The "Climate Action Programme for the Chemical Industry (CAPCI)" and its Partners

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

IKI International Climate Initiative

FOREWORD

Chemicals are omnipresent in our modern economies as well as in our daily lives. Tens of thousands of chemicals and substance mixtures are currently registered for commercial use – and this number continues to rise. They are essential for manufacturing nearly all industrial products, from automobiles and electronics to household goods and textiles, and they are key components in the materials needed to develop renewable energy and sustainable mobility solutions.

At the same time, particular care is needed when handling and disposing of chemicals and the products that contain them. To this end, the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) pursues an integrated and holistic approach to chemicals management. The concept of sustainable chemistry aims to minimise the risks to human health and the environment while concurrently maximising the sector's positive impacts and contribution to sustainable development. Here, the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) strongly supports the work of the International Sustainable Chemistry Collaborative Centre (ISC_3), which promotes a transformation to a more sustainable chemistry worldwide.

The chemical and petrochemical industry is highly energy and carbon-intensive. For climate change mitigation, the establishment of strategies that tap into the chemical industry's huge potential for mitigating greenhouse gas emissions is key as well as supporting downstream industries in developing innovative solutions to achieve net-zero targets. The enormous efforts required to tackle climate change need to go hand in hand with the sound management of chemicals and waste. Developing adequate capacities among stakeholders is crucial to successfully implementing mitigation measures and driving the transformation towards a sustainable and climate-neutral future.

The German Federal Government is supporting the Climate Action Programme for the Chemical Industry (CAPCI) through the International Climate Initiative (IKI) to promote this effort. Based on the concept of sustainable chemistry, the programme aims to raise awareness and build capacities that will unlock the potential for innovation and mitigation within the chemical industry. I welcome that our partner countries have committed to pursuing more ambitious mitigation efforts and even climate neutrality by 2050. Effectively lowering global greenhouse gas emissions will only succeed if viable pathways for the transformation are found that consider national characteristics as well as the socio-economic context of each country.

The German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) recognises that the world faces the triple planetary crisis of climate change, pollution and biodiversity loss and that an integrated approach is needed to jointly tackle it.

Adopted by the first International Conference on Chemicals Management (ICCM1) in Dubai, the Strategic Approach to International Chemicals Management (SAICM) is a policy framework to promote chemical safety around the world through an integrated approach. The active involvement and cooperation of all relevant sectors and stakeholders is key to achieve the overall objective of producing and using chemicals in ways that minimize significant adverse effects on human health and the environment.

Scheduled to take place in Bonn in September 2023, the 5th International Conference on Chemicals Management (ICCM5) will mark a milestone on the path to responsibly managing chemicals and waste in line with the 2030 Agenda for Sustainable Development. ICCM5 is expected to further develop the framework and to strengthen cross-sectoral collaboration along the value chain.

In my view, CAPCI provides an excellent example of how cross-sectoral cooperation – in this case at the interface between climate protection and chemical safety – can be beneficial for both sides. I hope that the experience gained from this project will inspire other stakeholders to follow this example.

Finally, I would like to thank all our partners, who contribute to the success of CAPCI.

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EXECUTIVE SUMMARY

Chemical products and substances constitute the basis of modern-day manufacturing activities. Almost all major industries rely on input provided by this sector, the chemical industry represents a major economic player that supplies over 95 per cent of all industrial sectors. While providing innumerable benefits, many of chemicals and chemical products in use today demand special care and safety precautions on account of the risks that their hazardous components can pose to human health and the environment.

One reality that is often overlooked is that the chemical industry is one of the key actors in relation to one of the most paramount challenges of our times: climate change. According to the 2022 sixth assessment report from the International Panel on Climate Change, the chemical and petrochemical industry account for 7.4 per cent of the global greenhouse gas (GHG) emissions when considering emissions directly controlled by the companies (scope 1) as well as those associated with purchased electricity, heat or steam (scope 2). One of the reasons behind this major contribution relates to this industry's extensive and continued use of fossil hydrocarbons, making the chemical and petrochemical sector responsible for around 10 per cent of global energy demand. When including emissions along the value chain (scope 3), this number is even higher. Scope-3 emissions occur upstream, e. g. in the extraction and transport of raw materials and feedstocks, as well as downstream, e. g. from substances with high global warming potential (such as fluorine-containing substances still used for cooling and foaming).

While the chemical industry is one of the top-three industrial sectors in terms of GHG emissions, along with cement and steel, it is also a major source of innovative solutions and materials for decarbonising other sectors such as energy and transport. Tapping the potential of the chemical industry to advance mitigation and low-emission technologies is crucial for effectively tackling climate change.

Achieving a climate-friendly transformation in the chemical industry demands significant innovation efforts and unprecedented levels of long-term investment into new technologies. Today, however, a lack of awareness about the importance of the chemical industry and the potential it holds, as well as gaps in capacity, constitute major barriers to this goal. Effecting change requires knowledge, qualified professionals and sensitised decision-makers across the public, private and academic sectors. Developing countries and emerging economies, for their part, need technical, scientific, managerial and political capacities to effectively compete in the market as well as manage the issues of climate change, the environment and sustainable resource management.

Through the framework of the International Climate Initiative (IKI), the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) has established the Climate Action Programme for the Chemical Industry (CAPCI) to help address these challenges. CAPCI is executed by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and operates in collaboration with global partners such as the International Council of Chemical Associations (ICCA) and the Paris Committee on Capacity Building (PCCB) of the UNFCCC. With a focus on raising awareness and building capacity, CAPCI helps identify and unlock the potential held by the chemical industry in mitigating climate change and driving innovation.

The activities pursued by CAPCI include both country-specific and more general topic-specific knowledge-sharing measures at the global level. During its first phase, the programme organised events at international conferences as well as a series of global webinars addressing practical and political aspects of the nexus between sustainable chemistry and climate change. These global events revealed that, among many relevant stakeholders and especially those in the private sector, a large degree of interest exists surrounding the topic of climate change mitigation opportunities in the chemical industry.

CAPCI has also collected and evaluated best practices related to applying climate-friendly, environmentally sustainable and efficient technologies in the production and use of chemicals. These are shared via a global online knowledge platform together with factsheets and other resource materials. As a basis for future country-specific capacity-building measures, the programme conducted an in-depth training-of-trainers course on the topic of the chemical industry and climate change with participants from five partner countries:

Argentina, **Ghana**, **Peru**, **Thailand** and **Vietnam**.

Efforts such as these are based on the principle of building from existing knowledge, solutions and successful experiences rather than seeking to re-invent the wheel. Close cooperation has also been carried out with other relevant initiatives in the areas of resource efficiency, circular economy, climate policy and chemicals, such as the International Sustainable Chemistry Collaborative Centre (ISC3), the Power2X Hub, the Nitric Acid Climate Action Group (NACAG) and the PROKLIMA programme for integrated climate change mitigation and ozone layer protection.

In five partner countries cited above, CAPCI has supported baseline studies and public-private dialogues aimed at identifying priorities, needs and gaps in the chemical industry. Some of CAPCI's partner countries have recently raised the ambitions in their nationally determined contributions, with Thailand and Vietnam having even committed to achieving climate neutrality by the middle of the century. As a result, they are revising their national climate policies and developing specific mitigation strategies that need to include all relevant emission sectors – including the chemical industry. In support of these measures, CAPCI will support the selected partner countries in developing roadmaps specific to the chemical sector that contribute to mitigating greenhouse gas emissions and ultimately proceeding on the pathway towards climate neutrality.

The programme also held stakeholder dialogues to discuss, verify and design actions based on the results from the baseline studies carried out in the CAPCI partner countries. These sessions made it evident that each country is faced with a specific context in regard to the production and use of chemicals. At the same time, one characteristic that was common among all of them was the need to raise awareness and build capacity for climate change mitigation efforts in the chemical industry. This represents a crucial element for identifying and leveraging successful pathways toward greenhouse gas mitigation in the partner countries. CAPCI considers the entire menu of mitigation technologies, from low-cost options such as measures for increasing energy and resource efficiency to more complex solutions such as shifts to renewable energy sources or the application of Power-to-X solutions, carbon capture and use (CCU) etc. One best practice from Germany that generated interest among the partner countries was the use of chemical parks as so-called Verbundstandorte, in which inter-linkages between different plants and companies at these parks lead to impressive synergies and optimisation in energy and resource flows. The parks contribute to a local circular economy and thereby significantly reduce greenhouse gas intensity.

This report provides an overview of learning experiences and results generated by CAPCI to date. The initial findings point to a great deal of interest in the nexus between the chemical sector and climate change at the international level, as well as among developing countries and emerging economies in particular. This may owe to the fact that the role of the chemical industry and its potential for tackling climate change have largely been underestimated across the globe. Defining efficient pathways for a transformation to low-emission economies is essential for ensuring the sustainable development and competitiveness of any country. CAPCI supports partner countries in carrying out roadmap studies exploring options for greenhouse gas mitigation in the production and use of chemicals that are economically sound and anchored in the 2030 Agenda for Sustainable Development – avoiding potential trade-offs with other goals.

CONTENT

CHAPTER 1

The Climate Action Program for the Chemical Industry (CAPCI)

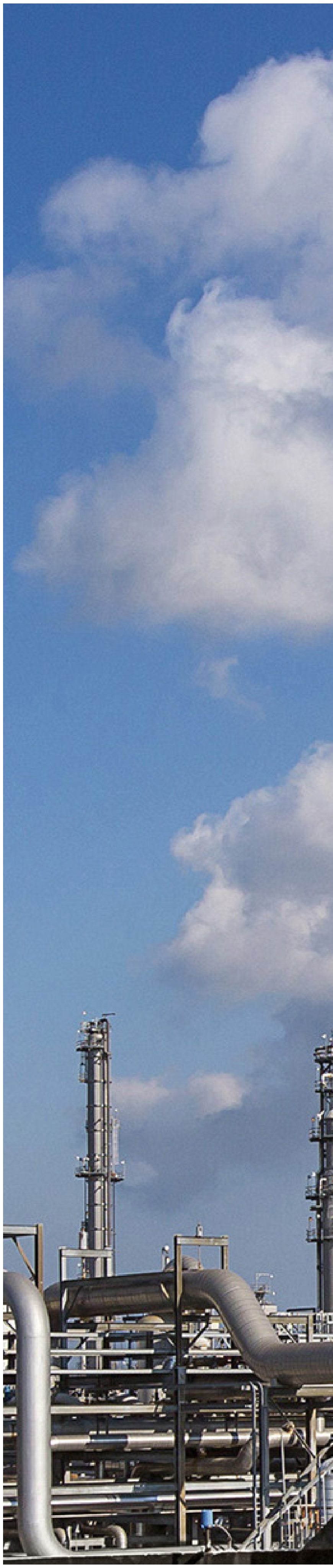



Photo: ©BASF SE

1.1 Empowering stakeholders through knowledge

In the sixteenth century, the philosopher Francis Bacon stated that "knowledge is power". In this spirit, CAPCI adopts a two-pronged approach to advancing knowledge-sharing and empowering stakeholders in addressing the nexus chemistry – climate change and associated challenges and opportunities. First, the programme provides stakeholders and decision-makers with information, applied knowledge and best practices regarding GHG mitigation opportunities in the production and use of chemicals. Second, it supports activities in selected developing and emerging countries aimed at better understanding the connection between the chemical industry and climate change as well as implementing measures for reducing related GHG emissions.

Photo: Fahrul Azmi, unsplash

This publication is directed to stakeholders from the private sector, public institutions, civil society and academia that have to do with the production and use of chemicals or climate change, be it in a direct form or indirectly in advisory institutions, research or government and regulatory bodies. It is meant as a contribution to enhance the discussion on chemistry and climate change, presenting the chemical industry as a key sector for building pathways towards climate neutrality. CAPCI presents its main learning experiences providing an overview on the strong linkages between chemistry and climate change. It seeks to inform and inspire the reader on potentials of the chemical industry for implementing GHG mitigation strategies and contributing to achieve climate targets. Furthermore, it shows possibilities for the transfer of knowledge and experiences between industrialized countries and developing or emerging countries as well as south-south collaboration.

This report presents highlights from the first phase of CAPCI in 2021 and 2022.

- Chapter 1 gives an introduction to CAPCI along with its knowledge and capacity-development services.
- Chapter 2 provides a brief analysis of the nexus between the chemical industry and climate change.
- Chapter 3 summarises key results from five CAPCI pilot countries, including insights related to the national baseline studies and national stakeholder dialogues supported by CAPCI
- Chapter 4 shares the key messages discussed at the global CAPCI webinars and
- chapter 5 reflects on opportunities for possible future CAPCI activities.

1.2 Launching dialogue in developing and transition countries

To date, CAPCI has supported five pilot countries across three continents with efforts to raise awareness nationally, conduct climate change analyses and develop capacities. To identify the initial pilot countries, CAPCI reviewed the chemical industry landscapes, chemical industry GHG emissions, energy mixes, NDCs and collaborative UNFCCC initiatives across numerous GIZ partner countries. Based on these criteria as well as the existence of partner interest and a favourable cooperation landscape, the countries ultimately selected for the pilot were Argentina, Ghana, Peru, Thailand and Vietnam. CAPCI's main partner organisations in these countries are the ministries of environment and industry as well as the associations of the chemical industry.

Photo: Pawel Chu, unsplash

Stock-taking, information-sharing and stakeholder dialogue

In each country, CAPCI supported activities of stock-taking, information, awareness creation and discussion on the nexus chemistry – climate change. The first step in these efforts involved developing baseline studies that shed light on the landscape of the chemical industry of each country – covering production processes, economic impact, company size and focus and GHG emissions. Mapping the structures and challenges of the chemical industry allowed for tailored measures aimed at GHG reduction to be developed. Highlights from the baseline studies can be found in Chapter 3.

CAPCI then organised national stakeholder dialogues in collaboration with national partners from government and private sector to provide further insights into the national chemical industry while also identifying needs and opportunities for GHG reductions. Stakeholders from the public sector, industry and academia were invited to help identify which approaches and mitigation options were viable, the actions required to advance them, needs for capacity building and international funding opportunities to support in their implementation. At all of the national stakeholder dialogues, the participants recognised that the chemical sector is an important actor in relation to climate change as well as broader national sustainable development agendas.

Developing capacity and training trainers

The baseline studies and national stakeholder dialogues identified gaps in capacity development in each country. To address these, CAPCI worked with HEAT GmbH in Germany to design an online training-of-trainers course. The content of this course covers the six key areas shown in the text box below. Over a period of seven weeks, a diverse group of 30 participants from the five pilot countries acquired knowledge about the nexus between the chemical industry and climate change, in addition to detailing existent needs and gaps in their countries and designing country-specific training interventions.

An important aspect of the training-of-trainers course was its interactive platform that allows participants to exchange information with the instructors, the CAPCI team and one another. In addition to the written materials the participants received, a discussion forum and exercises ensured they could explore the topics with adequate depth using interactive learning techniques.

The target audience for the training course included representatives from government institutions and the private sector, particularly professionals from the chemical industry with prior knowledge regarding climate policies as a prerequisite for taking. One of the expected outcomes of the course was for participants to be capacitated to serve as enablers of subsequent capacity-building activities in partner countries with support from CAPCI. Through this approach, the course turned participants into knowledge multipliers and agents of change for the topic of climate change mitigation and a sustainable chemical industry.

FOCUS TOPICS AT THE CAPCI TRAINING-OF-TRAINERS COURSE

- Sustainable chemistry and climate change: addressing the relevance of the chemical industry for tackling climate change etc.
- Overview of the chemical industry and its subsectors: covering relevant sources of greenhouse gas emissions and reduction options
- Climate policies and their implications for the chemical sector: including the UNFCCC, Paris Agreement and Article 6, examples for emission reduction initiatives, race-to-zero, NDCs etc.
- Assessment methods and concepts as a basis for effective and efficient design and implementation of mitigation measures in the chemical industry: tackling emission accounting and reporting, GHG protocols etc.
- Technologies for emissions reduction in the chemical sector: presenting energy and process-related mitigation options along with solutions for products with high global warming potential (GWP)
- Circular economy in the chemical industry: identifying cost-efficient mitigation measures with mutual benefits based on the efficient and circular use of resources that avoid and minimise potential trade-offs

1.3 Raising awareness globally and sharing knowledge

The national CAPCI capacity-building activities were also complemented by global activities that included webinars, study visits and side events at international meetings, as outlined below.

Photo: Malte Helmhold, unsplash

Webinars for worldwide information-sharing and awareness-raising

CAPCI engaged representatives from the chemical industry, politics and associations during a series of global webinars focused on sharing knowledge, networking and raising awareness. The participants interacted to jointly identify challenges, develop potential solutions and arrive at key findings. In 2021, CAPCI has organised four webinars on the following topics (see chapter 4 for key messages from each):

- **The role and importance of the chemical industry for tackling climate change**: This webinar provided a global perspective on sustainable chemistry for climate change mitigation and raised awareness about the importance of the chemical industry to this end.
- **Innovation in and from the chemical sector as a driver for low-carbon solutions**: The second webinar addressed technological aspects as well as mechanisms, required preconditions and sustainability considerations needed for scaling up low-emission processes and products.
- **Climate policies and a political framework for transforming the chemical industry:** The third session focused on climate policies and a discussion of suitable political frameworks for enabling the transformation of the chemical industry and the related value chains with the aim of reducing emissions and achieving climate neutrality.
- **Practical solutions for tackling climate change**: The fourth webinar discussed learning experiences and best practices from the chemical industry.

Study visit

Aiming to further deepen knowledge, CAPCI organised a study tour in Germany for the experts from the partner countries and participants from the training-of-trainers course. This study programme included a visit to ACHEMA, the world's leading trade fair for the chemical process industry, which included a workshop on green hydrogen/PtX technologies. The participants also visited two chemical parks to gain insights into the advantages of chemical parks as **Verbund sites** that leverage energy and resource efficiency along with circular business models. The study tour included visits to leading chemical companies with ambitious climate targets as well as to a green hydrogen pilot plant. These site visits provided experts from the pilot countries the opportunity to learn about on-site sustainable chemical processes and mitigation measures.

At the end of the study tour, CAPCI organised a reflection workshop at which participants discussed the Roadmap Toward a Climate Neutral Chemical Industry in Germany (VCI 2019a)[1] and the Chemistry for Climate (C4C)[2] initiative of the German Chemical Industry Association (VCI). This workshop invited representatives from the German public authorities responsible for chemical and climate policies, representatives from GIZ projects related to the chemical industry and climate protection and experts from academic institutions. Participation from such a broad array of experts fostered diverse points of reflection and contributed to deepening the participants' hands-on experience.

Side event at the BRS Triple CoPs

In association with the Government of Ghana, CAPCI helped to organise a side event on 14 June 2022 within the framework of the so-called BRS Triple-COP, the Convention of Parties to the Basel, Rotterdam, and Stockholm Conventions. This event addressed the relation between ambitious climate policies and the sound management of chemicals and waste from a holistic perspective. The event made evident that, apart from being an important source of greenhouse gas emissions, the chemical industry holds significant potential for providing innovative solutions that can tackle the challenge of climate change considering trade-offs.

Side event at the COP 27

In cooperation with project "Supporting Preparedness for Article 6 Cooperation (SPAR6C)" funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK) CAPCI organized a side event within the COP27 that took place in Egypt on the 10th of November 2022. It was carried out within the framework of the 4th Capacity Building Hub of the United Nations Climate Secretariat and its Paris Committee on Capacity Building. Under the heading "Building Sustainable National Capacities for Climate Action and Article 6 Implementation", the joint side event reflected the discussion on how to support developing countries and economies in transition for taking climate action and making use of flexible financing mechanisms according to Article 6 of the Paris Agreement on Climate Change.

[1] Verband der Chemischen Industrie VCI (2019) Roadmap 2050 Treibhausgasneutralität Chemieindustrie https://www.vci.de/services/publikationen/broschueren-faltblaetter/vci-dechema-futurecamp-studie-roadmap-2050-treibhausgasneutralitaet-chemieindustrie-deutschland-langfassung.jsp

[2] Chemistry 4 Climate, Über Chemistry4Climate | VCI

1.4 CAPCI partnerships

In its first two years of existence, CAPCI has pursued close collaboration with numerous organisations and projects at the global and national levels. One important partner at the global level is the International Sustainable Chemistry Collaborative Centre (ISC3)[3], based in Bonn, Germany. ISC3 is an international centre that promotes and develops sustainable chemistry solutions worldwide. Other important global CAPCI partners include GIZ projects in the area of climate change such as the Nitric Acid Climate Action Group (NACAG), PROKLIMA for integrated ozone and climate protection and the Power-to-X (PtX) Hub.

CAPCI also cooperates with the International Council of Chemical Associations (ICCA), national chemical associations in its partner countries, the Secretariat of the United Nations Framework Convention on Climate Change through its Paris Committee on Capacity-building (PCCB Network) and ministries responsible for industrial development and climate policy.

COLLABORATION WITH GIZ PROJECTS FOCUSED ON CLIMATE CHANGE

Implemented by GIZ, the Nitric Acid Climate Action Group (NACAG)[4] aims at reducing global nitrous oxide emissions generated through the production of nitric acid. The initiative offers technical support to plant operators and governments on abatement technologies, provides policy advice to its partner governments and provides financial support for the modernisation of nitric acid plants.

The Power-to-X (PtX) Hub[5] is an international platform implemented by GIZ through which knowledge and best practices are shared regarding opportunities for using green hydrogen for a range of purposes. PtX can be used for purposes such as producing CO_2-neutral fuels and chemicals based on renewable electricity. Many GIZ partner countries have the potential to build sustainable hydrogen and PtX value chains, creating opportunities to reduce GHG emissions.

PROKLIMA[6] is a cluster of GIZ-supported projects for integrated ozone and climate change mitigation efforts that promote the use of green cooling technologies as well as environmentally friendly refrigerants and foam-blowing agents. The cluster primarily aims to promote the substitution of technologies based on fluorinated substances with extremely high GWP through the use of natural gases.

3 https://www.isc3.org/
4 https://www.nitricacidaction.org/
5 https://ptx-hub.org/team/
6 https://www.giz.de/fachexpertise/html/61049.html

CHAPTER 2

A snapshot of the climate-sustainable chemistry nexus

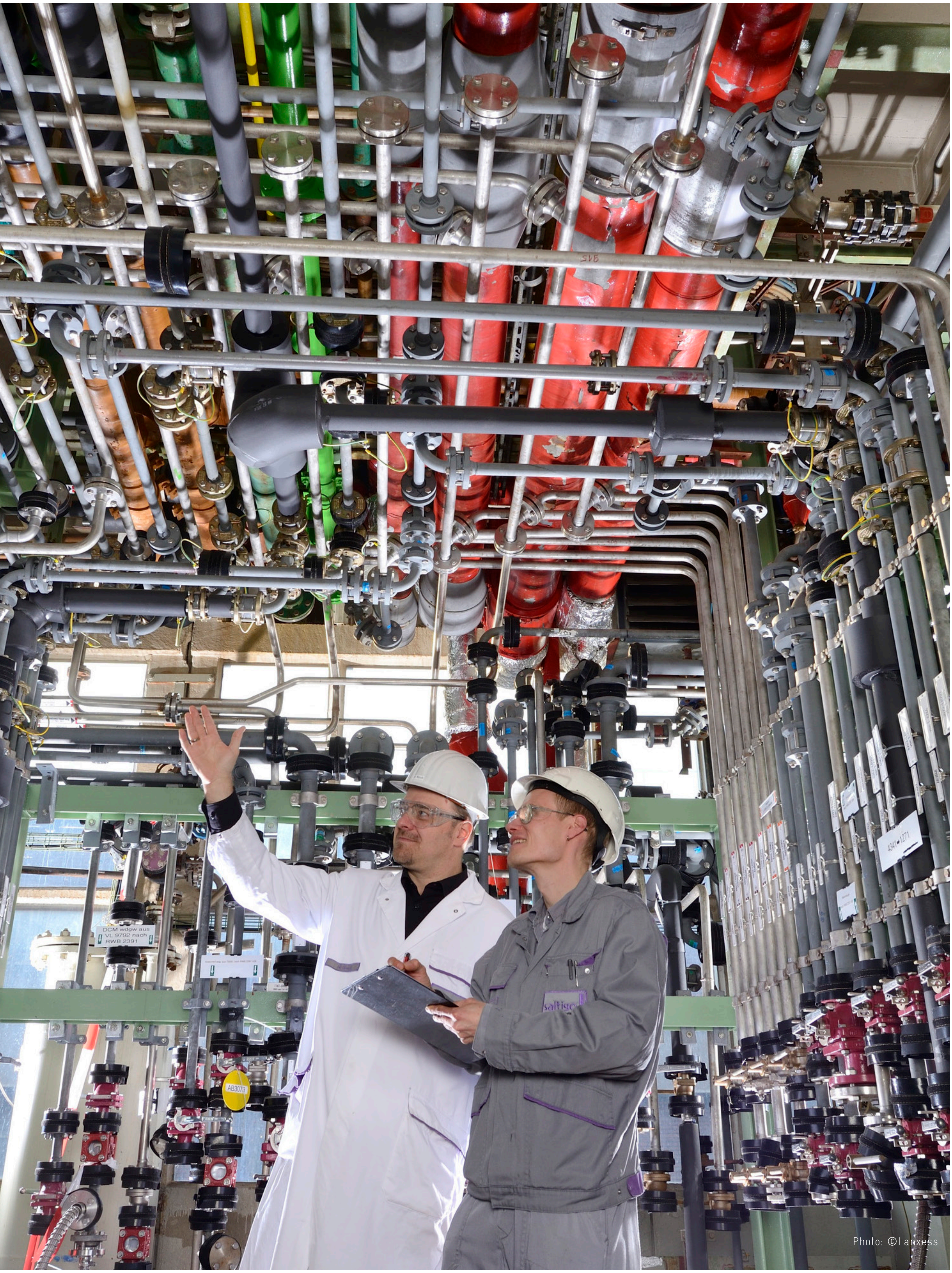


Photo: ©Lanxess

2.1 The chemical industry contributes to and is key to address climate change

A dual message has emerged through CAPCI-supported activities in relation to the responsibility and role of the chemical industry in addressing climate change. On the one hand, despite some progress made, the chemical industry continues to be one of the largest emitters of GHG emissions globally. Tackling this will require transformative changes on an international scale, including both in developed as well as in developing and transition countries – as discussed in sections 2.2 and 2.3.

On the other hand, the chemical industry is in a unique position to develop technologies and products that can mitigate climate change, enhance circularity and advance sustainability. Innovations in chemistry have the potential to transform entire value chains and reduce GHG footprints, such as via energy-saving and emissions-reducing technology and materials. Some of the relevant economic sectors and actors include building and construction, energy, transportation, consumer goods and individual consumers (ICCA 2019)[1]. This aspect is discussed in Section 2.4.

The chemical industry

… continues to be one of the largest emitters of GHG emissions globally.

… is in a unique position to develop technologies and products that can mitigate climate change, enhance circularity and advance sustainability.

[1] International Council of Chemical Associations (2019) Enabling the future: chemistry innovations for a low-carbon society. https://icca-chem.org/wp-content/uploads/2020/05/Enabling-the-Future.pdf

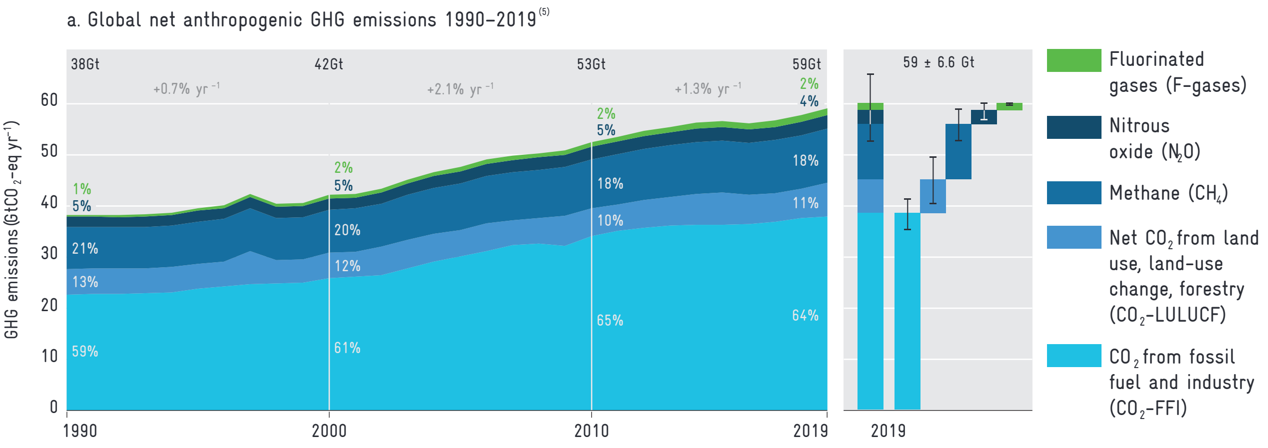
2.2 GHG emissions from the chemical industry are a global challenge

Global greenhouse gas emissions continue to rise

According to the Intergovernmental Panel on Climate Change (IPCC), global GHG emissions in 2019 were approximately 59 gigatonnes of CO2 equivalent – with a margin of error of +/- 6.6 gigatonnes. Global GHG emissions have continued to rise across all GHG categories in the period from 1990 to 2019 (see figure 2.1), though the average rate of emissions growth slowed, from 2.4% (from 2000-2010) to 1.3% for 2010- 2019(IPCC 2022 a)[2].

The cumulative net CO2 emissions over the last decade (2010-2019) were as large as the carbon budget the world has left to limit global warming to 1.5°C. To better illustrate this, about 1,500 gigatonnes of CO2 emissions have been emitted since 1970, with about 1,000 gigatonnes added since 1990 and 410 added since 2010. The remaining carbon budget to limit global warming to 1.5°C with a probability of 67 per cent stands at 400 +/-220 gigatonnes of CO2 – which now leaves little room for manoeuvring.

Figure 2.1: Trends in emissions for major groups of greenhouse gases, 1990 – 2019 (IPCC 2022 a)

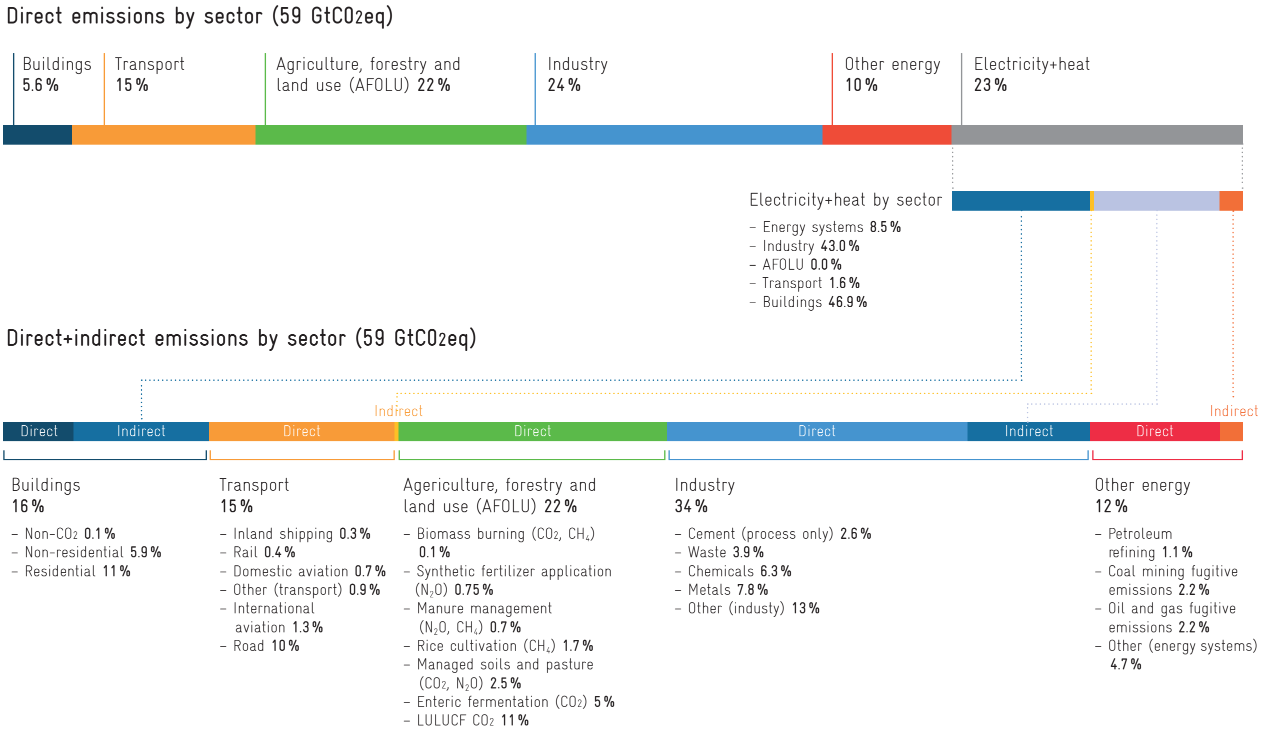


[2] Intergovernmental Panel on Climate Change (2022a)
Working Group III contribution to the Sixth Assessment Report of the IPCC, Summary for policy makers. IPCC_AR6_WGIII_SPM.pdf

Industrial GHG emissions have risen faster than emissions in all other sectors

GHG emissions from industry, which includes emissions from the chemical industry, have risen faster than those in any other sector since 2000 (IPCC 2022 b)[3]. Emissions here stem from fuel combustion, production processes, products and waste. Together, this accounted for 14.1 gigatonnes of CO2 equivalent or 24 per cent of all direct anthropogenic emissions in 2019 (IPCC 2022 b). This makes the industry sector the second-largest overall contributor – only behind the energy supply sector itself. When indirect emissions from power and heat generation are included, industry is the largest GHG emitter, responsible for 20 gigatonnes of CO2 equivalent or 34 per cent of global emissions in 2019 (see figure 2.2).

Figure 2.2: Contribution to total GHG emissions (direct and indirect) by sector and sub-sector in 2019 (IPCC 2022b)

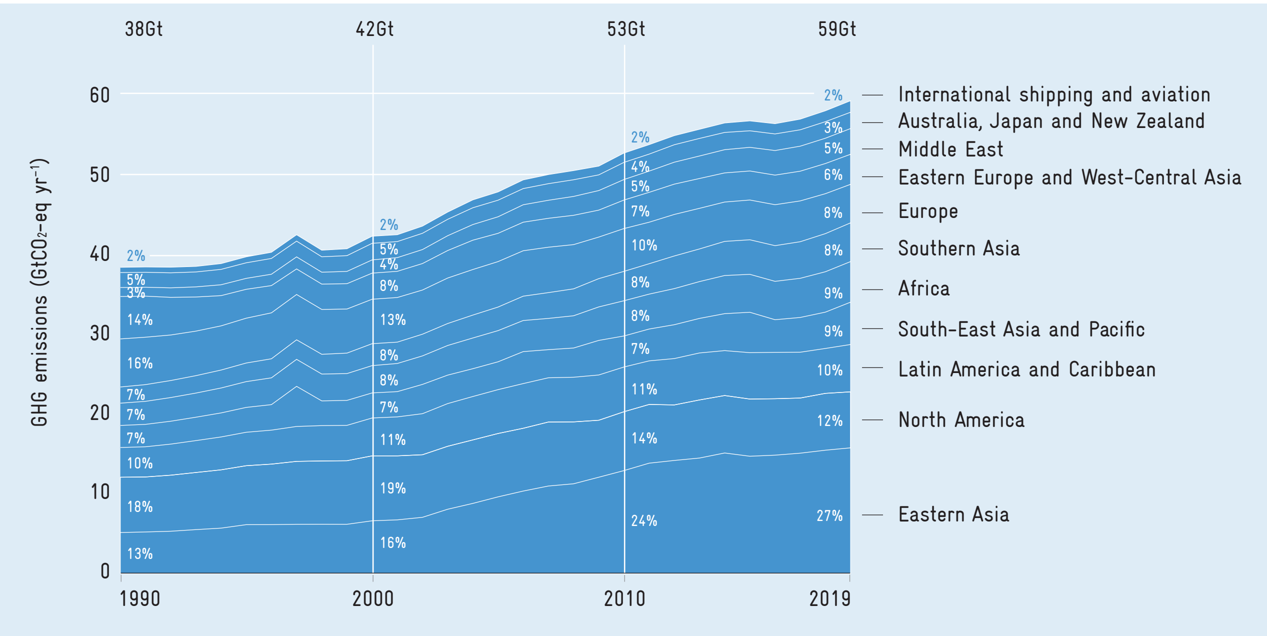


[3] Intergovernmental Panel on Climate Change (2022 b) Working Group III contribution to the Sixth Assessment Report of the IPCC, full report. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf

The relative contribution of regions to global GHG emissions is changing

While GHG emissions have risen globally, the relative share of emissions from developing and emerging economy regions is increasing. While North America and Europe historically accounted for the largest portion of global emissions, their share dropped to 18 per cent by the end of the last decade while Eastern Asia became the largest emitter with a 27-per-cent share, and other regions comprised of developing and emerging economies having increased as well: South East Asia and the Pacific (from 7 to 9 per cent), the Middle East (from 3 to 5 per cent) and Africa (from 7 to 9 per cent) (see figure 2.3).

Figure 2.3: Global net emissions and share by region, 1990-2019 (IPCC 2022a)[4]



[4] Intergovernmental Panel on Climate Change (2022 a) Working Group III contribution to the Sixth Assessment Report of the IPCC, Summary for policy makers. IPCC_AR6_WGIII_SPM.pdf

GHG emissions from industrial processes have increased exponentially in some regions

Between 1990 and 2019, GHG emissions from industrial processes increased exponentially in almost all regions, except the European Union which is the only region that has decreased its emissions (see figure 2.4). In Latin American and the Caribbean, for example, GHG emissions tripled over this period while emissions increased 12-fold in Sub-Saharan Africa – albeit from a low starting point. The current leader in global GHG emissions from industrial processes is China, contributing 1,220 million tonnes of CO_2 equivalent in 2019 compared to 94.35 million tonnes in 1990.

Figure 2.4: GHG emissions from industrial processes, 1990-2018 (www.climatewatchdata.org 2022)[5]

Region	GHG 1990 in Mt CO_2eq)	GHG 2019 in Mt CO_2eq)
Sub-Saharan Africa	13.74	162.88
Latin America and the Caribbean	57.21	167.81
East Asia and the Pacific	231.15	1637.26
South Asia	30.12	209.86
European Union	216.95	160.35
North America	193.81	260.84
G20 without China	827.42	1204.58
China	94.35	1220.29

[5] Climate Watch (n.d). Historical GHG Emissions. https://www.climatewatchdata.org

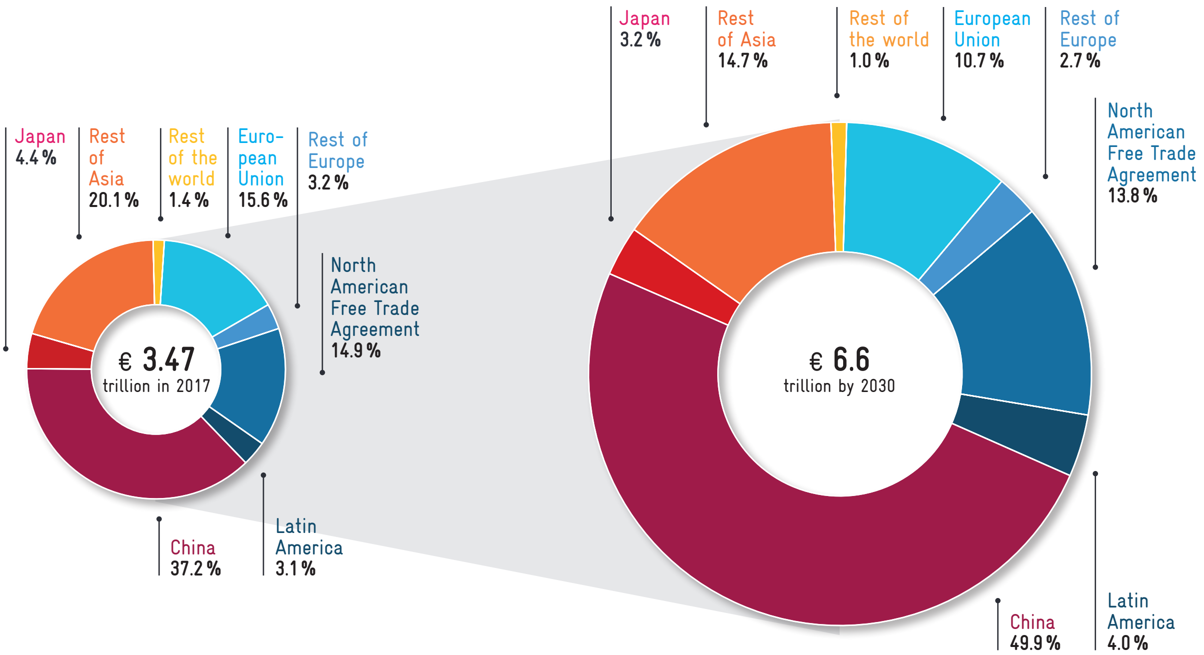
The chemical industry is a major contributor to global GHG emissions

The chemical and petrochemical industries account for around 10 per cent of the world's final energy demand (WBCSD 2018)[6] and 7.4 per cent of global GHG emissions (IPCC 2022 b)[7]. Of this, 63 per cent of emissions generated by the chemical industry results from process-related energy requirements, with two main processes accounting for the lion's share (44 per cent) of total emissions: the production of petrochemicals and of ammonia (IPCC 2022 b).

The chemical industry is projected to grow exponentially

Between 2000 and 2017, the global chemical industry's production capacity almost doubled, from 1.2 to 2.3 billion tonnes (UNEP 2019)[8]. Global sales totalled USD 3.47 trillion in 2017, making the chemical industry the world's second-largest industrial sector. Sales are projected to nearly double again from 2017 to 2030 (figure 2.5). Projected growth is highest in Asia, with China on course to account for 50 per cent of global chemical sales by 2030 (UNEP 2019).

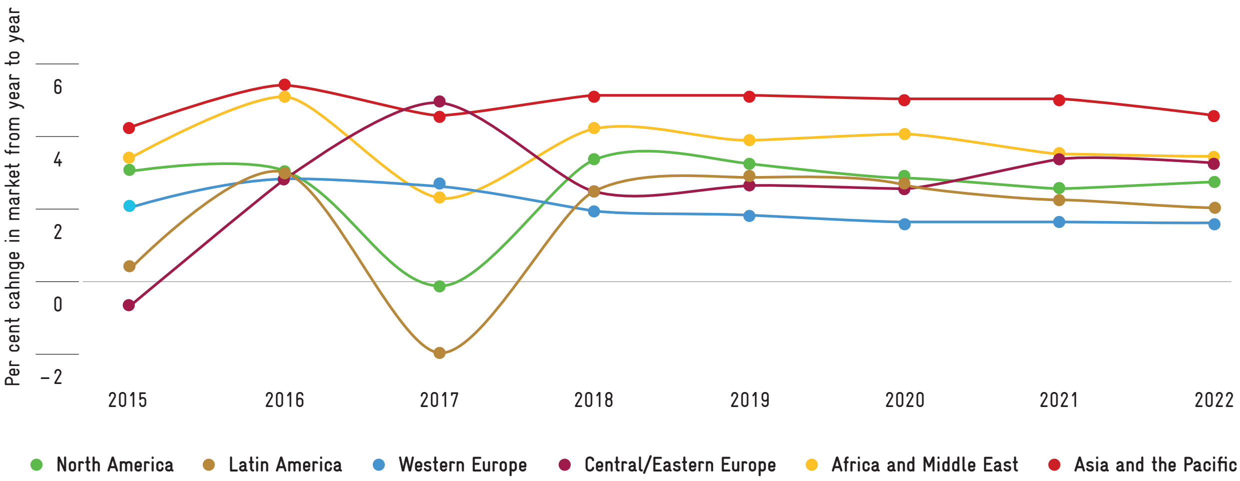
Figure 2.5. Projected growth of the sales of the chemical industry by 2030 (excluding pharmaceuticals) (UNEP 2019 adapted from CEFIC 2018)



[6] World Business Council for Sustainable Development (2018) Chemical Sector SDG-Roadmap. https://www.wbcsd.org/Programs/People-and-Society/Sustainable-Development-Goals/Resources/Chemical-Sector-SDG-Roadmap
[7] Intergovernmental Panel on Climate Change (2022 b) Working Group III contribution to the Sixth Assessment Report of the IPCC, full report. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf
[8] United Nations Environment Programme (2019) Global Chemicals Outlook II. https://www.unep.org/resources/report/global-chemicals-outlook-ii-legacies-innovative-solutions

An increasing share of chemical production is happening in developing countries and emerging economies. High production growth rates are expected not only in Asia and the Pacific but also in Africa and the Middle East (Figure 2.6). GHG emissions will continue to rise in tandem with increasing production of chemical products unless major resource efficiency improvements are put in place.

Figure 2.6: Annual production growth in the chemical industry by region, 2015-2022 (UNEP 2019 based on American Chemistry Council (2017))



CONSIDERING CHEMICAL RISKS IN CLIMATE CHANGE ADAPTATION PLANNING

An important but undervalued dimension of the climate change-chemicals nexus concerns chemical risks posed by changing climate patterns, such as the observed increase in extreme weather events. For example, chemical plants and chemical storage facilities located close to flood-prone rivers may become flooded after torrential rainfall and release toxic emissions into the air, water and land. Long-term droughts may affect the development and spread of pest-threatening agricultural production and the use of pesticides. Obtaining a better understanding of these connections is important, requiring that they be integrated into national, local and sectoral climate change adaption planning. For a deeper discussion on this topic, see UNEP 2021. The report concludes that climate change can increase the introduction of hazardous chemicals into the environment, increase the use of chemical fertiliser and pesticides and increase the mobilisation and volatilisation of chemicals from material storage and stockpiles due to rising temperatures (UNEP 2021 a)[10].

2.3 Technology options to reduce the climate impact of the chemical industry

The transformation to a low-carbon chemical industry requires action through several pathways, including technological and political solutions as well as smart organisational structures. It also requires agreement and commitment on the part of governments, industry and other stakeholders and belief in the principle that a climate-neutral chemical industry is possible. The position paper from the global chemical industry issued in 2021 (ICCA 2021)[11] provides some promising starting points. It sets out a vision that the chemical industry can indeed become climate-neutral if certain conditions are met. This section provides a snapshot of some of the technological approaches that can help to achieve this vision.

Measuring greenhouse gas emissions as a starting point

At the company level, it is important to start with reliable data on the different sources and quantities of greenhouse gas emissions. A common tool used for assessing these emissions is the Greenhouse Gas Protocol[12] which provides a guideline for companies how to do their carbon accounting. According to this tool emissions can be attributed to three categories or scopes:

- **Scope 1**: Direct GHG emissions from sources owned or controlled by the company, e.g. carbon dioxide from fossil fuel combustion or production processes (for example N_2O emissions from nitric acid production).
- **Scope 2**: Indirect emissions from purchased electricity, steam, heat or cooling.
- **Scope 3**: Other indirect emissions occurring during the extraction and transport of purchased materials or related to the use of the chemical industry's products, e.g. (fluorinated substances used as cooling or foam blowing agents, and characteriszed as having by very high global warming potentials (GWP)).

[10] United Nations Environment Programme (2021) Chemicals, waste and climate change – Interlinkages and potential for coordinated action.
http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-POPS-PUB-Report-Interlinkages-ClimateChange-2021.English.pdf
[11] International Council of Chemical Associations (2021) Statement on Climate Neutrality.
https://icca-chem.org/news/icca-statement-on-climate-policy/
[12] Greenhoue gas protocol https://ghgprotocol.org/

The Chemical Industry of the European Union (EU 27) managed to reduce its GHG emissions (scope 1) by 54 per cent in the period from 1990 to 2019 while production volume increased by 47 per cent (CEFIC website)[13]. A closer look reveals that the far-reaching reduction of process-related emissions constitute the majority of this, mainly N_2O as well as fluorinated gases. CO2 from the combustion of fossil fuels could also be significantly reduced, albeit to a somewhat minor degree. Despite this remarkable progress, the path to climate-neutrality is still long.

For the German chemical industry, a study[14] of possible mitigation pathways revealed that climate-neutrality is indeed possible but requires massive investments in innovative technologies paired with the phase-in of enormous amounts of renewable energy. Important elements include the electrification of fossil-fuel-based processes as well as the use of green hydrogen and Power-to-X technologies. A publication called "Implementing Low-carbon Emitting Technologies Initiative in the Chemical Industry" (WEF, 2021)[15] also names electrification and alternative hydrogen production as building blocks towards achieving this goal. Alternative carbon sources also play a crucial role, e. g. biomass from agricultural waste, as well as recycling of plastic waste and carbon capture and utilisation (CCU).

In summary, the menu of mitigation options available to the chemical industry is broad. The options available not only include profound and ambitious technological changes but also low-hanging fruit at the start of this pathway, i.e. measures that are cost-efficient or even money-saving and relatively easy to implement. The following sections present selected mitigation options to provide an illustration of the range of options available.

Increasing energy and resource efficiency, optimising processes, reducing losses

Many chemical companies, especially in developing countries and emerging economies, have a range of options available to avoid or reduce GHG emissions through relatively cost-efficient process optimisation and efficient technologies. As a first step, it is important to identify and foster the efficient use of all relevant resources and minimise losses of energy and materials (including energy carriers), e. g. in handling, transport and storage.

Increasing energy efficiency is a particularly fundamental step. All chemical reactions involve energy, be it in its release (exothermic) or input (endothermic). The production of numerous sorts of chemical feedstocks is endothermic and requires significant amounts of energy. Potential measures to minimise energy use still have not been leveraged by made companies. Achieving energy savings not only reduces GHG emissions but also has the potential to lower costs. A number of pathways exist to reduce energy consumption in chemical production: Continuously measuring process

[13] European Chemical Industry Council (CEFIC) European Performance 2020 Environmental Performance - cefic.org [14] Verband der Chemischen Industrie VCI (2019) Working towards a greenhouse gas neutral chemical industry in Germany Studie_Treibhausgas_engl_v1.indd (vci.de)

[15] World Economy Forum (2021) Implementing Low-carbon Emitting Technologies Initiative in the Chemical Industry WEF_Implementing_Low_Carbon_Emitting_Technologies_in_the_Chemical_Industry_A_Way_Forward_2021.pdf (weforum.org)

data such as pressure and temperatures helps to optimise chemical processes and energy use, an approach that can be supported by machine learning-based systems and artificial intelligence.

Other approaches include reducing the number of steps in producing chemical products – as each step generally requires energy – or replacing outdated machines. Insulating buildings in manufacturing plants leads to reduced energy use while also creating a comfortable working environment. The ultimate aim is to design chemical processes that minimise the need for energy, as stated in one of the Green Chemistry principles (Anastas and Warner 1998)[16]. The use of catalysts is an option for reducing temperatures in chemical processes. Similarly, the use of enzymes allows certain chemical reactions to take place at room temperature and ambient air pressure at sea level.[3]

Alternative ways to produce ammonia

Ammonia production is one of the main sources of GHG emissions in the chemical industry, with conventional ammonia production using the Haber-Bosch process being especially energy intensive. According to the ICCA, ammonia production in 2010 consumed about 2.8×10^{17} joules or 2.8 exajoules of energy and generated 340 million tonnes of CO_2 equivalent (ICCA 2019)[18]. Mitsubishi Gas Chemical recently developed a process making use of a special membrane and catalyst which significantly reduce the required pressure and temperature compared to the Haber-Bosch process, with the potential to save around 40 million tonnes of CO_2 equivalent annually by 2050 (ICCA 2019). Industry that continues to use the Haber-Bosch process can apply green hydrogen instead of grey hydrogen as a feedstock to reduce GHG emissions.

Photo: James Baltz, unsplash

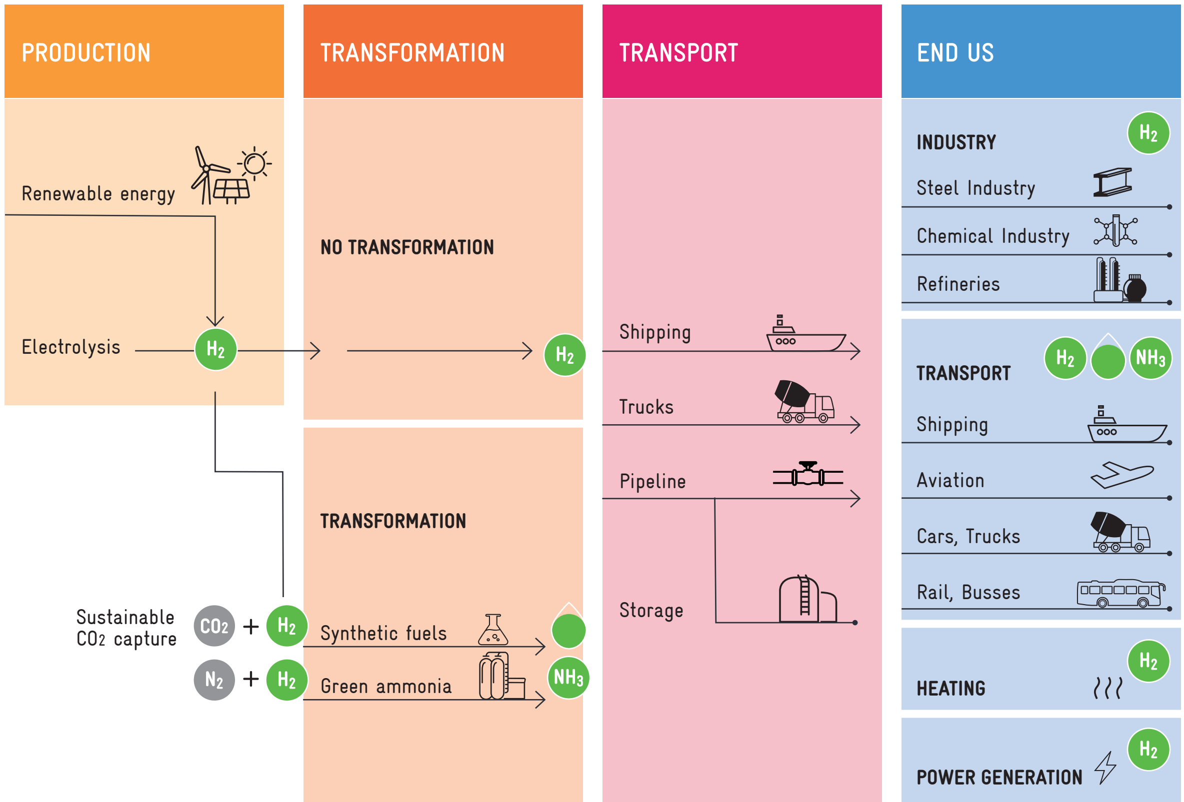
16 Anastas, P.T and Warner, J.C. (1998) Green Chemistry: Theory and Practice. Oxford University Press.

17 International Council of Chemical Associations (2019) Enabling the future: chemistry innovations for a low-carbon society. https://icca-chem.org/wp-content/uploads/2020/05/Enabling-the-Future.pdf

Green hydrogen and Power-to X for a net-zero pathway

For over a century, the chemical industry has used fossil resources, mainly oil, coal and gas, to produce basic chemicals such as ammonia, methanol, ethylene and propylene. These chemicals serve as a platform for a wide range of other chemicals, materials and products along the chemical industry value chain. Given the high greenhouse gas emissions associated with these feedstocks throughout their life cycle, alternative technologies are being explored that which use different types of chemical feedstocks generate little or no GHG emissions.

Figure 2.7: Green hydrogen production, conversion and uses across the energy system (IRENA 2020)[20]



[18] International Renewable Energy Agency (2020) Green Hydrogen: A guide to policy making.
Green hydrogen: A guide to policy making (irena.org)

About 95 per cent of the hydrogen produced worldwide today comes from steam methane reforming, partial oxidation of hydrocarbons or coal gasification (IRENA 2020)[18]. These processes, which are also referred to as grey hydrogen, consume significant amounts of energy and lead to substantial CO_2 emissions. Currently, electrolysis produces around 5 per cent of global hydrogen – an energy intensive process that splits water molecules into oxygen and hydrogen – mostly as a by-product of chlorine production. According to PricewaterhouseCoopers, hydrogen demand is on the increase and may reach between 150 to 500 million metric tonnes per year by 2050. These projections depend on global climate ambitions, sector-specific activities, energy-efficiency measures, direct electrification, and use of carbon-capture technologies (PWC 2022)[19].

Using renewable energy for water electrolysis generates green hydrogen and oxygen – without any GHG emissions. As a climate-neutral intermediate product, green hydrogen is an ideal medium for substituting fossil fuels in industrial processes and other applications. Green hydrogen is not only well suited for storing generated renewable energy, it is also used by the chemical industry as a feedstock and can serve as a basis for other basic chemicals in so-called Power-to-X (PtX) approaches, e. g. for green ammonia and green methanol. In the long run, green hydrogen and PtX have significant potential for advancing the sustainable energy transition and providing net-zero options for the chemical industry. We must bear in mind, however, that sustainability criteria must be applied in the design of green hydrogen strategies and their practical implementation to minimise trade-offs.

Enhancing circularity

By promoting the use of waste, waste heat and steam generated in one company/plant as input for another company/plant within a chemical park, circular economy solutions make a clear contribution to GHG mitigation. The same is true of intelligent waste management and recycling as well as certain waste-to-energy technologies, e. g. power generation from refuse-derived fuels or biogas from anaerobic wastewater treatment used as an energy input. In the context of the low-emission transformation of the chemical industry, other circular solutions offer possibilities for replacing fossil fuels as a feedstock through alternative sources, such as plastic waste, biomass (e. g. from agricultural waste) or carbon capture.

[19] PricewaterhouseCoopers (2022) The green hydrogen economy. https://www.pwc.com/gx/en/industries/energy-utilities-resources/future-energy/green-hydrogen-cost.html

[20] International Renewable Energy Agency (2020) Green Hydrogen: A guide to policy making. Green hydrogen: A guide to policy making (irena.org)

Chemical recycling

Plastics production still largely based on fossil hydrocarbons continues to grow, accounting for a considerable amount of GHG emissions. According to the OECD Global Plastics Outlook and the corresponding database[21], nearly 1,800 megatonnes of CO_2 equivalent were attributed to the life-cycle of global plastics production in 2019. Net-zero scenarios not only need to consider GHG emissions associated with chemical manufacturing (mainly scope 1) but also those associated with their products and related waste (scope 3). In terms of the end-of-life stage, over 90 per cent of today's polymer waste ends up to in waste incineration plants, in landfills or in the environment. Against this background, the chemical industry envisages chemical recycling of plastic waste as an alternative, in which technologies like pyrolysis lead to a liquid secondary raw material that with almost equivalent properties as raw oil and therefore might replace it. In larger scale this solution might work, when potential social and environmental impacts are considered and good collection and/or take-back systems are in place that avoid plastic pollution.

For example, in Japan alone, around 600,000 metric tonnes of shredder residue from discarded vehicles is generated each year. Mitsui Chemicals, together with a Japanese automotive company, has developed a pyrolysis-based liquefaction process that converts polymer waste into oil. The shredder residue contains various plastics, additives and metals and, by using a thermal process, the recyclables are separated with a focus on collecting polypropylene. The oil obtained from this is processed in naphtha crackers like its fossil equivalent, becoming new raw material to produce bulk plastics.

Carbon capture and utilisation (CCU)

Carbon capture technologies from waste gases to cutting-edge direct air capture can play an important role in the context of climate protection and GHG mitigation. At the same time, the natural storage of CO_2 in biomass should also not be overlooked as an option. Rather than pumping CO_2 into subterraneous storage, e. g. via carbon capture and storage, carbon feedstock can be utilised for plastics, fuel or other chemical products as an interesting alternative. As this process is energy intensive, however, carbon capture and utilisation will only become viable when large amounts of renewable energy are available at a competitive price. This could open the channel for CO_2 to become a basic material for plastics or synthetic energy carriers such as jet fuel. Based on a long-term vision, carbon can remain in the economic cycle, for example through chemical or mechanical recycling in a circular economy while minimising the release of plastic into the environment and reducing fresh carbon inputs, especially those from fossil sources.

Various approaches to CCU are currently being tested and implemented on a pilot basis. Covestro, for example, has developed a new catalyst together with the CAT Catalytic Centre at RWTH Aachen University to use CO_2 as a raw material for plastics. The German biotech start-up Electrochaea has developed a reactor in which single-cell microorganisms (archaea) convert CO_2 and hydrogen into methane. Siemens and Evonik have developed a kind of artificial photosynthesis mirroring nature's way of transforming light into chemical energy: a electrolysis process using renewable energy produces chemicals from CO_2 and water (ICCA 2019)[22].

[21] OECD (2023), "Global Plastics Outlook: Greenhouse gas emissions from plastics lifecycle - projections", OECD Environment Statistics (database), https://doi.org/10.1787/e39547a0-en

[22] International Council of Chemical Associations (2019) Enabling the future: chemistry innovations for a low-carbon society. https://icca-chem.org/wp-content/uploads/2020/05/Enabling-the-Future.pdf

2.4 Advancing a low carbon economy through green and sustainable chemistry

Avoiding hazardous substances and trade-offs

Beyond demonstrating climate-friendly solutions in the chemical industry, one of the central goals of CAPCI is to identify and avoid potential trade-offs between climate protection and chemicals management. This means that the use of hazardous substances with adverse effects on human health and the environment needs to be brought to a minimum; and even environment and climate-friendly technologies that are needed for the energy and mobility transition come along with new raw material demands and need to be assessed under sustainability criteria. For example, the presence of hazardous substances in materials and products, be they intentional or unintentional, impedes environmentally sound recycling and poses a challenge to the circular economy. Examples of contaminated recycled materials include flame retardants in children's toys made from recycled plastic and polycyclic aromatic hydrocarbons that contaminate rubber playgrounds made of recycled tires. Promoting sustainable material management, full disclosure of materials and improved knowledge-sharing along the entire supply chain including recyclers is therefore key. Furthermore, expanding sustainable product design based on green and sustainable chemical innovations can minimise or avoid hazardous substances in products and ensure recyclability of materials and products after their use.

The vision of green and sustainable chemistry

While risks and hazards of chemicals and chemical products have long been a focus of international discussions on chemical policies and chemicals management, the concept of green and sustainable chemistry is relatively new. It addresses the benefits and positive effects certain types of chemistry (see below) can have on the production and use of chemicals (ISC3 2021)[23]. The chemistry's contribution to address climate change provides a striking example. The ICCA has identified five main sectors where the chemical industry can contribute to a low-carbon transformation of the economy through innovation, namely: Power Generation and Storage, Mobility and Transportation, Food and Agriculture, Buildings and Construction, and Industry and Manufacturing (ICCA 2019). Avoiding negative trade-offs to reap these benefits without harming human health and the environment is essential.

To guide sustainable chemistry innovation and avoid trade-offs, UNEP has developed **10 Green and Sustainable Chemistry Objectives and Guiding Consideration** (UNEP 2020)[24], page 33. These are shared with relevant stakeholders to stimulate innovative action at various levels and in different settings. The objectives range from eliminating (or minimising) chemical hazards to ensuring that chemistry innovation addresses global sustainability challenges. The assumption is that the potential for chemistry to implement the 2030 Sustainable Development Agenda can be fully reaped without causing adverse human health and environmental impacts if chemistry innovations become compatible with the 10 Green and Sustainable Chemistry Objectives.

[23] International Sustainable Chemistry Collaborative Centre (2021) Policy Papers https://www.isc3.org/page/policy-papers
[24] United Nations Environment Programme (2020) Green and Sustainable Chemistry: Framework Manual. https://www.unep.org/explore-topics/chemicals-waste/what-we-do/policy-and-governance/green-and-sustainable-chemistry

TEN OBJECTIVES AND GUIDING CONSIDERATIONS FOR GREEN AND SUSTAINABLE CHEMISTRY (UNEP 2020)

Objective 1:
Minimising chemical hazards. Design of chemicals with minimal or no hazardous properties for use in materials, products and production processes ("benign by design")

Objective 2:
Avoiding regrettable substitutions and alternatives. Develop safe and sustainable alternatives for chemicals of concern through material and product innovations that do not create negative trade-offs

Objective 3:
Sustainable sourcing of resources and feedstocks. Use of sustainably sourced resources, materials and feedstocks without creating negative trade-offs

Objective 4:
Advancing sustainability in production processes. Use of green and sustainable chemistry innovation to improve resource efficiency, pollution prevention and waste minimisation in industrial processes

Objective 5:
Advancing sustainability of products. Use of green and sustainable chemistry innovation to create sustainable products and consumption with minimal or no chemical hazard potential

Objective 6:
Minimising chemical releases and pollution. Reduction of chemical releases throughout the life cycle of chemicals and products

Objective 7:
Enabling non-toxic circularity and minimising waste. Use of chemistry innovations to enable non-toxic circular material flows and sustainable supply and value chains throughout the life-cycle

Objective 8:
Maximising social benefits. Consideration of social factors, high standards of ethics, education and justice in chemistry innovation

Objective 9:
Protecting workers, consumers and vulnerable populations. Safeguards for the health of workers, consumers and vulnerable groups in formal and informal sectors

Objective 10:
Developing solutions for sustainability challenges. Focus chemistry innovation to help address societal and sustainability challenges

2.5 Plastics: An example of the chemical climate change challenge

Demand for plastic continues to climb

Plastics production is one of the most important fields of the chemical industry and, as outlined above, it is also very relevant for the climate. At the same time, the plastics lifecycle was identified as a major challenge in CAPCI's partner countries due to wide-spread plastics pollution in the environment, particularly in oceans and coasts. According to the OECD, plastic consumption has quadrupled over the past 30 years, driven by growth in emerging markets (OECD 2022)[25]. Global plastics production doubled from 2000 to 2019 to reach 460 million tonnes. According to the IPCC, demand for plastics has increased the most of any industrial product since 1970 (IPCC 2022 b)[26].

Photo: Sylwia Bartyzel, unsplash

[25] Organisation for Economic Co-operation and Development (2022) Global Plastic Outlook. Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD

[26] Intergovernmental Panel on Climate Change (2022 b) Working Group III contribution to the Sixth Assessment Report of the IPCC, full report. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf

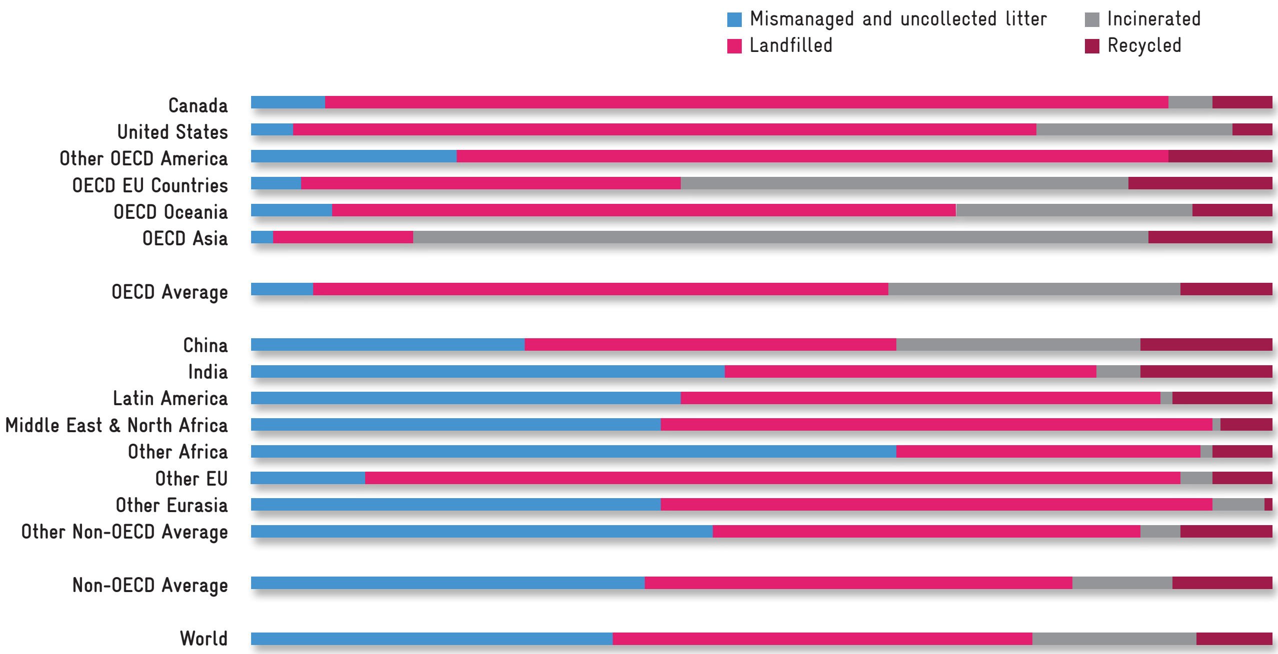
Plastics are responsible for significant amounts of greenhouse gases

Plastics account for 3.4 per cent of global GHG emissions (OECD 2022). In addition to macro-plastics, significant amount of microplastics – synthetic polymers with a diameter of less than 5 mm – enter the environment through industrial plastic granulates, synthetic textiles, road markings, tire abrasion and other sources. The current dependence level of over 99 per cent on fossil feedstocks, low recycling rates and high emissions from petrochemical processes are among the challenges for reaching a global net-zero emissions target.

Plastic recycling rates need to substantially increase

Most plastic ends up in landfills, is incinerated or leaks into the environment. While almost half of all plastic waste is generated in OECD countries, in many regions such as Africa, Latin America and Asia, waste plastic is often not collected and therefore ends up in the environment, where it slowly decomposes and generates GHGs. Globally, only 9 per cent of plastic waste is successfully recycled while 22 per cent is mismanaged (OECD 2022).

Figure 2.8: Share of plastics treated by waste management category, after disposal of recydling residues and collected litter, 2019 (OECD 2022)



Certain plastics can help to reduce greenhouse gas emissions

Plastics are important for reducing GHG emissions in other areas as well. They can be used to reduce the weight of vehicles: containers made of plastic are lighter than those made of glass, metal or wood thus reducing fuel consumption in logistics. While no common visions for fossil-free plastics exist to date, several promising approaches can be identified (IPCC 2022 b).

To achieve global climate mitigation targets while meeting demand for plastics and chemicals it is important, first of all, to reduce virgin raw material input for products, to reuse products and to recycle product materials at the end of their life – with incineration, waste treatment and waste disposal being less preferred options. To meet this requirement, sustainable materials management, resource efficiency and life cycle management are essential (UNEP 2019)[29].

Plastics from biomass may also reduce greenhouse emissions

Another option for reducing GHG emissions associated with plastics is to use biomass as a feedstock for chemical production. Instead of using carbon atoms from fossil raw materials, biomass – such as from sugar cane, corn or crop residues – can be used as a feedstock for polymer production. This pathway has the potential to absorb certain amounts of carbon dioxide from the atmosphere.

The resulting chemicals are identical to their fossil-based counterparts. Braskem has developed, for example, a process to convert bioethanol into ethylene to produce polyethylene (PE) and ethylene-vinyl acetate copolymer (EVA). It has also worked with Haldor Topsoe to develop monoethylene glycol (MEG) from sugarcane. MEG is an important raw material for the production of polyethylene terephthalate (PET) – the plastic widely used in packaging and textiles. Another example is Mitsui Chemicals' technology for producing polypropylene (PP) from biomass using a strain of the bacterium Escherichia coli (E.coli) developed through gene recombination.

POLICY OPPORTUNITIES PROVIDED BY SAICM – BEYOND 2020

The Strategic Approach to International Chemicals Management (SAICM) is a global policy framework that fosters multi-stakeholder and multi-sectoral dialogue and action to achieve the sound management of chemicals throughout their life cycle. Originally mandated to work until 2020, stakeholders are currently negotiating a future framework for SAICM beyond 2020 that will be adopted at the upcoming 5th International Conference on Chemicals Management (ICCM5) in Bonn, Germany, in September 2023. These negotiations open the door for addressing the climate change-chemical interface through a new framework. At the intersessional SAICM meeting in Bucharest in 2022, an integrated approach to chemicals and waste management was discussed, an important dimension of which includes the integration of chemicals management and sustainable development issues and initiatives, including climate change. Strategic objectives and targets to identify more specific actions are currently being negotiated, opening up an opportunity for stakeholders to address the chemistry-climate change nexus in the Beyond 2020 process.

[29] United Nations Environment Programme (2019) Global Chemicals Outlook II. https://www.unep.org/resources/report/global-chemicals-outlook-ii-legacies-innovative-solutions

CHAPTER 3

Diving deeper at the national level: Insights from CAPCI partner countries

Photo: Nasa, unsplash

DEEP DIVE:

- » Argentina
- » Ghana
- » Peru
- » Thailand
- » Vietnam

Introduction

This chapter summarises insights gathered across CAPCI cooperation activities conducted with five partner countries: Argentina, Ghana, Peru, Thailand and Vietnam. Seeking to analyse and discuss the situation of the chemical industry in the context of climate change, the initiative carried out baseline studies along with two national stakeholder dialogues with participants from the chemical industry, the scientific community and the government. These activities provided valuable results and learning experiences that are being fed into designing CAPCI capacity-development programmes for the chemical industry and related stakeholders. According to the Paris Agreement, all signatory countries are required to define their specific objectives, policies and strategies for tackling climate change via Nationally Determined Contributions (NDCs). These are voluntary commitments on the part of the signatory states to the Paris Agreement that set out concrete reduction targets to be achieved within a specific timeframe – broken down into individual sectors. Periodically, the countries report on their progress and consistently set more ambitious targets. In this context, CAPCI aims to enhance the capacity of stakeholders in partner countries related with the chemical sector for the development of effective sector plans, roadmaps and measures for greenhouse mitigation in support of their NDCs.

Numerous developing and emerging countries have established climate-neutrality and zero-emission scenarios as key targets. This is the case for Thailand and Vietnam, which committed to achieving climate-neutrality by 2050 at the 26th Conference of Parties (COP26) in Glasgow in 2021. Raising the ambition of mitigation targets implies that all relevant emission sectors – from energy generation, transport, housing and industry to waste management, agriculture, forestry and land-use – must define their possible share of emission reductions. However, experience gathered in the scope of CAPCI has uncovered a lack of reliable data on industrial emissions, and specifically from the chemical industry. Moreover, while the majority of GHG emissions generated by the chemical industry stems from fossil energy use, these are generally attributed to the energy sector, meaning that overall emissions generated by the chemical sector are frequently far from clear and, in many cases, underestimated. As CAPCI has discovered, government agencies and industry players themselves are often unaware of the critical importance and potential of the chemical industry in the context of tackling climate change – even more so when we consider the entire value chain of chemical production and use.

Lessons learned from CAPCI suggest that the production and use of chemicals has started to receive greater attention because of more ambitious NDCs and higher mitigation targets in many countries, which are followed up by sector plans that dig much deeper for identifying climate protection measures. Meaningful mitigation plans for the chemical industry as well as individual companies can only be established if reliable GHG data for the different subsectors and sources are available. For this reason, GHG accounting was identified as a key topic in the context of information, awareness-raising, capacity building and training activities as well as advisory support for companies – particularly small and medium-sized enterprises. Responsible care programmes[1] have proven to be an excellent starting point for practically implementing climate protection efforts in the chemical industry. These allow countries to address synergies and trade-offs between climate protection and chemical management.

A number of important questions arise for future CAPCI work here: Are there any enabling policy frameworks out there that can steer the chemical sector toward climate-friendly and sustainable practices? What specific needs do the chemical industry have? What government incentives have proven to be effective for getting companies to switch to more climate-friendly processes? Are there specific subsidies or other support mechanisms for SMEs? Do the relevant stakeholders have access to know-how and financial resources to reduce their GHG emissions?

In the following sections the reader finds first an overview on the economic importance as well as key figures for energy demand and GHG emissions for the 5 partner countries that CAPCI has been cooperating with: **Argentina**, **Ghana**, **Peru**, **Thailand** and **Vietnam**. Based on this background, relevant policies and strategic objectives are described under the heading "country vision", followed by resulting challenges and conclusions on how to bridge the identified gaps, according to the stakeholder dialogues realized in each of these countries.

[1] Responsible Care is the global chemical industry´s unifying commitment to the safe management of chemicals through their life cycle, while promoting their role in improving quality of life and contributing to sustainable development https://icca-chem.org/resources/responsible-care-global-charter/

Supporting CAPCI Activities in
» Argentina

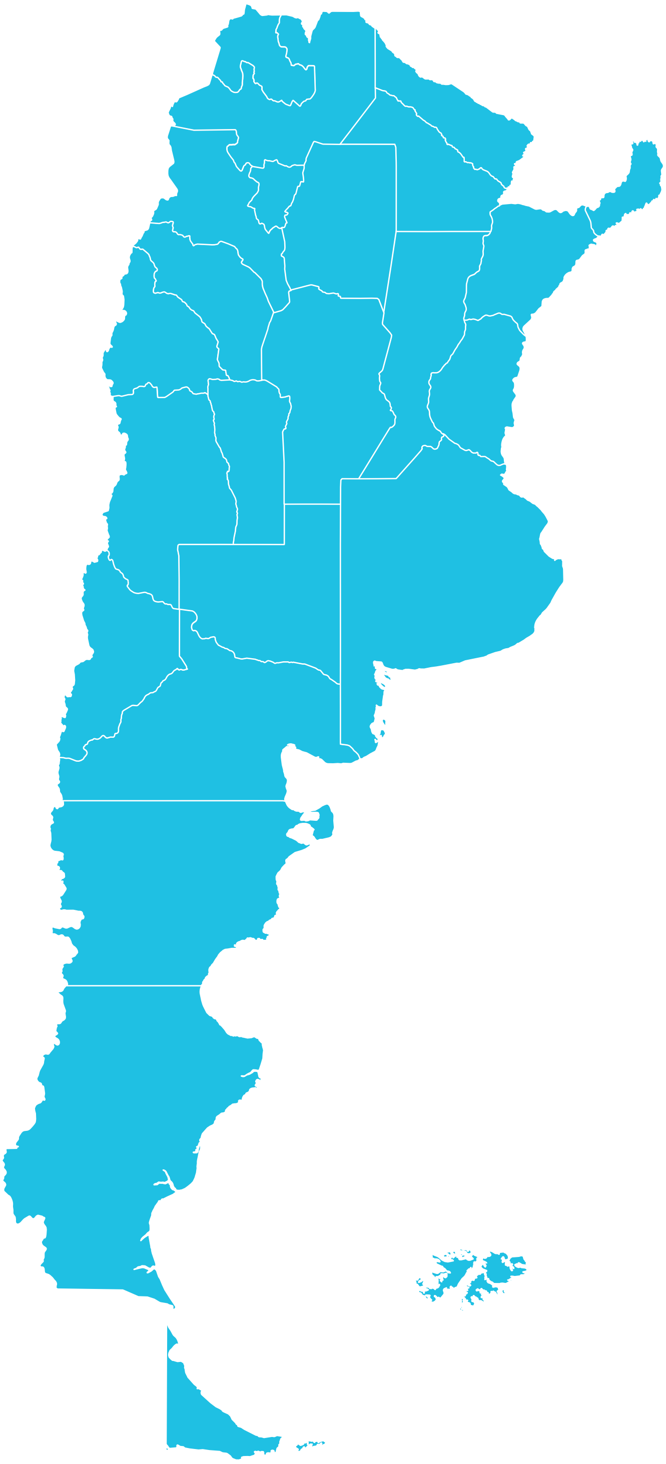
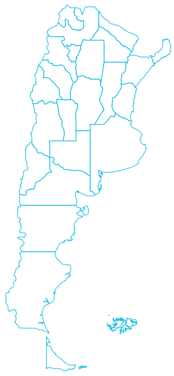


Photo: Hector Ramon Perez, unsplash

Photo: Juan Cruz Mountford, unsplash

Deep dive: Argentina



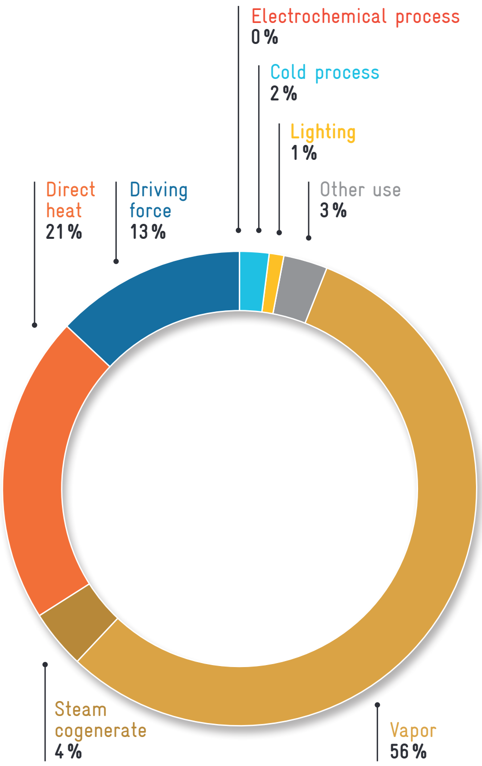
Economic importance

Argentina is one of the largest economies in Latin America, with a gross domestic product (GDP) of over USD 487 billion in 2021 (World Bank 2022a)[2]. The total annual production value of the chemical industry is around USD 18 billion, accounting around 12 per cent of Argentina's total manufacturing revenue or 4.2 per cent of the nation's gross domestic product (GDP). Over 110,000 people are employed in Argentina's chemical and petrochemical industry, with SMEs accounting for 50 per cent of total employment – with each direct job generating eight indirect jobs (CIQyP 2021)[3].

Energy demand and GHG emissions

Argentina's industrial sector accounted for 22.4 per cent of final energy demand in 2017, representing the third-largest energy consumer. Of this amount, 14.3 per cent was used by the chemical sector. The petrochemical sector alone was responsible for nearly 1.4 million tonnes of oil equivalent, powered by 22 per cent electrical energy and 78 per cent gas (GFA 2021)[4]. The lion's share of energy consumption was used for steam generation (see figure 3.1). In terms of the energy supply, 53 per cent is generated from gas, 33 per cent from oil, 3 per cent from nuclear, 10 per cent from renewable energies and the rest from coal (IRENA 2022a)[5].

Figure 3.1:
Distribution of energy demand of the Argentinian petrochemical industry in 2017 (GFA 2021)



[2] World Bank (2022a) Gross Domestic Product GDP of Argentina. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=AR
[3] Cámara de la Industria Química y Petroquímica www.ciqyp.org.ar
[4] GFA Consulting Group (2021) Propuesta de Plan Nacional de Eficiencia Energética. 09011503_PropuestaPlaNEEAr.pdf (eficienciaenergetica.net.ar) International Renewable Energy Agency (2022) Energy Profile Argentina. https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/South%20America/Argentina_South%20America_RE_SP.pdf
[5] International Renewable Energy Agency (2022) Energy Profile Argentina. https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/South%20America/Argentina_South%20America_RE_SP.pdf

Photo: Benjamin Rascoe, unsplash

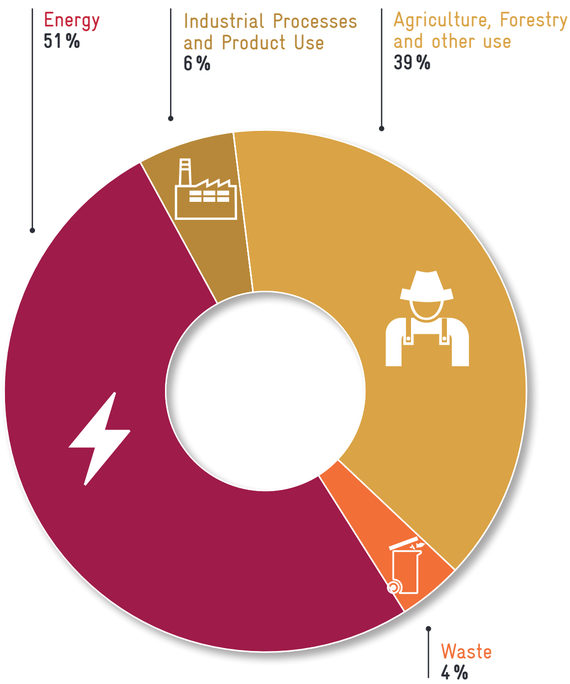
Photo: Benjamin Massello, unsplash

In 2018, Argentina's GHG emissions amounted to 366 million tonnes of CO2 equivalent, with the energy sector responsible for over half of this figure (MAyDS 2021)[6]. Emissions from the industrial processes and product use sector (IPPU) accounted for 5.7 per cent of GHG emissions in 2018 (figure 3.2). The IPPU sector generated 20.8 million tonnes of CO2 equivalent, with 11.7 per cent or 2.4 million tonnes of CO2 equivalent stemming from the chemical industry. The petrochemical industry was responsible for a majority of GHG emissions with, 1.2 million tonnes of CO2 equivalent, followed by the ammonia sector at just under 0.7 and fluorochemicals at just over 0.6.

A detailed look at the data shows that the 5.7 per cent of GHG emissions attributed to the IPPU sector represent a minor part of total emissions. Another 9.8 per cent of total emissions were caused by the combustion of fossil fuels in the industrial sector. The same is also true for the chemical and petrochemical industry, the total emissions of which are significantly higher than those registered under the IPPU sector. Due to a lack of detailed data, however, no exact values can be cited. The bulk of process-related emissions from the chemical sector covered under IPPU arise from nitric acid production and the release of nitrous oxide (N_2O), with a high degree of global warming potential.

Figure 3.2:
Distribution of GHG emissions in Argentina across all sectors in 2018 in million tonnes of CO2 equivalent (MAyDS 2021)

Note: Most of the GHG emissions emitted by the industrial sector as well as by the chemical industry's subsector stem from fossil fuel burning. These are not included in the represented IPPU sector but rather in the energy sector.



[6] Ministerio de Ambiente y Desarrollo Sostenible de Argentina (2021) Fourth Biennial Update Report to United Nations Climate Change of Argentina BUR4.
https://unfccc.int/sites/default/files/resource/4to%20Informe%20Bienal%20de%20la%20Rep%C3%BAblica%20Argentina.pdf

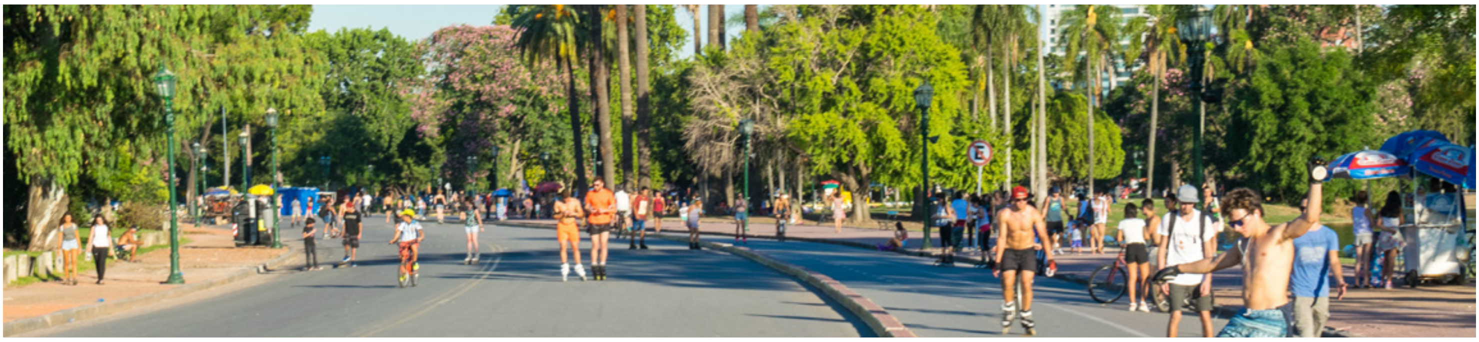


Photo: Benjamin Rascoe, unsplash

Country Vision

Argentina has defined clear goals to address climate change. In 2016, Argentina committed itself in its NDCs to reduce its emissions by 18 per cent by 2030 compared to a business-as-usual scenario. In December 2020, Argentina submitted its second NDC, which was updated in November 2021 with an increased ambition target 27.7 per cent higher than the previous one set in 2016. Under the new target, net emissions are not to exceed 349 million tonnes of CO2 equivalent by 2030 (Presidencia Argentina 2021)[7].

With the introduction of Law 27.520 on minimum standards for climate change adaptation and mitigation the end of 2019, existing institutions such as the National Climate Change Cabinet were formalised. The law consolidates policies and measures that were already regulated by other norms, and it likewise includes measures aimed at the collection of data and information on climate change while establishing a basis for planning those targeting adaptation and mitigation (Gaspes E. 2022)[8].

Developed in 2022, the National Climate Change Adaptation and Mitigation Plan covers six strategic areas, two of which directly impact the chemical industry: Energy Transition and Productive Transition. To reach the goals set out in each strategic area, Argentina aims to start moving towards a transition economy, strengthen its institutions, pursue research, development and innovation, and promote citizen participation and empowerment (MAyDS 2022)[9]. The strategic area Productive Transition primarily focuses on the industrial sector – for which sector plans are currently being developed. This includes topics such as sustainable design and process innovation, valorisation of waste streams and the development of national value chains, each of which has a significant impact on the chemical industry. The Energy Transition also addresses the industrial sector, including aspects such as energy efficiency, low-GHG energy production and the introduction of modern technologies.

Existing challenges

As in the other CAPCI partner countries, representatives from the chemical industry, associations and the public sector in Argentina got together during two national stakeholder dialogues to discuss the situation in the country. With support from CAPCI, Argentina's chemical and

KEY STAKEHOLDERS

[7] Presidencia Argentina (2021) Actualización de la meta de emisiones netas de Argentina al 2030 NDC. Argentina Second NDC (Updated submission) | UNFCCC
[8] Gaspes E. (2022), Baseline Study: Characterization of the Chemical Industry in Argentina, CAPCI-GIZ
[9] Ministerio de Ambiente y Desarrollo Sostenible de Argentina (2022) Plan Nacional de Adaptación y Mitigación al Cambio Climático, Resumen Ejecutivo. https://www.argentina.gob.ar/sites/default/files/resumen_ejecutivo_pnaymcc.pdf

Photo: Andrea Leopardi, unsplash

petrochemical industry association CIQYP organised these virtual information and discussion events. The 48 participants at the first dialogue and 54 in the second heard input presentations covering the political framework and technological initiatives in Argentina and also exchanged insights related to the activities of international chemical companies addressing climate protection, the circular economy and new technological approaches. The participants emphasised the fact that not only modern processes for emitting lower GHG are needed, but a combination of political measures, financing solutions and broad social acceptance for reducing GHG emissions across all sectors of the economy. Additionally, players from the public sector, the business community and industry – along with their respective associations – must collaborate to guide the transition process in the chemical industry toward carbon neutrality.

Large chemical companies have already begun using and introducing climate-friendly processes, and renewable technologies are being implemented in the electricity sector. To ensure that a low-emission transformation is likewise feasible for small and medium-sized businesses, these will need access to the necessary infrastructure, financial assistance and a comprehensive transfer of know-how. Climate change is still a rather recent challenge on the agenda of the chemical and petrochemical industries in Argentina, calling for a strategic response. Stakeholders can, however, build on solid experience and methods from the responsible care programme addressing chemical management and handling – one that is well established in Argentina.

Bridging the gap

The participants in the national stakeholder dialogues brought up problems as well as potential solutions. They believe that, in order to collectively identify and implement solutions, communication among all the pertinent players must be strengthened. Each country will require individual solutions tailored to their respective needs: while international experience and approaches may be relevant for Argentina, these must be adapted to each context.

Guaranteeing political commitment from corresponding regulations is a crucial factor for ensuring that the industry and general population take the transformation to climate-friendly production seriously. Funding is likewise essential as it allows for investment into the technologies needed to achieve the GHG emission-reduction targets, while also strengthening competitiveness and satisfying additional environmental and sustainability criteria.

The Argentinian chemical industry could significantly lower its carbon footprint by switching to power generated from renewable energy sources. Apart from recognising that energy efficiency measures combined with self-sufficient electricity generation from renewable sources is the most important approach for cutting GHG emissions and substituting fossil energy carriers in the long term, the participants agreed that this can also prevent production disruptions and even cut expenses in the face of possible power outages and high electricity bills. Moreover, the reduction of laughing gas emissions from fertiliser production and, as a forward-looking option, the phasing-in of green hydrogen and PtX technologies present interesting economic opportunities contributing to climate-neutrality. The climate-oriented transformation of the chemical and petrochemical sector is an enormous and complex challenge. Recognising that economic, social and environmental sustainability are fundamental and must comprise a key part of strategy development, the stakeholders of the chemical industry decided on a roadmap study to identify feasible and efficient low-emission pathways. In coordination with CIQyP, CAPCI will provide specific training courses – particularly for companies, including small and medium-sized enterprises – that build on the existing responsible care programme for Argentina.

Supporting CAPCI Activities in

» Ghana

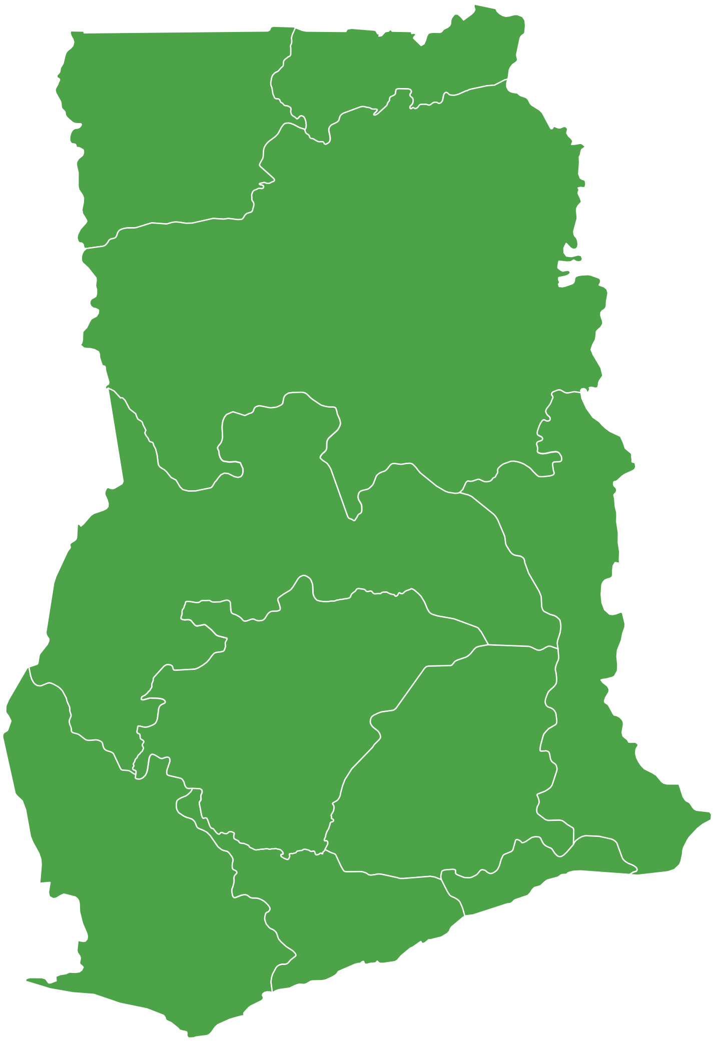
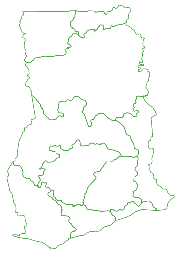


Photo: Kofi Nuamah Barden, unsplash

Photo: Seyiram Kweku, unsplash

Deep dive: Ghana

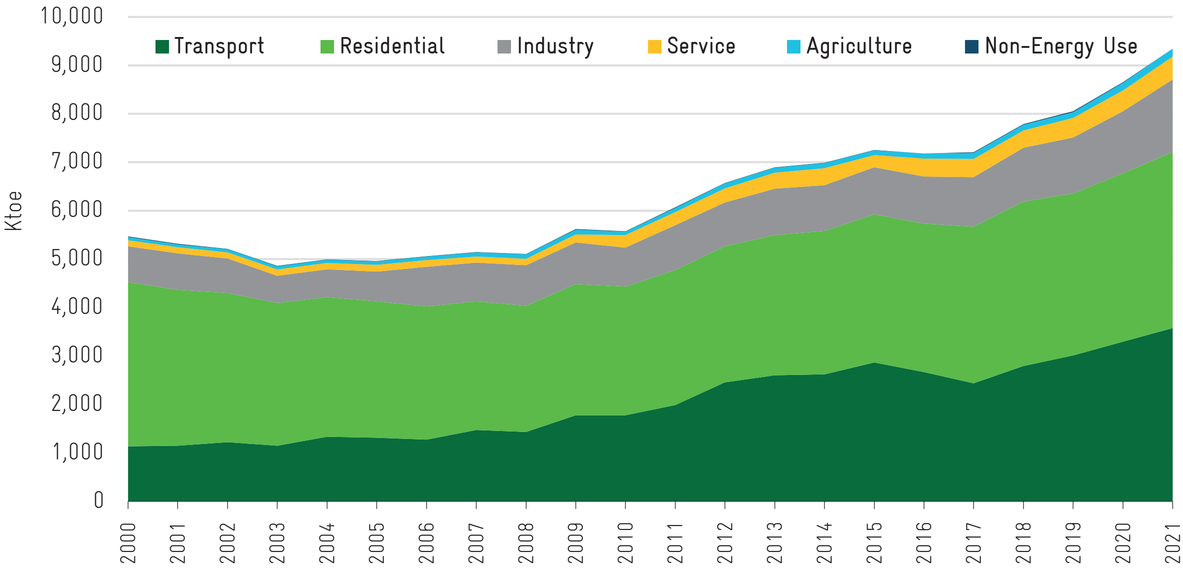


Economic importance

In 2021, Ghana's GDP amount to USD 78 billion (World Bank 2022b)[10], of which the amounted sector contributed 49 per cent and the industrial sector (broadly taken to included, e. g. mining) contributed 30 per cent – followed by agriculture with 21 per cent (ITA 2022)[11]. The country's largest industries are petroleum, mining, energy, paints, aluminium smelting, steel, light manufacturing, furniture, textiles and food processing.

The chemical sector makes up around 6 per cent of national GDP in Ghana as well as a significant share of the manufacturing sector (Jumpah 2022)[12]. In 2019, the country's chemical imports reached USD 1.1 billion, with China representing the largest trading partner for the sector. Only about 3 per cent of the nation's overall chemical demand is met by domestic chemical production, mostly consisting of glycerol – a by-product of the soap-making industry. Glycerol is the only industrial chemical manufactured and exported by Ghana. The bulk of chemical exports are those that have been formulated and repacked (EPA 1997)[13].

Figure 3.3: Final energy consumed by sector (Energy Commission 2022)

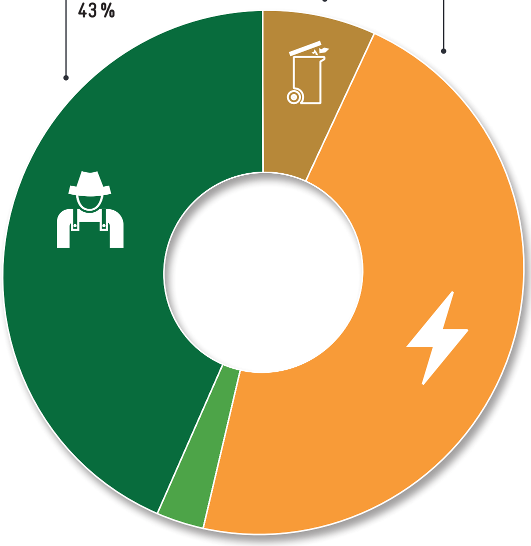


[10] World Bank (2022b) Gross Domestic Product GDP of Ghana. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=GH
[11] International Trade Administration (2022) Ghana Country Commercial Guide. https://www.trade.gov/country-commercial-guides/ghana-market-overview
[12] Jumpah D. (2022) Baseline Study on Chemistry and Climate Change in Ghana, CAPCI – GIZ

Photo: Virgil Sowah, unsplash

The government's strategic plan for the sound management of chemicals and waste considers as part of its strategy the promotion of sustainable consumption and production through the use of safer alternatives and innovative solutions to prevent or minimise risks to human health and the environment. To this end, awareness among the chemical industry needs to be raised to promote investment into research and development programmes that will advance green and sustainable chemistry, cleaner production and the deployment of life-cycle management approaches for chemicals (EPA 2021)[14].

Figure 3.4:
GHG emissions in Ghana in 2019 (MESTI and EPA 2021a)



Energy demand and GHG emissions

Energy consumption across different sectors of the economy has increased significantly over the past 20 years (see figure 3.3). The household and transport sectors are by far the largest end users, accounting for 38.9 per cent and 38.3 per cent of total energy consumption, respectively, in 2021, while industrial users accounted for 16 per cent and services for 5.1 per cent (Energy Commission 2022)[15].

Around 39 per cent of the energy supply derives from oil, 17 per cent from gas, 44 per cent from renewable energy and the rest from carbon (IRENA 2022b)[16].

The country's total greenhouse gas emissions stood at almost 59 million tonnes of CO_2 equivalent in 2019. The energy sector is the most significant source of emissions, representing 46.6 per cent of total national emissions. Ghana's GHG emissions have presented an upward trend, having increased by 16 per cent in 2019, with 2016 taken as a base year. This increase in GHG emissions is associated with Ghana's economic activities, particularly its strong reliance on the export of hydrocarbons, precious minerals, timber and cocoa. More specific data for GHG emissions from the chemical sector have so far not been mapped.

Predictions for the current decade show that Ghana's emissions will increase by 70 per cent to 100 million tonnes of CO_2 equivalent by 2030, up from 59 million tonnes in 2019. This expected rise in emissions is being driven by the expansion of fossil-fuel intensive manufacturing and electricity generation, urban road transport, gas flaring and solid waste disposal (MESTI and EPA 2021a)[17].

[13] Environmental Protection Agency (1997) National Profile to Assess the Chemicals Management Infrastructure in Ghana. Microsoft Word - GHANA.DOC (unitar.org)
[14] Environmental Protection Agency (2021) Sound Management of Chemicals and Waste in Ghana Strategic Plan (2021 – 2030)
[15] Energy Commission (2022) National Energy Statistics of Ghana. https://energycom.gov.gh/files/2022%20Energy%20Statistics.pdf
[16] International Renewable Energy Agency (2022b) Energy Profile Ghana. ENERGY PROFILE - Ghana - IRENA
Ministry of Environment, Science, Technology and Innovation and Environmental Protection Agency (2021a) Ghana´s Third Biennial Update
[17] Report to United Nations Climate Change. https://unfccc.int/sites/default/files/resource/gh_BUR3_1282021_submission.pdf

Photo: Joek Winkler, unsplash

Photo: Jay Eshie, unsplash

Country vision

Ghana joined the UNFCCC in September 1995 and adopted a National Policy on Climate Change in 2013. Led by the Ministry of Environment, Science, Technology and Innovation (MESTI) und the Environmental Protection Agency (EPA), Ghana presented an updated version of its NDC in 2021, covering 19 policy actions across 10 priority areas that collectively target absolute GHG emission reductions of 64 million tonnes of CO_2 equivalent by 2030, taking 2019 as a reference year (MESTI and EPA 2021b)[18].

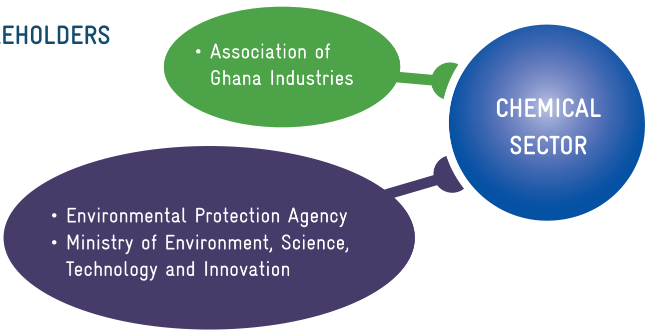
For 34 of the defined mitigation measures, Ghana aims to implement nine unconditional programmes of action that would result in a reduction of 8.5 million tonnes of CO_2 equivalent by 2025 and a further 24.6 million tonnes of CO_2 equivalent compared to cumulative emissions in a baseline scenario for 2020-2030. Ghana also aims to adopt 25 additional conditional programmes of action if financial support from international organisations and private sector is made available – with the potential for reducing an additional 39.4 million tonnes of CO_2 equivalent by 2030. The policy actions presented in Ghana's NDC are related to: social inclusion, early warning and disaster risk management, building resilience, food and landscape restoration, smart communities, sustainable mobility, sustainable energy transition and responsible production.

Existing challenges

The current measures identified for reducing GHG emissions in Ghana presently do not include any specific focus on the chemical industry. To map the challenges facing the chemical industry in connection with climate change, CAPCI worked with the Association of Ghana Industries and the country's Environmental Protection Agency through two national stakeholder dialogues with representatives from the chemical industry, business associations, government institutions and academia. These dialogues addressed the current situation and sought to find joint approaches for potential solutions. The participants identified various challenges that need to be addressed in order to achieve climate-friendly chemical production:

- Bringing together stakeholders from ministries, industry and non-governmental organisations to agree on roles and responsibilities is not always easy.
- The scientific community needs to be more involved, requiring that closer links be established with industry.

KEY STAKEHOLDERS



[18] Ministry of Environment, Science, Technology and Innovation and Environmental Protection Agency (2021b) Updated Nationally Determined Contribution under the Paris Agreement (2020 – 2030) of Ghana. https://unfccc.int/sites/default/files/NDC/2022-06/Ghana%27s%20Updated%20Nationally%20Determined%20Contribution%20to%20the%20UNFCCC_2021.pdf

Photo: JJ Jing, unsplash

- While often available, climate-friendly processes and technologies are not implemented due to a lack of advisory support from technical institutions, public incentives, adequate networking possibilities and cooperation structures.

- Reliable data is often lacking, requiring analyses to be conducted regularly to determine how the chemical sector has achieved reductions and how it can do so in the future.

- Properly handling over 3,000 tonnes of plastic waste that is generated across Ghana every day, 86 per cent of which is mismanaged.

- E-waste has also become a challenge in Ghana: estimates show that 171,000 metric tonnes of e-waste is generated annually, the bulk of which is not managed properly (World Bank 2021)[19].

After surveying ten chemical companies, three government organisations and four universities, the baseline study commissioned by CAPCI concluded that there is little awareness of climate change and little knowledge of climate-friendly practices among chemical companies. In their view, companies point to a lack of incentive mechanisms to promote sustainable chemistry along with the corresponding financing mechanisms. The latter applies, above all, to the large number of small chemical companies.

Bridging the gap

At the national stakeholder dialogues, participants highlighted the need for improved regulations, financing options and technical support would encourage companies to invest more in sustainable technologies. To reduce GHG emissions, concepts tailor-made for Ghana's chemical sector are required. Renewable energy and, in the long run, green hydrogen and PtX are among the most viable solutions to replace fossil fuels. There is also significant need to improve the know-how among responsible stakeholders in the chemical industry regarding climate-friendly processes, which can be provided by way of training programmes and participation in international networks.

Companies can start by focusing on low-hanging fruit such as resource efficiency, loss reduction, energy saving and the use of renewable energy in operations. Energy audits can be used to identify and evaluate a company's energy consumption – which can be used as a basis for developing measures to reduce their energy requirements. Companies can benefit from the fact that green loans in Ghana for climate-friendly solutions are available while interest rates are low or zero. Capacity building and technical support should be provided or improved to prepare them for developing well-designed measures and accessing financing instruments.

[19] World Bank (2021) Ghana Country Environmental Analysis. https://openknowledge.worldbank.org/handle/10986/33726

Supporting CAPCI Activities in

» Peru

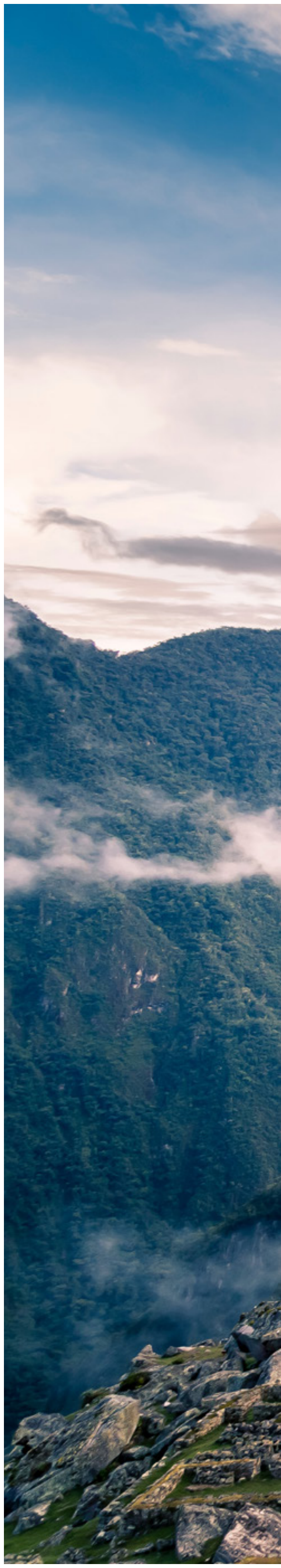


Photo: Willian Justen de Vasconcellos, unsplash

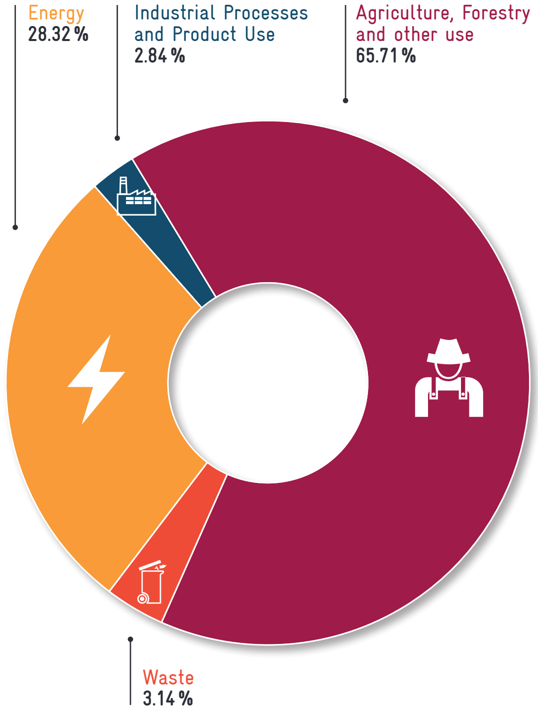
Photo: Aarom Ore, unsplash

Deep dive: Peru

Economic importance

According to World Bank[20] data, Peru's GDP in 2021 was USD 223 billion, of which the industrial sector accounted for 13.1 per cent, making it the country's second-largest economic sector. This sector employs 8.5 per cent of the total working population across over 100,000 companies, most of which are concentrated in the Lima region. The chemical industry contributed 0.9 per cent to the national GDP[21] and 7 per cent of the manufacturing sector in 2020. The subsector of chemical products is the most important, accounting for 5 per cent of the industrial sector's GDP. The chemical industry in Peru is divided into three subsectors: basic chemicals and fertilisers, chemical products and pharmaceutical products and medicines – which collectively generated around USD 15.6 billion in 2020 (Fernandez 2022)[22]. The petrochemical industry is not included in this figure.

Figure 3.5:
GHG emissions in Peru by sector in 2016 (MINAM 2016 a)



[20] World Bank (2022c) Gross Domestic Product GDP of Peru. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=PE
[21] Note: In contrast to other countries, these data do not include the petrochemical industry
[22] Fernandez L. (2022) Baseline Study: Estudio de la Industria Química y Cambio Climático en Peru, CAPCI-GIZ

Photo: Alexandra Tran, unsplash

Energy demand and GHG emissions

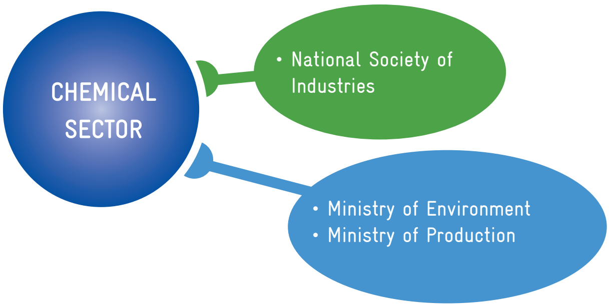
In Peru, 48 per cent of the energy supply comes from oil, 27 per cent from gas, 22 per cent from renewable sources and 3 per cent from coal (IRENA 2022c)[23]. While Peru's 2016 Annual Report on Greenhouse Gases in the Energy Sector provides aggregated data on emissions from carbon dioxide, methane and nitrous oxide in the manufacturing and construction sectors (MINAM 2016a)[24], no specific data exists for the chemical sector.

According to the National Greenhouse Gas Inventory (MINAM 2016a), the country's total net GHG emissions in 2016 were 205 million tonnes of CO_2 equivalent. GHG emissions from the IPPU sector amounted to 5.8 million tonnes of CO_2 equivalent in the same year, representing 2.8 per cent of total emissions at the national level. The chemical industry accounted for 0.1 million tonnes of CO_2 equivalent, consisting of process-related emissions from nitric acid and sodium carbonate production, which corresponds to 2.3 per cent of IPPU emissions (see figure 3.5). These figures do not include indirect emissions. Additionally, no emission data are available for the combustion of fossil fuels used by the chemical industry for the purpose of energy production, despite accounting for the largest share of the industry's GHG emissions. As such, we are unable to quantify total GHG emissions of Peru's chemical industry.

Country vision

Peru set out its institutional framework for climate-related action upon signing of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, which the country ratified in 1993. Chaired by the Ministry of the Environment and including the Ministry of Production as one of its 16 members (MINAM 2016b)[25], the National Commission on Climate Change is responsible for developing and promoting the National Strategy on Climate Change. The ENCC from 2015 serves as the guiding document for climate action, with the Ministry of Environment responsible for coordinating its implementation. The government has used these to develop its Nationally Appropriate Mitigation Actions (NAMAs), create a national GHG inventory and introduce financial instruments for advancing climate-friendly actions. The NDCs envision a 40 per cent reduction in total GHG emissions by 2030, 30 per cent of which is to be achieved through investments stemming from public and private funds and another 10 per cent through investments linked to international funds (Gobierno del Perú 2020)[26].

KEY STAKEHOLDERS



[23] International Renewable Energy Agency (2022c) Energy Profile Peru. https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/South%20America/Peru_South%20America_RE_SP.pdf

[24] Ministerio del Ambiente de Peru (2016a) Inventario Nacional de Gases de Efecto Invernadero – INGEI. https://infocarbono.minam.gob.pe/annios-inventarios-nacionales-gei/ingei-2016/

[25] Ministerio del Ambiente de Peru (2016b) Tercera Comunicación Nacional del Peru a la Convención Marco de las Naciones Unidas sobre el Cambio Climático. Tercera Comunicación Nacional del Perú a la Convención Marco de las Naciones Unidas sobre el Cambio Climático | SINIA | Sistema Nacional de Información Ambiental (minam.gob.pe)

[26] Gobierno de Peru (2020) Intended Nationally Determined Contribution of Peru (updated submission). https://unfccc.int/documents/499569

Photo: Adrian Dascal, unsplash

Existing challenges

As in the other CAPCI partner countries, experts from Peru's industry, associations, politics, and scientific community came together for two national stakeholder dialogues. Held virtually, these dialogues included the participation of over 200 people, with the industry association SNI playing an active role in organising them. The first meeting focused on international experience and case studies deemed relevant for companies in Peru. At the second, a baseline study carried out by national consultant Lourdes Fernandez on behalf of CAPCI was presented and discussed. Comments and feedback received from Peruvian representatives of associations, the public sector and industry were collected to update and refine this study.

The national stakeholder dialogues and the study reveal a lack of orientation and guidelines that would facilitate a comprehensive assessment of GHG emissions emitted by the chemical industry in Peru. While chemical companies submit a range of information to various government agencies, this data is not included in the national GHG inventory due to lack of coordination and prioritisation (Fernandez 2022)[27].

The stakeholder dialogues also revealed a serious gap in terms of capacities for greenhouse gas accounting and targeted climate actions, e. g. qualified personnel that can record emissions, optimise processes and implement mitigation and circular economy measures. Furthermore, a lack of knowledge is evident about the effects of climate change among the workforce as well as among management and the general populace. As a consequence, most companies do not possess the technical and managerial know-how needed to optimise their processes and reduce GHG emissions (Fernandez 2022). This is even more critical as a large number of small informal enterprises are also involved in handling of chemicals. On account of the high level of informality and lacking environmental permits, such activities are not regularly controlled and monitored, nor are their emissions.

[27] Fernandez L. (2022) Baseline Study: Estudio de la Industria Química y Cambio Climático en Peru, CAPCI-GIZ

Photo: Janaya Dasiuk, unsplash

Bridging the gap

The baseline study and the national stakeholder dialogues indicate that Peru faces a pronounced need for training, especially on the topics of green/sustainable chemistry and climate change, emissions accounting and the importance of the chemical industry in combating climate change. Tailor-made training programmes for professionals and employees in the public sector, business associations and companies could lay a solid foundation for change. The Peruvian industry association SNI is planning to roll out national training courses in coordination with the CAPCI team for employees of chemical companies with regard to efficient and climate-friendly technologies as well as building awareness about the importance of climate change.

Efforts on the part of the chemical industry to advance climate-friendly modernisation measures would greatly benefit from an overall national decarbonisation strategy, and particularly from an energy transition aimed at tapping the vast potential held by renewable energy sources in Peru.

The Ministry of Environment has created the High Commission on Climate Change to develop climate change adaptation and mitigation measures under the NDCs. The NDCs envision a 40 per cent reduction in total GHG emissions by 2030. 30 per cent of the reduction is to be achieved through investments with public and private funds, and 10 per cent through investments with international funds.

In 2018, the country enacted the Framework Law on Climate Change. With the law, sectoral authorities are responsible for public action on climate change and those parts of the NDCs associated with their sector. They report the status of implementation to the Ministry of Environment as it monitors and evaluates the NDCs. In addition, the authorities also send the sectoral GHG inventories to the Ministry of Environment. Sector authorities are also responsible for building institutional capacity for climate change policies, processes and mitigation actions.

Complementing the climate strategy, there is also a roadmap for circular economy in the IPPU sector initiated by the Ministry of Production (PRODUCE) and the Ministry of Environment (MINAM) in 2020. This aims to promote the transition from a linear to a circular economy.

Supporting CAPCI Activities in

» Thailand

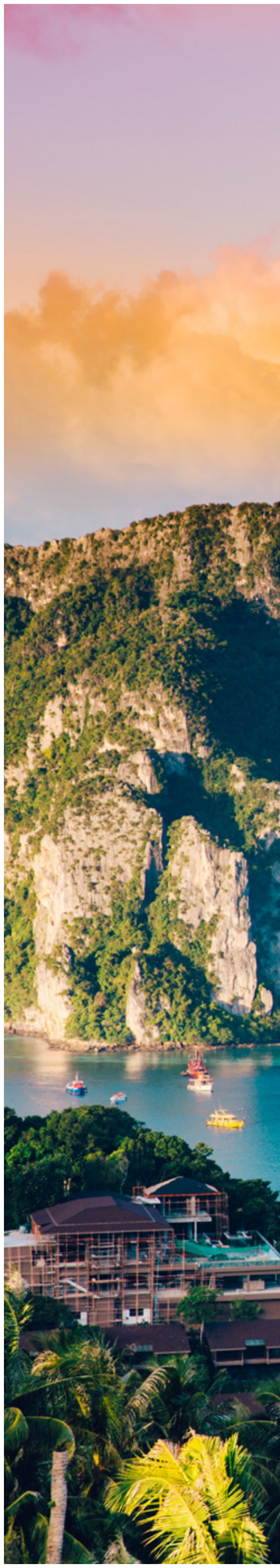
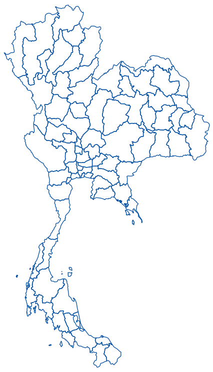


Photo: JJ Jing, unsplash

Photo: Braden Jarvis, unsplash

Deep dive: Thailand

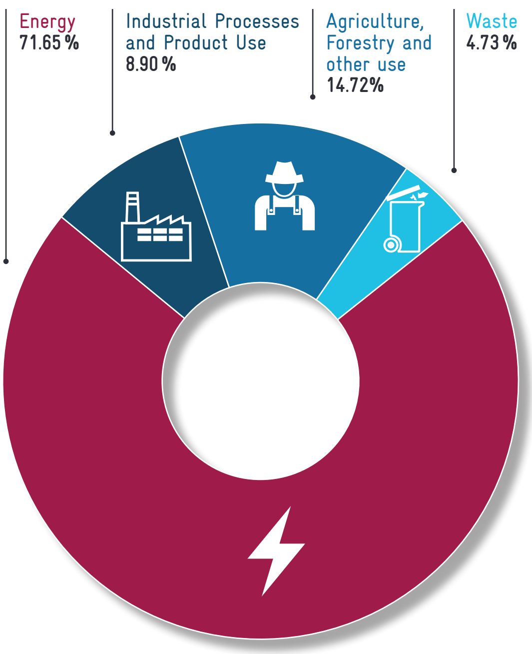


Economic importance

Thailand's industrial sector including the chemical industry accounted for nearly 27 per cent of the country's USD 506 billion GDP in 2021 (World Bank 2022d)[28]. A closer look at the distribution of GDP by industrial sector and company size shows that the chemical industry generates the lion's share of GDP in this sector, mainly focused on coke and refined petroleum products, chemicals and chemical products, plastics and rubber and basic pharmaceuticals. Looking at company size, while the chemical sector is dominated by large companies, small and medium-sized enterprises also assume considerable importance, particularly in terms of employment.

Although Thai industry has access to resources and is integrated into global supply chains and trade, local value creation is often lacking. The result of this is that investment in new technologies and modern production processes often fall by the wayside, slowing down the technological and economic development of its industrial sector.

Figure 3.6:
GHG emissions in Thailand by sector in 2016 (MNRE 2020)



[28] World Bank (2022d) Manufacturing value added (% of GDP) – Thailand. https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=TH

Photo: Matthew Nolan, unsplash

Photo: Kate Ferguson, unsplash

Energy demand and GHG emissions

The chemical sector consumed 3.5 million tonnes of oil equivalent in 2018, representing 11.5 per cent of energy demand in the country's manufacturing industry (DEDE 2018)[29]. Around 40 per cent of energy supply stems from oil, 27 per cent from gas, 13 per cent from coal and 21 per cent from renewable sources (IRENA 2022d)[30]. The Third Biennial Update Report (MNRE 2020)[31] for the United Nations Framework Convention on Climate Change (UNFCCC) estimated Thailand's GHG emissions for 2016 to be 354 million tonnes of CO_2 equivalent, 254 million of which are attributed to the energy sector. Industrial processes and product use (IPPU) account for 32 million tonnes of CO_2 equivalent – over a third, or 11.97 million tonnes, which stems from the chemical industry. The IPPU figures only include emissions from processes and product use and not the main contributor: the energy-related emissions of the chemical industry, which are included in the figures for the energy sector. We have not found reliable data on overall sector total emissions.

Country vision

Thailand ranks ninth in the long-term climate risk index (CRI) and, as such, was among the countries most affected by climate change in the period between 2000 and 2019 (Germanwatch 2021)[32]. At the COP26 in Glasgow in November 2021, the Thai government announced its intention to achieve carbon neutrality by 2050 and net-zero GHG emissions by 2065 (COP26 2021a)[33]. In practice, this means that all sectors contributing to emissions – from energy and transport to IPPU, waste and agriculture – are required to define and implement ambitious mitigation strategies in pursuit of this goal.

Additional reduction measures have been included to ensure the net-zero scenario becomes a reality by 2065. The overall reduction target for 2030 has already been increased from 25 per cent to 40 per cent (Bright 2022)[34]. Climate change has reached the highest level of politics and incorporated into the overall national strategy (2018 – 2037) to ensure long-term continuity. In the new NDC roadmap (2021-2030), the government aims to define measures for reducing greenhouse gases in energy and transportation, industrial processes and product use (IPPU), and waste sectors (Global Compact Network Thailand 2021)[35]. This does not, however, include an overall emission reduction target specifically set for the chemical sector – with the exception of reducing fluorinated gas consumption in refrigeration and air-conditioning technologies.

[29] Department of Alternative Energy Development and Efficiency, Ministry of Energy of Thailand (2018) Thailand Energy Efficiency Situation. https://webkc.dede.go.th/testmax/sites/default/files/thailand_EE_situation_report_2561.pdf
[30] International Renewable Energy Agency (2022d) Energy Profile Thailand. https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/Thailand_Asia_RE_SP.pdf
[31] Ministry of Natural Resources and Environment of Thailand (2020) Third Biennial Update Report BUR3. https://unfccc.int/documents/267629
[32] Germanwatch (2021) Global Climate Risk Index https://www.germanwatch.org/en/cri
[33] COP26 (2021a), High Level Segment Statement COP26, Remarks by Prime Minister of Thailand. https://unfccc.int/documents/367046
[34] Bright Management Consulting (2022) Baseline Study of the Chemical Industry in Thailand - Final Study Report, CAPCI-GIZ
[35] Global Compact Network Thailand (2021) Thailand´s Long-term Greenhouse gas Emission Development Strategy https://globalcompact-th.com/news/detail/602

Photo: Robin Noguier unsplash

Thailand's overarching economic development vision seeks to implement a "Bio Circular Green Economy", which currently guides the country's climate policies. Increasing the renewable energy and energy efficiency are, for example, explicit priorities within this vision. The government has made various policy instruments available to this end, including financial incentives, voluntary carbon programmes, certification schemes and tax exemptions for companies that implement energy-efficiency measures or use renewable energies (Bright 2022).

KEY STAKEHOLDERS

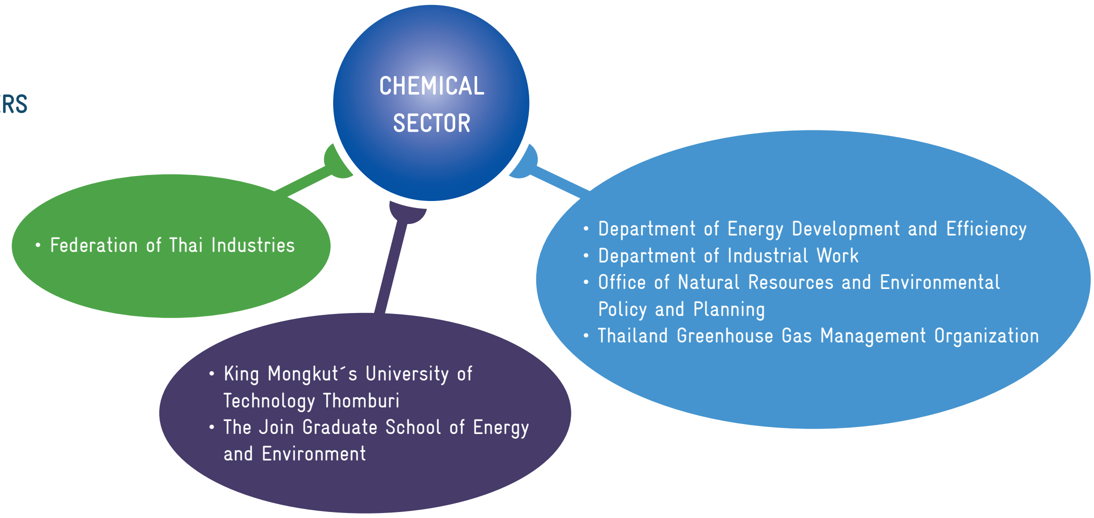


Photo: Sippakorn Yamkasikorn unsplash

Existing challenges

Despite Thailand's ambitious goals, the country does face some challenges on the road to a climate-friendly chemical industry. In cooperation with its Thai partner organisations, CAPCI carried out two national stakeholder dialogues on the nexus chemistry-climate change with representatives from chemical associations, industry players and policy-makers. A total of 100 people participated in the first national dialogue, and 64 in the second. After input presentations, the participants worked in six groups to identify the country's specific needs and challenges. The participants also formulated recommendations on how these challenges should be addressed.

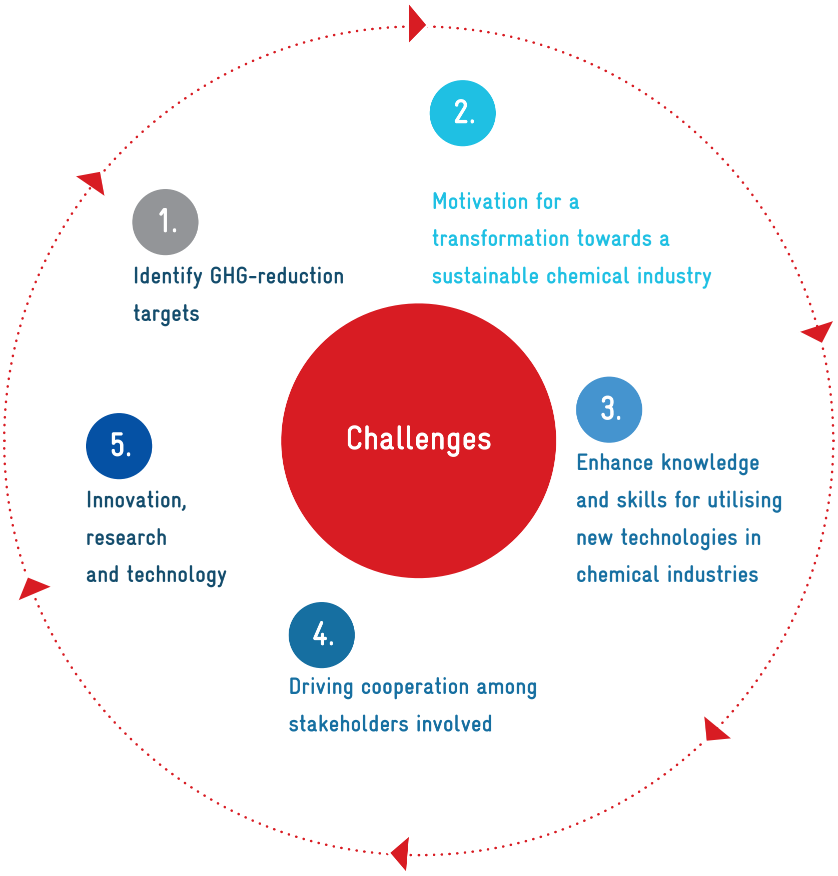
Smaller chemical companies lag behind in the use of modern and efficient technologies – such as for heat recovery or energy efficient components and machinery – whereas their larger counterparts in Thailand's chemical industry already apply these. Small and medium-sized enterprises hold insufficient technological knowledge and access to financing. Moreover, they lack overall awareness of the topic and suffer from a pronounced need for information and technology transfer to introduce best practices of efficient and climate-friendly production processes, low-waste and low-emission product design and waste disposal and recycling.

Another crucial point identified relates to the fact that companies tend to work in isolation. This represents a particular challenge as the transition towards efficient, circular and climate-friendly technologies requires cooperation and changes beyond individual companies, such as across value chains that include suppliers and customers, clusters, networks and industrial areas that facilitate clean and efficient infrastructure. Thailand enjoys a long-standing policy and specialised authorities for establishing industrial parks that offer attractive conditions to chemical companies as well. However, the potential that these organised industrial areas offer for creating synergies via joint infrastructure or optimised material and energy flows remains underutilised.

While the political will for achieving a climate-friendly industry is present, the public sector needs to communicate this clearly and create understanding across the private sector. The numerous government programs and investment assistance already in place are not yet sufficient to enable the private sector to transition to a fully climate-friendly industry. Finally, economic incentives and benefits are needed to motivate companies to mitigate their GHG emissions. Overall, it is evident that further steps for adjusting this framework are needed to reach the carbon-neutrality aspirations by 2050 and the net-zero target by 2065.

Bridge the gap

The participants identified two overarching questions during the dialogues: What's needed to meet the challenges? And who needs to be on board? These were discussed in the second national dialogue by representatives from industry, government, academia and international cooperation in working groups (Bright 2022).



1.

Identify GHG-reduction targets

To progress with overall modernisation and increase production efficiency, companies first need to record their emissions, establish strategies and identify mitigation measures wherever possible. Based on this, each company should define its reduction targets. At the political level, concrete targets and measures for the chemical industry should be integrated into the Nationally Determined Contributions (NDCs), as well as into corresponding sector plans.

2.

Motivation for a transformation towards a sustainable chemical industry

Different media channels should be used to generate awareness and knowledge about GHG reduction among all stakeholders. The public sector needs to promote concrete projects and efforts more firmly, e. g. through energy efficiency purchasing projects or Green Industry Certifications. Training programmes, advice and financial incentives should be provided and publicised.

Challenges

3.

Enhance knowledge and skills for utilising new technologies in chemical industries

The Department of Alternative Energy Development and Efficiency (DEDE) provides regular training courses and assistance for assessing energy consumption and saving potentials. However, further knowledge transfer and training on low-carbon production processes and technology transfer are needed. With the new Climate Change Act being drafted, small and medium-sized enterprises are now required to report their GHG emissions. While the government is already supporting small and medium-sized enterprises in preparing accurate GHG emission reports, more support is needed. To point companies in the right direction, policymakers and innovation agencies can support the private sector by fostering pilot projects and promoting innovation. CAPCI has been asked to prepare demand-oriented training programmes in cooperation with its Thai Partners built on the Responsible Care Programme of Thailand.the business. The government is already supporting SMEs to prepare accurate GHG emission reports.

4.

Driving cooperation among stakeholders involved

Achieving the climate goals is an important challenge for the Thai government as well as for industry and individual companies. Coordinated efforts are needed with clear reduction targets and key performance indicators (KPI) to track progress. To facilitate collaboration, a common platform should be set up, comprised of representatives from relevant government institutions, universities and industry sectors.

5.

Innovation, research and technology

Waste recycling and prevention must improve, as this can make a major contribution to reducing GHG emissions in both the chemical industry and waste management. Financial institutions need to provide funding to allow companies to invest in new tools and machinery or upgrade existing equipment. Collaboration with academic institutions can spur and scale up local innovation. To develop and provide sufficient and adequate renewable raw materials for the chemical industry, research should address the link between chemistry and agriculture.

Supporting CAPCI Activities in

» Vietnam

Photo: Ruslan Bardash unsplash

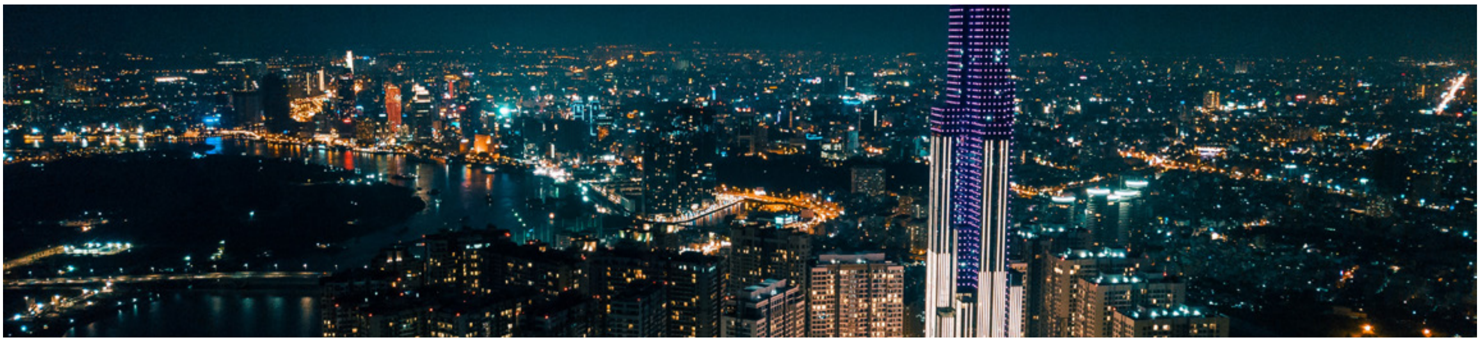


Photo: Tron Le unsplash

Deep dive: Vietnam

Economic importance

Vietnam's GDP in 2021 amounted to USD 363 billion (World Bank 2022e)[36], 33.7 per cent of which was represented by the industrial and construction sectors, which includes the chemical industry (World Bank 2022f)[37]. According to the General Statistic Office of Vietnam, the manufacturing and production subsector was the country's economic engine in 2021, having grown at a rate of 6.4 per cent year-on-year – a trend that had been observed for several years.

The chemical industry is the fifth-largest industrial subsector in terms of direct annual contribution to GDP (Le Dang and Ho 2022)[38], responsible for 10–11 per cent of the overall GDP in the industrial sector. Vietnam exported a total of USD 5 billion in chemicals and chemical products in 2018 (Trade Office – Vietnam Embassy in Spain)[39]. The country's chemical sector is divided into ten subsectors, among which fertilisers account for almost half of the sector's total production volume (Le Dang and Ho 2022).

The chemical industry currently does not add much in terms of value and, apart from fertilisers, most intermediate products are imported. The country does not manufacture products such as synthetic rubber, high-quality basic chemicals, noble gases or engineering plastics, and growth dynamics depend heavily on foreign direct investment. A large proportion of local chemical products remain in the country, one example being fertiliser production, 90 per cent of which consists of inorganic phosphate and nitrogen fertilisers. These mainly satisfy domestic demand and only a small proportion of nitrogen fertilisers is exported.

36 World Bank (2022e) GDP (current US$) – Vietnam for 2021. GDP (current US$) - Vietnam | Data (worldbank.org)
37 World Bank (2022f) Vietnam – Industry , Value Added (% of GDP). Vietnam - Industry, Value Added (% Of GDP) - 2022 Data 2023 Forecast 1985-2020 Historical (tradingeconomics.com)
38 Le Dang and Ho (2022) Baseline Study: Characterization of the Chemical Industry in Vietnam, CAPCI – GIZ
39 Trade Office – Vietnam Embassy in Spain (2019) Chemicals Market in Vietnam. https://chemspain.org/wp-content/uploads/2019/01/Chemicals-market-of-Vietnam.pdf

Photo: Son Vu Ler unsplash

Photo: Bui Hoang Lien unsplash

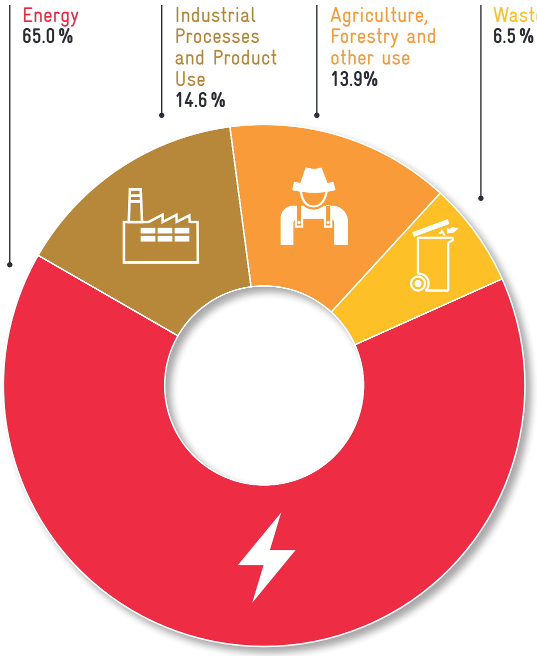
Energy demand and GHG emissions

In Vietnam, 48 per cent of the energy supply comes from coal, 25 per cent from oil, 8 per cent from gas and 20 per cent from renewable sources (IRENA 2022e)[40]. Implementation of the Vietnamese Renewable Energy (RE) development strategy by 2030 – a vision extending to 2050 – has reached and even exceeded its targets for renewable energy, covering solar power (4,696 MW), wind power (377 MW), biomass power (325 MW) and small-sized hydropower (3,647 MW) (MONRE 2021)[41].

In 2016, Vietnam's GHG emissions were approximately 317 million tonnes of CO_2 equivalent. Of these, 65 per cent were attributed to the energy sector, which includes energy use in other sectors such as fossil fuel combustion in the industrial sector including the chemical industry. The sector's industrial processes and product use (IPPU) was responsible for 46.1 million tonnes of CO_2 equivalent in 2016, representing 14.6 per cent of total emissions in that year (MONRE 2021). (See figure 3.7).

Emissions from the IPPU sector include 1.3 million tonnes of CO_2 equivalent stemming from the chemical industry – which only encompasses contributions from the production of nitric acid and ammonia.

Figure 3.7:
Ratio of GHG emissions by sector in 2016 (MONRE 2021)



[40] International Renewable Energy Agency (2022e) Energy Profile Vietnam. Viet-Nam_Asia_RE_SP.pdf (irena.org)
[41] Ministry of Natural Resources and Environment of Vietnam (2021) Third Biennial Update Report of Vietnam. https://unfccc.int/documents/273504

Photo: Doan Tuan unsplash

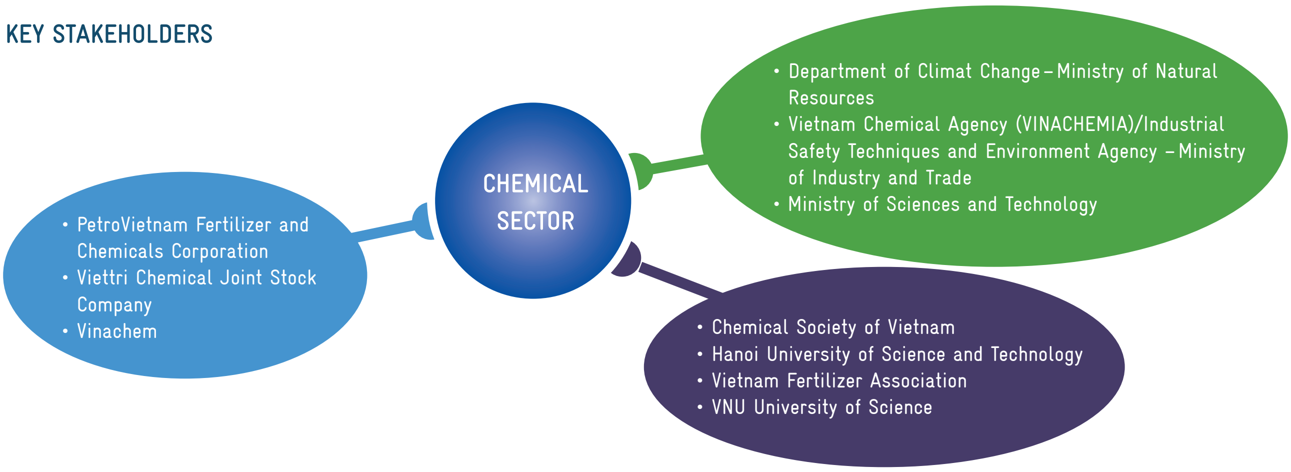
Country vision

GHG emissions in Vietnam increased ed by 335 per cent between 1990 and 2017 (MONRE 2021). At the same time, the country has become highly vulnerable to climate change, with rising sea levels and extreme weather posing series threats. At the COP26 in Glasgow, the Vietnamese prime minister committed to achieving net-zero emissions by 2050 and reducing methane emissions by 30 per cent by 2030 (COP26 2021b)[42]. In addition, the country adopted a declaration to move away from the use of coal in the decade between 2030 and 2040 and it joined the Lowering Emissions by Accelerating Forest Finance (LEAF) coalition. Vietnam is soon to adjust its NDCs to meet the newly set targets. This will impact 1,662 companies, including over 90 chemical plants. Vietnam has also established a legal basis for energy saving and environmental protection, linked to the mitigation of GHG emissions (Le Dang and Ho 2022).

Existing challenges

Vietnam has drawn up a strategy for developing its chemical industry. According to the Ministry of Industry and Trade (MOIT), this includes regulations on energy-saving measures and green chemistry. Despite its ambitions, the strategy fails to consider the influence of the chemical industry on climate change and lacks the corresponing mitigation measures. During two national dialogues organised by CAPCI together with its Vietnamese partner organisations, the involved stakeholders from politics, the private sector, academia, national and international associations shed light on the situation of the chemical industry in Vietnam, identifying challenges and possible scenarios for solutions. A total of 85 people took part in the first stakeholder dialogue in January 2022 and 66 in the second session in March 2022.

KEY STAKEHOLDERS



[42] COP26 (2021b) High Level Segment Statement COP26, Remarks by Prime Minister of Vietnam. https://unfccc.int/sites/default/files/resource/VIET_NAM_cop26cmp16cma3_HLS_EN.pdf

Photo: Georgios Domouchtsidis unsplash

The first national stakeholder dialogue discussed existing institutional arrangements, regulations and initiatives and identified gaps in national regulations along with overlapping roles and responsibilities. It also focused on the need to improve stakeholder cooperation, technical and financial support, and know-how and awareness regarding the relationship between climate change and the chemical industry. During these dialogues, the participants also outlined challenges in specific production processes. Fertiliser production was identified as the most energy and carbon-intensive chemical subsector, one in which technical progress is particularly urgent. GHG inventories have, for example, only been detailed for ammonia and nitric acid production. Gaps in available data do, however, remain an issue for mapping GHG-emissions across other sub-sectors.

Local universities only conduct limited research on climate protection as well as options for process optimisation in the chemical industry. Additionally, participants found that the topic is insufficiently addressed in teaching, with minimal interaction between academic institutions and governmental organisations regarding GHG mitigation in the chemical industry (Le Dang and Ho 2022).

Bridging the gap

To meet the challenges in the chemical industry, the Vietnamese chemical agency Vinachemia has drawn up specific development targets, including an objective for the country's chemical industry to apply state-of-the-art technologies by 2040. The chemical agency aims to reorganise its operations internally in order to boost efficiency and establish industry clusters to promote an attractive environment for investors.

In light of Vietnam's commitment to climate neutrality, it will be critical for the country to advance awareness-building among stakeholders and capacity-building for actions related to greenhouse gas emissions and mitigation options in the chemical sector. The chemical agency has already established a green chemistry network, and additional important prerequisites for modernising the country's chemical sector involve technical support and financial incentives. As the stakeholders involved in the CAPCI dialogues stated, numerous technological options for reducing emissions. These are often available in combination with energy savings and improved process efficiency, as the International Council of Chemical Associations (ICCA) has demonstrated in a variety of publications. Many of these solutions seem very pertinent for Vietnamese companies to adopt.

Even before COP26, the Ministry of Natural Resources and Environment (MONRE) had worked with business associations to develop a roadmap for reducing GHG emissions. A separate roadmap is likewise in place for phasing out ozone-depleting substances (ODS) – which often have extremely high global warming potential and are regulated under the Montreal Protocol (and the Kigali Amendment). Following the COP26 in Glasgow, the Vietnamese prime minister also established an associated steering committee with representatives from different relevant sectors for implementing the roadmap.

CHAPTER 4

Insights from global CAPCI dialogues and webinars

In parallel with activities conducted alongside its partner countries, CAPCI together with the International Council of Chemical Associations and the capacity building network of the UN Climate Secretariat organised a series of four global webinars in 2021 under the heading

"The Nexus Chemistry – Climate Change: Understanding Trends, Risks and Opportunities".

The online events featured highly interactive discussions on various facets of the nexus between the chemical industry and climate change, bringing together a total of almost 600 participants from around the globe.

Photo: Luke Southern, unsplash

4.1 Role and importance of the chemical industry in tackling climate change

The first webinar titled “The role and importance of the chemical industry for tackling climate change” was held on 2 September 2021. Its aims were to raise awareness regarding the importance of the chemical industry in mitigating climate change and to provide a global perspective on the vision of sustainable chemistry in the context of climate change mitigation. Representatives from UN Chemicals, BASF/ICCA and UNFCCC gave presentations covering topics such as trends and developments in the chemical industry, the role of the chemical industry in future-oriented low-carbon technologies, and climate-change scenarios and impacts. Around 280 people from 39 countries took part in this first webinar.

The KEY MESSAGES from the webinar include:

- Climate change is a cross-cutting global challenge that requires urgent action. Current global warming of more than 1°C has already led to significant negative impacts and humanity is heading for a global temperature rise of at least 2.7°C this century (UNEP 2021b)[1].
- There is no one-size-fits-all solution to address climate change. Regional differences in economic systems, geographical context, infrastructure, market needs and political/societal acceptance must be taken into account. What is needed are tailor-made approaches guided by the SDGs and addressing factors such as technological feasibility as well as environmental, social and financial conditions.
- The chemical industry plays a significant role in addressing climate change, not only due to its own high share of global greenhouse gas emissions but also owing to its innovative potential for developing climate-friendly and sustainable technological solutions.
- Reliable political frameworks are necessary to leverage the chemical industry´s potential for mitigating climate change as well as to facilitate the large-scale introduction of low-emission production technologies. Climate-friendly technologies paired with market-based and policy solutions are necessary to reduce greenhouse gas emissions.
- Collaboration among governments, industry and key stakeholders is essential for implementing the transformation needed and for maximising the contribution made by the chemical industry toward achieving the goals of the Paris Agreement.
- The costs of climate-friendly technologies may be considered as a barrier in many countries. At the same time, the cost of inaction is even higher, especially as this can lead the world to a no-return pathway. As such, business-as-usual is simply not an option.

The CHALLENGES identified include:

- Managing chemicals throughout global supply chains is critical. The cross-border trade of chemicals and chemical products should respect a series of regulations and also consider new challenges that may arise in future, such as border adjustment mechanisms intended to reflect climate-related externalities.
- Managing chemical supply chains may become more challenging and require a forward-looking approach.
- Considering a life-cycle perspective is essential for avoiding burden-shifting.
- Carbon, as an element, is one of the main sources of energy in the chemical industry as well as a feedstock material for many products.

[1] United Nations Environment Programme (2021 a) Emissions Gap Report https://www.unep.org/resources/emissions-gap-report-2021

4.2 Innovation in and from the chemical sector: A driver for low-carbon solutions

The second webinar on "Innovation in and from the chemical sector: A driver for low-carbon solutions" focused on technological considerations as well as the mechanisms, basic conditions and sustainability aspects crucial for scaling up low-emission processes and products. Speakers from Evonik/ICCA, PROKLIMA-GIZ, Leuphana and DECHEMA/ISC3 addressed the topic during four input presentations. A total of 110 participants from 24 countries took part in the webinar on 6 October 2021.

2ND WEBINAR

The KEY MESSAGES from the webinar include:

- The chemical industry holds major potential as well as responsibility for helping achieve the goals of the Paris Agreement.
- Ambitious scenarios for a climate-neutral chemical industry will depend on further developing and scaling up innovative technologies that minimise or eliminate GHG emissions throughout the chemical value chain.
- At the same time, the chemical industry is a provider of low-emission solutions, such as innovative materials and products needed for low-emission technologies in other sectors.
- Lifecycle GHG assessments and inventories in the chemical industry constitute a basis for identifying reduction opportunities at the company and sector levels.
- Important pathways toward achieving a greenhouse gas-neutral chemical industry include: increasing efficiency in the production and use of chemicals, cutting energy and process-related GHG emissions, reducing losses, improving mechanical and chemical recycling processes and technologies, and gradually replacing fossil hydrocarbons, e.g. via Power-to-X and Power-to-Chemical technologies.
- Start-ups also hold significant potential to contribute to the transformation of the chemical industry on account of their capacity to develop new and disruptive ideas, their flat management structures and their fast decision-making processes.

The CHALLENGES identified include:

- The complexity inherent to the chemical industry necessitates tailor-made solutions that include a range of different technology options and reflect the specificities of the respective country, company and environment.
- Recycling chemical products and developing new materials can provide opportunities for business development and job creation.
- Potential trade-offs must be taken into account at the early stages of introducing a new technology, e.g. the use and introduction of undesired hazardous chemicals in supply chains.

4.3 Climate policies and transforming the chemical industry and its value chains

The third webinar on "Climate policies and transformation of the chemical industry and its value chains" focused on the topic of transforming the chemical industry and associated value chains toward lower emissions and climate neutrality. Speakers from WWF Climate & Energy, the Environmental Protection Agency of Ghana and Covestro/ICCA spoke about the role of the chemical industry in climate policies along with the ongoing dynamics and negotiations during COP26. The webinar took place on 3 November 2021 and welcomed 81 participants from 18 countries.

3RD WEBINAR

The KEY MESSAGES from the webinar include:

- The recent IPCC report (IPCC 2021)[2] sends a strong message to the COP26 about the growing urgency to raise global ambitions and accelerate actions for mitigation and adaptation.
- The COP26 meeting in Glasgow was momentous due to new and updated nationally determined contributions (NDCs) that countries were requested to submit.
- Enabling policy and regulatory frameworks are needed to promote innovation and green investment across all sectors in order to achieve significant GHG reductions and support the NDCs in line with the Paris Agreement.
- Addressing carbon externalities through appropriate pricing structures such as taxes may constitute effective ways to incentivise the reduction of GHG emissions.
- Incentives to promote market readiness for innovative climate protection technologies are needed, coupled with policies that promote research and development.
- A combination of new technologies, enabling policy frameworks, effective financial mechanisms and widespread societal acceptance are essential for reducing GHG emissions.

The CHALLENGES identified include:

- Carbon leakage may occur when businesses transfer production to countries with lower emissions standards to avoid costs related to required investments into climate-friendly technologies.
- In addition to adequate price and incentive structures, a life-cycle perspective is essential for avoiding burden-shifting, though it is not always easy to implement.

[2] Intergovernmental Panel on Climate Change (2021) Working Group I Climate Change 2021: The Physical Science Basis, Summary for policy makers https://www.ipcc.ch/report/ar6/wg1/chapter/summary-for-policymakers/

4.4 Good practices and practical solutions from the chemical industry

The fourth webinar focused on the topic of "Good practices and practical solutions from the chemical industry". With speakers from Mitsubishi/ICCA, the Nitric Acid Climate Action Group (NACAG) and UNIDO, the webinar presented learning experiences, practical solutions and approaches for climate change mitigation, energy efficiency and circular economy across the chemical industry.
Held on 1 December 2021, the event was attended by 90 participants from 13 countries.

The KEY MESSAGES from the webinar include:

- Chemical leasing is a business model aimed at reducing the use and consumption of chemicals. Through this model, the client does not purchase chemicals (such as disinfectant) but rather a service (such as plant protection and pest management), thereby creating incentives for avoiding the excessive use of chemicals.
- Power-to-X (PtX) technologies are important vehicles for reducing fossil energy use and for defossilising the chemical industry.
- New materials and technologies for climate protection should be developed hand in hand with circular economy approaches that ensure intelligent recycling and recovery of secondary raw materials.
- The technological innovation needed for promoting a sustainable transformation of this sector demands cooperation among many different stakeholders along with the establishment of effective collaboration mechanisms.
- Innovation related to the concept of sustainable chemistry can contribute to creating sustainable energy systems and avoiding trade-offs between climate protection and sound chemical management. It can also help reduce resource depletion and pollution through innovative and sustainable products free of toxic substances.

The CHALLENGES identified include:

- The production of nitrogen-based fertilisers such as nitric acid is highly GHG intensive. Though GHG-abatement technologies are quite wide-spread and well-established, the conversion of the entire value chain to climate-friendly production methods remains a major challenge, especially in economic terms.
- Cost-burdens associated with the introduction of new technologies and the use of sources other than fossils feedstocks (such as recycled materials) in a circular economy are a major challenge and could represent a barrier unless incentive and subsidy schemes are adapted.

4.5 Conclusions

Photo: Sigmund, unsplash

The webinar series on the nexus chemistry – climate change, that was realized in 2021, did not only show high interest in the topic but also gave valuable insights into challenges and potentials of the sector regarding a climate-friendly and sustainability-oriented transformation. It can be concluded that the chemical industry with all related value chains has enormous potentials for contributing to climate protection, reducing not only its own significant emissions but also contributing to climate-friendly solutions in other important sectors of the economy. In many parts of the value chains related with chemicals production and use of chemicals, there are already solutions available or under development, particularly regarding sustainable, low-emission processes and products. Nevertheless, the rollout of low-emission technologies is a huge challenge that requires enormous efforts and investments, in order to improve resource and energy efficiency, modify or optimize existing processes, enhance circularity, have access to sufficient amounts of renewable energy and, as far as possible, renewable feedstocks or advance the introduction of innovative technologies such as green hydrogen and power-to-X or carbon capture and utilization. The envisaged transformation will require adequate political, economic and regulatory framework conditions as well as incentives on international and national level in combination with intense research and development. Innovation is considered a key driver of low-carbon solutions in and from the chemical sector, while sustainability criteria must be applied from the earliest stages in order to ensure synergies and avoid any possible trade-offs.

CHAPTER 5

Organisational approaches and outlook


Photo: BASF Ludwigshafen, ©BASF SE

5.1 Organisational approaches

Companies are crucial stakeholders in the drive toward achieving sustainable chemical production and use. At the same time, leveraging the vast potential held by the chemical sector for advancing mitigation efforts, efficient resource use and sustainability require efforts that go beyond individual companies. Examples of such organisational approaches geared to generate synergy already exist, such as organising chemical parks into so-called **Verbundstandorte**, considering the entire life-cycle of products and materials and implementing sustainable value-chain management.

Chemical parks and Verbund sites for promoting sustainability

Chemical parks are professionally managed complexes that offer chemical and pharmaceutical companies a wide range of services. In Germany, many chemical plants are located in chemical parks, which are designed, developed and operated in a way that connects all on-site activities and facilities. Companies buy and sell products from one another, their by-products are used as raw materials at other plants in the park, wastewater is treated and reused, solid waste is processed, recycled or incinerated, and electricity and steam are generated and fed into the distribution network.

This network, or **Verbund**, between production facilities and infrastructure holds a broad range of opportunities and benefits. These includes the ability to sustainably produce fuels, hydrogen, methane and energy by closing the loop at existing infrastructure plants and the ability to produce, store, distribute and use green hydrogen through innovative technology. Some of the technological developments piloted and used by the chemical industry in Germany have the potential to be transferred to other chemical parks, such as proton exchange membrane (PEM) electrolysis, hydrogen storage in liquid organic hydrogen carriers (LOHC) or the production of chemicals such as e-fuel using power-to-liquid technology.

Applying life-cycle thinking and analysis

Life cycle analysis (LCA) provides insights into broader sustainability considerations through all the stages of the chemical and product life cycle while also including social considerations. Companies increasingly use LCA approaches to support their sustainable supply-chain risk management efforts. The Global Chemicals Outlook (UNEP 2019a)[1] highlighted that LCA is effective for helping to avoid negative trade-offs – such as shifting the burden from one aspect of sustainability to another, from the present to the future or from one stage of the life cycle to another.

Factors addressed by LCA include raw material extraction, energy and water use during chemical synthesis and product manufacturing, the carbon footprint, chemical occurrence and behaviour in waste streams, and options to recycle chemicals for renewed use. LCA approaches are useful for advancing the sustainable management of materials, non-toxic material flows and the circular economy in general. LCA also promotes the implementation of SDG 12, 'Ensure sustainable consumption and production patterns', by recognising that chemical and waste management is directly linked to promoting resource efficiency, reducing waste and mitigating climatic and environmental impacts.

[1] United Nations Environment Programme (2021a) Chemicals, waste and climate change – Interlinkages and potential for coordinated action. http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-POPS-PUB-Report-Interlinkages-ClimateChange-2021.English.pdf

5.2 The way forward: Future opportunities for CAPCI

Adopting sustainable supply-chain management

Sustainable supply-chain management ensures that a company or organisation's purchasing and procurement decisions comply with overall as well as specific sustainability criteria. The concept covers a range of considerations from product design and development to material selection, manufacturing, packaging, transportation, warehousing, distribution, consumption, return and disposal.

Adopting sustainable and resilient supply-chain management practices can help organisations and companies to reduce their greenhouse gas emissions as well as any negative impacts on the environment and human health. It also allows them to optimise their end-to-end operations while concurrently advancing sustainability aims.

One example of sustainable supply-chain management in the chemical sector is the programme titled Together for Sustainability. Through this initiative, the 26 involved chemical companies work together based a common set of auditing and assessment standards to drive innovation aimed at addressing identified sustainability challenges[2].

Enhancing capacity-building and developing a roadmap

In collaboration with national associations and government partners, CAPCI assesses and implements diverse activities to deepen its capacity-building program. One important work package involves country-specific capacity-building measures executed with help from trainers that have taken part in CAPCI's ToT course on Sustainable Chemistry and Climate Change. This includes designing different training modules for consultants, chemical company staff and political leaders to help them identify mitigation options as well as specific strategies and roadmaps for their country. The programme partners in Argentina have already started defining a roadmap of their own, with CAPCI providing support for carrying out a technical study and dialoguing with all relevant stakeholders about effective and realistic pathways toward mitigation in the chemical sector.

2 Together for sustainability: https://www.tfs-initiative.com/

ROADMAP EXAMPLE: CHEMISTRY FOR CLIMATE (C4C) IN GERMANY

In 2019, the German Chemical Industry Association (VCI) published a roadmap study titled 'Working towards a greenhouse gas neutral chemical industry in Germany', which analysed possible pathways toward a greenhouse gas-neutral chemical industry[3]. The study concluded that, while technically possible, this goal would require large amounts of renewable electricity at competitive prices, as well as sufficient availability of green hydrogen. Additionally, new sources of carbon for material use would need to be mobilised once fossil sources are substituted.

With this roadmap analysis in mind, the chemical and pharmaceutical industry in Germany set the goal of becoming greenhouse gas neutral by the middle of the century. To support relevant actions in this regard, the Association of German Engineers (VDI) and the Association of the Chemical Industry (VCI) launched the Chemistry4Climate (C4C)[4] Platform in May 2021. C4C serves as a core building block for Germany to achieve its NDC goal: climate neutrality by 2045. Over 80 stakeholders from industry, politics and civil society participate in C4C, which is also supported by the German Federal Ministry of Economic Affairs and Climate Action (BMWK).

Chemistry4Climate creates opportunities for updating the roadmap along the way and developing a technological pathway to become climate neutral by 2045. The platform serves to develop concrete recommendations for political decision-making and form working groups that address key topics such as energy supply and infrastructure, the circular economy, raw material supplies and regulatory frameworks.

Inspiring and engaging other countries

Through its cooperation activities and partnerships with relevant international and national stakeholders, CAPCI has successfully developed an entire suite of knowledge products, learning experiences and capacity-development services. The programme has also built a network of interested experts and institutions dedicated to sharing knowledge and experiences related to greenhouse gas mitigation efforts and building a circular economy through sustainable chemistry innovation. This know-how and expertise have been consolidated and made available for interested governments, companies, associations and the scientific community to take advantage of worldwide. CAPCI is looking forward to sharing these services and the lessons learned across the five pilot countries as well as inspiring others to build their own path to a climate neutral chemical industry.

[3] Verband der Chemischen Industrie VCI (2019) Roadmap 2050 Treibhausgasneutralität Chemieindustrie – https://www.vci.de/services/publikationen/broschueren-faltblaetter/vci-dechema-futurecamp-studie-roadmap-2050-treibhausgasneutralitaet-chemieindustrie-deutschland-langfassung.jsp

[4] Chemistry 4 Climate, VCI, Über Chemistry4Climate | VCI

References

Anastas, P.T and Warner, J.C. (1998) Green Chemistry: Theory and Practice. Oxford University Press.

Bright Management Consulting (2022) Baseline Study of the Chemical Industry in Thailand - Final Study Report, CAPCI-GIZ.

Climate Watch (n.d). Historical GHG Emissions. https://www.climatewatchdata.org. Accessed on 4 November 2022

Cámara de la Industria Química y Petroquímica www.ciqyp.org.ar

COP26 (2021a), High Level Segment Statement COP26, Remarks by Prime Minister of Thailand. https://unfccc.int/documents/367046
Accessed on 29 November 2022

COP26 (2021b) High Level Segment Statement COP26, Remarks by Prime Minister of Vietnam. https://unfccc.int/sites/default/files/resource/VIET_NAM_cop26cmp16cma3_HLS_EN.pdf
Accessed on 29 November 2022

Department of Alternative Energy Development and Efficiency, Ministry of Energy of Thailand (2018) Thailand Energy Efficiency Situation. https://webkc.dede.go.th/testmax/sites/default/files/thailand_EE_situation_report_2561.pdf
Accessed on 29 November 2022

Energy Commission (2022) National Energy Statistics of Ghana. https://energycom.gov.gh/files/2022%20Energy%20Statistics.pdf
Accessed on 29 November 2022

Energy Commision (2019) Renewable Energy Master Plan of Ghana. https://www.energycom.gov.gh/files/Renewable-Energy-Masterplan-February-2019.pdf
Accessed on 29 November 2022

Environmental Protection Agency (1997) National Profile to Assess the Chemicals Management Infrastructure in Ghana. Microsoft Word - GHANA.DOC (unitar.org)
Accessed on 29 November 2022

Environmental Protection Agency (2021) Sound Management of Chemicals and Waste in Ghana Strategic Plan (2021 – 2030)

European Chemical Industry Council (CEFIC) European Performance 2020
Environmental Performance - cefic.org
Accessed on 27 January 2023

Fernandez L. (2022) Baseline Study: Estudio de la Industria Química y Cambio Climático en Peru, CAPCI-GIZ

Gaspes E. (2022), Baseline Study: Characterization of the Chemical Industry in Argentina, CAPCI-GIZ.

Germanwatch (2021) Global Climate Risk Index https://www.germanwatch.org/en/cri
Accessed on 29 November 2022

GFA Consulting Group (2021) Propuesta de Plan Nacional de Eficiencia Energética. 09011503_PropuestaPlaNEEAr.pdf (eficienciaenergetica.net.ar)
Accessed on 29 November 2022

Global Compact Network Thailand (2021) Thailand´s Long-term Greenhouse gas Emission Development Strategy https://globalcompact-th.com/news/detail/602
Accessed on 29 November 2022

Gobierno de Peru (2020) Intended Nationally Determined Contribution of Peru (updated submission). https://unfccc.int/documents/499569
Accessed on 29 November 2022

Greenhoue gas protocol https://ghgprotocol.org/
Accessed on 27 January 2023

Instituto Nacional de Estadísticas y Censos de Argentina (2021) Sustancias y productos químicos respecto al nivel general del índice de producción industrial manufacturero. https://www.indec.gob.ar/
Accessed on 15 January 2021

Instituto Petroquímico Argentino (2019) Anuario Instituto Petroquímico Argentino. https://noticiasutnfrn.files.wordpress.com/2020/04/anuario-ipa-2019.pdf
Accessed on 29 November 2022

International Council of Chemical Associations (2019) Enabling the future: chemistry innovations for a low-carbon society. https://icca-chem.org/wp-content/uploads/2020/05/Enabling-the-Future.pdf
Accessed on 20 November 2022

International Council of Chemical Associations (2021) Statement on Climate Neutrality. https://icca-chem.org/news/icca-statement-on-climate-policy/
Accessed on 29 November 2022

International Sustainable Chemistry Collaborative Centre (2021) Policy Papers
https://www.isc3.org/page/policy-papers
Accessed on 27 February 2023

Intergovernmental Panel on Climate Change (2021) Working Group I Climate Change 2021: The Physical Science Basis, Summary for policy makers
https://www.ipcc.ch/report/ar6/wg1/chapter/summary-for-policymakers/
Accessed on 27 February 2023

Intergovernmental Panel on Climate Change (2022 a) Working Group III contribution to the Sixth Assessment Report of the IPCC, Summary for policy makers. IPCC_AR6_WGIII_SPM.pdf
Accessed on 29 November 2022

Intergovernmental Panel on Climate Change (2022 b) Working Group III contribution to the Sixth Assessment Report of the IPCC, full report.
https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf Accessed on 29 November 2022

International Renewable Energy Agency (2020) Green Hydrogen: A guide to policy making. Green hydrogen: A guide to policy making (irena.org)
Accessed on 29 November 2022

International Renewable Energy Agency (2022a) Energy Profile Argentina.
https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/South%20America/Argentina_South%20America_RE_SP.pdf
Accessed on 29 November 2022

International Renewable Energy Agency (2022b) Energy Profile Ghana.
ENERGY PROFILE - Ghana - IRENA
Accessed on 29 November 2022

International Renewable Energy Agency (2022c) Energy Profile Peru.
https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/South%20America/Peru_South%20America_RE_SP.pdf
Accessed on 29 November 2022

International Renewable Energy Agency (2022d) Energy Profile Thailand.
https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Asia/Thailand_Asia_RE_SP.pdf
Accessed on 29 November 2022

International Renewable Energy Agency (2022e) Energy Profile Vietnam.
Viet-Nam_Asia_RE_SP.pdf (irena.org)
Accessed on 29 November 2022

International Sustainable Chemistry Collaborative Centre (2021) Policy Papers https://www.isc3.org/page/policy-papers
Accessed on 29 November 2022

International Trade Administration (2022) Ghana Country Commercial Guide. https://www.trade.gov/country-commercial-guides/ghana-market-overview
Accessed on 29 November 2022

Jumpah D. (2022) Baseline Study on Chemistry and Climate Change in Ghana, CAPCI – GIZ.

Le Dang and Ho (2022) Baseline Study: Characterization of the Chemical Industry in Vietnam, CAPCI – GIZ.

Ministerio de Ambiente y Desarrollo Sostenible de Argentina (2021) Fourth Biennial Update Report to United Nations Climate Change of Argentina BUR4. https://unfccc.int/sites/default/files/resource/4to%20Informe%20Bienal%20de%20la%20Rep%C3%BAblica%20Argentina.pdf
Accessed on 29 November 2022

Ministerio de Ambiente y Desarrollo Sostenible de Argentina (2022) Plan Nacional de Adaptación y Mitigación al Cambio Climático, Resumen Ejecutivo.
https://www.argentina.gob.ar/sites/default/files/resumen_ejecutivo_pnaymcc.pdf
Accessed on 29 November 2022

Ministerio del Ambiente de Peru (2022) Infocarbono.
https://infocarbono.minam.gob.pe/
Accessed on 29 November 2022

Ministerio del Ambiente de Peru (2016a) Inventario Nacional de Gases de Efecto Invernadero – INGEI. https://infocarbono.minam.gob.pe/annios-inventarios-nacionales-gei/ingei-2016/
Accessed on 29 November 2022

Ministerio del Ambiente de Peru (2016b) Tercera Comunicación Nacional del Peru a la Convención Marco de las Naciones Unidas sobre el Cambio Climático. Tercera Comunicación Nacional del Perú a la Convención Marco de las Naciones Unidas sobre el Cambio Climático | SINIA | Sistema Nacional de Información Ambiental (minam.gob.pe)
Accessed on 29 November 2022

Ministerio de Energía y Minas de Peru (2019) Balance Nacional de Energía. https://cdn.www.gob.pe/uploads/document/file/1875333/Balance%20Nacional%20de%20la%20Energ%C3%ADa%202019.pdf?v=1620784938
Accessed on 29 November 2022

Ministry of Environment, Science, Technology and Innovation and Environmental Protection Agency (2021a) Ghana´s Third Biennial Update Report to United Nations Climate Change. https://unfccc.int/sites/default/files/resource/gh_BUR3_1282021_submission.pdf
Accessed on 29 November 2022

Ministry of Environment, Science, Technology and Innovation and Environmental Protection Agency (2021b) Updated Nationally Determined Contribution under the Paris Agreement (2020 - 2030) of Ghana. https://unfccc.int/sites/default/files/NDC/2022-06/Ghana%27s%20Updated%20Nationally%20Determined%20Contribution%20to%20the%20UNFCCC_2021.pdf
Accessed on 29 November 2022

Ministry of Industry and Trade of Vietnam (2022) Gov´t approves chemical industry development strategy till 2040. https://moit.gov.vn/en/news/latest-news/gov-t-approves-chemical-industry-development-strategy-till-2040.html
Accessed on 29 November 2022

Ministry of Natural Resources and Environment of Thailand (2020) Third Biennial Update Report BUR3. https://unfccc.int/documents/267629
Accessed on 29 November 2022

Ministry of Natural Resources and Environment of Vietnam (2021) Third Biennial Update Report of Vietnam. https://unfccc.int/documents/273504
Accessed on 29 November 2022

Nitric Acid Climate Action Group NACAG. https://www.nitricacidaction.org/
Accessed on 29 November 2022

Organisation for Economic Co-operation and Development (2022) Global Plastic Outlook. Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD
Accessed on 29 November 2022

Power-to-X PtX Hub. https://ptx-hub.org/team/
Accessed on 01 March 2023

Proklima, integrated ozone and climate protection PROKLIMA – Naturally cool
Proklima, integrated ozone and climate protection (giz.de)
Accessed on 01 March 2023

Presidencia Argentina (2021) Actualización de la meta de emisiones netas de Argentina al 2030 NDC. Argentina Second NDC (Updated submission) | UNFCCC
Accessed on 29 November 2022

PricewaterhouseCoopers (2022) The green hydrogen economy. https://www.pwc.com/gx/en/industries/energy-utilities-resources/future-energy/green-hydrogen-cost.html
Accessed on 29 November 2022

United Nations Environment Programme (2019) Global Chemicals Outlook II. https://www.unep.org/resources/report/global-chemicals-outlook-ii-legacies-innovative-solutions
Accessed on 29 November 2022

United Nations Environment Programme (2020) Green and Sustainable Chemistry: Framework Manual. https://www.unep.org/explore-topics/chemicals-waste/what-we-do/policy-and-governance/green-and-sustainable-chemistry
Accessed on 29 November 2022

United Nations Environment Programme (2021a) Chemicals, waste and climate change – Interlinkages and potential for coordinated action. http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-POPS-PUB-Report-Interlinkages-ClimateChange-2021.English.pdf
Accessed on 29 November 2022

United Nations Environment Programme (2021b) Emissions Gap Report
https://www.unep.org/resources/emissions-gap-report-2021
Accessed on 29 November 2022

Together for sustainability: https://www.tfs-initiative.com/

Trade Office – Vietnam Embassy in Spain (2019) Chemicals Market in Vietnam
https://chemspain.org/wp-content/uploads/2019/01/Chemicals-market-of-Vietnam.pdf
Accessed on 24 February 2023

Verband der Chemischen Industrie VCI (2019 a) Roadmap 2050 Treibhausgasneutralität Chemieindustrie
https://www.vci.de/services/publikationen/broschueren-faltblaetter/vci-dechema-futurecamp-studie-roadmap-2050-treibhausgasneutralitaet-chemieindustrie-deutschland-langfassung.jsp

Verband der Chemischen Industrie VCI (2019) Working towards a greenhouse gas neutral chemical industry in Germany. Studie_Treibhausgas_engl_v1.indd (vci.de)
Accessed on 27 January 2023

Verband der Chemischen Industrie VCI Chemistry 4 Climate. Über Chemistry4Climate | VCI

Vietnam Electricity Group (2020) National Energy Development Strategy of Vietnanm https://en.evn.com.vn/d6/news/National-energy-development-strategy-to-2030-with-vision-to-2045-66-163-1784.aspx
Accessed on 29 November 2022

World Economy Forum (2021) Implementing Low-carbon Emitting Technologies Initiative in the Chemical Industry. WEF_Implementing_Low_Carbon_Emitting_Technologies_in_the_Chemical_Industry_A_Way_Forward_2021.pdf (weforum.org)
Accessed on 27 February 2023

World Bank (2022a) Gross Domestic Product GDP of Argentina.
https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=AR
Accessed on 02 March 2023

World Bank (2022b) Gross Domestic Product GDP of Ghana. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=GH
Accessed on 29 November 2022

World Bank (2022c) Gross Domestic Product GDP of Peru.
https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=PE
Accessed on 02 March 2023

World Bank (2022d) Manufacturing value added (% of GDP) – Thailand. https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=TH
Accessed on 29 November 2022

World Bank (2022e) GDP (current US$) – Vietnam for 2021.
GDP (current US$) - Vietnam | Data (worldbank.org)
Accessed on 29 November 2022

World Bank (2022f) Vietnam – Industry , Value Added (% of GDP).
Vietnam - Industry, Value Added (% Of GDP) - 2022 Data 2023 Forecast 1985-2020 Historical (tradingeconomics.com)
Accessed on 29 November 2022

World Bank (2021) Ghana Country Environmental Analysis. https://openknowledge.worldbank.org/handle/10986/33726
Accessed on 29 November 2022

World Business Council for Sustainable Development (2018) Chemical Sector SDG-Roadmap. https://www.wbcsd.org/Programs/People-and-Society/Sustainable-Development-Goals/Resources/Chemical-Sector-SDG-Roadmap.
Accessed on 29 November 2022

Abbreviations

ACHEMA	World Forum for the Process Industries
BMUV	German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of Germany
BMWK	German Federal Ministry of Economic Affairs and Climate Action
BRS	Basel, Rotterdam and Stockholm Conventions
BUR3	Third Biennial Update Report to United Nations Climate Change
BUR4	Fourth Biennial Update Report to United Nations Climate Change
CAPCI	Climate Action Programme for the Chemical Industry
CAT	Catalytic Centre
C4C	initiative Chemistry for Climate
CCU	Carbon capture and utilization
CCUS	Carbon Capture Utilization and storage
CEFIC	European Chemical Industry Council
CIQyP	Cámara de la Industria Química y Petroquímica
COP26	UN Climate Change Conference UK 2021
CRI	Global Climate Risk Index
DECHEMA	DECHEMA Gesellschaft für Chemische Technik und Biotechnologie
DEDE	Department of Alternative Energy Development and Efficiency, Ministry of Energy of Thailand
DIW	Department of Industrial Works, Ministry of Industry of Thailand
DOP	Dioctyl Phthalate
ENCC	National Strategy on Climate Change of Peru
EPA	Environmental Protection Agency of Ghana
EPS	Expanded Polystyrene
EU	European Union
EVA	ethylene-vinyl acetate
EVN	Vietnam Electricity Group
FTI	Federation of Thai Industries
GCO II	Global Chemical Outlook II
GCPC	Ghana Cleaner Production Centre
GDP	Gross Domestic Product
GFA	Gesellschaft für Agrarprojekte in Übersee
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GHG	greenhouse gases
Gt	Giga Tons
GWP	Global Warming Potential
ICCA	International Council of Chemical Associations
ICCM5	5th International Conference on Chemicals Management
IEAT	Industrial Estate Authority of Thailand
IKI	International Climate Initiative
INDEC	Instituto Nacional de Estadísticas y Censos de Argentina
Infocarbono	Peru's CO_2 emission registry
INGEI	Inventario Nacional de Gases de Efecto Invernadero de Peru
IPA	Instituto Petroquímico Argentino
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRENA	International Renewable Energy Agency
ISC3	International Sustainable Chemistry Collaborative Centre
ITA	International Trade Administration
KPI	Key Performance Indicators
LCA	Life cycle analysis
LEAF	Lowering Emissions by Accelerating Forest coalition
LOHC	Hydrogen Storage in Liquid Organic Hydrogen Carriers
MAyDS	Ministerio de Ambiente y Desarrollo Sostenible de Argentina
MEG	Monoethylene glycol
MESTI	Ministry of Environment, Science, Technology and Innovation of Ghana
MINAM	Ministerio del Ambiente de Peru
MINEM	Ministerio de Energía y Minas de Peru
MNRE	Ministry of Natural Resources and Environment of Thailand
MOIT	Ministry of Industry and Trade of Vietnam

MONRE	Ministry of Natural Resources and Environment of Vietnam
NAMA	Nationally Appropriate Mitigation Actions
NACAG	Nitric Acid Climate Action Group
NDC	Nationally Determined Contributions
ODS	Ozone Depleting Substances
OECD	Organisation for Economic Co-operation and Development
OEFA	Organismo de Evaluacion y Fiscalización Ambiental de Peru
ONEP	Office of Natural Resources and Environmental Policy and Planning of Thailand
PCCB	Paris Committee on Capacity Building
PCD	Pollution Control Department of Thailand
PE	polyethylene
PEM	Proton Exchange Membrane
PET	polyethylene terephthalate
PP	polypropylene
PPMM	Law 27.520 on Minimum standards for Climate Change of Argentina
PRODUCE	Ministry of Production of Peru
PROKLIMA	Proklima Integrated Climate and Ozone Protection
PS	Polystyrene
PtX	Power to X
PVC	Polyvinyl chloride
PWC	PricewaterhouseCoopers
RE	Renewable Energy
REMP	Renewable Energy Master Plan of Ghana
RWTH	Aachen University, Rheinisch-Westfälische Technische Hochschule Aachen
SAICM	Strategic Approach to International Chemicals Management
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprises
SNI	Sociedad Nacional de Industrias de Peru
SPAR6C	Supporting Preparedness for Article 6 Cooperation
SUNAT	Superintendencia Nacional de Aduanas y Administración Tributaria de Peru
TGO	Thailand Greenhouse Gas Management Organization
ToT	Training of Trainers
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VCI	German Chemical Industry Association
VINACHEMIA	Vietnam Chemicals Agency
VND	Vietnamesischer Đồng
WBCSD	World Business Council for Sustainable Development
WEF	World Economy Forum
WWF	World Wild Fund for Nature

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