The green transition

A trilogy of perspectives exploring how governments can accelerate a green and just transition

EY

Building a better working world

Addressing the climate crisis and accelerating the green transition

The first two decades of the 21st century have been dramatic regarding technology-driven innovation and social disruption caused by regional conflicts, a cost-of-living crisis and the global pandemic. Yet, looming over the rest of the century and beyond is an even greater threat to our status quo: the climate emergency that will reshape how and, in many cases, where people live and work.

Governments worldwide need to act swiftly and in a coordinated manner if we are to counter the existential threat global society now faces.

They already play a critical role in catalyzing public and private investments, and they have proven ability to shape new industrial strategies, foster business partnerships and incentivize public action.

How, then, can governments best shape policies that deliver a meaningful just transition away from fossil fuels rather than well-meaning pledges?

To better understand what economic growth will look like in the coming years and how it might differ across regional economies, the EY organization collaborated with Politecnico di Milano to model the potential value and impacts of the green transition process.

This provided EY teams with a detailed understanding of how feasible different transition pathways could be, subject to various changes in social, political and economic conditions.

In this trilogy of articles, we explore different pathways toward the transition to a low-carbon economy.

In the first article, we explore how governments can harness the power of technology to drive green innovation.

In the second article, we contemplate how to transform the job market to drive the green economy.

In the third and final article, we consider how governments can improve the fairness and effectiveness of carbon pricing through a long-term and internationally coordinated approach.

George Atalla
EY Global Government & Public Sector Leader

Gianluca Di Pasquale
EY Global Green Economies and Infrastructure Leader and Future Cities Co-leader

Meghan E. Mills
EY Global Government & Public Sector Strategy & Operations Leader; EY Global Sustainability and Green Economies Leader and Future Cities Co-leader

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If there's no silver bullet, can green tech hit the target?

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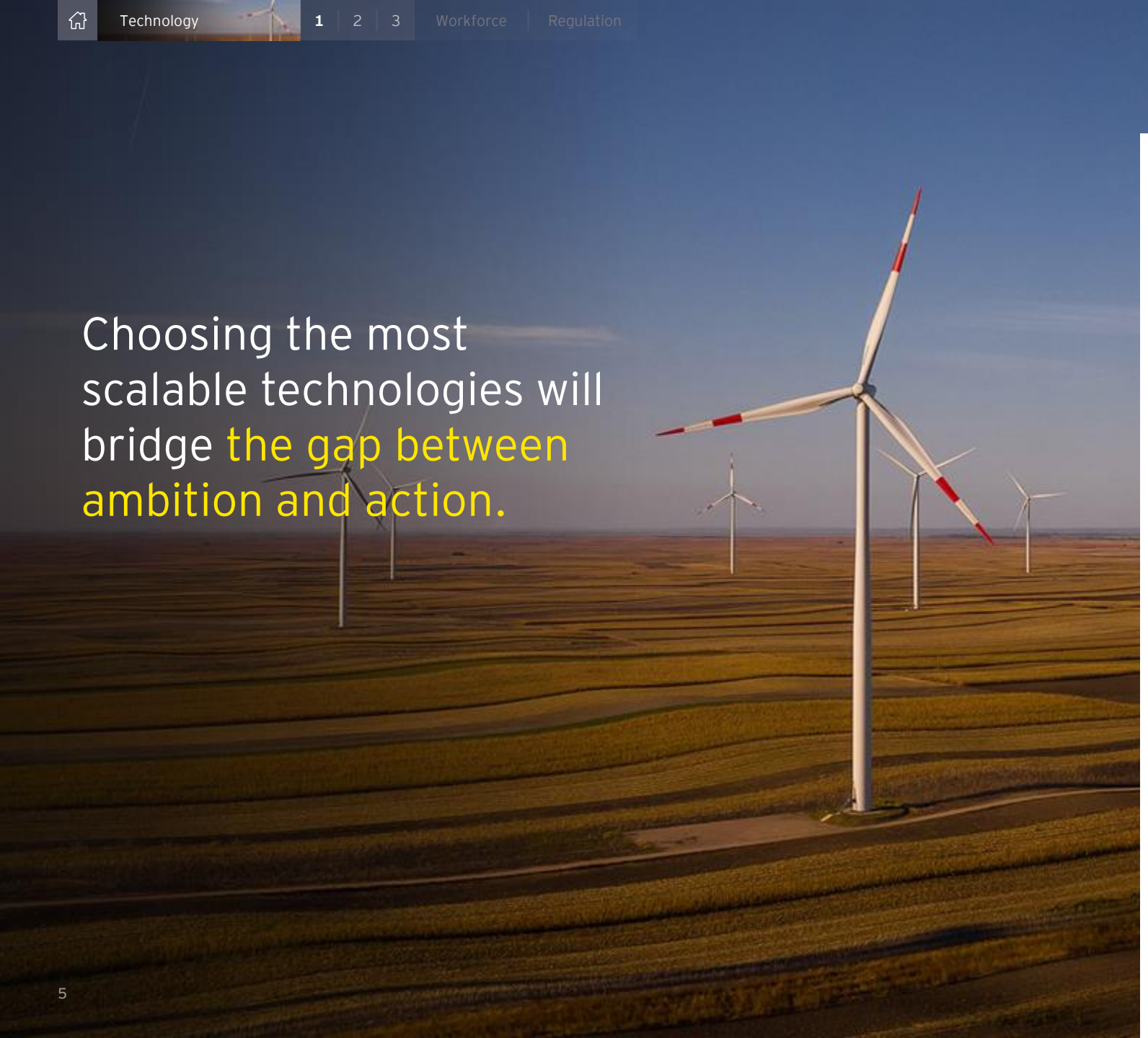


Choosing the most scalable technologies will bridge the gap between ambition and action.

Article in brief

Current governmental policy commitments aren't enough to deliver net zero.

Technology can help bridge the gap, but only with the right level of governmental support.

Getting the mix right between policy and investment in scalable technologies will be critical to success.

Explore more →

All governments are looking at the best ways to fulfill their Nationally Determined Contributions (NDCs) to reducing greenhouse gas (GHG) emissions.[1]

One strategy governments worldwide are embracing is direct public investment in research and development, technology and innovation.

If used strategically, public investment in green technology can be transformative, not least because it can be instrumental in accelerating private investments and public-private sector blended finance.

The potential for technology to drive low-carbon innovation, and help industry and society transition away from fossil fuels, is clear.

> Over the past decade, consider renewable sectors' growth and associated economies of scale, such as wind and photovoltaic.

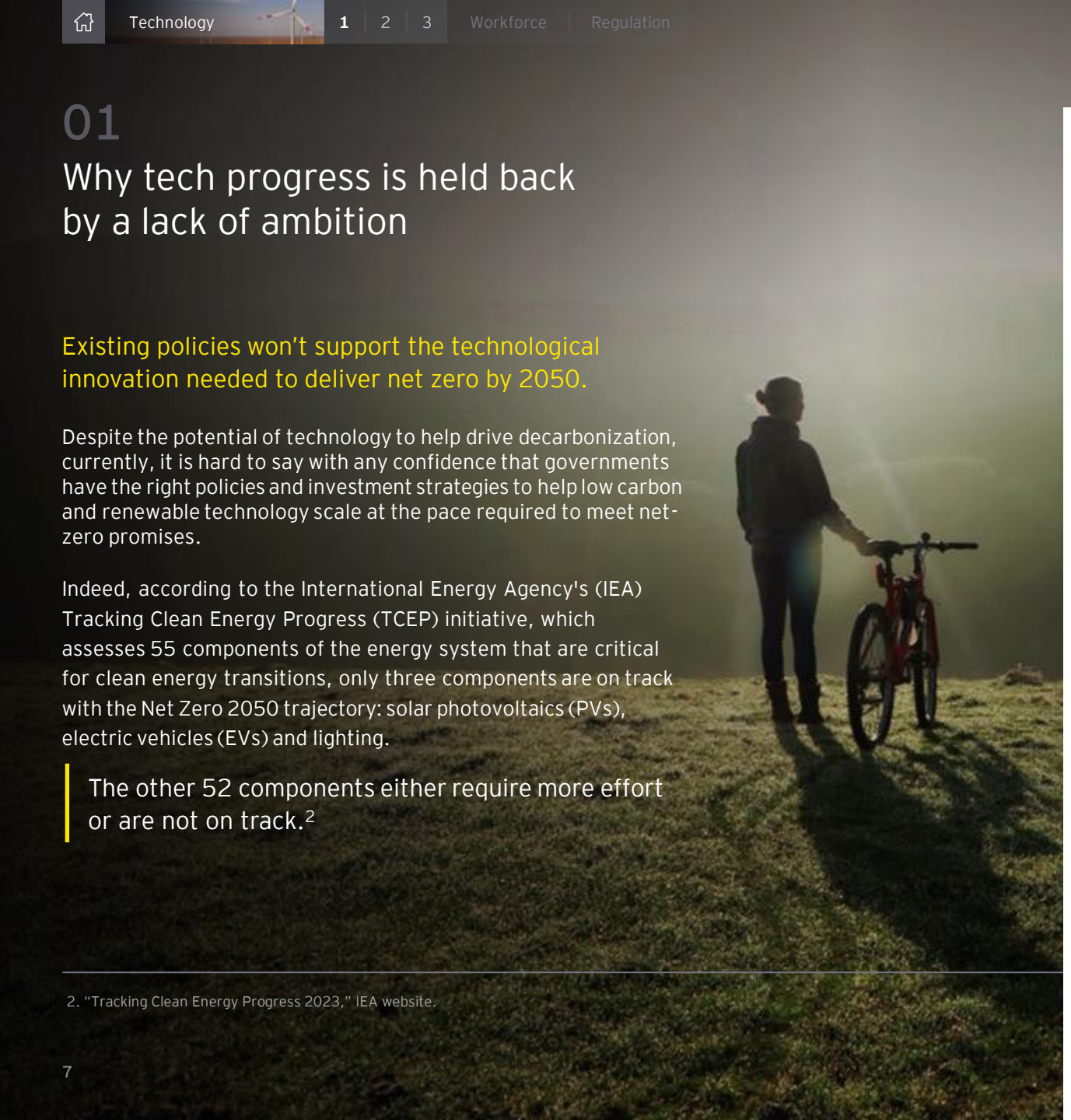
Increased innovation around electric battery power and storage capabilities will continue to reshape transportation, as will sustainable biofuels. Green hydrogen also offers an exciting renewable, low-carbon pathway.

Technologies such as carbon capture, utilization and storage (CCUS) could yet play an important role in helping to rid the power and utility sector of its dependency on coal and natural gas. Then there is the renewed interest in nuclear power (either traditional, small scale or fusion), a potentially important and dependable form of non-fossil fuel energy and power.

1. "Nationally Determined Contributions (NDCs)" UNFCCC website.

01

Why tech progress is held back by a lack of ambition



Existing policies won't support the technological innovation needed to deliver net zero by 2050.

Despite the potential of technology to help drive decarbonization, currently, it is hard to say with any confidence that governments have the right policies and investment strategies to help low carbon and renewable technology scale at the pace required to meet net-zero promises.

Indeed, according to the International Energy Agency's (IEA) Tracking Clean Energy Progress (TCEP) initiative, which assesses 55 components of the energy system that are critical for clean energy transitions, only three components are on track with the Net Zero 2050 trajectory: solar photovoltaics (PVs), electric vehicles (EVs) and lighting.

> The other 52 components either require more effort or are not on track.[2]

2. "Tracking Clean Energy Progress 2023," IEA website.

Readiness of energy transition components

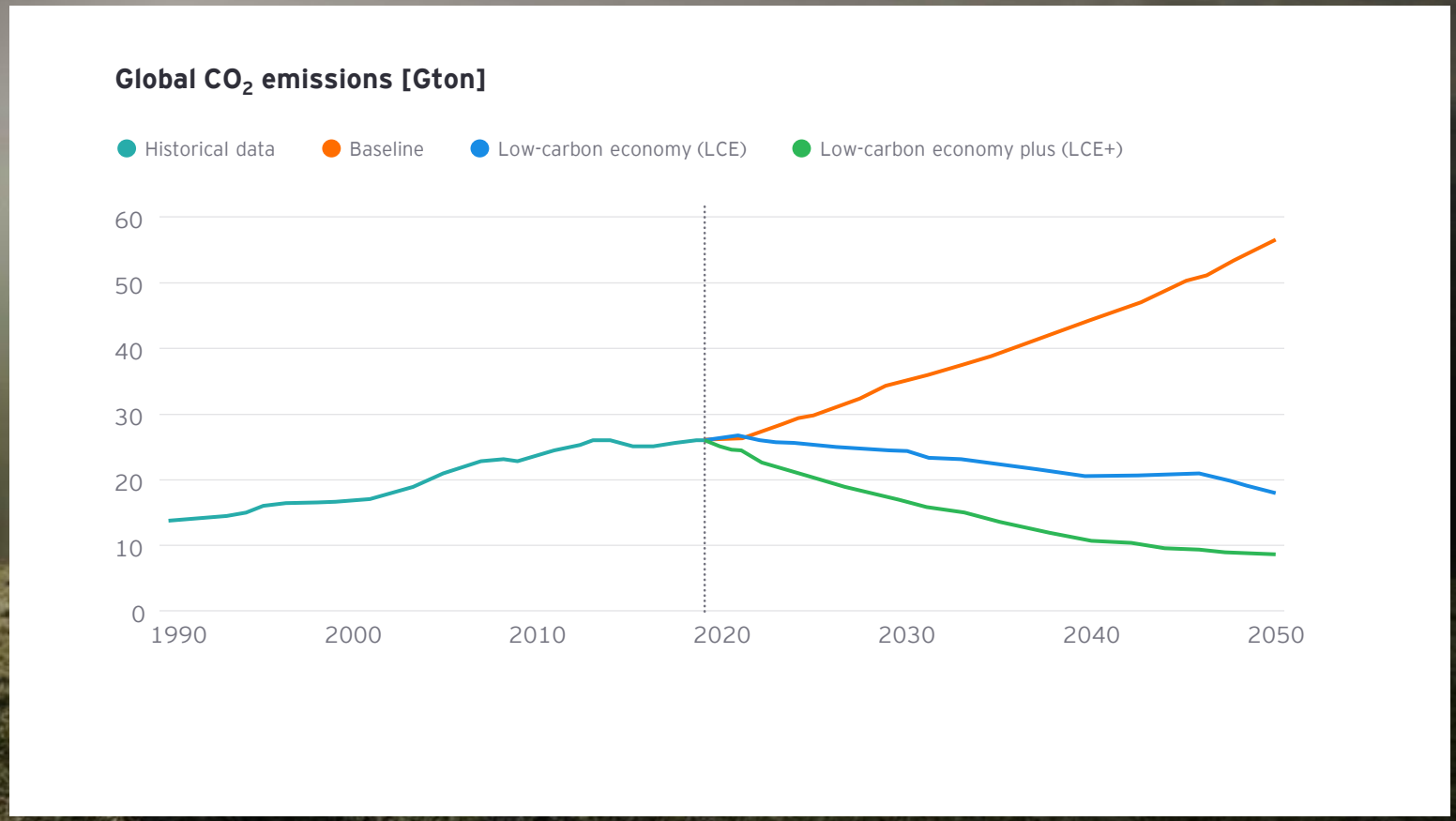
Sector	Technology	Readiness
Power	Renewables (solar, wind, hydroelectric)	🔴
	Hydrogen	🔴
	Smart grids and demand response	🔴
	District heating	🟠
	Grid-scale storage	🔴
	CO_2 capture and utilization	🔴
	Nuclear electricity	🔴
	PVs	🟢
Transport	EVs	🟢
	Rail	🔴
	International shipping	🟠
	Aviation	🟠
	Biofuels	🟠
Industry	Iron, steel and aluminum	🟠
	Cement	🟠
	Chemicals	🟠
	Pulp and paper	🟠
Building	Heating and cooling	🔴
	Building envelopes	🟠
	Heat pumps	🔴
	Lighting	🟢

🟠 More efforts needed 🟢 On track 🔴 Not on track

Clearly, the current policy path, global level of investments and existing technologies are not enough to reach net zero by 2050, which is a missed opportunity given that 2030 climate goals can be met with existing technologies, according to the IEA Net Zero 2050 trajectory.

However, by 2050, half of the required CO_2 emission reduction should come from technologies that are still in the demonstration or prototype phase.[3] These include carbon absorption, hydrogen-fueled engines, advanced batteries and clean cement. If governments are truly committed to realizing a just transition, they must take a proactive approach to increasing the development and deployment of existing and new technologies.

> In line with the IEA conclusions, our model shows that current policies and technologies are not enough to reach net zero by 2050.



3. Net zero by 2050: A Roadmap for the Global Energy Sector, IEA, 2021

1 LCE scenario

Under this scenario, the current set of executive policies in place based on leveraging commercially viable technologies will only be able to curb emissions by 8Gton by 2050, causing a 32% CO_2 emission reduction. While projected global governmental actions lead to a positive environmental impact, current policies won't deliver the net-zero target by 2050.

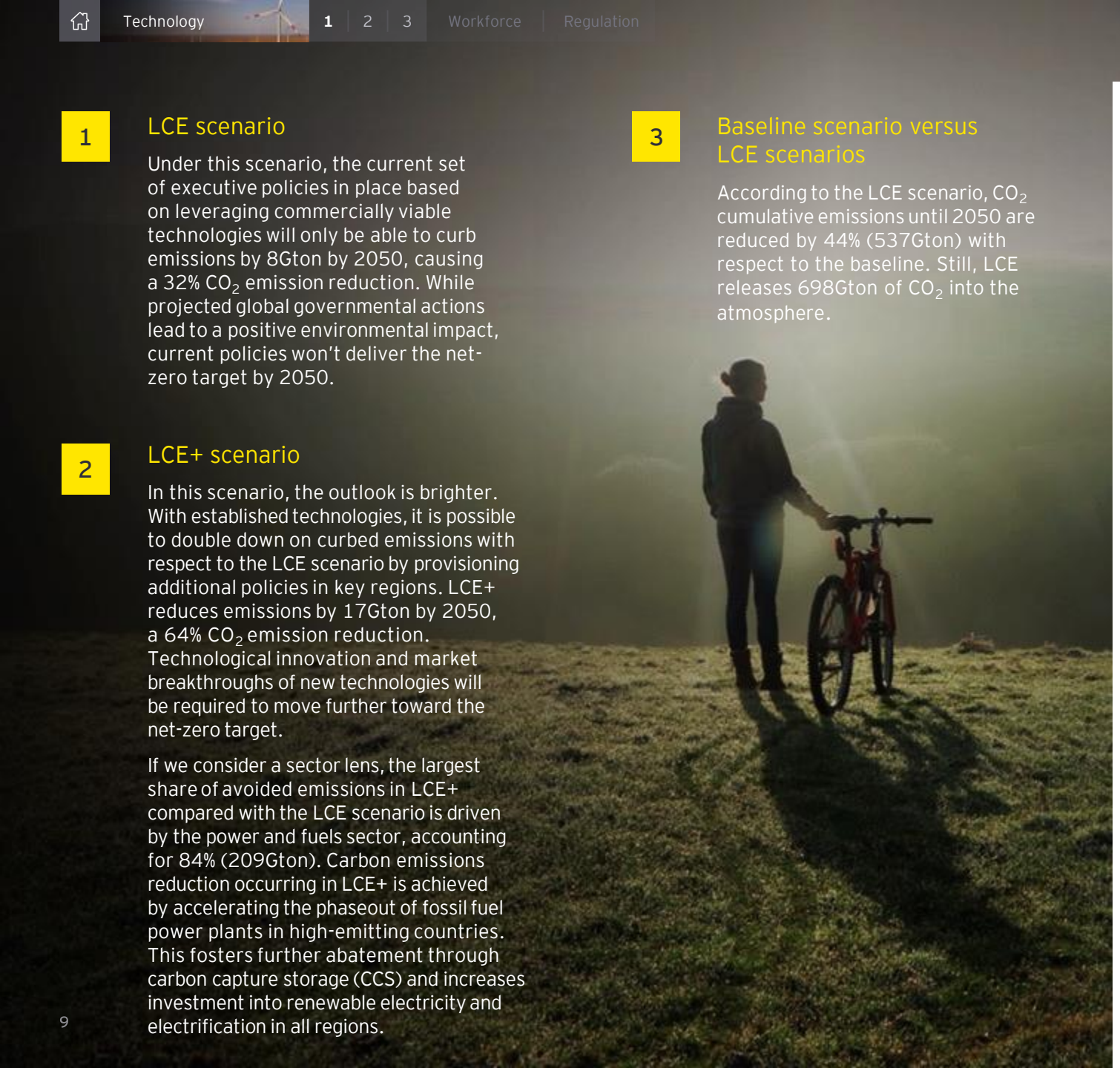
2 LCE+ scenario

In this scenario, the outlook is brighter. With established technologies, it is possible to double down on curbed emissions with respect to the LCE scenario by provisioning additional policies in key regions. LCE+ reduces emissions by 17Gton by 2050, a 64% CO_2 emission reduction. Technological innovation and market breakthroughs of new technologies will be required to move further toward the net-zero target.

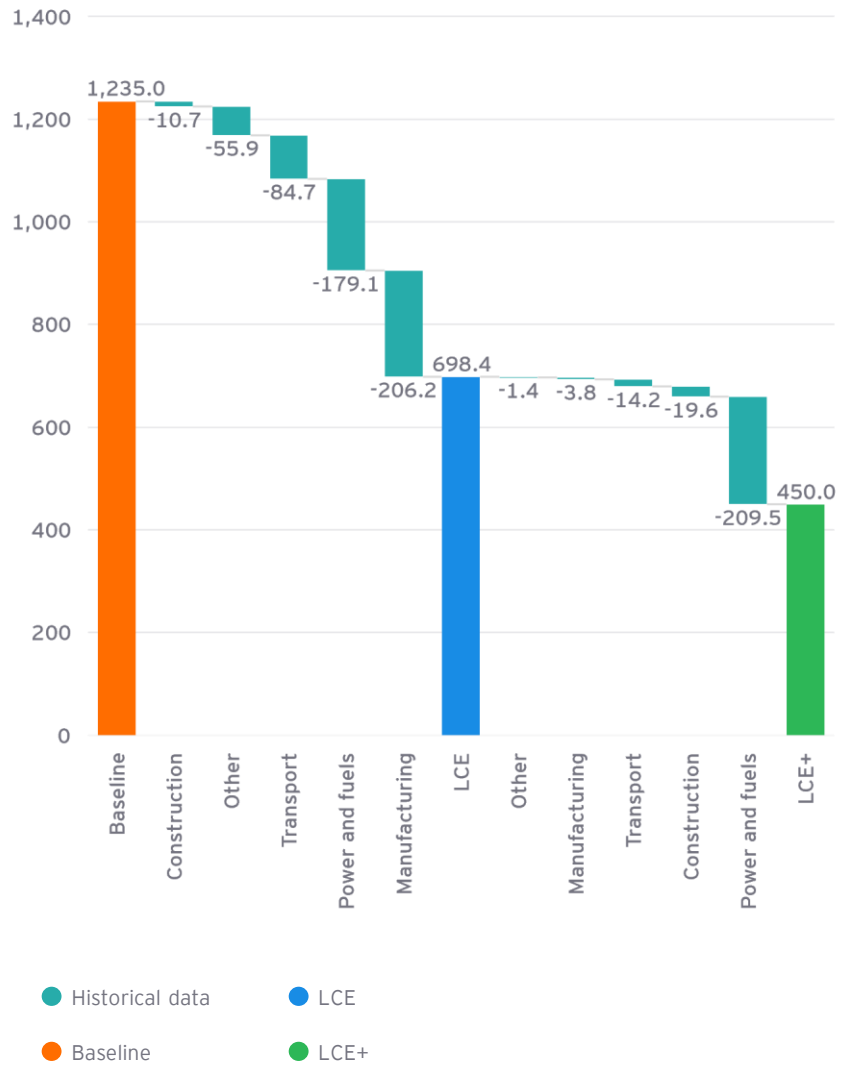
If we consider a sector lens, the largest share of avoided emissions in LCE+ compared with the LCE scenario is driven by the power and fuels sector, accounting for 84% (209Gton). Carbon emissions reduction occurring in LCE+ is achieved by accelerating the phaseout of fossil fuel power plants in high-emitting countries. This fosters further abatement through carbon capture storage (CCS) and increases investment into renewable electricity and electrification in all regions.

3 Baseline scenario versus LCE scenarios

According to the LCE scenario, CO_2 cumulative emissions until 2050 are reduced by 44% (537Gton) with respect to the baseline. Still, LCE releases 698Gton of CO_2 into the atmosphere.



Global CO_2 cumulative emission difference by key economic sector by 2050 [Gton]



02

Which tech game changers can governments support?

There is a need to support technological innovation and market breakthroughs of new technologies to move toward the net-zero target.

> “The private sector plays a crucial role in driving the energy transition. It will ultimately create markets and sustainable economic growth that we can all benefit from. To get there, governments need to strike a balance between regulating and incentivizing investment through policy, giving investors confidence for the long term, enabling solutions to be scaled, to ensure an equitable impact for all.

Amy Brachio
EY Global Vice Chair – Sustainability

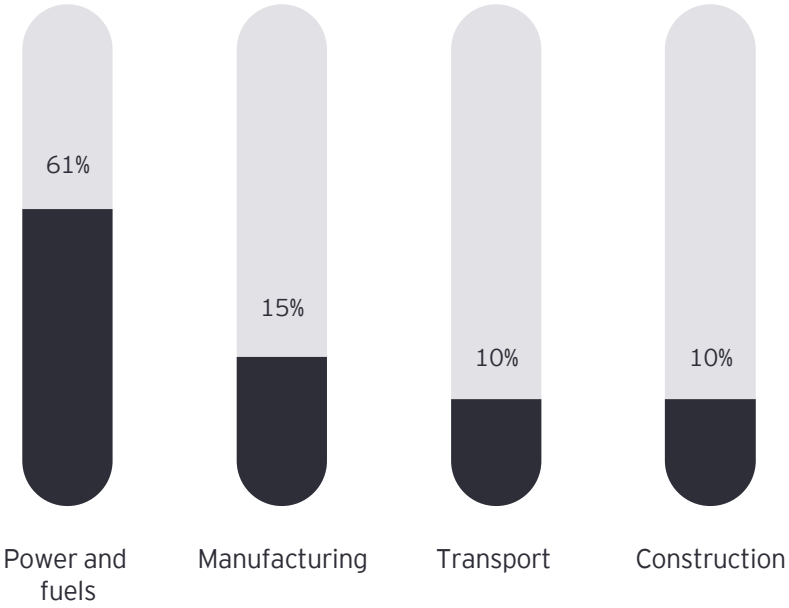
Given the time it takes to scale innovation, leveraging current and established technologies will maximize efforts to decarbonize while minimizing the costs (financial and nonfinancial) up to 2030.

But to make the leap required to reach net zero by 2050, governments must work harder to regulate and incentivize decarbonization via breakthrough technologies.

These technologies can speed up the green transition, but some costs are still prohibitive, as is the case with green hydrogen and carbon capture, usage and storage (CCUS). Their decarbonization potential is still less significant than other technologies (such as wind and solar, which also are cheaper).

According to our analysis, the power and fuels sector will still represent the major carbon emitter in 2050, accounting for 61% of emissions, followed by manufacturing (15%), transport (10%) and construction (10%).

Expected major carbon emitters in 2050



Here’s how these **four sectors** can drive decarbonization through technology.

1 Power and fuels

No single established technology can deliver net-zero goals on its own, and there's no need for this.

The real game changer in future power generation will be how governments can encourage low-carbon energy transition at pace and at scale while keeping the lights on and still improving the lives of their citizens.

Established technology will play an important role in smoothing out this transition. One example will be improved natural gas processing through Internet of Things (IoT) technology to reduce the risk of methane leakages (the gas is 28 times more potent in driving atmospheric global warming than CO_2 over 100 years and 84 times more potent on a 20-year timescale.)[4]

Natural gas can be seen as a transition path to fully renewable energy where a rapid increase in wind, solar and geothermal power supply is needed.

Progress is happening at pace and the world is on course to add as much renewable power in the next five years as it did in the past 20.[5] But developing the ability to store the energy produced and distribute it when needed will be revolutionary.

Smaller-scale, demand-driven technology — namely solar capture, wind harnessing systems and battery storage — will shape the consumer decentralization of energy production in the coming decades.

Distributed energy resources (DERs) and smart grids will play an important role in the energy transition. As the EY Renewable Energy Country Attractiveness Index shows, as markets seek to rapidly integrate more renewables, stronger regulatory support with subsidies and tax credits is essential to improving grid flexibility and predictability for future price realization.[6]

Decentralization has been a trending topic for decades, but one potential driver of this change is the massive deployment of EVs, accompanied by a comparable decarbonization of the power sector.

This presents an opportunity in the power-transport sector coupling, since car batteries operating in vehicle-to-grid (V2G) mode can absorb the excess power supplied by non-dispatchable renewable energy and increase power grid flexibility.

How governments legislate and regulate for an energy future where citizens are not dependent on a central power grid will be one of the important policy challenges.

4. "Methane emissions," European Commission website.
5. "Renewables," IEA website.
6. Renewable Energy Country Attractiveness Index 2023, EY.

2 Manufacturing

Manufacturing companies are struggling to make a sustainable breakthrough in performance using traditional manufacturing excellence approaches.

To achieve enhanced sustainability, leading manufacturing companies must take transformative initiatives across the entire value chain. New solutions enabled by green technologies are essential to meet net-zero goals. Several technologies are already available, but are not economically viable due to the absence of specific incentives.

Waste sorting and identification remains a key process for industrial products companies in the reduction of pollution in the environment. A call for accountability in environmental impact over the product lifecycle will drive leading companies to build circular manufacturing ecosystems.

> **Repurposing old equipment with either new components or an entirely new process is helping companies reduce equipment wastage and save costs.**

Offering takeback services is one way manufacturers are extending product lifecycle and earning customer loyalty. Material passports documents — consisting of all the materials included in a product or construction — will also help manufacturers achieve circularity.

Chemical companies are setting carbon neutrality goals and are prioritizing decarbonization through the efficient use of materials. They also are increasing the use of alternative energy sources (e.g., hydrogen and renewable energy), as well as investing in biorefining technology, such as H2ACE, which can capture carbon.

Sustainable sourcing will enable companies to reduce their Scope 3 emissions (all indirect emissions that happen in the upstream and downstream activities of an organization). Using renewable materials in the chemical industry — advanced materials and chemicals, such as polymeric materials, biomaterials, composites and nanomaterials — is becoming more important in terms of long-term costs and environmental protection and sustainability.

Bio-based raw materials sourcing can substitute existing input materials with less toxic, renewable materials or adjunct materials, which have a longer service lifetime in production. And sustainable plastics can be either biodegradable or made from biological materials — as is the case with bio-PET, which uses fermented leftovers from sugar manufacturing to produce soft drink bottles.

Perhaps the technological opportunity closest to hand is digital manufacturing. The sector is already undergoing an unprecedented digital transformation. Digitally enabled manufacturing offers new opportunities to optimize production for sustainability.

From using Industrial IoT in factories to minimize errors to leveraging digital inventory, Industry 4.0 digital solutions can make a big impact.

Additive manufacturing helps designers make stronger, lighter parts that use less material and fewer resources to transport, resulting in higher sustainability. Artificial Intelligence (AI) also can provide manufacturing enterprises with better capability to forecast consumer demand, streamline production processes and automate specific processes using robotic machinery in real time.

Digital twin modeling of entire value chains, meanwhile, can improve the sustainability of products and services across the lifecycle from cradle to cradle. This can include designing for reuse to minimize material use during manufacturing. It can also involve estimating carbon emissions for modeling reverse logistics for circular economy systems. Scaling up these initiatives will have an immediate impact on reducing an entire organization's carbon footprint.

> “How we use data will play a big role in helping shape new green economies. It will involve a better use of the data to create better products and services.

Craig Coulter
EY Global Advanced Manufacturing & Mobility, Strategy & Operations and Sustainability Leader

3 Transport

Governments throughout the world are wrestling with the challenge of rapidly decarbonizing our transportation systems.

Some cities, such as Paris, are planning to ban all vehicles from their city center. Other cities are planning comprehensive restrictions on using internal combustion engine vehicles (ICEVs) and investing in new mass transit infrastructure. One recent study even suggests the UK could see CO_2 reductions greater than the impact of eliminating all UK domestic aviation emissions simply by using e-cargo bikes for 7.5% of the journeys diesel vans[7] make currently.

Governments are targeting large corporate and commercial fleet owners through incentive policies to trigger the transition to EVs. And logistics and large freight players are announcing ambitious decarbonization targets: FedEx committed to carbon-neutral operations by 2040,[8] while Maersk aims to decarbonize ocean transport through a 50% carbon intensity reduction by 2030 (versus the 2020 baseline), targeting net zero by 2040.[9]

The transformation of the transport sector is mainly driven by three factors — electrification (EVs and charging infrastructure), shared mobility and autonomous driving.

The next 30 years of transportation will continue to be dominated by the automobile: with rapid adoption of EVs taking place in Europe and China and a more gradual one in the US and the rest of the world. The real advancement, however, won't be the EVs themselves, but rather the charging infrastructure and advanced batteries keeping them on the road.

Governments have a major role to play in incentivizing the development of charging infrastructure and ensuring its reach covers more than just the heavily urbanized and financially wealthy areas currently being supported. At the same time, upcoming technologies, such as sustainable fuels, connected technologies for autonomous vehicles and shared mobility, battery-powered container ships, zero-emission power train systems for trucks and urban air mobility, need to be commercialized and implemented at a mass scale.

One example is Boeing, which has set an ambitious target to advance the long-term sustainability of commercial aviation by committing that its commercial airplanes will be capable and certified to fly on 100% sustainable aviation fuels by 2030.

The transport sector requires a coordinated policy approach to facilitate decarbonization across modes of transport.

Governments need to implement these measures at multiple levels — national, regional and city — while managing travel demands and uptake of EVs or zero-emission vehicles, creating enabling infrastructure, increasing availability of low-carbon fuels and encouraging R&D for transport technologies (including the recycling of batteries and their component materials).

> "The chicken-and-egg scenario right now is that people are not buying EVs because there isn't the charging infrastructure. Yet infrastructure is not being installed because there are not enough EVs.

Marc Cotelli
EY Americas eMobility Energy Leader

7. "Sharing the Load: the potential of e-cargo bikes," Green Alliance, 2022.
8. "FedEx Commits to Carbon-Neutral Operations by 2040," FedEx, 03 March 2021.
9. "Decarbonising ocean transport," Maersk website.

4 Construction

As steel and concrete production contribute so much to GHG emissions, the need to decarbonize the sector has become very pressing. Numerous solutions are in development to speed up the green transition in the construction sector.

Green hydrogen and CCUS can play a critical role in the sustainable transformation of the construction sector. The IEA projects that by 2060, CCUS needs to be installed on 21% of global crude steel production capacity.[10] In October 2022, ArcelorMittal teamed up with BHP, Mitsubishi Heavy Industries Engineering (MHIENG) and Mitsubishi Development to trial carbon capture technology at its steel plants in Belgium and North America.[11]

Several post-combustion carbon capture projects on cement plants are currently in development.

Innovation in the construction sector also is focused on the identification of alternative materials, such as mass timber, a cross-laminated wood that will see accelerated use over the next years.

In addition to being a lower-emission material than cement and steel, mass timber products are modular and can be used more flexibly in construction projects. New York City recently approved using cross-laminated timber in the construction of buildings up to 85 feet tall.[12]

Moreover, ultra high-performance fiber reinforced concrete has the potential to improve the sustainability and resilience of infrastructure and buildings, thanks to its lower-carbon footprint, higher durability, strength and recyclability. Another promising emerging material for the construction industry is mycelium, which is used to produce bricks. A mycelium brick is formed from organic waste and the mycelium of fungus, making it totally organic. Using mycelium in construction is still in the embryonic phase but has strong potential for applications such as insulation.

Additive manufacturing — or 3D printing technology — will also play a growing role in construction practices, providing speed and efficiency. Its high automation potential can lead to reducing costs in an industry among the least automated of all sectors. In Texas, a giant 3D printer is building the first 3D-printed two-story house in the US.[13]

10. "Carbon Neutral Energy Intensive Industries report," UNECE, 2022.
11. "Carbon capture in the steel industry," ArcelorMittal, 27 October 2022.
12. "What's Old is New Again: Mass Timber Construction in New York City," CityRealty, 22 July 2022.
13. "The Largest 3d Printed Building Project In The US," COBOD website.

03
How governments can bridge the ambition gap

Governments must focus both on policies and investment strategies to scale up existing and breakthrough technology.

Several different technologies, at varying stages of maturity, offer the promise of helping global business and society transition to a net-zero future. But technology is only as effective as the way in which it is employed and how it is enabled through strategy, development and decision-making.

Given the size of the task in achieving a green transition that reaches net zero, governments must play a leadership role in supporting, and sometimes subsidizing, technological innovation, incentivizing private financing and fostering public-private cooperation.

There is no one-size-fits-all approach to supporting technological progress. Different technologies require different levels and types of support, depending on their own growth path, market penetration and ability to change the energy landscape.

Governments can support technology adoption and market integration through several actions, starting with regulation. This is best applied when the technology is already well established or proven to be achievable in the near term so it can be deployed at scale. The rapid growth of renewable energy (especially wind and solar power) and vastly improved internal combustion engine vehicle (ICEV) fuel efficiency performance are two examples of technologies that have flourished, thanks in part to regulatory pressure on the energy and automobile sector.

Governments can also leverage tax incentives and user subsidies, which are best employed to support established technologies but not yet fully commercially viable.

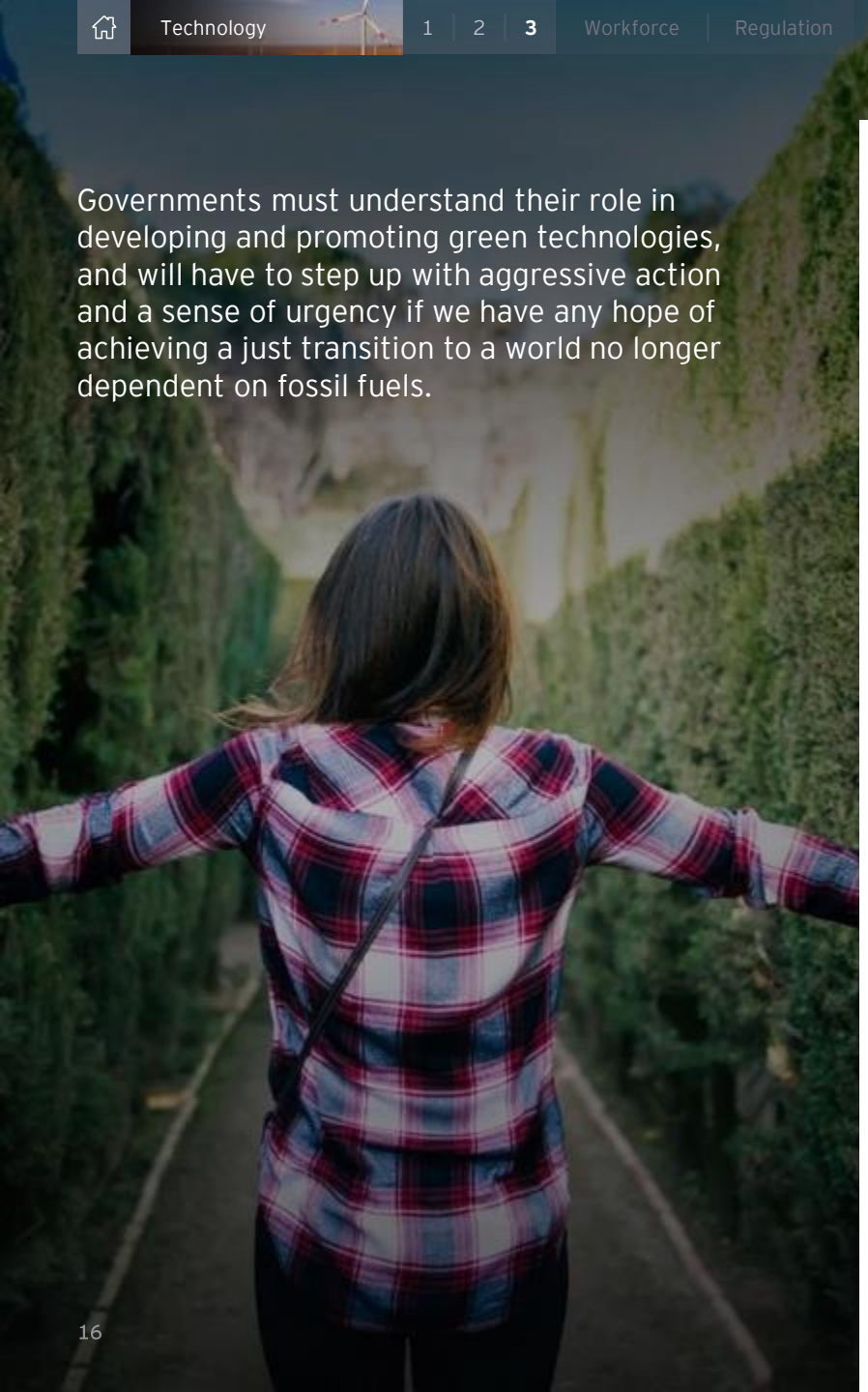
> Over the past decade, we have seen incentives and subsidies successfully deployed by governments to encourage the adoption of EVs, boost home energy efficiency (in the form of insulation and more sustainable construction) and even shift consumer behavior around recycling.

Supporting core research and development through funding and creating connections between business and academia is critical to support technological progress. This approach helps underdeveloped but promising technologies that are not yet operationally deployable. The past decade has seen this approach applied to CCUS technology in the US and Europe, widespread research into tidal and oceanic energy, and the development of green hydrogen at scale.

Another type of action involves direct public ownership, oversight and management of technologies.

This approach generally is restricted to sensitive or hazardous operations that are yet to be commercially feasible and, out of necessity, will remain under government oversight even if operated by private companies. Next-generation nuclear and large-scale hydroelectric power are examples where governments in some parts of the world are taking a direct role. Ownership and control of hazardous waste disposal facilities is another example.

> Essentially, green technologies will be highly influential in helping the world dramatically reduce GHG emissions, but their effectiveness will only be as good as the way in which they are supported, funded and deployed.



Governments must understand their role in developing and promoting green technologies, and will have to step up with aggressive action and a sense of urgency if we have any hope of achieving a just transition to a world no longer dependent on fossil fuels.

We believe governments can take the following actions now:

1. Target funding to improve innovation and create an enabling environment through appropriate policies that help lower risk and incentivize higher levels of private investment. This can be achieved through a mix of incentives and penalties (i.e., green taxes, incentives to green investments on both citizen and corporate levels, and support to tech R&D clusters and startups), which will set the pace of the transition.

2. Create integrated policies to foster public-private cooperation across industry sectors. Decarbonizing only the power sector is not enough. Other industries and consumption patterns need deep transformation as well. All sectors of the economy must be included in the process, taking into consideration that some sectors will have limited margins of improvement with the technologies currently available.

3. Adopt a technology-neutral perspective that relies on the specific capacity and cost of each technology to contribute to the transition. This approach can also help couple different technological needs in a way that recognizes the specific contribution each of them delivers to a sustainability pathway.

4. Embrace science-informed policymaking. To foster technological innovation and leverage data, governments should use an evidence-based policymaking approach and tools (consultations, multilateral dialogue and policy briefing) within a broader science diplomacy framework.

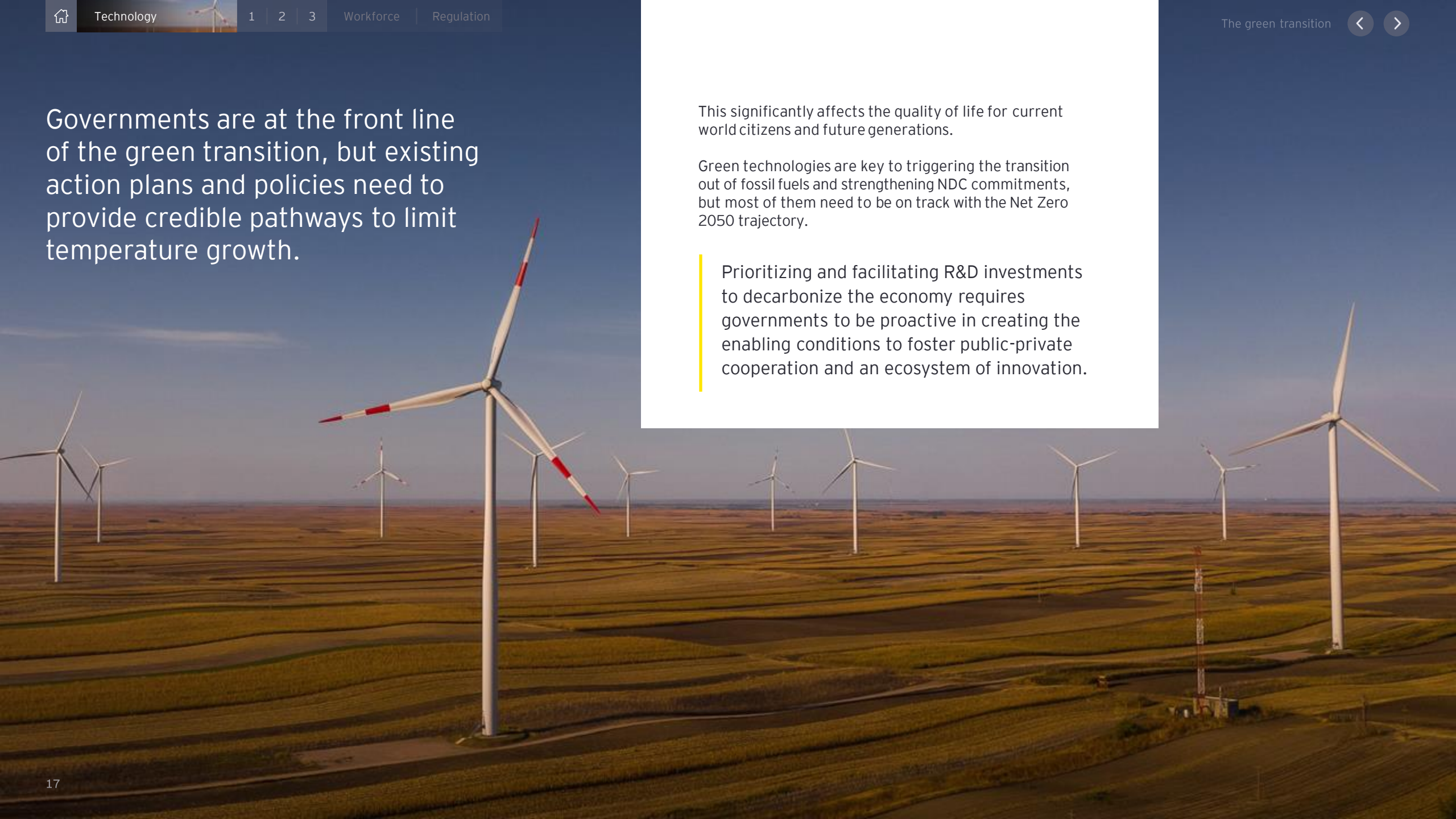
5. Advance behavioral change at individual group and societal levels. As a direct consequence of governments' awareness campaigns, incentives and innovative solutions, the impact of behavioral change may bring a significant contribution to decarbonization.

Governments are at the front line of the green transition, but existing action plans and policies need to provide credible pathways to limit temperature growth.

This significantly affects the quality of life for current world citizens and future generations.

Green technologies are key to triggering the transition out of fossil fuels and strengthening NDC commitments, but most of them need to be on track with the Net Zero 2050 trajectory.

> Prioritizing and facilitating R&D investments to decarbonize the economy requires governments to be proactive in creating the enabling conditions to foster public-private cooperation and an ecosystem of innovation.



Article two:
Green workforce

How can workers find their place in the green economy?

02

The push toward a low-carbon economy and just transition will shape a new era of economic growth and a new jobs landscape.

In brief

Green climate action will have a long-term positive impact of global growth as governments deliver on their commitments.

Total employment will also increase, but the regions that are heavily dependent on the fossil fuel sector will take longer to see the benefits of an upsurge in green jobs.

Governments and businesses must invest, prepare for the new green employment ecosystem and provide training solutions through capacity building and a greater public-private collaboration.

Explore more

Governments must be poised to proactively ensure a just green transition and a new era of jobs and growth. The importance of green jobs will increase as a component of labor input and a crucial factor for accomplishing the green transition process.

This isn't just about which jobs will disappear and which will be created. There are also more fundamental issues at play. The future sustainability of the labor market will be vital to delivering a just transition for all of society. In a dynamic framework where time is a critical variable, any structural mismatch of the labor market, such as shortages of human capital, will delay the green transition process.

The job market is already being transformed from the bottom up:

65%

of employees are more likely to work for companies with environmental policies in line with their values. Similarly, two-thirds of workers also express their desire to learn green skills to become more valuable in the workplace of the future.[14]

These trends are even stronger when considering the values of new generations about to enter the workforce.

88% of business school students

consider environmental issues in business a top priority for their future careers. Moreover, two-thirds are looking for solutions to integrate sustainability into their future occupations.[15] Universities and companies are already adapting to meet such expectations and provide a lifelong career to students and workers.

The new green jobs that will make the difference in reaching net-zero environmental ambitions will require a different skill set and will not directly replace those lost in fossil fuel-dependent industries.

That's why it is important that governments have the insight to focus on the sectors creating new employment opportunities and anticipate the trends shaping the way people will work in the coming decades.

14. Future of the Sustainable Workplacein the age of COVID-19 and Climate Change, Unily, 2020.
15. "The Next Phase of Business Sustainability," Stanford Social Innovation Review website, March 2018.

01

The great decoupling of emissions and growth

Green climate action will raise global GDP per capita while reducing total energy consumption and CO_2 emissions in the long term.

For over 200 years, global economic growth has been powered by fossil fuels. That collaboration shaped the modern industrial world and, for the most part, raised global living standards. However, as we now know, that progress has come at a potentially catastrophic cost to the planet and the wellbeing of future generations.

As global governments commit to a phased transition away from fossil fuels into renewable energy, they will need to understand how this new era will shape economic growth, how it will differ from the fossil fuel age they've been used to, and how they can develop policies and plans to fully support and harness new power sources for the betterment of all society.

To better understand how this economic growth will look across different regional economies, we ran three different scenarios in our modeling with Politecnico di Milano — the key takeaway confirming a grand decoupling between GDP growth and CO_2 emissions.

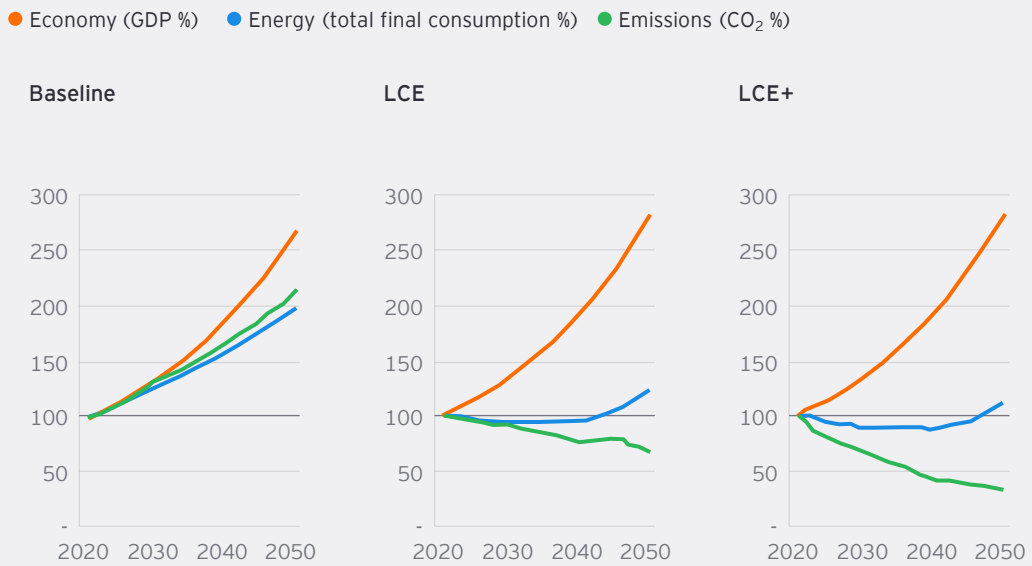
5.2% increase in global GDP per capita.

We predict the first long-term decoupling of GDP from energy consumption — a landmark achievement in its own right. Both LCE and LCE+ scenarios will result in a persistent increase of global GDP per capita by 4.7% and 5.2% respectively versus the baseline scenario.

While global GDP is growing, the trend in total energy consumption in the 2020 to 2040 decades will decrease (in the LCE and LCE+ scenarios), thanks to intense policy action in Western countries (the EU27+UK and US in particular). This trend is later counterbalanced in the 2040 to 2050 decade by the strong energy demand growth occurring in emerging economies.

Total final energy consumption and CO_2 emission trends highlight a second long-term decoupling: By comparing the LCE and LCE+ scenarios with the baseline scenario, the CO_2 emission trend is reversed and shows a progressive reduction of CO_2 emissions, even after the rebound of the energy consumption in the 2040 to 2050 decade. The key driver is the strong penetration of renewable energy solutions that allows higher energy consumption without generating the CO_2 emissions that would have occurred if such consumption growth was led by fossil fuels.

Global economy under three transition scenarios

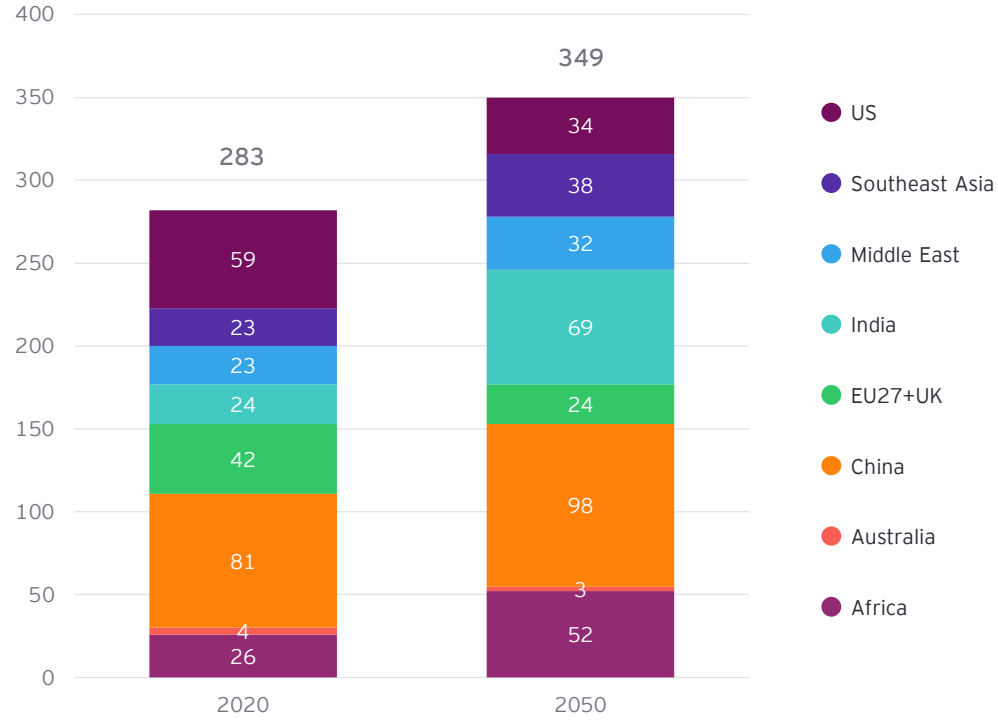


According to the modeling, total energy consumption will rise globally by 23% in 2050 versus 2020 levels.

This growth is led by a rising population and standards of living in emerging economies, especially in India, but is not projected to result in a global increase in CO_2 emissions due to technological advances in sustainable energy generation.

Such transformations will also herald fundamental changes in the global job market, creating new opportunities and positions in the green economy while making roles in fossil-based industries and dependent sectors redundant.

Total energy consumption under LCE scenario in 2020 and 2050 (expressed in exajoules)



02

How will global employment evolve in the green growth era?

The net effect on employment triggered by the green transition is positive but will harshen inequalities among regions.

Just as economic growth will be reshaped in different ways by decoupling from fossil fuel power, so will the jobs market. Occupations specifically tied to fossil fuel production will be lost. For example, more than 18 million jobs currently related to oil, gas and coal globally[16] may be at risk. Phasing out fossil fuels will affect other workers along the value chain and impact local economies as well.

For governments, a critical part of ensuring a just transition will be balancing the social benefits and risks of reducing fossil fuel jobs while replacing them with green employment. They will have to anticipate what the new labor market will look like.

Specific questions are:

- How many new jobs will the market create?
- What skill levels are needed to fulfill them?
- Where are the most likely locations for these jobs?
- Can those currently working in fossil fuel sectors easily transition into the new green economy?

16. World Energy Employment report, IEA, 2022.

In some parts of the energy sector, the transition is already taking place. Some of the major oil and gas companies are investing heavily in utility, electricity generation and offshore wind. Meanwhile, both oil and utility providers are seeking to build EV infrastructure. Even mining companies will continue to offer employment opportunities as they transition out of coal into the minerals needed to run many renewable technologies. Upskilling and re-skilling become key drivers for companies as they transform their business models, ensuring they keep and attract the right people with green skills to deliver.

> None of this transition will be simple though — there will be few like-for-like job opportunities. Many of the newly created jobs will be in various locations and require different skill sets.

“

To prepare for a new era of green jobs and growth, governments will need to create a positive impact, not just in terms of the professional and personal lives of people but also their health and social equity.

Shalinder Bakshi
EY Global Government & Infrastructure PAS Leader

Fewer green jobs will be created within eco-industries[17] than fossil fuel jobs lost because of the higher productivity gains provided by renewable energies. However, millions of new jobs will be created along the entire value chains tied to these core green economy sectors. We call them "other green jobs," and they include manufacturing, transport, construction and other services, hence leading to a net-positive job balance. **According to our research, 46 million green jobs (in the regions accounting for 80% of global GDP and CO_2 emissions) will be generated by 2050 under both the LCE and LCE+ scenarios.**

Focusing on gray jobs connected to fossil fuels,[18] 66 million and 73 million will be lost under the LCE and LCE+ scenarios respectively.

Gray jobs

73 million

gray jobs will be lost under the LCE+ scenario.

The net effect on employment is, however, positive considering the 172 million (LCE scenario) and 148 million (LCE+ scenario) "other green jobs" that will be created through the transition. The net job generation will be 151 million under LCE and 120 million under LCE+. The difference is mainly due to a higher increase in productivity generated by the LCE+ scenario, where renewable technologies are boosted by a higher pace of investment.

Job creation

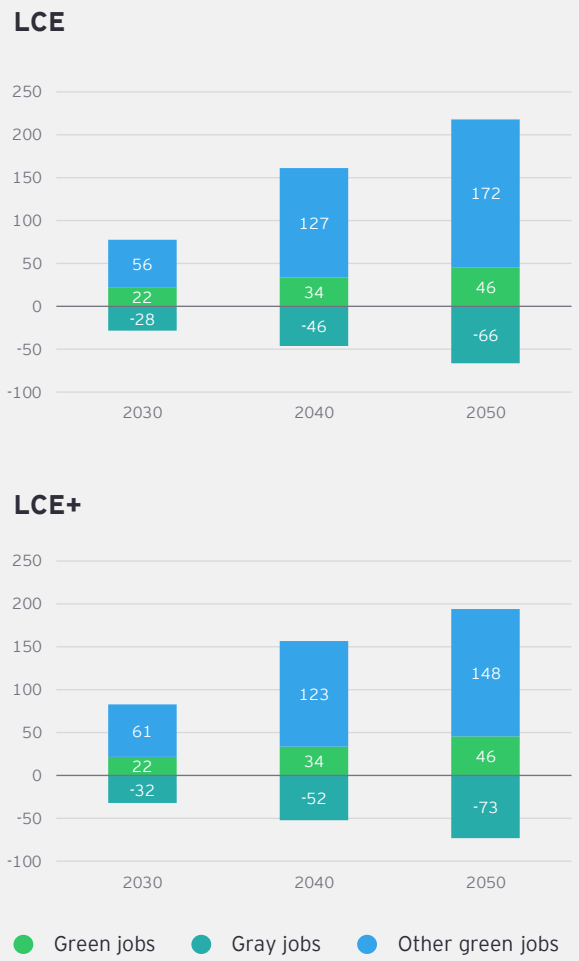
172 million

Other green jobs will be created under the LCE + scenario.

17. Eco-industries include environmental goods and services sectors undertaking economic activities that have outcome products for environmental protection and resources management. These include sectors such as industries producing or generating green energy, producing and using green vehicles, and treating waste. They are opposed by the gray sectors, mostly belonging to fossil fuel supply chains.

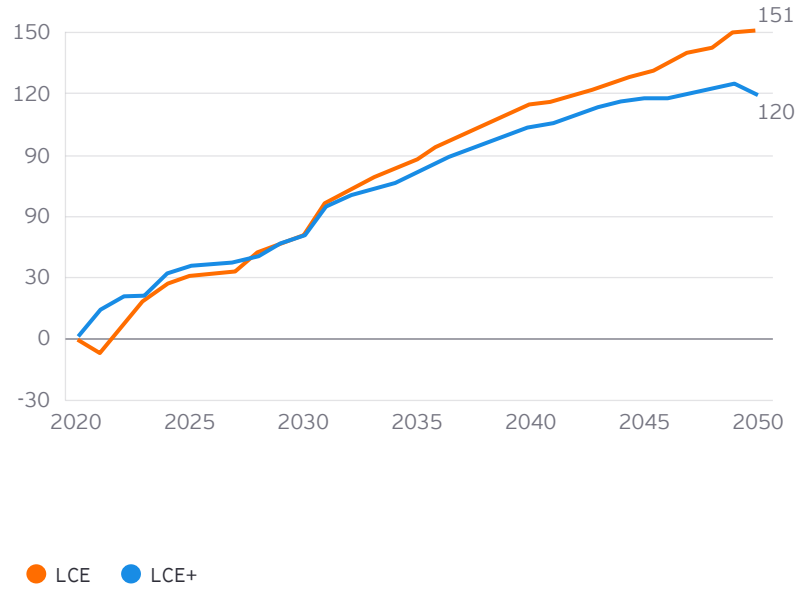
18. Gray jobs include coal, crude oil and natural gas extraction, coal and crude oil refinery, electricity production by coal, oil and gas, road transport by ICEVs, ICEVs manufacturing.

Change in employment from baseline by sector (expressed in millions)



These changes won't play out uniformly across the world. A closer look at regional situations indicates a significant imbalance. In fact, the transition will harshen inequalities among some regions.

Total employment by scenario (deviation from baseline)



> Employment changes won't play out uniformly across the world. In fact, the transition will harshen inequalities among some regions.

When looking at how the employment landscape will change, we were able to identify three key clusters.

The first cluster is composed of the EU27+UK, China and — to a lesser degree — the US.

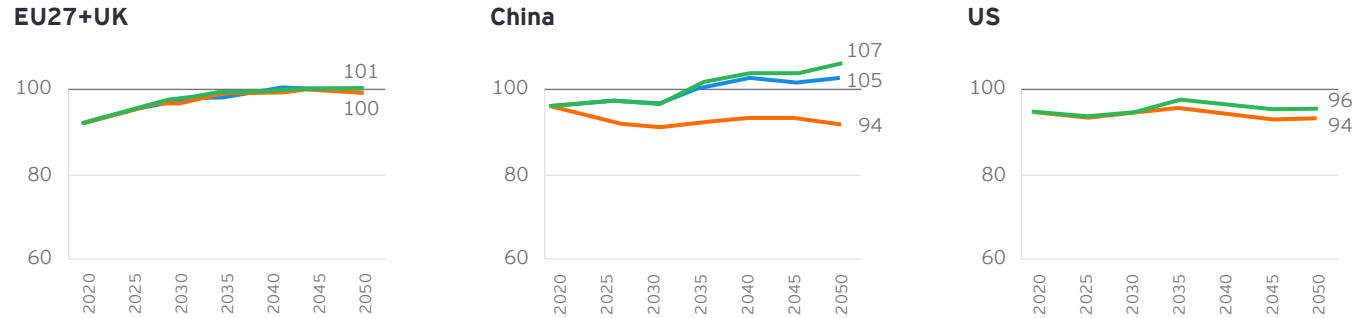
Here we have regions where a combination of negative labor force trends (mainly due to demographic patterns) will intersect with higher demand for new green jobs and skills.

This means part of the green job requirement might not be internally met and would have to be attracted from other regions.

The second cluster is composed of the Middle East and — to a lesser degree — Australia.

For example, oil rents — the difference between the value of crude oil production at regional prices and total costs of production — constitute over 11% of GDP in MENA countries.[19] Though this share has fallen significantly in the last decade (it was over 29% in 2011), it is still way above the global average of 1%. Due to the transition, socioeconomic sustainability risks will likely increase as the employment rate drops.

Employment rate by scenario



In particular, China and the EU27+UK are likely to experience conditions above 100% full employment.

Employment rate by scenario

These seem to be the most negatively affected regions due to their heavy specialization in fossil fuel supply chain and trade.

* The line at 100 represents "full employment."

19. "Oil rents (% of GDP)," World Bank website.

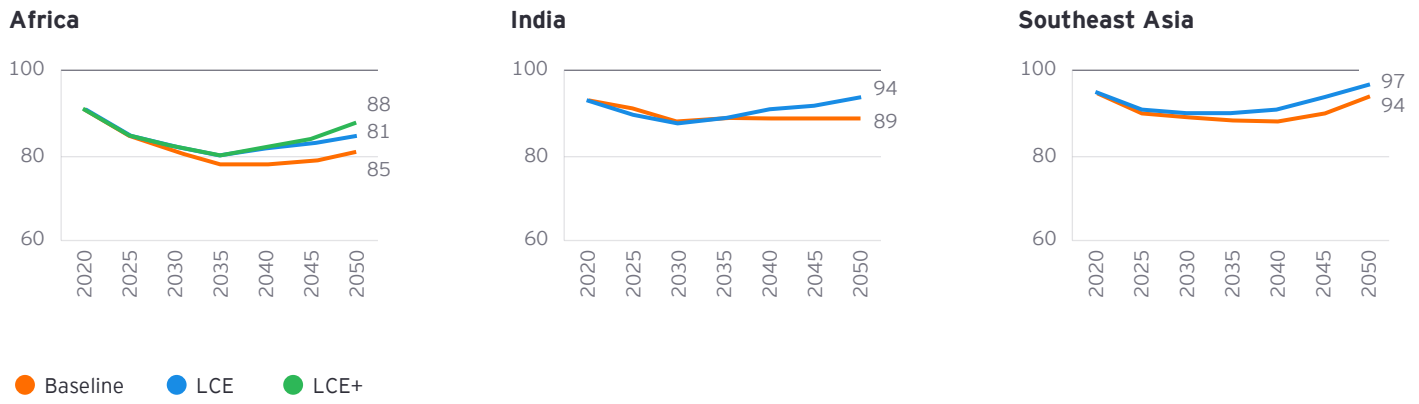
The third cluster encompasses India, Southeast Asia and Africa.

Africa is likely to experience a significant initial drop before 2035. In Africa and India, rather than transition-related investments, a significant component of new job creation after 2035 will be due to trade multipliers activated by growth demand in the Organisation for Economic Co-operation and Development (OECD) countries. For example, hydrogen generation in Africa could help the region become a global player through green hydrogen exports, potentially activating €1 trillion of investments.[20]

In the mining sector, 58% of the international supply of cobalt — a critical raw material used as a component of cathodes in batteries and as a catalyst in fuel cells — comes from the Democratic Republic of Congo (DRC).[21] Growing demand for EV batteries and other energy storage solutions will increase demand for RDC's cobalt.

> India and Southeast Asia will almost maintain their employment levels up to 2040 and will improve them in the 2040 to 2050 decade.

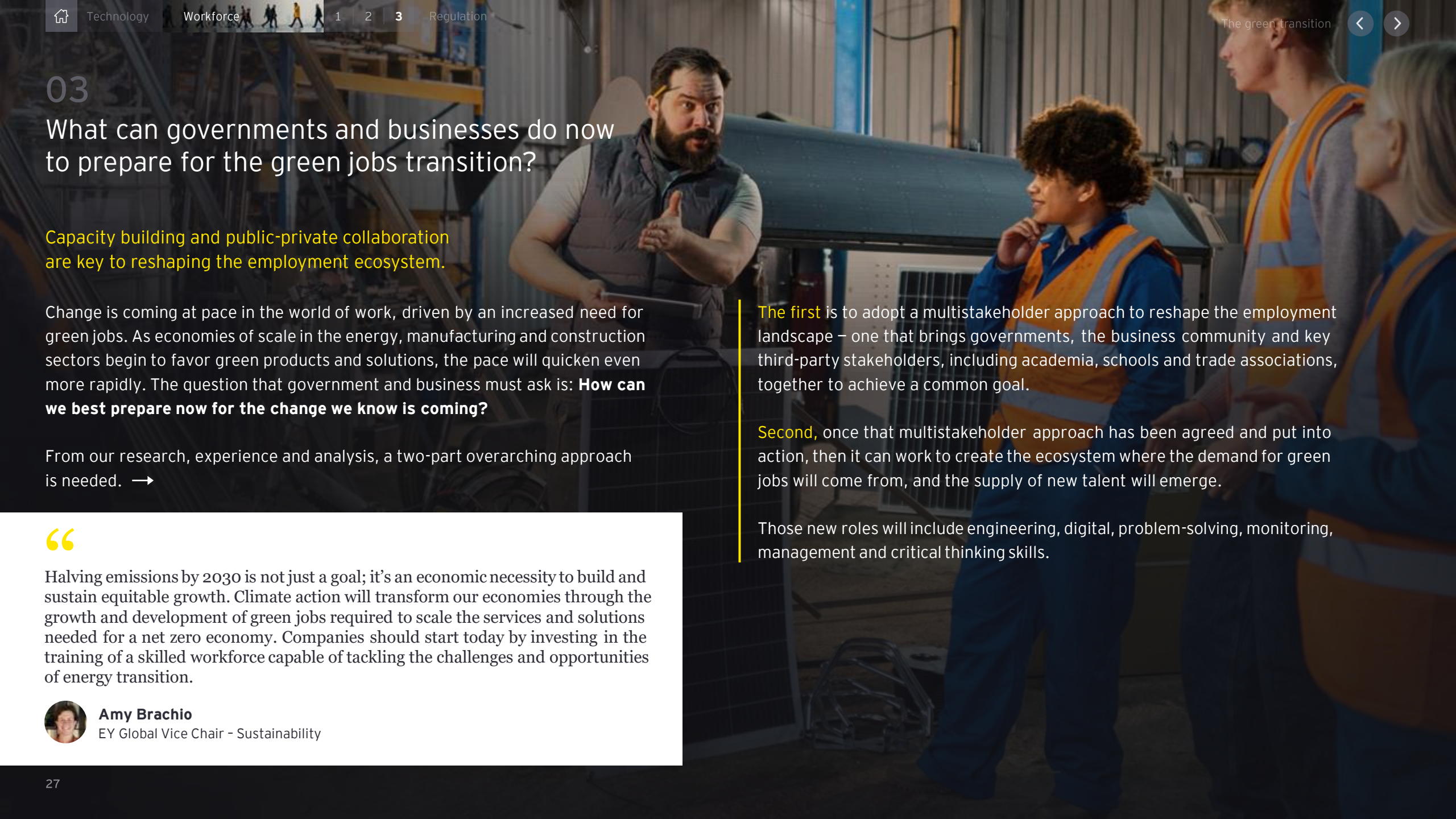
Employment rate by scenario



> Green jobs will be crucial in accompanying the transition process even more than support of overall labor input.

In fact, a shortage of skilled labor and changing demographic patterns of the working age population associated with decoupling from fossil fuels could lead to stability issues in different regions, either by overheating the labor market or increasing social unsustainability.

20. "New study confirms €1 trillion Africa's extraordinary green hydrogen potential," EIB, 21 December 2022.
21. "Critical Raw Materials in Africa," EU Commission website.



03

What can governments and businesses do now to prepare for the green jobs transition?

Capacity building and public-private collaboration are key to reshaping the employment ecosystem.

Change is coming at pace in the world of work, driven by an increased need for green jobs. As economies of scale in the energy, manufacturing and construction sectors begin to favor green products and solutions, the pace will quicken even more rapidly. The question that government and business must ask is: **How can we best prepare now for the change we know is coming?**

From our research, experience and analysis, a two-part overarching approach is needed. →

The first is to adopt a multistakeholder approach to reshape the employment landscape – one that brings governments, the business community and key third-party stakeholders, including academia, schools and trade associations, together to achieve a common goal.

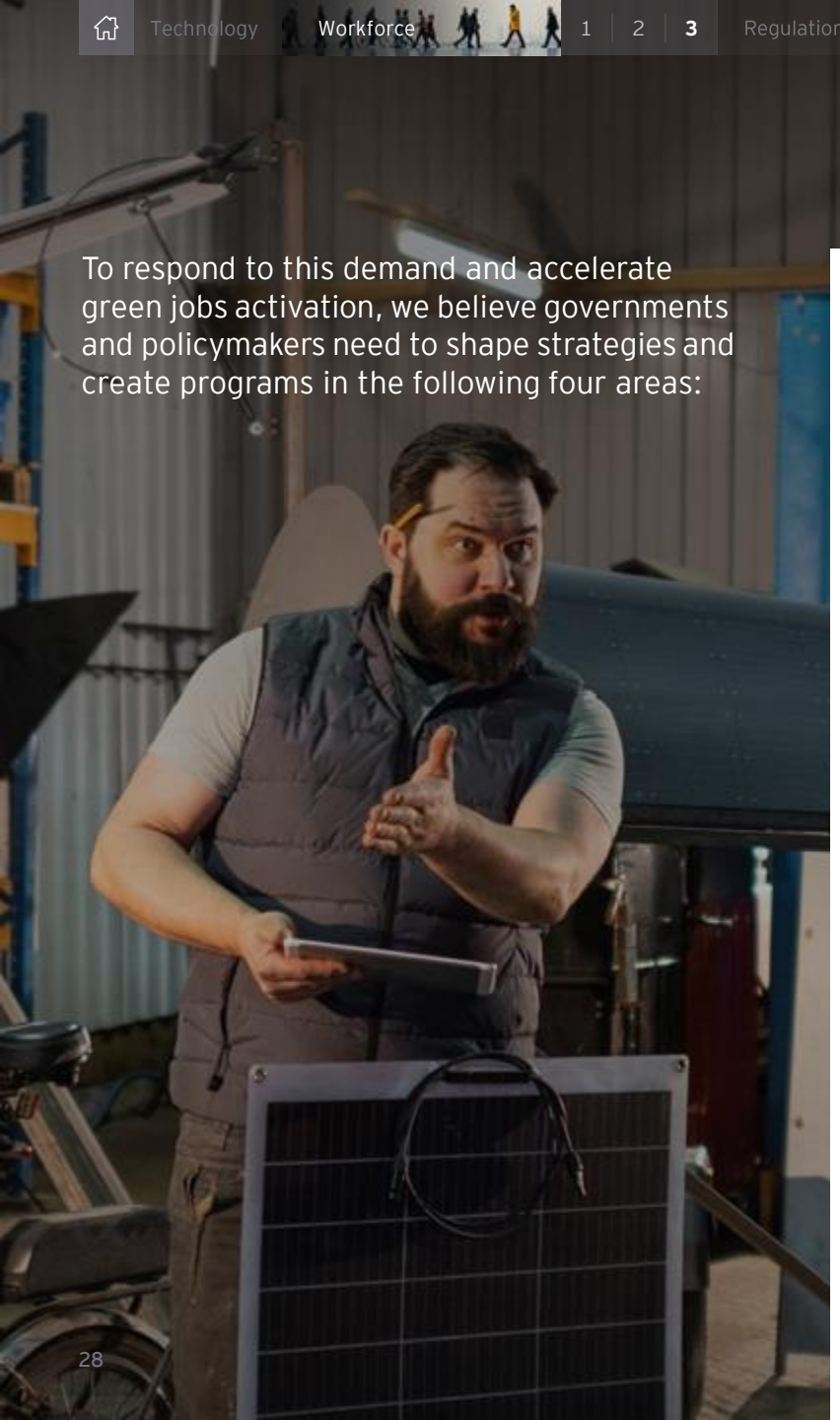
Second, once that multistakeholder approach has been agreed and put into action, then it can work to create the ecosystem where the demand for green jobs will come from, and the supply of new talent will emerge.

Those new roles will include engineering, digital, problem-solving, monitoring, management and critical thinking skills.

> “Halving emissions by 2030 is not just a goal; it’s an economic necessity to build and sustain equitable growth. Climate action will transform our economies through the growth and development of green jobs required to scale the services and solutions needed for a net zero economy. Companies should start today by investing in the training of a skilled workforce capable of tackling the challenges and opportunities of energy transition.

Amy Brachio
EY Global Vice Chair – Sustainability

To respond to this demand and accelerate green jobs activation, we believe governments and policymakers need to shape strategies and create programs in the following four areas:



1. Public sector capacity building and internal training policies to support the execution of the green transition. Governments must anticipate increased demand for new types of skills and know-how to deliver on green initiatives. Targeted funding and a national green skills plan can help map out the quantity and type of skills needed, where new green jobs should be located (to ensure no regions are left behind), and how to invest in education and retraining.

2. Coherent policies within sectors that create and support efficient social and financial mechanisms for lifelong learning (including social protection allowing for an opportunity to undertake training for a green job when leaving the previous occupation) and re-skilling people into new occupations.

3. Education programs for young people that introduce green skills (e.g., sustainability and circular economy knowledge) and digital competencies (e.g., programming, data analytics and information security). Digital also impacts on how green jobs will be delivered in an emerging hybrid environment where teams are working remotely, online, in person and offshore. Openness to these types of working dynamics will also impact an organization's diversity and inclusion agenda and the wellbeing of employees — all critical factors in driving a better ESG strategy for an organization.

4. Business and governments should closely collaborate to make sure existing employees are best equipped to transition into green jobs and that new employees enter a working environment that can make the best use of their skills.

The required shift to a green economy involves more than just creating and replacing jobs; it requires a fundamental restructuring of the labor market to ensure a sustainable and equitable transition.

Current trends indicate a growing demand for green skills and environmentally conscious workplaces among employees and students, highlighting the need for governments to invest in education and training programs to meet these demands. While the challenge is immense, effective leadership — planning and acting now — will help shape a future that benefits future generations and creates positive legacies.

It's evident that governments must address the challenges posed by the climate emergency and ensure a comprehensive and equitable transition. As we consider the path forward, it is crucial to recognize the significant role that technology plays in achieving a greener future.

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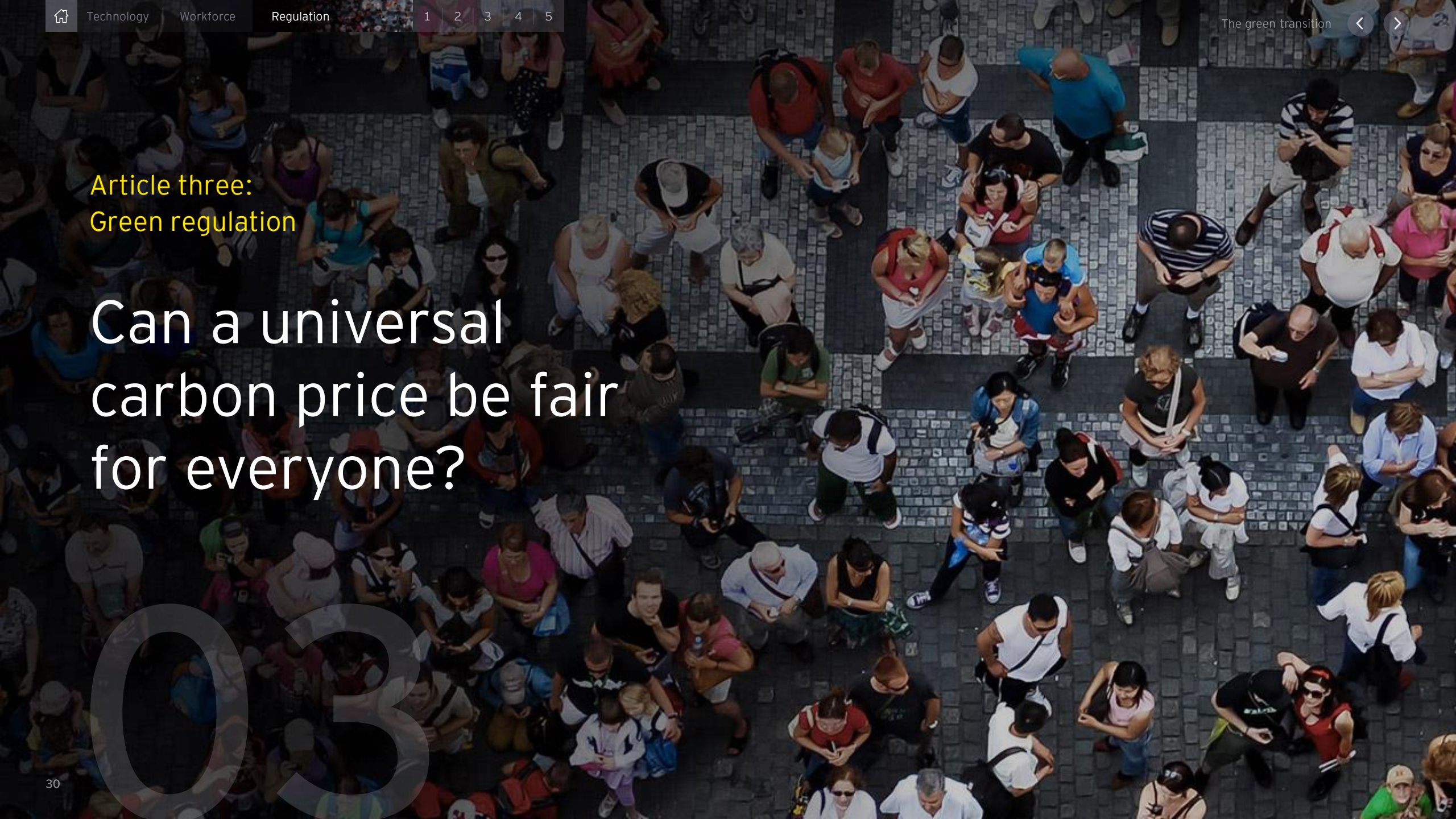
Governments will need to collaborate with educators and business to foster green skills and competencies for people starting their careers, as well as workers who need to be re-skilled.

George Atalla
EY Global Government & Public Sector Leader



Article three:
Green regulation

Can a universal carbon price be fair for everyone?

03

Most governments and climate experts agree we need carbon pricing to reach net zero.

Delivering a just and fair transition is the hard part.

Article in brief

Carbon pricing can be a game changing tool to meet climate targets, but it has yet to scale and limit CO_2 emissions globally.

Current schemes need to be more consistently applied. Coordinated action across the globe will remove disparities, leakages and the need for border adjustments.

Applied equitably and flexibly, carbon pricing could give certainty to plan a long-term transition.

Explore more →

01

Why we need to increase carbon regulation now

A globally consistent carbon pricing scheme has the greatest potential to help governments achieve their stated climate change goals.

The global climate emergency is accelerating as national governments fail to meet their net-zero commitments.

More than 130 countries, representing over 80% of global GHG emissions, have communicated a net-zero target through domestic laws, policies or high-level political pledges.

However, just 26 countries have followed through with ambitious climate plans, according to the UN IPCC. Meanwhile, global emissions continue to rise.[22]

Scientists, governments and the world of business have spent the last 25 years debating the best way to reduce human-created and -driven carbon dioxide (CO_2) emissions — the key driver of our climate emergency.

Repeatedly, they have reached the same conclusion — we need to set a clear and binding carbon price to reflect the true cost of activities that generate emissions. The rationale is straightforward: A price on carbon enables business and government to calculate the true economic cost of emitting CO_2 (and, by extension, other GHGs), accelerating the path to decarbonization and achieving net-zero goals.

The concept of carbon pricing is not new. One of the biggest carbon pricing schemes is the EU's Emissions Trading System (ETS), launched back in 2005.[23] In 2021, China launched its own national ETS, building on the success of pilot carbon markets implemented in various regions and cities.[24]

However, to date, these schemes have failed to limit CO_2 emissions globally. What has gone wrong? Clearly, we can't blame ineffective carbon pricing alone for global governments' inability to limit climate emissions. Nevertheless, there's no doubt that most schemes have been poorly implemented to date.

In order to meet climate targets, we need a consistent, globally connected carbon marketplace. An effective and globally consistent carbon pricing scheme has the greatest potential to be a game changing tool to help governments achieve their stated climate change goals — NDCs[25] — through implementing carbon taxes and emission trading schemes. To make carbon pricing a success, it is worth spending a little time understanding what has been achieved so far to make improvements.

22. Global Energy Review: CO_2 Emissions in 2021, IEA, 2022.
23. "Development of EU ETS (2005-2020)," European Commission website.
24. "China National ETS," International Carbon Action Partnership website.
25. "Nationally Determined Contributions (NDCs)," UNFCCC website.

02
What have we learned from existing carbon pricing strategies?

Carbon taxes and trading schemes can lead to a more just transition, but current applications are suboptimal.

A carbon price is an additional cost levied by governments to establish the economic cost of emissions. Pricing emissions allows organizations and consumers to consider the true costs of their activities, thereby giving an economic incentive to reduce emissions.

> The higher the CO_2 content of a process (or behavior), the stronger the incentive to transform.

A carbon price also helps rebalance the impacts of GHG emissions — shifting the economic burden back to the organizations and countries that are responsible for them.

Carbon pricing also helps address the "green premium" — the additional cost of green relative to non-green behavior that has proved a barrier for companies and consumers in the past. It does so by raising the cost of non-green behaviors, practices and technologies. Credits, incentives and grants can also reduce the green premium by lowering the cost of green behavior.

A successful carbon pricing mechanism should not only encourage low-carbon behavior; it should also drive investment, innovation and implementation of low-carbon technologies and projects by making adopting the technologies that are financially advantageous for emitters.

In addition, revenues raised by governments can be given back to taxpayers through direct payments or by reducing the amount of tax collected, mitigating negative effects for lower-income households.

One advantage of carbon pricing policies is that they are technology neutral — the schemes do not pick winners or discriminate among decarbonization solutions, leading to fewer market distortions and a more just transition to a low-carbon economy.

Another advantage is that efficient carbon pricing policies can realign supply chains and global trade, shifting the production of goods to the most efficient (and least carbon-intensive) regions — hence leaving no space for carbon leakages.

Today, carbon pricing schemes in **39 national** and **33 subnational** jurisdictions cover 23% of global emissions, raising **US$95 billion.**[26] Given that carbon prices are rising as high as US$90 per ton in the European Union,[27] it's clear that expanding the reach and coordinated impact of carbon pricing could play a major role in transforming the global economy.

Carbon pricing schemes

US$95 billion

raised as a result of carbon pricing schemes in 39 national and 33 subnational jurisdictions.

26. Carbon Pricing Dashboard, The World Bank, 2023.
27. More Countries Are Pricing Carbon, but Emissions Are Still Too Cheap, IMF, 2022.

How carbon pricing works

Two principal forms of carbon pricing schemes are ETSs and carbon taxes.

An ETS — or cap-and-trade system — limits the total amount of GHG emissions and allows industries with low emissions to sell their extra allowances to those with larger ones. An ETS establishes a market price for GHG emissions by creating this supply and demand.

A carbon tax does the opposite. It directly sets a price on carbon by defining a tax rate on GHG emissions or the carbon content of fossil fuels. In this way, the emission reduction outcome of a carbon tax is not predefined, but the carbon price is.[28]

Despite the advantages of carbon pricing, the current schemes tend to be geographically fragmented and need more consistent application across territories — reducing their net effectiveness due to carbon leakages.

In addition to geographical fragmentation, ETS schemes operate at different levels of government, from supranational (e.g., EU Member States) to national (e.g., Canada or the United Kingdom), and from province and state level (e.g., Oregon or Hubei) to city level (e.g., Beijing or Tokyo).

Despite the flaws in the current implementation of carbon pricing worldwide, the number of systems operating shows that carbon pricing is now firmly rooted in government thinking and policy consideration.

The introduction of big schemes, such as China's national ETS, point to the potential for real progress. While it only applies to the country's power sector, it is already the world's largest ETS and covers around 12% of global CO_2 emissions[30].

Another reason effective carbon pricing could succeed is that the corporate world has been applying carbon pricing internally in its operations and planning for decades. More than 2,000 companies representing over US$27 trillion in market capitalization currently use an internal carbon price or plan to implement one within the next two years, according to research by the Carbon Disclosure Project (CDP).[31]

> Most of the surveyed companies cite low-carbon investment as a key reason for embracing carbon pricing. Improving energy efficiency and changing internal behavior also are important factors.[32]

In 2022, **ETSs** accounted for almost nine gigatons (Gt) of CO_2e, representing representing 17.5% of global GHG emissions.

However, while France sets a carbon tax of US$49/ton CO_2e, Poland's is less than US$1/ton CO_2e. The same is true with ETS where the price of emissions allowances traded in 2023 was US$96.3/ton CO_2e, while that of China was US$8.15/ton CO_2e.[29]

"Equitable carbon pricing fosters both innovation and emissions reduction. Integrating carbon price scenarios into long-term business plans will be crucial to adapt to future developments. Companies that proactively prepare can gain a competitive advantage through decarbonization, driving the wider value sustainability can create and protect through their business model and strategy.

Amy Brachio
EY Global Vice Chair – Sustainability

28. "Pricing Carbon," World Bank website.
29. "Carbon Pricing Dashboard," World Bank website.
30. "In-depth Q&A: Will China's emissions trading scheme help tackle climate change?," Carbon Brief, 24 June 2021.
31. Putting a price on carbon: The state of internal carbon pricing by corporates globally, CDP, 2021.
32. "Lessons from first campus carbon-pricing scheme," Nature website.

03

How can we create a global carbon price framework?

Pricing carbon as a commodity and on a worldwide scale will help deliver the best results.

The coordination of individual emissions reduction efforts is critical if the world is to optimize its combined global impact, encourage collective action and prevent leakage.

That is starting to happen. For example, in October 2022, the OECD announced the formation of an Inclusive Forum on Carbon Mitigation Approaches (IFCMA).[33] It aims to boost the achievement of carbon reduction targets by using better data and knowledge sharing through multilateral coordination. The IFCMA seeks to do this by bringing together global perspectives on carbon policy.

At the same time, as governments grapple with the enormous task of meeting NDC targets, they also need to ensure the economic and social wellbeing of society. That's why any successful carbon pricing scheme will need to be fair and effective to avoid challenges raised in the past.

Current carbon markets need restructuring to reduce global emissions and achieve NDC targets. Proper CO2 accounting will be essential to promote a clear and uniform understanding of a country's progress toward NDC commitments and the effectiveness of policy interventions.

Key criteria to ensure fair and effective design of carbon frameworks will include:

- Pricing carbon as a commodity that reflects negative externalities.
- Adapting schemes to the unique industrial structures and trade balances of different regions.
- Designing and implementing mechanisms that ensure equitable treatment and fair distribution of benefits.
- Meeting international sustainability principles and standards.

33. OECD Secretary-General Report to G20 Finance Ministers and Central Bank Governors on the Establishment of the Inclusive Forum on Carbon Mitigation Approaches, OECD, October 2022.

There are two main forms of CO_2 accounting

1 Production-based accounting

This evaluates the CO_2 emissions generated within domestic borders, whether for domestic use or export.

Under this framework, CO_2 is merely considered an emission produced by a polluter, and a tax is imposed on the industrial sector responsible for it.

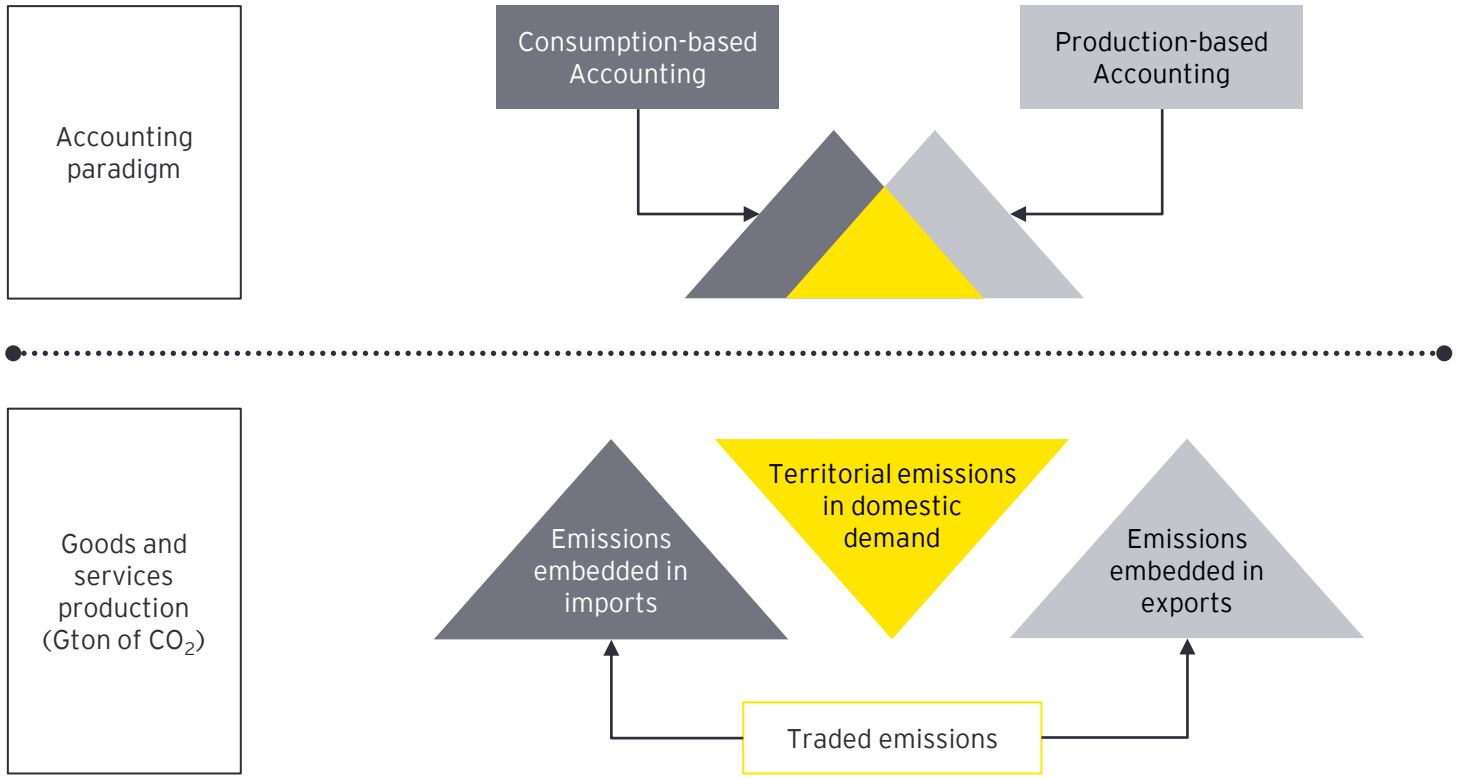
However, such CO_2 accounting methods may lead to carbon leakages and production shifts between countries where no regulation exists.

2 Consumption-based accounting

This evaluates the CO_2 embedded in a country's demand — regardless of where emissions are initially generated.

Under this framework, CO_2 is considered a commodity embedded in goods and can be traded and priced, and CO_2 generation is taxed because goods embedding CO_2 will be purchased along the supply chain. Therefore, there are no carbon leakages.

Accounting paradigms and countries' production



When the CO_2 emissions of a region accounted via a consumption-based approach are greater than those measured via a production-based approach, it means the CO_2 emissions embedded in imported products exceed the CO_2 emissions generated by the region to produce exported products. For example, if emissions are measured under a consumption-based approach, **the share of CO_2 emissions is**

18% – 19%

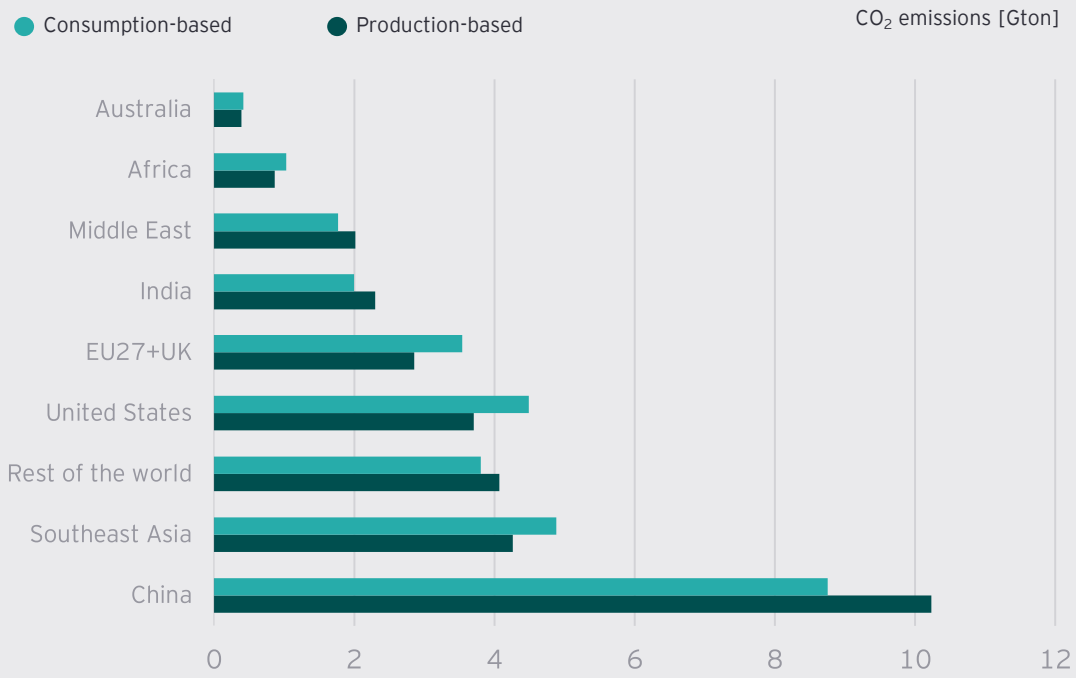
higher in the US and the EU compared with a production-based approach.

In comparison, **CO_2 emissions are**

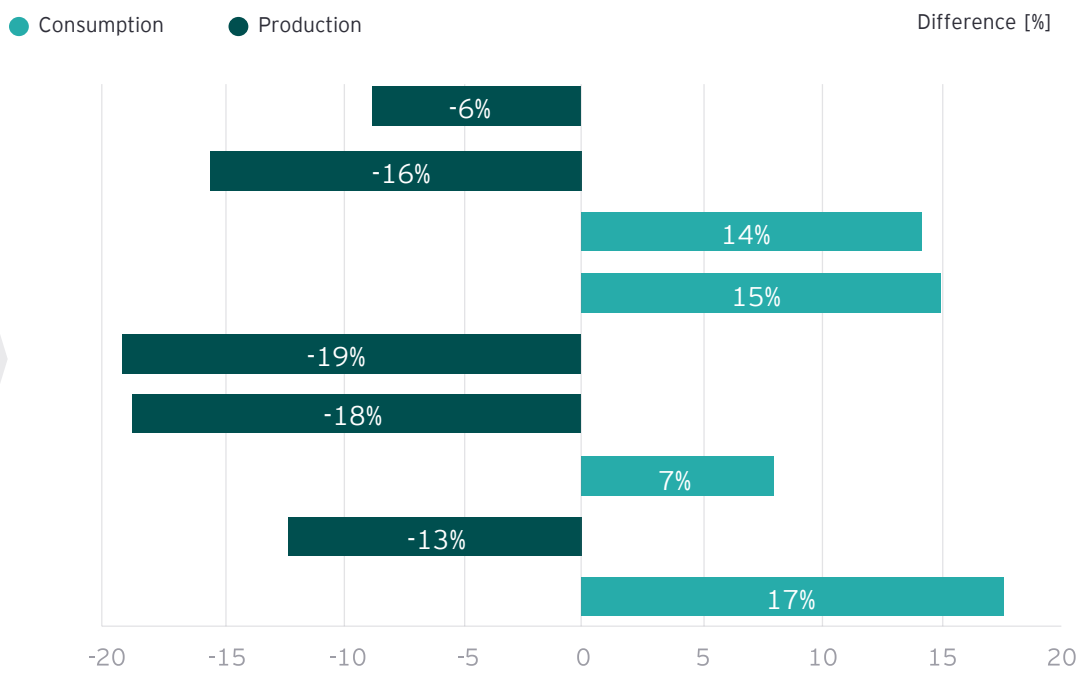
15% – 17%

lower in consumption-based measurements than in production-based measurements in India and China respectively.

Carbon emissions in different regions by accounting method



Difference in carbon emissions between consumption-based and production-based accounting method



The case for pricing carbon as a commodity in the long term

Our research model looked at trade patterns between countries and the carbon intensity in the production of goods, mapping CO_2 emissions by origin and region. This is a precondition for assessing different pricing mechanisms as the contribution of a region to global CO_2 emissions changes when shifting from the consumer to producer approach.

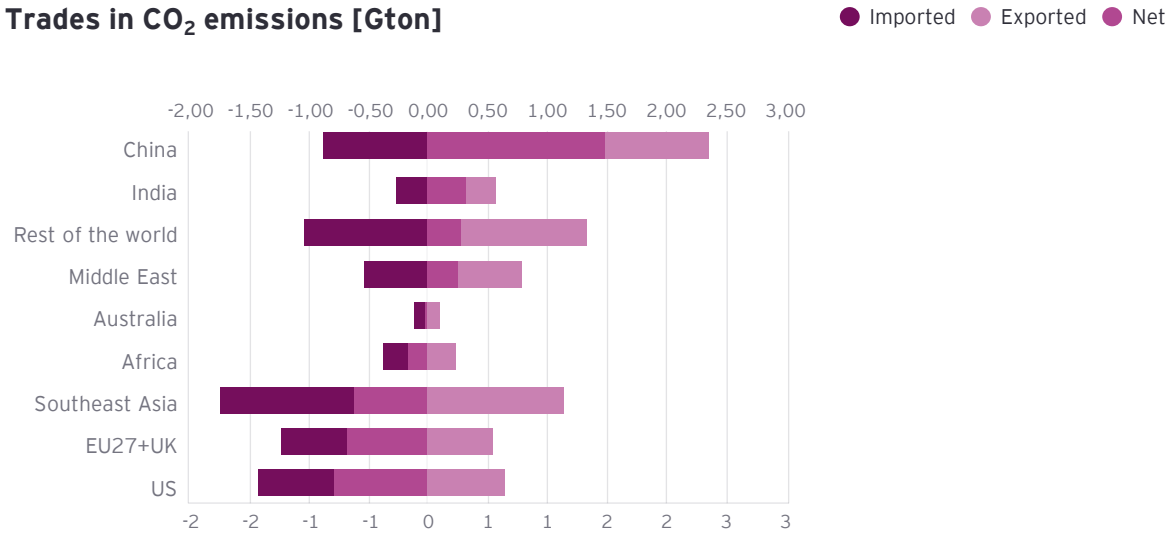
In our analysis, we considered the emissions embedded in each region's demand. Regions may be net carbon exporters (carbon producers) or importers (carbon consumers) according to their economic and industrial structure.

Regions characterized by a lower emission intensity (the US, EU27+UK and Southeast Asia) are net carbon importers from regions with the highest CO_2 emission intensity (China, India, the rest of the world and the Middle East).

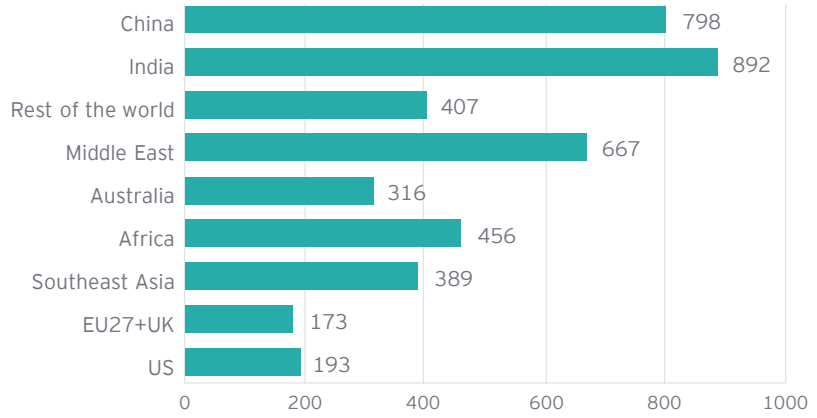
This situation leads to higher pollution since the regions that pollute the most to produce goods (characterized by a higher CO_2 emission intensity) are the same ones that export most of these goods around the world.

A positive impact on global emissions could be achieved through the decarbonization of supply chains in carbon-exporting regions — notably by engaging carbon producers to create a decarbonized supply chain.

Trades in CO_2 emissions [Gton]



CO_2 emissions intensity [t/€m]



Adopting the consumption-based accounting method — where CO_2 is considered a commodity embedded in goods — could help drive this transformation.

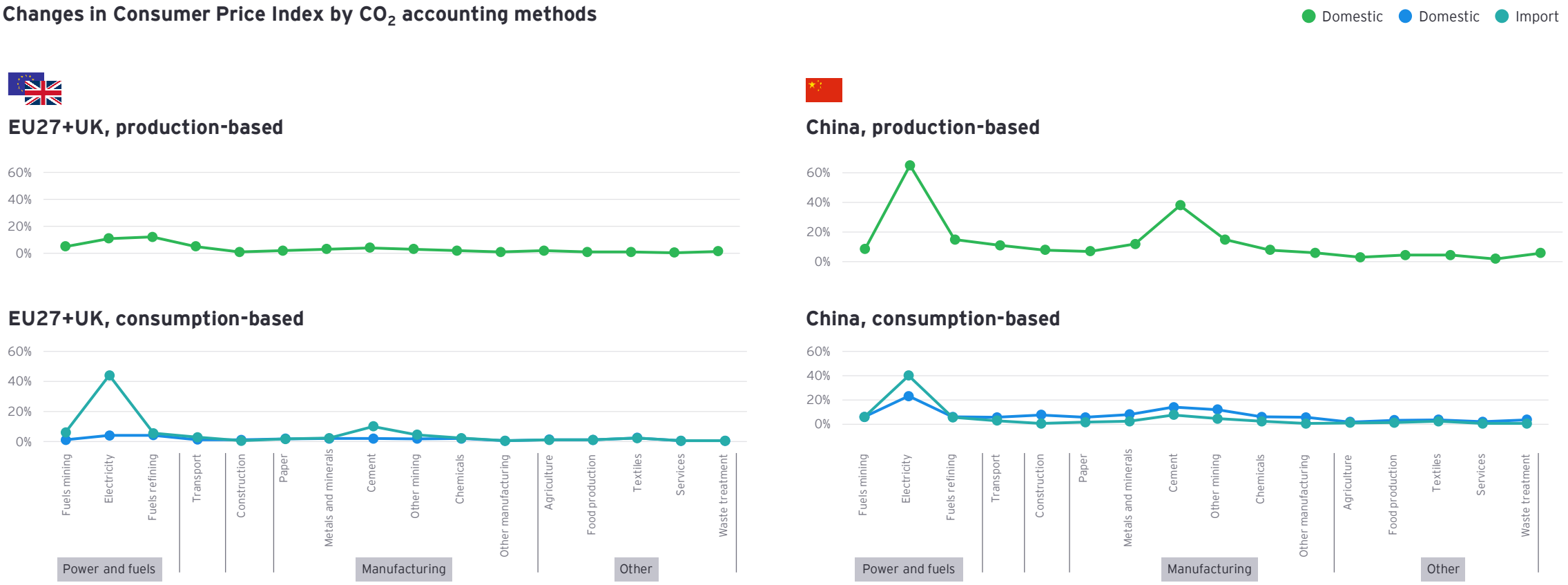
This finding is derived from our analysis of the dynamics of prices for domestic and imported goods in different industries and regions, summarized below. We examined the case of a predefined CO_2 price applied to a net carbon exporter, such as China, and to a net carbon importer, such as the EU27+UK.

The consumption-based accounting method suggests a smoother change in price for domestic products compared with the production-based approach.

The major effects are related to price indices of imported goods: Compared with the production-based approach, they change significantly and proportionally to the CO_2 emissions caused by the country's consumption of imported goods.

Considering the emission as a commodity (using consumption-based accounting) would act as a disincentive to importing or consuming products with high CO_2 content and lead to a fairer share of the costs between importing regions and exporting regions. It could also mitigate against carbon leakages.

Changes in Consumer Price Index by CO_2 accounting methods



04

What will a viable carbon price framework look like?

We need to establish a pricing system that will be equitable for all nations.

The global application of consumption-based accounting and pricing will require a phased approach due to the substantial undertaking of establishing an efficient and equitable global carbon pricing framework that accommodates diverse government and societal contexts.

These challenges are also rooted in historical emissions imbalances, whereby some countries benefited from fossil fuel usage while others grapple with the consequences of climate impacts. Addressing this equity concern implies sizable financial transfers, which potentially hinder political negotiations, particularly in achieving parity under a universal carbon price.

The prevailing trend highlights a dynamic landscape of diverse policy frameworks. As the international community discusses the possibility of a global pricing scheme, it presents an opportunity for governments to adopt a blended approach.

1. Domestic CO_2 emissions should be priced on a production-based scheme with the application of a carbon price by a determined country, levied on its productive sectors' output, proportional to the CO_2 directly emitted within the national borders. This framework reflects currently adopted carbon pricing policies, such as ETSs.

2. Additional prices should be applied on imported products and added according to a consumption-based scheme, thus avoiding the shift of production from one country to another. This also prevents generating carbon leakages in countries where no environmental regulation is in place.

One mechanism based on these principles is the Carbon Border Adjustment Mechanism (CBAM), currently being planned in the EU.[34]

The combination of the two approaches tries to mitigate some weaknesses (e.g., carbon leakages) of standard production-based schemes by assigning a markup to carbon embedded in imported goods.

The aim of this mechanism is to impose a CO_2 penalty on imported products coming from regions with less restrictive environmental policies.

> “For carbon pricing to be truly transformational and deliver a just transition, governments should adopt a coordinated approach that ensures different national approaches — be they taxes or trading systems — work in concert together and without loopholes.”

George Atalla
EY Global Government & Public Sector Leader

34. “Carbon Border Adjustment Mechanism: Questions and Answers,” European Commission website.

Benefits of pricing carbon as a commodity in shaping the energy transition

To better assess the effects of a consumption-based approach, our research looked at one of the biggest emitting sectors, the global power sector, which is responsible for 43% of global emissions.

We tested three scenarios (plus one as a baseline) that generate comparative analyses on the impacts of different carbon prices and modes of implementation on two elements: CO_2 emissions and tax revenues.

1 The first scenario is called the universal price floor. In this scenario, all regions implement the same carbon tax of €190 per ton of carbon. This is the highest price reached in the IEA's Announced Pledges Scenario introduced in 2021.

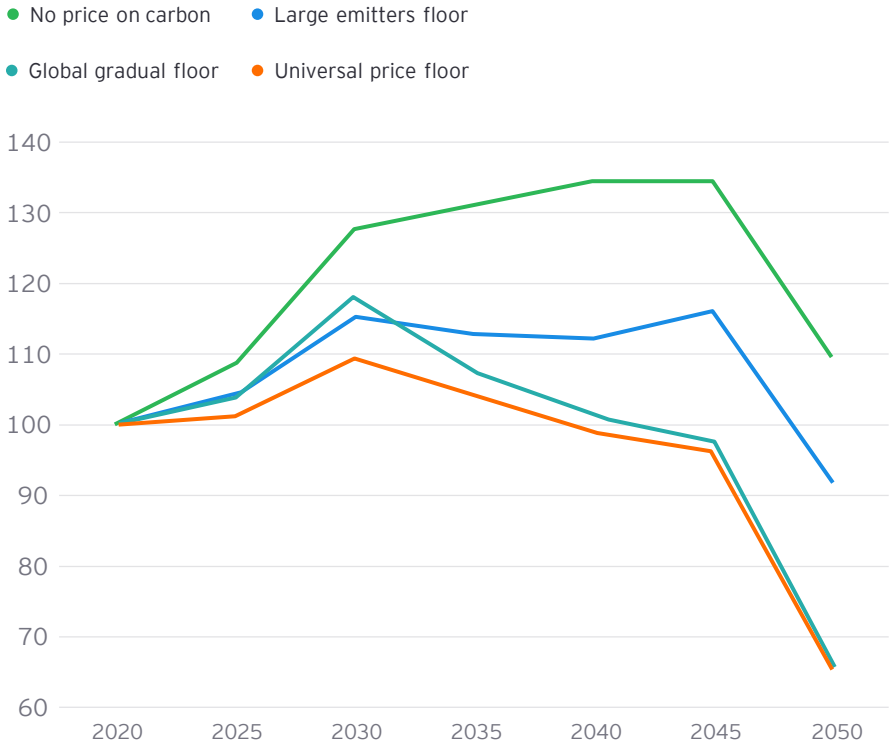
2 The second is the global gradual floor. In this scenario, all regions implement a specific carbon price level that gradually increases over time. Here, the 2020 to 2030 regional carbon prices match the carbon taxation levels the International Monetary Fund[35] reported. While the 2030 to 2040 prices align with IEA estimates, 2050 prices are at the same level as the universal price floor of €190 per ton of carbon.

3 The third scenario is the large emitters floor. In this scenario, price floors are aligned to the stated policies in each region or country. In EU27+UK, US and Australia, the carbon price starts at €70 per ton of carbon, gradually shifting toward €190 per ton of carbon in 2050. In China, it gradually shifts from €8 per ton of carbon to €30 per ton of carbon in 2050.

Our research shows that higher international carbon price floors and a wider geographical application of pricing mechanisms will lead to a faster green transition by 2050.

> Notably, we found that CO_2 emissions within the power sector in 2050 can be reduced anywhere from 17% to 68% and government tax revenues may range from €15.4t to €80.5t.

Global change in CO_2 emissions generated by the power sector [%]



35. International Monetary Fund.

Ultimately, we concluded that the universal price floor would raise €80.5t from carbon taxation, most of which is coming from regions with higher emission intensity. The global gradual floor would raise €42.2t and the large emitters floor would raise €15.4t.

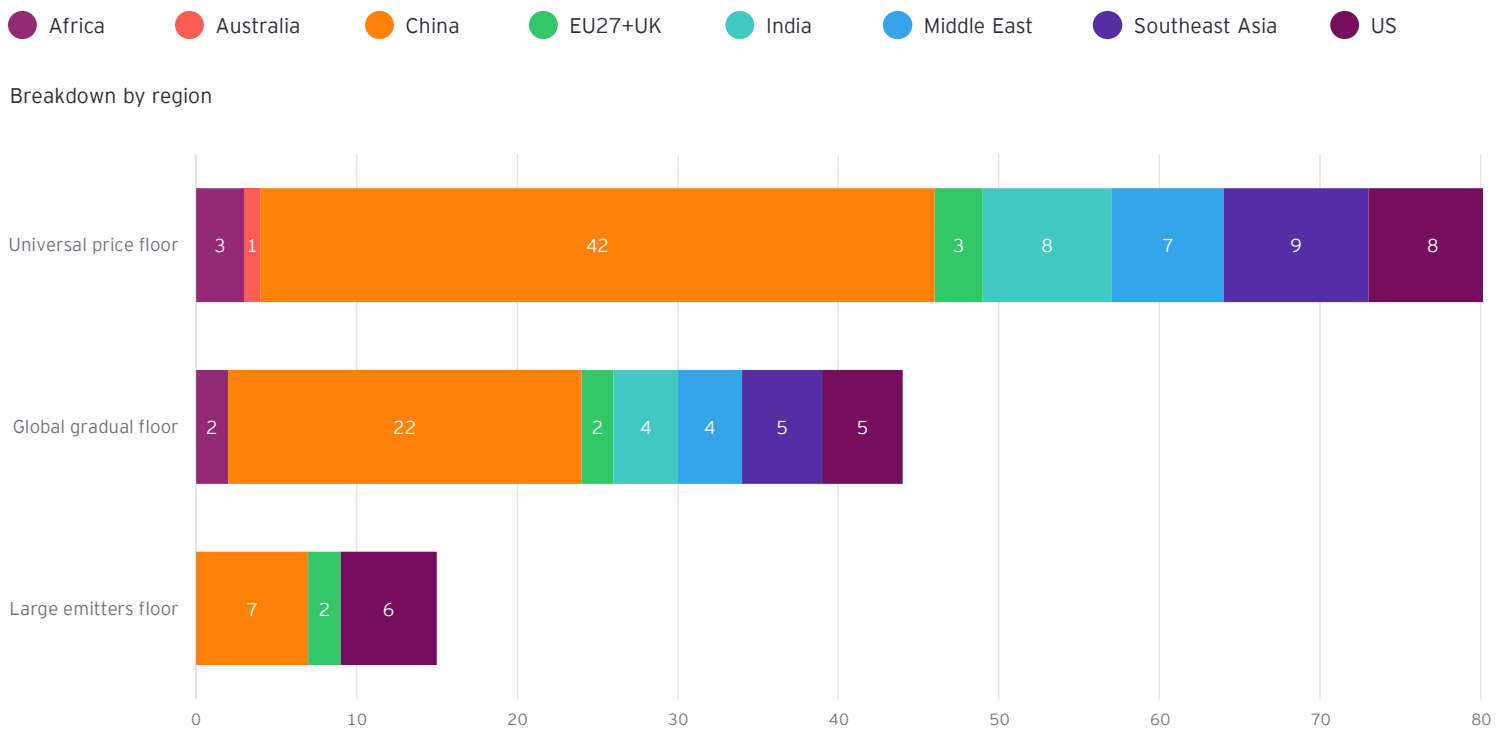
Expected increase from carbon taxation:

€80.5t
Universal price floor

€42.2t
Global gradual floor

€15.4t
Large emitters floor

Cumulative undiscounted tax revenues for the power sector for 2020 to 2050 [€t]



05

How can governments shape carbon regulation to deliver value?

The **seven important factors** to consider

The idea of one globally agreed carbon price and mechanism might make economic sense, but it is unlikely to be achieved in an era where the world is so divided geopolitically, economically and culturally.

As governments consider how best to incorporate carbon pricing into their national decarbonization policies and strategies, they must juggle not just the economic impacts of such schemes but also the political and societal. Carbon pricing can be a contentious topic, and negotiations around implementing carbon reduction policies can become a drawn-out process unless governments have clear objectives of what they want to achieve.

> How, then, should governments start shaping carbon regulation that is optimal for their home economies and effective for the planet as a whole?

> “The big question in terms of carbon pricing —whether it’s in the form of a direct tax or a cap-and-trade system — is what to do with the money you raise? That’s really important from a social impact perspective because putting a price on carbon will likely impact all parts of society — but some more than others.

Andrew Philips
EY Global Government & Infrastructure Tax Leader

Here are some **important factors** for governments to consider:

1 Know what type of pricing is best for your economy and society

The beauty of a comprehensive carbon price is it sends a signal to every business to effectively price carbon as they would any other input into their business. That gives companies the incentive to reduce carbon to the lowest possible levels. Governments that are not using carbon pricing will have to make thousands of micro interventions across the whole economy to try and align those incentives to reduce carbon. Governments that rely on the carrot — the incentives to make carbon relatively more expensive but not directly so — will ultimately have to face the budgetary challenges of this approach.

The first step is to choose the best form of carbon pricing for your country. Do you want to implement a direct tax on carbon or establish an ETS? If you pursue a carbon tax, what industries do you tax first? If you pursue an ETS, what industry sectors and GHGs will be covered? How do you expand coverage over time? And how do you adjust taxation on imported products?

After deciding on a pricing structure, you must set some design issues:

- What should the initial tax rate be and how will it rise over time?
- How close to the source of the emissions do you assign the statutory burden of the tax?
- What will the CO_2 cap be?
- How will allowances be distributed?
- What happens to existing regulations?

And, perhaps most importantly, from a political perspective, how are the revenues allocated?

2 Offsetting as an alternative route to carbon pricing

The near future of carbon emissions regulation will see a patchwork of measures to drive abatement in different countries. One key element that can link these measures is carbon offsets (i.e., reductions in GHG emissions or increases in carbon storage used to compensate for emissions that occur elsewhere). Even in sectors where you might not have official carbon price mechanisms, many countries will allow companies to meet abatement targets by buying offsets.

At present, many companies around the world are making commitments to reach net zero, but they don't necessarily have abatement technologies to achieve this, so are buying offsets to meet their requirements. In these marketplaces, offsetting creates a common price without the need for a formal carbon pricing mechanism. However, the carbon credits market must be carefully assessed to ensure effective and accurate accounting.

If governments create an offset price that is high enough that it garners international trading interest, you can bring industry sectors with you and give real incentives to decarbonize. And, because offsets could be allowed to be traded across countries, abatement efforts in one country can be calibrated to another through offsets. As an example, it might make sense for countries characterized by a lower emission intensity to undertake carbon abatement through technology projects or carbon storage in countries with higher emission intensity – where industrial plants are more antiquated and natural assets are cheaper to restore.

3 Have a clearly articulated plan to distribute the revenue raised

Some governments may choose to lower other types of taxes that would potentially reduce macroeconomic damage caused by imposing carbon pricing. Another option is to use the revenue to invest in clean energy and technology infrastructure. It could be returned to taxpayers in the form of a universal basic income or relief for low-income households most impacted by increased food and energy prices. Or it could be used to tackle other social issues related (or unrelated) to climate change. Some business advocates even recommend redistributing the revenue back to individual companies to finance decarbonization investments.

Whatever the strategy, how governments spend carbon revenue will be some of their most important decisions from a social impact point of view in the future.

> "Soon, we will see a variety of carbon pricing systems coexisting as separate markets. To achieve a unified approach, harnessing the potential of blockchain integrated with IoT is crucial. The main challenge is establishing an ecosystem that promotes trust, transparency, and interoperability.

Gianluca Di Pasquale
EY Global Green Economies and Infrastructure Leader and Future Cities Co-leader

4 Demonstrate transparency to build credibility and support for the pricing system

Transparency will be key to maintaining credibility for a connected framework of different regional and national carbon pricing systems. Governments will need to accurately measure both carbon outputs and the effectiveness of offsetting schemes. This way, they will be able to minimize carbon leakage, reduce double accounting and combat carbon fraud and greenwashing.

Technology and better data analytics can help improve transparency. Already, space technologies, including satellite data, are helping monitor the physical management and credibility of tropical forests involved in carbon offsetting projects.

Distributed ledger technology is being used to track carbon emissions and footprints through global supply chains, and a combination of AI and data analytics is giving companies fresh insight into the carbon risks and mitigation in their operations and those of their suppliers.

The value of this information will only grow in the coming years and can provide the raw data that informs and shapes a global carbon price.

5 Bolster reporting to drive adoption

Better information allows more thorough and expansive corporate reporting on carbon emissions — something that is fast becoming mainstream now that governments all over the world are bolstering and regulating nonfinancial reporting. In the EU, the new Corporate Sustainability Reporting Directive requires most companies to report how climate change impacts not just their own business but also the planet and society.

In the US, the Securities and Exchange Commission (SEC) has proposed rule changes that would require companies to report climate-related risks that are likely to have a material impact on their business and financial condition. Moving forward, the combination of improved carbon data and the demands for more robust sustainability reporting will only increase the credibility and value of carbon pricing.

6 Build a working and governing culture that understands the importance of decarbonization

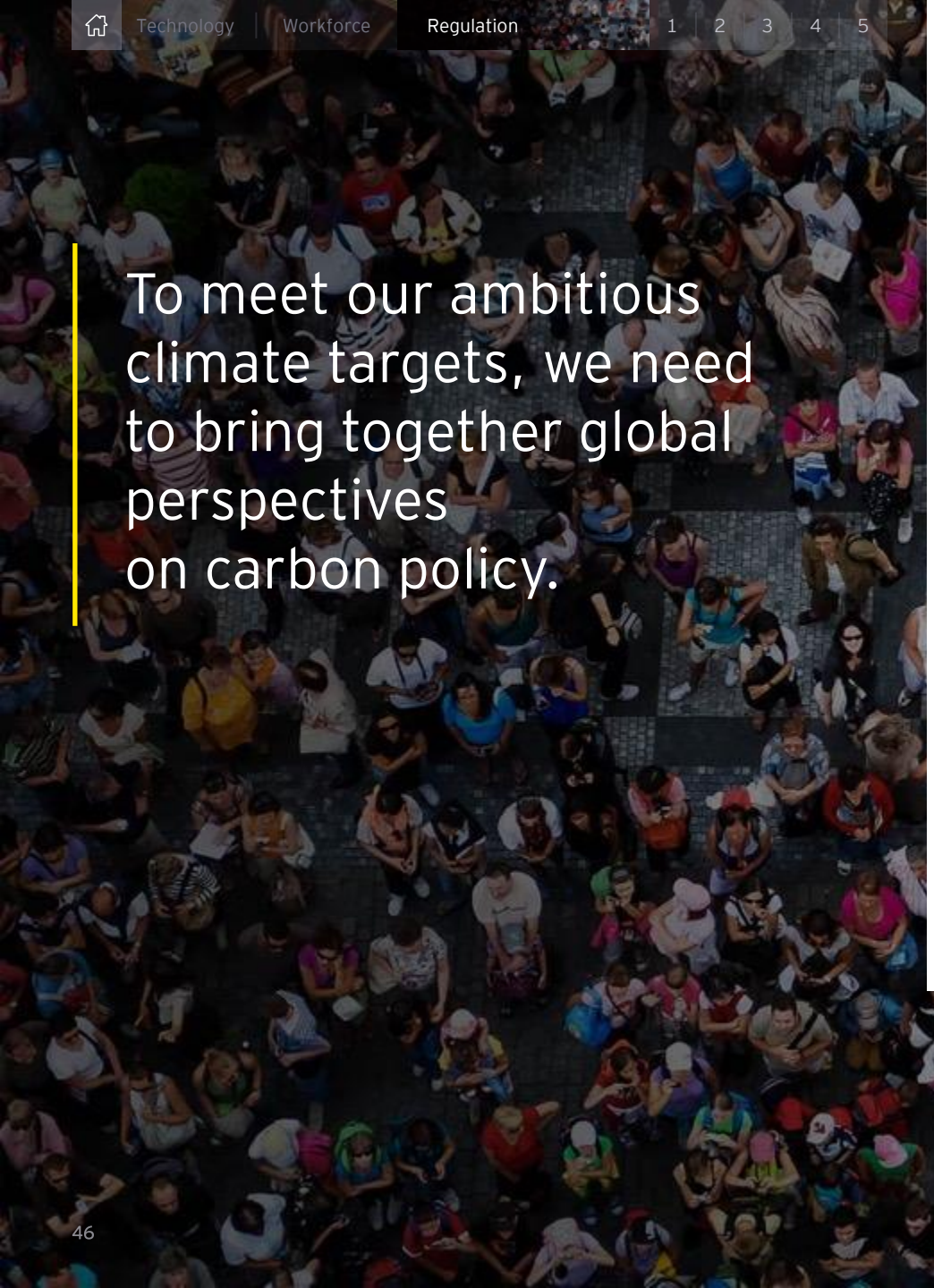
The coming decades are going to require a new breed of governmental and business professional if the world is to achieve net zero. That means economists, policymakers, executives and managers who think differently and understand that the climate emergency, biodiversity and the preservation of the planet are fundamental to their decision-making.

This will necessitate new types of green jobs, but it will also require a mind shift — actually, a cultural shift — in the entire workforce. This is already taking place as a new generation versed in the global school climate strikes and marches enters the workforce. And it will be further shaped by the hard-nosed economics of climate change and carbon pricing.

From now on, profitable business will increasingly mean green business — even as entrenched areas of the gray economy slowly start to dwindle.

7 Leverage carbon pricing for global climate resilience and innovation

Governments can harness the revenue generated from carbon pricing as a significant source for international redistribution by contributing to a pool of funds to support vulnerable nations' climate resilience and facilitate the transition to low-carbon economies. This collaborative approach demonstrates developed nations' commitment to global climate action and establishes a framework for mutual benefit. Even countries with lower carbon intensity can reap the rewards, as they can export their advanced green technologies and solutions, engage in joint projects and ventures with developing countries, enhance supply chain resilience and foster improved global trade relations. Examples such as technology transfers are crucial for enabling less-developed nations to adopt clean and efficient technologies, accelerating their transition, and facilitating the exchange of expertise, knowledge and solutions.



To meet our ambitious climate targets, we need to bring together global perspectives on carbon policy.

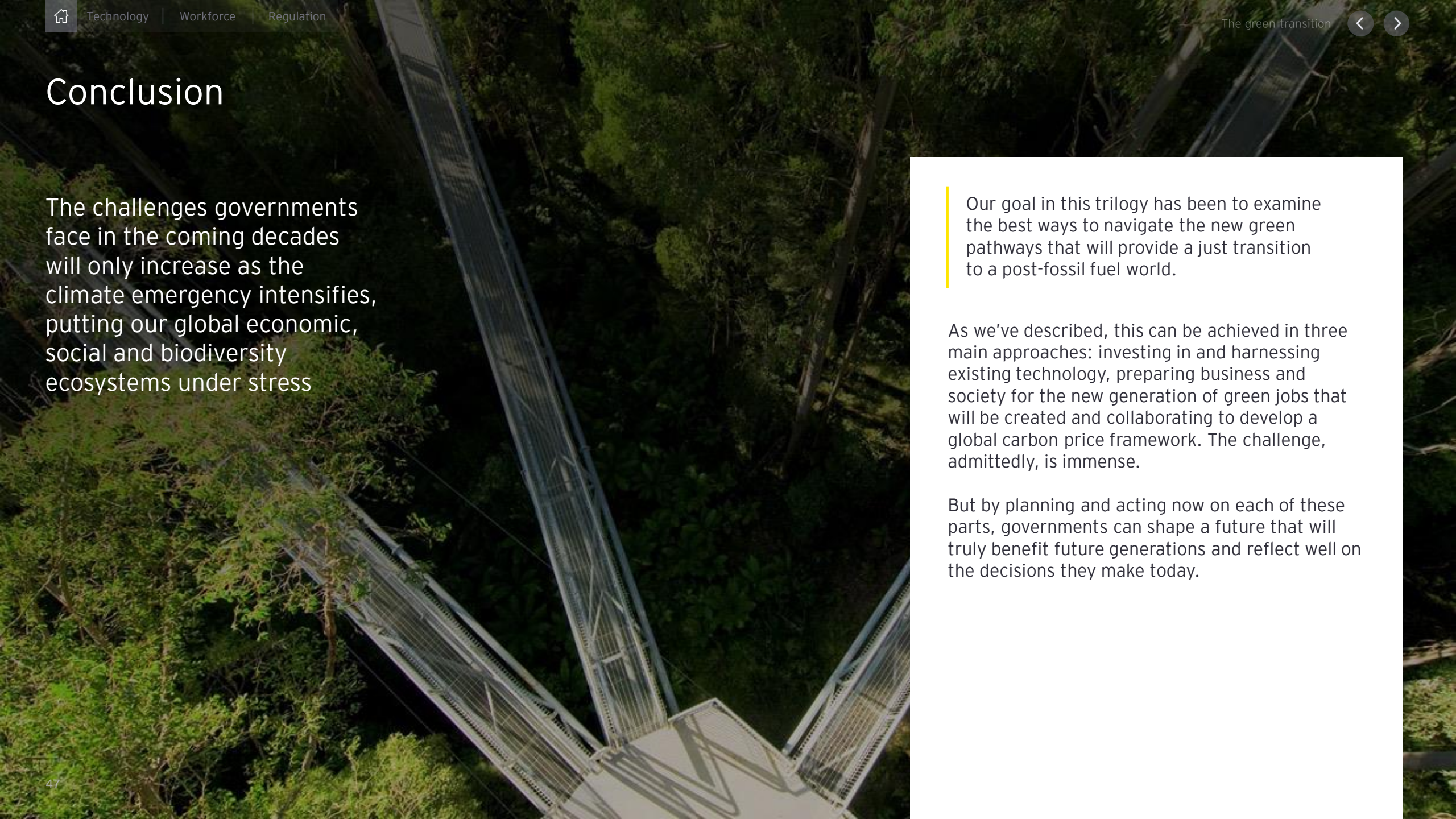
We must bring global perspectives on carbon policy together to meet our ambitious climate targets. Coordinated efforts are required to price carbon as a commodity worldwide to deliver the best results. Negotiations should be consistent and adapted to the industrial structure and trade balances of different countries and regions.

Governments have been too timid regarding climate regulation for too long, afraid that establishing higher emissions standards will alienate key industries, causing companies to relocate to countries and regions with more relaxed policies.

The reality today is that the business world knows the price of carbon will continue to rise and is looking for leadership and certainty from government. Some cross-border leakage will still occur, but the pathways to net zero have already been established. If government leads, business will follow.

Conclusion

The challenges governments face in the coming decades will only increase as the climate emergency intensifies, putting our global economic, social and biodiversity ecosystems under stress



> Our goal in this trilogy has been to examine the best ways to navigate the new green pathways that will provide a just transition to a post-fossil fuel world.

As we've described, this can be achieved in three main approaches: investing in and harnessing existing technology, preparing business and society for the new generation of green jobs that will be created and collaborating to develop a global carbon price framework. The challenge, admittedly, is immense.

But by planning and acting now on each of these parts, governments can shape a future that will truly benefit future generations and reflect well on the decisions they make today.

Methodology

We collaborated with Politecnico di Milano to model the potential value and impacts of the green transition process. Specifically, we focused on what governments' NDCs to meet the target of 1.5 degrees Celsius set by the UN 2015 Paris Agreement will mean for gross domestic product (GDP) and jobs growth over the next three decades.

To do this, we modeled two scenarios plus a baseline scenario:

> The first scenario is called LCE. This scenario models GDP based on NDC policy announcements, including the COP27 pledges.

> The second scenario is LCE+, which provides a feasible pathway to minimize carbon emissions beyond political pledges. It is based on reducing emissions by adopting the optimum, least-emissions pathway within key industry sectors and available technologies.

> The third — baseline scenario — depicts no policy implementation or technological changes, with energy demand driven only by economic growth until 2050.

About the model

The analysis is based on an input-output stock-flow consistent model (IOSFC), a technique that fully accounts for how energy is produced in (with financial and human capital), and how it flows through (as an input into production and consumption), the economy.

In business parlance, IOSFC modeling techniques generate an economy-wide integrated set of financial, economic and physical energy accounts, describing changes to both the balance sheet (e.g., stocks of assets) and the income statement (e.g., flows of energy, goods and services) in a consistent fashion. The technique produces realistic projections of major macroeconomic, financial and real energy variables, enabling a detailed understanding of the feasibility of different transition pathways subject to social, political and economic constraints such as government debt ratios and the unemployment rate.

> In this instance, the data set for this model covered: the EU27+UK, the US, Asia, the Middle East and Australia, which together represent 75% of global GDP and 80% of global CO_2 emissions.

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EY contributors

Amy Brachio
EY Global Vice Chair – Sustainability

Andrew Horstead
EY Global Energy & Resources Lead Analyst

Andrew Philips
EY Global Government & Infrastructure Tax Leader

Andre Winarto
EY Global Energy & Resources Knowledge Leader

Anil Valsan
EY Global Advanced Manufacturing & Mobility Knowledge Leader

Ankit Jain
Manager, Ernst & Young LLP

Anthony Tricot
Senior Manager, Ernst & Young LLP

Ben Falk
Director, Ernst & Young LLP

Craig Coulter
EY Global Advanced Manufacturing & Mobility, Strategy & Operations and Sustainability Leader

Erin Roberts
EY Global Engineering & Construction Leader

George Atalla
EY Global Government & Public Sector Leader

Gianluca Di Pasquale
EY Global Green Economies & Infrastructure Leader; Future Cities Co-leader

Jane May
EY Global Transformation Leader – People Advisory Services

Kasia Klaczyńska Lewis
LL.M., Partner, EY Law

Lauren Haney
Senior Manager, Ernst & Young AB

Marc Coltelli
EY Americas and EY Global eMobility Energy Leader

Marco Cavalli
Manager, EY Advisory S.p.A.

Maria Rodriguez
EY Global Government & Public Sector Knowledge Leader

Martin Ceccon
Partner, Ernst & Young AG

Meghan Mills
EY Global Government & Public Sector Strategy & Operations Leader; Global Government & Infrastructure Sustainability Leader; Future Cities Co-leader

Paras Shah
EY Global Strategy & Execution Leader – Global Advanced Manufacturing & Mobility

Shalinder Bakshi
EY Global Government & Infrastructure People Advisory Services Leader

Tony Canavan
EY Global Government and Public Sector Transport Leader

West Coghlan
Associate Director, Ernst & Young Americas LLC

Acknowledgments and thanks (2/2)

International Advisory Board members

Academic contributors

Abbas El-Zein
Professor, School of Civil Engineering and Head of the Geoenvironmental Laboratory, University of Sydney

Diana Shendrikova
Assistant Professor, Department of Energy, Politecnico di Milano; UNESCO CHAIR in Energy for Sustainable Development

Dr. Leonardo Ghezzi
Serior Economist, Head of the Regional Macroeconomic Unit, Istituto Regionale Programmazione Economica Toscana (IRPET)

Dr. Luca Franza
Senior Energy Decarbonization Policy Expert, HEAS AG

Dr. Renato Paniccià
Senior Economist, Expert in Input-Output Economics, Istituto Regionale Programmazione Economica Toscana (IRPET)

Emanuela Colombo
Full Professor, Department of Energy - Politecnico di Milano; Rector's Delegate to Science Diplomacy; UNESCO CHAIR in Energy for Sustainable Development

Lorenzo Rinaldi
Research Fellow, Department of Energy, Politecnico di Milano

Matteo Vincenzo Rocco
Associate Professor, Department of Energy, Politecnico di Milano

Mohammad Amin Tahavori
Research Fellow, Department of Energy, Politecnico di Milano

Prof. Manfred Hafner
International Energy and Decarbonization Expert; CEO, HEAS AG

Ralph hall
Undergraduate Programs Director and Associate Professor, Urban Affairs and Planning and Associate Director, School of Public and International Affairs, Virginia Tech

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