

In collaboration with Cambridge Industrial Innovation
Policy, University of Cambridge, and the United
Nations Industrial Development Organization



The Future of Industrial Strategies: Five Grand Challenges for Resilient Manufacturing

WHITE PAPER

JANUARY 2023

Contents

3	Foreword
4	Executive summary
5	1 Global megatrends
7	2 Five grand challenges
9	2.1 Decarbonizing manufacturing operations, products and supply chains
11	2.2 Enhancing supply chain transparency and resilience
13	2.3 Speeding up scale-up and adoption of new technologies
15	2.4 Securing the future of the manufacturing workforce
17	2.5 Linking business values with social and environmental responsibility
20	3 Towards a future strategy agenda
22	Contributors
23	Endnotes

Disclaimer

This document is published by the World Economic Forum as a contribution to a project, insight area or interaction. The findings, interpretations and conclusions expressed herein are a result of a collaborative process facilitated and endorsed by the World Economic Forum but whose results do not necessarily represent the views of the World Economic Forum, nor the entirety of its Members, Partners or other stakeholders.

© 2023 World Economic Forum. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, including photocopying and recording, or by any information storage and retrieval system.

Foreword



Francisco Betti
Head, Shaping the Future
of Advanced Manufacturing
and Value Chains,
World Economic Forum



Adnan Seric
Manager, Innovation Lab,
United Nations Industrial
Development Organization



Carlos López-Gómez
Head, Policy Links, IfM
Engage, Cambridge
Industrial Innovation Policy

Manufacturing industries have been a source of social and economic growth for both developed and emerging economies. Today they stand at a critical juncture. The increase in global disruptions, from geopolitical and macroeconomic events to the accelerating pace of technological innovation, is having a profound impact on the state of global production systems and is forcing unprecedented transformation across value chains.

To stay competitive and navigate this new global context, companies and governments must come together and work continuously in close collaboration to rethink and redesign industrial strategies that ensure productivity, innovation and economic growth.

Against this background, the World Economic Forum, in partnership with the Cambridge Industrial Innovation Policy, University of Cambridge,

and the United Nations Industrial Development Organization (UNIDO), is bringing together governments and companies to understand the challenges and trends transforming industries. The aim is to inform the design and development of the next generation of industrial strategies, providing a space for companies and governments to come together and shedding light on the latest global trends and priorities.

This paper proposes a framework to facilitate the discussion between the public and private sectors and structure the conversation on the future of industrial strategies. Its ultimate goal is to act as a catalyst to convene key stakeholders and facilitate dialogue around best practices, priorities and new opportunities for change, so that manufacturing industries remain a source of inclusive growth.

Executive summary

Three global megatrends are creating increasingly frequent disruptions, which are in turn reshaping global value chains and pushing manufacturing systems to transform themselves.

These megatrends are: emerging technologies, climate change and geopolitical tensions.¹ Their fallouts – ranging from economic uncertainty and changes in governance to environmental degradation and technological step-changes – are becoming ever more common, requiring a two-pronged approach of short-term adaptation and longer-term transformation from manufacturers and governments alike.²

The World Economic Forum, in collaboration with Cambridge Industrial Innovation Policy, University of Cambridge, and the United Nations Industrial Development Organization (UNIDO) has identified five grand challenges for companies and governments to work on and help inform the next generation of industrial strategies:

1. Decarbonizing manufacturing operations, products and supply chains.
2. Enhancing supply chain resilience.

3. Accelerating the scaling up and adoption of novel industrial technologies.
4. Securing the future of the manufacturing workforce.
5. Linking business values with social and environmental responsibility.

In this new global context, public and private sector leaders need to design new mechanisms for collaboration and coordination that ensure continuous knowledge exchange, which is the key to unlocking future industrial strategies that ensure productivity, innovation and growth.

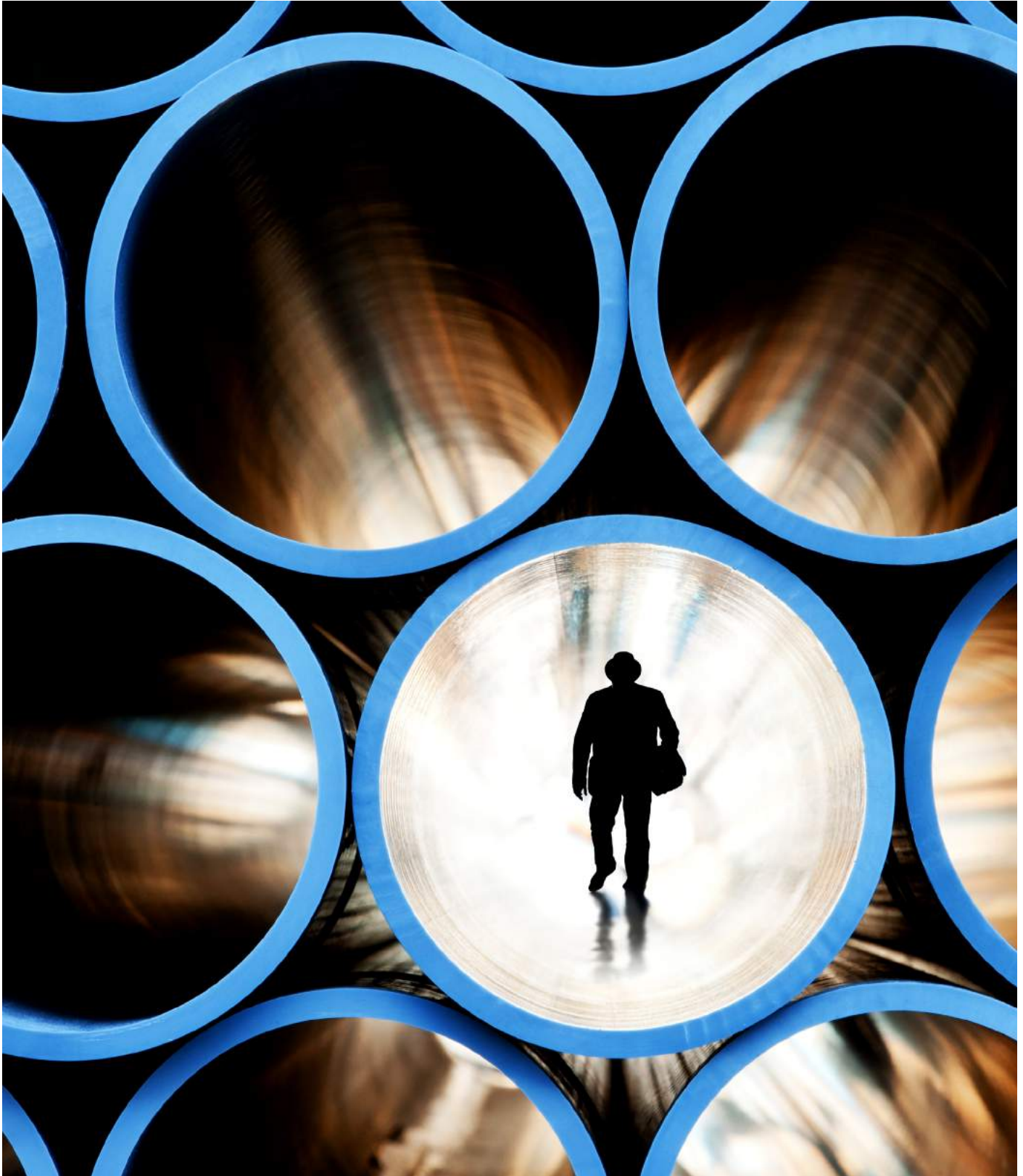
The Forum will continue to provide a neutral space for leaders from across industries, public sector, civil society and academia to understand and anticipate global trends and their implications, share best practices and knowledge, incubate new private-public collaborations and inform policy that supports manufacturing industries in navigating ongoing challenges while preparing for the future.



1

Global megatrends

Three global megatrends are creating new opportunities and challenges for the manufacturing ecosystem.



Geopolitical tensions

Global trend: Political shifts, protectionism, the war in Ukraine, COVID-19 induced supply chain shocks and growing competition for talent are exposing companies and governments to numerous vulnerabilities – including rising energy prices, global shortages, production scarcity and logistical delays in getting key components.

Implications: Geopolitical tensions are challenging strategies and operating models across all manufacturing sectors and are shifting attention to resilience and security. As a result, many governments and industrial companies have started exploring how to adopt a more regional, friend-shoring or near-shoring approach towards globalization and international trade, while attempting to balance the benefits of diversified globalization and concerns for sustainability practices.

Technological innovations

Global trend: The world is in the midst of technological change unprecedented in pace and scope, and keeping abreast with new technologies is essential for economic success. Yet, technological step-changes are also generating hyper-competition, accelerating cybercrime and widening an existing technological divide between front-runners and laggards.

Implications: Making technology adoption and innovation a key cornerstone of manufacturing strategies is of paramount importance for

business competitiveness. As the UNIDO Industrial Development Report 2020 highlighted, the economic benefits from adoption of new advanced manufacturing technologies include, but are not limited to, productivity gains and easier access to international markets and value chains.³ Further advancements in areas such as digitalization require deeper collaboration between manufacturing companies and governments alike, and would encourage upgrading of industrial structures while unlocking opportunities for enhanced supply chain resilience and workforce augmentation.⁴

Climate change

Global trend: Climate change has been a threat for several decades, but its rapidly expanding effects and global implications are forcing companies and governments to raise new commitments and explore newer decarbonization strategies that yield results faster.

Implications: Climate-related pressures require governments and manufacturing firms to adapt in the short term and transform for the long term. In this vein, new strategies to decouple industrial outputs from CO₂ emissions, decarbonizing supply chains and mapping future demand of critical materials vis-a-vis current reserves will all be of paramount importance.

As these three megatrends continue to impact the economy and society, the new and fast-changing environment in which companies and governments operate today creates unique challenges – but also opportunities – to drive industrial transformation and generate new social and economic value.

This requires manufacturers and governments to join forces and collaborate to rethink industrial strategies and shape a new industrial agenda that calls for specific sets of actionable responses around five main challenges:

- Decarbonizing manufacturing operations, products and supply chains.
- Enhancing supply chain resilience.
- Accelerating the scaling up and adoption of novel industrial technologies.
- Securing the future of the manufacturing workforce.
- Linking business values with social and environmental responsibility.

2

Five grand challenges

Key to addressing the symptoms of these megatrends, the five grand challenges require a collaborative response involving multiple dimensions of action from the public sector, private sector, academia and civil society.

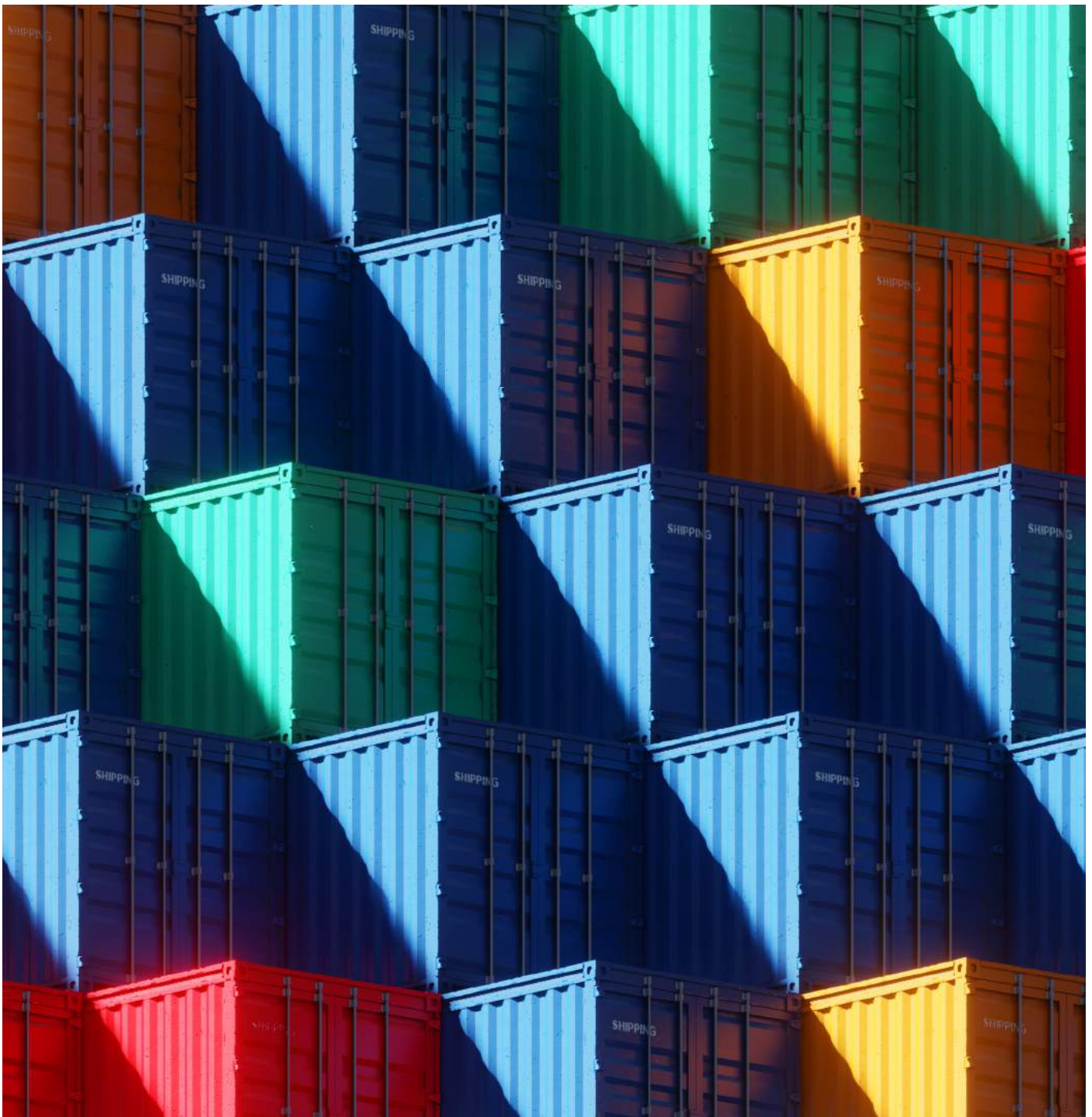


TABLE 1 | Five grand challenges and key steps

Grand manufacturing challenge	Action areas for public and private collaboration
Decarbonizing manufacturing operations, products and supply chains	<ul style="list-style-type: none"> – Increasing resource efficiency – Improving material substitution – Enhancing energy efficiency – Enabling fuel switching – Advancing carbon capture and storage – Gathering better data and establishing digital standards – Establishing specific actions in carbon-intensive industries
Enhancing supply chain transparency and resilience	<ul style="list-style-type: none"> – Improving the understanding and end-to-end visibility of supply chains – Using a range of approaches: building domestic production capacity, redundancy, stockpiling, trusted partnerships and sourcing from nearby countries – Supporting development and enforcement of business continuity planning – Strengthening international coordination and collaboration – Encouraging the use of resilience-enhancing technology
Speeding up scale-up and deployment of novel industrial technologies	<ul style="list-style-type: none"> – Bringing together the expertise of actors across the manufacturing system – Establishing collaborative linkages with a range of research actors – Providing demonstration facilities and supporting networks for knowledge exchange – Providing technical assistance to help manufacturers adopt new technologies in current production lines and retrofit legacy systems – Investing in enabling infrastructure – Partnering with research institutions and industrial networks in developing countries
Securing the future of the manufacturing workforce	<ul style="list-style-type: none"> – Building stronger relationships between employers and training providers – Supporting on-the-job training and apprenticeships – Challenging outdated public perceptions of manufacturing – Broadening and diversifying the demographic base of the manufacturing workforce – Placing workers at the core of technology adoption – Offering reskilling and upskilling programmes, particularly to vulnerable groups – Establishing safety nets to support those losing their jobs and enabling a just transition
Linking business value with social and environmental responsibility	<ul style="list-style-type: none"> – Decreasing gender disparities and promoting diversity in the manufacturing industry – Ensuring the safety, ethics and regulatory security of new technologies – Using solutions such as predictive maintenance, drones and data analytics to reduce workers' exposure to safety risks – Exploring the potential of new forms of corporate ownership and governance

For each challenge, this report focuses on:

- Defining the challenge.
- Outlining some key action areas for the public and private sectors to reach a consensus on and kick-start collaboration.
- Sharing additional relevant resources to deep-dive on the topic.

2.1 Decarbonizing manufacturing operations, products and supply chains

What is the challenge?

While manufacturing is an essential economic activity, in order to achieve the world's climate targets, the emissions associated with industrial production need to be removed or significantly reduced.

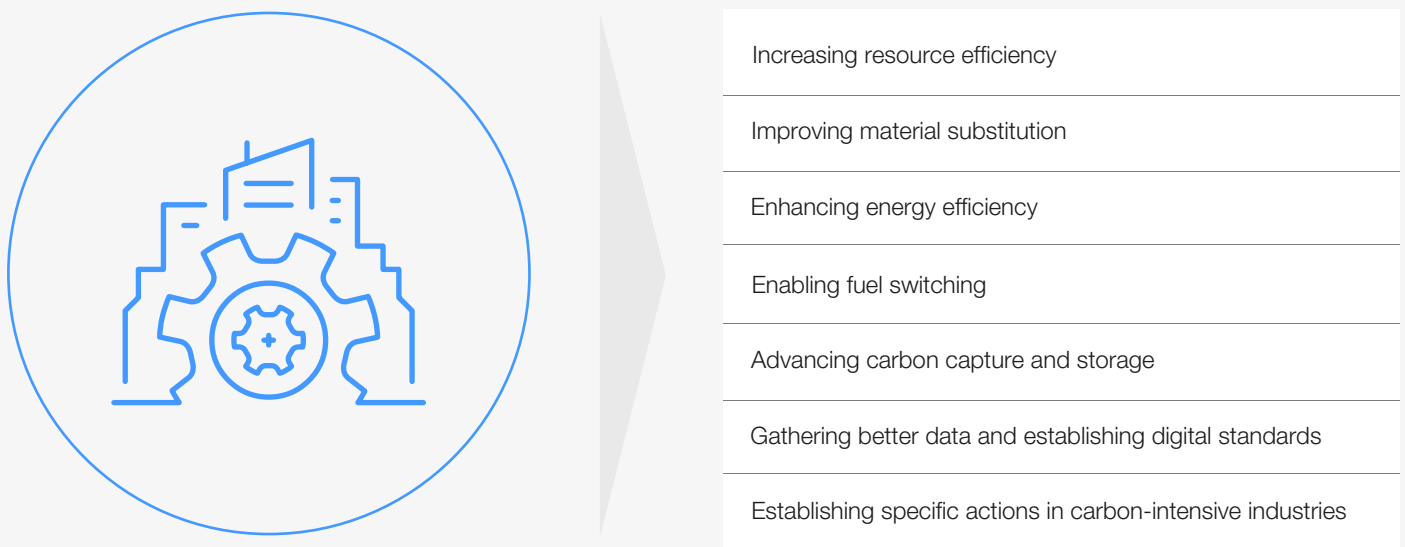
Reaching key climate targets will not be possible without a significant reduction in industrial production-related emissions.⁵

Reducing emissions in the industrial sector is as complicated as in other high-emitting sectors like transportation and power. The variety of processes involved in industrial production – ranging from blast

furnaces and petrochemical plants to machining centres – means that many solutions need to come together to minimize emissions in the sector.⁶

The high temperatures required in heavy industry operations are currently achievable only by burning fossil fuels. Quitting fossil fuels, adopting renewables and electrifying operations is essential, but given the state of current technologies, large-scale electrification often comes with a large price tag. Heavy industries must therefore redouble efforts at identifying and expanding the green technologies that can reach sufficiently high temperatures.⁷

FIGURE 1 Decarbonizing manufacturing operations, products and supply chains



Additionally, on the industrial side, emissions-intensive assets such as blast furnaces and cement kilns have long operational lives of around 30-40 years.⁸ Companies have limited economic incentives for a quick transition to new, more energy-efficient processes. Consumers everywhere are demanding greener products throughout the supply chain, reshaping industry and product standards, procurement policies and financial

incentives. Increased responsibility is being assigned to manufacturers to understand the entire life-cycle of their product and its ecological impact.

However, the journey from raw material to final product in many modern industries cuts across sectors and geographies, making it hard to obtain reliable data on their environmental impact and identify where interventions can deliver the best value.

What are the key areas of collaboration for the public and private sectors?

The process of decarbonizing manufacturing will determine the success of economies. A successful transition is in the interest of industry players and governments alike. Despite the variety of industrial processes and approaches, public and private sector actors can benefit from coming to consensus about and collaborating for:⁹

Increasing resource efficiency. A world of finite resources must reduce the flow of materials through the economy, by using products more efficiently and for longer – in production as well as end-user consumption.

Improving material substitution. The use of low embodied-carbon materials can be increased. For example, raw resources in the cement industry are currently replaced with waste and by-products from other industrial processes. Rather than traditional resources like clay, elements from other industrial processes such as alumina, silica, calcium and iron can be used in the kiln as raw materials.¹⁰

Enhancing energy efficiency. This reduces operating costs while cutting emissions – a shared goal for governments and industry. Businesses can achieve this by upgrading processes and equipment, installing/improving heat recovery systems and clustering with other sites to utilize waste heat and other by-products.

Enabling fuel switching. Hydrogen, electricity and bioenergy can all replace fossil fuels for meeting heat, motion and electrical demands. Limiting global warming to 1.5°C will require substituting fossil fuels and increasing the share of electricity in the industrial sector's final energy demand to 35% by 2030, 40-45% in 2040 and 50-55% in 2050.¹¹

Advancing carbon capture and storage (CCS).

CO₂ produced by larger industrial point-sources can be captured and transported to storage sites, thus reducing the emissions that go into the atmosphere. But investment in and use of CCS capabilities will require the buy-in of a larger set of stakeholders than any one industry or government player.

Gathering better data and establishing digital standards.

To track and develop appropriate plans of action, manufacturers will need access to more complete and reliable sources of data about the environmental impacts of their operations and of their supply chains. This data should be used to agree on clear targets and standards from governments to suppliers, partners and customers. Without clear insights from data, uniform tracking of CO₂ footprints, for example, will be impossible.

Supporting infrastructure development and innovation.

Infrastructure is a public good that often markets alone cannot create. To decarbonize industries, public-private partnerships and economic incentives such as government investments and subsidies are needed to address infrastructure development and deployment barriers for key technologies and innovations.

Establishing specific actions in carbon-intensive industries.

Chemicals, steel and cement are three heavy industries that account for nearly 60% of all industrial energy consumption and around 70% of CO₂ emissions from industry.¹² A new industrial policy is needed to pay special attention to creating specific plans of action in these CO₂-intensive industries.

Further resources:

[Climate Change 2022: Impacts, Adaptation and Vulnerability](#): A report on the assessment of climate change impacts on ecosystems, biodiversity and human communities.

[Industry Net Zero Accelerator](#): A cross-industry collaboration platform to support businesses and other stakeholders to upgrade their net-zero strategies by enabling the dissemination of knowledge, best practices and experience.

[Net-Zero Challenge: The supply chain opportunity](#): A report focusing on upstream supply-chain emissions.

2.2 Enhancing supply chain transparency and resilience

What is the challenge?

In times of frequent production shocks and high inflation rates, the main challenge is to find the right balance between economic efficiency and resilience.

Manufacturing firms provide goods critical to life, the economy and national security. From food and medicines to fertilizers, and from machinery for energy production to communications infrastructure, the shifting realities of the international production system have impacted the realities of most individuals' lives over the past five years.¹³

Approaches such as lean manufacturing and just-in-time production have been extremely effective at helping firms to reduce costs by minimizing work-in-progress, lead times and inventories. Approaches such as these have bolstered the profitability and efficiency of production but leave it highly susceptible to material and component disruptions along supply chains.

During the COVID-19 pandemic, countries across the globe experienced key product shortages – including but not limited to semiconductors, critical minerals and medical supplies. This revealed the need to better understand the vulnerabilities facing manufacturing supply chains,¹⁴ especially as manufacturing supply chain resilience is increasingly seen as an integral element of national security.

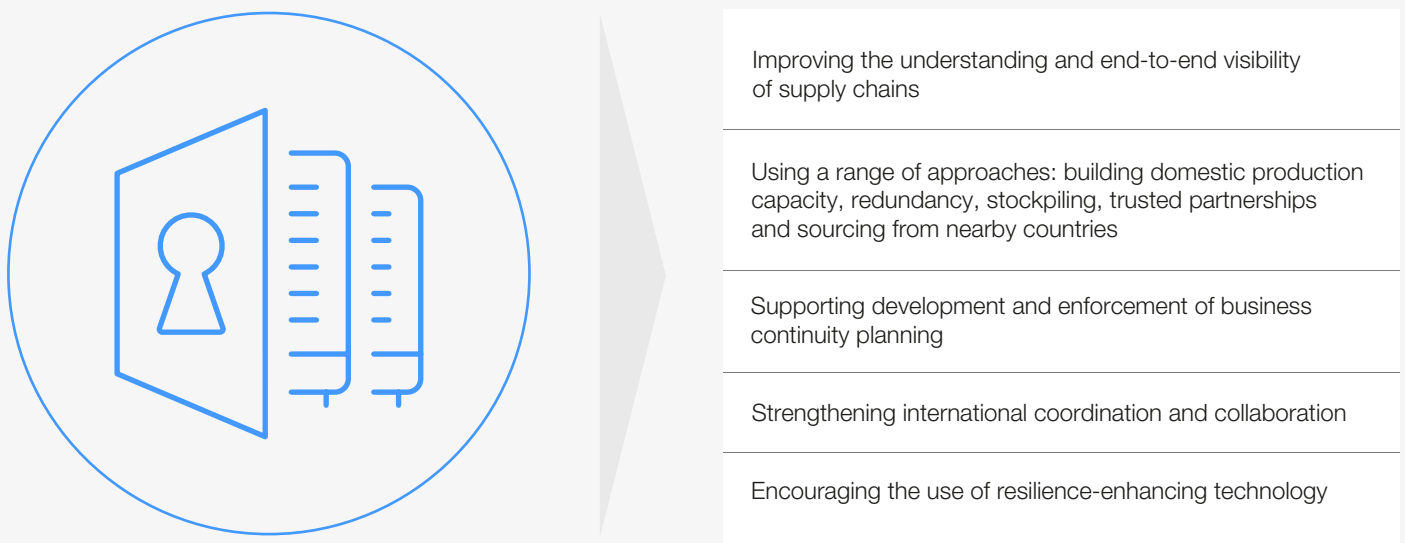
At the same time, geopolitical tensions and weather-related events are increasing the frequency of global disruption. It is no longer a question of whether disruptions will happen, but when. To best serve their consumers and constituents, supply chains must adapt and transform in anticipation of future disruptions.

Faced with the challenge of enhancing the resilience of manufacturing supply chains, many countries are debating about maintaining adequate stocks of life-saving products and retaining minimum levels of “sovereign” production capacity.¹⁵

Inventories, however, represent money and resources that are not being put to good use, and it is unrealistic for countries to produce all types of essential goods regardless of demand fluctuations. At the same time, a global, circular economy is only possible through an optimized management of manufactured goods – whether it is extending the shelf life, reusing, repurposing or eliminating need altogether.

Finally, cyberattacks are now a growing concern for the continuity of business operations. An increase of digitalization in manufacturing, while good, must balance risk, with special attention to cyberattacks and IT systems failure.

FIGURE 2 Enhancing supply chain transparency and resilience



What are the key areas of collaboration for the public and private sectors?

Since the start of the pandemic, supply chain shocks have been felt beyond manufacturers and governments, down to the household level. To better serve consumers and constituents alike, a more proactive response is required from the public and private sectors by:

Improving the understanding and end-to-end visibility of supply chains: Going forward, companies with better visibility of supply chains and their pain points will be better positioned to actively respond to disruptions, and supply chain data can further inform private and public sector actions. The public and private spheres can come together to identify current and future supply chain risks, analyse limitations in the processes of handling, transport and storage, and plot possible future methods and routes to avoid disruption.

Using a range of approaches: To ensure the supply of essential goods, companies must reconsider how they build domestic production capacity, redundancy, stockpiling, trusted partnerships and sourcing from nearby countries. Firms and governments should consider an extensive cost-benefit analysis of all the various approaches in conjunction.¹⁶ Governments can work with the private sector by clarifying the scope of essential products, providing advance visibility of procurement strategies, defining stockpiling needs, agreeing paths to increased production, and developing stress tests that assess and address vulnerabilities across supply chains. National supply chain task forces bringing together the public and private sectors can be effective for coordinating emergency supply, production and distribution.¹⁷ In addition to preparatory measures, flexible legislation may be required for emergency situations.

Supporting development and enforcement of business continuity planning: Policy-makers have the opportunities to work with the private sector to promote business practices, such as business continuity planning, which reduce the risks of supply

chain disruptions and minimize their impacts when they do occur. The Guidelines for Multinational Enterprises of the Organisation for Economic Co-operation and Development (OECD), for example, provide recommendations for companies to anticipate and respond to future shocks and expect companies to conduct due diligence of the risks associated with their operations and supply chains.¹⁸ Governments can support private sector efforts by providing advisory services and trainings on business continuity planning to the most vulnerable firms, with emphasis on small and medium enterprises.¹⁹

Strengthening international coordination and collaboration: Some actions to facilitate the flow of essential goods require collective action among governments, firms and international organizations. For example, fostering common approaches that include procedures and international standards that facilitate the flow of essential goods requires coordinated international buy-in. Increasingly complex products and processes require collaboration, especially since some key raw materials are concentrated in a handful of countries. International collaboration that uplifts nations and enables resilient supply chains is thus ever more critical.

Encouraging the use of resilience-enhancing technology: Motivated by boosting the productivity and growth of industrial digitization over the past decade, the manufacturing landscape has become increasingly competitive. The pandemic has accelerated the adoption and application of digital technologies with the potential to enhance supply chain resilience. Digital technologies of various levels of complexity can enable real-time monitoring and information exchange among actors in the chain, increase production flexibility, and enable remote working and workspace reconfiguration. Governments can work with industry to encourage technology adoption through several instruments such as technical advisory services, technology adoption incentives and digital skills development programmes.

Further resources:

[Sendai Framework for Disaster Risk Reduction 2015-2030](#): A report on seven targets and four priorities to reduce and prevent disaster.

[Fostering Economic Resilience in a World of Open and Integrated Markets – Risks, Vulnerabilities and Areas for Policy Action](#): A report that identifies three policy options for cooperation for strengthening the resilience of global supply chains, particularly for essential goods.

[Adding the Resilience Dimension to Industrial Policy: Lessons from COVID-19](#): Guidance on the future of industrial policy in a post-pandemic world.

[Navigating Global Value Chain Disruption](#): An initiative supporting companies and governments in navigating disruptions to global value chains.

[Circular Operations and Value Chains through Traceability](#): An initiative bringing together stakeholders across the manufacturing sector to drive the transformation from linear to circular value chains.

2.3 Speeding up scale-up and adoption of new technologies

What is the challenge?

Materializing the full value of innovation poses a dual challenge for the global manufacturing community. On one hand, the challenge is that new technology solutions that have been proven but are still at the demonstration or prototype stage today need to be scaled up. On the other, the broad deployment in industry of technologies already available in the market needs to be accelerated.

Nowhere is the scale-up challenge clearer than in the case of novel low-carbon production technologies. More than 60% of the mitigation needed urgently relies on technologies that are not yet available at scale.²⁰ Some of the most pressing needs concern the scale-up of advanced batteries, hydrogen electrolyzers and direct air capture and storage.²¹

Manufacturing scale-up challenges also exist in other fields, from biotechnology and advanced materials to nanotechnology and quantum computing. All of these hold the promise of improved efficiency, processes and products with more advanced functionalities.

However, businesses cannot simply rely on scaling new technologies. Reaping the benefits of innovation also requires broad deployment in industry. Many firms, especially smaller ones, are unable to use even existing technologies due to the lack of technical capabilities, uncertainty about the business case, capital shortage or simply resistance to change.²²

Such adoption barriers are evident in the case of digital technologies. Not only are these technologies becoming more affordable and more widely accessible, they are also being prioritized by governments around the world. However, their industrial adoption is still relatively limited, particularly in developing countries. An especially challenging barrier is the cost and technical complexity involved in integrating new digital technologies on top of existing legacy systems. Similarly, when companies have installed capital-intensive and long-lived equipment, they are reluctant to deploy innovative low-emissions technologies.

FIGURE 3 Speeding up scale-up and adoption of new technologies



Bringing together the expertise of actors across the manufacturing system

Establishing collaborative linkages with a range of research actors

Providing demonstration facilities and supporting networks for knowledge exchange

Providing technical assistance to help manufacturers adopt new technologies in current production lines and retrofit legacy systems

Investing in enabling infrastructure

Partnering with research institutions and industrial networks in developing countries

What are the key areas of collaboration for the public and private sectors?

Government policies should play a crucial role in shortening the time needed to bring new technology to mass production and to diffuse it widely.²³ This goal will require new linkages and partnerships in some key areas, including:

Bringing together the expertise of actors across the manufacturing system:

While public-private partnerships have received attention for many years, new connections are important throughout the manufacturing ecosystem. Manufacturers should gather insights and expertise from a range of actors such as users, shop floor technicians, suppliers and designers, in addition to traditional voices such as industrial researchers and engineers.²⁴

Establishing collaborative linkages with a range of research actors:

In some situations, the scale-up of new technologies will go beyond the scope of a single institute or research group. The collaboration of facilities, tools and expertise among the likes of university research centres, technology centres, national laboratories and metrology labs will facilitate and strengthen the industry's transformative journey.²⁵

Providing demonstration facilities and supporting networks for knowledge exchange:

As manufacturing technologies progress to greater scale and levels of complexity, demonstrating the technical feasibility of products and processes embodying these technologies encourages their

uptake. Dedicated research environments that include demonstration facilities – such as pilot lines, test beds and factory demonstrators – will play a key role in helping to de-risk the adoption of emerging technologies. Additionally, they will play a crucial role in supporting networks for knowledge exchange among industry, government and academia.

Providing technical assistance for adoption in current production lines and retrofitting of legacy systems:

Technology adoption is a process fraught with challenges, and public-private efforts must support smaller firms in particular. Business services and public technology centres, for example, can take the lead in supporting manufacturers in adopting new technologies in their current production lines and in integrating them on top of existing processes and legacy systems.

Investing in enabling infrastructure: Enabling infrastructure, especially expanding the coverage and quality of digital infrastructure, is needed. This is particularly true in developing countries.

Partnering with research institutions and industrial networks in developing countries:

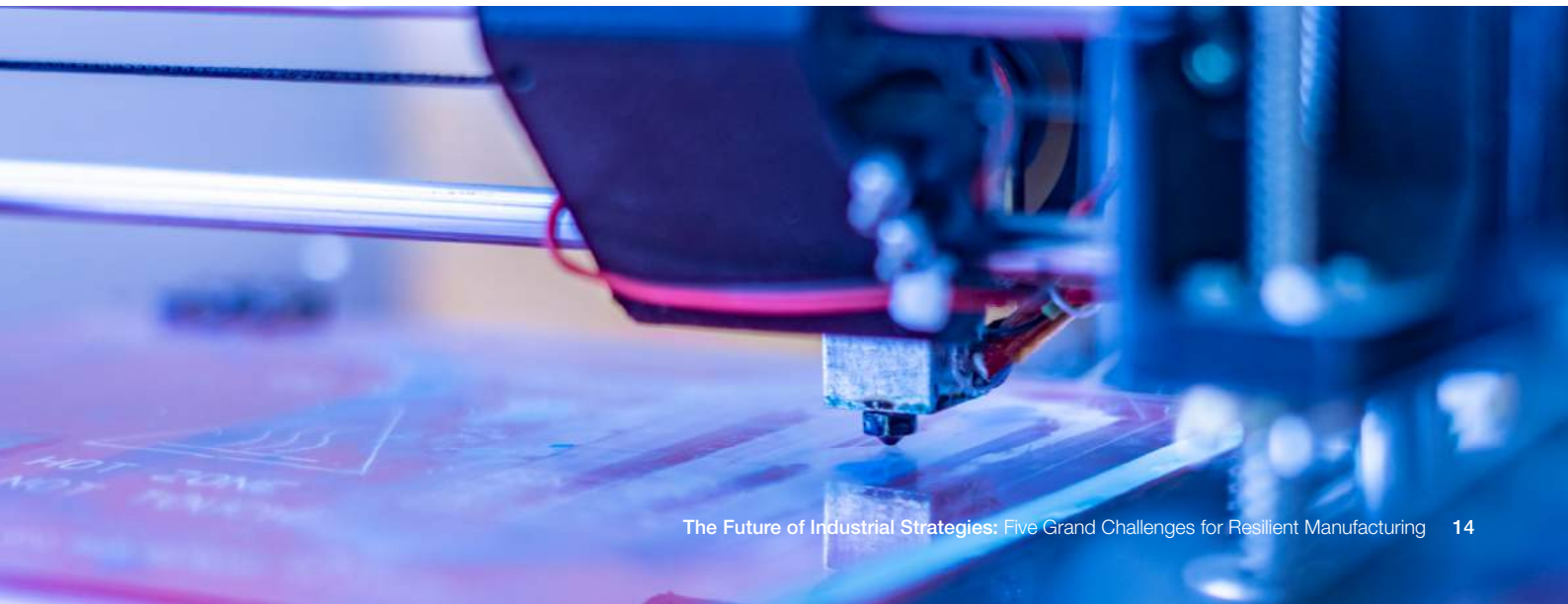
Knowledge transfer from first-mover countries is also crucial for growth. High-income countries can support and benefit from the global diffusion of low-carbon products, processes and energy systems by helping build capacity and partnering with research institutions and industrial networks in developing countries.

Further resources:

[Accelerating the Development and Diffusion of Low-Emissions Innovations](#): A report taking a collaborative look at how to best enable the shift towards net zero emissions.

[Institutions for Technology Diffusion](#): A technical note analysing public technology extension service programmes.

[Global Lighthouse Network](#): A community initiative demonstrating leadership in using Fourth Industrial Revolution technologies in manufacturing.



2.4 | Securing the future of the manufacturing workforce

What is the challenge?

For manufacturers in developed countries and emerging markets, securing a skilled workforce fit for the future is one of the most pressing challenges reported.

Despite the association so commonly made between new technologies and job losses, evidence suggests that concerns around a jobless future have been exaggerated. In fact, new technologies are creating new jobs, sometimes at an even faster pace than previous trends.²⁶

However, it is true that new technologies will need employees to have more skills. As the demand for advanced skills is rising, manufacturers are already struggling to recruit and retrain a talent pool that can complement the deployment of new technologies.

Developing digitally enabled products and processes, for example, require workers who have new multidisciplinary competencies combining mechanics, electronics and software. New roles in information management are emerging, requiring proficiency in forms of modelling, simulation tools and data analytics across the value chain. Operations management increasingly requires complex system thinking, problem-solving and wider sets of non-technical skills such as cross-disciplinary and cross-geographical collaboration.

Cybersecurity competencies are becoming more important as processes and machines become increasingly connected to the internet.²⁷

The growing demand for customized products means that design and production engineers are required to communicate and respond much quicker to a wider variety of product specifications. To address “mass customization” challenges, new technician roles will be required to design, operate and upgrade flexible products and production systems, often combining multiple technologies in single machines and operations. Due to this demand, product designers are expected to make more intensive use of emerging technologies such as virtual reality.

Coupled with the need to train and educate a new workforce, outdated public perceptions are working against manufacturing companies. While the narrative is changing in some countries, manufacturing is perceived as intensive, repetitive, dangerous and low-paid physical labour.²⁸ In particular, developing countries face skill shortages associated with fragmented education and training systems. Juxtaposed against this are developed economies with rapidly ageing populations. As a result, despite the exciting career opportunities offered by the manufacturing sector, firms struggle to attract talent.

FIGURE 4 | Securing the future of the manufacturing workforce



Building stronger relationships between employers and training providers

Supporting on-the-job training and apprenticeships

Challenging outdated public perceptions of manufacturing

Broadening and diversifying the demographic base of the manufacturing workforce

Placing workers at the core of technology adoption

Offering reskilling and upskilling programmes, particularly to vulnerable groups

Establishing safety nets to support those losing their jobs and enabling a just transition

What are the key areas of collaboration for the public and private sectors?

Reaping the benefits of innovation requires feedback loops between technicians, engineers and managers that actively engage in managing products, processes and supply chains. As such, industrial strategies and skill development policies need to be mutually reinforcing. Key action areas for public and private sector collaboration include:

Building stronger relationships between employers and training providers: The fact that more people are leaving the industrial workforce than entering it calls for stronger relationships between employers and vocational trainers.

Supporting on-the-job training and apprenticeships: The rapidly changing nature of manufacturing highlights the need to have a system that responds to new skill requirements in a timely manner. A more dynamic ecosystem of education and training, accounting for different levels of skills and experience, and tailored to a diversity of sectors, is required. To maintain a competitive talent advantage, on-the-job training, apprenticeships and new ways of leveraging technology and apprenticeships will require greater collaboration across the workforce ecosystem – including government agencies, education providers and workers' representatives.

Challenging outdated public perceptions of manufacturing: More needs to be done to communicate that manufacturing is not a thing of the past but in fact provides exciting opportunities for those interested in cutting-edge technologies. The pivotal role that manufacturing industries will play in combatting societal challenges such as climate change and health needs to be accentuated. As industrial policy paves the way for a more sustainable future, those involved in its creation, from governments to industry, can play a critical role in rebranding the narrative around those in the industrial workforce.

Broadening and diversifying the demographic base of the manufacturing workforce: Part of the success of curating a manufacturing workforce with the right skillset will be the ability to increase its diversity and bringing in women, older people, immigrants and young people in transition from school to working life.

Placing workers at the core of technology adoption: A culture that places workers at the core of technology adoption is crucial.²⁹ Collaboration between humans and machines depends on efficient and safe interactions designed to empower and augment workers' capabilities. For example, utilizing the integration of tools like process sensing or analytics with augmented/virtual/extended reality (AR/VR/XR) can provide continuous, real-time feedback for workers.³⁰

Offering reskilling and upskilling programmes, particularly to vulnerable groups: To ensure that technological change does not deepen inequalities, workforce reskilling and upskilling programmes must pay particular attention to vulnerable groups. Enhanced safety nets must be put in place to support those losing their jobs.³¹

Establishing safety nets to support those losing their jobs and enabling a just transition: Creating the best possible outcome for laid-off employees is a shared responsibility of the private sector, government and academia. Safety nets, such as unemployment insurance, are key in the short-term, and should be coupled with training and educational opportunities that enable a quick re-entry into the workforce. Opportunities like these pair well with national strategies like bolstering a skilled workforce or upskilling for advanced technology operators.³²

Further resources:

[What Happened to Jobs at High Risk of Automation?:](#) A study examining jobs over the past decade perceived to be at risk of automation.

[Manufacturing the Future Workforce:](#) An international study linking workforce development and innovation.

[Augmented Workforce: Empowering People, Transforming Manufacturing:](#) A report highlighting augmentation technologies assisting in the creation of a more inclusive and productive workforce.

[Augmented Workforce Initiative:](#) An initiative to balance autonomous systems, productivity and workforce empowerment.

2.5 Linking business values with social and environmental responsibility

What is the challenge?

As consumers' and governments' demand for sustainable business grows, the main challenge is to identify the business cases that offer a profitable balance between the costs of corporate social responsibility practices and the payoffs from new business opportunities involving social and environmental responsibility.

Given current trends, corporations are increasingly required to examine their broader contributions as socioeconomic actors. In addition to environmental accountability, manufacturers are expected to raise the standards of social development, help tackle growing inequality and set a high bar for respect of workers' fundamental rights.

In doing so, they are also expected to embrace open governance, while reconciling the interests of stakeholders including employees, shareholders, investors, consumers, public authorities and civil society groups.³³

Historically, manufacturing has been dubbed the “key to prosperity” due to its unique potential to contribute to productivity, trade and, more generally, economic development.³⁴ The economic effects of geopolitical disruptions like the COVID-19 pandemic have reinvigorated the debate about the role of manufacturing industries in national economic recovery and long-term growth. Yet, given the current pace, key milestones including Sustainable Development Goal 9, which includes the target to significantly increase industry's share in employment and GDP, with special metrics for least developed nations, will not be achieved.

Traditionally, manufacturing has also been seen as a source of well-paid jobs for workers with different levels of education, including those without a university degree.

However, manufacturing jobs held by women – like in other sectors of the economy – tend to be lower paid than their male counterparts'. Additionally, women remain severely under-represented in managerial positions.³⁵

The COVID-19 pandemic has further exposed societal inequalities, affecting certain population groups disproportionately, including the self-employed, women and working people at both ends of the age curve. It is imperative that conversations around social responsibility keep in mind historical disparities and include roadmaps for parity moving forward.

The safety challenges that industry faces are pressing. Almost 3 million deaths are directly attributed to inadequate safety measures and hazardous work environments across the world every year. Work-related safety incidents result in the loss of approximately 3.9% of annual global GDP.³⁶

Technological change can exacerbate this challenge. As industries intensify the use of digitalized industrial systems enabled by computer vision, data analytics and artificial intelligence (AI), new sources of psychosocial risks are emerging that pose a risk to workers' mental well-being.

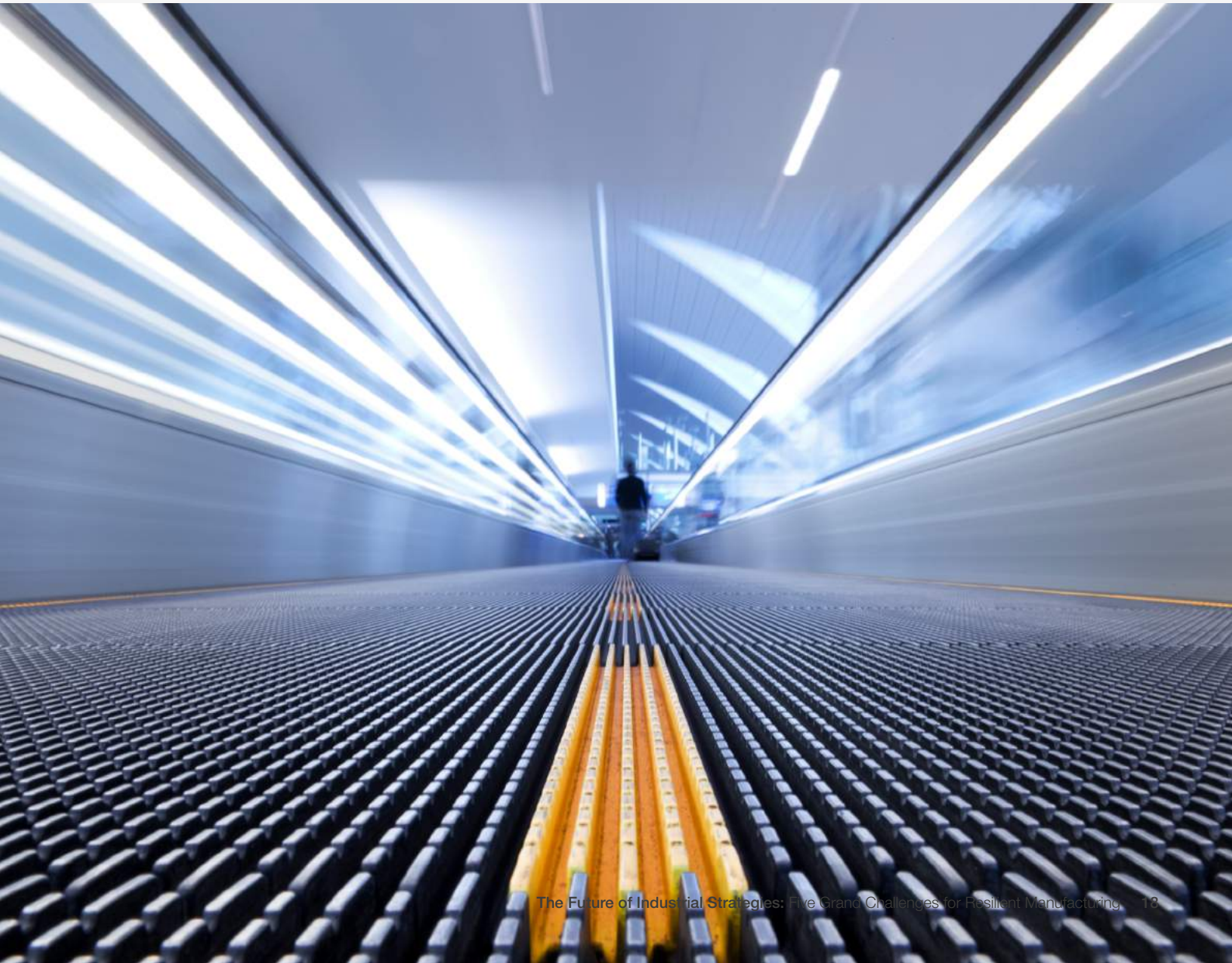
In a landmark decision, the International Labour Conference added safety and health to the Fundamental Principles and Rights at Work in June 2022. This promotes a human-centred approach to the future of work and calls for a renewed vision of the role of workers that keeps up with the pace of technological change.³⁷ To achieve the United Nations' 2030 agenda for the Sustainable Development Goals (SDGs), specifically SDG3 (good health and well-being) and SDG8 (decent work and economic growth), exposure to occupational risk factors and attributable health loss must be minimized and in fact eliminated.³⁸



FIGURE 5 | Linking business values with social and environmental responsibility



- Decreasing gender disparities and promoting diversity in the manufacturing sector
- Ensuring the safety, ethics and regulatory security of new technologies
- Using solutions such as predictive maintenance, drones and data analytics to reduce workers' exposure to safety risks
- Exploring the potential of new forms of corporate ownership and governance



What are the key areas of collaboration for the public and private sectors?

Firms on the frontlines of resource use, product development and labour relations must take a lead in developing socially responsible production and consumption frameworks. Governments must work closely with them on the following action areas:

Decreasing gender disparities and promoting diversity in industrial development: If properly designed and implemented, industrial strategies can cut away at existing gender-based discrimination and empower women in the workforce. Diversity at the workplace leads to high performance, improved decision-making, and ultimately, greater output.³⁹

UNIDO has identified the need to strengthen efforts to (a) promote equal opportunities for women and men to engage in agriculture-based value chain development; (b) address gender-related constraints to the transformation from informal to formal businesses; (c) strengthen women's entrepreneurial and technical skills, access to technologies, business support services, advocacy and self-help networks; and (d) integrate gender dimensions in interventions made after any disruptive events.⁴⁰

Ensuring the safety, ethics and regulatory security of new technologies: The fast-paced technological development under way today requires certification and regulation to ensure its safety, ethics and security. Foresight studies can help anticipate the opportunities and challenges

associated with these technologies.⁴¹ Governments are uniquely positioned to lead national, regional and global collaboration to propose, review, adopt and regulate new guidelines and standards for industrial safety. Countries must invest in their national occupational safety and health (OSH) infrastructure across all elements: regulation, compliance, data, qualifications and specialized services.

Using solutions such as predictive maintenance, drones and data analytics to reduce workers' exposure to safety risks: Companies must treat safety as a key management issue, improve compliance with legislation and understand the interlinkages between safety and company performance. Technology-enabled solutions such as predictive maintenance, drones and data analytics can reduce the exposure of workers to safety risks and prevent accidents.⁴²

Exploring the potential of new forms of corporate ownership and governance: Finally, businesses should explore the opportunity for new forms of corporate governance and ownership, such as social enterprises. They should consider actions such as establishing a social or environmental mission as the overall goal of the organization, limiting disparities in the pay structure of the firm, ensuring transparency and fairness in hiring processes, and including environmental concerns in their procurement decisions, among other good practices.

Further resources:

[Women's Empowerment Principles](#): A set of principles offering guidance on how to promote gender equality and women's empowerment in the workplace, marketplace and community.

[The Economic Dividends for Gender Equality Certification \(EDGE\)](#): A global initiative to create an assessment methodology and business certification standard for gender equality.

[OECD Due Diligence Guidance for Responsible Business Conduct](#): A report that provides recommendations to help enterprises minimize the adverse impacts of their operations, supply chains and other business relationships.

[OK Computer? The safety and security dimensions of Industry 4.0](#): A report summarizing security risks and offering insights into strategies to address matters of safety and security.

[Global Initiative for Future Industrial Safety](#): An initiative to encourage practices of safety through best practices, policy and manufacturing capabilities.

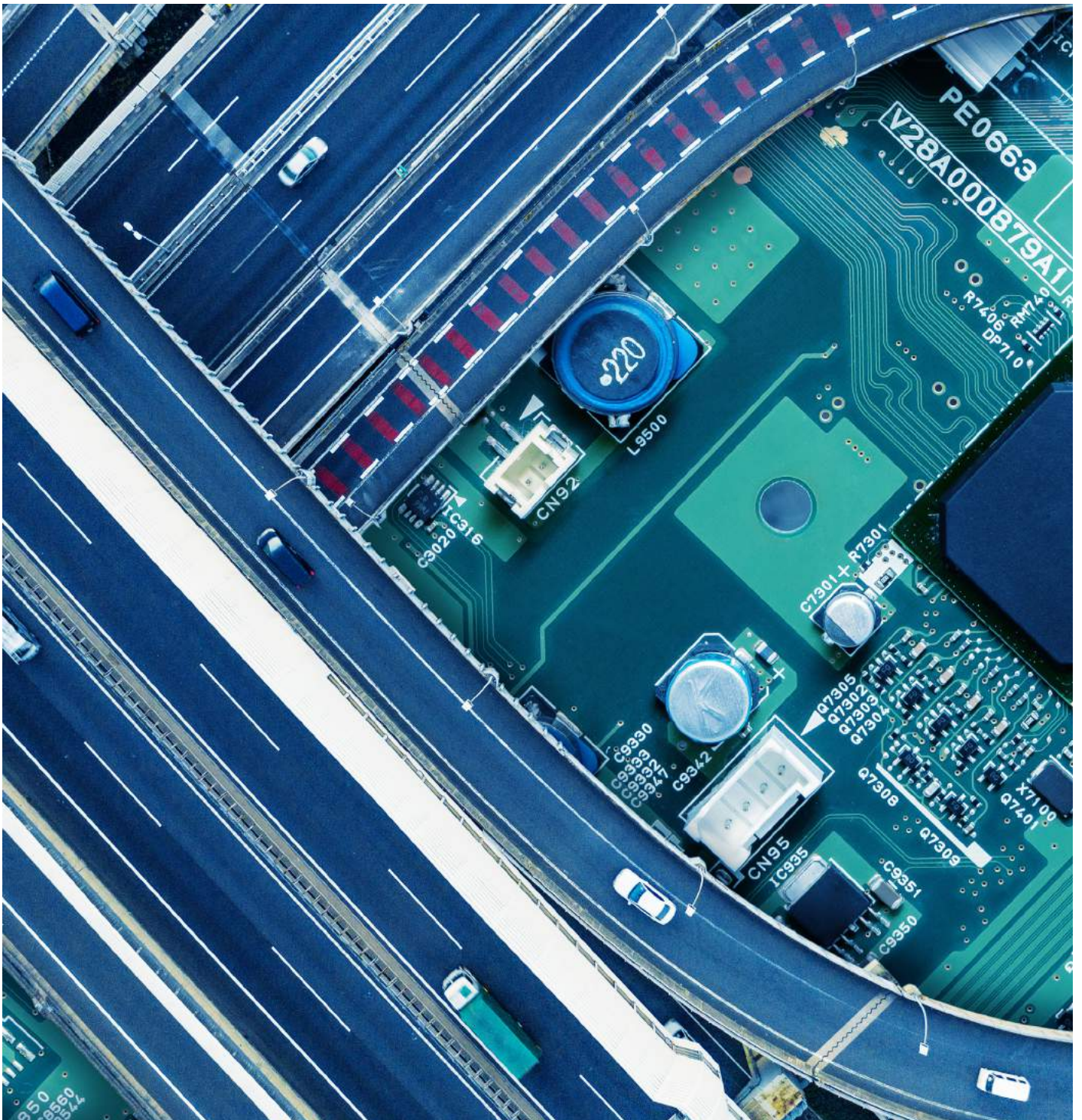
[Unlocking Innovation and New Business Models](#): An initiative to shape more sustainable, resilient and inclusive ways of driving value for all stakeholders.

[Ramping up Africa's Vaccine Manufacturing Capability is Good for Everyone. Here's Why](#): A report on how to sustainably expand Africa's vaccine industry that examines regional and global benefits.

3

Towards a future strategy agenda

This paper suggests some initial steps for collaboration and the actions that can be taken in response to the five grand challenges facing the manufacturing ecosystem.



A successful strategy for the future of competitive manufacturing requires answering key questions, including which policy responses industry and governments should prioritize and how those responses are applicable in respective country contexts.

Action must be taken in consultation with manufacturers. As the five challenges require new approaches, including sizeable investments from governments, the allocation of capital must be responsible and feasible. Building resilience by incorporating social responsibility in new business models, fostering environmental transitions, upskilling workforces and preparing for other disruptions may not produce immediate returns; however, these investments will pay off over time. Understanding which responses are most important for balancing future competitiveness and achieving national goals thus remains a crucial component of any industrial strategy.

Governments and industry must tailor policy to their domestic contexts. For example, material substitution, in some contexts, may be best achieved through taxes and subsidies, while other contexts require awareness-raising campaigns. The type of policies depends on a myriad of factors, including maturity of the respective industry, behavioural insights and national priorities. Hence, even if governments identify their most important responses, the question of how to adapt and transform in a specific context remains paramount.

Identifying which policies work in a given context requires an understanding of local conditions and needs, as well as access to best practices and a shared thought community.

As this initiative moves forward, the goal is not to provide one-size-fits-all approaches but to use initial insights from discussions with governments and companies as a knowledge repository on which strategy design and development can be based. This work will gather expertise and experiences, offer a knowledge-sharing mechanism, and, as the initiative progresses, communicate insights through easy-to-access tools.

In concrete terms, the next steps will be to carry out consultations with stakeholders to gather experiences on what has worked well in the past, how governments prioritize among existing options, and what action to take differently moving forward. This in-depth exploration will reveal which factors, mechanisms and processes are most important for designing successful industrial strategies.

A coordinated and inclusive approach to addressing the five grand challenges facing the manufacturing ecosystem is the fastest way to establishing industrial policies that can adapt to new challenges while achieving parity between economic and societal success. By providing leaders in the manufacturing ecosystem with the ability to share knowledge and spark discussion, this initiative will foster the industrial policies of tomorrow.



Contributors

World Economic Forum

Maria Basso

Platform Curator, Shaping the Future of Advanced Manufacturing and Value Chains

Francisco Betti

Head, Shaping the Future of Advanced Manufacturing and Value Chains

Memia Fendri

Community and Initiatives Lead, Shaping the Future of Advanced Manufacturing and Value Chains

Kyle Winters

Community and Initiatives Specialist, Shaping the Future of Advanced Manufacturing and Value Chains

Francesca Zanolla

Community and Initiatives Specialist, Shaping the Future of Advanced Manufacturing and Value Chains

Cambridge Industrial Innovation Policy, University of Cambridge

Mateus Labrunie

Policy Analyst, Policy Links Unit, IfM Engage

Carlos López-Gómez

Head, Policy Links Unit, IfM Engage

United Nations Industrial Development Organization

Nobuya Haraguchi

Chief, Research Unit

Alejandro Lavopa

Coordinator, UNIDO Industrial Development Report

Stefan Pahl

Officer, Impact and Innovation

Adnan Seric

Manager, Innovation Lab

Partner organizations

ABB Ltd

Analog Devices

Coherent

Flex

Magic Leap

Rockwell Automation

Siemens

Western Digital

Endnotes

1. World Economic Forum, *Navigating Global Value Disruption*, 2021, https://www3.weforum.org/docs/WEF_Navigating_Global_Value_Chains_Disruptions_2021.pdf.
2. World Economic Forum, *Taking Big Leaps in Value Chain Resilience - adaptation and transformation*, 2022, <https://www.weforum.org/agenda/2022/09/taking-big-leaps-in-value-chain-resilience-adaptation-and-transformation/>.
3. United Nations Industrial Development Organization, *Industrial Development Report*, 2020, <https://www.unido.org/sites/default/files/files/2019-12/UNIDO%20IDR%20main%20report.pdf>.
4. Jinzhu Zhang et al., *The Impact of Digital Economy on the Economic Growth and the Development Strategies in the Post-Covid019 Era: Evidence from Countries Along the "Belt and Road"*, 2022, <https://www.frontiersin.org/articles/10.3389/fpubh.2022.856142/full>.
5. Sophie Boehm et al, *State of Climate Action 2021*, https://files.wri.org/d8/s3fs-public/2021-10/state_climate_action_2021.pdf?VersionId=QBSICe3wSIKmOHc1rYyhdX3j3iSCqual.
6. Angela Anderson, Katie Lebling, Zachary Byrum and Carrie Dellensky, *A New Industrial Revolution for a Livable Climate*, <https://www.wri.org/insights/decarbonize-us-industry>.
7. Ibid.
8. International Energy Association, *Net Zero by 2050: A Roadmap for the Global Energy Sector*, <https://www.iea.org/reports/net-zero-by-2050>.
9. Climate Change Committee, UK, *The Sixth Carbon Budget - Manufacturing and Construction*, 2020.
10. The European Cement Association, *In Brief: Raw Material Substitution*, 2018, <https://lowcarboneyconomy.cembureau.eu/5-parallel-routes/resource-efficiency/raw-material-substitution/>.
11. Sophie Boehm et al., *State of Climate Action 2021*, https://files.wri.org/d8/s3fs-public/2021-10/state_climate_action_2021.pdf?VersionId=QBSICe3wSIKmOHc1rYyhdX3j3iSCqual.
12. International Energy Association, *Net Zero by 2050: A Roadmap for the Global Energy Sector*, <https://www.iea.org/reports/net-zero-by-2050>.
13. Carlos López-Gómez et al., *Adding the resilience dimension to industrial policy: Lessons from COVID-19*, <https://www.unido.org/api/opentext/documents/download/25404127/unido-file-25404127>.
14. The United Nations Industrial Development Organization, *Industrial Development Report 2022*, <https://www.unido.org/sites/default/files/files/2021-11/IDR%202022%20-%20EBOOK.pdf>.
15. European Parliament, *Resilience of global supply chains: Challenges and solutions*, [https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698815/EPRS_BRI\(2021\)698815_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698815/EPRS_BRI(2021)698815_EN.pdf).
16. UK Parliament, *Economic Impact of COVID-19 on Trade and Investment*, <https://publications.parliament.uk/pa/cm5801/cmselect/cm/trade/286/28602.htm>.
17. Carlos López-Gómez et al., *Adding the resilience dimension to industrial policy: Lessons from COVID-19*, <https://www.unido.org/api/opentext/documents/download/25404127/unido-file-25404127>. <https://www.unido.org/api/opentext/documents/download/25404127/unido-file-25404127>.
18. Organisation for Economic Co-operation and Development, *OECD Guidelines for Multinational Enterprises*, 2011, <http://mneguidelines.oecd.org/guidelines/>.
19. The United Nations Industrial Development Organization, *Industrial Development Report 2022*, <https://www.unido.org/sites/default/files/files/2021-11/IDR%202022%20-%20EBOOK.pdf>.
20. Sophie Boehm et al., *State of Climate Action 2021*, https://files.wri.org/d8/s3fs-public/2021-10/state_climate_action_2021.pdf?VersionId=QBSICe3wSIKmOHc1rYyhdX3j3iSCqual.
21. International Energy Association, *Net Zero by 2050: A Roadmap for the Global Energy Sector*, <https://www.iea.org/reports/net-zero-by-2050>.
22. W.M. Cohen and D.A. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, 1990, Vol. 35, No. 1, Special Issue: Technology, Organizations, and Innovation, pp. 128-152.
23. P. Shapira and J. Youtie, "Institutions for Technology Diffusion and the Next Production Revolution" in *The Next Production Revolution: Implications for Governments and Business*, pp 243-275, Organisation for Economic Co-operation and Development, 2017.
24. Eoin O'Sullivan and Carlos Lopez Gomez, "An international review of emerging manufacturing R&D priorities and policies for the next production revolution" in *The Next Production Revolution: Implications for Governments and Business*, OECD, 2017, pp. 325-360.
25. Ibid.
26. OECD policy brief, *What happened to jobs at high risk of automation?*, <https://www.oecd.org/future-of-work/reports-and-data/what-happened-to-jobs-at-high-risk-of-automation-2021.pdf>.

27. Carlos López-Gómez and Eoin O'Sullivan, *New Skills for New Industries*, Centre for Science, Technology & Innovation Policy (CSTI), University of Cambridge, 2015.
28. OECD policy brief, *What happened to jobs at high risk of automation?*, <https://www.oecd.org/future-of-work/reports-and-data/what-happened-to-jobs-at-high-risk-of-automation-2021.pdf>.
29. World Economic Forum, *Augmented Workforce: Empowering People, Transforming Manufacturing*, https://www3.weforum.org/docs/WEF_Augmented_Workforce_2022.pdf.
30. Executive Office of the President of the United States, *National Strategy for Advanced Manufacturing*, <https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf>.
31. Cambridge Industrial Innovation Policy, *Don't Fear the Robots: How Developing Countries can Prepare for Industry 4.0 and Safeguard Jobs*, <https://www.ciip.group.cam.ac.uk/reports-and-articles/dont-fear-the-robots-how-developing-countries-can/>.
32. The White House, Fact Sheet: Biden-Harris Administration Announces Roadmap for Nature-Based Solutions to Fight Climate Change, *Strengthen Communities, and Support Local Economies*, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/11/08/fact-sheet-biden-%E2%81%A0harris-administration-announces-roadmap-for-nature-based-solutions-to-fight-climate-change-strengthen-communities-and-support-local-economies/>.
33. European Commission, *Green Paper: Promoting a European Framework for Corporate Social Responsibility*, https://ec.europa.eu/commission/presscorner/detail/en/DOC_01_9.
34. United Nations Industrial Development Organization, *Industrial Policy for Prosperity: UNIDO's Strategic Support*, 2011, <https://kji.bit.edu.cn/docs/20150119224011417373.pdf>.
35. United Nations Industrial Development Organization, *UNIDO Guide to Gender Analysis and Gender Mainstreaming the Project Cycle*, 2021, https://www.unido.org/sites/default/files/files/2021.-06/Gender_mainstreaming_Guide_1_Main%20guide.pdf.
36. International Labour Organization, *Social Dialogue Towards a Positive Safety and Health Culture*, https://www.ilo.org/global/topics/safety-and-health-at-work/news/WCMS_842851/lang--en/index.htm.
37. International Labour Organization, *International Labour Conference adds safety and health to Fundamental Principles and Rights at Work*, 2022, https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_848132/lang--en/index.htm.
38. United Nations Industrial Development Organization, *International Conference on Ensuring Industrial Safety: The role of government, regulations, standards and new technologies*, 2019, <https://www.unido.org/sites/default/files/files/2020-01/International%20Conference%20on%20Ensuring%20Industrial%20Safety.pdf>.
39. United Nations Industrial Development Organization, *UNIDO As A Platform to Promote Women's Economic Empowerment and Entrepreneurship*, <https://www.unido.org/sites/default/files/files/2019-10/Leaflet%20UNIDO%20Final.pdf>.
40. United Nations Industrial Development Organization, *Gender Equality and Empowerment of Women Strategy 2016-2019*, https://www.unido.org/sites/default/files/2015-10/GC.16_8_E_Gender_Equality_and_Empowerment_of_Women_Strategy_2016-2019_0.pdf.
41. OECD, *Fostering Economic Resilience in a World of Open and Integrated Markets*, <https://www.oecd.org/newsroom/OECD-G7-Report-Fostering-Economic-Resilience-in-a-World-of-Open-and-Integrated-Markets.pdf>.
42. LR Foundation, *New Global Initiative for Future Industrial Safety*, <https://www.lrfoundation.org.uk/en/news/global-initiative-future-industrial-safety/>.



COMMITTED TO
IMPROVING THE STATE
OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org