was able to reach an agree-



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The demand for oil, 1900-2020

The demand for oil is closely linked to the performance of the world economy. The graph opposite shows how consumption has fallen in conjunction with global crises, whether health-related, such as the Spanish flu of 1918-1920, geopolitical, such as the energy shocks of 1973 and 1979, or economic/financial, including the 1929 depression and the sub-prime mortgages crisis of 2008. The drastic reduction in global economic activity and travel during the first quarter of 2020, due to the spread of COVID-19, depressed global oil demand by 3.8% compared to the same period of 2019.



ment in April to implement a historic cut. Also, unlike the 2014-2016 cycle, the declines in oil output outside OPEC+, particularly in the US and Canada, were sharper and faster during this cycle.

Price recovery and determining factors

These reductions in supplies, alongside the recovery in oil demand as lockdowns over the globe started to ease, lifted the price of oil from below \$20 in April to the \$40-\$45 price range. However, looking forward, the price recovery could be choppy and will be shaped by a

number of factors. As a result of OPEC+ cuts, there is plenty of spare capacity in the system and over time this capacity will start leaking back into the market either as part of a deliberate policy to ease cuts or if OPEC+ compliance weakens. Also, crude and products stocks have reached high levels which will act as additional buffers that cap oil prices. However, the most important factor that will shape the price recovery is the demand side of the equation. In this regard, there are three key uncertainties surrounding global oil demand recovery: Will there be a second wave of lock-

downs? When (if ever) will oil demand recover to the pre-virus level? Once the global economy stabilizes, will the growth rate in oil demand return to the pre-virus level? The reality is that no one knows the answers to these questions and at best one can only construct different scenarios and assess their differing impact on oil balances and prices. Also, the last two questions are directly related to the researchers' views on the speed of the energy transition and whether COVID-19 has accelerated its pace. Many believe that COVID-19 could hasten the peak of global oil demand with some even

arguing that oil demand may have already peaked and that it will never reach its pre-virus level. But there is no clear evidence to support this or the alternative view.

The projections of oil demand growth are highly sensitive to underlying assumptions such as economic and population growth, government policy and shifts in consumers' behavior. One key assumption relates to the growth rate. Many economists believe the world economy is already experiencing "secular stagnation" and that COVID-19 will reinforce some of the underlying elements of that stagnation. Increased uncertainty will

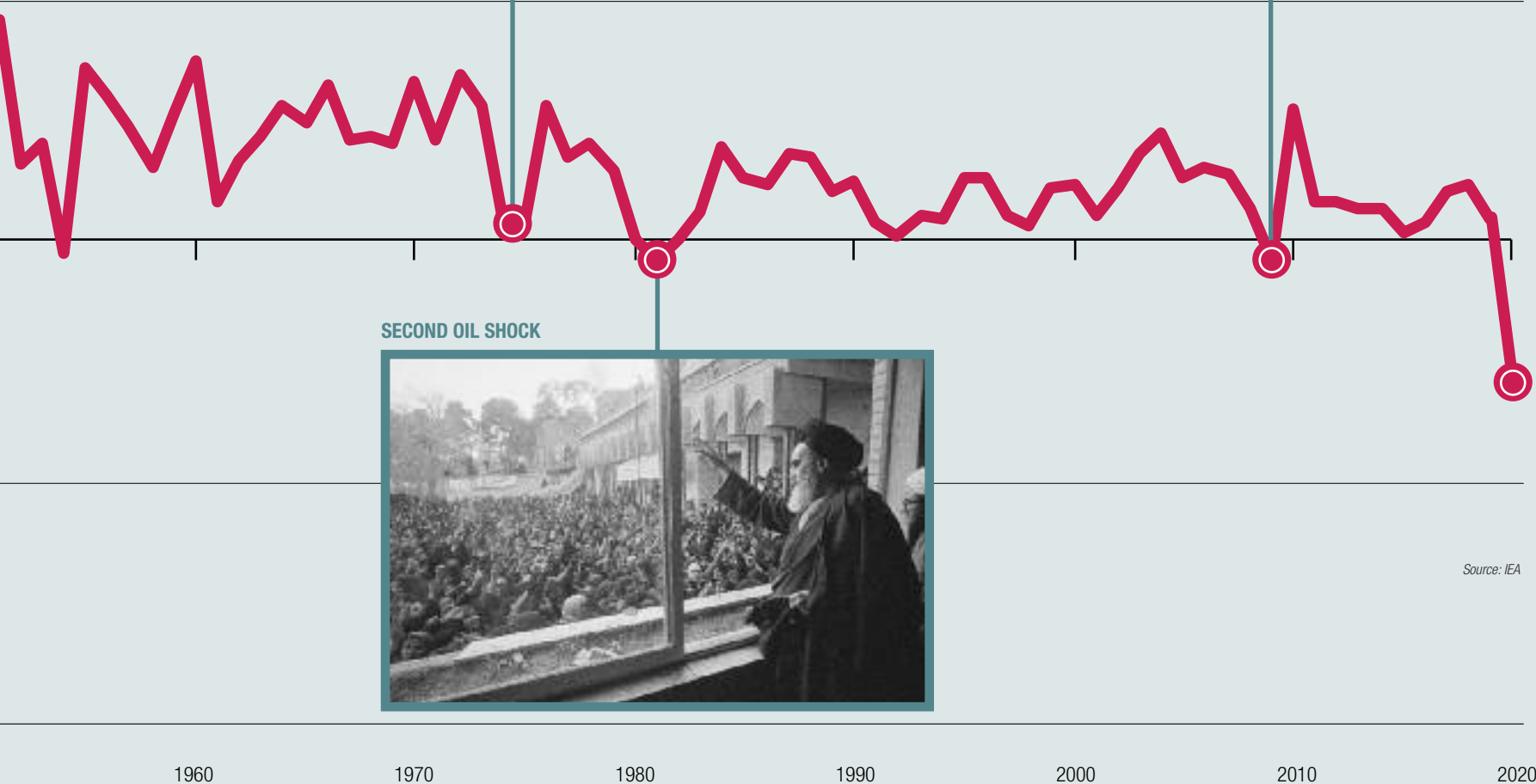
FIRST OIL SHOCK



FINANCIAL CRISIS



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SECOND OIL SHOCK



Source: IEA

raise precautionary savings for households and reduce firms' incentive to invest, especially because many have seen their debt levels soar after months of crashing revenues. Also, many are of the view that globalization, which has been the main engine for growth for the past few decades, has peaked and that COVID-19 will accelerate the break-up of global supply chains. World trade is no longer expanding faster than world GDP and it is estimated that uncertainty may slow the expansion of global value chains by at least 35 percent. All these factors could shift the global economy to a slower growth

path and thus lead to slower energy demand and emissions growth. In this context where pre-virus engines for growth have stalled, government stimulus measures to kick-start economies are key to the global economic recovery. Some governments are in a good position to increase spending and finance it through increased borrowing. According to the IMF, global public debt is expected to reach an all-time high exceeding 100 percent of GDP in 2020-2021, a surge of 19 percentage points from a year ago. Average overall fiscal deficit is expected to soar to 14 percent of GDP, 10 per-

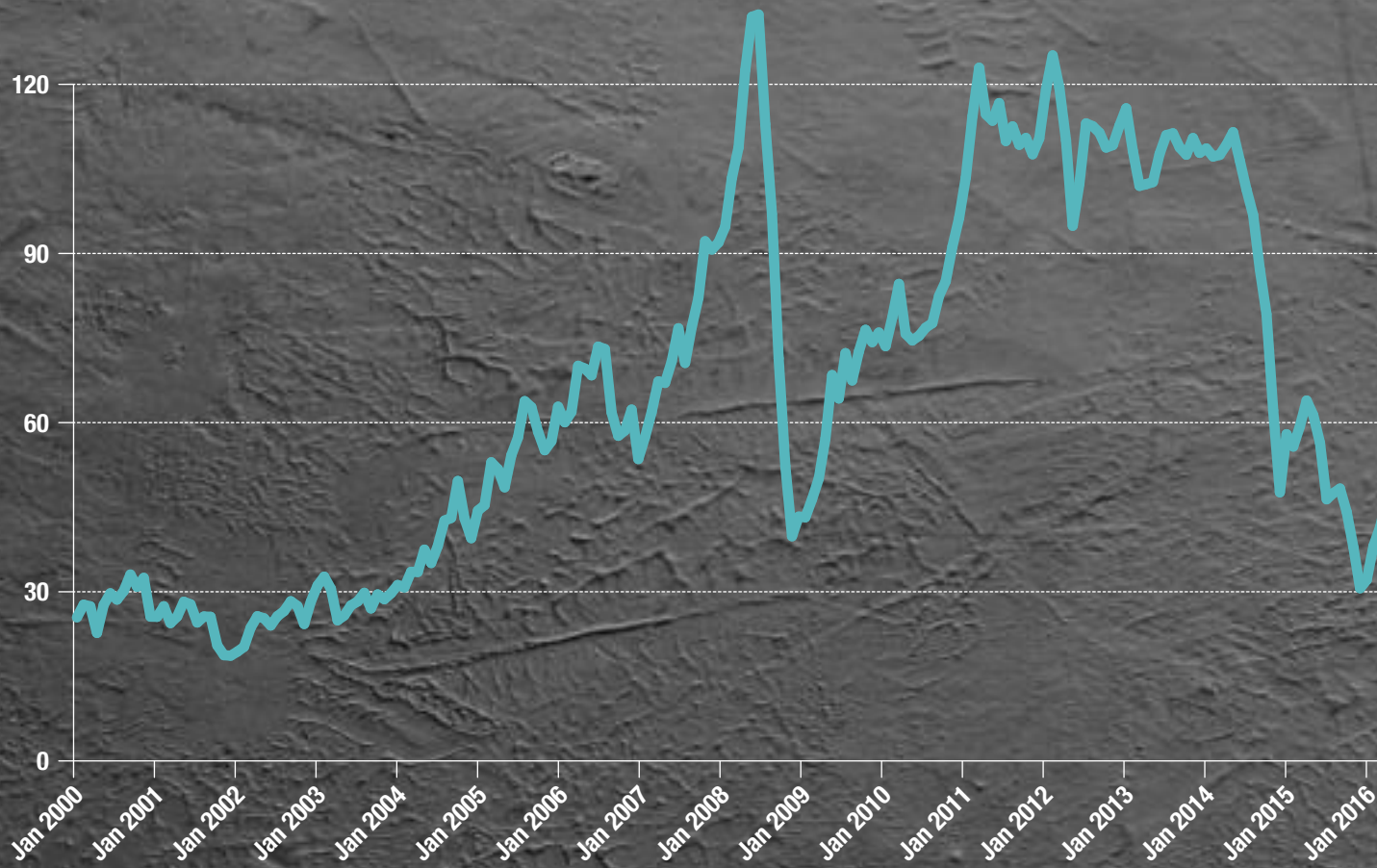
centage points higher than 2019. The current environment of low interest rates is conducive for many governments to increase their debt ratios, stimulate the economy and spur growth of badly hit sectors.

The opportunity to speed up the energy transition

But unlike the 2008 global financial crisis, there has now been much more pressure for stimulus measures directed towards projects that accelerate the energy transition and move us closer to a zero-carbon emission economy. For instance, there have been calls for these stimulus packages →

Twenty years of prices

The economic crunch due to the spread of COVID-19 and the termination of the OPEC+ agreement have led to one of the biggest crises in the history of the oil markets: in April 2020, crude oil prices fell to an all-time low of \$18.31 per barrel. However, unlike what happened in the 2014-16 cycle, producing countries responded very quickly. In April, OPEC+ reached an agreement to make a historic production cut. The decrease in supply, together with the recovery of oil demand as the lockdowns in the various countries began to ease, has brought the price of oil back to between 40 and 45 dollars.



to unleash massive investment in renewable power systems, boost the construction sector via green buildings and green infrastructure, provide targeted support to innovative low-carbon activities and accelerate the transition of the fossil fuels industry. While the world should not miss on the opportunity to move to a more sustainable path and a decarbonized energy system, these calls to kill two birds with one stone face serious challenges:

- Stimulus measures should first and foremost be growth-promoting and be implemented as early as possible. Some projects can achieve both targets of promoting green policies and stimulating the economy. For instance, through investment in more efficient buildings, governments could stimulate the construction sector. However, this dual target can't be achieved for all types of investments or projects, and in such cases, the green stimulus should not act as a barrier to economic recovery.

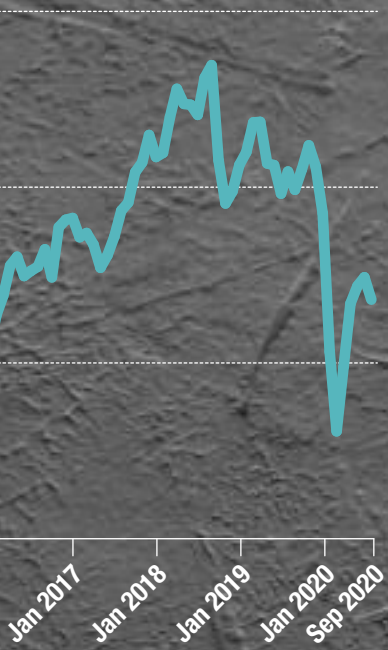
- Although it may be possible to scale up renewable projects such as solar and wind fairly quickly, this is not the case for other projects such as hydrogen and CCUS (Carbon Capture Utilization and Storage) which still lack a functioning and mature hydrogen/CCUS industry able to absorb capital immediately at a large scale.
- Different parts of the world will follow different paths depending on their portfolio of assets. For instance, countries such as China and India could support both the solar and coal industries as the latter can achieve multiple objectives such as promoting growth in some regions and enhancing energy security.

In short, the confidence bands around oil demand projections are very wide and will depend among other things on the ability of governments to stimulate the economy, the type of stimulus packages put in place, the lack of uniformity in the energy transition around the globe,

and its non-linear presentation, as COVID-19 has shown. However, regardless of whether oil demand grows at the pre-virus level once the economies stabilize, the debate on peak oil demand matters because it has resulted in a massive shift in perceptions about the role of hydrocarbons in the energy mix and this is altering the behavior of key players—be they governments, financiers, companies or consumers—with effects on the energy sector. For instance, there is evidence that the energy transition risks have impacted investors' risk preferences and their general attitude towards the sector. This could in turn affect the availability and cost of finance. Most of the international oil companies are already shifting their portfolios towards low-carbon projects such as gas and renewables and restructuring their business models towards higher electrification. COVID-19 will reinforce this shift in perceptions. For instance, there is a strong belief that oil consumption related to mobility and car ownership will fall

sharply as more people decide to work from home. On the other hand, the pandemic could induce a drop in the use of public transport, create a preference for more private passenger vehicles and lead people to avoid planes in favor of cars when possible. Furthermore, while people's purchasing habits may turn increasingly to digital platforms, reductions in shopping trips could be offset by higher delivery truck miles. But here policy is key as governments could choose to ride the wave of enforced changes in consumer behavior and go for "green recovery" initiatives such as the electrification of the vehicle fleet and/or the adoption of hydrogen in trucking. These shifts in perceptions and aspirations about the changes in the energy mix are occurring much faster than what could realistically be achieved on the ground. History shows that factors such as scale, legacy assets and path dependency imply a slow change in the energy mix. And while COVID-19 may have accelerated shifts in consumers' behavior, it

Source: U.S. Energy Information Administration



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is still early to tell how durable these changes will be and whether the new work and driving habits on their own will result in a massive reduction in oil demand. While it is true that stimulus packages may be directed more towards greener projects than previous recovery programs, it is also true that the environment has become more challenging for many players. The IEA notes that “the speed and scale of the fall in energy investment activity in the first half of 2020 is without precedent and that many companies reined in spending, project workers have been confined to their homes, planned investments have been delayed, deferred or shelved and supply chains interrupted.” COVID-19 has also hit households very hard, particularly those in low income brackets, and thus governments will be reluctant to shift the cost of decarbonization to consumers. And although governments have introduced massive stimulus packages and have increased their debts ratio to stimulate the economy, concerns

about “fiscal imprudence” may result in shifts in policy that weaken the stimulus. Furthermore, COVID-19 has exposed the weaknesses of existing frameworks of global cooperation and coordination.

How international oil companies will behave

In this context, international oil companies (IOCs) find themselves in a very challenging position. An accelerated transition would pose a significant challenge for IOCs, disrupting their business models and undermining their profitability. Decarbonization and maintaining high returns within the existing set of technologies and business models is not feasible and thus investment in low-carbon energy technologies that are able to generate returns higher than current renewable projects is key for those companies aiming to participate in the energy transition, or to lead it. Also, while low carbon technologies represent a new and an expanded opportunity set, questions

remain as to whether IOCs will be able to capture these opportunities and develop business models that ensure viability and profitability.

IOCs are required to make such a transformation at times when investors’ appetite for financing the sector is waning and finance is becoming more restricted and more costly. Also, to increase their attractiveness, IOCs are under pressure to return money to their shareholders through dividends and buyback programs. COVID-19 and the lower oil price has made things worse by eroding their profitability and reducing the relative attractiveness of hydrocarbon projects vis-à-vis renewables which have lower long-term returns but offer low risk and stable cash flows. The dilemma that IOCs face reflects a deeper issue. There are costs associated with the energy transition and shifting these costs solely to IOCs, shareholders or consumers is not realistic and will not achieve the desired objective. These costs should be shared. Direct government support and taxation (e.g., environmental taxation) should aim to get to net zero carbon as quickly and efficiently as possible, in a way that is technology neutral. So far, government support for decarbonization has concentrated on decarbonizing electricity, but decarbonization of electricity and electrification will not take us to net zero emissions; at most, they may enable a country to decarbonize 60-70 percent of the economy. Other decarbonization measures are needed and IOCs are well suited to deliver some of them.

Business as usual for IOCs is not a choice regardless of what happens to oil demand. There is a clear realization that any company that fails to appreciate the changes induced by climate change concerns and societies’ desire for cleaner energy could lose its societal license to operate, its competitiveness, its ability to attract and keep talented personnel and even its access to capital. The IOCs are already well into the transition and are currently pursuing different opportunities that are broadly consistent with the decarbonization objective. These opportunities could be broadly divided into two. First, IOCs are investing in areas where decarbonization involves replacing fossil fuels, for instance renewable power and electrification of energy markets. These are opportunities for IOCs, but by doing so they move away from their core competitive advantage and will compete with many other players, for instance from the electricity sector and especially the digital world. Another more general challenge for IOCs investing in these low carbon technologies is to show

that they are better placed than others to succeed; and in fact, most of their investment has concentrated in large offshore wind projects, where their know-how confers to them at least some competitive advantage. IOCs are yet to make a strong case to financial markets, shareholders and the wider society that they can prosper producing renewable electricity, if indeed there is such a case to be made.

Second, IOCs are also making investments to sustain existing lines of business and lower emissions compared to business as usual, for instance by improving efficiency, capturing and storing carbon, reducing methane emissions, decarbonizing natural gas and setting carbon offsetting schemes. These are needed as renewable power technologies and electrification alone will not come close to full decarbonization of the energy sector. These are areas where IOCs (as well as some national oil companies) have comparative advantage, and in which they could demonstrate leadership. The stimulus packages provide the IOCs with a unique opportunity to do so. They should tap these packages and demonstrate that decarbonization of their activities and products can be achieved, that the projects are scalable, and that they have the ability to manage big projects and complex supply chains, integrate projects and develop technologies to decarbonize the energy mix in the most effective and least costly manner. One reason why carbon capture and sequestration (CCS) or hydrogen from methane do not receive much political support is that their feasibility and competitiveness at scale has not been demonstrated. Through such demonstration projects, IOCs can establish the costs and benefits and prove scalability, enhancing their position as leaders in the transition and competing with other players for public funds. This is the time to partner with policy makers and to push for public-private partnerships to promote innovation.

What the above shows is that, irrespective of which of the two strategies is taken (or a combination of the two), there is a fundamental trade-off between expected return and the variance of return, i.e., the cost of reducing the long-term risks and increasing resilience is to accept lower expected return on existing assets by investing in measures that align the hydrocarbon sector with low carbon scenarios. This lowers the overall return but reduces the risk of business disruption in the long run. Both IOCs and shareholders should acknowledge this trade-off.



The Momentum Behind the Clean Molecule

Hydrogen has had a few false dawns, but this time is different. It is now supported by a broad coalition of companies and enjoys unprecedented political support



LUCA FRANZA

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The COVID-19 pandemic has brought many things to a halt. Momentum for hydrogen is not one of them. The clean molecule—which holds great promise for storing zero-carbon energy and transporting it over long distances, coupling gas and electric systems, and decarbonizing hard-to-abate sectors—is still the talk of the town. In the EU, the unprecedented decision to allocate hundreds of billions of euros for green recovery further improved the outlook for hydrogen. The energy consultancy Wood Mackenzie has recently revised its estimate on future green hydrogen capacity upwards. The total capacity of announced green hydrogen projects that will become operational by 2025 is 3.2 gigawatts (GW), 12 times as much as total capacity installed in the period 2010-2020.

Hydrogen keeps on rocking

So much is going on in “hydrogen country” that it is hard to keep track of all the daily news. Since the spread of the COVID-19 outbreak to the EU, there has been a further acceleration in the adoption of hydrogen policy visions and in the announcement of international agreements. The EU launched its Hydrogen Strategy on 8 July, following the publication of the Dutch and German national hydrogen strategies in April and June respectively. In parallel with the EU Hydrogen Strategy, the EU Strategy for Energy System Integration and the Clean Hydrogen Alliance have been launched. In July, eleven infrastructure companies presented an EU Hydrogen Backbone Plan.

Not only policy visions, but also concrete projects are moving forward. In the Netherlands, the ambitious NorthH2 project—hinged on plans of sizeable green hydrogen production from offshore wind—was launched at the end of February. In July, HYZON opened Europe’s first dedicated hydrogen truck production factory in the Netherlands. While frontiers between EU countries were being closed to limit the spread of the virus, a cross-border hydrogen infrastructure project between France and Germany—MosaHYc—was announced at the end of May.

In June, the Italian energy infrastructure company Snam signed a five-year agreement with Alstom, a promoter of sustainable mobility, to develop hydrogen trains in Italy, and in July it successfully tested the world’s first “hybrid” hydrogen turbine with Baker Hughes, the oil field service company, to pave the way for hydrogen-gas blending in Italy. ENI—which has recently embarked on a reorganization process to step up decarbonization efforts—announced in June that it will scale up its carbon →

capture and storage (CCS) project around Ravenna to create one of Europe's biggest CO₂ and blue hydrogen hubs.

In July, Spain's Iberdrola and Fertiberia signed an agreement to build large solar PV installations and electrolyzer capacity to produce green hydrogen and ammonia, which will be used in the production of fertilizers. Portugal is also moving fast. In July, the projects chosen as beneficiaries in the framework of the country's national hydrogen strategy were announced. H₂ Sines by EDP and Galp and H₂Enable by Bondalti Chemicals are the largest. All of the abovementioned projects, started after the beginning of the COVID-19 outbreak, add to numerous projects launched in 2019 and before, which are listed in a useful IEA Database.

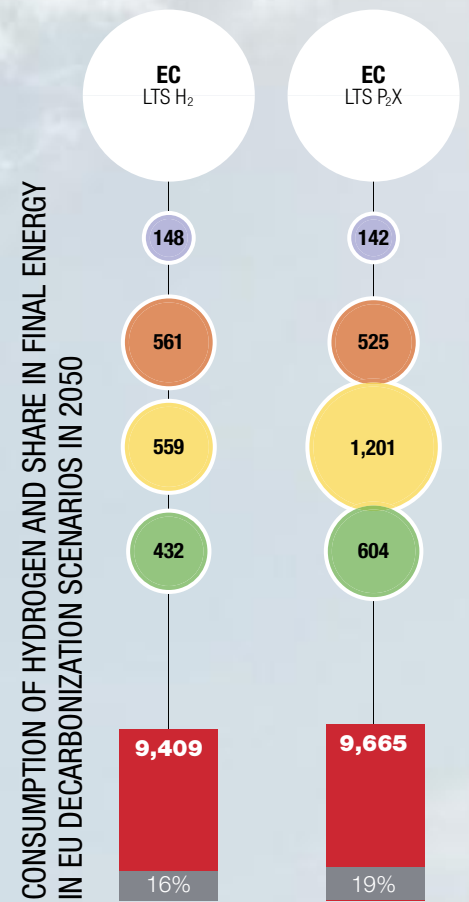
Scaling: the importance of competition and coordination

Hydrogen projects are increasingly ambitious in their scope and scale, with a significant number of them already targeting large-scale production. In practice, however, clean hydrogen production scaling still needs to be achieved. This will be the main challenge that the hydrogen industry will have to win in the next years. Final investment decisions (FIDs) will be made once there are sufficient guarantees that projects are financially sustainable in the long term.

Importantly, recent project announcements span across the entirety of what will be the future hydrogen value chain: from the construction of dedicated renewable energy systems (RES) capacity, electrolyzers and steam methane reforming/CCS facilities to hydrogen-ready pipelines and fuel cells, trucks, trains and other hydrogen appliances for hydrogen in end-use sectors. Often, single projects involve diverse stakeholders that are collectively able to coordinate upstream, mid-stream and downstream investment. Finally, while until 2018 hydrogen was only raising interest in a handful of countries—like Japan, Norway and the Netherlands—there are now hydrogen projects in virtually every EU country and also outside the EU and including MENA neighbors that seek to exploit and export their remarkable RES production potential. Competition—namely among electrolyzer and fuel cell producers—is welcome, in order to bring down costs. A prospective race between the EU and China on hydrogen technologies, for example, should be saluted as an enabler of a global breakthrough. While cheap Chinese technologies crucially helped the uptake of solar PV, this time the EU will have to do a better job at balancing

An ever increasing presence

Hydrogen will be an increasing presence in the European energy mix. Hydrogen projects are increasingly ambitious in terms of scope and size, and many are already destined for large-scale production. The graph shows how in most of the scenarios (developed by Institutes, Agencies or by the European Union itself), hydrogen and derived fuels represent between 10% and 23% of the EU's final energy consumption by 2050.



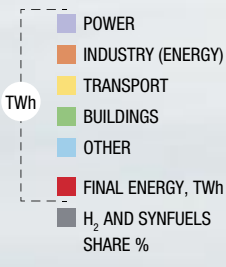
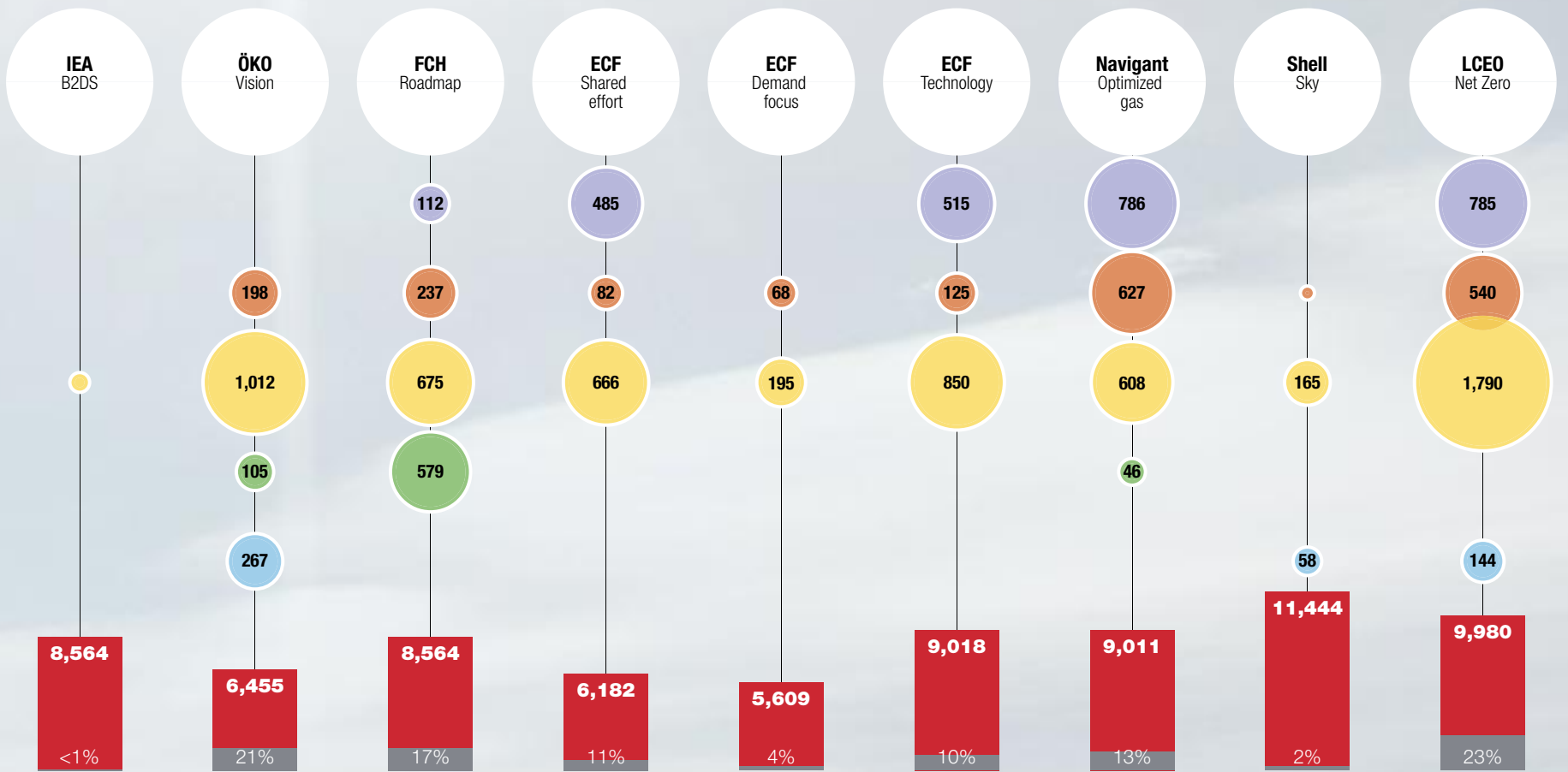
the interest of achieving industrial leadership (and not losing first-mover advantage) and allowing market dynamics to abate costs. In the meantime, the current tangible pressure to be ahead of the curve is healthy because it induces companies to take bold steps. Alongside competition, forms of coordination are needed because some hydrogen investments are interdependent. For example, in order for schemes to bring North African hydrogen to Europe to be successful, there needs to be high-level coordination to align investments in renewable energy installation, gas pipeline conversion (or construc-

tion of dedicated hydrogen lines) and end-user markets—to make sure that the timing of supply and demand creation is synchronized. Long-term contracts with state guarantees might also be needed to make hydrogen projects bankable, similar to the natural gas market creation fifty years ago.

Why COVID-19 could have killed the momentum for hydrogen—and why it didn't

COVID-19 had raised concerns that large energy investors would become reluctant to invest in riskier, visionary projects and would prioritize quick returns, focussing on their

core business. Other concerns were that smaller hydrogen technology providers would face bankruptcy and that budget-constrained governments would cut hydrogen-enabling investments. The latter scenario would probably be the worse, as it is estimated that seventy percent of energy transition investments will have to be allocated by governments. In the initial phase of the COVID-19 crisis, it was unclear whether the EU would deprioritize decarbonization. The fear was that efforts to support the “old economy” sectors that form the backbone of the EU economy would absorb all of the EU's financial capacity. These concerns are not fully



– Hydrogen for non-energy uses is not included, hydrogen for syngas is included based on 75% efficiency (for EC, ECF and Öko scenarios).
 – Hydrogen for power generation is not consumed as final energy.

EC: A Clean Planet for all - A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy, European Commission, 2018, November

IEA: Net Zero by 2050: from whether to how, International Energy Agency, 2017, June

ÖKO: The Vision Scenario for the European Union, 2017 Update for the EU-28, Öko-Institute, 2017, February

FCH: Hydrogen Roadmap Europe, Fuel Cells and Hydrogen, Joint Undertaking (FCH 2 JU), 2019, February

ECF: Net Zero by 2050: from whether to how, European Climate Foundation (ECF), 2018, September

Navigant: Gas for climate, Ecofys / Navigant, 2019, March

Shell: Sky - Meeting the goals of the Paris Agreement, Shell, 2018, March (regional coverage is EU+)

LCEO: Deployment Scenarios for Low Carbon Energy Technologies, Joint Research Center, 2019, January

Source: Joint Research Centre (JRC)

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dispelled, but things are definitely moving in the right direction. For now, the EU Hydrogen Strategy is a broad vision and significant doubts exist on the feasibility of its targets. However, its adoption could not have been more timely, as it gave strong and immediate signs that commitment to clean molecules would be maintained and even raised; paved the way for and started to identify the regulation needed to unlock market opportunities for hydrogen; and provided a framework to channel private and (booming) public investment towards hydrogen. This proved crucial to maintain momentum for hydrogen in the EU in the

midst of the COVID-19 crisis. Another welcome element of current hydrogen plans is their marked international dimension, in an era of growing fragmentation and autarkic temptations. At the same time, the EU seems committed to use hydrogen as an opportunity to build industrial leadership and strategic autonomy. Hydrogen should be used to establish new links of positive interdependence with countries of its Southern and Eastern Neighborhoods, whose prosperity is crucial (also) for stability in the EU.

This time is different
 Yes, hydrogen has had a few false

dawns, but this time is different. It is now supported by a broad coalition of companies, from utilities to car manufacturers, from oil companies to transmission operators. Some of them are faced with existential threats and massive stranded asset risks—factors encouraging them to bet on hydrogen. It also enjoys unprecedented political support. As a recipient of green recovery funds, it can be one of the few grounds of political synergy between Northern and Southern Europe. RES production costs have come down significantly, increasing the viability of green hydrogen relative to 20-30 years ago—when the fuel made

a false start. At the same time, system adaptation costs due to RES are rising. The limitations of near-full electrification pathways (and their hefty costs) are increasingly clear as RES deployment increases, proving the need for clean molecules as enablers of RES. To be sure, hydrogen needs to see huge investments to take off. At the same time, it holds the promise of long-term affordability. The possibility to re-use existing gas infrastructure offered by hydrogen should not be missed at a time when it is particularly important not to waste precious resources.



Transport/The Secretary General of the International Transport Forum

Build Back Better

COVID-19 and climate change pose a monumental double challenge to our mobility. Transport needs to react, reboot and rethink



YOUNG TAE KIM

He is the Secretary-General of the International Transport Forum (ITF), the world's only body with a mandate for all modes of transport. The ITF currently has 62 member countries and is a sister-organization of the OECD. Each May, the ITF organizes the Summit of Transport Ministers, which includes a dialogue with business leaders.

global health crisis of the magnitude we are experiencing has not struck the international community for over a century. All countries and all areas of our daily life are profoundly affected and in disarray.

No cure for the new disease exists at this point. Recent results suggests that highly effective vaccines are on the way, but it will take time before they can be approved and distributed. In the meantime, humankind remains exposed.

The sole weapon we currently possess against the virus is to reduce close physical contact among humans as much as possible. The virus is incapable of travelling, but we humans inadvertently carry it to new places where it can wreak havoc.

As a result, the world has witnessed a near standstill. From local transport to global supply chains, nothing has been spared. In urban traffic and on global trade routes, bustling movement has given way to eerie calm. Roads around the world resemble arteries without blood, as one commentator put it. Activity in the aviation sector has fallen to unheard-of lows, as have car sales in many countries. In cities around the world citizens' mobility is in single-digit percentages compared to the pre-coronavirus era.

A paradigm shift for transport

The transport sector finds itself in an unprecedented situation, as one of its chief societal roles is to enable citizens to meet face to face and it is therefore perhaps our greatest facilitator of social interaction. However, that function has come to a grinding halt as a result of the limitations im-



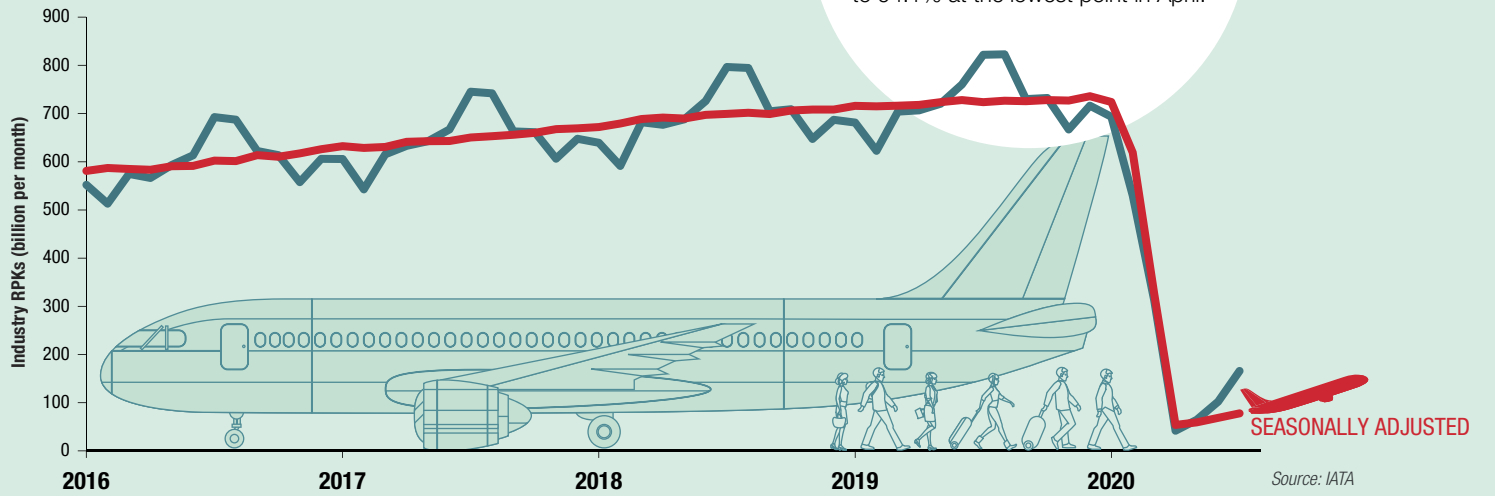


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Sector crisis

AIRPLANES

Aviation is one of the sectors most affected by the COVID-19 crisis. The 80% global decline in the number of flights operated has caused severe financial distress to the sector, so much so that a loss equal to double that recorded in the global crisis of 2008 is estimated. The sector is expected to experience its biggest shock of the century.

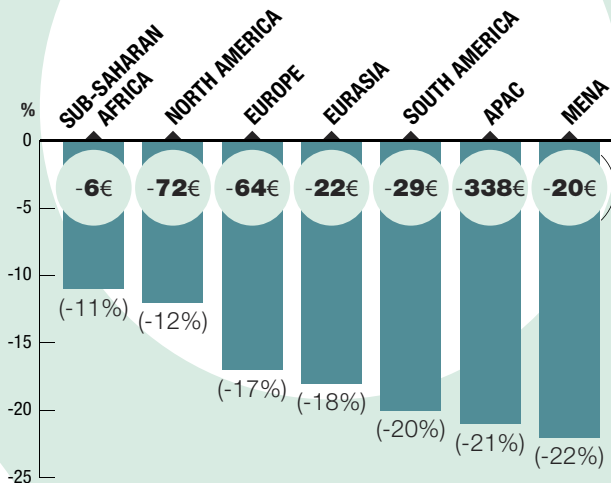


ROAD TRANSPORT

Globally, road freight companies are expected to suffer losses of over €550 billion in 2020. European passenger transport, particularly affected by the lockdown measures, is facing losses of €80 billion. Revenues have fallen by 80% on intercity scheduled services and up to 100% on tourist and cross-border bus services.

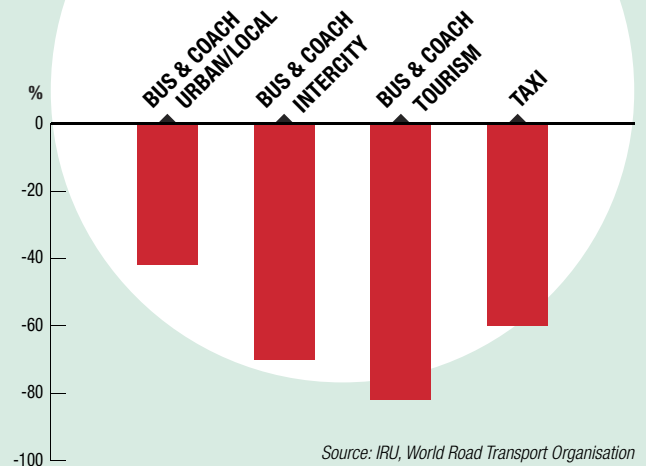
TURNOVER IMPACT BY REGION ON ROAD FREIGHT TRANSPORT

FY 2020² (billion euros)



IMPACT ON 2020 PASSENGER TRANSPORT TURNOVER BY SEGMENT

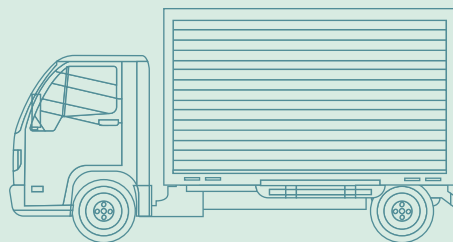
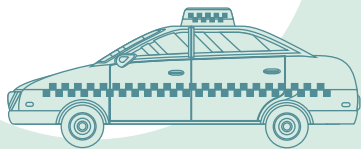
FY 2020¹



COVID-19 IMPACT ON ROAD PASSENGER TRANSPORT

Impact on FY 2020¹

-81 billion€
(-57%)



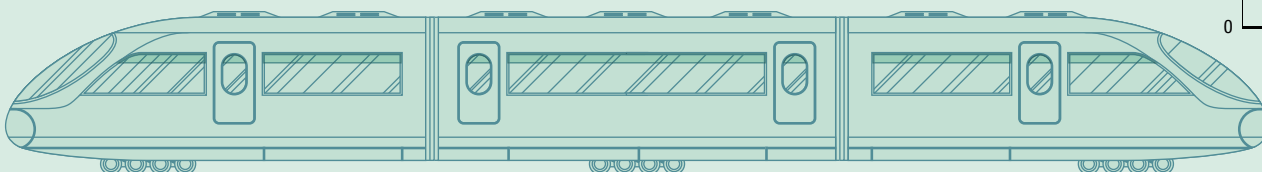
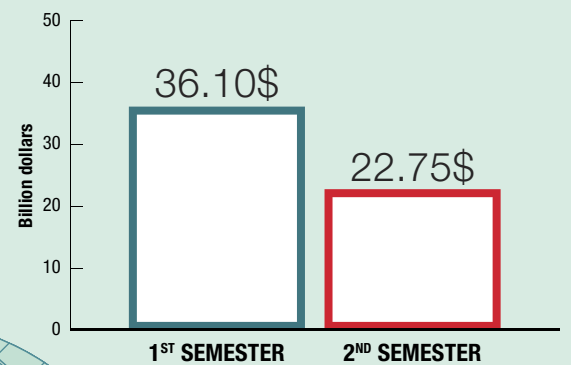
¹ European Union (27) + UK, where the road freight annual turnover represents 1% of the nominal GDP

² Estimation based on 78 major economies

RAIL TRANSPORT

Rail transport has also suffered a severe backlash. Looking at revenues, the estimate shows over \$36 billion in losses in the first half of 2020. Losses are continuing in the second half of the year with around \$23 billion in lost revenues in the second half of the year. In total, almost \$60 billion have been lost in 2020.

LOSSES IN PASSENGER REVENUES IN 2020



Source: Management Of COVID-19, UIC COVID-19 Task Force

posed by the spread of the coronavirus around the world.

At the same time, transport must continue to function where moving people and goods is an imperative, not a choice. Doctors and nurses must be able to get to work, hospitals must be able to receive needed supplies and confined citizens rely on deliveries reaching nearby shops. Not least, international supply chains must continue to move as seamlessly as possible to keep inevitable economic impact limited.

It is a paradigm shift as world leaders have never before put such constraints on the movement of people and goods. Decisions are now needed on ways to run transport services within these constraints in such a way that the sector can survive this difficult time.

Health workers are the undisputed heroes of the current struggle. Not far after them come the truck drivers who deliver food supplies to supermarkets, the bus and taxi drivers who take doctors and nurses to their workplace in hospitals, the ship crews that keep supply chains from faltering entirely, and the pilots who have been flying stranded travelers home. We owe them gratitude and, above all, every effort to ensure they can do their job as safely as possible.

Overcoming the crisis

The transport sector as a whole has responded to the coronavirus crisis with compassion and creativity. Car makers have shifted production to build respirators. Rail operators have turned high-speed trains into rolling hospitals. Grounded airline cabin crews with first-responder training have supported medical professionals. Taxis and ride-sharing services have offered free transport to patients and medical staff and delivered food to vulnerable citizens. And there are many other examples.

As terrible as the crisis is, it brings out the best in many and is also a reminder of three essential factors for a successful recovery. First, we will overcome the crisis more quickly and effectively if we work together across existing divides. Companies from very different fields teaming up to build breathing aides together provide a very practical example in this respect. Second, expertise and evidence-based decisions make all the difference. We will hardly beat the virus and resurrect our economies based on guesswork and gut feelings. The sharing of private sector mobility data with governments to help contain COVID-19 infections is an example where these two basic tenets come together. Third, while we deal with the crisis in the most effective way, we must also think about the future and plan for the post-pandem-



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ic age. Few dispute that the world after the crisis will be different and most agree that many, and profound, changes will be forced upon us. We have both the knowledge and tools to shape decisions and to pursue opportunities in this epochal transformation, but we must make the right choices.

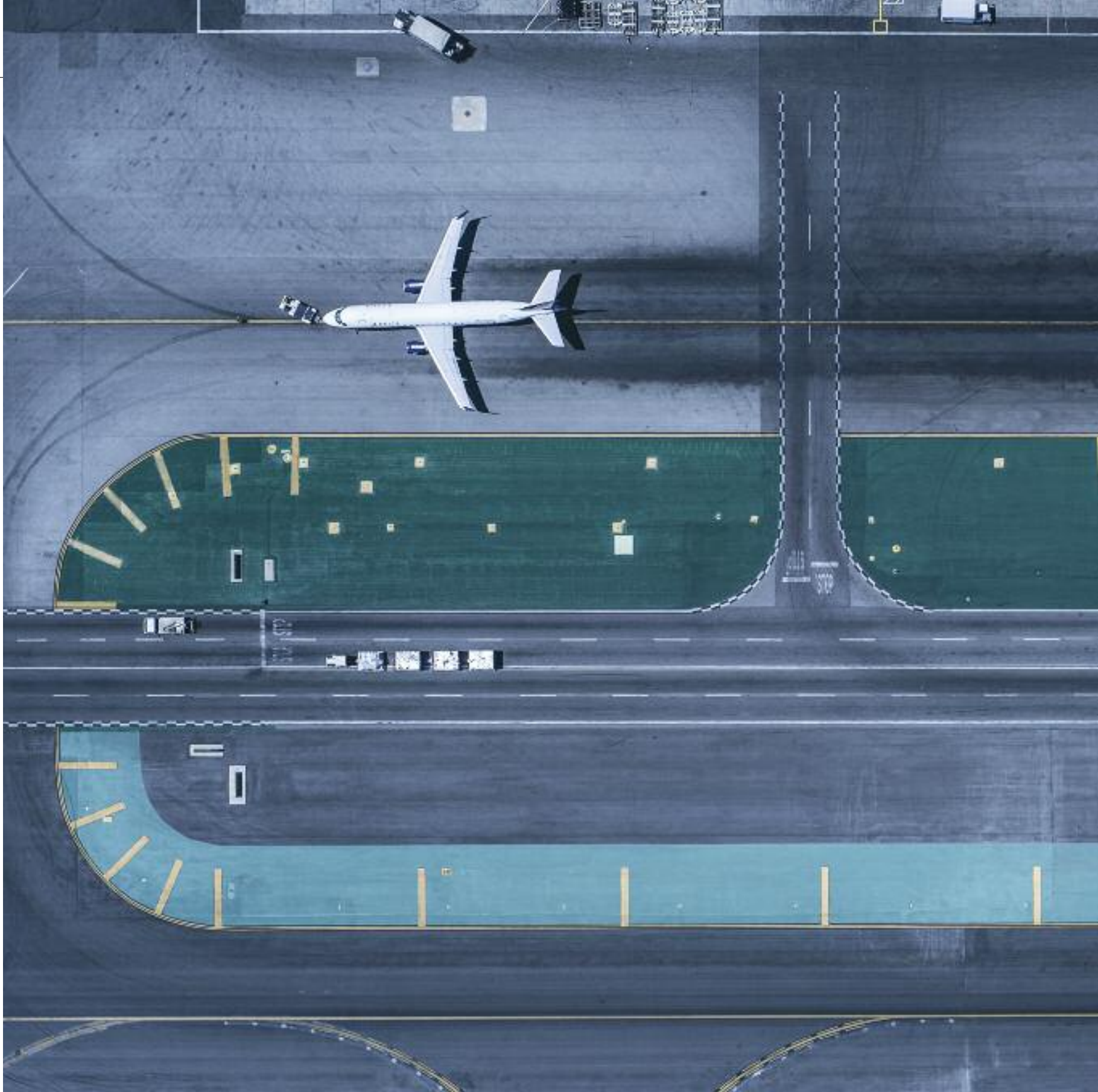
Preparing for the coming transformation

Some observers have pointed to the positives associated with the unprecedented drop in transport activity. Air pollution has fallen markedly in many regions and greenhouse

gas emissions from transport are likely to be 20 percent lower in 2020 than under normal circumstances according to projections of the International Transport Forum (ITF). The number of traffic deaths is likely to fall because of fewer cars on the roads. Cycling has gained ground as a low-risk, healthy alternative to shared transport in many places. More than a thousand cities worldwide have converted road space into temporary pop-up bicycle lanes, also known as “corona lanes.” Many mayors aim to make these changes permanent and that would profoundly change the urban fabric of cities. New →

A CONCRETE ANSWER

The transport sector as a whole has responded to the coronavirus crisis with compassion and creativity. Car makers have shifted production to build respirators. Rail operators have turned high-speed trains into rolling hospitals.



technologies such as drones and automated vehicles are also showing their potential by carrying out tasks with the minimum human contact that the present situation calls for.

Yet there is a risk that even these few upsides of a bleak and harrowing crisis may not last. If our economies rebound by burning fossil fuels following an unheard of—and urgently needed—economic stimulus program, CO₂ emissions, including those from transport, could quickly increase.

The lessened demand for energy caused by COVID-19, for oil in particular, has been exacerbated by a supply shock due to the end of restraints on production from OPEC producers and Russia (OPEC+) in early March. This combination increased the risk of underinvestment in oil sup-

ply and could lead to rising oil prices once demand bounces back. The result could be a less solid economic recovery—unless greater energy efficiency mitigates the rebound.

How to square circles

All this increases the importance of policy action. Governments now have the ability to set policies in ways that will boost the transformation of transport towards more sustainable, more accessible, more resilient and more inclusive mobility. We need to “build back better.”

To exit this crisis strengthened rather than weakened, transport needs to do one thing above all others: find a common path forward with the energy sector. Almost half a century after the first oil shock, transport is still 94 percent dependent on fossil oil.

Clean mobility is impossible without clean energy. Now is the historic moment where both sectors need to come together with a common vision, a common roadmap, and common tools to decarbonize.

To chart a common pathway, world leaders need to square a few circles. Policies that effectively tackle climate change and improve air quality must accompany policies that make energy more affordable and enable easier access to energy for the developing world.

One immediate task for decision makers is to promote investment in solutions that combine lower emissions of greenhouse gases and air pollutants with greater energy efficiency. For the transport sector, the most promising way to turn this vision into reality is to quickly shift demand for



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mobility to more efficient transport modes, to drastically increase the share of low-emission vehicles and to greatly expand the use of low-carbon energy vectors for the transport of people and goods.

An electrifying prospect

Public transport excels in terms of energy use per passenger-kilometer but this only holds true with enough users on board. Ensuring that public transport riders are safe, and feel safe, in the COVID-19 era will be critical to keeping public transport environmentally sound and economically viable. The use of masks, the sanitizing of vehicles and stops, the use of enhanced air filtering technologies are all necessary actions that deserve government support, in order to regain the confi-

dence of citizens that collective transport remains a safe mobility option. At the same time, the pressure to make the transition to affordable low-emission vehicles and low-carbon fuels will grow. Smaller and lighter vehicles, electrified or even non-motorized, offer urban dwellers new mobility options. Yet for them to become ubiquitous, the fabric of our cities must become more welcoming and adapted to make their use easy and safe—notably by providing charging infrastructure and allocating road space differently.

The necessary investments are also needed to create new jobs quickly and provide a springboard for future growth, and the electrification of transport is a candidate for such a green growth strategy. It already offers a cost-competitive complement,

MORE SUSTAINABLE MOBILITY IS NEEDED

The transport sector is facing an unprecedented situation due to the restrictions imposed by the coronavirus. Political action plays an important role in this situation: governments now have the opportunity to implement policies aimed at stimulating the transformation of the sector, creating more sustainable and more resilient mobility.

Photo: Los Angeles airport.

and even an alternative, to mobility using internal combustion engines, and the opportunities for reducing urban pollution, increasing energy efficiency and enhancing energy diversification are undeniable.

Electrification also offers greater possibilities for creating different and even entirely new products. Electric motors have greater potential for miniaturization and customization than traditional vehicle propulsion systems, and they are also easier to integrate into existing systems, which reduces investment risks—as hybrid and plug-in hybrid powertrains show. The economics of battery production are continuously improving, and countries that attract investments from battery manufacturers and electric vehicle makers will benefit from resultant sustained growth.

The time of silos is over

Some of these opportunities may also exist for other alternatives to oil. Low-carbon hydrogen and fuels derived from hydrogen and biomass (including electrofuels) may turn out to become game changers for powering ships, aircraft and trucks operated over long distances where direct electrification faces greater challenges. Hydrogen is not yet available at a price that most end users could afford, but that may change as more cheap renewable electricity becomes available, for instance from offshore windfarms. Natural gas could also provide low-emission energy for generating hydrogen—as long as it is paired with carbon capture and storage and avoids atmospheric leaks of methane, a potent greenhouse gas.

Our aim at the ITF, now more than ever, is to help decision makers in government and industry translate their decarbonization ambitions into actions. One concrete way in which we are doing this is with the Transport Climate Action Directory (www.itf-oecd-org/tcad), launched in July 2020. The Directory contains more than 60 different transport CO₂ mitigation measures along with the evidence base needed to assess their effectiveness in specific contexts and thus to implement measures that achieve leaders' climate objectives.

Transport and mobility are at the epicenter of the two defining challenges of our times, the accelerating climate emergency and the global COVID-19 health crisis. Both are inextricably linked, and both demand immediate action as well as strategic responses. While we need to act decisively now to meet both these challenges, it must not be at the expense of a considered long-term response. We should heed the advice of the great French scientist Louis Pasteur, whose discovery of the principles of vaccination saved millions of lives: “Chance favors the prepared mind.”

Solutions to overcome the crisis and mitigate its impact must be found across transport modes and across economic sectors. The time of silos is over. In concert with other sectors—energy foremost among them, but also with trade, tourism or urbanism—the transport sector will have to play a central role in the recovery. The International Transport Forum will contribute its share—by carrying forward the global policy dialogue for better transport, and by helping governments to build an evidence base for better decisions in these difficult times.



Smart cities/The strategies to make urban spaces more livable

Flattening the Curve in the City



In

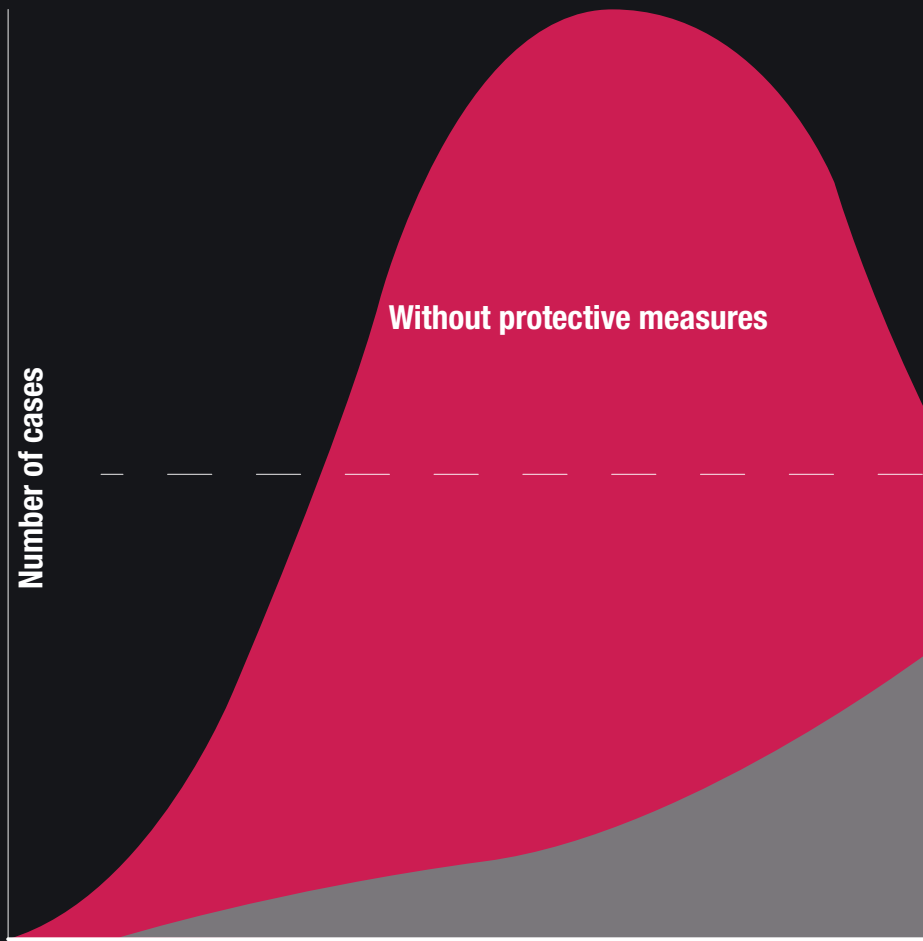
CARLO RATTI

An architect and engineer, he teaches at MIT, where he directs the Senseable City Laboratory. He is also the founding partner of the CRA-Carlo Ratti Associati international design and innovation firm. He is currently co-chair of the World Economic Forum's Global Future Council on Cities and Urbanization.

a well-known scene from the first film in the Fantozzi series (centered on the eponymous Italian literary and film character, created in the early 1970s and played by the writer and actor Paolo Villaggio), the narrator solemnly recounted what happened when the lead woke up and began his frantic race against time to get to work: "To make sure he could stamp his timecard at 8:30 a.m. exactly, 16 years ago Fantozzi used to set his alarm to 6:15. Today, by dint of continuous experiments and refinements, he managed to set it to 7:51... that is, at the limit of what is humanly possible!" In a memorable sequence, after going out to the street through his window, Fantozzi rushed into an oppressive urban landscape, dodging kicks and punches until he managed to jump onto a bus overflowing with people. Cities are inhabited by thousands of Fantozzis, all driven by the urgency to stamp their timecard at the same moment.

Number of cases

Without protective measures



Diluting demand when it exceeds the maximum capacity of a system has been an effective strategy during the pandemic to prevent infrastructure from meltdown. The same tactic could now be used to reduce peak demand for roadways, transit and other systems



A concept gone viral

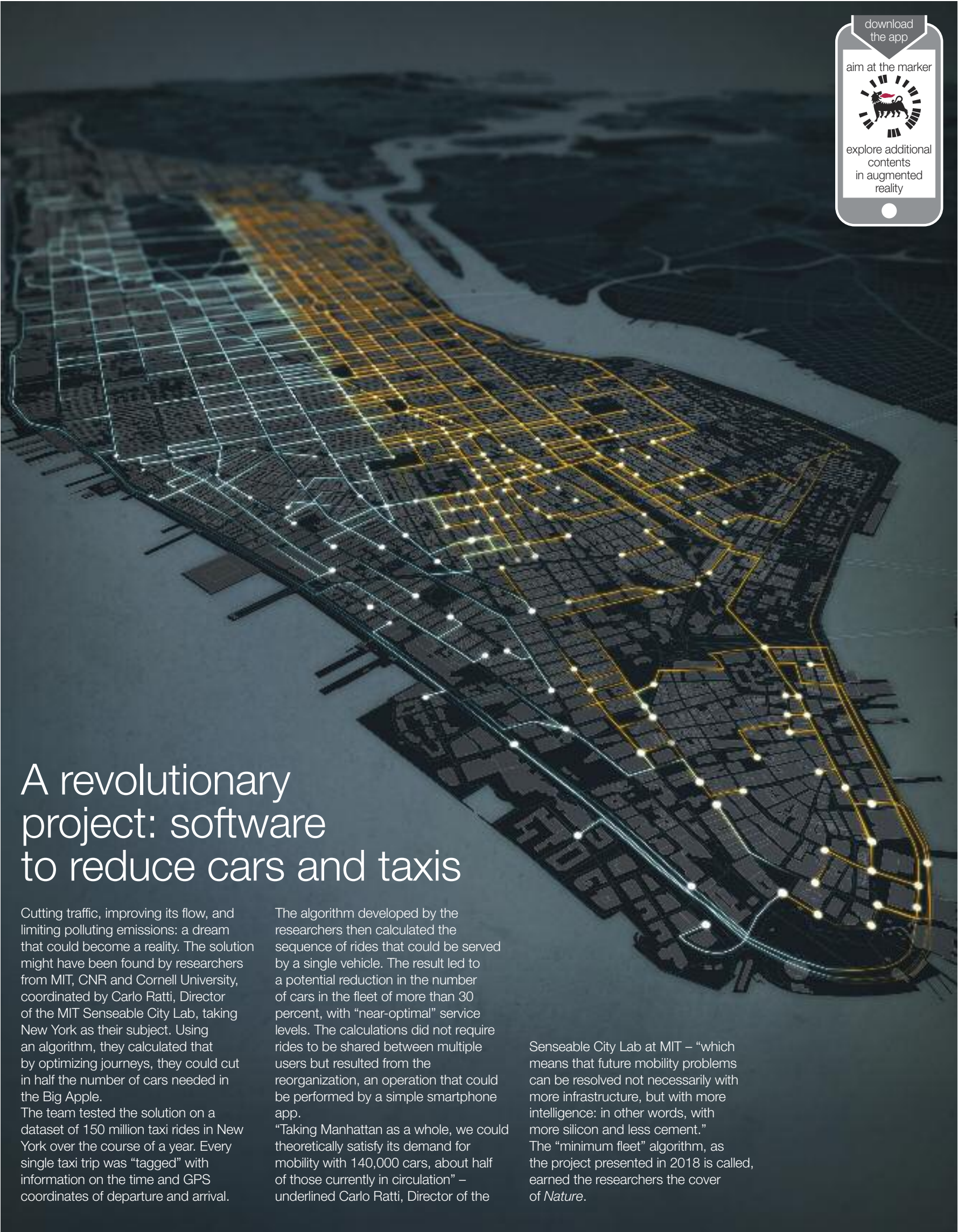
The concept of flattening the curve came about only a few months ago, when an American scientist, Drew Harris, tweeted this chart, which went viral. Harris, Assistant Professor at the Thomas Jefferson University College of Population Health, did not produce the graph himself: he saw it in *The Economist*, where it was published as the repurposing of a study conducted 13 years ago on the effects of social distancing on the spread of a COVID-19 like virus. Harris used the graph to convey a concept that became highly significant: “The longer it takes for coronavirus to spread the population, the more time hospitals have to prepare.” The concept was then summarized as flattening the curve, a key to combating the pandemic, but one also applicable to other fields.

Healthcare system capacity

With protective measures

Time since first case

Adapted from CDC/The Economist



A revolutionary project: software to reduce cars and taxis

Cutting traffic, improving its flow, and limiting polluting emissions: a dream that could become a reality. The solution might have been found by researchers from MIT, CNR and Cornell University, coordinated by Carlo Ratti, Director of the MIT Senseable City Lab, taking New York as their subject. Using an algorithm, they calculated that by optimizing journeys, they could cut in half the number of cars needed in the Big Apple.

The team tested the solution on a dataset of 150 million taxi rides in New York over the course of a year. Every single taxi trip was “tagged” with information on the time and GPS coordinates of departure and arrival.

The algorithm developed by the researchers then calculated the sequence of rides that could be served by a single vehicle. The result led to a potential reduction in the number of cars in the fleet of more than 30 percent, with “near-optimal” service levels. The calculations did not require rides to be shared between multiple users but resulted from the reorganization, an operation that could be performed by a simple smartphone app.

“Taking Manhattan as a whole, we could theoretically satisfy its demand for mobility with 140,000 cars, about half of those currently in circulation” – underlined Carlo Ratti, Director of the

Senseable City Lab at MIT – “which means that future mobility problems can be resolved not necessarily with more infrastructure, but with more intelligence: in other words, with more silicon and less cement.” The “minimum fleet” algorithm, as the project presented in 2018 is called, earned the researchers the cover of *Nature*.

download the app

aim at the marker

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The Fantozzi scene reminds us of the unpleasant conditions faced by commuters and other workers every morning. But there is another way to improve this situation. We could put into practice what we have learned in the last few months of the pandemic—the strategy of flattening the curve.

A valid strategy beyond the pandemic

The mantra of flattening the curve was based on the insight that cases of COVID-19 infection can be better managed if they are spread out over time. Social distancing and the use of masks cannot stop the virus, but they can help slow its spread, avoiding the overload of hospitals and shortages of mechanical ventilators or beds.

Something similar happens in other contexts. When demand exceeds the maximum capacity of a system, any given infrastructure (hospitals, highways or power grids) becomes congested and approaches meltdown. By diluting the demand for health-care, the strategy of flattening the curve has saved many lives. That same strategy could be used by our cities to make them better places to live.

Although things have improved somewhat compared to the extreme synchronization of urban life in Fantozzi's time, city infrastructures continue to suffer due to peak demand problems. Nine o'clock commuters clog the streets, causing traffic jams and accidents, and the same happens at lunchtime or in the evening on their way home.

Some might now suggest that we simply upgrade the road network. In fact, this would not solve the problem, but would result in oversized and expensive infrastructure, assets destined to be underused most of the time. To improve the efficiency of our cities, we can take a better course of action by diluting peak demand.

The flexible working arrangements we have discovered over the course of the COVID-19 pandemic present us with a unique opportunity to reschedule our agendas wisely and avoid overloading city infrastructures. In the last few months, many of us have begun to travel in a staggered manner, going to the office on alternate days and at alternate times. As well as reducing the risk of infection, this means that traffic flows can be spread out more evenly. Hopefully, after the end of the pandemic, each of us can continue to enjoy this flexibility. Let's imagine what might happen if one colleague in our working group started the day via Zoom, not arriving at the office until noon, while another, already at their desk at

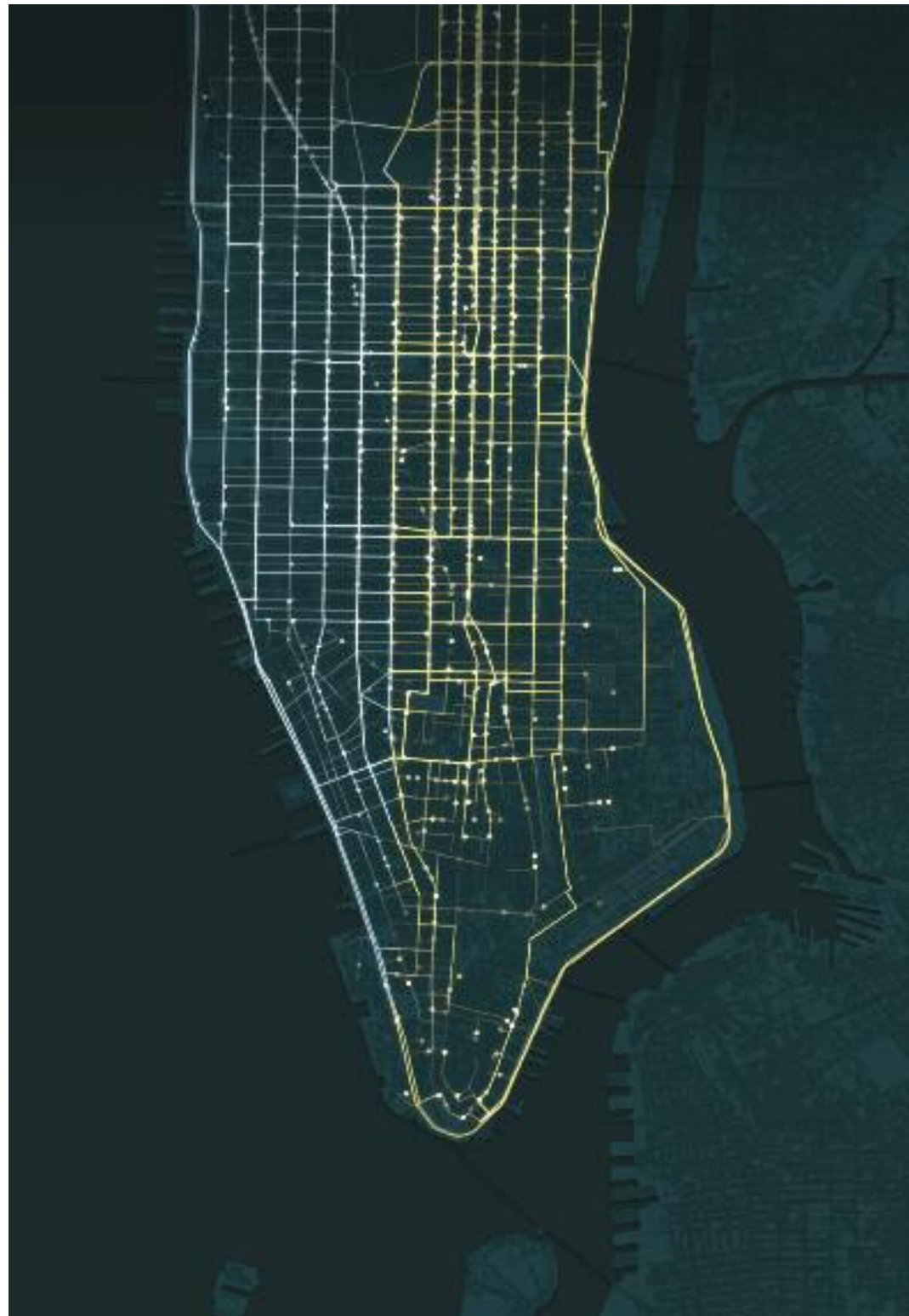
THE "MINIMUM FLEET" IN NEW YORK

The image on the opposite page and the one above illustrate some studies of the algorithm used in the "minimum fleet" project. The image on page 78 represents 1 minute of taxi rides with passengers in New York City on April 20, 2011, starting at 10 am. The one on this page represents 5 minutes of taxi rides with passengers in New York City on April 20, 2011, again starting at 10 am. In both images, the left side, with the lines colored blue, represents the Fleet Optimization Model; the right side, with the lines colored yellow, represents the current taxi system. The dots signify destinations.

9 a.m., left for home in the early afternoon and continued work remotely. If such options were in general use, Fantozzi's rush hour would be no more.

A model to reduce peaks in traffic

Of course, flexibility per se does not guarantee the balanced use of urban infrastructure. Government authorities should provide incentives to reduce peak usage. In that regard, digital platforms could play a major role. In Singapore, for example, motorists are obliged to pay a fee when they drive on particularly busy roads. This model, known as Electronic Road Pricing (ERP), has resulted in substantial reductions in peak demand over the past two decades. ERP is a system whereby traffic can be controlled, and jams and accidents can be reported in real time. For example, if a crash slows down road A, or traffic causes too high a level of air pollution on road B, ERP increases the cost of access to those specific roads. This results in a twofold advantage. On the one hand, traffic is reduced. On the other, it promotes the usage of public transport, which can in turn be funded by road tolls. It is of course also crucial to focus on the potential risks. Digital platforms and incentive systems should genuinely protect the common good and not leave the streets to the better off and their cars. We must not forget that many workers, especially those in precarious employment, cannot afford the flexibil-

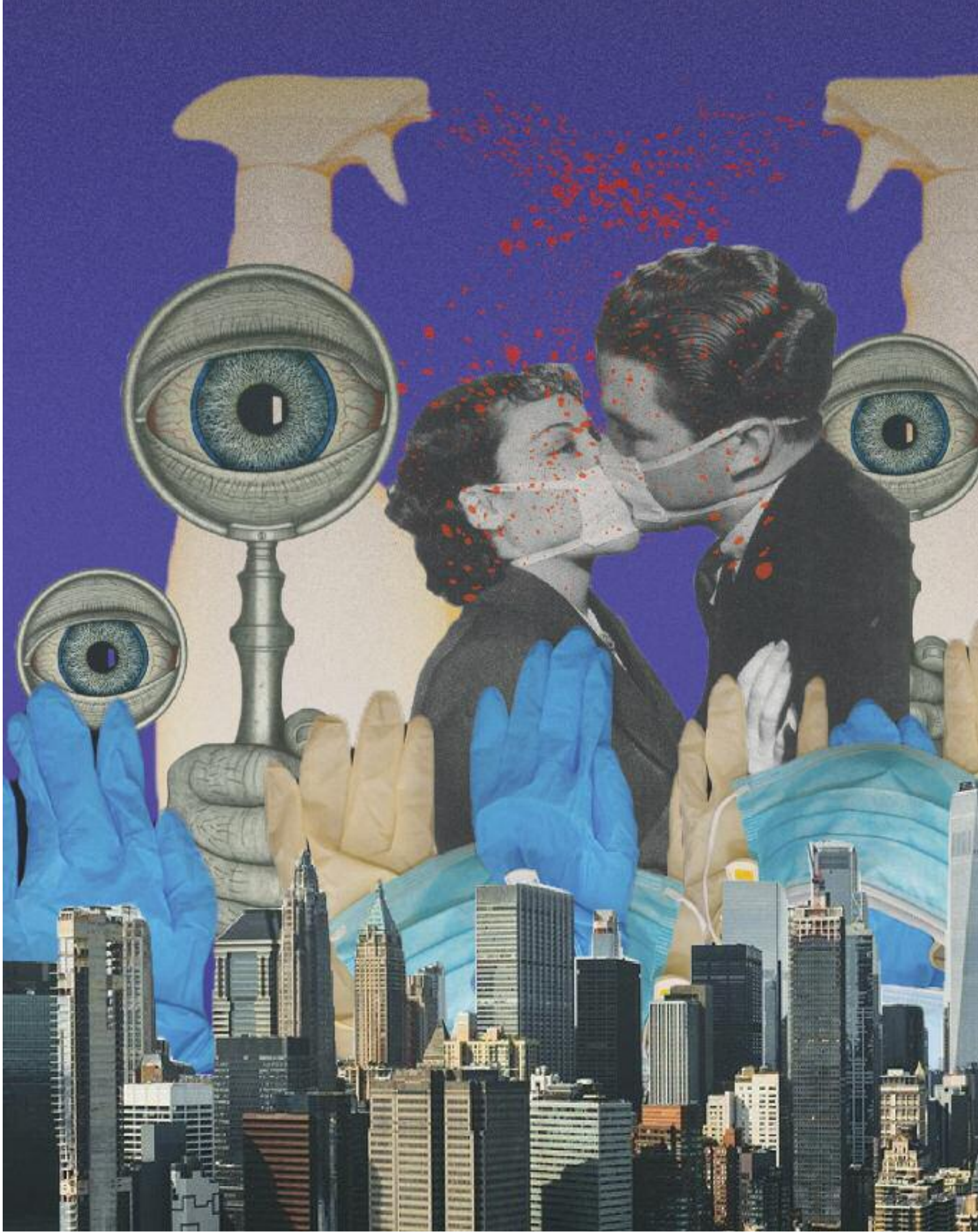


© MIT SENSEABLE CITY LAB

ity to reschedule their lives, nor do they have the financial means to pay expensive tolls. Just as the flattening of the COVID-19 curve must be accompanied by financial support for low-income people who are unable to work and study remotely, the flattening of the urban infrastructure curve must prioritize issues of social equality. For example, incentives could be created, based on criteria such as profession, socio-economic status or any disabilities. The increases in municipal revenue could be used to support public transport. Even if there were a way to perfectly reschedule urban infrastructure usage, a certain degree of flexibility would still have to be maintained to deal with unexpected spikes in demand. Unforeseen events—such as natural or environmental disasters—

require us to take immediate, synchronized action. It is also important to remember that there are situations where synchronization is desirable. Taking to the streets together to celebrate our country's victory at the World Cup cannot be diluted to a period of 12 or 24 hours. Even so, the scenes of the accountant Fantozzi and his torments as he wakes up are not necessarily inevitable. It is up to all of us to decide how we want to manage our cities. In the first few months of 2020, we discovered how beneficial it could be to flatten the curve as an agonizing response to the public health crisis. We hope that this strategy will soon enable us to improve many other areas of our life in the city.





ASEAN/COVID-19 will not stop the advance of the Far East

The Asian Century is Drawing Ever Closer

The new coronavirus will accelerate two trends already underway: the establishment of a multipolar global order with multilevel governance; and the centrality of the Asia System, an informal web of relations not necessarily dominated by China



Director of the Rome office and advisor to the Chairman of Associazione Italia-ASEAN, an organization founded and chaired by Enrico Letta to foster exchanges and reciprocal knowledge between Italy and the countries of Southeast Asia. Bordonaro has previously worked in various capacities at the Italian Ministry of Foreign Affairs, the United Nations, and European institutions.

DEVICES

A macroscopic view of how all kinds of protection devices are now an integral part of our daily life.

In February 3, 2020, when we were still very far from case number one being recorded in Italy (February 21), and even further from the classification of COVID-19 as a pandemic (March 11), I outlined two phenomena in *The Huffington Post* that would subsequently prove significant and probably recurrent.

On February 3, there was still talk of suspending the celebrations for the Chinese New Year and of a crisis in luxury tourism, but little else. My argument, given the advanced stage of the globalization process, was that any natural event that was beyond the control of humans and affected some of the global value production chains could have caused much wider socioeconomic domino effects than we could imagine, given the dense web of links that exist in our world. The second part of my argument was that these combinations of natural phenomena and economic shocks, in addition to having profound effects, would become more recurrent.

The COVID-19 crisis is part of a well-defined but constantly evolving context; the pandemic will not be a defining element of the 2020s, but rather a pretext to encourage or slow down existing trends. Comparisons with similar events of the past are irrelevant because the context in which we find ourselves today is very different from previous ones. Concepts like the digitalization, virtualization and intergenerational responsibility associated with globalization mean that 2020 is light years away from the SARS period of 2002-2004. A more significant comparison, albeit not supported by evidence, could be drawn with the

Black Death of the fourteenth century, 1346-1353, and the start of the Renaissance. In any case, COVID-19 remains a unique natural phenomenon, with economic and social consequences that remain to be analyzed.

The trend towards a multipolar global system is accelerating

The most macroscopic trend, which was already underway before the coronavirus and which will now accelerate, is the reaffirmation of a multipolar global system with a widespread and multilevel governance. From a historical perspective, the geopolitical experiences of bipolarity and unipolarity are just grains of sand in a large hourglass. For those born in the 2000s, New York is by no means the symbolic “capital” of Planet Earth, nor does Moscow represent its alternative pole. The same would apply to those born from the dawn of time up to the 1930s.

Likewise, among the organizations that regulate social life, the hegemony of national and hyper-centralist states is experiencing a slow and constant decline which, excluding the century-old experience of totalitarianism, began at least with the French Revolution. States tend to aggregate or coordinate with each other upstream and to give more autonomy to their sub-organizations downstream. Coronavirus will only accelerate this phenomenon.

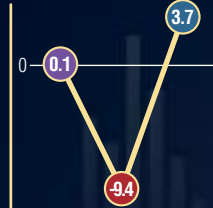
Even before the pandemic in 2014, Chinese President Xi Jinping, at a meeting of Asian leaders in Shanghai, said “It is the duty of the Asian people to take charge their own →



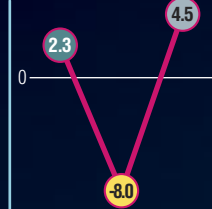
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In the current global slowdown, a large part of Asia is still expected to record positive growth rates, even in 2020, which, although significantly lower than pre-COVID-19 calculations, will be much higher than those of Western economies.

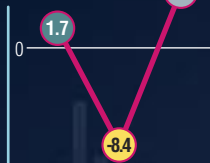
LATIN AMERICA AND THE CARIBBEAN



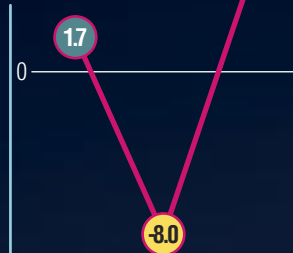
UNITED STATES



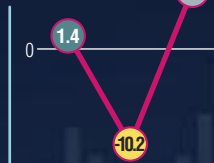
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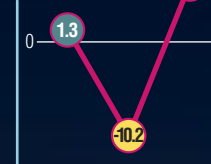
ADVANCED ECONOMIES



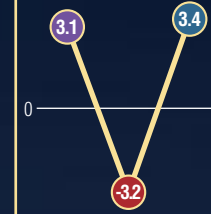
UNITED KINGDOM



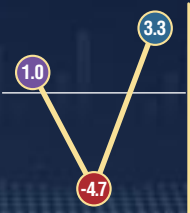
EURO AREA



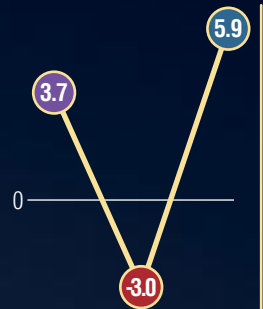
SUB-SAHARIAN AFRICA



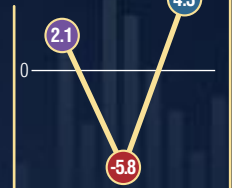
MIDDLE EAST AND CENTRAL ASIA



DEVELOPING ECONOMIES



EMERGING AND DEVELOPING EUROPE



Growth projections

affairs, to solve the problems of Asia and ensure the security of Asia.” For at least a couple of decades Asia has made great strides in creating an Asian system detached from Western formalism and legalism. There is a more or less hidden trend towards socialization and a meeting of political, business and academic elites, between think tanks, journalists and sports and youth organizations, from across the vast Asia-Pacific area.

Western theoretical abstractions portray Asia as a train with a very powerful Chinese locomotive, at a crossroads between hegemony and anarchy. The reality is that, unlike the West, Asia has extremely deep multipolar and multi-civilization roots and knows how to manage “disorder.” These roots are returning to the surface and today they mix with imported elements from the West: state sovereignty and fluid borders; cultural and religious divisions with multi-ethnic identities; consumerism and materialism with clanship and kinship ties. There will be neither hegemony nor anarchy, but a fluid order of foreigners among foreigners, of big and small, interconnected and widespread communities, aiming to achieve material well-being by creating relationships.

For the past two centuries, Asians

have been fed a historical narrative in which animosities with neighbors abounded. Today, however, although stereotypes and mutual suspicions remain—especially between India and Pakistan, China and Japan, Saudi Arabia and Iran—Asians are beginning to rediscover and get to know each other better, to be less foreign to one another or to be all equally foreign, through diplomacy, business, tourism and university exchanges.

With regional media such as TRT, Al Jazeera or CCTV, young Asians are getting more comfortable in their relationship with their counterparts in the region and especially with their “Asianness.” Korean music and cinema and Indian showbiz are now the global pride of Asia. Over time, perceptions will change, interests will align, policies will change and coordination of the Asian system will become more structured. The most astute and farsighted Asians interpret their return to the control room of history as a natural destiny, a new, but not unprecedented, cycle in the world order. There is none of the disorder that Westerners complain about.

This does not mean that Asia is or will be free from conflict. On the contrary, Asia is the stage of some of the greatest geopolitical clashes in

the world: the relentless one between Shiites and Sunnis, perpetuated, personally and by proxy, by Iran and Saudi Arabia; the conflict on the Korean peninsula; the territorial and maritime disputes between China and, respectively, India, Japan and Vietnam; the impossible alliances, with regard to Syria, in which Israel and the Arab countries join forces against Russia and Iran; the fragile Lebanon and Iraq; Nagorno-Karabakh, the Kurdish question, Kashmir and many others.

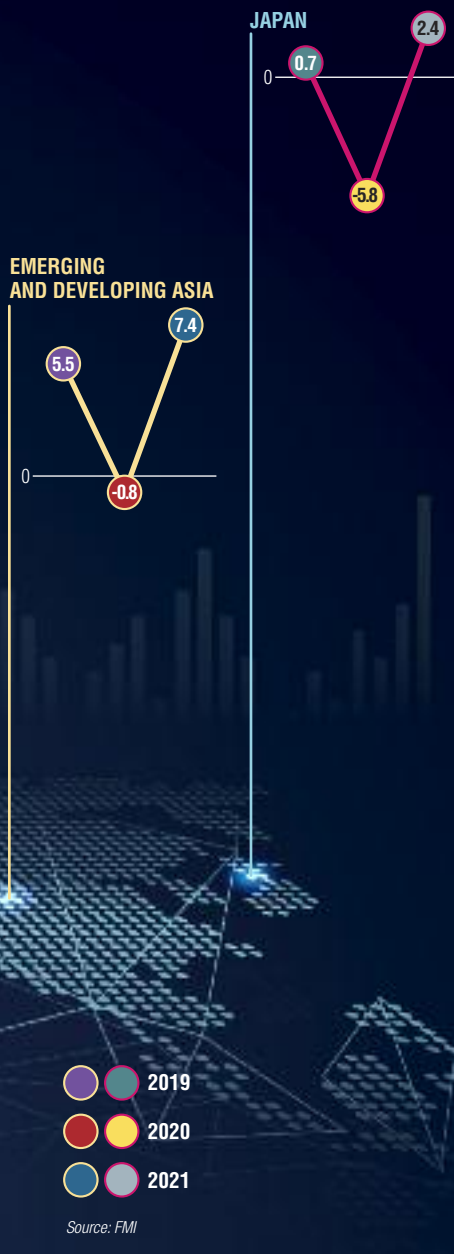
Despite the abundance of conflicts in Asia, in recent decades Asian countries have generally remained stable. Diplomatic or commercial friction should therefore be seen as evidence of how important each member of the Asian system is compared to the others. The main tensions in Asia are not between civilizations but between nation states. Asian civilizations maintained deep relationships of mutual respect and cultural assimilation prior to the Western “divide and conquer.” For a long time, in fact, the Asian identity has been syncretic, rather than specifically ethnic or national. Today an Asian syncretic identity is being restored and this is the lesson to be learned, for Asians themselves, but above all for Europeans and for the whole world.

An injection of vitality for intra-Asian trade

To add substance to this socio-political examination, while the coronavirus shock is reinforcing some of the dynamics that were already growing in the pre-COVID era, intra-Asian trade should also receive a significant boost. The post-COVID world will see an Asia even more central to all issues of global significance.

According to The United Nations Conference on Trade and Development (UNCTAD), in 2018, intra-regional trade in Asia grew to 60 percent of all foreign trade recorded by individual Asian countries. Therefore, when Asian countries turn to the world market, in 60 percent of cases they satisfy their requirement by dealing with an Asian partner. Only in 40 percent of cases, when the goods or services are not available in the national market, do they deal with Europeans, Africans or Americans.

Only one regional bloc, Europe with 68 percent, surpasses Asia in terms of the degree of commercial integration of its system in terms of intra-regional trade. In third place is North America (excluding the Caribbean, including Central America) with 33 percent. In sad fourth place are Africa and Latin America, →



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Antonino D'Arpa manages visual communication for public and private entities in the fields of tourism, art and environmental, economic and social sustainability. His vision combines art and technology, communicating ideas through emotions, assembling images and creating visual concepts based on personal and contemporary themes that enrich the visual bouquet already provided by reality.

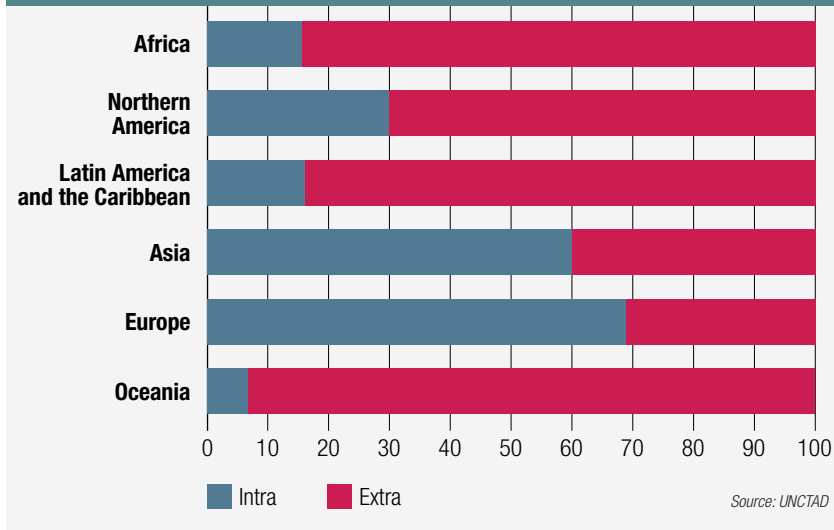


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CREATIVITY (above)
Globalization takes creativity beyond borders and brings civilizations closer.

INFODEMIA (right)
An overload of information in a globalized world means we have to choose which sources to be influenced by.

INTRA- AND EXTRA-REGIONAL EXPORTS



In 2018, 60 percent of all Asian exports were to trading partners on the same continent. In Europe, this rate was 69 percent. By contrast, in Oceania, Latin America and the Caribbean, Africa and North America, most of the trade was extra-regional.

on equal pegging with 16 percent each. The ranking ends with Oceania at 6.7 percent, although that figure is qualified by the fact that the region can be considered an appendage of the Asian system, with Japan and China among its main trading partners, together with the US.

We can predict that despite COVID-19, Asian economies will grow, as will intra-Asian trade. As a result, the degree of integration of the Asian system will also increase, the key player in the affirmation of a new multipolar world that exists far from the logic of national states.

While it is true that the economic impact of COVID-19 will reduce the growth of Asian economies in 2020, China and the The Association of Southeast Asian Nations (ASEAN) area will remain key players in intra-Asian trade, especially as the rebound in these markets is expected to be vigorous and by 2021 to be driven by the recovery of Chinese demand for goods. Furthermore, manufacturing in China and ASEAN still offers attractive economic conditions, not only for Asian companies, but also for those in the US and Europe that continue to invest in them.

Most Asian economies will also grow in 2020

By adapting to the digitalization of trade and logistics and interacting more at regional level, Asian economies can still do better than those around the world.

The International Monetary Fund predicts that China will grow around one percent in 2020 and eight percent in 2021. Vietnam, which is strongly integrated with the Chinese economy and that of ASEAN part-

ners, is a candidate to be the fastest growing economy in Southeast Asia, with an ambitious goal of a five percent increase in GDP even in 2020. It is no coincidence that the Vietnamese market has matured to become one of the main production centers in the world, with easy access to China, but now also to the European Union, following the entry into force, in August, of an important free trade agreement. Vietnam is an excellent example of the world that awaits us: a world with different degrees and levels of integration, far from twentieth-century ideologies, with a decisive role for Asia and the actors of its system.

The opening to international trade, initiated in 1986 with the “Doi Moi” policy, has proved to be fundamental for the Socialist Republic of Vietnam. As had already happened with China, the simultaneous presence of a formally communist government and the adoption of the market ideology have produced positive results, bringing the country onto the global business stage, with the attraction of foreign technology and investments. Two other policies, closely linked and maintained by the Vietnamese establishment, have set the conditions for strengthening foreign direct investments (FDI). On the one hand, efforts have been made to “desaigonize” the country in favor of developing Hanoi. Subsequently, with a process that scholars have identified as “deconcentration,” a decision was made to give spending capacity to the provinces, with transfers made from richer to poorer ones, indicating infrastructure construction as a strategic priority for the development of the country. And while Vietnam was untying some of the typical knots of the totalitarian state,

opening up to the market economy and strengthening its local structures, at the same time, in order to participate in other games being played on the Asian and global stage, it became a member of ASEAN, an organization founded in 1967 to counter the communist bloc, but today another key player in the multipolar and multilevel world.

Not even the most experienced scriptwriters would be able to foresee the future at the moment. In the case of the COVID-19 pandemic, predicting the future is completely impossible, given that the present is still fully underway. One can certainly try to assess whether such a natural event will have the effect of accelerating or slowing down current trends. In this case, the elements that will be most clearly reinvigorated by the coronavirus are: the possibility that natural phenomena will have repercussions on the global economy; the restoration of a multipolar global order with a multilevel governance; and the centrality of the Asia System, an informal web of relations not necessarily dominated by China.

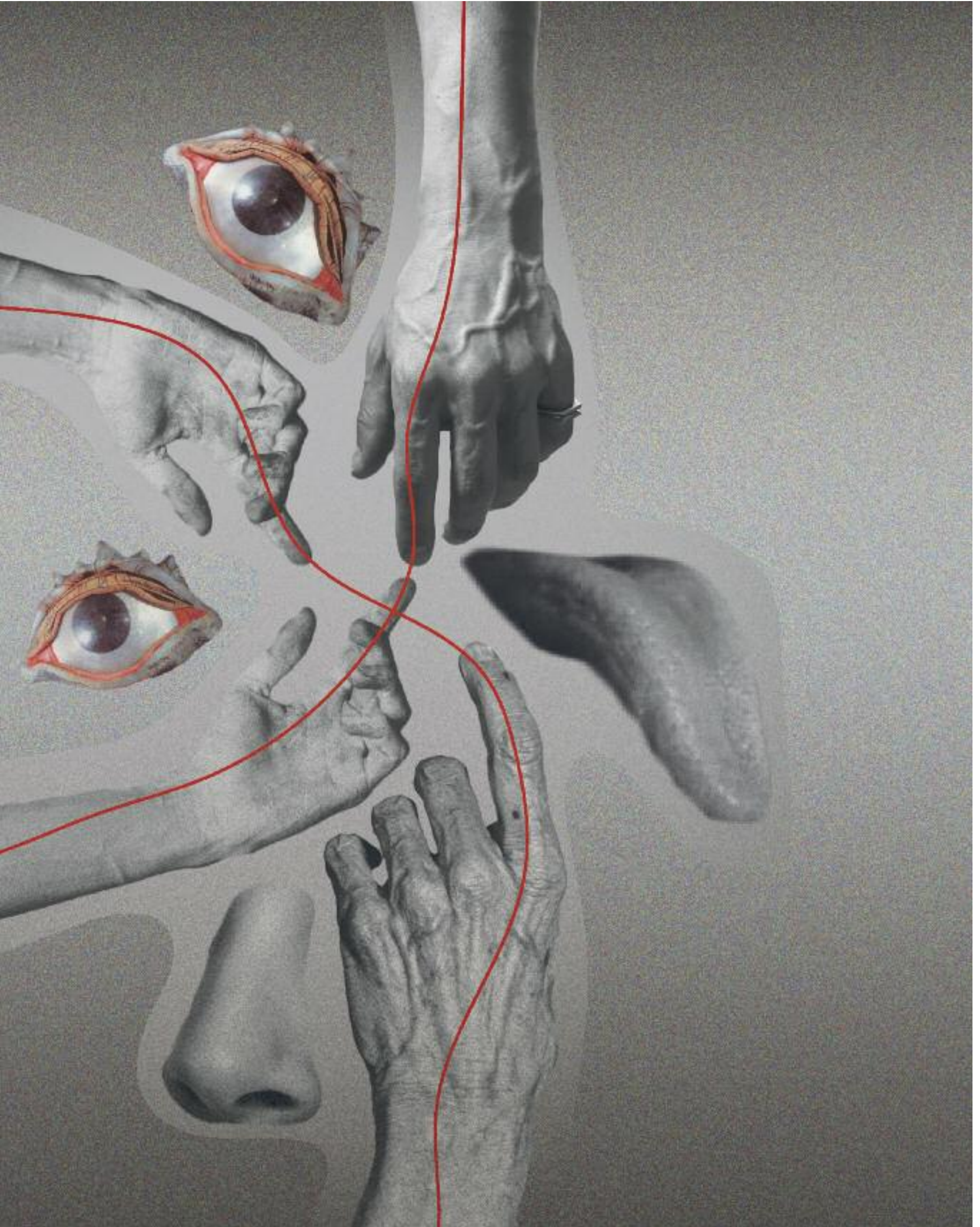
Finally, it is worth focusing on the temporal proximity between two major local unforeseen events, with an impact on the lives of almost all the inhabitants of the planet and for a long period: the socio-economic crisis born of the bankruptcy of Lehman Brothers in September 2008, and the socio-economic crisis arising from the Wuhan COVID-19 outbreak in November 2019. This relative closeness of the two events heralds a future world in which we will be facing continuous emergencies while trying to plan and make predictions. But if after COVID-19 we were to face a new global crisis, might we perhaps say that we are entering the Age of the Unexpected?



INFECTION

Our hands, mouth and nose, vital elements of our life and activities, are transformed into infection carriers.





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China-USA/Comparing responses to COVID-19

The Global Powers Confront the Crisis

The world's two largest economies have responded differently to the crisis. While the Trump Administration rejected green stimulus measures, China supported the clean energy sector, though those efforts have been offset by other, more carbon-intensive stimulus



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NICOLA BILOTTA, FABRIZIO BOTTI,
LUCA FRANZA* - IAI

measures to contain the spread of the SARS-CoV-2 virus have resulted in an unprecedented contraction in global economic activity, with greater repercussions on international production, employment, and trade than in the wake of the 2008-2009 global financial crisis. Estimates of the impact of the pandemic on the global economy predict negative growth in gross domestic product (GDP) of -4.9 percent in 2020, while the first half of the year saw a significant decrease in hours worked (equivalent to 155 million full-time jobs) and in international trade (-3.5 percent year-on-year).

A new kind of recession

The COVID-19 pandemic differs from the triggers of previous recessions. The measures necessary to contain the new coronavirus—such as quarantine, lockdowns with vari-

ous degrees of restrictions and social distancing—drastically limit the mobility of the populations involved, with extremely severe direct effects for the sectors of the economy most reliant on social interaction, including tourism, transport, entertainment and catering. The usual channels for amplifying the initial effects of the crisis on international markets, such as the financial sector and foreign demand, have also led to a substantial weakening in the prices of major commodities, especially oil and gas, with markedly negative consequences for countries whose exports are concentrated in their extractive industries.

While the ongoing pandemic crisis can be seen as symmetrical at a global level, the effects on individual countries are likely to be of a different nature, magnitude and timing, with economic recovery influenced by a

number of factors, including developments in numbers of infections and the effectiveness of containment strategies, the differentiated dependence of individual economies on the worst affected sectors, as well as by external cash flows and economic progress prior to the crisis. Although the projections for change in 2020 GDP are negative for all regions of the world, more pronounced effects are expected for advanced economies (-8 percent) compared to the expectations for emerging and developing economies (-3 percent). This article aims to look further into both common traits and divergent dynamics during the health and socio-economic crisis. We also consider the policy responses adopted by the world's two main economies, the United States and China, especially in terms of the substantial consequences for global energy demand →

and the transition to a low-carbon economy.

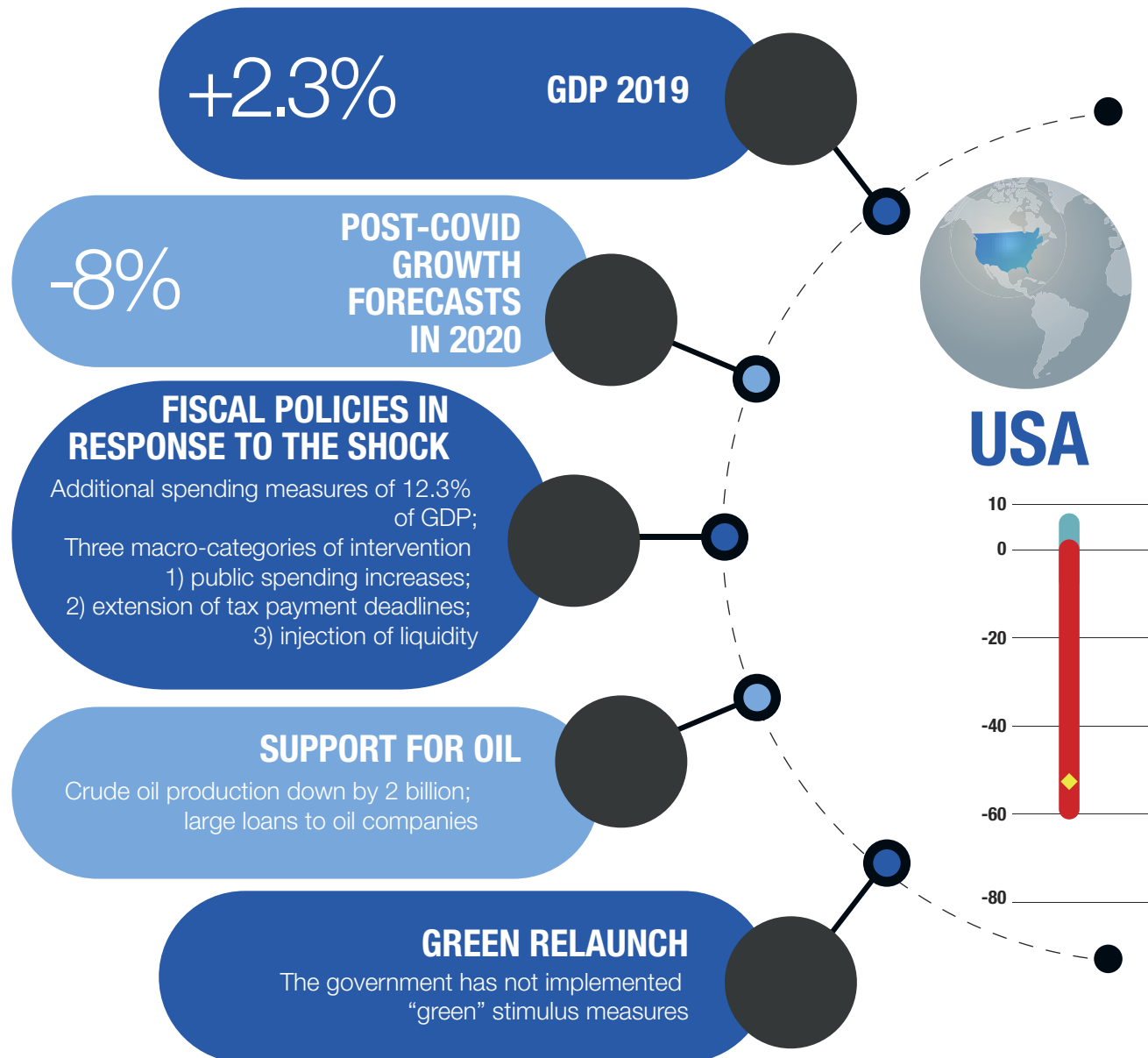
In China, following the sharp contraction in the first quarter of this year (-6.8 percent), GDP is expected to return to moderately positive growth in the second half of 2020 (+1 percent). In fact, compared to other major global economies, the Chinese government had to face an earlier closure of non-essential production that took place in mid-February and start its gradual reopening in April, following the adoption of effective containment measures.

In the United States, the persistence of the epidemic resulted in a severe impact on economic activity in the first half of the year (-32.9 percent year-on-year in H2). The spread of infection has differed across the 50 states and the adoption of fragmented containment measures has resulted in a differentiated reopening of production activities, with significant restrictions still in place in 20 states, where personal care services, indoor entertainment and catering remain closed or have only partially resumed. This scenario suggests a more gradual recovery in the second half of the year with negative GDP growth in 2020 of -8 percent (although these forecasts are better than those in the Eurozone and the United Kingdom, which stand at -10.2 percent).

Standing on the shoulders of giants

Significant fiscal measures, worth a total of USD 12 trillion around the world, and expansionary interventions by central banks and financial regulators have limited the short-term effects of the pandemic on global public health, employment, and manufacturing. However, the dimensions and make-up of the measures to stimulate the economic recovery taken by the United States and China have diverged to date.

Although an international comparison between the volume of fiscal policies in response to COVID-19 must take into account the differentiated impact of the pandemic and other shared shocks to the system, as well as the differing scope of the pre-existing social buffers, it is noteworthy that the United States has increased spending and waived or deferred tax revenue equal to 12.3 percent of GDP, compared to a rate in China of 4.1 percent. Even when other categories of government fiscal measures are considered, the United States reports a percentage of liquidity support (through loans, equity capital or guarantees) for GDP significantly higher than in China (2.6 percent and 0.5 percent respectively).



Fiscal policy comes into play...

The post-COVID-19 economic recovery measures taken by the Trump administration include a wide variety of fiscal policy interventions. Consistent with the guidelines adopted by the main Member States of the European Union and the United Kingdom, they fall into three macro-categories: 1. increases in public spending and the waiver of tax revenues (equivalent to 9.2 percent of GDP, mainly made up of direct income support measures, loans and incentives for companies that maintain their workforce, with an emphasis on small and medium-sized enterprises and increases in health spending); 2. deferral of tax and social security payments (equivalent to 2.6 percent of GDP); 3. other guarantees and liquidity injection measures (equivalent to 2.6 percent of GDP). As part of these measures, specific sectoral interventions worth USD 32 billion are planned for the air transport industry, the largest share of which (USD 25 billion) has been allocated to passenger transport companies, with the remainder to cargo and auxiliary contractors.

...if cautiously

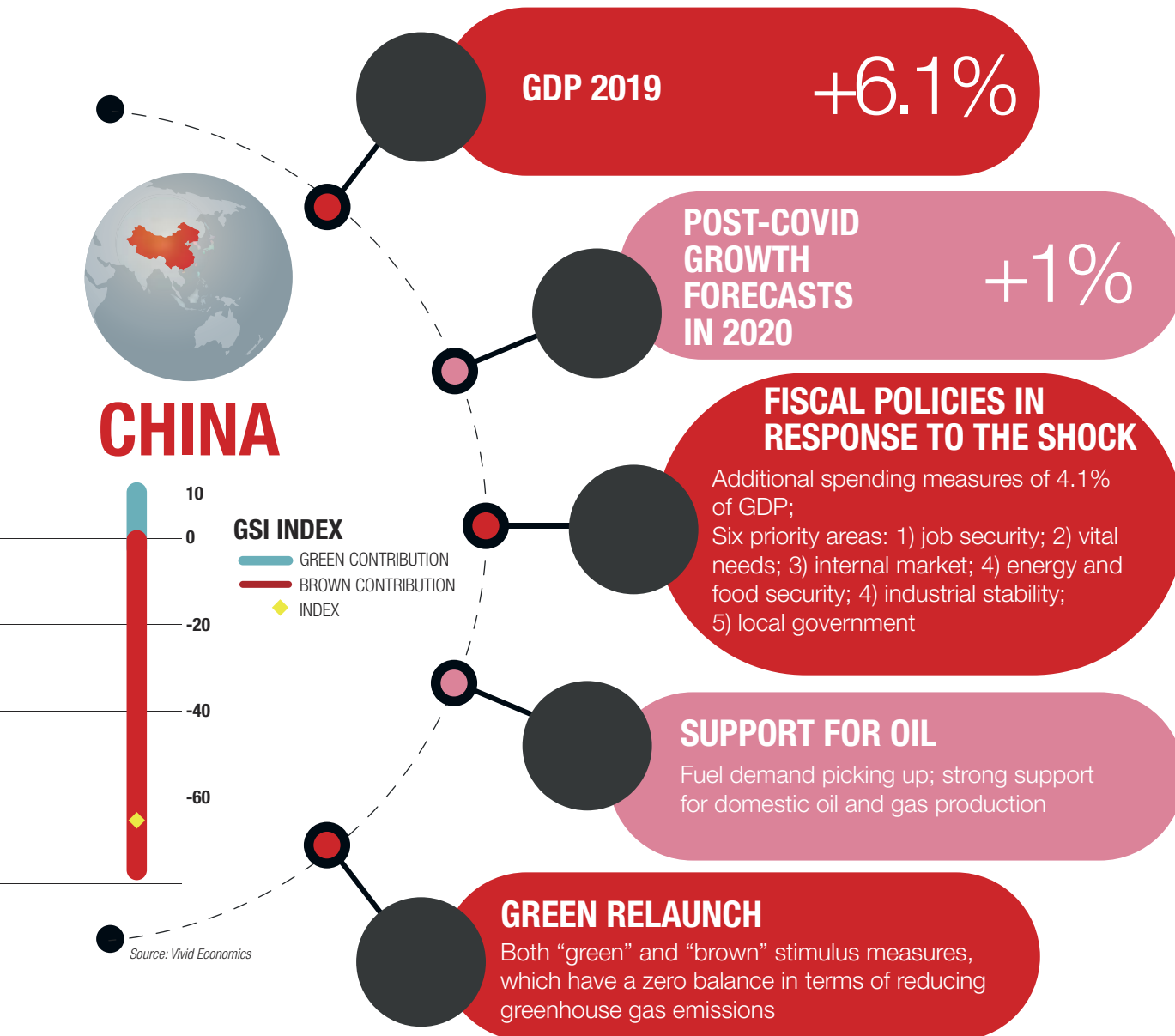
China has instead instituted measures to support households and businesses more cautiously. While the central government had introduced expansionary measures equivalent to 13 percent of GDP to mitigate the effects of the 2008 financial crisis, the public interventions to pull the country out of the COVID-19 crisis amounted to around 4.5 percent (RMB 4.6 trillion). Overall, China's fiscal and lending policies in 2020 in response to the coronavirus shock constitute only 40 percent of those in 2009 in the wake of the global financial crisis.

During the Third Session of the 13th National People's Congress of the People's Republic of China on May 22, the Chinese government identified six priority areas for maintaining national security: job security, basic vital needs, the operation of market entities, energy and food security, industrial stability and value chains and the functioning of local governments. Their emphasis on the resilience of production networks confirms China's strategic focus on infrastructure investment. The promotion of investment in the construction of IT and communications infrastructure

was relaunched at the State Council executive meeting on April 28, to foster two-way cooperation between communication platforms and production sectors, to support industrial integration and to create an environment conducive to the development of the platform economy.

Discretionary fiscal policy interventions also covered spending on epidemic prevention and control, the production of medical equipment and other public investments in healthcare, suggesting further expansion of the public sector, including support for state-controlled enterprises. Economic recovery measures aimed at cutting emissions were taken in April, extending subsidies and tax incentives on electric cars to 2022 and implementing a plan to extend the battery charging network by 50 percent within the year, to broaden the scope of electric vehicles in the country (USD 1.43 billion).

Compared to the U.S. and Europe, China has introduced less direct subsidy to workers and consumers, favoring measures to support infrastructure investment. This approach not only risks widening inequalities within the country, but weakens the

**“BROWN” MEASURES**

The “Greenness of Stimulus Index” developed by Vivid Economics is an indicator of the total fiscal spending in response to COVID-19 categorized as having either a positive or negative impact on the environment. The final index for each country is an average of sectoral impact, normalized to a scale of -1 to 1. We then multiply the score by 100 to get the final value you see on the graph. The five sectors are chosen for their historical impact on climate and environment: agriculture, energy, industry, waste and transport. Two components of stimulus are analyzed: the size of the fiscal flow (F value) to each environmentally intensive sector, and the overall impact of that stimulus on climate and environment (B value). The index confirms that Chinese and US measures are mostly “brown.”

evolutionary process in China’s industrial policy, which is now less export-oriented and more focused on meeting domestic demand (domestic consumption contributed 57.8 percent of annual GDP growth in 2019). This has implications for the sustainability of the recovery in China and for its trading partners.

Overall, however, the complex recovery plans of the two rival powers share a predominance of sector-neutral measures with few exceptions as highlighted above, suggesting a trend of returning to pre-crisis production specialization, especially in the United States.

In support of oil

It is still too early to measure the impact of the U.S. and China’s recovery strategies on energy and the climate, as the substantive effects of these plans—often not yet fully defined—will only become visible over the next few years. However, it is already possible to observe certain points of contact and divergence between the moves made by the U.S. and China. Although they are both net importers of oil, the U.S. and China also produce the commodity themselves. Companies operating in the sector

in both countries have experienced increasing difficulties in recent months. U.S. oil producers have suffered particularly heavy losses due to the decrease in prices triggered by COVID-19. Compared to the first quarter of 2019, Chevron lost USD 8 billion in revenue in the first quarter of 2020, with losses at ExxonMobil of USD 1 billion. Among the non-majors (mid-cap companies, mostly shale producers), Diamondback lost USD 2.5 billion, Cimarex USD 1 billion, and Pioneer and Concho around USD 500 million each. U.S. crude oil production fell by 2 million barrels per day due to low prices and market dynamics (unlike production in the OPEC Plus bloc, which has decreased because of coordinated production cuts). The Trump administration has ordered sizable loans to oil companies to safeguard a sector whose importance to the American economy has increased in recent years, especially in certain states such as Pennsylvania and Texas.

In China, however, Sinopec production fell by only 0.4 percent year-on-year in the first half of 2020 and Petrochina saw an increase of 7 percent. Unlike most of the rest of the

world, domestic oil and gas production in China has remained surprisingly high, partly due to government pressure to continue investing. In China, where the pandemic broke out, demand for fuel began to recover relatively early, in April. Domestic oil production is considered strategic in both the U.S. and China, especially in the context of rising geopolitical tensions and volatility in production areas such as the Middle East. Therefore, some degree of political support for the oil sector will remain in both countries, in order to limit dependence on imports, albeit to a lesser extent after the Democratic victory in the U.S. elections in November.

Emissions will return

Looking beyond support for the oil and gas sector, other U.S. economic recovery measures are also prompting vehement criticism for their lack of consideration of climate and environmental factors. The criticisms are not only motivated by ethical considerations, but also by growing concern that whereas the rest of the world, including China, is using the crisis to innovate in its models of economic development, Trump’s U.S.

has been stuck in an antiquated development model and therefore risks losing global competitiveness and economic leadership. While the criticisms of the Trump administration are well-founded, these arguments are rooted in over-optimism in assessing the “green” elements of China’s recovery plans. A more in-depth analysis shows that the carbon intensity of the recovery plans in China and the United States are not that different (unless a full assessment cannot be carried out until after the fact).

Some agencies have tried to measure the possible carbon intensity of stimulus packages. Vivid Economics, for example, has developed the “Green Stimulus Index.” This indicator fully captures the green component of the European recovery plans and confirms that the Chinese and U.S. measures are mostly “brown” (i.e., they support polluting activities, inconsistent with the target to reduce greenhouse gas emissions). Interestingly, in net terms, the American and Chinese stimulus measures are substantially equally climate negative. The difference lies in China having introduced stimulus measures with a positive impact on →



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CHINA, THE FIRST TO EXPERIENCE LOCKDOWN
Above, a deserted street in Wuhan, Hubei province, photographed on February 7, 2020. The city was the epicenter of the epidemic in China. Below, a cinema in Wuhan on July 20, 2020, the day when all the cinemas in the city were reopened, authorized by the China Film Administration, after all the necessary measures against COVID-19 had been taken.

reducing emissions, which are more than offset negatively by highly brown stimulus measures. Conversely, the carbon intensity of the U.S. economic stimulus is slightly lower, although—at least at government level—the U.S. has not implemented any green stimulus measures. One factor that helps differentiate the prospects for greenhouse gas emissions by China and the U.S. is that China started the road to recovery ahead of the U.S. and emissions and GDP growth are correlated. Greenhouse gas emissions are expected to resume growth in China sooner than in the U.S.

USA vs. IEA

It must be noted that the economic recovery measures adopted by the

U.S. are at odds with those proposed by the International Energy Agency (IEA), of which the U.S. is a member. In conjunction with the International Monetary Fund, the IEA has developed a green recovery strategy that could reduce CO₂ emissions by 4.3 billion tons and expand global GDP by 3.5 percent to 2023. The sectors listed by the IEA in which investment has the greatest potential for job creation and added value include energy efficiency in buildings, eco-friendly urban transport infrastructure and solar panels. While the EU (including Italy with the “ecobonus” scheme) are moving in this direction, the U.S. is not. In addition, the U.S. response in 2020 looks very different from what it did after the 2008-2009 crisis. Back then,

U.S. investments in electric cars and lithium-ion batteries contributed to cost-cutting and standardization of grid storage and electric vehicles. On the other hand, analysis of the U.S. recovery and its carbon footprint must also be tempered with the consideration that, despite the government’s lack of action, many U.S. companies continue to invest in green technologies. For example, Amazon plans to purchase 100,000 electric vans for deliveries by 2024, and DHL expects that, by 2025, 70 percent of its “first and last mile” deliveries will be made using clean modes of transport. The crisis will not end any time soon, so there will be further rounds of public spending, although where these will go is uncertain and largely dependent on the outcome of the presidential election in November.

Chinese ambiguity

China is another kettle of fish altogether. As mentioned, China has introduced several green recovery measures. In May 2020, the National People’s Congress announced investments in electric vehicles and fuel cells, infrastructure to support digitization, electric vehicle charging stations and ultra-high-voltage electricity transmission networks. The Politburo Standing Committee has approved spending of USD 1.4 trillion over the next 5 years on the construction of new infrastructure to support the energy transition. In addition to the announcements, substantive measures have been taken for electric vehicles and charging stations, as have others to support the heavy-duty trucks market (renewal of fleets). More generally, the Chinese government also favors reorienting the economy toward high-tech (5G data centers and



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technology), which should make the country's GDP less dependent on manufacturing and pollution-producing industries.

At the same time, however, doubts persist over the feasibility and political will of Chinese decision-makers to implement the most ambitious measures and it must be noted that the green measures are accompanied by continued support for pollution-producing sectors. China plans to build many coal-fired power plants (180 GW of the world's 500 GW of fossil fuel-based electricity production capacity under construction is in China) and the crisis triggered by COVID-19 can only further motivate the Chinese government to support the socio-economic stability of coal-producing regions.

Future uncertainties

The economic recovery measures taken by the Trump administration to date are heading in the opposite direction to the green recovery strategies adopted by the EU and advocated by the IEA. The moves made by the Chinese government are more difficult to interpret. While China's recovery strategy includes certain green elements, it also confirms support for heavily polluting activities, and it is unclear to what extent their announcements will result in substantive measures. Changes in CO2 emissions over the coming years will depend partly on the recovery measures and their impact, partly on exogenous factors. Not only does uncertainty about the future spread of the virus affect the reliability of economic recovery projections, which forecast global growth of 5.4 percent (4.5 percent in the U.S. and 8.2 percent in China) by 2021, but other factors are likely to put the global economy at risk in



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the coming months, as does the eventual nature of the recovery itself. In particular, the rising tensions between the U.S. and China, especially in the commercial and technological fields, and the resulting threats to the strength of global production networks, the gradual strain of relations between the OPEC+ oil-producing countries, and the widespread political and social instability inherent in a recession, will impact the international context where the economic recovery policies of the United States and China will be played out. The prospects for recovery in the United States and its global rival will also be affected by the outcome of November's presidential elections. Joe Biden's victory could result in different foreign pol-

icy strategies but also in divergent economic recovery plans, with the latter focusing more on climate change and reducing emissions from the U.S. economy.



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WHEN NY WAS "ON PAUSE"

Above, a deserted Times Square on March 22, 2020, a few hours before the implementation of the "New York on pause" executive order, which put the state "on pause" until April 19. The restrictions caused a lot of harm to the tourism and entertainment industries. Below, pedestrians pass through New York's Grand Central Station, deserted during rush hour on a Friday following the March 22 lockdown.



MENA/Risk reduction challenges and strategies

A Fundamental Compromise

Oil exporting countries in the Middle East must understand that the reduction of long-term risk requires the acceptance of lower return from existing assets because of investment in decarbonization measures



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YOUNG, A NEW GENERATION OF OMANIS

The project presented on these pages tells of a country in the making, Oman, through the portraits and experiences of its new generations. Four Italian photographers: Umberto Coa, Nicolò Panzeri, Vanessa Vettorello, and Serena Vittorini explored the sultanate, following different itineraries, to portray its many different faces: from the creative and digitized young people of Muscat to the children of the more rural areas dedicated to caring for their family, from successful sportsmen to tourism industry operators. All aiming

for modernity with respect for local traditions. Women and men whose faces portray the authenticity of the country and their pride in the beauty and opportunities that Oman offers.

Above, the bay of Sur, a coastal town famous for its shipyards where the dhows, the typical Omani wooden boats, are still built by hand.



BASSAM FATTOUH AND RAHMAT POUDINEH

Bassam Fattouh is the Director of the Oxford Institute for Energy Studies and Professor at the School of Oriental and African Studies, University of London. He specialises in international oil pricing systems, OPEC pricing power, security of Middle Eastern oil supplies, and the dynamics of oil prices and oil price differentials.

Rahmat Poudineh is Senior Research Fellow at the Oxford Institute for Energy Studies. He has published numerous peer-reviewed academic articles on a number of key issues relating to the energy sector, including: electricity market design, power system flexibility, renewable support schemes and the implications of the energy transition for oil companies.

ENA (Middle East and North Africa) oil exporting countries have been hit by two severe shocks: COVID-19 and the oil price collapse. Together, they have had a massive adverse impact on their economies and key sectors and exposed some of the challenges and vulnerabilities these economies faced even before the virus. In 2019, even with an average Brent price above USD 64 per barrel, most MENA oil exporters were running a budget deficit. In this current low oil price environment, budget deficits as a percentage of GDP are expected to rise sharply. All MENA countries are projected to run large deficits both in 2020 and 2021, and their debt ratios are likely to deteriorate as they increase borrowing to cover deficits and stimulate their economies. However, the stimulus packages announced thus far have been relatively small and limited in scope, a reflection of the impact of lower oil prices on government revenues. The result may be a much slower economic recovery.

The priority is to consolidate the public purse

In the short to medium term, MENA oil exporters' focus has been on fiscal adjustment. MENA oil exporters have attempted to stabilize their fiscal expenditure and partially decouple it from oil price cycles through a mix of fiscal and monetary policies, increased government saving rates and the build-up of foreign assets. However, due to a mixture of political and social considerations, regional competition, corruption and mismanagement, procyclical fiscal policies whereby government spending expands during periods of high oil prices and contracts during downturns have been the key feature of most oil exporting countries' economic policy. The challenge is that expansionary fiscal policy during boom times forces oil exporters to adopt painful choices when oil prices fall. As a result of this imprudent fiscal policy, many countries do not have the strong fiscal and financial positions that would provide room to maneuver during oil price downturns.

Oil exporting countries are also major importers, and their current account balances fare no better. In 2019, even with a relatively high oil price environment, the majority of MENA oil exporters ran current account deficits. In the current crisis, there are opposing effects on the current account. The reduction in oil revenue will widen the current account deficit while the likely reduction in consumer spending, attendant lower imports and the large exit of foreign labor and the associ-



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The diver

Maisa Al Hooti, 30, is an underwater photographer committed to fighting ocean pollution and protecting her country's underwater environment.



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The translator

Asma Al Hadidi, 26, is a translator and works on communication for Nizwa Fort, one of the main tourist attractions in Oman.

ated decline in remittance flows will narrow it. But overall, the reduction in oil revenues is likely to dominate, and in 2020 and 2021, MENA oil exporters are projected to run large current account deficits, particularly in Iraq, Algeria and Oman. If these countries are to address the fiscal and current account deficit by hydrocarbon export revenues, the price of oil must be higher. The breakeven price for fiscal balance ranges from around USD 45 per barrel for Qatar to around USD 245 per barrel for Iran. Regardless of the limitations of breakeven indicators,

the point is that current oil prices are much lower than breakeven prices and budget deficits are not sustainable in this low-price environment. Reducing the gap entirely through budget cuts is challenging, as it requires a massive reduction of government spending in some critical areas such as public wages, health and social development, education and the military. Despite these challenges, governments can reduce the budget deficit, to some extent, through, for example, the reduction of public wages and subsidies or the delaying of capital projects (measures

that have already been taken in a number of countries). In severe cases, they can depreciate their currency, but to the extent that these measures reduce the welfare of citizens and impact negatively the private sector, they will face public and private sector backlash. Governments will have little choice but to rely on external and domestic borrowing. The external debt to GDP ratio in most countries is relatively low with the exception of Bahrain, Qatar and Oman but because of the crisis debt rules may be relaxed. But the downside is that ex-

ternal debt exposes the country to exchange rate and credit risks whereas financing the budget deficit by domestic borrowing can deprive the private sector of much needed credit and further drag down private sector activity. Those countries with a large enough buffer in the form of a sovereign wealth fund or foreign currency reserves (FX) are in a better position to withstand a period of low oil prices. Given the wide uncertainty that oil-exporting countries face, one would expect a cautious fiscal policy, but this is not the case for some of these countries. Countries



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The influencer

Areej AL Balushi, 32, is an influencer and a blogger. With her 250,000 Instagram followers, her passion for fashion has become a second job, which has allowed her to travel and tour the world.



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The music producer

Firas Al Bakri, 27, is a music producer. Returning to Oman after completing his studies in Dubai, he is contributing, through his work, to shaping the musical landscape of his country.

The photographer

Ali Al Sharji, 23, self-taught photographer has already exhibited his works in Europe, the United States and the Middle East. His photographs investigate the evolution of traditional culture and its contamination with elements of modernity.

such as Bahrain and Oman seem especially vulnerable to oil price shocks, as their foreign reserves are only equivalent to between 1.1 and 6 months of imports in 2020. Countries like Saudi Arabia and Algeria have accumulated large FX reserves. However, a deeper look at these countries reveals that these reserves have been falling. For example, in Algeria FX reserves were USD 194 billion in the first quarter of 2014 but at the end of the first quarter of 2020 they stood at USD 60 billion. At this rate of decline, reserves will be exhausted in 2022.

Focus on oil production strategies

Along with cutting current and capital expenditure, MENA oil exporting countries could pursue oil output strategies to boost their revenues, but this approach involves important trade-offs. On the one hand, adopting a high volume or market share strategy risks a fall in oil revenues as the higher revenue due to higher volumes may not compensate for the loss in revenues due to the lower oil price. This is especially true in the short term, as low oil prices may not result in the immedi-

ate shut in of production in high cost producers, but the uncertainty also pertains to long-term revenues if other producers turn out to be more resilient to a low oil price environment and/or if demand does not strongly recover. On the other hand, cutting output to support prices may result in loss of market share and may not result in large increases in revenues if the cuts are replaced by increases in output from non-participating producers. Also, depending on the size of the demand shock, the output cut may not be big enough to raise prices for a sustained

period. Finally, as recent events have shown, negotiating a sustained output cut among large number of producers is becoming increasingly difficult given the size of the cut, the diverse nature of players and their different interests.

MENA oil exporting countries are also exposed to long-term challenges related to the energy transition and increased uncertainty about oil demand growth. The main challenge for oil-exporting countries is loss of the revenues essential for the functioning of their economies. Another challenge is the ability to monetize →



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The climber

Nadhira Alharthy, 41, is the first Omani woman to climb Everest and heads the Ministry of Education's Department of Citizenship. Initially, her parents didn't understand her passion for mountaineering, which, in their eyes, made her too different from other girls.

The artist

Sabrina Busaidi, 28, artist and co-founder of "The Community," a platform that supports young artists living in Oman. Her work revolves around self-understanding, through the interaction between the external (physical) and the internal (spiritual) world.



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their large reserve base. For some resource rich countries, the proved reserve to production ratio extends to several decades, beyond all peak oil demand forecasts. This brings into focus the difficulty in monetizing the reserve base.

Three risk management strategies

MENA oil exporters can adopt three possible strategies to manage their

long-term risks whether it is from sustained low oil prices due to persistence of shocks or as a result of structural changes due to the energy transition. These strategies include conservative bet-hedging (always play it safe), diversified bet-hedging (don't put all your eggs in one basket), and a combination of the two. Over the last few decades, the focus has been on diversification. Initiatives on economic diversification in

the national development plans of MENA oil exporting countries have been proposed since the 1970s with the aim to provide a safeguard against commodity price fluctuation and to prepare for an era of depleted oil reserves. Since the turn of the new century, however, energy transition changed the discourse from peak oil supply to peak oil demand. This has given new momentum to diversification efforts in these coun-

tries. However, these countries face real challenges to their attempt to realize a meaningful diversification strategy. This is because diversification is only successful if it offers risk reduction by pooling uncorrelated income streams. In other words, if these countries diversify into sectors where inputs rely on hydrocarbon infrastructures, they may not achieve sufficient risk reduction. On the other hand, if they diversify into sub-



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The engineer

Shahryar Asadi, 24, is an Iranian engineer. Like many of his compatriots in recent years, Asadi has chosen to move to Oman in search of work.

The tour guide

Mubark Said Mubark, 25, comes from a poor family. He attended school until he was 14 and then decided to leave it to work with animals. He now works as a tour guide.



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stantively different areas that have little in common with their current primary industry, which constitute their core competitive advantage, they run the risk of failure of establishing viable non-resource export sectors. Furthermore, achieving diversification requires building human capital, improving education systems and the introduction of extensive reforms to improve the business environment, transparency and economic governance. Fiscal diversification requires the introduction of taxes, both direct and indirect. It also needs streamlined procedures, the reduction of excess monopoly rents in non-tradable sectors and the removal of barriers to private sector participation. There is uncertainty about whether and how quickly such extensive economic and institutional reforms can be implemented in these countries.

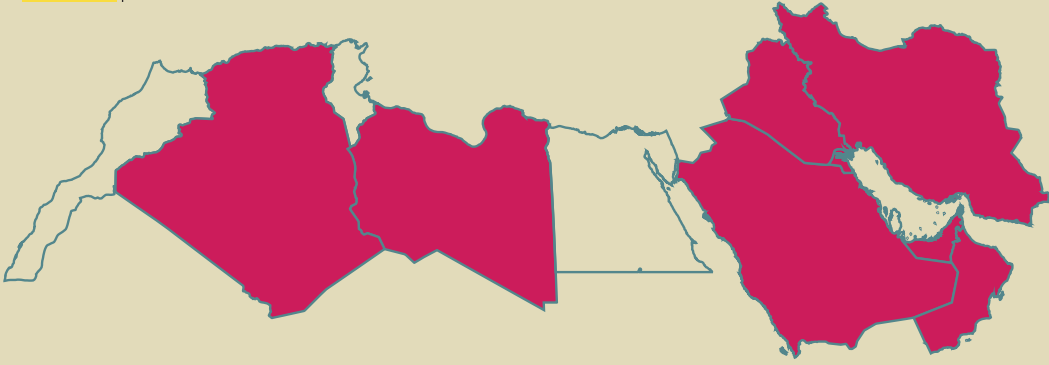
Another strategy is for MENA oil exporters to focus on their competitive advantage and increase their resilience through a conservative bet-hedging strategy. Conservative bet-hedging is defined as a strategy that decreases the fitness of a player to its environment in their typical conditions in exchange for increased fitness in stressful conditions. How can this strategy be translated in the context of some MENA oil export- →



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The taxi driver

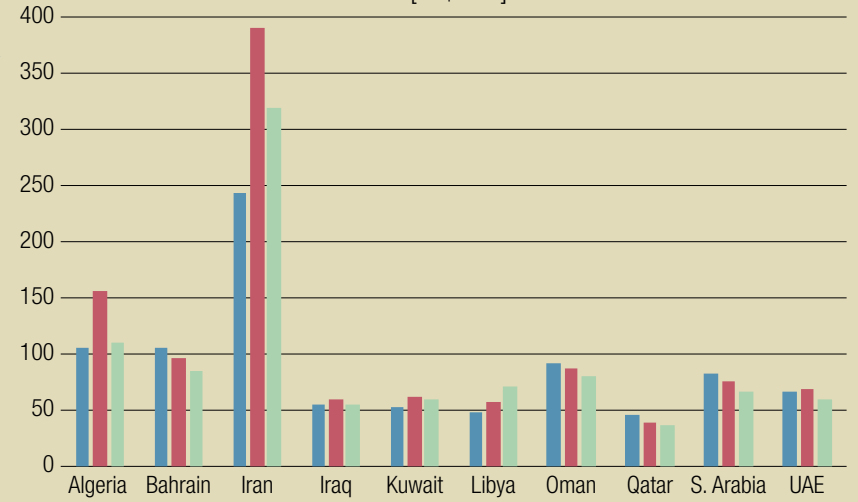
Daya Said Al Daoodi, 19, loves his job as a taxi driver because it allows him to meet different people from different countries every day.



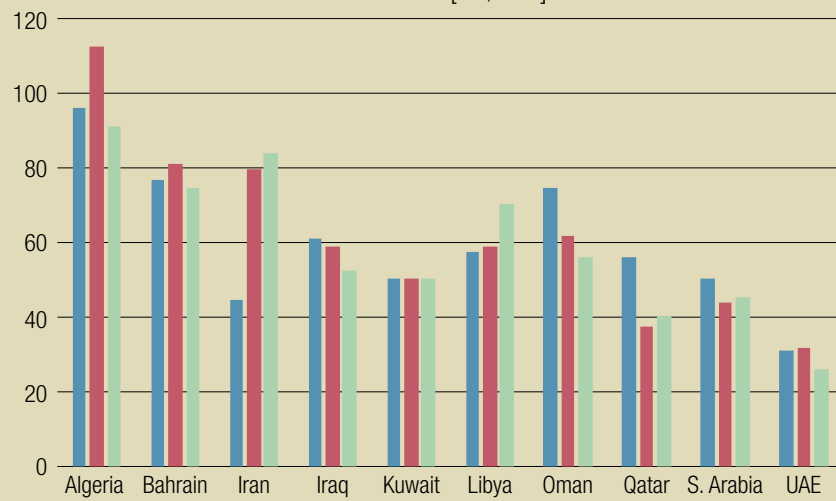
EconoMENA

Current market conditions, characterized by low oil prices, will sharply increase the deficit/GDP ratio of MENA exporting countries, which will therefore find themselves managing large deficits in both 2020 and 2021.

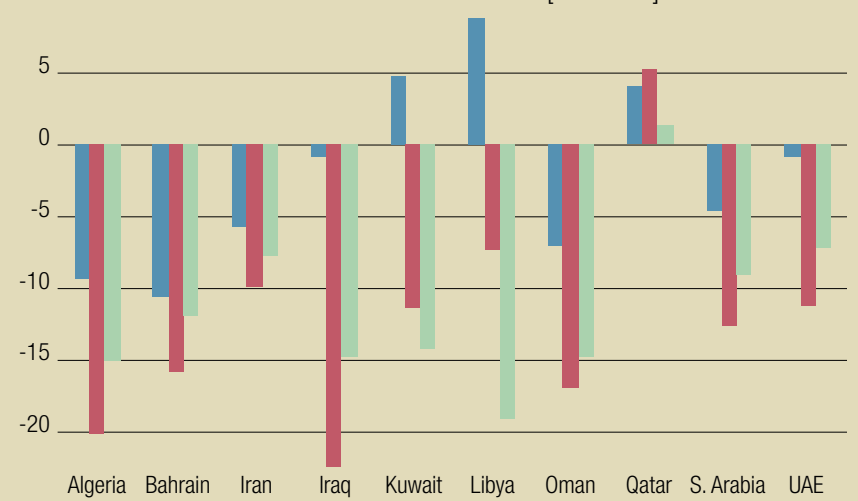
FISCAL BREAK EVEN OIL PRICE [US\$/BRL]



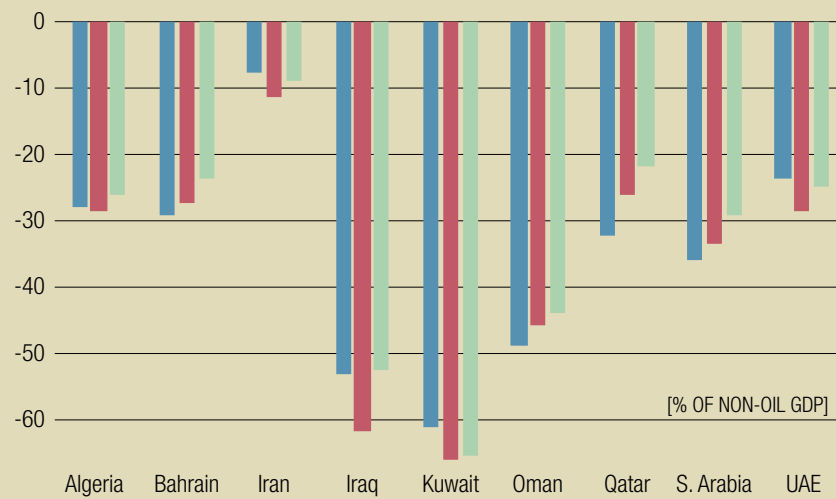
EXTERNAL BREAK EVEN OIL PRICE [US\$/BRL]



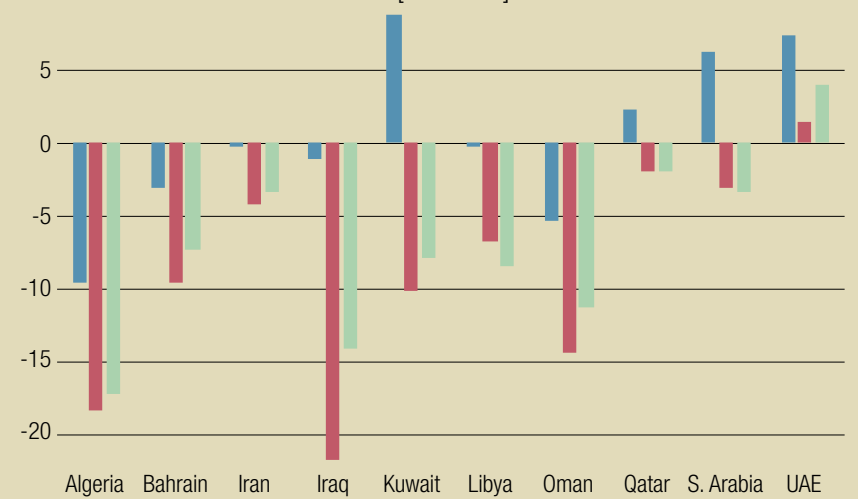
GENERAL GOVERNMENT FISCAL BALANCE [% OF GDP]



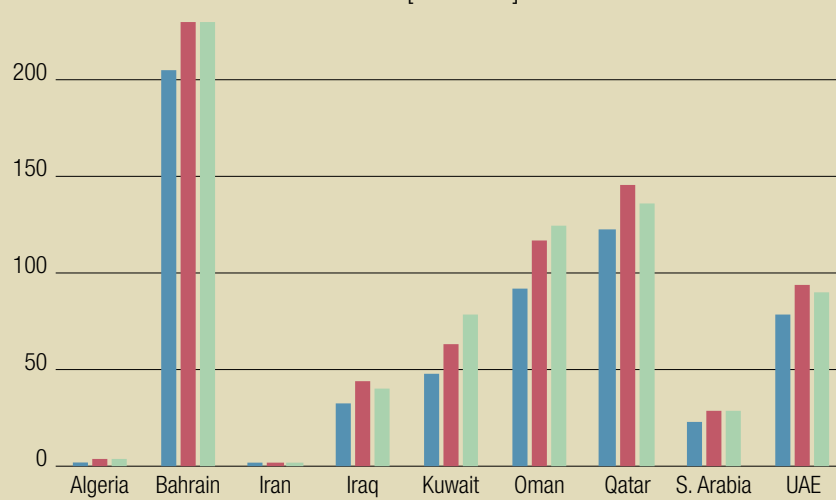
GENERAL GOVERNMENT NON-OIL FISCAL BALANCE



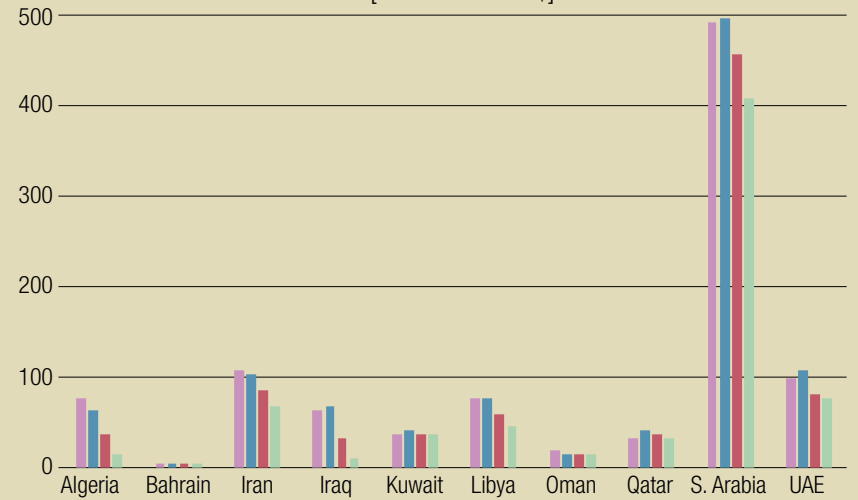
CURRENT ACCOUNT BALANCE [% OF GDP]



TOTAL GROSS EXTERNAL DEBT [% OF GDP]



GROSS OFFICIAL RESERVES [BILLIONS OF US \$]



Source: FMI (2020), Regional Economic Outlook: Middle East and Central Asia/IMF (2020)



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ing countries? The core sector of oil exporting countries is the extraction and exportation of crude oil, natural gas, natural gas liquids, and condensates. This is a high return, but also a high-risk business given the volatility in the oil price and the potential change in demand patterns. Adopting a conservative bet-hedging strategy to shield against the risks of revenue disruption involves taking a set of key measures:

- Improving the cost efficiency of the oil and gas sector so the energy sector can compete in a tough environment;
- Decarbonizing the production process of oil and gas as this constitutes a new source of comparative advantage;
- Decarbonizing the final petroleum products to ensure greater acceptance and demand for your key products.

For cost efficiency oil exporters can, for example, focus on investments which are low on the cost curve, run them efficiently and take measures that optimize operations and capture operational synergies across various elements of the value chain.

The sustainability of the oil industry

For decarbonization, these countries

can reduce the carbon intensity of oil/gas production process and decarbonize the end products through a combination of change in the operational procedure and investment in low carbon technologies. For example, investment in carbon capture, storage and utilization (CCUS) enables these countries to decarbonize their final products and thus strengthen the economics and sustainability of their oil/gas industry. The key part of a conservative bet-hedging strategy, in this context, is to replace oil exports, as oil demand declines, with new energy carriers that are clean and can be produced using existing oil and gas infrastructures.

The return on a conservative bet-hedging strategy is undoubtedly lower than the current default strategy of oil and gas exports given the costs involved in decarbonization and the lower margins in low carbon businesses, but its risk profile is also lower. This strategy is less complex to implement given its close relationship with the existing hydrocarbon business and countries can build on their core strengths. Currently many of the decarbonization technologies such as CCUS are very costly but this means there is significant room for cost efficiency gains

and R&D that these countries can exploit. During the transition era these countries can still export oil/gas and benefit from the generated rents, while at the same time, improve the return on decarbonized products.

However, this strategy suffers from two main drawbacks. First, there is some degree of correlation between the prices of all energy products when there is, for example, a global decline in energy demand. Second, with the growth of decentralized technologies, future energy systems will be characterized by a high level of competition and the absence of energy superpowers. This means it becomes increasingly difficult to extract rent beyond marginal costs. It might also not deliver other government objectives such as job creation for local workforces as the energy industry is very capital-intensive.

Most likely MENA oil exporting countries with developed energy sectors and stable investment and political environments will pursue a combination of conservative bet-hedging and diversified bet-hedging strategies to varying degrees. But irrespective of the strategy taken, in the face of disruptive forces such as the energy transition, there is a fundamental trade-off: the cost of reduc-

The organic civil servant

Abdullah Bin Mohamed al Riyami, 35, works for the Ministry of Defense. In his spare time he takes care of his family's fields, located 2000 meters high in the Jebel Akhdar region. To protect his plants from pests, he uses organic products supplied to farmers by the government.

ing the long-term risks and increasing resilience is to accept lower expected return on existing assets by investing in measures that align their hydrocarbon sector with low carbon scenarios. In other words, policy-makers need to realize that while decarbonization policies come at a cost and thus lower the overall return, they also reduce the risk of disruption of their energy sector and economies in the long run.





Society/The global epistemological crisis and artificial intelligence

The World We Want and the One to Come

A more livable and sustainable world is within reach. We have the resources, technology, and energy necessary to make it happen. But vision, will and, most of all, courage will be required from all of us



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DERRICK DE KERCKHOVE

Scientific Director of Media Duemila/TuttiMedia Observatory and Visiting Professor at the Polytechnic of Milan, de Kerckhove directed the McLuhan Program in Culture & Technology of the University of Toronto from 1983 to 2008. He is the author of numerous publications on the digital age, including *The Skin of Culture* and *Connected Intelligence*.

On October 10, TED's association with Future Stewards posted via YouTube the results of a global transgenerational consulting operation addressed free of charge to all socio-economic levels. Celebrities or not, the 50 participants of the *Countdown to a better, greener, healthier, thriving, resilient, fairer, cooler, creative future* shared their suggestions to rebuild a better world after COVID-19. Al Gore, Ursula van der Leyen, Richard Attenborough and Jane Fonda as well as professionals, architects, artists, renewable energy experts and other innovators showed with hope and enthusiasm that "the world we want" can be achieved, provided that as soon as possible we take advantage of their detailed, positive and soundly applicable advice. "The world to come" is unique, and it may appear presumptuous in these

times of political and environmental uncertainty to make pleasant predictions about an anxious future. But we can hope that the world to come will follow the general direction proposed in the *Countdown*.

Two seemingly incompatible scenarios

The problem is to make compatible two apparently incompatible scenarios: on the one hand, the dignified survival of human beings of all conditions in all latitudes (expressly stated in the Sustainable Development Goals program of the United Nations), and on the other, an unshackled economy that sets the planet on fire. In addition, the current social de-cohesion caused in part by the exponential growth of fake news, denialist groups and conspiracy activists is causing a global epistemological crisis. In the crisis of meaning, the underlying cause is that the digital transformation, through social media, has given voice to a multitude of people without information and with wrong and dangerous opinions. These opinions in turn lead to populist elections and chaos that hinders both considered reaction to the threat of COVID-19 and the measures necessary to fight it. In this infodemic, the reality of "objectivity" is lost because it has become seamlessly confused with the subjectivity of everyone.

Sophocles said: "Nothing great enters the life of mortals without carrying a curse." If by curse we mean digital transformation, this is because the two worlds refuse to become a single environment that insists that development be based on balance and equality of rights and duties.

The digital transformation brings change that goes far beyond better business organizations. It is not just about management or a new communication system but is about all of us and touches our sensitivity and daily life. At the deepest level it is about a clash between the alphabetical culture of the past and the digital culture of the present and future. The digital culture is not simply added to the alphabetical culture but overrides all its assumptions. For example, the alphabet gave personal control of language to the western individual, who exploited it in the silence of reading and as a bulwark of private and inviolable conscience. In contrast, the digital invades the mind, outsources on various screens its cognitive function such as memory and judgment and traces all of our mental and physical movements. Moreover, technology brings the decision-making center from within the person to without in machines that suggest or anticipate man's decisions. We are facing a historical,

anthropological, psychological, personal and social reversal.

Artificial intelligence: problem and potential solution

The solution at the heart of this transformation could be found in the accelerated progress of Artificial Intelligence (AI). By now, a growing part of human judgment is given to AI to make decisions in medical, legal, military, administrative and many other domains. It could also be that the principle of objectivity will move to the algorithm to avoid disappearing definitively in social incoherence.

However, the algorithm cannot always be trusted. It will be of utmost future concern to focus on education to avoid children becoming victims of an algorithmic trap, a trend that is clearly described in *The Social Dilemma*. The documentary analyzes and describes the insidious manipulation by social media to motivate choices and actions in people who don't suspect their origin or processes even as they gleefully participate in them.

The future will probably be completely controlled by AI. The recent leap made by AI techniques amazes us because it goes far beyond the now classic victories of IBM's Big Blue at Go and chess. GPT-3 (Generative Pretraining Transformer, third iteration) is a linguistic model that allows the machine to create content on demand. The difference between it and Wikipedia is that the latter's database only provides pre-existing answers, whereas the new intelligence benefits from 175 billion parameters to give self-generated answers. The *Guardian* on September 8, 2020 published the first article completely written by an Artificial Intelligence. In fact, as reported by the newspaper *La Repubblica*: "It was not entirely the robot that wrote the editorial. A *Guardian* journalist—a human as the case may be—gave GPT-3 the following written instructions: "Please write a short op-ed (editorial) of about 500 words in simple and concise language. Focus on why humans should have nothing to fear about artificial intelligence."

This is not the time or place to give details about the essence of the text; the fact is that we have reached the turning point where the machine can write a text in very few seconds having very few indications. What would happen if the machine generated so much fake news about the environment that it would reverse the trend on the "Green Deal" of Ursula von der Leyen, for example? That's why the symbiosis, that is the active collaboration between man and machine, must be the solution to →

bring together the world to come with the world we want. That's why we humans have to remodel the tools before they model us in their image.

New technologies and direct democracy

Infact we have been witnessing a strong collaboration between man and machine in “Symbiotic Autonomous Systems Initiative (SAS)” a research promoted by the International Association of Electric and Electronic Engineers (IEEE), a project in continuous development that starts with the first examples of symbiosis available in a series of areas that influence our economic system and way of life. The initiative, in which I have been participating for four years, proposes a 360 degree vision based on technology and standardization with an engineering focus, but incorporating complementary points of view, including economic, regulatory, ethical and socio-cultural perspectives. I am involved in the latter because the transformation promoted by technological evolution in all walks of life requires social awareness, ethical considerations, planning and dissemination by current and future actors. The energy issues discussed below are drawn from our predictions in the first two White Papers (2017 and 2018).

“The technologies that support datacracy, or algorithmic governance, could also usher in the emergence of a networked direct democracy as well as a post-scarcity/post-capital ecosystem. In a direct (or pure) democracy—as practiced in Switzerland—citizens vote directly (there are no elected representatives) on matters of governance such as laws, policies and bills, this being analogous to voting on a referendum in an indirect democracy. In addition, voting irregularities that have long plagued democratic voting may be addressable in an algorithmic direct democracy model utilizing ubiquitous, strongly encrypted, remote e-voting (online or digital voting) based on blockchain technology. This would simultaneously create anonymous, publicly accessible records of the voter ID, candidate ID and the time. While post-scarcity and post-capital ecosystems are often seen as synonymic, this is not necessarily the case. In a post-scarcity ecosystem, resources are no longer scarce due to adoption of renewable clean energy; fusion power, which uses water for fuel, cannot lead to a meltdown, and powers itself by generating more energy than it takes to operate the fusion reactor itself; and ubiquitous molecular and atomic scale raw material is used by future 3D printers to transform what are referred to as blueprints into a wide

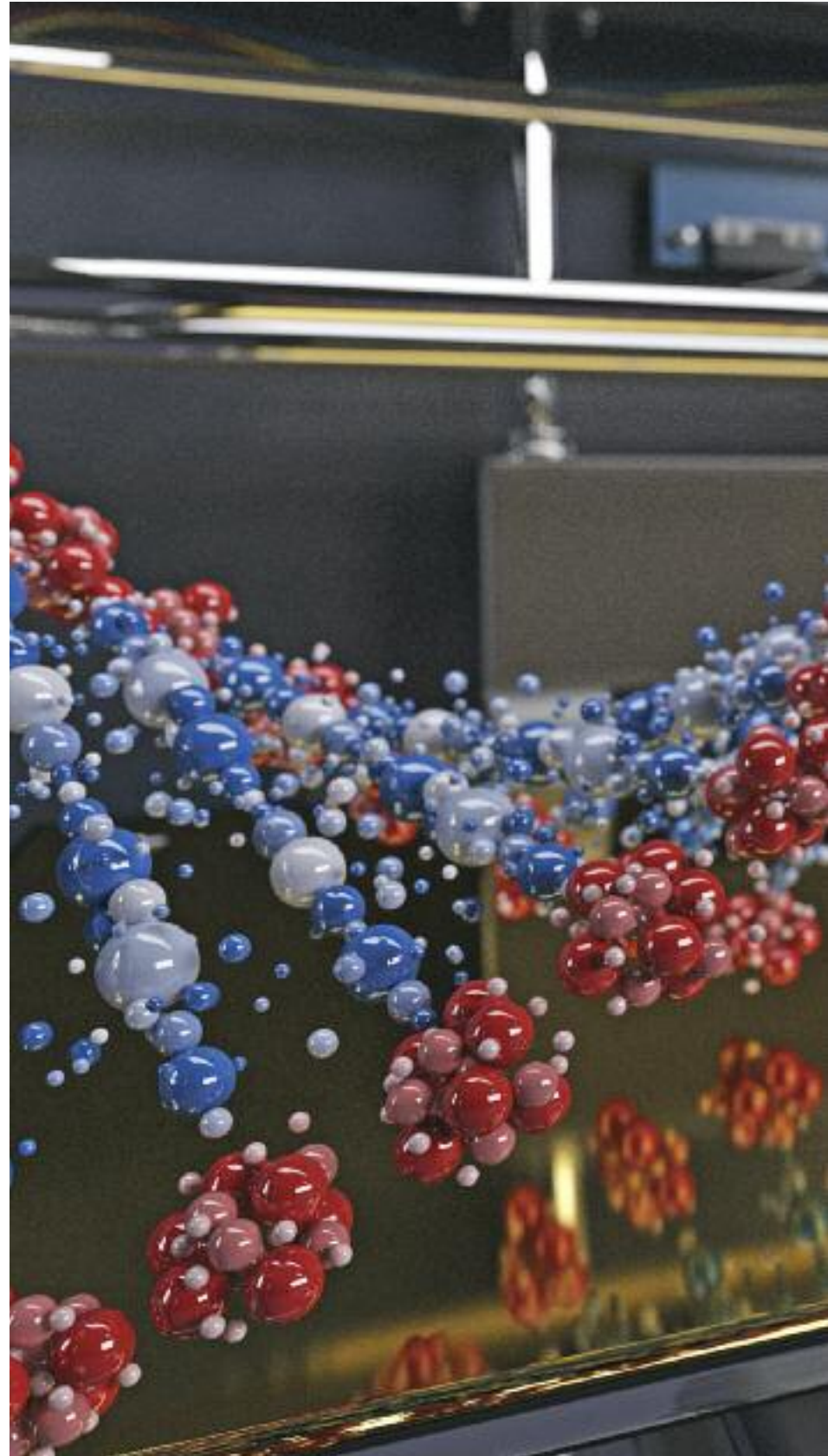
THE FUTURE OF PRODUCTION

Future 3D printers will be able to produce a wide portfolio of objects, including foods, biological tissue and organs, mechanical and electronic products, tools and components, and other outputs—all at minimal cost. In the photo, a 3D printed DNA helix.

portfolio of objects, including foods, biological tissue and organs, mechanical and electronic products, tools and components, and other outputs—all at minimal cost. Moreover, natural resources are handled by a global algorithmic network (comprising advanced automation, Artificial Intelligence and robotics) that will perform all steps in the resource location-acquisition-processing-manufacturing-maintenance-distribution sequence.

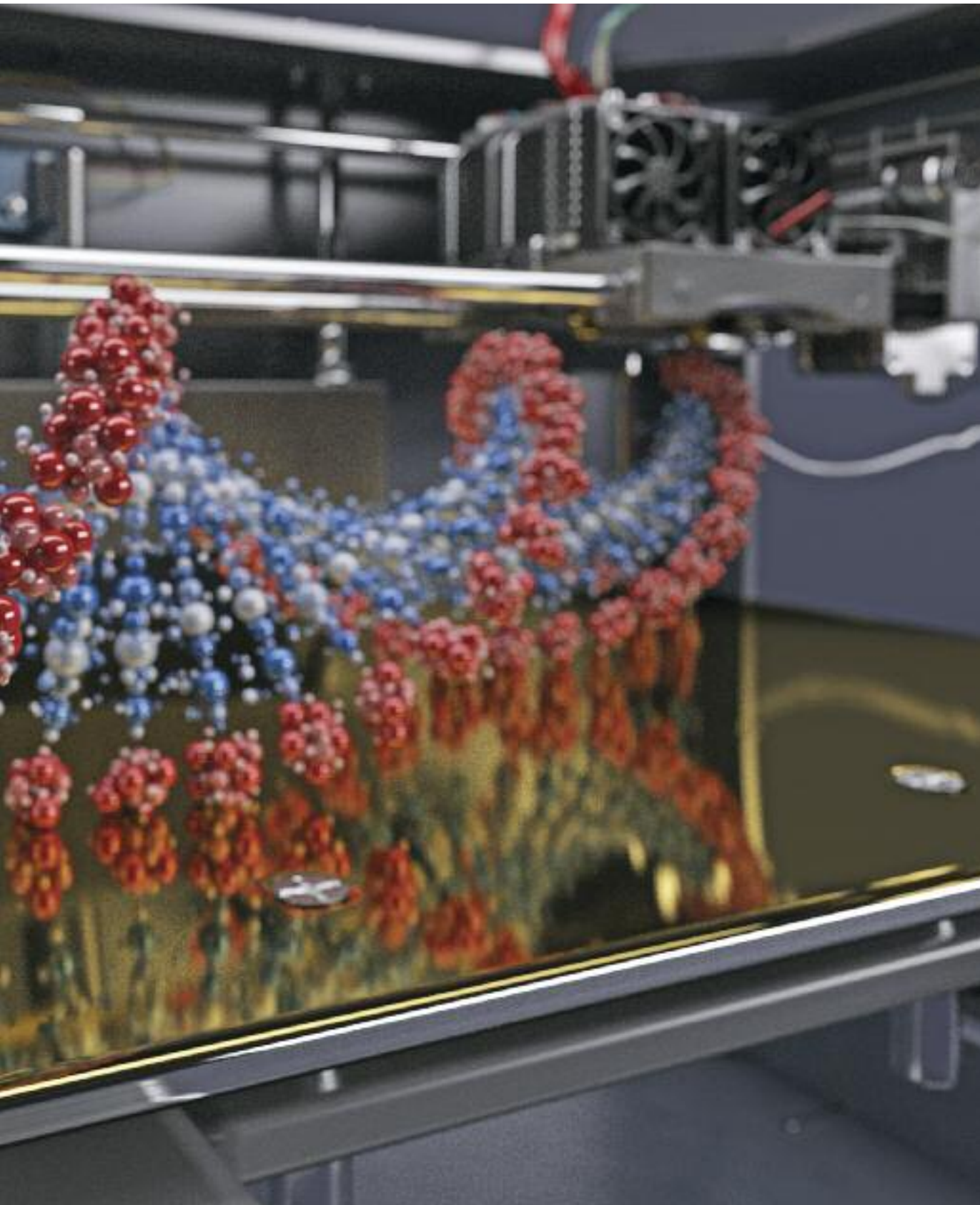
A fully automated SAS post-capital ecosystem (in which goods, services and information are universally accessible at no monetary costs) could then theoretically emerge when the above human labor-free system generates global economies of scale and algorithmic optimization to minimize costs to the point of making capital unnecessary, thereby transforming values and ethics that then prioritize societal well-being and global preservation. A post-capital supply-and-demand system could thereby leverage global crowdsourcing protocols and local/personal molecular manufacturing to operate automatically and perpetually optimize ecosystem operations, security and environmental issues addressed by datacracy-like intelligent algorithmic systems.” (White Paper I 49-50).

In the second White Paper (published in November 2018) we have



approached the concept, back in fashion, of the “circular economy”: “The World Economic Forum defines a circular economy as an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals (which impair reuse and return to the biosphere), and aims for the elimination of waste through the superior design of materials, products, systems and business models. In a manufacturing plant based on a circular economy protocol, for exam-

ple, waste materials in linear (standard) plants are replaced by the output of two classes of reusable outputs in which material flows are of two types—referred to as nutrients—these being biological nutrients (designed to re-enter the biosphere safely) and technical nutrients (which are designed to circulate at high quality in the production system without entering the biosphere, as well as being restorative and regenerative by design). In short, as a result of these practices an industrial circular economy produces no waste or pollution.” (White Paper II, 138-139)



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The search for new renewable energies

Our reflection has also led to new renewable energies including artificial photosynthesis—a biomimetic (that is, mimicking biology) chemical process that replicates the natural process of photosynthesis by converting sunlight, water, and carbon dioxide into carbohydrates and oxygen, and which generally refers to any system that captures and stores energy from sunlight in the chemical bonds of the resulting solar fuel. Related technologies involve engineering photoautotrophic microorganisms and enzymes to generate

microbial biofuel and sunlight-based biohydrogen production and converting CO₂ directly from air into biomass and fuels. Another example is a recent hybrid water splitting–biosynthetic system that when combined with solar photovoltaic cells promises solar-to-chemical conversion rates roughly 10-fold more efficient compared with natural photosynthesis and also avoids the toxicity associated with previous attempts. Cost-effective artificial photosynthesis technologies well-suited to housing installations in urban and densely-populated suburban areas are inkjet-printable solar panels, ar-

tificial leaves and (even for woven polyester cotton fabrics) spray-on solar cells—an important focus given the interaction between continued population growth, increasing urbanization and rising energy demand.

Our research, taking into account the advancements in quantum physics applications, has identified a potentially inexhaustible new source of energy in the so-called thermionic energy conversion:

“Thermionic energy conversion (TEC) is the direct transformation of thermal to electrical energy—specifically, from thermions (heat

quanta) to electrons—by thermionic emission (hot electrons spontaneously ejected from a surface). While TEC is currently used in solar cells to increase conversion efficiency, it has the potential to, for example, convert the heat of an in-use battery to electricity. While no researcher would assert that TEC is a self-perpetuating system, a limited charger-independent system can be envisioned with solar charging built into the display—a 0.55mm transparent pane placed between the phone’s display and touchscreen. That said, a system approaching a fully closed-loop system might be feasible by equipping a smartphone with both high-conversion ratio TEC and WYSIPS components. On a larger, more ambitious scale, researchers are assessing the potential of TEC systems (also referred to as Thermionic Converters) for both space and terrestrial applications.”

Research reveals that so-called “renewable” energy sources are much more abundant and omnipresent than fossil fuels and absolutely less polluting. This means that a healthy future can not only be imagined, but also realized. Dismantling and converting fossil energy, although a complex and painful operation because it is already installed almost everywhere as the main source, will eventually be mandatory to produce and use the energy of the future.

A world close to that which we want is still possible and much more livable than the present one. The technological conditions are there, as are the material resources, especially energy, the most precious of all. But vision, will and, most of all, courage are required from all of us. Changing attitudes is critical, and while the process may seem simple, it can be very difficult in practice. Neither the evidence of climate disasters nor political persuasion is enough, and although enforced obligation works, the world wants to avoid a fascist solution. To change attitude and behavior, we need neither force nor prayer, but we need to change the ground itself. For example, we should not merely forbid all motorized traffic in some historical districts but should do so in all the city centers of the world. Another ground-changing idea would be to combine ministries of defense and education so that they share equally a common budget, thus making it clear that the real defense of a country in the information age is to increase intelligence and creativity rather than armaments. That is the kind of world I would like to see and support.





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