Publication of the Low-Carbon Emitting Technologies initiative

WORLD ECONOMIC FORUM

Towards Net-Zero Emissions

Policy priorities for deployment of low-carbon emitting technologies in the chemical industry

WHITE PAPER

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Executive Summary

This document aims to share the **overarching key policy areas** identified by the members of the Collaborative Innovation for Low-Carbon Emitting Technologies (LCET) initiative to enable the **development and upscaling of low-carbon technologies in the chemical sector and related value chains**.

The LCET initiative looks at solutions that can be applied globally. However, in the context of the European Green Deal, this paper is **focusing on the European Union**. The LCET community members welcome the European Commission ambition to fulfil the climate neutrality objective by 2050 and ensure that this is closely linked to a competitive and viable industry.

The LCET members consider the following policy areas are critical to support the large-scale deployment of low-carbon emitting technologies:

- **Access to affordable renewable energy** and a reliable supply as the **key enabler** for the decarbonization of the chemical industry
- Recognition that **all emission reduction saving potential initiatives** (scope 1, 2, 3) are essential for industry to meet the 2050 net-zero emissions ambition
- Implementation of a framework to **honour the emission abatement potential of CCU** (carbon capture and utilization) and **bio-based technologies**
- **Public funding and investment support** needed to maintain the competitiveness and strong technological leadership of the European industry
- Foster a market environment that **rewards supply of low-carbon and circular** products despite the higher complexity of value chains – a climate contribution, for instance, could be effective for increasing economic feasibility, stability and predictability for industry transformation
- **Products' carbon footprint[1] must be considered over the entire value chain**, whether originating from Europe or from abroad, and including end-of-life in a circular economy
- **Global collaboration** is required to finalize the Paris Rulebook at COP26 as Article 6 will create a shared framework for international global carbon markets to collaborate[2]

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1 Chemical industry context

In the global response to climate change, the chemical industry plays a double role. First, it provides essential solutions and products to enable the transition to a net-zero future of other industries and consumers by being highly integrated across different value chains with around 96% of all manufactured goods being touched by chemistry,[3] from transportation to healthcare to shelter to nutrition. Second, the industry itself is on an innovation journey towards net-zero emissions.

Due to global population growth and a growing middle class, it is expected that demand for chemicals and materials will quadruple by 2050 vs 2010 following the growth path of world GDP.[4] It is essential that this demand growth is aligned with a net-zero future and the chemical industry must play its part to enable this.

The chemical industry is already making significant investments in reducing greenhouse gas emissions (GHG) associated with operations and life cycle products. To further fulfil these climate goals, industry and government should work together to promote and encourage the adoption of new low-carbon emitting technologies. Such technologies, however, are in many cases either not even developed or still in R&D phase and, in most cases, are less competitive compared to the established routes in already depreciated assets.

Some 85% of total 1.5 gigatonnes of the chemical industry emissions are energy-related, 15% process-related.[5] Hence, the industry transition will require a significant shift towards renewable energy, which means challenges regarding availability and price of renewable energy. To fulfil the energy needs of the chemical industry, other thermal energy technologies will also need to be considered. This is especially true for the most energy-intensive chemicals, the base chemicals.

The chemical industry has provided, and will continue to provide, its share of GHG emission reduction to support the ambition of the EU to reduce such emissions by 55% by 2030 (compared to 1990 levels) and to become climate-neutral by 2050. To deliver this commitment, the chemical industry has to master two challenges: (1) reliable access to large quantities of competitive emission-free energy; and (2) development and implementation of new technologies that operate on renewable rather than fossil sources of energy and raw material.

In addition, to be able to deliver the objectives of carbon neutrality within the next 30 years, the industry needs to act now, given the long investment cycles in this asset-heavy industry.

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2 Collaborative Innovation for Low-Carbon Emitting Technologies (LCET) initiative

The World Economic Forum's Collaborative Innovation for Low-Carbon Emitting Technologies (LCET) initiative was started in 2019 as a **CEO-led initiative** of climate action champions to **accelerate the development and upscaling of low-carbon emitting technologies for chemical production and related value chains, through a collaborative innovation approach**. The ambition of the initiative is to set the industry on a path to net-zero emissions by 2050.

The LCET initiative is part of the Mission Possible Partnership, a broader international coalition working to decarbonize heavy industry and transport sectors (aluminium, concrete, chemicals, steel, aviation, shipping and trucking), leveraging the power of a broader coalition of organizations focused on the net-zero transition.

The following **five LCET technology clusters** have been created in parallel to **assess the potential of those groups of technologies for the reduction of GHG emissions** in industry and to foster the formation of alliances for the collaborative implementation of the prioritized technologies, potentially structured as joint ventures, start-ups, consortia and others:

- Carbon capture and utilization
- Biomass utilization
- Electrification
- Alternative hydrogen production
- Waste processing

The LCET initiative members are analysing how these groups of technologies can be complementary, when they could be developed and upscaled, and under which technical and economic conditions. These technical studies and concrete technology development analyses will, therefore, **help to close data and knowledge gaps on technologies**, which will need to be addressed **to enable informed policy and funding decisions**.

With the engagement of 60+ chief technology officers, technology senior vice-presidents and senior technology experts, each technology cluster advances the actions identified, such as **joint techno-economic studies for potential spin-off projects** (e.g., demonstration plants, R&D hub) and cross-technology collaborative activities focusing on **shaping the enabling environment** (e.g., access to renewable energy and alternative feedstocks). In addition to the core technical working groups, policy and financing workstreams have recently been created as enablers for the low-carbon technology developments at scale, leveraging opportunities for dialogue and collaborative action with key policy-makers and financial institutions.

As there is no silver bullet for the chemical industry GHG emissions reduction, and technology development may not always be successful, **multiple technologies need to be explored**.

As indicated above, most of the potential projects based on low-carbon emitting technologies proposed and assessed are commercially unfeasible under current market conditions. For them to work, completely new business models, large investments and probably new funding mechanisms stimulated by a supporting policy framework will be required. Considering the urgency for climate action, **sharing knowledge, engagement and collaboration** between the chemical industry and policy-makers is essential for the development and large-scale deployment of low-carbon emitting technologies.

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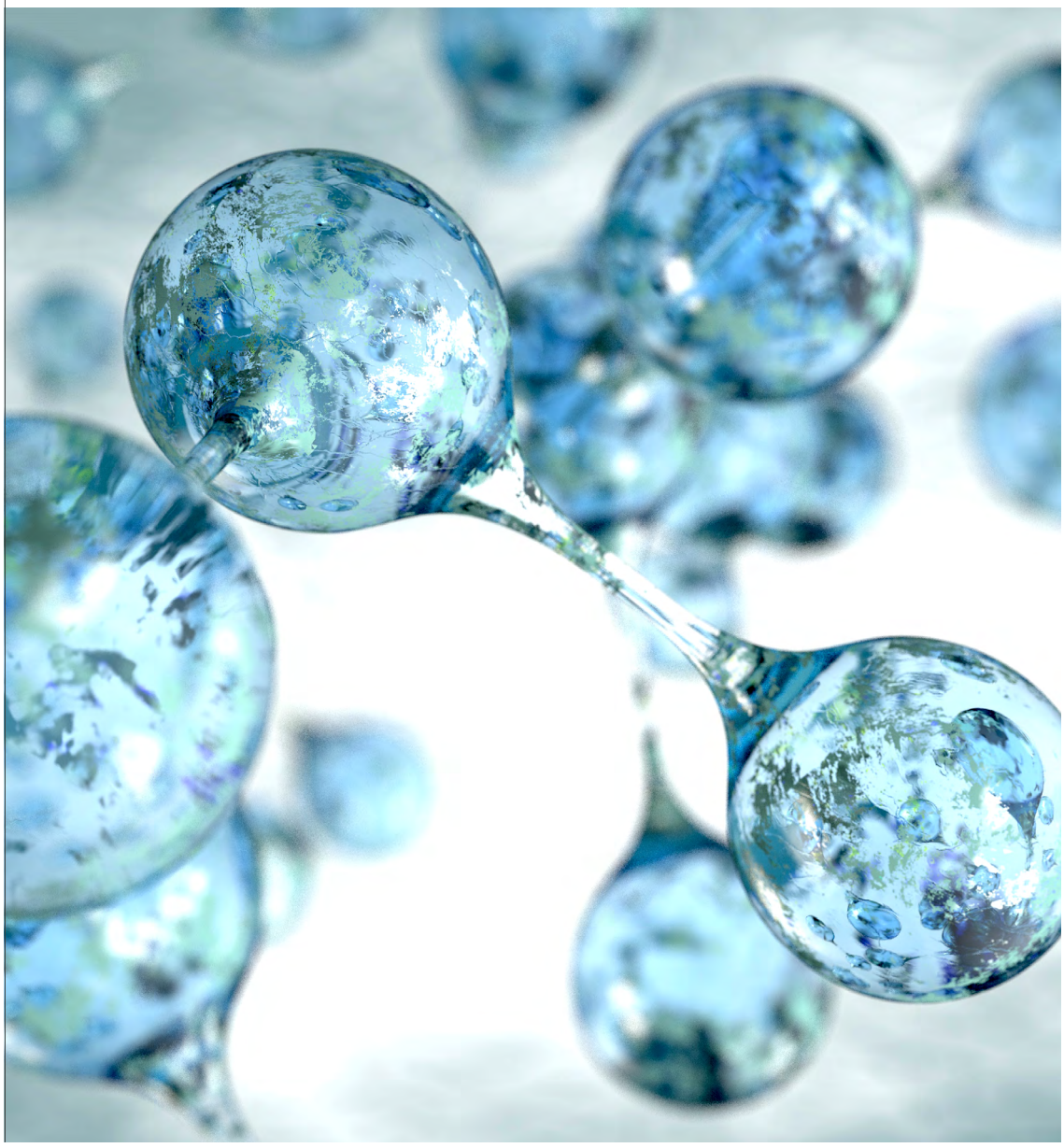
3 Overview of key policy areas identified



3.1 Access to affordable renewable energy

Renewable energy is the key enabler for the decarbonization of the chemical industry. For industrial use, electricity from renewable resources will be the mode of "green" energy in the near future and until 2050 and beyond. Hydrogen, either as low-carbon ("blue") hydrogen produced SMR + CCS or electrolyser and renewable ("green") hydrogen (produced from green electricity) will serve as fuel for mobility and as an energy carrier that enables transportation, storage and, in case of renewable hydrogen, buffering of green energy to balance energy supply and demand. Additionally, it serves as a raw material for products with a lower carbon footprint and is also instrumental to close the carbon loop in the context of chemical circularity.

Abundant renewable energy including low-carbon and renewable hydrogen as well as the respective infrastructure connecting energy and chemical hubs is a pre-condition to achieve an emission-free industry. This must come at **globally competitive cost** to avoid jeopardizing global competitiveness and risking relocation of energy intensive industries towards other areas of the world.

Although the expansion of renewables and related infrastructure is increasingly supported by both industry and governmental regulations, policy instruments that encourage their economically viable use would foster a more rapid deployment:

- **Access to green energy and hydrogen** in large quantities and at globally competitive cost:
  - Policies simultaneously addressing increased use of renewable energy as well as efficiency improvements through holistic and agreed Life Cycle Assessments (LCA)
  - Policy framework on renewable energy import from countries with high renewable energy potential (e.g., Middle East, South America, Australia, etc.) covering an EU-wide aligned regulation and taxation based on above (unified) LCA methodology
  - Discussion and agreement on policy frameworks with selected key countries outside the EU to ensure globally aligned approaches and maintain international competitiveness of EU based chemical industry
- **Infrastructure development** that provides reliable supply at affordable cost:
  - EU-wide aligned approach on policies and infrastructure financing to support (cross-border) electrical power grid expansion and energy storage facilities
  - Funding of projects to prove the technical and economic viability of energy imports from countries with high renewable energy potential (e.g., Middle East, South America, Australia, etc.) through various transportation options such as pipelines or chemical carriers covering export, shipping and import facilities

3.2 Recognition of all emission reduction saving potential initiatives towards the 2050 net-zero emissions ambition

The increasing ambitions towards net zero stipulated by the Paris Agreement, the EU Green Deal and via voluntary targets from companies, imply that accounting and complying for **indirect emissions**, preferably through international recognized principles, will play an ever-increasing role in achieving these pledges.

From the regulatory standpoint, the EU compliance obligations have largely focused on Scope 1 and 2 emissions, with the main policy instrument to drive decarbonization being the European Emission Trading System (EU-ETS), the Energy Taxation Directive (ETD) currently under review in the context of the EU Green deal, and the Renewable Energy Directive (RED). Other GHG compliance regulations are emerging at the member state level, but there is no clear view which emissions scope is currently being regulated with compliance obligations in different national jurisdictions.

CCU technologies avoid emitting carbon emissions by turning carbon into a chemical product. A very good example of this is the use of CO and CO_2

from the process industry to produce, for instance, polyols. For both molecules to be converted, a volume of renewable electricity is necessary either to:

– Replace the electricity or heat that is no longer produced by burning the CO molecule

– Provide the energy to incorporate the CO_2 molecule into the chemical product

Moreover, the process industry has developed ways to recycle these chemical products to keep this recycled carbon out of the atmosphere for ever.

Many companies, regulated under EU or national obligations, have also significant Scope 3 emissions, which corresponds to the indirect GHG emissions that are a consequence of the company's activities (other than consuming electricity, heat and steam generated off-site). Transforming the value chain from linear to circular is a key principle to reduce the entire value chain footprint.

An example of a Scope 3 emission reduction is the emission savings that **chemical recycling** of mixed plastics waste offers versus energy recovery through incineration of waste. Typically, this emission saving takes place at the scale of the EU economy. **Existing regulation does not credit companies involved in recycling for those savings**.

The increased **utilization of biomass** as a feedstock for the chemical industry reduces the demand for fossil feedstock and eliminates the fossil carbon emission. It is a circular economy solution for converting waste and residues into valuable products. For example, the GHG emission reductions of bio-ethylene production are estimated at over 90% compared to the fossil alternative.[6] Coupled with CCU technologies, biomass can even create a carbon sink.

Methodologies for assessing the carbon footprint need to be harmonized showing the actual difference in CO_2 footprint between biobased and fossil products at any stage of the life cycle, irrespective of the selected system boundaries.[7] Biomass utilized must be produced sustainably in order to reach full CO_2 reduction potential.

To summarize:

– Innovative low-carbon emitting technologies such as CCU and bio-based solutions have a higher production cost than the fossil equivalent product and cannot be economically viable on the consumer market without the financial support by an adequate regulatory framework. Legislation should honour their emission abatement potential by providing, for instance, tax incentives based on a long-term legislative sustainability target

– Recognition of Scope 3 emission reductions is essential to reach our ambition to invest in the circular economy and meet the 2030 climate targets

3.3 Programmes and public funding support for the development and deployment of higher technology readiness levels technologies (TRL 7-9)

The European Union has established a variety of funding mechanisms to support industry in its transition to carbon neutrality. With Horizon Europe or the Innovation Fund, a strong focus on low-carbon emitting technologies in industries already exists. Maintaining the competitiveness and the strong technological leadership of the European industry must be the prime goal of public funding and investment support.

– Europe must become the preferred place to invest in innovation, with the objective to maintain, or grow, its strong technological leadership. A favourable framework to stimulate investment in research and innovation, including the scale-up in Europe of advanced technologies (demonstration, first-of its-kind units) and best suited financing mechanisms from public or private investors for high-risk projects is necessary. This also requires that EU regulations support the deployment of low-carbon and more sustainable technologies.

– Ensure ambitious research and innovation funding for industry to support risk-sharing. As the chemical industry is strongly involved in partnerships under Horizon Europe (e.g., Process4Planet, Circular Bio-based Europe), and these instruments are proven to deliver high impact, the EU should increase the partnerships budget and allow attractive funding rates. This would be in line with the fact that industry is the main driver for innovation and for addressing the urgency of many global challenges. Without large-scale innovation funding, which also allows large-scale cross-sectoral collaboration, as initiated by Horizon 2020, the respective technological advances will be delayed or not happen at all.

– Public funding throughout the whole development chain covering all areas of technology readiness levels (TRL) ranging from one (initial concepts) to nine (commercially proven) is necessary to support the transition to low-carbon emitting technologies.

– To foster commercialization on an industrial scale and to overcome both CAPEX as well as OPEX constraints, compared to established technologies and depreciated assets, funding mechanisms to implement demo projects of these technologies with TRL of seven to nine at relevant scale are necessary.

– Ensure that the European Commission takes a leading role in providing support for research and innovation for more sustainable alternatives (processes, products and materials). The development of further sustainable alternatives requires a common, widely accepted understanding of "sustainable products" (what is a sustainable product, criteria, guideline, baseline) and improved methodologies for risk assessments (see next section below).

– Continue with chemical industry involvement in the process of co-defining the relevant research and innovation topics for future funding. This assures the call topics are addressing the industrial needs and are relevant to the economic reality industry is confronted with. The well-established practice to involve various stakeholders, including industry, in discussing and defining new topics should be further strengthened.

– The digitalization of the economy spans all sectors, including upstream industries like the chemical industry. Digitalization has a great potential to support the goal of carbon neutrality. This fact should be reflected in the funding programmes and policy development to ensure a free flow of cross-border data.

– Realizing the EU ambitions between now and 2050 requires specific skills and the educational system needs to be equipped to address the upcoming shortage in skilled work force (e.g., STEM education, digital skills). The complete change of paradigm for the chemical industry – coupled with its essential role in the transition – is an enormous challenge that requires a world-class work force for research, innovation and technology.

3.4 Creating a market in Europe for circular and low-carbon products

Policies should be able, gradually, to capture the complexity of value chains, including the impact of circularity and technology developments over time. Product footprint must be considered over the entire value chain whether originating from Europe or from abroad, including end-of-life in a circular economy. The aim would be to **reward and create a demand for products from low-carbon and circular value chains**.

European policy-makers are developing a **sustainable product initiative** which is welcome. With such a legal framework, all products produced or sold in the EU would ultimately be in line with technical standards for sustainability. Valuable policy concepts to be considered could, for instance, be a) sustainability and **information (labelling and disclosure)** requirements for most relevant products; b) **extended producer responsibility** for sustainability, making producers responsible for intervention before products become waste (take-back schemes, providing products as a service); c) minimum product sustainability requirements on **public procurement** (e.g., CO_2-footprint); d) role of products in contribution to decarbonization of the economy by **avoided emissions from the value chain**.

Ideally, the development of EU **standards for low-carbon products** should proceed in mutual understanding with major trading partners within the World Trade Organization, and with significant stakeholder engagement including industry. This would not only prevent market access of less sustainable alternatives but also could level the global playing field and spur new technological leadership for low-carbon manufacturing.

A **climate contribution** on certain products could generate financial flows expedient for increasing economic feasibility during the transformation of industry and end markets by providing stability and predictability for investments into low-carbon production.

It is important to create the right conditions for Europe's ecosystem of companies to survive, thrive and continue developing solutions for a climate-neutral and circular economy. Timely and large amounts of investments need to be channelled so they contribute to the industrial transformation and benefit both consumers and producers. A strong and well-functioning EU single market should respect EU and WTO rules at all times. Nothing shall enter Europe that does not comply with EU rules. Therefore, better **enforcement is essential** with, for instance, product standards for goods imported to EU. The use of digital solutions and tools may help to detect and tackle non-compliant products entering the EU market.

3.5 Global collaboration

Meaningful progress towards achieving climate ambition is clearly a global challenge and global policy efforts should align to promote a level playing field, prevent carbon leakage, preserve manufacturing competitiveness and, for harder to decarbonize sectors, should consider opportunities to deploy and incentivize technology development to reduce GHG emissions in the near term. In addition, efforts need to align and support a competitive manufacturing environment to ensure that these additional investments work in concert with strong domestic economies and access to global markets.

- Parties should finalize the Paris Rulebook at COP26, as Article 6 has the potential to accelerate low-carbon emitting technologies through expanded carbon markets. Participant parties (countries) will be able to coordinate and link their national efforts by participating in a shared structure to reduce emissions while saving cost through international collaboration. Global carbon markets have the potential to bring additional public and private finance and catalyze emissions reductions.

- Coordinate efforts between the industry and policy-makers to enable faster adoption of low-carbon emitting technologies. For example, streamline information, data and knowledge sharing of non-proprietary data and knowledge to enable quicker adoption of low-carbon emitting technologies around the globe, such as hydrogen best practices/equipment standards, CCUS protocols, electrification of industrial processes, biomass utilization, and recycling, among others.

- Policies should be transformed to be able to capture the complexity of global value chains, including the impact of circularity and technology developments over time. Product footprint must be considered over the entire value chain, from raw material production to end-of-life of a product, especially in a transition to a circular economy. Policies should enable data transparency among countries on a product footprint in all stages of the value chain. Having a global standard and practice will support consistent emissions quantifications between countries.

- A sound and detailed definition of climate neutrality is required to provide a strong signal for long-term investments. A clear definition and accounting framework are particularly important for the chemical industry, which is expected to play a significant role in developing carbon utilization pathways.

- All sectors of the economy need to be on board to reach climate neutrality. International climate policies should reflect the ability of different sectors of the economy to achieve significant GHG emissions reduction over the short, mid and long term.

- Standardization of global climate ambition, policies and actions to rank sectors among these parameters:
  - Marginal abatement cost
  - Investment cycles
  - Exposure to global competition
  - Current share of GHG emission and progress so far
  - Impact of emissions on other sectors of the economy

- Promote international dialogue and work towards a common globally aligned climate ambition.

- On international trade, commit to the overall partnership of avoiding trade barriers and develop greater market access for products with lower carbon footprints.

- Funding programmes to support large-scale deployment of low-carbon emitting technologies in the chemical industry should be specifically designed to increase global collaboration between industry members and countries.

Conclusion

To pursue the chemical industry transformation to a net-zero and circular future, the LCET members are convinced that **public and private collaboration** is essential for the development and large-scale deployment of low-carbon emitting technologies.

The LCET policy community members are looking to engage at the beginning with European policy stakeholders to advance jointly that agenda and share technical data and knowledge for the development of future key climate policies. As progress is being made, the LCET policy community will strive to engage with policy stakeholders from other regions to tackle climate change as the global challenge it represents.

This white paper highlights the overarching key priorities areas identified by the LCET members to enable the policy environment for the industry transformation to climate neutrality. In a second phase, the community is aiming to pinpoint policy dimensions for specific projects to be spun off from the LCET collaboration and be able to provide related data and knowledge.

Signatories

This paper was developed by the members of the Collaborative Innovation for Low-Carbon Emitting Technologies initiative policy workstream.

- Air Liquide
- BASF
- Borealis AG
- Clariant
- Covestro
- Dow Inc.
- Johnson Matthey
- Linde plc
- Royal DSM
- SABIC
- SIBUR
- Solvay
- Total
- Wacker Chemie AG

Contributors

World Economic Forum

Estelle Blanc-Paque
Project Specialist, Collaborative Innovation for Low-Carbon Emitting Technologies initiative

Joanna Kolomanska-van Iperen
Project Lead, Collaborative Innovation for Low-Carbon Emitting Technologies initiative

Fernando J. Gómez
Head, Chemical and Advanced Materials Industry

This paper was co-developed through the Collaborative Innovation for Low-Carbon Emitting Technologies initiative policy workstream and was made possible through the invaluable contributions of all participants.

Contact
For questions about the Collaborative Innovation for Low-Carbon Emitting Technologies initiative and the Forum's Shaping the Future of Energy, Materials and Infrastructure Platform, contact Joanna Kolomanska-van Iperen at joanna.kolomanska@weforum.org and Estelle Blanc-Paque at estelle.blanc-paque@weforum.org.

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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