European Commission

The *Just Transition* Dimension of Industrial Decarbonisation Plans across the EU

Synthesis

Introduction

As set out in the European Green Deal and the Sustainable Europe Investment Plan, a Just Transition Mechanism (JTM) shall complement other actions under the multiannual financial framework for the period 2021 to 2027. It shall contribute to addressing the social, economic, and environmental consequences, in particular for workers affected, in the process of transitioning towards a climate-neutral Union by 2050.

The Just Transition Fund (JTF) is one of the pillars of the Just Transition Mechanism implemented under cohesion policy. The aims of the JTF are to mitigate the adverse effects of the climate transition by supporting the most affected territories and workers concerned and to promote a balanced socio-economic transition. In line with the JTF's single specific objective, actions supported by the JTF should directly contribute to alleviating the impact of the transition by mitigating the negative repercussions on employment and by financing the diversification and modernisation of the local economy.[1]

In the context of the JTF, the Just Transition Platform (JTP) was launched to assist EU Member States and regions to unlock the support available through the JTM. The Platform serves as an important political interface for DG REGIO but also for various other European Commission services (including DG ENER, DG CLIMA, DG GROW). It provides a single access point to support and knowledge on Europe's transition to a sustainable, climate-neutral economy. Specifically, it provides technical assistance and advice, including a dedicated helpdesk. The Platform also promotes sharing of knowledge and exchanges of best practices to a wide range of stakeholders, particularly in regions dependent on fossil fuels or carbon-intensive industries. The Platform organises regular events for all stakeholders and provides opportunities to financial actors, social partners, business representatives, youth organisations and transition experts to discuss the needs and challenges of the just transition. Another key initiative involves four dedicated JTP Working Groups for carbon-intensive regions, focusing on steel, cement, chemicals as well as horizontal stakeholder strategy.

Context and Objectives

Another component of the JTP are **periodic ad-hoc analyses** that are dedicated to further investigate subjects and themes of particular interest. In this ad-hoc provision of analysis, the focus is oriented towards **industrial decarbonisation plans across the EU**. Attaining the climate and energy targets of the European Union (EU) will heavily depend on the ability of industries to transform to climate-neutral operations. Especially carbon-intensive industries face a challenging road ahead, as transformations will require holistic approaches that tackle various parts of the industrial processes at once.

To this end, across the EU, at different levels (Member State, region, specific industry) and to different degrees of detail, **decarbonisation plans are being developed**. Often, these plans are referred to in the respective Territorial Just Transitional Plans (TJTP) currently being developed by EU Member States. The TJTPs include an outline and timeline for the transition process until 2030 and 2050 and identify the eligible territories expected to be most negatively impacted by this transition. Moreover, they set out the social, economic, and environmental challenges stemming from the phasing out of fossil fuel-related activities or decarbonisation of greenhouse gas-intensive processes or products.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1056

Importantly, they ought to describe the types of operations to be funded by the JTF and outline the intended use of Pillar 2 (InvestEU) and Pillar 3 (Public Sector Loan Facility) of the JTM.

While existing decarbonisation commitments of industries or regions are often cited in TJTPs, yet they do not always comprehensively describe the details of such decarbonisation efforts. As such, a first objective of this ad-hoc analysis was to pursue **a closer review of 10 decarbonisation plans across the EU,** delivered in the form of case studies and offering insight into the strategies being formed and commitments made. These plans are succinctly synthesised in the pages that follow and are reviewed in some more depth in the case studies provided in the Annex.

The **socio-economic dimension of the transformation** underway, which can also be considered as the ***just transition*** dimension, is a significant perspective to adopt. The Just Transition Fund plays an important role in this regard, since one of its principal objectives is to support regions in alleviating the socio-economic impacts of the transformation of carbon intensive industries. The degree to which the *just transition* dimension is being considered in industrial decarbonisation plans across the EU varies considerably. As such, another objective of this ad-hoc analysis was to **review decarbonisation plans** to the degree that they directly **consider and plan for the socio-economic dimension of the transition** ahead. Insights from plans that do so are also highlighted in a dedicated section of the synthesis as well as included in the case studies of plans that consider this dimension.

Overview of selected decarbonisation commitments across the EU

Austria: Reduction of CO_2 emissions for Austrian industry by 61% until 2030

The study **Climate Neutrality for Austria by 2040** (2021) outlines the vision that will allow the whole economy to completely decarbonise by 2040 and achieve a reduction of emissions for the Austrian industry of 61% by 2030. This will primarily be pursued through several main strategies: the electrification of industrial processes, the use of carbon-neutral gases, the further development and employment of carbon capture technologies and the promotion of circular economy activities.

Croatia: Reduction in overall CO_2 emissions by 40% until 2030 and 80% until 2050

The **Croatian Low-Carbon Development Strategy** (2021) outlines the path to reducing CO_2 emissions by 40% until 2030 and by 80% until 2050. The strategy, which covers all sectors of the economy, estimates investment needs of up to EUR 900 billion until 2030, which will focus on promoting necessary research, development and innovation, as well as circular economy initiatives.

Cyprus: Increasing the productivity of the Cypriot industry, including through investment into sustainability measures

The **New Industrial Policy** (2020) of Cyprus is a comprehensive industry plan that seeks to increase industry productivity by investing into sustainability measures, innovation and digitalisation, infrastructure, as well as the promotion of skills and training. Consisting of six main pillars, Pillar 1 is dedicated to investing into infrastructure that will promote innovative low-carbon technologies, clean and renewable energy, smarter use of resources, as well as carbon capture and storage solutions.

Denmark: Reducing CO_2 emissions of the energy-intensive industry by 70% until 2030

Climate Partnerships between the government and the business community are being developed with 14 sectors in the Danish economy, establishing a vision as to how each sector will contribute to the national 70% CO_2-reduction target.

The **Climate Partnership for energy-intensive industry** (2021) outlines a:

- 30% reduction through energy efficiency measures, alternative fuels and changes in product composition
- 20% reduction through the use of biogas and electrification
- 20% reduction through carbon capture technology

Thirteen other sectors have established similar partnerships[2]: aviation, shipping & maritime, commerce, construction, defence, energy and utilities, finance, food and agriculture, inland transport, life science and biotech, manufacturing, services, and circular economy.

France: Reducing $C0_2$ emissions of the steel industry by 31% and of the chemical sector by 26% until 2030

The French National Council of Industry, together with companies and employee representatives, have developed 19 official industry plans binding to both private and public actors.

The **French Steel Industry Plan** (2022) seeks to reduce emissions by 31% until 2030 and to be carbon-neutral by 2050 through i) creating conditions for the sector to become more internationally competitive, ii) supporting the transformation to carbon-neutral operations, and iii) strengthening the attractiveness of the steel industry through employment and skill-development. The **French Decarbonisation Roadmap for the Chemicals Sector** (2018) seeks to reduce emissions by 26% until 2030 by leveraging existing measures, such as energy efficiency initiatives and the further development of carbon-free heat sources, while also pursuing measures that are not yet as established, such as the use of low-carbon hydrogen, the capture and storage of carbon and the electrification of processes.

Seventeen other sectors have established similar sector contracts[3]: agri-food, sea industry, construction, energy, future solutions, waste transformation, electronics, rail, fashion and luxury, nuclear, health, digital infrastructure, automotive, aeronautical, water, security, and timber.

Germany: Goal of becoming climate-neutral by 2050

The **Steel Action Concept** (2020) was co-developed by the Federal Government together with the steel industry and builds upon Germany's Industrial Strategy 2030, the Climate Action Plan 2050, and the Climate Action Programme 2030.

While no specific emissions reductions are specified, the Steel Action Concept seeks to contribute to the 2030 and 2050 climate targets and determines it "likely that significant CO_2 reductions in the sector" can be achieved in the years up to 2030. To this end, the government and industry will jointly seek to i) develop a more level playing field in the global steel market by tackling market distorting measures, ii) avoid carbon leakage by preventing the relocation of energy-intensive industries to countries with less-stringent

[2] https://climatepartnerships2030.com/the-climate-partnerships/

[3] https://www.conseil-national-industrie.gouv.fr/les-contrats-de-filiere

standards and iii) promoting investment into innovative technologies as well as considering the skills development of employees.

Sweden: Fossil-free cement & concrete production by 2030 and fossil-free mining & mineral operations by 2045

The Fossil Free Sweden Initiative was launched by the national government in order to gather and accelerate the climate efforts being made across sectors, municipalities and regions. In this context, 22 different industries have developed dedicated roadmaps to outline their paths to fossil-free or climate neutral operations.

The roadmap for the **cement industry** (2018) seeks to achieve fossil-free and climate-neutral cement and concrete production by 2030, principally through the development of technologies for carbon capture (including geological carbon capture), the electrification of processes, as well as carbonation. Moreover, the choice of building materials will be guided by a long-term vision that incorporates comprehensive life-cycle analyses.

The roadmap for the **mining and minerals sector** (2019) outlines the path towards fossil-free and climate-neutral mining and mineral operations by 2045, through a focus on electrification, bioenergy, as well as carbon capture and storage technologies. However, significant investments in R&D will be necessary, as well as effective and fair permit processes.

Twenty other industries and sectors have developed similar roadmaps[4]: aggregates, agriculture, heavy transport, passenger transport, aviation, concrete, construction, digitalisation, electricity, consumer goods, food, forest, gas, heating, heavy road haulage, maritime, petroleum and biofuel, recycling, skiing, and steel.

The Netherlands: Reduce C02 emissions of the North Sea Canal area by 50% until 2030 and to close to zero by 2050

The national government requested six clusters across the country to develop their Cluster Energy Strategies, which outline both the commitment of industry actors as well as how the government can support.

The **Regional Plan of the North Sea Canal Area** (2020) envisions a reduction of CO_2 emissions across industries by 50% until 2030 and to almost zero by 2050. To this end, companies have submitted around 45 project plans that concern, among others, carbon storage, the electrification of industry, the use of hydrogen, the electrification of industry and the use of geothermal energy for heat. Essential conditions for the climate transition, which the regional and national government can help foster, include the further development of a robust energy infrastructure network, investments into risky or early-stage technologies and the importance of a workforce that is sufficiently trained for the transition.

Five further cluster plans[5] have been developed for the Northern Netherlands, Rotterdam-Moerdijk, Zeeland-West Brabant and Chemelot/Limburg, as well as a "Cluster 6", which is for all remaining industries.

[4] https://fossilfrittsverige.se/en/roadmaps/

[5] https://www.klimaatakkoord.nl/actueel/nieuws/2020/10/22/industriele-clusters-publiceren-plannen-2030-2050

The Just Transition Dimension

The review of the ten decarbonisation strategies outlined above provide some insight into how the socio-economic effects of the transition can be appropriately considered and planned for. Of these ten plans, three include considerations that seek to ensure that the transition is a *just* one, by specifically taking into account socio-economic impacts and assessing the consequent need for labour force trainings and skill development initiatives.

Some helpful insights from selected plans are highlighted below:

The French Steel Industry Plan (2022)

The Plan explicitly reflects on how to strengthen the attractiveness of the steel industry for employees and how future jobs can be created and filled through training and skills development. Conscious that the success of the steel industry transformation will depend on the current and future workforce, the Plan outlines:

i. The importance of promoting the opportunities offered by the transition of the steel industry in regard to the scientific (R&D in materials or processes) and technological (engineers, computer scientists, data scientists) dimensions. This is planned to be better communicated through participation in student forums, fairs and industry-specific events.

ii. That companies must be able to better anticipate future needs and determine the degree to which training and employment can be offered to meet these requirements. The importance of including work councils in the development of these tools at an early stage is deemed as critical.

iii. The need to strengthen the funding for training and skill development, by providing both staff training for sectors in particular demand and developing transition programmes to support employees affected by structural change. Moreover, facilitating access to the labour market for qualified foreign workers is also deemed as an important strategy.

The Steel Action Concept – Germany (2020)

The Steel Action Concept in Germany clearly acknowledges that the success of the transformation will fundamentally depend on whether employees in the steel sector are prepared and trained for new tasks as they arise. If employees are not properly trained and their skills developed, investments in new technologies have limited sense. The government underscores that companies need to develop viable concepts to determine how the training and continued employment of the workforce can be ensured and the future demand for skilled labour met. Work councils should be involved early in the development of new training and skill development concepts.

A variety of measures have been adopted that seek to support companies in receiving funding for measures in the field of further training and skills development:

i. The act on opportunities to gain qualifications: enhances advisory services for further training and skills development; improves support available for further training of employees at risk of losing jobs to new technologies or for those who seek to obtain advanced vocational training for occupations that face skills shortages.

ii. The act to promote advanced vocational training and enhance the promotion of training: expands targeted forms of assistance to employees and their employers in companies that are particularly affected by structural change as well as rewards collective work agreements on advanced vocational training.

iii. The skilled immigration act: aims to facilitate access to the labour market, in particular for third-country nationals with vocational training qualifications. In addition to improving the legal framework, special attention is paid to its practical implementation, such as improving administrative procedures for recognising foreign qualifications, a joint strategy with businesses for attracting skilled labour, as well as an improved marketing approach.

The Regional Plan of the North Sea Canal Area – The Netherlands (2020)

The Metropolitan Region Amsterdam is working together with House of Skills, the Amsterdam Economic Board and the provinces of Noord-Holland and Flevoland on a *Human Capital Agenda (HCA) – Climate Challenge*. The aim is to ensure that there are sufficient technically trained people to carry out the many climate projects planned in the region.

To formulate concrete objectives, specific lines of action were developed:

i. Ensure that climate job skills and technologies are part of the curriculum and that technical education is provided by trained teachers.

ii. Talent development and retention, by setting up hybrid learning environments and ensuring continuous learning pathways.

iii. Ensure that sufficient work placements and apprenticeships are available and that appropriate supervision and guidance in the workplace is provided.

iv. Work towards a more skills-oriented labour market and establish learning communities for research and innovation.

Analysis: Some considerations

Upon review and analysis of the ten decarbonisation plans, some salient points can be highlighted. First, it is clear that **industries are actively preparing for the transformation** to come and that there are certain cross-cutting innovations that can support the reduction of GHG emissions across industries. The promotion of carbon capture and storage in order to reduce emissions is, for instance, a prominent technology across different industries. Furthermore, the need for an energy infrastructure that generates renewable energy and ensures sufficient supply, as well as the provision of reliable and affordable electricity, will be two critical points for various industries. Undoubtedly, the decarbonisation of industries will thus require **significant R&D and investment into innovative production technologies**, so that these can be further developed and applied. In addition to financial support, the aim of governments must be to ensure that incentives exist for companies to make medium- and long-term investments. In this regard, state aid guidelines will need to ensure that higher initial operating costs during the industrialisation phase of new technologies can be compensated. The government can further be of support in both ensuring that public procurement procedures include sustainability criteria and that environmental standards for products in the EU are created, to which imported products must adhere to as well. In this context, further measures must be taken to create a level playing field and ensure that carbon leakage is avoided, so as to prevent the relocation of energy-intensive industries to countries outside the EU with less stringent standards.

Next, across the case studies reviewed, it is insightful to observe the vast array of structures that have been established to promote carbon-neutral industrial operations. In some countries *climate partnerships* have been formed, while in others *industry roadmaps*, *action plans*, *sector contracts* and *cluster plans* have been developed. However, what

seems to be a key ingredient throughout is that **important stakeholders from both public (regional or national government) and private spheres (companies), as well as from intermediate bodies (industry representations) and employee representations, are included in the creation of the plans**. Ensuring that all relevant stakeholders are involved allows for serious commitments (from both public and private actors) to be agreed upon, which in some cases may act in a binding manner.

Finally, the analysis of the plans has also shed light on the degree to which **the socio-economic perspective, or the *just transition* dimension, has been considered across decarbonisation strategies**. While it is widely appreciated that the transformation of industries on the path to climate-neutral operations will have significant socio-economic impacts, the degree to which industrial decarbonisation plans directly consider such a human dimension varies greatly. While some plans offer detailed considerations, other plans do not take this human dimension directly into account. Of the ten plans reviewed, **only three have specifically considered – to different degrees – the future needs in terms of skills and training requirements** and detail endeavours to match this demand. These plans acknowledge that while new technologies to innovate industrial processes are significant, what is equally crucial is the adequate provision of labour that can then operate these new tools in new environments. The *Human Capital Agenda (HCA) – Climate Challenge* in The Netherlands is just one helpful example that illustrates how local government, regional government and network organisations can collaborate to ensure that the labour market will be sufficiently trained to pursue the many climate projects planned.

However, the plans that do consider this perspective are in the minority, since of the total sample of plans reviewed, the *just transition* dimension is largely missing when future challenges are considered. This suggests that **more attention must be given to this important element and that industrial decarbonisation plans need to consider the *just transition* dimension, not as an afterthought, but as a key pillar of a successful transition**. The urgency of the matter is clear too, since adequately understanding and training for future labour force skills and capacities requires time. Thus, these processes must start now so that when technologies and new industrial processes are ready, the required labour force is appropriately equipped and trained. The Just Transition Fund plays an important role in this regard since it seeks to support regions in alleviating the socio-economic impacts of the transformation of carbon-intensive industries towards climate-neutrality. Specifically, it can be employed for such endeavours as up- and reskilling of workers as well as programmes for job-search assistance and the active inclusion of jobseekers. The associated Territorial Just Transition Plans should thus be used to describe the planned transition process and, importantly, ought to detail how socio-economic consequences are being considered and what programmes will seek to address this dimension.

Annex

Review of selected industrial decarbonisation plans across the EU

1. **Austria:** Climate Neutrality for Austria by 2040 - Contribution of Austrian Industry
2. **Croatia:** Low-carbon development strategy of the Republic of Croatia until 2030 with a view to 2050
3. **Cyprus:** New Industrial Policy 2019 - 2030
4. **Denmark:** Energy Intensive Industry - Climate Partnerships
5. **France:** Decarbonisation Roadmap of the Chemicals Industry
6. **France:** Steel Industry Plan
7. **Germany:** The Steel Action Concept
8. **Sweden:** Roadmap Cement – for Climate-neutral Concrete Construction
9. **Sweden:** Roadmap for a Competitive Fossil-free Mining and Minerals Industry
10. **The Netherlands:** Cluster Energy Strategies – North Sea Canal Area

Austria - Industry

Key Points

A study (**Climate Neutrality for Austria by 2040**) to assess the decarbonisation potential of the whole industry, commissioned by the Austrian Federal Government.

The most emmissions-intensive sectors are: the iron & steel sector, the stone, earth & glass sector, the cement & the chemicals industry as well as the paper & printing sector

Objective: **completely decarbonise the Austrian energy sector and the whole economy by 2040**

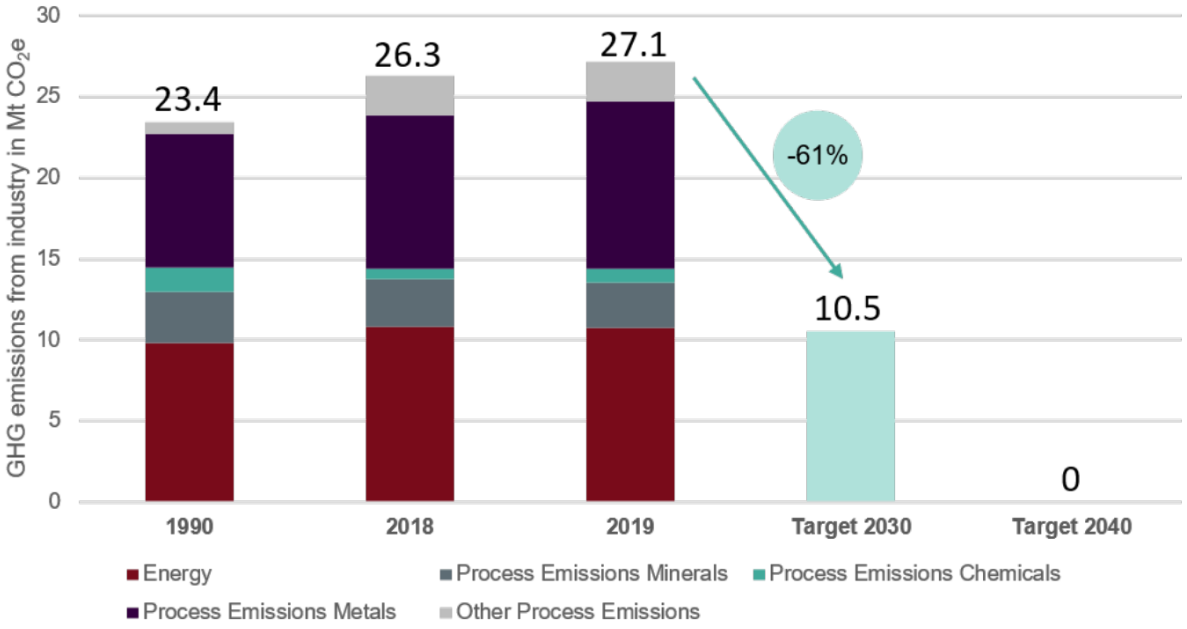
The Industry Plan (2021) has three central components: an analysis of the current situation of the industry, technical decarbonisation possibilities and costs of the transformation

***Just Transition* dimension** explicitly considered in the Plan: **No**

Background

In its current legislative program, the Austrian federal government is pursuing the ambitious target of completely decarbonising its energy sector and the whole of its economic system by 2040. GHG emissions by the industry have risen from 23 to 27 Mt CO_2e since 1990. The production of metals such as iron and steel, products made from stone and earth such as cement and bricks, and chemical products generate a particularly high level of GHG emissions. The following chart shows the trend in GHG emissions as well as targets for the industry for 2030 and 2040.

Figure 1: Trend in GHG emissions and GHG targets for Austrian industry for 2030 and 2040



Source: Chart from Austrian Climate Neutrality Study, based on Umweltbundesamt 2021.

Austrian industries and the services attributable to it contribute over EUR 75 billion to the country's total gross value creation, or 34% of total value added in Austria. Industry,

including the services attributable to it, provides employment for over 960,000 people, meaning that almost one in every three employees indirectly works in this sector.

These contributions show that a decarbonisation strategy based on pushing out the industrial companies is not a sensible solution. Options must therefore be presented that permit the cost-efficient decarbonisation of these companies. A consortium was commissioned by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) to prepare a scientific study, titled **Climate Neutrality for Austria by 2040 (2021)**[6], to determine:

I. How the Austrian industry currently compares to other countries?

II. What decarbonisation options are available to the individual industrial sectors?

III. What investment costs these technological options would entail?

Climate neutrality for Austria by 2040

I. Austrian industry in detail – current situation

Overall, GHG emissions attributable to the Austrian economy totalled 60 Mt CO_2e in 2018. Of this amount, 26 Mt CO_2e stem from industry and 10.3 Mt CO_2e from energy generation. On average, Austria's industry is more emissions-intensive than that of Germany, the Nordic countries and its main trading partners Italy and Switzerland. Iron and steel production is the most emissions- and energy-intensive sector in Austria, generating 9.6 Mt CO_2e, largely due to the use of coal and coke in the production process. Geogenic (process-related) CO_2 emissions from the stone, earth and glass sector also contribute close to 3 Mt CO_2e and are the second most emissions-intensive sector in Austria. Final energy supplied via natural gas results in overall emissions of 7 Mt CO_2e and the use of electrical energy in industry is responsible for indirect emissions of 7 Mt CO_2e.

II. Technical decarbonisation potential

The technical decarbonisation potential in each sector can be pursued through four overarching decarbonisation strategies:

- Electrification
- Carbon-neutral gases
- Carbon capture
- Circular economy

In the **iron and steel production sector**, merely using **carbon-neutral gases** could save up to 10 Mt of CO_2e per year – depending on the gas employed and the upstream chain required – by using direct reduced (or sponge) iron and electric arc furnaces. This shift in technology also offers a further benefit during the transition to climate-neutral steel production: should iron ore reduction capacity in Austria fall temporarily, a consistent quantity of high-quality steel could be produced using sponge iron available on the international market by rapidly expanding the electric arc furnaces that are planned.

The biggest challenge to decarbonising the **stone, earth and glass sector** and the **cement industry** is the geogenic emissions generated by processes to strip CO_2 from mineral compounds. Thus, the use of **carbon capture technologies** has a key role to play. Besides the established process of amine scrubbing, a wide range of options from this family of technologies are currently being tested in pilot facilities to determine their suitability for industrial use. The reduction in GHG emissions that could be achieved through these means is around 90%. In other words, using technologies to avoid geogenic

[6] https://www.bmk.gv.at/dam/jcr:77f55fa2-d9a6-42d9-8cd0-64e466d2c913/Climate_neutrality_Austria_2040.pdf

emissions could save about 2.5 Mt CO_2e a year provided that the captured CO_2 can be isolated over the long term.

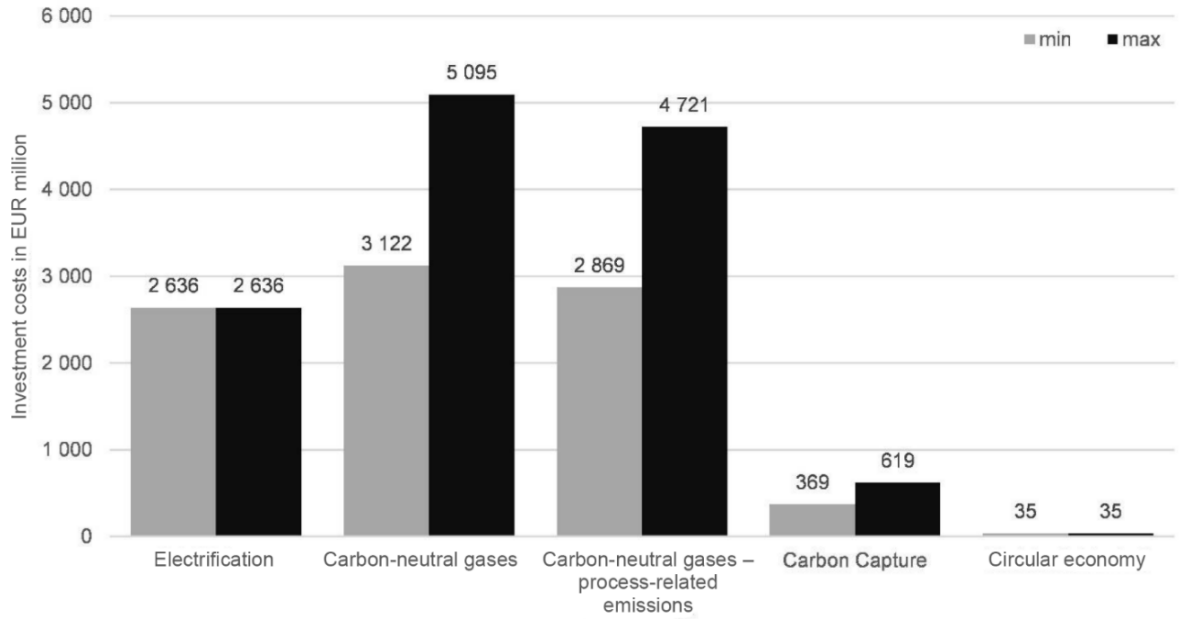
The decarbonisation potential in the remaining sectors is largely restricted to energy-related emissions generated by burning fossil fuels. However, the **chemicals industry** and the **paper and printing sector** both have their own sector-specific characteristics that need to be taken into particular consideration. In the remaining, **non-energy-intensive sectors**, electrification (heat pumps) and the use of carbon-neutral gases are potential ways forward. Decarbonising the supply of high-temperature process heat could reduce GHG emissions by between 3.8 and 5.5 Mt CO_2e.

Decarbonising industries will have a significant impact on the energy system. in the case of hydrogen electrolysis, for instance, switching to carbon-neutral gases and their production will increase demand for electrical energy. As well as using natural gas as the hydrogen source, the use of methane pyrolysis to supply carbon-neutral hydrogen from natural gas also requires electrical energy to run the pyrolysis system.

III. Costs of the transformation

Regarding energy-related GHG emissions, it is clear that converting room heating and air-conditioning systems and process heat below 200°C will require significant investment. Whilst the use of carbon-neutral gases appear to be the lowest-cost option for room heating and air-conditioning systems, other factors aside from simple cost efficiency need to be factored into the choice of the decarbonisation strategy. Factors such as resource efficiency, associated upstream chains and available resource potential need to be considered. With regard to the use of high-temperature heat pumps for process heat below 200°C, the anticipated cost efficiency of large-scale industrial plants puts this cost benefit into perspective. The following table summarizes the value ranges for investment costs for each decarbonization strategy.

Figure 2: Value ranges for investment costs for each decarbonisation strategy



Source: Chart from Austrian Climate Neutrality Study

The total investment costs between now and 2040 for the decarbonisation options presented vary between EUR 6.2 billion and EUR 11.2 billion (excluding operating costs), depending on the technologies chosen. What percentage of the investment costs would require additional funding cannot be reliably estimated. The cost-effectiveness of the decarbonisation measures depends on the corresponding operating costs (particularly for energy) and on other framework conditions (e.g. taxes, CO_2 price). The lower the costs for CO_2-free electricity, biogas and CO_2-free hydrogen, the more cost-effective the options.

Croatia - Economy

Key Points

The strategy is a **national, long-term and multi-sectoral** strategy by the Croatian government.

The strategy applies to **all sectors of the economy**, and is particularly related to energy, industry, transport, agriculture, forestry & waste management.

Objective: **40% reduction in CO_2 emissions by 2030** and **~80% reduction by 2050**

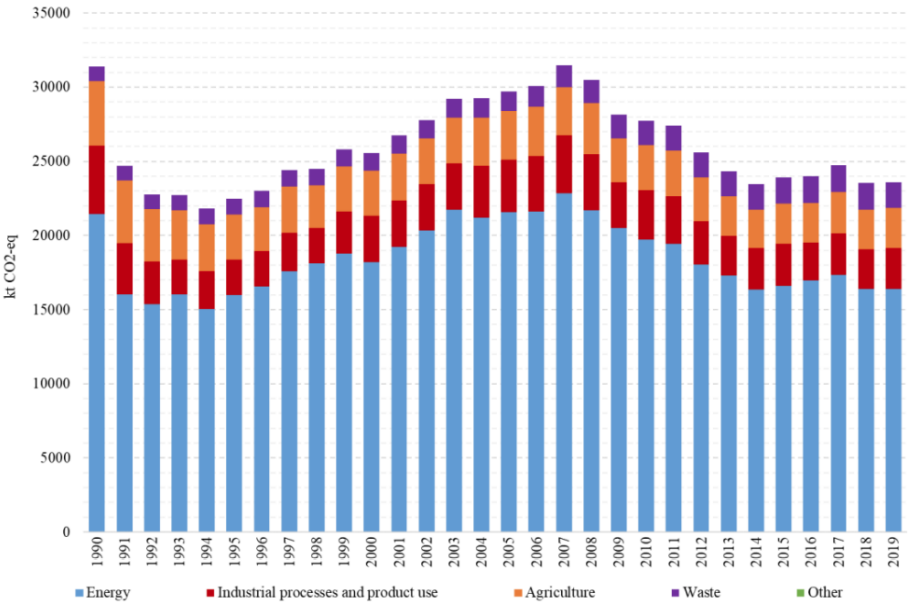
The **Low-Carbon Development Strategy (2021)** outlines three main reduction scenarios for the different economic sectors in Croatia.

***Just Transition* dimension** explicitly considered in the Plan: **Yes** (though not explicitly related to the need for skill development and training for a climate-neutral economy)

Background

In Croatia in 2018, total GHG emissions amounted to 24 Mt CO_2e, which represents a reduction in emissions of 25% compared to emissions in 1990. The trend of emissions by sector and over time is shown in the figure below.

Figure 1: Trend of greenhouse gas emissions by sector



Source: Croatian Low-Carbon Strategy

The **electricity and heat production** sector in 2018 accounted for 14% of emissions, while the **oil and gas production and refining** sector accounted for 7%, of which 75% were emissions from refineries. **Traffic** accounted for 27% of total emissions, of which road passenger transport was 72% and road freight transport 25%. Importantly, the transport sector had 60% higher emissions than in 1990. Emissions from the **manufacturing industry** account for about 21% of total emissions, of which close to half relate to emissions due to fuel combustion, and the other half to process emissions.

Pursuant to Article 15 of the EU Regulation on Governance, Croatia developed a **Low-Carbon Strategy (2021)**[7]. The strategy is a national, long-term and multi-sectoral strategy with the purpose to initiate changes that will contribute to the reduction of GHG emissions. In the drafting it, a number of scenarios were analysed, numerous models for simulations and optimisations were applied, and an integrated model for national greenhouse gas projections was developed.

The Low-Carbon Development Strategy follows four general objectives:

1. Achieving sustainable development based on knowledge, a competitive low-carbon economy and efficient use of resources.
2. Increasing the security of energy supply and the sustainability of energy supply, as well as increasing energy availability and reducing energy dependence.
3. Solidarity by fulfilling the obligations of the Republic of Croatia under international agreements, within the framework of EU policy.
4. Reduction of air pollution in order to reduce the negative impact on the health and quality of life of citizens.

The Croatian Low-carbon Development Strategy

Three main scenarios to reduce emissions

The **reference scenario** (NUR) is a continuation of existing practice, in line with current legislation and accepted targets by 2030. This scenario assumes technological progress and the growth of the share of renewable energy sources and energy efficiency based on the market situation and the target energy standards set today. The **gradual transition scenario** (NU1) is seeks to meet the emission reduction objectives under the EU's internal commitment scheme, and the related objectives of the Paris Agreement to keep the temperature rise within 2 °C and preferably within 1.5 °C. In this scenario, emission reductions are achieved through the application of a **series of cost-effective measures, strong incentives for energy efficiency and the use of renewable energy sources** that could be largely market-competitive in electricity generation after 2030. The **strong transition scenario** (NU2) is sized with the aim of achieving an 80% reduction in emissions in 2050, compared to 1990. In this scenario, as well as in the NU1, a strong **increase in emission allowance prices up to 92.1 EUR/t CO_2 in 2050, and very strong energy efficiency measures are assumed**. The share of renewable energy sources in 2030 under this scenario is 36.4%, and in 2050 it could be 65.6%.

Until 2030 it is envisaged to achieve a **7% reduction in emissions in non-ETS sectors**, compared to 2005 emissions. Until 2050 it is planned to reduce GHG emissions with a trajectory between the low-carbon scenarios NU1 and NU2, with the aim of a more ambitious NU2 scenario.

Financing

It is estimated that the transition to low-carbon development will require HRK 38.65 to 65.92 billion (EUR 513 to 875 billion) in the period from 2021 to 2030, i.e. from 0.92 to 1.6% of the GDP. In the period from 2031 to 2050, the cost will amount to between HRK 107.09 and 167.95 billion (EUR 1,422 to 2,230 billion; from 0.96 to 1.51% of the GDP). The framework for the financing of measures already exists to a large extent, in terms of possible sources of funding. The government has significant financial resources at its disposal, but the investment needs currently exceed the available funds.

[7] https://mingor.gov.hr/UserDocsImages/klimatske_aktivnosti/odrzivi_razvoj/NUS/lts_nus_eng.pdf

Impact of the scenario on the environment and nature

Although the implementation of the Low-Carbon Development Strategy has a positive effect on reducing emissions, some aspects pose a potential threat to certain parts of the environment and nature. Environmental protection measures and measures aimed at mitigating the effects on the conservation objectives and the integrity of the ecological network area are thus an integral part of the Low-Carbon Development Strategy.

Research, development and innovation

Research and development are among the biggest potential factors contributing to GDP growth, which is why Croatia needs to increase its R&D expenditure to move closer to the EU average. Access to funds should also be provided to the private sector, for applied scientific and development research, and pilot and demonstration projects. The ministry responsible for climate policy, inter-coordination bodies and representatives outside the public sector must be strongly involved in the planning of funding programmes and in the monitoring of implementation.

Low-carbon development at local level

At local level, the mitigation and adaptation measures to climate change are linked, and the synergy of resource use is the strongest. The Low-Carbon Development Strategy indicates the need to implement a number of **measures in the planning and construction of integrated systems in cities**. These include public and other transport, buildings, utilities, autonomous systems, education systems, information and communication technologies (ICT), urbanism, innovative solutions in various fields and raising public awareness.

Low-carbon economy and business patterns

Regarding business patterns, the most significant is the **transformation of business according to the principles of the circular economy**. It is necessary to implement a policy of sustainable consumption and production, to encourage sustainable patterns of behaviour and business in all economic sectors. The Life Cycle Assessment (LCA) concept, which monitors the environmental footprint of products and services and is based on scientific indicators, should be implemented.

Just Transition Dimension

While the following element of the Low-Carbon Development Strategy considers the just transition dimension, it does so more by focusing on the behavioral changes that will be required from society and does not focus as much on the necessary training and skill development that will be required for a carbon-neutral economy. Nevertheless, we provide an overview below.

Socio-economic impact

The overall expected benefits for society (considering external costs) are positive, and result in a lower overall social cost. The main challenge of the implementation and the pace of the changes is the need for high investments that can pose a significant challenge for certain segments of the economy. A limiting factor to an accelerated transition may be the ability of the economy, society and individuals to participate in the processes in a timely manner, due to large initial investments, regardless of the fact that the transition processes can bring long-term benefits to society and the environment.

A low-carbon transformation can bring net benefits to society, but additional EU funds are needed to implement the measures.

Education and active involvement of citizens in low-carbon development

The education system must become a leader in promoting the principles of low-carbon development; young people entering the education system today will be the promoters of change in the future, and without their knowledge and conviction, the goals of the Low-Carbon Development Strategy will not be implemented. In the period from 2021 to 2030, education on sustainable development and climate change in Croatia will be developed, supplemented and modernised, and generations of citizens will be fully and systematically "climate aware".

Critically, **new skills will need to be taught to meet the challenges of the transition to low-carbon development**. The initiation of systematic raising of knowledge about the concept of sustainable development and awareness of climate change should take place through:

- Continuous improvement of the level of education on sustainable development and climate change issues in the regular education system (primary school, secondary school, colleges and universities)
- Adapting secondary and higher education programs to the learning needed to master the knowledge and skills associated with the low-carbon economy and smart specialization
- Lifelong learning through the media (newspapers, television and the Internet) on the principles of the Low-Carbon Strategy that will educate all people, all Croatian residents who are no longer part of institutional education
- Development of application tools for calculating and monitoring the environmental footprint, carbon footprint, for young people, for their activities, for educational institutions, and households.

Thirdly, low-carbon practical solutions will need to be built into social life, production, consumption and development management in the direction of increasing sustainability.

Cyprus – New Industrial Policy

Key Points

The New Industrial Policy (2020) addresses socio-economic conditions, the specific needs of the economy and citizens, as well as the requirements for climate change.

The Cypriot industrial sector is facing long-term and structural weaknesses.

Objective: increase of industry productivity through the facilitation of the industrial ecosystem & the appropriate investments in the sustainability, innovation, digitisation, infrastructure and skills of industries and enterprises.

Plan has **six strategic pillars**: infrastructure, business environment, digitalisation, skills, financing, access to markets.

***Just Transition* dimension** explicitly considered in the Plan: **Yes** (though not explicitly related to the needs for a climate-neutral industry)

Background

The island economy of Cyprus and its distance from Central Europe are the main factors that affect both the competitiveness and the productivity of industry and entrepreneurship. The fact that the economy consists of 99.9% small and medium enterprises (SMEs), of which 93.3% are very small enterprises (up to 9 people), contributes to this challenge.

This alone implies that Cyprus does not have the natural (and other) resources that could support sustainable development, nor the ability to produce large quantities in an efficient manner. Small business size, the lack of natural resources and difficult access to them, as well as low capacity for innovation, are obstacles to achieving economies of scale, which would allow for improved competition with large-scale foreign competitors.

The Cypriot industrial sector is facing long-term and structural weaknesses:

- Reduced competitiveness
- Obstacles in the development of industry
- Skills gap among human resources
- Lack of strategic investments in industrial activities and R&I
- Difficult access to financing
- Insufficient coordination between competent services for the full exploitation of export opportunities
- Lack of strategic cooperation between companies in the domains of production, distribution and export

The biggest challenge is to ensure cooperation and coordination of all stakeholders for the implementation of the new industrial policy with a common vision. The **vision of the government** is the creation of a robust, flexible, smart and technologically developed industry with related services, which will contribute substantially to the development and competitiveness of the Cypriot economy and the well-being of the citizens. The **mission of the new industrial policy** is the development of innovative products and services of high added value that will contribute to the viability and competitiveness of the Cypriot industry. The **main objective** is the gradual increase of industry productivity through the

facilitation of the industrial ecosystem and appropriate investments in the sustainability, innovation, digitisation, infrastructure and skills of industries and enterprises. The **sustainability of such a policy** is of utmost importance for both present and future generations. Recognizing the importance of industry, the state, in cooperation with its strategic partners, aims to create the appropriate mechanisms, infrastructure and financial tools for industry to become a vital pillar of economic growth.

The New Industrial Policy of Cyprus 2019-2030

The **New Industrial Policy has six main pillars**. Pillar 1 is especially relevant to restructure the Cypriot industry in a climate-neutral way. The remaining pillars are focussed on improving the industrial/business environment (2), the digitalisation of industry (3), development of skills (4), increasing access to finance (5) and enhancing access to markets / extroversions, exports and investments (6).

PILLAR 1 – Infrastructure for sustainable production and development

Increasing the competitiveness of industrial products and services implies increasing productivity and innovation and reducing operating costs - especially production-related costs. Moreover, the **utilization and development of innovative low-carbon technologies and clean energy, the smart use of resources, the use of renewable energy sources** (especially for energy intensive industries), as well as carbon capture and storage solution will accelerate the transformation of the country's energy system.

Pillar 1 is directed at six different aspects:

1. **Infrastructure for energy savings and measures to improve energy efficiency**

   The consumption of energy in the industrial sector (2016) represents 13% of national energy consumption. The cement industry is the main consumer of the sector, with a share of almost 60% of the total industrial energy consumption. The Ministry of Energy, Trade and Industry has prepared several measures to improve energy efficiency, such as financial incentives to conduct energy audits or promoting the appointment of an energy manager.

2. **Infrastructure for renewable energy sources and power generation**

   In regard to renewable energy, the National Action Plan for renewable energy sources (RES) is implemented, which provides for the promotion of RES in the fields of electricity, heating / cooling and transport. In this context, a support scheme for the promotion of electricity generation from renewable sources for own consumption is envisioned, as well as a scheme for the production of electricity from renewable sources.

3. **Infrastructure for energy investments and development of trans-European energy networks**

   Cyprus is the only EU Member State that remains energy-isolated from TEN-E and is heavily dependent on electricity generation from conventional energy sources. For this reason, the government promotes the import of natural gas in Cyprus in the form of Liquefied Natural Gas (LNG).

4. **Circular economy**

   Cyprus' performance is below the EU average in terms of resource utilization. Furthermore, there is a need to tackle problems such as water scarcity and over-pumping, which continue to be challenges for industry, but also opportunities for research and development. The action plan incorporates proposed actions such as the connection of industrial areas with the waste system.

5. Infrastructure of industrial districts and commercial areas

In recent years, the operation and management of the industrial zones is a challenge, mainly due to the economic crisis that has hit the industrial sector. Many of the companies that are based in industrial areas show a reduced turnover. Actions to address the challenges are focused on: strengthening the recovery process and monitoring rents; supervision of industrial areas to control proper operation; effective implementation of the terms of the contracts; modernization of existing infrastructure of industrial areas and zones; development of a new energy and industrial Area.

6. Infrastructure for research, development and innovation

The strengths of the Cypriot innovation system are found in the number of international scientific publications, the percentage of the population with higher education and the growing number of trademark applications. The main weaknesses are the limited occasions of scientific-private sector cooperation, the difficulties of the private sector in co-financing public R&D expenditure and the low investment of Cypriot companies, which remain well below the EU average. Actions promoted in the plan include the creation of innovation hubs or technology transfer centers.

Just Transition Dimension

PILLAR 4: Developing new skills and strengthening / upgrading existing skills

While this pillar considers the just transition dimension and addresses the need to develop new skills as well as upgrade existing ones, it focuses on more general (as well as digital) requirements and does not directly consider the skills needed to ensure an increasingly climate-neutral industry. Nevertheless, we provide an overview below.

A key condition for the success of the New Industrial Policy is the existence of properly trained human resources at all levels, which should have the necessary knowledge, skills and abilities. Special emphasis is given to the development of human resources that will guide the management of the new digital age and will lead this new path of development.

Actions promoted

- To support the enrichment of the curricula of higher education and lifelong learning, the Universities of Cyprus have created "**Liaison Offices with the Business World**». The aim of these offices is to achieve closer cooperation and connection of universities with companies.
- The Ministry of Education and Culture has established the **Post-Secondary Institutes of Vocational Education and Training** (MIEEK) to cover the immediate needs of the labor market. The programs offer free, high-quality education and training programs.
- The Human Resource Development Authority is implementing actions and plans that contribute to **the upgrading of knowledge and skills of human resources**. These actions and plans can be used by industrial and other companies and relate to the integration of the unemployed and the inactive potential in the economy.
- Cyprus established the **National Alliance for Digital Jobs**, connecting 40 bodies from the public, private and academic sectors. Since 2016, this Alliance has been implementing the **Digital Jobs Action Plan**, which focuses on three pillars: education and training, certification and awareness.
- The Department of Electronic Communications in collaboration with the Productivity Center organizes **Workshops and Training Programs for learning e-Government systems** and acquiring digital skills.

- Cyprus provides tax incentives for **attracting or repatriating Cypriots or foreign highly qualified professionals for employment** and at the same time training of local staff.
- In June 2018, the legislation was adopted to facilitate the **approval of scientific visas.**

Denmark – Energy Intensive Industry

Key Points

Energy-intensive climate partnership one of **14 official partnerships** coordinated by the Danish government with the business community

Industry provides important materials for various other sectors, and accounts for 1.6% of GDP, with 630 associated companies and 19,000 jobs.

Objective: **70% reduction in CO_2 emissions by 2030**

Climate Partnership (2021) outlines three main paths towards reduction: investments in energy efficiency, replacement of coal and natural gas with biogas, and carbon capture technologies.

***Just Transition* dimension** explicitly considered: **No**

Background

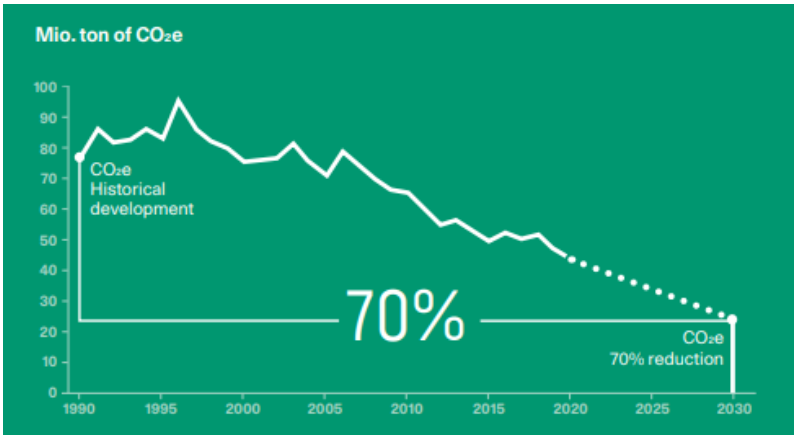
The energy intensive industry in Denmark contributes with crucial materials for society – for buildings, manufacturing, transport, food processing and energy production. It supplies the construction industry with products such as cement, concrete, asphalt, brick, glass and insulation materials. Refineries convert crude oil into fuels such as gasoline, fuel gas oil, fuel oil, gas products and jet fuel. Around 1.6% of Denmark's GDP stems from this industry, encompassing 630 companies and associated to 19,000 jobs. With around 4.8 Mt of C02 emissions, the sector accounts for approximately 14% of the country's overall emissions.

The **challenge ahead**: It is difficult to decarbonise the energy intensive industry, both because it requires large amounts of energy to reach the necessary process temperature, which is often above 1,000 degrees Celsius and because the raw materials release CO_2 emissions as part of the production process. The sector has reduced emissions by 7% as compared to 1990 levels, largely due to increased energy efficiency. However, emissions are projected to grow leading up to 2030 without the introduction of new initiatives.

In view of these challenges, the **objectives** set forth by the **Climate Partnership for Energy-Intensive Industry (2021)** is to contribute to the government's goal of reducing overall CO_2 emissions by 70% until 2030 by equally **reducing CO_2 emissions of the energy-intensive industry by 70% until 2030**.[8]

[8] Climate Partnerships 2030 – Energy intensive industry: https://climatepartnerships2030.com/the-climate-partnerships/energy-intensive-industry/

Figure 1 – Historical development and future projection of C02 emissions in Denmark



In order to reach these goals, the Climate Partnership has developed initiatives and recommendations, which are detailed below. The climate partnership for energy-intensive industries is one out of **14 climate partnerships initiated by the Danish government** with the business community (https://climatepartnerships2030.com/the-climate-partnerships/). The purpose of the partnerships is to establish a 2030-vision for how the sector will contribute to the national 70% CO_2-reduction target. The 14 partnerships were tasked with presenting a proposal on how their individual sector could contribute to CO_2e reductions in a just way, supporting Danish competitiveness, exports, jobs, welfare and prosperity. Each partnership is chaired by a representative from a private sector company appointed by the Danish government with 1-2 business organisations serving as secretariats. The proposal had to include measures that the sector itself could take to reduce emissions as well as recommendations to remove barriers and improve framework conditions in order to support reductions and green competitiveness. Based on the climate partnerships recommendations and roadmaps, the Danish government will assess if and how the inputs can be addressed politically.

Initiatives and recommendations

The objective of reducing direct emissions of the industry by 70% until 2030 will be pursued through three main approaches:

1. A **reduction of 30%** is possible and potentially profitable through investments in further energy efficiency measures, increased use of alternative fuels (such as biogas and waste), and changes in products (e.g., cement with a lower content of chalk).
2. A **reduction of 20%** can be achieved through replacing coal and natural gas with biogas, and the electrification of processes at low and medium temperatures. This requires an increased supply of biogas, expansion of gas infrastructure and price support.
3. A **reduction of 20%** is possible through carbon capture at the largest emitters. The methods and technologies for CCUS are still in their infancy, so establishing a public-private partnership to develop them further is proposed.

In order to pursue these goals, the industry has developed initiatives and recommendations for itself as well as for the government.

Industry initiatives

1. **Change in product mix** towards more sustainable products (recycled materials, new materials, less waste).

2. Shift away from coal and petcoke towards **alternative fuels** (biomass, waste).
3. Increased focus on **energy efficiency**.
4. Own investments in **utilization of waste heat**: surplus heat from energy intensive companies can be used for heating e.g. in district heating networks – thereby reducing emissions from combined heat and power plants. To realise this potential, taxes on the use of surplus heat must be removed.
5. Public-private partnerships on **carbon capture**.

Government initiatives

1. The introduction of more climate-friendly products requires higher demand and, consequently, willingness to pay a higher price. **Sustainability as a criterion in public procurement** is one tool that can be used to stimulate demand. Thus, developing a public procurement strategy that includes demands for total economic calculations, CO_2 footprint and sustainability – based on LCA.
2. Inclusion of **sustainability requirements in regulations** such as building regulations, product standards or public plans.
3. Ensure predictable and financially attractive **supply of biogas**. Biogas can replace fossil fuels in processes where high temperatures are necessary and which, therefore, cannot be electrified. To realise these reductions, further investments in biogas production, infrastructure and price support are needed.
4. Preparation of a national strategy for **carbon capture storage and utilization** in relation to priorities, framework conditions, support and infrastructure as well as the establishment and support of a specific "lighthouse" project to uncover opportunities, set up a realistic business case and explore the possibilities for systems exports.

France – Chemical Sector

Key Points

Plan a part of the **19 official industry contracts** coordinated by the French National Council of Industry

Chemical industry among the **three highest-emitting sectors** in the manufacturing industry in France.

Objective: **Reduction of GHG emissions of 26% until 2030**

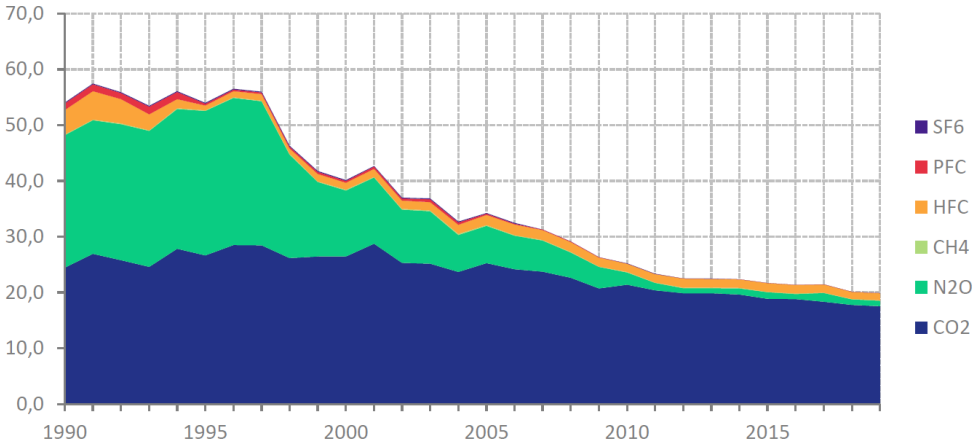
French Decarbonisation Roadmap for the Chemicals Sector (2018) has two central elements: emissions reduction trajectory based on established decarbonisation measures; sensitivity analysis of the decarbonisation potential of less mature measures

***Just Transition* dimension** explicitly considered in the Plan: **No**

Background

The chemicals sector is one of three sectors with the highest emissions in the manufacturing industry, along with metallurgy and building materials. The two most emitting sub-sectors of the chemicals sector are petrochemicals (27%) as well as fertilizers and nitrogenous products (14%). More than 50% of the emissions associated to the chemicals sector, presented over time in the figure below, are linked to the combustion of fossil energy products for the production of heat, which are necessary for industrial processes. More than 40% of emissions are linked to process emissions (chemical reactions other than combustion and gas flaring on chemical facilities).

Figure 1: GHG emissions of the chemicals sector in France (in Mt CO2), 1990 - 2019



Source : CITEPA, avril 2020 – Format SECTEN.

In light of this, the **French Decarbonization Roadmap of the Chemistry Sector (2018)** has been established, which sets forth an objective to **reduce GHG emissions by 26% until 2030** (compared to 2015). Specifically, the roadmap has a twofold purpose:

1. To propose a trajectory for reducing GHG emissions by 2030, based on established decarbonization measures (energy efficiency, low-carbon heat, reduction of N_20 and HFCs).

2. To develop a sensitivity study on the decarbonization potential of less developed measures in order to identify the conditions allowing further decarbonization by 2030.

The roadmap is one of 19 official industry plans coordinated by the Strategic Committee of Sectors (CSF) of the French National Council of Industry (https://www.conseil-national-industrie.gouv.fr/les-contrats-de-filiere). The CSF are a key part of the National Council's approach to transforming industries across the country. The objective is to establish, via these bodies, a concrete, effective and regular dialogue between the state, companies and employee representatives on all the key subjects that will enable French industrial transformation. Together, they develop contracts that are binding to both the state and the private actors. Specifically, the French Decarbonization Roadmap of the Chemistry Sector is based on two central elements that will be further elaborated below:

- Emissions reduction trajectory in the chemicals sector by 2030
- Sensitivity analysis of the decarbonisation potential of less mature measures

The French Decarbonization Roadmap of the Chemistry Sector

Emissions reduction trajectory in the chemicals sector by 2030

The various measures making it possible to achieve a 26% reduction in annual GHG emissions by 2030 as well as the associated annual emission reductions are described in the table below.

Approach	Annual reduction of emissions of GHG between 2015 and 2030 (in Mt CO_2-eq.)
Energy efficiency	-1.8
Biomass heat	-1.4
Solid Recovered Fuels heat	-0.8
N_2O	-0.8
HFC	-0.9
Total	**-5.7**
In % in relation to 2015	**-26%**

To this end, the overall actions to be carried out by both the state and the sector are listed below.

By the sector:

- Take advantage of the tools put in place as part of the recovery plan as well as those available at European level.

By the state:

- Provide visibility on the sustainability of the French Recovery Plan (for energy efficiency; low-carbon heat from biomass or solid recovered fuels, while limiting conflicts of use; the decarbonization of processes, in particular through electrification).
- Maintain the tools allowing competitive and predictable access to low-carbon electricity, while encouraging energy efficiency.
- At EU level: defend effective mechanisms of protection against relocation of CO_2 sources of emissions, including corrective provisions to avoid side effects at export and on downstream sectors.

Decomposition by measure

1. Energy efficiency

In the future, reductions in energy consumption will be either due to iterative improvements, in particular via actions to recover waste heat, or to the replacement of equipment at the end of its life. For example, the installation of a new production workshop will be an opportunity to develop a deposit of waste heat. Similarly, the replacement of a distillation tower will be the opportunity to install new equipment that makes the most of the waste heat for the preheating of the reagents.

By the sector:

- Draw up an assessment of the use of project calls.
- Implement profitable energy efficiency improvement projects to achieve reduction targets.
- Promote the implementation of energy efficiency operations, in particular through access to training programs.

By the state:

- Continue supporting investment in energy efficiency projects.

These measures could combine to result in a **possible reduction of -1.8 Mt CO_2** emissions.

2. Carbon-free heat source

The combustion of Solid Recovered Fuel (SRF), replacing part of the carbon heat sources, at a rate of 2.5 TWh/year will allow a reduction in GHG emissions of 0.8 Mt CO_2 between 2015 and 2030. Furthermore, the combustion of biomass, up to 4.7 TWh/year, will reduce emissions by another 1.4 Mt CO_2 between 2015 and 2030. Combined, these two measures would make it possible to reduce emissions up to 2.2 Mt CO_2 between 2015 and 2030.

By the sector:

- Pursue the launch of heat decarbonization projects to achieve emission reduction targets
- Evaluate the potential of decarbonization of solar thermal, high temperature heat pumps and mechanical vapor recompression for the chemical industry.

By the state:

Biomass and SRF

- Continue investment and operating support for biomass and SRF AAPs.

Biogas

- Set up a support framework for the self-consumption of biogas, in particular when it comes to favoring this method over an injection of biomethane into the network.

Connection to waste-to-energy plants (WTE)

- Map the sources of heat linked to WTE (quantity/quality of heat available).
- Plan the installation of new WTEs with regard to the location of industrial sites, the only energy consumers capable of efficiently recovering the waste heat from these installations.

3. Reduction of N_20 emissions

Technologies exist and have been implemented for many years to reduce N_2O emissions: today, 95% of N_20 produced is captured and destroyed. According to experts, it would be possible to reach a rate of 98/99% in the coming years with a doubling of installations or through new catalysis technologies. This would correspond to an emissions reduction of 0.8 Mt CO_2.

By the sector:

- Pursue efforts to reduce N_20 emissions to achieve the emission reduction objectives identified.

By the state:

- Continue supporting investment in decarbonization.

4. Reduction of hydrofluorocarbons (HFC) emissions

It is difficult to estimate what the potential for reducing HFC emissions from the chemical industry could be in the coming years. France Chimie proposes an emissions reduction target of 0.9 Mt CO_2, in line with the EU target (60% reduction compared to 2005). A dialogue with the refrigeration gas sector will be necessary to identify any limitations to this lever.

By the sector and state:

- Identify the measures for accelerating the decarbonization of the fluorinated gas sector.

Sensitivity analysis of the decarbonisation potential of less mature measures

An estimate of the decarbonisation potential of less mature measures, specifically the use of low-carbon hydrogen, carbon capture and storage as well as electrification processes, are discussed below.

Measure	Reduction scenarios of emissions of GHG between 2015 and 2030 (in Mt CO_2)		
	Min.	Med.	Max.
Low-carbon H_2	-0.5	-0.9	-1.1
CCS	-0.2	-0.4	-0.6
Electrification	-0.1	-0.3	-0.5
Total additional measures	-0.8	-1.6	-2.2
In % in relation to 2015	-4%	-7%	-10%
Sum of all measures	**-6.5**	**-7.3**	**-7.9**
In % in relation to 2015	**-30%**	**-34%**	**-36%**

By combining these additional measures with the measures identified in Section 2, the reduction in GHG emissions from the chemicals sector between 2015 and 2030 could therefore be between 30% (minimum scenario) and 36% (maximum scenario). However, these scenarios are indicative of future potential and thus cannot yet be integrated into the decarbonisation trajectory for 2030.

1. Use of low-carbon hydrogen

Low-carbon hydrogen is identified as a raw material and a major energy vector that will contribute to the energy transition in the transport and industry sectors.

By the sector:

- Propose projects for the use of carbon-free hydrogen.

By the state:

- Maintain a low-carbon and competitive electricity supply over the long term.
- Promote the production and consumption of low-carbon hydrogen.
- Work on setting up funding mechanisms.

- Investigate the effectiveness of a carbon border adjustment mechanism for ammonia production.

2. Carbon Capture and Storage

Carbon capture and storage (CCS) is regarded as a viable medium-term solution to reduce GHG into the atmosphere.

By the sector:

- Study the viability of projects for the capture and storage/use of CO_2: for chemical activities, as well as the possibility of launching a pilot project on a French industrial site.

By the state:

- Accompany a large-scale project that can be duplicated.
- Involve maintaining competitive and predictable access to competitive low-carbon electricity, which is required to capture CO_2.

3. Electrification of processes

The electrification of processes represents limited potential in the chemicals sector. However, the costs of the projects envisaged remain reasonable in relation to the outcomes it could support.

By the sector:

- Study the viability of process electrification pilot projects on a French industrial site
- Invest in utility or process electrification projects.

By the state:

- The cost of electricity is a determining factor in ensuring sufficient profitability. Thus, essential to foster a competitive and predictable electricity supply.

France – Steel Sector

Key Points

Plan a part of the **19 official industry contracts** coordinated by the French National Council of Industry

French Steel Industry key **supplier of various downstream sectors**

Objective: **31% reduction in CO_2 emissions by 2030** and carbon neutral by 2050

French Steel Industry Plan has three central pillars: increasing competitiveness, low-carbon transformation & employment attractiveness

***Just Transition* dimension** explicitly considered in the Plan: **Yes**

Background

Steel is an essential material for the French economy. Positioned upstream of many value chains, French steel producers supply various downstream sectors, such as the automotive, aeronautics, construction and mechanical industries. Moreover, it directly contributes to developing new materials and solutions for the manufacturing of wind turbines, electric vehicles and hydrogen transport. As such, French steel producers are essential to the ecological transition of French industry as a whole.

The French steel industry is facing three major challenges:

1. The European steel industry faces international competition that is not subject to equal environmental regulations, leading to an international competitive disadvantage. Persistent global overcapacity and a steady rise in non-European imports have led Europe to account for only 7% of global production.
2. GHG emissions of the French steel industry account for 21.7 Mt of C02, accounting for more than 80% of total GHG emissions of the mining and metallurgy sector. As such, there is a need for massive investment in order to decarbonise its processes.
3. The steel industry workforce is declining and the public image does not reflect a modern, innovative and attractive industry.

In view of these challenges, the **objectives** set forth by the National Low Carbon Strategy imply a **reduction of CO_2 emissions by the steel industry of 31% until 2030** and a move towards carbon neutrality by 2050.[9] The following table shows the projected production volumes and associated CO_2 (t) emissions.

[9] Amendment to the mining and metallurgy sector contract: https://www.conseil-national-industrie.gouv.fr/files_cni/files/csf/mines-metallurgie/csf_mines-et-metallurgie-avenant-au-contrat-2021.pdf

Steel Industry	Production (Mt)			Emissions (tCO_2) per ton		
	2019	**2030**	**2050**	**2019**	**2030**	**2050**
Primary Steel	10.5	11.34*	12.7*	1.86	1.16*	**
Secondary Steel	4.8	**	**	0.42	**	**

Source: World Steel in Figures (2019), ETS (2019), *estimations **to be defined

In order to reach these goals, the Strategic Committee for the Mining and Metallurgy Sector has developed a **French Steel Industry Plan (2022).** This plan is part of the broader Mining and Metallurgy Sector contract (2019 & 2021), one of 19 official industry plans coordinated by the Strategic Committee of Sectors (CSF) of the French National Council of Industry (https://www.conseil-national-industrie.gouv.fr/les-contrats-de-filiere). The CSF are a key part of the National Council's approach to transforming industries across the country. The objective is to establish, via these bodies, a concrete, effective and regular dialogue between the state, companies and employee representatives on all the key subjects that will enable French industrial transformation. Together, they develop contracts that are binding to both the state and the private actors. Specifically, the French Steel Industry Plan has three central pillars that will be further described below:

I. Improve the international competitiveness of the French steel industry.

II. Support its transformation to a low-carbon future.

III. Strengthen its attractiveness in terms of employment.

The French Steel Industry Plan

I. Create the conditions for the sector to become more competitive on an international level

1. Combating overcapacity in the context of the G20 and the Global Forum on Steel Excess Capacity (GFSEC)

The EU, joined by 29 members of the Steel Overcapacity Forum, has called on G20 leaders to address the massive overcapacity in global steel production by reducing supply, eliminating subsidies, and increasing transparency.

2. Ensure strict application and improvement of trade defence instruments and measures allowed by the WTO

Effective enforcement of trade regulations is essential for the French and EU steel industry, which regularly faces situations where exporting countries do not respect commitments made in the framework of WTO agreements. Thus, the industry encourages the EC to take firm action against unfair behaviour, including all relevant anti-subsidy and anti-dumping measures; promote greater transparency in third countries; develop and make full use of European toolbox, including the International Procurement Instrument (IPI), strengthen enforcement in response to violations and take an active part in the European debate.

3. Ensure reliable access to competitive, low-carbon energy in the long-term.

Energy costs can compose 40% of total operating costs for steel manufacturers and are one of the key drivers of competitiveness. Providing access to decarbonised electricity and hydrogen at competitive prices is therefore essential. To this end, the industry seeks to promote access to renewable energy (including nuclear electricity) via long-term contracts

at competitive prices; enhance flexibility of industrial consumption through the use of load-shedding devices; ensure that taxation of energy products and electricity considers specificities of sectors to be carbonised.

II. Achieve carbon neutrality by 2050

1. Encourage innovation and industry financing

Decarbonising the steel industry will require significant R&D and investment in innovative production technologies. In addition to financial support, the aim is to create incentives for local companies to make medium and long-term investments. To this end, state aid guidelines will need to be revised, in order for higher operating costs to be compensated during the industrialisation phase of new technologies and the use of renewable energy; "carbon contracts for difference" should be implemented to encourage investment in low-carbon technologies; support a framework for sustainable financing of the industry's transition plan; encourage public-private investment opportunities as well as EU financing tools (i.e., Innovation Fund, Horizon Europe).

2. Develop energy infrastructure needed for low-carbon economy

Essential to anticipate the increase in energy consumption and to develop energy infrastructure that ensures access to competitive, decarbonised energy. To this end, necessary to accelerate expansion of the power grid, mobilize all assets of current and future electricity mix, develop and consolidate industrial relations with suppliers of decarbonised hydrogen.

3. Build a market for hydrogen technologies

The success of the steel industry transformation also depends on the availability of decarbonised hydrogen. Thus, essential to: build a long-term industrial plan to design deployment of decarbonised hydrogen production capacities; encourage construction of electrolysis units near steel industry; implement financial operating aid for additional production costs associated with the use of decarbonised hydrogen; promote EU industrial partnerships in low-carbon hydrogen sector.

4. Promote the circular economy through steel

Through using scrap metal as a raw material, the steel industry is playing an important role in the circular economy. This must be further strengthened, since of the 12.5 million t of scrap metal in France, the industry only uses 4.2 million t at the moment. Thus, there is a need to: develop an approach to better locate and recover French scrap metal, recycle steel products and elements they contain (e.g., chromium, cobalt, nickel); limit exports of scrap metal to third countries; simplify and facilitate transport of materials between EU MS.

5. Create markets to promote low-carbon or circular economy products

Regulatory framework must ensure fair competition between EU producers and third-country producers, which can be subject to less strict social and environmental regulations. Thus, important to: improve consumer information by communicating carbon footprint of products; stimulate demand through circularity and sustainability criteria in public procurement.

6. Develop environmental standards for traded steel products in the EU

The carbon footprint of a tonne of steel in France amounts to 1,876 kg eq. CO_2, compared with 2,125 in China or 2,800 in India. To promote products with lower environmental impact it is essential to develop environmental standards that imported products must adhere to.

7. Accelerate decarbonisation at EU level (European Green Deal) and prevent carbon leakage

The European Green Deal raises the EU's climate ambition, and discrepancy to less ambitious regions in the world raises risk of carbon leakage. To prevent this, important to

implement an EU Carbon Border Adjustment Mechanism (CBAM) by 2023. This mechanism should be designed to be non-discriminatory and compatible with WTO rules.

Just Transition Dimension

III. Strengthen the attractiveness of the steel industry through employment and skills

1. Support businesses to accelerate the digital transformation of the industry

An essential lever for modernising the steel industry, improving its production processes and product quality as well as strengthening its competitiveness and attractiveness is to seize the opportunities offered by the digital transformation. To this end, the industry must:

- Transform, prepare and train for the 4.0 professions of the future steel industry
- Develop operational mobility and connectivity of tools (e.g., big data, data management, augmented reality, artificial intelligence)
- Promote innovation in the steel industry; improve its image in order to attract new talent and a greater female workforce
- Develop and strengthen external partnerships to build training courses adapted to the development of new 4.0 industry skills.

2. Create jobs for the future through training and skills development

The success of the transition will depend on the preparation and training of current and future employees. Thus, it will be critical to:

- Continue efforts to promote the steel industry to secondary school students and describe the various possibilities (electromechanical, automation and maintenance engineers) through events such as Industry Weeks or the organisation of visits to schools.
- Promote more among higher education students the opportunities offered by the transition of the steel industry in regard to the scientific (R&D in materials or processes) and technological (engineers, computer scientists, data scientists) dimensions, via actions such as the participation of industrialists in student forums, fairs and industry-specific events.
- Encourage companies to anticipate future needs and determine how training and employment can be provided to meet these needs. Essential to include work councils in the development of these tools at an early stage.
- Strengthen the funding for training and skill development (staff training for sectors in demand and transition programmes to support employees affected by structural change) and facilitate access to the labour market for qualified foreign workers.

Germany – Steel Industry

Key Points

The Steel Action Plan was co-developed by the Federal Government and the steel industry.

Steel industry supplies key German manufacturing industry, employs around 86,000. The sectors CO_2 emissions are 30% of all industrial emissions.

Objective: **Climate-neutral by 2050**

The Steel Action Plan outlines **three main pillars**: creating a level playing field on the global steel market; avoiding carbon leakage; working together to make progress on the transformation

***Just Transition* dimension** explicitly considered: **Yes**

Background

The steel industry has a key role to play in Germany, as the manufacturing industry is highly steel-intensive. Despite efforts made to improve its climate footprint, the German steel sector is one of the largest emitters of CO_2, amounting to 58.4 Mt (2018) or 30% of all industrial emissions. Since 2010, steel production in Germany has dropped by around 10% (approx. 4 Mt) from 43.8 Mt to 39.7 Mt, with the workforce declining by around 4,000 to 86,000.

The steel industry is currently facing significant **challenges**. The transformation to carbon-neutral processes entails a **substantial need for investment and rising manufacturing costs**. Moreover, in light of strong international competition, the steel sector is exposed to the danger of carbon leakage since many steel-makers in other countries do not have comparable standards or regulations. Furthermore, **global oversupply**, sometimes caused by government subsidies, is also distorting the global steel market. Nevertheless, despite these challenges, the **steel industry is committed to the Paris climate targets and to the EU's goal of becoming climate-neutral by 2050**.

In this regard, **The Steel Action Concept**[10] was co-developed by the Federal Government together and the steel industry, and builds on the Industrial Strategy 2030, the Climate Action Plan 2050, the Climate Action Programme 2030 and the European Green Deal. Specifically, the Steel Action Concept has three central pillars that will be further described below:

I. Create a level playing field on the global steel market

II. Avoiding carbon leakage

III. Working together to make progress on the transformation

[10] For a strong steel industry in Germany and Europe – The Steel Action Concept: https://www.bmwk.de/Redaktion/EN/Publikationen/Wirtschaft/the-steel-action-concept.pdf?__blob=publicationFile&v=3

The Steel Action Concept

I. Create a level playing field on the global steel market

Germany will call for more resolute **efforts to tackle market-distorting measures**, such as non-WTO-compliant subsidies or dumping prices as well as protectionist trade policies, particularly with a view to reducing related global overcapacities. To this end, the Federal Government supports the work of the Global Forum on Steel Excess Capacity (GFSEC) in order to attain the goals defined in the G20 process. The only way to keep exerting influence on the countries that are the chief contributors to the current overcapacities on the world market is via the G20. Moreover, the Federal Government will seek to ensure a rigorous application of EU trade safeguards and to improve them where necessary.

Specific steps:

- The Federal Government will support efforts to **bring China, the world's largest steel producer, back to the table of the GFSEC**. Should the GFSEC prove incapable of action for the foreseeable future, countries and regions which are particularly hard-hit by over-production must agree on an alternative joint approach without China.
- A number of adjustments to the existing **EU steel safeguard measures** were agreed upon and entered into force on 1 July 2020. The Federal Government will seek to ensure that the effects of these measures are monitored by the European Commission and that further adjustments are made as needed.

II. Avoiding carbon leakage

Through carbon emissions trading, the EU deploys a market-based instrument to reduce greenhouse gas emissions. Until a level global playing field with all the key steel-making countries is attained, further effective measures will need to be taken to **prevent the relocation of energy-intensive industries to countries with less stringent standards**.

Specific steps:

- The **free-of-charge allocation of emission allowances** within the EU ETS is an effective instrument that should be continued to avert the risk of carbon leakage. The Federal Government calls for its continuation and deems it should be designed in such a way that it creates incentives for technological innovation and the long-term transformation of industry.
- In addition to free-of-charge allocation as compensation for direct carbon costs, it is also important to consider adequate options for **offsetting carbon-related increases in electricity prices** for industrial installations. The Federal Government will continue to advocate its position during the review of the ETS State Aid Guidelines for 2021-2030.
- It should be determined whether a border tax or an alternative approach can be designed in a legally robust manner to ensure protection against carbon leakage. The EC presented its proposal for establishing a **Carbon Border Adjustment Mechanism** in July 2021 and the Council agreed in March 2022.

III. Working together to make progress on the transformation

To pursue the objectives, **technological leadership in the field of innovative and climate-friendly production processes** will be essential. This will require investments worth tens of billions of euros over the next two decades and will only take place if all the stakeholders have a reliable basis on which to plan for the medium to long term. German steel companies need to start taking resolute action now to convert production to climate-neutral processes in a speedy and rigorous manner while considering their international competitiveness, and they need to start preparing the needed investments. This also involves considerations **about forward-looking forms of training and skills development for employees**.

Specific steps:

- The Federal Government is considering incentives to **stimulate additional demand** for more climate-friendly steel (e.g. inclusion of sustainability criteria in Federal Government procurement) and possibly **regulation**, by, for instance, a quota for low-carbon (by 2050, carbon-neutral or, as far as possible, carbon-free) steel in finished products.
- The implementation of **carbon contracts for difference** is another way to set incentives for companies to invest in and operate green technology. By financing, in full or in part, the differential between the current carbon price and a contractually defined carbon price oriented to emissions avoidance costs, companies could be given the necessary security to invest in forward-looking technologies. Within the framework of the National Hydrogen Strategy, a pilot process for testing carbon contracts for difference was approved in order to facilitate the conversion to climate-friendly industrial processes in selected sectors (steel and chemical industries).
- The development of a market for hydrogen technologies. The Federal Government, in the context of the National Hydrogen Strategy, will closely analyse and actively communicate the **hydrogen needs of the steel sector** in order to enable potential suppliers, consumers and investors to plan for the future. The objective is to achieve a situation in which the use of coking coal to make steel can be shifted to hydrogen, which requires that new steel production facilities are designed from the outset in a way that permits the use of both natural gas and hydrogen. To this end, the Federal Government has already launched a wide range of funding programmes, studies and projects.[11]

Just Transition Dimension

Creating viable jobs for the future through training and skills development

The transformation of the steel industry is not only a monumental task for companies and in terms of environmental protection, but also, and above all, poses a challenge to employees. The success of the transformation will **fundamentally depend on whether employees in the steel sector are prepared and trained for new tasks** as they arise. If employees are not properly trained and their skills developed, investments in new technologies are pointless. The switch to new production processes must not lead to lay-offs – on the contrary, it must secure long-term employment and open up fresh prospects both at company level and in terms of human resource development.

[11] Use of Hydrogen in Industrial Production (€430); National Decarbonisation Programme (approximately €1 billion); Carbon Avoidance in the Basic Materials Industry (€370 million up to 2023); Carbon2Chem (€140 million); KlimPro-Industrie (€80 million); Regulatory Sandboxes for the Energy Transition (€415 million)

The Federal Government believes that companies need to develop viable concepts to determine how the training and continued employment of the workforce can be ensured and the future demand for skilled labour met. Work councils should be involved early in the development of new training and skills development concepts. Only through joint efforts and trusting cooperation can we meet the challenges that lie ahead.

The Federal Government has adopted a variety of measures that allow companies, including those with larger workforces, to receive funding in an unbureaucratic manner for measures in the field of further training and skills development. Companies from the steel sector are encouraged to use these opportunities:

3. Act on Opportunities to Gain Qualifications

In addition to enhancing advisory services on further training and skills development, the Act has improved the support available for further training for employees whose jobs are at risk of becoming lost to technologies, who are otherwise affected by structural change or who wish to obtain advanced vocational training for an occupation that is facing a skills shortage.

4. Act to Promote Advanced Vocational Training amid Structural Change and Enhance the Promotion of Training

The Act expands targeted forms of assistance available to employees and their employers in companies that are particularly affected by structural change. In addition, work agreements or collective agreements on advanced vocational training are rewarded. From 2021, it will also be possible to file a single application to receive the support.

5. The Skilled Immigration Act

In order to secure skilled labour for the steel industry, the potential offered by qualified workers from third countries may also be used. The Act aims to facilitate access to the labour market, in particular for third-country nationals with vocational training qualifications. In addition to improving the legal framework, special attention is paid to its practical implementation. The Act has introduced, among other things, improvements in administrative procedures and procedures for the recognition of foreign vocational qualifications, a common strategy with business for attracting skilled labour, and an improved marketing approach.

Sweden – Cement Industry

Key Points

The **Cement Roadmap (2018)** was developed in association with Cementa, Sweden's only cement producer.

To reduce the cement industry's emmissions, which consist mainly of **process emissions**, new technologies, infrastructure & industrial solutions are required.

Objective: Achieve **fossil-free and climate-neutral cement & concrete production** by 2030

The Roadmap outlines which measures are needed to lead the cement industry into climate neutrality.

***Just Transition* dimension** explicitly considered: **No**

Background

Sweden has an ambition of zero net emissions of carbon dioxide by 2045. At the same time, today's 10 million inhabitants are expected to be just over 12 million at that time. Metropolitan regions are becoming denser and the need for housing and infrastructure will be great. Concrete is and will be crucial in the construction of a climate-proof and sustainable future Sweden. Limestone-based cement will continue to be the main binder in concrete for the foreseeable future. In order to make community building sustainable, new ways must be found to develop cement that enables climate-neutral concrete.

Today, cement manufacture accounts for four percent of Sweden's GHG emissions. The key challenge for the cement industry is the carbon dioxide emissions that arise when the raw material limestone is turned into cement clinker at high temperatures. In light of this, a **Roadmap Cement: for climate-neutral concrete construction (2018)** outlines the path towards the first fossil-free and climate-neutral cement plant by 2030.

This roadmap was developed in the context of the **Fossil Free Sweden initiative**, which was launched by the National Government to gather and accelerate the climate efforts being made across the business sector, municipalities and regions. The initiative operates through a small team led by a National Coordinator and has an independent status towards the Government. The mission is to speed up climate action in industry and encourage the Government to remove obstacles that could slow the transformation. As part of Fossil Free Sweden, **22 different industries have produced their own roadmaps**[12] to show how they can enhance their competitiveness by going fossil free or climate neutral. The roadmaps show the opportunities, identify obstacles and contain proposals for solutions both through the industries' own commitments and through policy proposals. Taken together, they show what a fossil free business sector can look like. The roadmaps have been presented to the Government and now form a basis for continued work by Fossil Free Sweden and the participating industries.

[12] https://fossilfrittsverige.se/en/roadmaps/

Roadmap cement for climate-neutral concrete construction

A number of measures have been identified that are crucial for climate neutral cement and concrete production and a climate neutral construction environment:

- A sustainable construction environment requires a life-cycle analysis
- Sustainability requirements in public procurement
- Support the transition to biofuels
- Emission rights trading
- Carbon capture: public initiatives for R&D
- Create commercial solutions to utilize and store carbon dioxide
- National strategy for storing carbon dioxide
- More clearly defined mandate for authorities
- Material-neutral allocation of public funds
- Commercial conditions for a circular economy
- Access to electricity

The need for long-lasting building materials

Concrete is needed to meet the need for housing and infrastructure. The greatest climate benefit is achieved by transforming concrete development as a whole and thus considering each part of the process. In this regard, a limestone-based cement production will continue to be a central part. The biggest climate effort Sweden can contribute is to create good conditions for this development and then export carbon dioxide-efficient process technology and knowledge of climate-efficient concrete development. In a future sustainable society, there will be a great variety of building materials. In order to meet the demand for welfare and sustainability, the limestone-based binders in concrete will be greatly needed in the future. This applies both in Sweden and globally. There are technical conditions to make the concrete climate-neutral.

Cementa is working towards a *zero vision* for carbon dioxide emissions during the life-cycle of concrete products. The work to reduce emissions is conducted in five main areas:

1. Energy efficiency.
2. Phasing out virgin fossil fuels by increasing the proportion of bio-based fuels.
3. Development of new types of cement with a smaller climate footprint.
4. Research on increased carbon dioxide uptake in existing concrete structures.
5. Carbon dioxide capture followed by reuse or geological storage, which in the long-run means a regeneration to rock mineral.

Climate investments

Between 1990 and 2017, Cementa reduced its emissions per tonne of cement by almost 15 percent through climate investments of more than SEK 1 billion (approx. EUR 0.93 billion). Today, the Swedish cement industry delivers products with a 15% lower climate footprint than the global average. Further climate improvements are continuing to take place higher up in the concrete value chain.

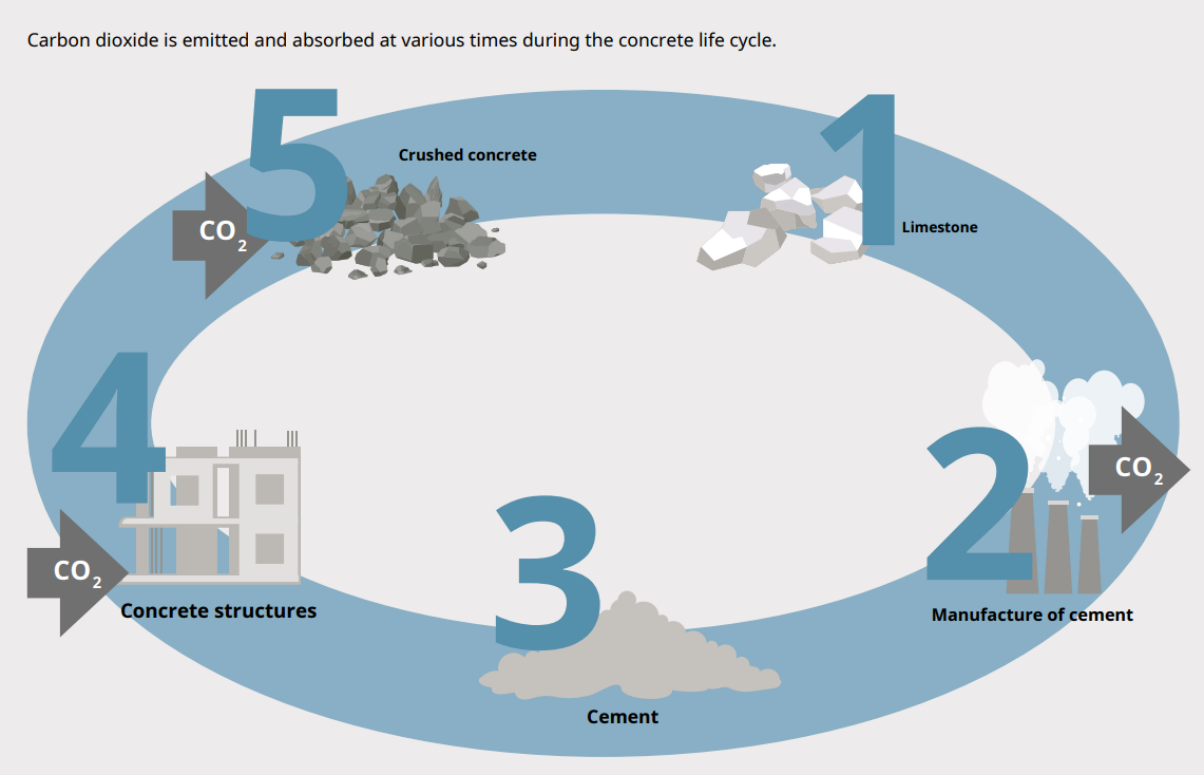
The majority of Cementa's carbon dioxide emissions are **process emissions** that are not due to energy consumption in the production process. Energy efficiency, changed fuel mix, and electrification do not address this challenge. Instead, it requires the development of technologies for carbon capture, carbon dioxide recovery in other industrial processes (carbon capture and utilization, CCU) and geological carbon capture (CCS) where carbon dioxide is eventually converted to minerals and rocks. Infrastructure and industrial

solutions are needed to take care of process-related emissions in order to avoid emissions to the atmosphere.

In the long run, the goal is to **replace thermal processes with electrified processes**. Electrification requires a stable and competitive supply of sustainably produced electricity. Basic conditions are currently being investigated in ongoing projects.

Moreover, 15–20% of process emissions from cement production are absorbed by existing concrete structures, called **carbonation**. This implies an annual intake of approximately 300,000 tonnes in Sweden. This uptake can be doubled by improving the crushing and handling of demolished concrete structures to create larger exposed concrete surfaces.

Figure 1: Carbon dioxide process in the concrete life-cycle



Source: Roadmap cement for climate-neutral concrete construction

The cement and concrete industries run a significant **logistics business**. Large volumes of cement are transported in bulk by sea to be temporarily stored at coastal terminals and then transported by truck to concrete manufacturers near the construction site. In Sweden, there are very good conditions for sea transport. To date, only a small part is transported via rail, mainly due to restrictions on freight traffic on the railway network, which means that much is redirected to the road network. Making greater use of the railway network thus presents an opportunity.

Continuing to **switch to biofuels or electrifying transport** could help reduce both the climate impact and energy consumption of cement production. It can also help reduce noise. Digitization throughout the construction phase also increases the preconditions for more efficient logistics planning.

Building a sustainable society

The societal investments that are made in housing and infrastructure must have as long a lifespan as possible. A guideline is at least 100 years. More short-lived constructions are neither sustainable nor socio-economically justifiable. Community planning must be robust and for the long-term. Furthermore, it needs to create an attractive and socially sustainable cityscape with the possibility of flexible use over time. Building with a concrete frame enables constructions with a long service-life and little maintenance.

The choice of building materials for a particular application should always be guided by a **long-term vision and a comprehensive life-cycle analysis**. There is a need for strengthened competence among public authorities in terms of climate impact and life-cycle analysis. The priority should be on the **public procurement** of projects with stricter climate requirements, where the material properties are valued on the basis of their climate benefit.

Concrete has an ability to **store energy and thereby balance uneven power production** and power output in a smart grid. For the future, this is an important feature that enables the increased use of renewable, yet irregular, power production. Thus, the key to reducing the climate impact of cities' energy systems is to balance power peaks.

Moreover, it is important to **increase the recycling of concrete**. Concrete is fully recyclable in various construction solutions. Today, the largest amounts of demolition concrete are recycled as backfill masses in, for example, roads, but a considerable amount of concrete is deposited. For this to change, more high-quality recycling methods need to be put in place.

Sweden – Mining and Minerals Industry

Key Points

Roadmap for mining and minerals industry one of **22 official industry roadmaps** developed in the context of the Fossil Free Sweden Initiative.

Sweden is the EU's largest mining nation, associated to around 35,000 jobs, and accounting for 10% of country's gross export value.

Objective: **fossil-free mining and mineral operations by 2045**

Roadmap (2019) outlines the importance of further R&D investments for electricity and bioenergy production, as well as carbon capture technologies.

***Just Transition* dimension** explicitly considered: **No**

Background

Sweden is the EU's largest mining nation with just over 90% of iron ore production and about 40% of production of lead and zinc, respectively, as well as 9% copper and 23% gold. The mining companies employ close to 7,000 people in Sweden, which can be multiplied by 4.9 to show the total work effect. Swedish machine suppliers supply about 60% of the world's underground equipment, and as such, the mining and mineral industry, together with the steel industry, accounts for 10% of the gross export value. Today the **mining and minerals sector** generates about **8% of Sweden's CO_2 emissions**, which are comparatively low levels in global comparison. This is because the Swedish mining sector is a world leader in the production of raw materials, intermediate products and equipment with a low carbon- and environmental footprint. Many processes and technologies in use are already fossil-free, particularly in mining operations, which are already extensively electrified.

Nevertheless, more work remains to be done. The Swedish mining and minerals sector has an important role to play in the transition to a sustainable future. Fossil-free systems for energy and transportation, climate-friendly buildings and increased recycling all depend on sustainably produced, high-quality metals and minerals – not least those metals and minerals in modern batteries and infrastructure. Both the development of existing technologies and an eventual shift to new technologies and processes will be required in order to pursue the objective of **fossil-free and climate-neutral mining and mineral operations by 2045**. To this end, and as part of its efforts to transition to fossil-free production the industry has jointly developed a **Roadmap to a Competitive and Fossil-free Mining and Metals Sector (2019)**.

This roadmap was developed in the context of the **Fossil Free Sweden initiative**, which was launched by the National Government to gather and accelerate the climate efforts being made across the business sector, municipalities and regions. The initiative operates through a small team led by a National Coordinator and has an independent status towards the Government. The mission is to speed up climate action in industry and encourage the Government to remove obstacles that could slow the transformation. As part of Fossil Free Sweden, **22 different industries have produced their own roadmaps**[13] to show how they can enhance their competitiveness by going fossil free or climate neutral. The roadmaps show the opportunities, identify obstacles and contain proposals for solutions both through the industries' own commitments and through policy proposals. Taken together, they show what a fossil free business sector can look like. The roadmaps have

[13] https://fossilfrittsverige.se/en/roadmaps/

been presented to the Government and now form a basis for continued work by Fossil Free Sweden and the participating industries.

Roadmap 2045 – the journey towards fossil freedom

One of the most important ways to achieve fossil-free operations is via **electrification**. The transition to electric power is well on its way and takes place primarily through continuous phasing out and new investments. Supported by biofuels where electricity can't be used, **machines and transportation within mining operations can be fossil-free by 2035**. Further automation and digitalisation will reduce energy needs and result in more efficient and optimized vehicle fleet. Infrastructure for charging, possibly alongside hydrogen tanking, will complement a strengthened electricity distribution network.

In regard to **metal and mining processing** however, the further development of several existing technologies will be critical. Biofuels can replace some of today's fossil fuels in the refining process, but both fuel properties and fuel supply must be developed. Electric heating techniques can be used in the long run but are immature today. R&D is also needed to find process paths and system solutions for fossil-free production of other metals. Managing the process emissions of lime and cement production requires the development and commercialization of technologies for carbon dioxide capture (CCS), geological storage and the use of carbon dioxide in other industrial processes (CCU).

Needed for the Transition: Electricity, Bioenergy, R&I

The transition to fossil-free requires extensive investment in research and development. Development of bio-based, electricity-based, and hydrogen-based processes for producing iron, copper, and other metals and minerals is an urgent priority. Efforts at the national level to enable CCS and CCU need to begin. It is clear that a fossil-free mining and metal sector will need to use more electricity and bioenergy than it does today. Estimates suggest that compared to today, a fossil-free sector in 2045 will require:

- **1-2 additional TWh of electricity**
- **6-7.5 addtional TWh of bioenergy**

In order to achieve these requirements, several critical conditions will need to be met:

1. **Effective and fair permitting processes** so that new and necessary, climate-efficient investments can be made possible.

Competitiveness and investment ability are affected by the permit process, which is required to run and develop mining and mineral projects. Difficulties in obtaining permits for changes in operations (or permits for completely new operations) have become an obstacle to new investments and therefore have an obvious braking effect, which impacts, among other things, the transition to new, fossil-free technology. A comprehensive review is necessary to ensure efficient and legally secure permit processes so that new and necessary, climate-efficient, investments are made possible.

2. A **holistic approach to political decision-making** that avoids suboptimal instruments that weaken competitiveness and make fossil-free operations more difficult

The mining and minerals industry is characterized by very large investments with a long-time horizon. Maintained or increased competitiveness is absolutely crucial for the mining and mineral industry companies to be able to make the investments for adaptations or new processes that the conversion requires. Investment capacity is affected by the industry's profitability. This means that taxes and other policies must consider the importance of safeguarding the conditions for maintaining global competitiveness. It is important that there are no "short-term obstacles" for long-term investments. Otherwise, a significant risk is that companies choose to make their investments in countries other than Sweden.

3. Investments in **research and development for fossil-free production processes and CCS**, including test and demonstration facilities

Technological steps and infrastructure investments are needed to further reduce emissions – investments that a competitive industry cannot make entirely on their own. State support will be needed for research, commercialization and risk-sharing. Government funding and broad collaboration between research and innovation actors in society is necessary throughout the innovation cycle – from basic research via pilot projects, all the way to full-scale implementation. Investments in the development of, for example, new industrial processes in which the state and the business community work together could result in large and lasting climate gains. One example is regarding carbon dioxide storage and utilization (CCS & CCU), where today major technical, economic, legal and infrastructural as well as political barriers must be overcome before an expansion is feasible. The existing infrastructure for transport and storage of carbon dioxide in Sweden is lacking and large investments and measures will be required to meet future needs.

4. Conditions that facilitate access to **fossil-free electricity** at a low total system cost and high reliability.

Many of the industry's conversion strategies are based on electrification of machines and processes, making access to electricity at competitive prices an essential prerequisite. This must be considered when deciding on electricity network connections that have a price-increasing effect, such as from trading in emission rights. In this regard, compensation for these indirect price increases at the national level, which exist in other EU countries, would be significant.

5. Access to **bioenergy at a competitive price**

The amount of biofuel that will be used for internal transport, heating and ventilation as well as for conversion processes will be significant, and the risk exists that there will not be sufficient supply of bioenergy for the restructuring of the Swedish industry to take place. A stable supply of bioenergy with the right properties and at a competitive price is thus key for mining and mineral operations to continue its transformation.

The Netherlands – Regional Plan of the North Sea Canal Area

Key Points

Regional Plan for the North Sea Canal Area (NZKG) one of **six cluster plans** developed at the request of the government that outline strategies to reduce greenhouse gas emissions.

NZKG carries significant regional and national economic importance, employing close to 80,000 and generating added value of around 9 billion euro.

Objective: **reduce CO_2 emissions by half until 2030 and to almost zero by 2050.**

The **Regional Plan NZKG (2020)** outlines the importance of investment and further innovation of critical energy infrastructure, laws, regulations & permits, as well as the key role of the labour market.

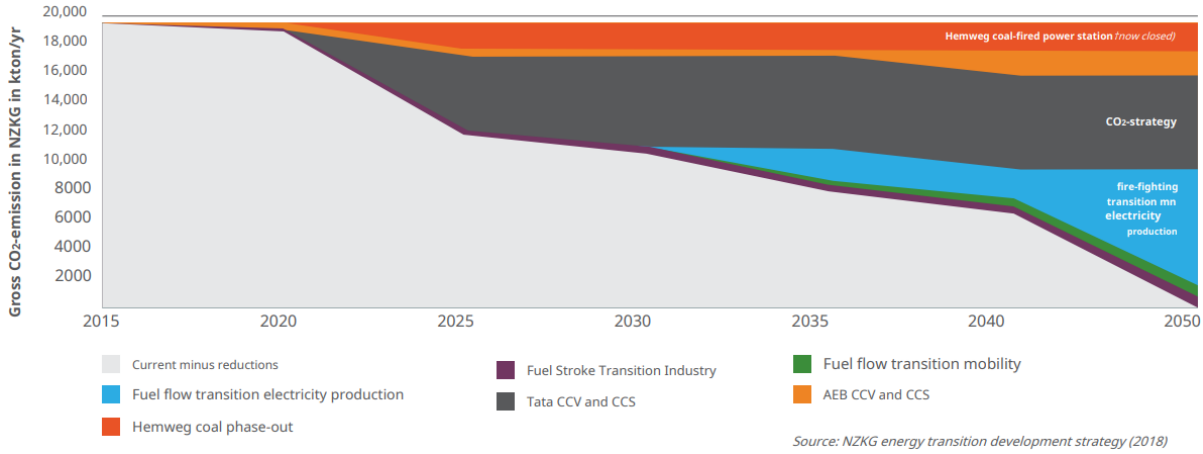
***Just Transition* dimension** explicitly considered: **Yes**

Background

The economic impact of industry and ports in the North Sea Canal area (NZKG) is substantial for both the region and the nation, employing more than 78,000 in the industrial sites, 25,000 of which are in the manufacturing industry. The added value generated in the NZKG amounts to almost 9 billion euro. Industry in the area can be roughly divided into three clusters economically and geographically: steel, food and energy. In the IJmond, Tata Steel, as one of the twelve large energy-intensive companies in the Netherlands, is an important driver in the energy and climate transition. The direct emissions of industry in the region in 2018 amounted to 18.3 megatons (Mt) CO_2 per year, which is around **11 percent of CO_2 emissions in the Netherlands as a whole** (164 Mt in 2017).

The public and private parties in the NZKG have been intensively working together for more than 25 years to strengthen the area, both economically and in terms of energy and climate. The organizations involved are aware that they depend on each other and have set up the NZKG Governance Platform for Energy Transition to be able to realize their climate objectives. In this context, the **Regional Plan NZKG (2020)** has been jointly developed. The Regional Plan outlines the developments in the field of industrial CO_2 emission reduction and energy saving in the North Sea Canal area. The parties in the NZKG want to **reduce CO_2 emissions by almost half until 2030 and to almost nothing by 2050**, as depicted in the figure below.

Figure 1 - Gross CO_2 emissions in the NZKG on the way to climate neutrality in 2050



Source: NZKG energy transition development strategy (2018)

This plan was developed at the request of the national government, which asked six clusters across the country to develop their **Cluster Energy Strategies**[14]. In addition to the joint commitment of companies, the plans also reflect what they need from the government and other parties. These are, for example, infrastructural facilities (pipe networks) and regulations. The clusters are currently already consulting with the energy infrastructure managers about the networks required for these plans (for electricity, gas, CO_2, hydrogen, heat). If all plans of are to be implemented, it could lead to an estimated 31 Mt emission reduction in the Netherlands by 2030. The emissions from the industry itself will then have decreased by 21 Mt, from a 53.5 Mt in 2020.

Regional Plan – North Sea Canal Area

The core of the Regional Plan is the transition of companies. CO_2 emissions must ultimately be reduced to zero by 2050. To this end, companies have submitted plans that directly contribute to the target of a 49% reduction in CO_2 emissions by 2030. Around 45 projects have been submitted that concern CO_2 storage, electrification of industry, use of (deep) geothermal energy for heat, exchange of heat between companies, use of hydrogen as fuel, etc. There are also plans that enable the reduction of current CO_2 emissions and offer market opportunities, such as hydrogen production and circular activities. The lion's share of the planned reduction can be realized with the major projects of Tata Steel (7.4 Mt) and the closure of the Vattenfall Hemweg coal-fired power station (2.5 Mt).

While the Regional Plan revolves around the transition of the companies, they cannot do it alone. The authorities in the North Sea Canal Area and the central government have agreed to provide the preconditions necessary for this transition. While these may vary according to the specific project, the following are essential conditions for the overall climate transition of the region.

Infrastructure

The energy transition requires a robust energy infrastructure network. Since the current electricity network cannot cope with the increasing demand for electricity, the challenge is to develop an adaptive energy network with the help of new technologies and strategies in which, based on supply and demand, it is possible to switch between different energy sources/modalities and energy can be stored temporarily.

[14] Five large industrial clusters (Northern Netherlands, North Sea Canal area, Rotterdam-Moerdijk, Zeeland-West Brabant and Chemelot/Limburg) and for other industry (referred to as cluster 6): https://www.klimaatakkoord.nl/actueel/nieuws/2020/10/22/industriele-clusters-publiceren-plannen-2030-2050

- In order to meet the electricity needs, a heavier **electricity grid** is needed. Discussions are underway with Liander and TenneT about the realization of new substations in the port area.
- There is a growing need for **hydrogen** to replace natural gas and as energy storage. Investments in hydrogen and heat/steam networks are necessary to substantially relieve the electricity grid. The NZKG is an obvious location for hydrogen production, because of the supply of renewable energy (shore wind at sea) and the sizeable (potential) demand. In this context, there is a major task to make the natural gas networks suitable for hydrogen, and projects are already underway (e.g., H_2ERMES).
- In order to help the industry with their climate objectives, there is also a need for a **CO_2 network**. In the North Sea Canal area there is both demand for and supply of CO_2 - thus both for CO_2 storage under the North Sea (CCS) and for usage (CCU). Projects are underway to realize this potential (e.g., Athos).
- **Heat supply** to the Amsterdam Metropolitan Area through residual heat and possibly geothermal energy. Residual heat utilization offers opportunities to make the urban environment climate neutral. However, setting up heat networks is not a core activity for industry, and companies do not want to be tied to a supply obligation, in order to remain flexible when, for example, their production process changes or decreases due to lower demand. As such, it requires the involvement and investment capacity of the public sector.
- Continued investment into the construction and maintenance of **offshore wind farms**, which is a fast-growing and economically important sector. The "Energy Port" – an agreement between public and private partners – will continue to play an important role in the future development of offshore energy production.
- Provide scope for the expansion of the **circular economy** in the area, with a distinct focus on circular activities such as the production of biofuels or the recycling cluster.

Financial resources, laws and regulations

Financial resources (or grants) to make investments commercially justifiable will play an important role. Many of the projects proposed are innovative in nature and have large risks or are at a very early stage and do not have clear commercialization pathways. In view of the social and environmental importance of the projects, the government should under the right circumstances provide financial support or help identify suitable financing options (regional, national and EU). Moreover, some plans will be hindered by existing laws and regulations as well as permit processes. In this context, it must be examined whether there are solutions for laws, regulations and permits that stand in the way of climate projects.

Just Transition Dimension

Human Capital Agenda – Climate Challenge[15]

The Metropolitan Region Amsterdam is working together with House of Skills, the Amsterdam Economic Board and the provinces of Noord-Holland and Flevoland on a *Human Capital Agenda (HCA) – Climate Challenge*. The aim is to ensure that there are sufficient technically trained people to actually carry out the climate projects. This is a national issue that needs to be translated regionally. The problem of a shortage of qualified personnel is widely recognised, especially with regard to technically trained personnel. The parties in the North Sea Canal area are prepared to take their responsibility in this and to play an active role. An administrative group has been formed that will give content and direction to the HCA – Climate Challenge.

[15] https://mraduurzaam.nl/wp-content/uploads/2020/11/Samenvatting-kader-HCA-K_versie-0.99-002.pdf

Why a *Human Capital Agenda – Climate Challenge*?

Coordination and cooperation between the various parties involved (governments, business and educational institutions) is necessary to achieve results. Without joint efforts there is a threat of fragmentation of knowledge, skills, experience and activities, inefficient use of resources, undesirable competition and inflated costs. Regional cooperation is also necessary to properly monitor developments in the regional labour market, to respond in a timely manner and to make proper agreements with national umbrella organizations (such as industry associations) and educational institutions.

Objectives

To formulate concrete objectives, four lines of action were developed:

1. Selection:

- At all schools:
  - climate / technology / technology part of the curriculum
  - technical education given by trained teachers
- The (continuous) recruitment campaigns are aimed at different target groups of children, young people and adults

2. Learning & Development:

- Talent development and retention
- Where possible, set up hybrid learning environments and ensure continuous learning pathways
- Work on a training offer that is in line with the target groups we focus on

3. Work:

- Ensure sufficient work placements and apprenticeships are available
- Ensure sufficient supervision and guidance in the workplace
- Commit to lifelong development
- Ensuring that a good match between supply and demand in the labour market

4. Innovate:

- Work towards a more skills-oriented labour market
- Establish learning communities for research and innovation
- Develop a knowledge infrastructure with professorships (secondary vocational education), lectureships (higher vocational education) and chairs

The realization of the climate objectives offers opportunities for the demand for labour and can provide a positive economic impulse, but it also requires an investment in facilitating secondary entry opportunities with associated training to the favourable sectors.