A net-zero Greenhouse Gas Emissions

Belgium 2050

Initiating the debate on transition policies

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1. EXECUTIVE SUMMARY

Purpose and context of this report

This report was developed and written by researchers from diverse disciplines and across different academic and research institutes in Belgium. It is the contribution of these researchers to the call for action under the 'Sign for My Future' campaign. It is inspired by the widespread societal call for climate action by 'youth for climate' and the coalition of a wide range of societal actors. It also, in particular, responds to the call for the scientific community to actively engage in this debate and was informed and guided by the latest scientific evidence on anthropogenic climate change and the related greenhouse gas (GHG) emissions pathways that stand a significant chance to avoid global average temperature increases of 1.5˚C and 2˚C compared to pre-industrial levels.

The main goal of this report is to support Belgian policy makers and key stakeholders in the development of a vision and strategy towards achieving net-zero greenhouse gas emissions in Belgium by 2050, while taking into account the impact of consumption inside Belgium leading to emissions outside of our country.

Addressing dangerous human-made climate change and a mid-century net-0 emissions target for Belgium

The urgency to tackle anthropogenic climate change cannot be stressed enough. Global average temperature has already risen by about 1°C from pre-industrial levels, and we are increasingly being confronted with the consequences: ice caps are melting, sea levels are rising, and extreme weather events such as heatwaves, droughts and floods are increasing in frequency and intensity.

As the Earth gets warmer, such extremes will become more common and if the warming rises above 2 °C, the risk of self-reinforcing climate change will increase considerably. Therefore, it is of great concern that in the last ten years, national pledges to reduce emissions have reduced the forecast of global warming from above 4°C by the end of the century to only around 3°C. Clearly, more policy action is needed across the world to limit warming to 1.5 or 2 °C.

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The Paris Agreement on climate change was a milestone in global political efforts to address manmade climate change. Parties to the Paris Agreement have engaged to "hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change". Belgium has (together with the EU), signed and ratified the Paris Agreement, which entered into force on May 6th, 2017.

The recent 'Global warming of 1.5˚C' report from the Intergovernmental Panel on Climate Change (IPCC) further emphasises the vital importance of limiting further warming to as low a level as possible and the need for deep and rapid emission reductions in order to do so. Specifically, to limit global warming to 1.5°C, global CO_2 emissions need to almost halve between 2010 and 2030 and reach 'net zero GHG emissions' by 2050. Net-zero GHG emissions implies that any remaining emissions are compensated for by active CO_2 removal (CDR) from the atmosphere. Timely and sizable CDR is expected to be important given the difficulty in entirely eliminating emissions from some sectors.

Given the above-mentioned urgency, the authors of this report recommend Belgium and the EU to adopt a 2050 net-zero greenhouse gas emissions target and put in place an adequate strategy followed by policies and measures to achieve this goal. Furthermore, it is highly recommended that any future strategy takes into account the reduction of Belgium's indirect emissions i.e. international emissions related to consumption in Belgium.

Current status of Belgium's climate action and the need for a consistent long-term strategy.

As part of the 2030 European Union (EU) climate and energy framework, EU Member States have to develop so called National Energy and Climate Plans (NECPs). These plans have the goal to further integrate and coordinate national, regional and EU climate and energy policies.

The EU's climate targets are split into two parts. The (fossil fuel-based) electricity generators and heavy industry (e.g. steel, chemicals, cement, …) are part of an EU-wide emissions trading system (EU ETS) with a single EU target. For the other parts of the economy (e.g. transport, buildings, waste, agriculture and forestry) there is an overall EU target which is translated into binding national sub-targets under the Effort Sharing Decision (ESD).

They NECPs contain Member States' plans to reduce emissions in their ESD sectors , how renewable energy will be further developed, how energy efficiency will be improved and how security of (energy) supply will be managed in the period 2020-2030. The draft Belgian plan was submitted to the European Commission at the end of 2018. The Commission will review the plans and offer recommendations. The final plans have to be developed by autumn 2019.

According to the Belgian NECP, existing climate mitigation measures will likely lead to an economy-wide increase in emissions between 2015 and 2030, mainly due to an expected increase in the emissions from the power sector which fall under the scope of the EU Emissions Trading System (ETS) (which covers energy production and heavy industry). Existing policies will lead to further minimal reductions after 2020 in the effort sharing decision sectors, with a reduction of 11% expected in 2030 (compared to 2005 emissions). This confirms the assessment by the European Commission as mentioned before that the current climate policy framework in Belgium is largely insufficient towards meeting the 2030 target.

The NECP also presents a scenario in which additional policies and measures are implemented at regional and federal levels. While these announced additional instruments might indeed lead to emission reductions in line with Belgium's 2030 climate goal, this (EU set) 2030 climate goal is far from sufficient to reach the Paris agreement target. Moreover, there exists a lot of uncertainty concerning implementation. Firstly, a full assessment of the additional policies is not presented, in particular regarding the provision of budgetary or other means of implementation. Some of the proposed instruments remain vague, and finally, there is no political commitment or agreement to implement all the announced instruments. This can partially be explained by the nature of the plan itself which does not require macro-economic analyses and detailed implementation provisions.

There are also more fundamental concerns with regard to the regional and national climate plans for 2030. The Walloon Climate Expert Commission found the 2030 climate plan for the Walloon region insufficiently ambitious because it postpones the major effort towards a zero-emission target to the period 2030-2050. The plan hence risks locking-in carbon intensive investments between 2019 and 2030 thereby increasing the overall costs of the climate policy. The plan was also criticised for having cumulative emissions that are incompatible with the 2°C target of the Paris agreement. The found lack of ambition and risk of locking-in carbon emissions is valid for the climate plans of the other regions in Belgium and ergo the national climate plan. It hence strengthens the case in favour of better and better coordinated long-term climate strategies in Belgium.

Approach and scope of this report

By developing a vision on how a 2050 net-zero greenhouse gas emissions Belgium might look like it becomes possible to back-cast from 2050 to today. This can bring about a new perspective on how GHG mitigation can be addressed today and how to avoid locking-in high GHG emissions over a period of decades. This type of foresight can help policy makers navigate the dense fog of the plethora of mitigation options that are being considered at the moment.

This report considers the transition to net-zero greenhouse gas emissions for the following areas:

- Mobility and logistics
- Buildings, the built environment and urban and regional planning
- Industry and materials
- Agriculture, food and forestry
- The electricity system

First, a vision of 2050 net-zero greenhouse gas emissions is presented for each of the above-mentioned areas. Our vision cannot be seen as the result of modelling or detailed calculations but must be considered as a projection of experts in these areas, based on their experience and knowledge of available literature on how net-0 emissions could become a reality and what it would look like in practice. At the end of this report a robust list of literature, which informed the 2050 sector visions, is presented.

Based on the vision of net-zero greenhouse gas emissions in different sectors, the necessary steps in the transition process become clear, along with the timeframes of implementation that need to be realised. This transition-based thinking thus provides information on actions that will need to be considered today to ensure timely implementation of the transition towards net-0 emissions and to avoid locking-in pathways that make it difficult or even impossible to achieve this long-term goal.

Vision for Net-0 greenhouse gas emissions in Belgium in 2050

Mobility and logistics

By 2050 there will be important changes to the transport and logistics systems with 'mobility as a service' (MAAS) having replaced the private car ownership focussed society of today. Cars, vans and busses will all be powered by electricity. The demand for transport will have been reduced due to densification of the residential areas. There will also be ample and convenient cycling and walking infrastructure and people will use cycle/walking short distances or use e-bikes for medium distances.

All goods that can be transported from the seaports will be placed on inland waterways and railways. Road transport of goods will have become the exception, the exception being for short and medium distances with zero-emission trucks. Goods for the city will be further bundled in a city distribution centre on the outskirts of the city and distributed by electric vans and cargo bikes. Short haul air travel will have been completely replaced by train or bus travel. In 2050, aviation will be making use of alternative/synthetic fuels and hybrid systems for long-distance flights. Shipping will be electric for short distances and use alternative fuels for long-distances.

Buildings, the built environment and urban and regional planning

In 2050, more nature and forests will have been created and protected, resulting in enhanced biodiversity and better resilience to deal with the impacts of climate change. Urban and regional planning will have been reorganised by reverting to both a focused urban densification on the one hand and de-densification or phasing out of roads and buildings in sensitive nature areas on the other hand. This operation will have enhanced efficient and sustainable energy use, but it will have also contributed to other benefits for society like improved sustainability of mobility, services and utilities, nature conservation and agriculture, water management, renewable energy production and climate adaptation. The eco-efficiency of the entire spatial system will thus have been improved.

The building stock will in 2050 operate in a completely fossil free manner by using 100% renewable energy sources, produced locally or sourced from another location. In this way, two dominant types of neighbourhoods will have come to exist. The first type would be served by a sustainable heating network; the second type sources sustainable electricity for supplying heat to buildings using a heat pump (also for domestic hot water). If possible and where appropriate, neighbourhoods would be supplied by so called e-fuels, like syngas and hydrogen, which will have been produced by sustainable electricity. Only a minor part of the buildings would be using biomass, biogas or direct electrical heating. In highly exceptional cases, like in historical buildings, a fossil fuel would still be used but with a highly efficient technology. Through upscaled retrofit of the existing building stock, supported by appropriate financial, regulatory and capacity-related incentives, all buildings would have acquired a proper degree of energy-efficiency and would therefore be fit for being serviced by the aforementioned renewable and sustainable energy sources.

Agriculture, food and forestry

In 2050, GHG emissions from agriculture and livestock farming would be in balance with CO_2 removal. In particular, carbon sequestration in soils will have been significantly increased as a result of improved agricultural practices. Greenhouse horticulture would no longer use fossil fuels but rely entirely on green electricity or other sustainable alternatives. Through a combination of less animal husbandry, genetic progress, better manure treatment, more sustainable feeding with grazing, emissions from livestock farming will have been significantly reduced. Indirect GHG emissions from agriculture and land use, i.e. emission that are not taken into account in the sector's mitigation efforts because they are accounted elsewhere (diet and feeding behaviour, choice of building materials, etc.), would also have fallen significantly. The share of animal proteins in the consumer's diet will have decreased in favour of vegetable-based proteins. Better coordination between producers and consumers using for instance digital platforms would reduce food losses. The use of packaging and transport in food production will have been significantly reduced. Reusable packaging will have largely replaced single use.

Industry and materials

By 2050 the industrial sectors' GHG emissions (direct and indirect) will be 90% lower compared to 2005 levels. Alternative production processes using electricity, hydrogen, sustainable biomass and circular feedstock, for example, have been widely implemented. Where there are remaining emissions that cannot be reduced by these alternative processes, they are captured and used in new products or stored. Companies will have embraced new business models with the aim of maximising the value of materials in the economy, making an essential contribution to the overall goal of reducing materials consumption. All (non-hazardous) waste and residue streams are brought back into circulation. Linear consumption will have disappeared. Industrial processes will have maximised symbiosis (heat, water, materials, residual flows) with other processes in the neighbourhood and with other sectors in the economy (e.g. buildings (heat), agriculture, food, energy, etc.).

Electricity system

A climate-friendly electricity system will be a key component in making the whole Belgian energy system and economy climate-friendly by 2050. Over 80% of the electricity will come from renewable sources, originating from both domestic and international sources. In 2050, the Belgian electricity system will be completely GHG emission-free. Domestic renewable power generation will often be co-owned by citizens, for example via energy cooperatives. The Belgian electricity system will have become fully integrated into a European energy system and market. In particular, the integration with power markets and electricity systems in neighbouring countries will have been fully optimised.

Other sectors will rely strongly on the electricity sector to meet their energy demand, especially those for which the integration of renewable energy presents a greater challenge, like mobility and the built environment. This increasing electrification will be accompanied by ambitious energy efficiency efforts across all sectors to manage the total electricity demand.

The electricity system will also have become heavily integrated with other energy vectors, like heating & cooling and gas systems, especially at the local level. This would include residual heat from industry, solar energy, deep geothermal energy and biomass applications, as far as the latter are sustainably sourced and processed. The integration of electric mobility with the power system would be an important element of the electricity system in 2050 with the large fleet of electric vehicles acting and being managed as a key electricity storage and grid management instrument. Other solutions further facilitate the integration of renewable energy, like gas-fired power plants fueled by synthetic gas, decentralized and large-scale storage, different types of demand response, and turning power into other energy carriers like gas, fuel, hydrogen or heat (P2X) which can also be more easily stored.

The transition to net-zero greenhouse gas emissions

Mobility and logistics

The electrification of passenger cars and vans will accelerate considerably in the period 2020-2030. From 2020, tax support for company cars must only be provided if they are electric, together with the abolition of the fuel card. Public and private charging stations need to have been rolled out and be bi-directional, allowing vehicle to grid and smart charging in 2030. From 2030 onwards, fossil fuel powered cars must no longer be allowed to be sold or registered. For new vans sold, this ban could be introduced as early as 2025. Smart road pricing (based on location, time, type of vehicle) should be gradually introduced as from 2025 in order to internalise the external costs of transport.

An ambitious investment plan for public transport and cycling infrastructure needs to be implemented as from 2020. The integration with the bicycle and (car) shared mobility systems will need to be facilitated by the development of sufficient parking facilities at the key transit nodes. The public sector needs to further stimulate (vehicle) sharing systems and integration of mobility services (MAAS) with a special attention to inclusion and sustainability of the mobility system.

Transport of goods via waterways and rail need to be further developed by creating a level playing field with other modes of transport. The use of railways for short and medium distances should be made the norm again by making it a cheaper and comfortable alternative compared to short-haul flights. In cooperation with neighbouring countries, a tax on kerosene, VAT on tickets and/or an airplane tax could be introduced. Investments will need to be done to facilitate and re-establish long-distance rail services (e.g. sleeper-trains).

Buildings, the built environment and urban and regional planning

The reorganisation of the urban and regional planning system will have to be well prepared so it can start to operate at full speed in the period 2020-2030. This operation will need to be guided by the principle of nodal value (knooppuntwaarde), i.e. the level of servicing and the concentration of economic activities. Other parameters would also be required to steer the spatial restructuring operation: mobility access scoring, sensitivity to flooding, potential for renewable energy production, strengthening of natural and agricultural functions, climate adaptation.

For the buildings sector the complete decarbonisation of all public and social housing by 2030 must become a priority. From 2030 on, all fuel oil and natural gas should be mandatorily phased out. New installations based on these fuels should no longer be allowed, even so in the renovation of existing building systems. Renovation of existing buildings should also be increased through better regulation, lower financial and other thresholds and fiscal reforms.

Industry and materials

In industry, in the period 2020-2030, key enabling technologies towards low-CO_2 emissions will have to be demonstrated through a large innovation programme. New industrial process installations must become climate-neutral as from 2030. Older installations will need to be refurbished, and thus integrate low-GHG-emitting technologies. Operational costs of new processes will need to continue to decrease through their gradual deployment in the period 2030-2040. The basic infrastructure to connect new processes (renewable electricity, H_2, CO_2, ...) must be ready at the level of the large industrial clusters in Belgium and connected clusters in neighbouring countries by 2030. By 2040, the energy infrastructure for the industrial transition will need to be completed and this network should be completed on a European scale.

The methods to keep most material flows circular and of high quality will have to be in place by 2030 and already under application for some important value chains. The supply chain for plastic waste (feedstock & mechanical recycling) must achieve sustainable volume (further cost savings being investigated). By 2040, the circular value chains should be operating on a large scale, with only a few residues that are difficult to recycle and hazardous waste streams still being incinerated.

Agriculture, food and forestry

In 2030, the first 10,000 ha of forest expansion in Flanders must be realised and a second more ambitious phase of 50,000 ha of forest expansion should be initiated. Ambitious forest and peatland restoration programmes are being implemented. Management plans of protected and unprotected nature, forest and water must be subject to a climate-change-robustness check. Management plans that fail to meet this check should cease to have access to government funding.

Organic agriculture and precision agriculture, less intensive tillage and the increased use of organic fertilizers should be contributing to a significant increase in the organic matter and carbon content in the soil. By 2030, in greenhouse horticulture, all companies have switched to alternatives to petroleum. The new investment wave towards 2050 must also phase out the use of gas and combined heat and power (CHP) in favour of renewable energy sources. In the livestock sector, better farm management in general and better feed management in particular should be in place to reduce enteric emissions from cattle in the first phase until 2030. Manure processing will need to become more efficient. Livestock farming is significantly reduced in the period 2020-2050, mainly because of the lower demand for meat. Consumer's diet will most likely shift significantly from animal to vegetable protein.

Electricity system

Preparing electricity markets and infrastructure for this large-scale integration of renewables is a task with a preeminent European character. Security of supply, cost-effectiveness, and inclusiveness is best guaranteed through an approach coordinated at the European level. In that regard, it is vital that Belgium swiftly implements the EU's recent Clean Energy for All package, which contains a range of guidelines and directives that prepare electricity markets and regulations for the transition, for example by setting out a framework for local energy communities. Increasing the share of renewable electricity, both through domestic (notably, wind) and international mechanisms, should be a priority in the period 2020-2030. In terms of infrastructure, Belgium will have to enhance its interconnection with neighbouring systems.

The electricity system must also increasingly be integrated with other energy vectors. While in 2030 the reliability of the Belgian electricity system will probably still mostly be guaranteed by gas power plants, beyond then, new technologies, supported by the increasing digitization of the electricity system, must progressively take over this role. To prepare for these changes, appropriate, technology-neutral market and regulatory frameworks will have to be put in place in the short-term. Additionally, mission-oriented RD&D programs should be set up for multi-energy systems, demand response, decentralized storage, hydrogen, etc. These present great opportunities for innovation, which can build on the strengths of existing Belgian companies and institutes.

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	2020	2030	2040	2050
Mobility & logistics		Start electrification vehicles + infrastructure Tax reform (subsidies diesel) Investments public transp./cycling Km Charging	Full electrification cars and vans Electrification shipping and alternative fuels for aviation/shipping Short-haul flights replaced by train Further modal shifts and mobility	
Buildings & Spatial Planning		Area and building roadmaps towards zero carbon Ban fossil fuels for new-build & deep retrofit Spatial planning reform Betonstop	Zero carbon energy for buildings: stand alone or heating networks Phase out oil and gas based heating Urban Densification	
Industry & Material		R&D moonshots + Demo. Breakthrough tech. Cluster Infrastructure for H_2, CC(U)S Enhanced materials efficiency & circularity	Full deployment of new process technologies Full sector coupling with power sector and integrated EU infrastructure for H_2, CC(U)s Circular value chains replace linear production	
Agriculture, Food & Forestry		10,000 ha additional forest added (Fl) Re-orient agricultural subsidies to sustainable farming Better feed management cattle	50,000 ha additional forest added (Fl) + increased resilience to climate change Agricultural techniques to restore soil quality Plant-based proteins (partly) replacing meat consumption Carbon Dioxide removal technologies	
Electricity System		Coordinated (full) domestic + EU renewable development Increased cross-border connections & market integration RD&Demo smart/flexible/multi-energy tech. & systems	Full integration of EU electricity system increasingly powered by renewable electricity Intelligent and flexible demand technologies & practices Full sector-coupling with industry, mobility and buildings sectors Seasonal and decentralised storage of renewable electricity	

Financing the transition

Many of the sectoral transition pathways include policy instruments that relate to investments and fiscal measures. It is however important to consider these in a broader context such as the impact on the public budget and fiscal burdens on consumers vis-a-vis the opportunity of behaviour change. Finally, investments and fiscal reform must also be forward looking. While short-term benefits from these instruments can be relevant, it is more important to also embed them into a long-term transition strategy.

It is clear that investments will be instrumental in achieving the transition to climate neutrality. It is therefore important that a coordinated investment plan be in place as soon as possible. This plan should cover all relevant levels of governance (e.g. communes, cities, industrial clusters, regions, federal level, neighbouring countries and EU). The plan should contain a transparent time-table and a monitoring instrument to follow up on the status of implementation. Next to strategic planning, there is also a need for additional investment instruments. Other EU Member States have used and are using national promotional banks to finance strategic long-term investments (e.g. KfW in Germany). In Belgium, such large-scale investment vehicles are not really present or used in this manner.

Frontloading a high number of public investments might create a significant budgetary imbalance. It should be a priority for the Belgian government to advocate strategic public accounting at EU level. Public investments that assist Member States with the transition to climate neutrality should be allowed to be taken off the public sector's balance sheet and be accounted separately using private sector capital depreciation factors.

The Belgian fiscal system is complex and contains elements that favour consumption and specifically consumption of fossil fuels. Before additional taxes are considered, adding to the complexity of the system, it is recommended to first audit the existing fiscal regime. Fiscal support for the consumption of fossil fuels (e.g. in the form of lower tariffs) should gradually be phased out, taking into consideration possible social impacts. Shifting of taxation will also become a relevant option. Electrification (in mobility, buildings and industry) will be one of the major pathways to climate neutrality. However, it is certainly not a given. Unfavourable pricing (due to taxation on electricity vis-a-vis fossil fuels) might slow down or even stop this transition in some sectors.

Therefore, it is recommended to, during the transition, implement a tax shift away from electricity towards higher taxes on the use of fossil fuels. Fiscal reform can be used to accelerate the transition in certain sectors. For instance, limiting the fiscal support for company and salary cars to only electric vehicles will create a lead market for these vehicles in Belgium, with up to 11% cars out of total car population becoming electric in Belgium by 2030 through this measure alone.

Existing subsidy or financing instruments must be better aligned with the transition to climate neutrality. For instance, the implementation of the Common Agricultural Policy via support for agriculture in Belgium should be used strategically as an instrument to facilitate the transition of this sector. A similar strategic approach will be needed inside the financing of municipalities in Belgium, with higher emphasis on assisting municipalities with the development of climate friendly infrastructure and/or performance-based financing related to climate consistent spatial planning. Another example would be the tax reduction for homeowners ('woonbonus'), which could be turned into a tax reduction for making houses climate friendly. This tax break should moreover be coupled with a 'location check' (based on building and area roadmaps) and should not be accorded for buildings that have an unsustainable location.

Finally, while internalising the external cost of GHG emissions (e.g. through a CO_2 tax) is recognised as an important instrument to mitigate these emissions, it might not always be the most appropriate or effective instrument inside a transition regime. In this context, regulation will prove to be very important for a timely transition. In particular regulations that prevent the sales of cars with internal combustion engines by 2030 or fossil fuel-based heating systems will be needed to avoid locking in GHG emissions up to 2050. But also, the strategic use of public procurement can be the driver towards lower GHG emissions. Local, regional and federal authorities can enable the transition in, in particular, buildings, industrial and transport sectors by including conditions related to (life-cycle) emissions in public tenders. They can create lead markets for climate friendly products and hence accelerate the transition outside the public sector.

Transition governance

Managing the complexity and interconnectedness of a transition to net-0 emissions, especially across government levels, while managing interactions with citizens, companies and other stakeholders, and responding to changing political and technological conditions, requires dedicated work and institutions. It is a learning process, without a detailed solution from the outset, but with a clear mission. The Belgian institutional framework is complex, has responsibilities for climate and energy policy that are scattered across levels and departments, and administrations that are insufficiently resourced to deliver decisive policy efforts.

Belgium lacks a comprehensive and integrated vision for its transition towards a climate-neutral society by 2050. Having such a vision brings a range of benefits. It transparently communicates Belgium's transition ambitions to all stakeholders. It provides clear guidance to public and private investors. It informs research and innovation programs in public, academic and private spheres. It consolidates visions for different sectors (electricity, mobility, etc.), which supports cross-sectoral policy efforts (financing infrastructure, cost sharing, spatial planning, etc.). It helps guarantee the short- and long-term security of supply of the country. Overall, it is a key tool to realize the transition in an effective and efficient way. It is therefore imperative that efforts to formulate this vision start as soon as possible.

The starting point of such long-term vision and strategy will have to be a solid political agreement that outlines long-term goals and the process to bring these about. Furthermore, it is recommended that the long-term goals and pathways (e.g. under the form of carbon budget) are therefore enshrined in legislation. This will guide policy makers and stakeholders during the implementation of policy instruments.

While high-level instruments that fix long-term targets and pathways are essential, they are most definitely not sufficient to secure the implementation thereof. It is important that once higher-level political goals are set (and legally enshrined) a stakeholder process starts on actual implementation. This cannot be an open-ended process. It must have a solid deadline, defined expected goals or ambition levels and be supported by expert leadership to guide the process. There exist good international examples of developing long-term sectoral strategies and implementing instruments with broad public support of societal stakeholders (e.g. the Dutch klimaattafels). A monitoring system should be put in place to track progress towards medium-and long-term goals.

This could be supported through an independent climate expert committee (as is the case in e.g. the UK and the Walloon Region) which reports on the state of implementation and can offer recommendations to improve the policy framework.

To implement the long-term strategies and instruments effectively and efficiently, in close collaboration with citizens and companies, government administrations need adequate institutional and financial resources. They need to be able to assist in the development and maintenance of the country's 2050 vision, and its translation to policy frameworks and measures. Crucially, they need the ability to coordinate and effect policies across government levels, institutions and stakeholders. Currently, Belgian national and regional administrations often lack the resources to do this. For example, they are presently unable to develop and maintain the in-house knowledge required to manage the transition, making them dependent on third parties. Public institutions with analytical and modelling capacity on climate and energy policies such as the Dutch 'Planbureau voor de Leefomgeving (PBL)' or the UK Climate Change Committee are missing in Belgium. These and other shortcomings need to be addressed as soon as possible.

But also, academia can engage itself more and in a more coordinated way to support the transition to climate neutrality in Belgium. This is possible through the establishment of an inter-academic independent National Climate Centre. It would provide its services to the authorities, institutions and citizens concerned. It would hence act as an interface between the various policy levels, various scientific institutions and citizens and hence could assist in generating support for policies and measures. In countries such as the United Kingdom, Germany and the Netherlands, there are already several examples of such independent national climate centres. The complex Belgian state structure in particular means that a strong mechanism must be put in place to achieve optimal cooperation between the various policy levels in order to be able to implement a widely supported, efficient and effective climate policy.

Conclusions

Based on available literature and, in particular, similar and more comprehensive exercises conducted at either a sector level or at an economy-wide scale in other countries, it is deemed possible to achieve net-0 emissions within the next 30 years while at the same time improving welfare and the economy. Furthermore, the transition to a climate friendly future will likely come with vital co-benefits such as lower air pollution and improved health, less traffic congestion, more nature and biodiversity, a lower dependence on imported fossil fuel and other material-based resources. The transition process will also have to provide instruments that assist with the adaptation to or protection from the ill effects of climate change that will transpire even if the global average temperature increase can be limited to below 2˚C or 1.5˚C.

If well designed and implemented, the transition process can also bring technological leadership through first mover advantages in the development, demonstration and commercialisation of critical innovations.

Finally, despite the fact that Belgium's direct GHG emissions are relatively small compared to other countries, developing and implementing a strategy towards mid-century net-zero greenhouse gas emissions will not be a futile task. First of all, Belgium has one of the biggest ecological footprints per person, causing substantial GHG emissions in other countries. Secondly, it would be consistent with the international (Paris) climate agreement signed and ratified by our country and hence fulfil an international commitment. Thirdly, demonstrating that our country - one of the most technologically advanced and wealthiest economies in the world - can develop a credible, implementable and economically viable pathway to climate neutrality will inspire other countries around the world to do the same and hence amplify our contribution to avoid dangerous climate change.

Achieving the transition to net-0 emissions will not be easy. Far from it. Completely transforming most of the sectors in society and related behavioural elements in a relatively short time-frame (i.e. 30 years) will likely be one of the greatest challenges our country has faced outside of wartime. It will require the mobilisation of all societal and economic actors and levels of government from local to federal. It will require sizeable investments to finance the infrastructure that will power our future society. It will need science and scientists to assist with designing the solutions for this future, either technological or related to governance, economic and social challenges. But as this report and others like it show, it is possible, desirable, and beneficial in many ways beyond addressing climate change.

2. INTRODUCTION

Purpose and context of this report

This report was developed and written by researchers from diverse disciplines and across different academic and research institutes in Belgium. It is the contribution of these researchers to the call for action under the 'Sign for my Future' campaign. It was inspired by the widespread societal call for climate action by 'youth for climate' and the coalition of a wide range of societal actors. It also, in particular, responds to the call for the scientific community to actively engage in this debate and was informed and guided by the latest scientific evidence on anthropogenic climate change and the related greenhouse gas emissions pathways that have a significant chance to avoid global average temperature increases of +1.5˚C and 2˚C compared to pre-industrial levels.

The main goal of this report is to support Belgian policy makers and stakeholders with the development of a vision and strategy towards achieving net-0 emissions in Belgium by 2050, while taking into account the impact of consumption inside Belgium leading to emissions outside of our country.

To avoid misrepresentation of the findings and recommendations of this document, it is important to stress the nature of this report - a document written by academics which seeks to reflect their individual and collective knowledge and experience in specific sectors and the overall climate policy framework (and hence not an academic report that has, for example, undergone a process of peer review). It also lays no claims at being a full fledged climate plan - given the limited time and resources available, it was not possible to develop or use models that would demonstrate the specific climate and macroeconomic impacts of the highlighted pathways.

This report does however seek to assist policymakers and stakeholders in the development of a long-term climate strategy for Belgium and offers recommendations on short-term policies and measures which could help bring about a long-term transition. It endeavours to inspire by deviating from classical incremental policy-making towards providing a realistic and science-based, yet hypothetical, climate-neutral 2050 vision for Belgium. Such foresight could help policy makers better navigate through the foggy plethora of mitigation options that currently lie under consideration. Forcing ourselves to backcast from a 2050 climate friendly society to where we are today can also provide a fresh perspective on how greenhouse gas (GHG) mitigation can be addressed today and how locking-in high GHG emissions over a period of decades can be avoided.

Guidance through this report

This report first introduces (in chapter 3) the current state of Belgium's GHG emissions and 2020 evolution of these over the period 1990-2016. It next considers the state of emissions vis-a-vis Belgium's 2020 target and looks at the the plan towards meeting the 2030 goals. It also briefly discusses the issue of indirect emissions outside Belgium but related to consumption in Belgium. Next, a short introduction is presented on the scientific basis for achieving net-0 emissions by mid-century together with the recommendation to adopt such goal in Belgium. This is followed by the state of long-term climate strategies in Belgium. Chapter 3 ends by presenting the approach towards sectoral net-0 transition pathways that is applied in this report.

In chapter 4, 2050 visions and transition pathways are presented for the following sectors: mobility and logistics, Buildings, the built environment and urban and regional planning, industry and materials, agriculture, food and forestry and power. This is followed by a section on financing and fiscality that uses the information from the sectoral approaches to inform the types of instruments that could be used in this area. The chapter concludes by looking at important cross-sectoral elements that will need to be addressed in any long-term climate strategy.

Chapter 5 discusses the governance needed for the climate transition and the instruments that might be required to be successful. This includes securing political leadership over multiple election cycles, ensuring the support for implementation with stakeholders supported by strong administrations and supporting role of the academic world.

Chapter 6 summarises the main elements of this report.

3. BELGIUM'S GREENHOUSE GAS EMISSIONS:

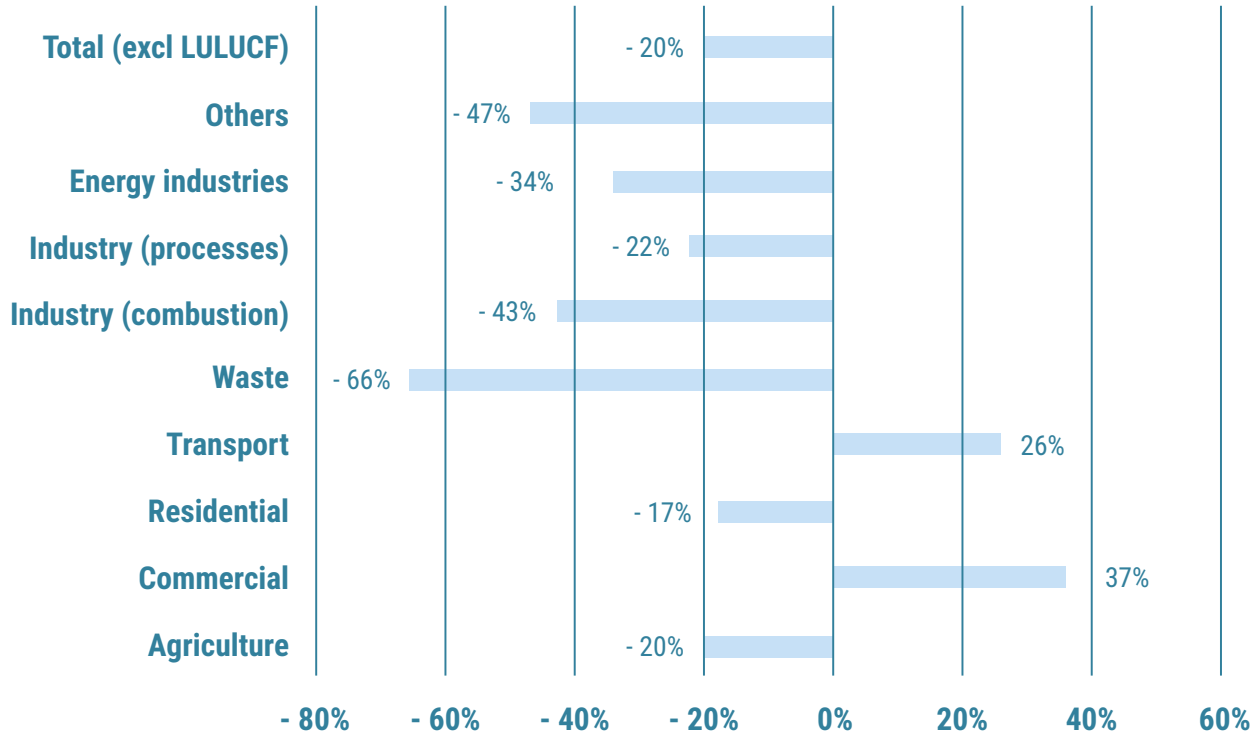
CURRENT STATUS, 2030 PLANS AND MID-CENTURY STRATEGIES

3.1. Current status of greenhouse gas emissions in Belgium

Evolution of greenhouse gas emissions between 1990 and 2016:

In Belgium, emissions of all greenhouse gases fell 19.7% in 2016 compared to 1990 and 20.7% compared to 1995, the base year for fluorinated gases (excluding LULUCF). The largest contribution to total emissions comes from CO_2, accounting for 85.1% in 2016. Emissions of CH4 (methane) represent the second largest share with 6.8%, followed by emissions of N_2O (nitrous oxide) with 5.1%. ETS and non-ETS emissions decreased 35% and 6% respectively in 2016 compared to 2005.

Important emission reductions ensued in most sectors and in particular the production of electricity, industry and the waste sectors. The transport sector and the tertiary sector however noted large increases of GHG emissions. Industrial emissions were reduced through large reductions of non-CO_2 greenhouse gases, by improvements in energy efficiency and by closures of major industrial installations in the period 1990-2016, in particular in the Walloon region. In the power sector, there was a fuel switch from coal to gas leading to lower emissions, and in the waste sector, the reduction of methane proved important. Transport and tertiary sectors noted an increase which is strongly linked to important economic growth in these sectors.



Belgium's 2020 GHG emissions reduction target

While the overall emissions in Belgium are in line with the EU's 2020 goal of economy-wide reductions of 20% compared to 1990, Belgium risks being in non-compliance when it comes to the EU target set for the so called Effort Sharing Decision (ESD) sectors which cover all emissions except those from the power sector and large industrial installations.

EU climate targets are split into two parts. First, the (fossil fuel-based) electricity generators and heavy industry (e.g. steel, chemicals, cement, …) are part of an EU-wide emissions trading system (EU ETS). These sectors have an EU-wide target of -21% by 2020 compared to 2005. For the other parts of the economy (e.g. transport, buildings and agriculture,) there is an EU target of -10% by 2020 compared to 2005 which is translated into binding national sub-targets. For Belgium, this goal is a 15% reduction by 2020 compared to 2005. However, in 2015, emissions were down by only 8% and are expected to reduce 9% in 2020 compared to 2005 with existing policies and measures . According to the European Commission's latest country report for Belgium as part of the EU's Semester evaluations , without additional measures, Belgium is expected to miss its 2020 GHG emission reduction target. The Commission expressed high concern about the climate policy governance in Belgium by stating that 'Its overall effectiveness is undermined by the complex and evolving division of competences.

This has led in the past to important delays in agreeing coordinated action, such as an internal effort sharing for the 2020 energy and climate targets, a common long-term vision for the energy transition and the completion of important infrastructure projects, such as the Regional express Network around Brussels. Differences in opinion on the introduction of a kilometre charge for passenger cars have also delayed progress in tackling growing congestion and transport emissions'.

Indirect emissions

It must be noted that the current way under which UNFCCC and EU targets are set only cover the direct emissions that take place within the geographical boundaries of a country and do not account for emissions that occur elsewhere in the world due to the consumption of its inhabitants. The difference between emissions occurring in-country and those that also take into account consumption can be large, in particular as concerns advanced economies. While there is no recent data on this matter for Belgium, VITO estimated the carbon footprint in Flanders including consumption to be 20 t CO_2-eq/capita in 2010. Compared to the 12 CO_2-eq/t capita emissions inside Flanders, this is a notable difference . In order to limit the average global temperature increase to 2 °C, global GHG emissions must be reduced to an average of 2 tonnes per capita by 2050.

3.2. Belgian climate goal for 2030 and expected impact of mitigation activities

For the period 2020-2030 the current EU framework continues in a similar way, with a split between the power sector and the heavy industry covered by the EU ETS on one side and the other sectors having a national mitigation goal. Overall, the EU aims to reduce its GHG emissions by 40% compared to 1990, in 2030. For the sectors covered by the EU ETS, this is implemented through an EU-wide 43% reduction target in 2030 compared to 2005. For the other sectors covered by the effort sharing decision (ESD), this means 30% reductions by 2030 compared to 2005. Again, this latter target is split up in separate national targets. For Belgium this implies 35% reductions by 2030, again with 2005 as the reference year.

As part of the new EU climate and energy framework, Member States have to develop so called National Energy and Climate Plans (NECPs). These plans have the goal to further integrate and coordinate national, regional and EU climate and energy policies. They contain Member States' plans to reduce emissions (in particular for the effort sharing decision sectors) in the period 2020-2030, how renewable energy will be further developed, how energy efficiency will be improved and how security of (energy) supply will be managed. The first of these plans was submitted to the European Commission at the end of 2018. The Commission will review the plans and offer recommendations. The final plans have to be developed by autumn 2019.

The main and top level findings regarding Belgium's climate actions towards 2030 are briefly presented below. This short overview does not do full justice to the complete Belgium NECP (and underlying regional plans), including the information on renewable energy, energy efficiency and energy security that is presented in the plan.

According to the Belgian NECP, existing climate mitigation measures will likely lead to an economy-wide increase in emissions between 2015 and 2030, mainly due to an expected increase in the emissions from the power sector which falls under the scope of the EU ETS. Existing policies will lead to further minimal reductions after 2020 in the effort sharing decision sectors (i.e. transport, buildings, waste and agriculture), with a reduction of 11% expected in 2030 (compared to 2005 emissions). This confirms the assessment by the European Commission as mentioned before that the current climate policy framework in Belgium is largely insufficient towards meeting the 2030 target.

The plan also presents a scenario in which additional policies and measures are implemented at regional and federal levels.These would lead to total economy-wide GHG emission reduction (excluding LULUCF emissions) of 29% by 2030 (103 Mt) compared to 2005. Emissions in the non-EU ETS or effort sharing decision sectors are expected to decrease between 2015 and 2030 from 73 Mton CO_2-eq to 51 Mton CO_2- eq. This would be a 35% reduction compared to 2005 (versus 11% with existing policies and measures). The EU ETS emissions, on the other hand, increase to 52 Mton CO_2 eq (versus 54 Mton CO_2 eq in the scenario with only existing measures) mainly due to an increase in emissions from electricity production.

The impact of these additional policies and measures is calculated using 2030 climate plans developed by the regions in Belgium:

- Additional measures in the Flemish Region are estimated to correspond to a 35 % reduction of GHG emissions in the Flemish non-ETS sectors in 2030 compared to 2005.
- In the Walloon Region, the sum of the expected consequences of the new policies and measures allows for a reduction of emissions in the non-ETS sectors of about 37% compared to 2005.
- For Brussels-Capital Region, the sum of the expected effects of the new policies and measures allows emissions in the non-ETS sectors to be reduced by about 32% compared to 2005.
- Finally, the Federal Government undertakes to continue the existing internal policies and measures, to implement the measures recommended in the NECP, and to adopt new measures that contribute to the achievement of the GHG emission reduction targets.

The national plan elaborates the above by highlighting the key policies and measures each region is planning to implement. While these announced additional instruments might indeed lead to emission reductions in line with Belgium's 2030 climate goal, there exists a lot of uncertainty concerning implementation. First of all, a full assessment of the additional policies is not presented, in particular regarding the provision of budgetary or other means of implementation. Some of the proposed instruments remain vague, and finally, there is no political commitment or agreement to implement all the announced instruments. This can partially be explained by the nature of the plan itself which does not require to include macro-economic analyses and detailed implementation provisions, as well as by the unfortunate timing given that the updating and implementation of the plan is interrupted by elections at regional and federal levels.

There are also more fundamental concerns with regard to the regional and national climate plans for 2030. The Walloon Climate Expert Commission did find the 2030 climate plan for the Walloon region insufficiently ambitious because it postpones the major effort towards a zero emission target to the period 2030-2050 . The plan hence risks locking-in carbon intensive investments between 2019 and 2030 thereby increasing the overall costs of the climate policy. The plan was also criticised for having cumulative emissions that are incompatible with the 2°C target of the Paris agreement. This analysis including the conclusions regarding the lack of ambition and risk of locking-in carbon emissions can be extended to the plans of the other regions in Belgium and ergo the national climate plan.

The Belgian National Energy and Climate Plan is currently being reviewed by the European Commission. Belgium is expected to present a final and reviewed plan in the second half of 2019.

3.3. Moving towards net-zero greenhouse gas emissions by 2050

3.3.1. The urgency to set mid-century targets and realise them

The urgency to tackle anthropogenic climate change cannot be stressed enough.

Global average temperature has already risen by about 1°C from pre-industrial levels, and we are increasingly being confronted with the consequences: ice caps are melting, sea levels are rising, and extreme weather events such as heatwaves, droughts and floods are increasing in frequency and intensity . As the Earth warms, such extremes will become more common and if warming rises above 2 degrees, the risk of self-reinforcing climate change increases considerably . Therefore, it is of great concern that in the last ten years, national pledges to reduce emissions have reduced the forecast of global warming from above 4°C by the end of the century to only around 3°C . Clearly, more policy action is needed across the world to limit warming to 1.5 or even 2 °C.

The Paris Agreement on climate change was a milestone in global political efforts to address manmade climate change. Parties to the Paris Agreement have engaged to "hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" .

Belgium has (together with the EU), signed and ratified the Paris Agreement, which entered into force on May the 6th 2017.

The recent 'Global warming of 1.5˚C' report from the Intergovernmental Panel on Climate Change (IPCC) further emphasises the vital importance of limiting further warming to as low a level as possible and the need for deep and rapid emission reductions in order to do so . Specifically, to limit global warming to 1.5°C, global CO_2 emissions need to almost halve between 2010 and 2030 and reach net zero by 2050. 'Net-zero' GHG emissions implies that any remaining emissions are compensated for by active CO_2 removal (CDR) from the atmosphere. Timely and sizable CDR is expected to be important given the difficulty in entirely eliminating emissions from some sectors.

Given the above mentioned urgency , the authors of this report recommend Belgium and the EU to adopt a 2050 net-zero greenhouse gas emissions target and put in place an adequate strategy followed by policies and measures to achieve this goal. Furthermore, it is highly recommended that any future strategy takes into account the reduction of (indirect) emissions outside of Belgium but related to consumption in Belgium.

3.3.2. Status on mid-century targets and strategies in Belgium

On 28 November 2018, the Commission presented its strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050. Through this strategy the European Commission seeks to demonstrate how Europe can lead the way to climate neutrality by investing in realistic technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, or research – while ensuring social fairness for a just transition. The strategy itself does not set new targets, but does develop mitigation pathways and strategies to 2050. The decision on a mid-century target will have to be endorsed by the EU Member States and the European Parliament, likely later in 2019.

In Belgium, the Walloon Region is the only region that has so far set a mid-century target (80-95% emission reductions by 2050 compared to 1990) and enshrined it into a decree (law). A unanimous parliamentary resolution recently set the GHG emissions target at -95% in 2050. The same climate decree has installed an independent expert committee which has to validate emission budgets towards these long term objectives.

The Flemish government has approved in 2017 the 'Vlaamse energievisie' which documents the vision of Flanders on a carbon-neutral and sustainable energy system. However, no legally binding long-term term goals have been set in Flanders. In 2016, the Belgian Federal government published 'Scenarios for a low carbon Belgium by 2050' that show that several pathways can be followed to reach a reduction of GHG emissions by 80-95% in 2050.

These scenarios were accompanied by a report on the macroeconomic impact of the low-carbon transition in Belgium. In October 2018, a Belgian inter-parliamentary committee on Climate Change concluded that Belgium must continue to take a leading role, together with other EU Member States, in aiming for a 95% reduction of GHG emissions by 2050 (compared to 1990) at EU level. In order to avoid lock-ins, the 95% reduction target for GHG emissions by 2050 must be translated into the necessary intermediate targets, each accompanied by a socio-economic and environmental impact analysis. Last but not least, also at the local level, there are important efforts and plans in cities to move towards climate neutrality by 2050 (e.g. Leuven, Ghent).

However, in the draft Belgian NECP, a coordinated long-term target or strategy is absent. While it might not be an explicit requirement to provide these elements in the NECP, such a plan should, from the perspective of smart and forward looking governance, be informed by a long-term strategy. This is so for two reasons. First of all, this would offer predictability and reassurance because it is important to know how policies and measures that will be put in place to achieve 2030 targets will impact the longer term. Secondly, because the absence of long-term goals might lead to unintended carbon lock-ins after 2030.

3.4. Initiating the debate on transition policies

Forcing ourselves to backcast from a 2050 climate friendly society to where we are today can also bring about a new perspective on how GHG mitigation can be addressed today and how to avoid locking-in high GHG emissions over a period of decades. This type of foresight can help policy makers navigate the dense fog of the plethora of mitigation options that are being considered at the moment.

This report considers the transition to net-0 emissions for the following areas:

- Mobility and logistics
- Buildings, the built environment and urban and regional planning
- Industry and materials
- Agriculture, food and forestry
- The electricity system supply and demand

First, a vision of 2050 net-zero greenhouse gas emissions is presented for each of the above mentioned areas. This presentation cannot be seen as the result of modeling or detailed calculations but must be considered as how experts in these areas, based on their experience and knowledge of available literature, project how in practice net-zero greenhouse gas emissions can become a reality. At the end of this report an exhaustive list of literature, which informed the 2050 sector visions, is presented.

Using 2050 net-zero greenhouse gas emissions as a starting point and how that can look like for the different sectors makes it is possible to look at the necessary steps in the transition process and at which point in time these need to be realised.

Finally, this transition-based thinking provides information on actions that will need to be considered today in order to ensure timely implementation in alignment with the transition to net-zero greenhouse gas emissions and to avoid locking-in pathways that make it difficult or even impossible to achieve the long-term goal.

4. SECTORAL TRANSITION PATHWAYS

4.1. Mobility and Logistics

4.1.1. Mobility and logistics in 2050

The transport system in 2050 will be climate-neutral. This will be due to a far-reaching transition in the way we travel and transport goods. The demand for transport will have already been reduced by a densification of residential areas. Multifunctional urban developments will reduce demand at the source. In freight transport, too, reduction at the source would allow the promotion of local production, circular economy and short value chains. People would naturally use digital means of communication in order to avoid certain journeys. In the case of passenger transport, the public transport system would have been developed in an efficient and reliable manner. There would also be ample and convenient cycling and walking infrastructure and a large number of people would cycle or walk short distances (while using e-bikes for medium distances). Car ownership would no longer be necessary in an urban environment thanks to different sharing concepts, a good public transport system and its integration in 'Mobility as a service' (MAAS), taking into account different types of users. Shared stand-alone electric cars would accommodate on-demand mobility in less accessible areas and allow people to switch to the mass-transit system at the mobility nodes. Car-free neighbourhoods would have become a household word and present attractive places to live and visit in the city.

In the case of goods transport, all goods that can be transported from the seaports would be placed on inland waterways and railways. Road transport of goods will have become the exception, and that too only for short and medium distances via zero-emission trucks. Goods destined for the city would be further bundled in a city distribution centre on the outskirts of the city and distributed with electric vans and cargo bikes. Short haul air travel will have been completely replaced by (high speed) train or bus travel.

In 2050, aviation will will make use of alternative/synthetic fuels and hybrid systems for long-distance flights. Shipping will be electric for short distances and use alternative fuels for long-distances.

4.1.2. Transition to 2050

The transition towards a climate-neutral transport and logistics system will require key initiatives to be implemented over the next decade.

The electrification of passenger cars and vans is expected to accelerate considerably in the period 2020-2030. From 2020, it would be essential that tax support for company cars be provided only if they are electric, together with the abolition of the fuel card. In this way, between 2025-2030 the quasi entirety of the company car fleet, i.e. 11% of the total Belgian fleet, could become electric. Companies must also be required to provide charging infrastructure for their employees. Between 2025-2030, the tax benefit for company cars also needs to be phased out completely.

In order to prepare for full electrification, the fast charging network in Belgium needs to be ready to accommodate a large fleet of Electric Vehicles (EVs) by 2030. Adequate numbers of concessions need to be provided to companies to install them and the electricity network will have to be reinforced (with European coordination). Public and private charging stations should be rolled out well before 2030. These charging stations should ideally be bi-directional, allowing vehicle to grid and smart charging. In this way, an optimal combination can be made with renewable energy, whereby the batteries of the electric cars can be used as storage.

From 2030 onwards, fossil fuel vehicles will no longer be allowed to be sold or registered similar to the announced policy in the Netherlands (2030) and Norway (2025). For new vans sold, this ban can be introduced as early as 2025, especially because vans are responsible for a significant proportion of GHG emissions due to more intense use compared to cars and availability of electrified alternatives.

Smart road pricing (based on location, time, type of vehicle) should be introduced by 2025 in order to internalise the external costs of transport. This is also important because the growing number of EVs will reduce tax revenues from diesel and gasoline duties. Strong differentiation in price for the urban environment (e.g. city tolls/congestion charging) and in the environmental friendliness of the car will be important to stimulate a change. Road pricing starts with a low fee but gradually increases over time. This system should replace the existing road tax for cars. The registration tax can be maintained or is absorbed by a VAT system that takes into account the climate impact of the car.

A well-functioning public transport system in combination with transit car parks and further development of the bicycle infrastructure would provide good alternatives to car use. Therefore an ambitious investment plan for public transport and cycling infrastructure needs to be implemented as from 2020. The integration with the bicycle and (car) shared mobility systems can be facilitated by the development of sufficient parking facilities at key transit nodes. Bicycle highways need to be developed more quickly and in cities too protected cycle paths should become the norm. Bicycle parkings thus need to be expanded. The public sector would need to further stimulate (vehicle) sharing systems and integration of mobility services (MAAS) with a special attention to inclusion and sustainability of the mobility system. Mobile applications can provide a better integration of services so that the user's comfort increases. A new generation of telecommunication services would make it possible to organise a lot of meetings without having to travel.

Interventions at the level of the urban and spatial structure of Belgium, see also section 4.2, would help to reduce the demand for mobility, in particular by private car use, and thereby enhance the effectiveness of public and soft transport modes.

Transport of goods via waterways and rail should be further developed by creating a level playing field with the other modes of transport. This can be done by internalising external costs or by introducing a carbon contribution, and removing organisational and technical obstacles to multimodal transport. The ports as key logistic hubs should play a proactive role in to achieve this. The creation of urban distribution centres on the outskirts of the city would make it possible to consolidate the goods and deliver them in an emission-free manner.

The use of railways for short and medium distances should become the norm again by making it a cheaper and comfortable alternative compared to short-haul flights. In cooperation with neighbouring countries, a tax on kerosene, VAT on tickets and/or an airplane tax should be introduced. Investments will be needed to facilitate and re-establish long-distance rail services (e.g. sleeper-trains). It needs to be investigated whether binding standards for the use of synthetic or sustainable biofuels in aviation can be introduced at the EU level.

The use of smart sensors in vehicles and infrastructure would allow the carbon footprint of the transport of products to be measured. Products and logistics services could then receive eco-labels based on this calculation. The external costs of international transport, in particular shipping, should be taken into account through a CO_2 tax, first at European level, and if possible, globally.






4.1.3. Actions to consider now

REGULATORY (incl. governance)	• Further and fully align spatial planning with mobility and freight transport: densification, multifunctional development and deployment of the development of regional logistics hubs in order to facilitate the bundling of transport (densification and interweaving). • Coordinate policy vision and instruments between the federal level and the regions with the goal to maximise synergies and streamlining (or merging) of policy instruments where needed. Enhance the monitoring of transport related CO_2 emissions and align federal and regional data. • Introduce legislation that prohibits the sales and registration of internal combustion engine vans as from 2025 and cars as from 2030. • Facilitate the installation of fast charging points for electric vehicles. Set goal for full national coverage for EV charging by 2030 at the latest and set interim targets. Support cities, communes and companies with public parking spaces in the roll out wof these facilities. • Fully electrify public bus transport by 2025 by putting it as a requirement in the governance agreements between regional governments and public bus services (Lijn, TEC, MIVB/STIB). • Ensure pricing and ticket integration with the different transport operators and combination with subsystems. Ensuring inclusiveness. • Advocate synthetic (or sustainable bio) fuel standards for aviation at EU environment and transport Council. • Buses on bus lanes should be given priority by means of an intelligent traffic lights system. • Introduce low-emission zones for shipping in all major ports. • Develop eco-labels for logistics.
FISCAL AND FINANCING	• Increase the registration tax (BIV) significantly (cf. Norway) with exemption for electric cars. Alternatively VAT can be used to create differentiation in costs between EV and internal combustion engines. On the other hand, premiums are given for the purchase of electric cars. These must be considerably higher than the current system but also inversely proportional to the value of the car (i.e. higher support for smaller vehicles). As soon as electric vehicles reach cost parity with internal combustion vehicles these premiums will be scrapped. This can already be the case as from 2025. • Increase the registration tax (BIV) significantly (cf. Norway) with exemption for electric cars. Alternatively VAT can be used to create differentiation in costs between EV and internal combustion engines. On the other hand, premiums are given for the purchase of electric cars. These must be considerably higher than the current system but also inversely proportional to the value of the car (i.e. higher support for smaller vehicles). As soon as electric vehicles reach cost parity with internal combustion vehicles these premiums will be scrapped. This can already be the case as from 2025.

- Smart road pricing (based on location, time, type of vehicle) should be introduced by 2025 in order to internalise the external costs of transport. This is also important because the growing number of BEVs will reduce tax revenues from diesel/petrol. Strong differentiation in price for the urban environment (e.g. city tolls/congestion charging) and in the environmental friendliness of the car. Mileage charging starts with a low fee but gradually increases over time. This system should replace the existing road tax for cars.
- Abolish professional diesel deduction: this will lead to a reduction in diesel fuel sold of 7% to 18% (based on fuel consumption 2016) and similar reduction of CO_2 emissions. A joint reduction of up to 14% of vehicle kilometres of heavy and light freight transport would be possible. Moreover, this measure leads to state revenues and also makes the playing field for alternative fuels more fair (in 2018 it amounted to 451 million euros).
- Develop ambitious investments plans for public transport by end of 2020 at the latest with the goal to deliver state of the art: adequate, safe and punctual services by 2025. Use national/regional investment bank, green bonds to finance these investments.
- Increase the investment in safe bicycle networks and support bicycle friendly communes and cities. The Belgian and regional governments should ask the European Commission to be more flexible with regard to public sector accounting to allow these investments to be written off over longer time period and hence not overburden the budget.
- Support the greening of the inland shipping sector.
- Lower VAT for car-sharing services and offer higher subsidies and additional free parking places for car-sharing services that move towards electric vehicles.
- Create a level playing field between intra-EU rail and short-haul flights in coordination with neighbouring member states by aligning (higher) VAT, kerosine taxation or other tariffs and by coordinated investments in efficient long distance railway connections.

INNOVATION

- Invest in R&D to facilitate integration of transport electrification in the electricity system (sector coupling) e.g. bi-directional charging.
- Use advanced information technology capabilities to practically enable Mobility as a Service as an alternative to car ownership i.e. the easy combination of different transport modes in one package. e.g. Pricing and ticket integration at the transport operators and combination with mobility sharing services.
- Invest in information technology to enable better data on goods (e.g. tracking) with the goal to make optimal use of inland shipping and rail without losing efficiency.
- Focus on behavioural change by means of user profiles, nudging techniques and support for campaigns that lowers barriers of adopting the new mobile concepts.

4.2. Buildings, the built environment and urban and regional planning

4.2.1. Buildings, the built environment and urban and regional planning in 2050

For the built environment a double target will have been set by 2050. First of all, all buildings would fulfill their energy needs without using fossil fuels and secondly, the urban and spatial structure of Belgium will have been reorganised in order to maximise sustainable functioning.

The building stock would operate in a completely fossil-free way by using 100% renewable energy sources. In this way two dominant types of neighbourhoods would come to exist. The first type would be served by a sustainable heating network. The second type would use sustainable electricity for supplying heat to buildings using a heat pump (also for domestic hot water). If possible and where appropriate, neighbourhoods will be supplied by so called e-fuels, like syngas and hydrogen, which would be produced by sustainable electricity.

Only a small fraction of the buildings would use biomass, biogas or direct electrical heating. In highly exceptional cases, like in historical buildings, a fossil fuel would probably still be in use but that too with a highly efficient technology. Also, in this case, a pathway towards phase-out would be appropriate.

Through upscaled retrofits of the existing building stock, supported by appropriate financial, regulatory and capacity-related incentives, all buildings would have acquired a proper level of energy-efficiency and would therefore be fit for being serviced by the aforementioned renewable and sustainable energy sources.

Urban and regional planning would have been reorganised by having reverted to both a focused urban densification on the one hand and de-densification or phasing out of roads and buildings in sensitive nature areas on the other hand. This operation will have enhanced efficient and sustainable energy use, but would have also contributed to other benefits for society like improved sustainability of mobility, services and utilities, nature conservation and agri-culture (in particular the extension of forest area, see section 4.4), water management, renewable energy production and climate adaptation. The eco-efficiency of the entire spatial system would thus have been improved.

Each investment in the energy efficient renovation of a buildingwould not only lowered the CO_2 footprint of Belgium, but will have also created local jobs, reduced energy poverty and energy dependence, raised comfort and indoor air quality and had a positive impact on the productivity of employees. In a similar way renewable energy production will have been stimulating the local economy, energy independence and the physical environmental quality. A targeted and smart redistribution of means will however be needed, e.g. to relieve energy poverty for economically weaker groups.

4.2.2. Transition path towards 2050

To realise the transition path towards 2050 several intermediate targets need to be defined for 2030. First, the complete decarbonisation of all public and social housing needs to be realised by 2030. This can come from a sort of 'Marshall Plan' for both building types, as they have a strong role in leading by example. Second, from 2030 on, all fuel oil and natural gas must be mandatorily phased out. New installations based on these fuels should no longer be allowed as from 2020, even so in the renovation of existing building systems. Third, with the use of proper incentives and measures, the reorganisation of the urban and regional planning system needs to be prepared and start to operate at full speed. This operation must be guided by the principle of nodal value (knooppuntwaarde), the level of servicing and the concentration of economic activities. Other parameters would also be needed to steer the spatial restructuring operation: mobility access scoring, sensitivity to flooding, potential for renewable energy production, strengthening of natural and agricultural functions, climate adaptation. To achieve this goal, destination plans need to be operational in all localities with zones being marked for building removal and zones designated for urban densification. This would mean raising the ambition and further detailing of the 'Beleidsplan Ruimte Vlaanderen' in Flanders and the Code du Développement territorial in the Walloon region.

4.2.3. Actions to consider now

In each building and neighbourhood an intelligent and context-based choice needs to made between raising the energy efficiency on the one hand and providing for the local production of renewable energy on the other hand. This can be translated into building and area roadmaps. The coordination between the two types of roadmaps can be done at the municipal level.

The urban planning and energy policy for buildings will need to be integrated into the other policy.

AREAS:

- Energy, by structural integration of the energy roadmaps with the area and building roadmaps (e.g. 'warmtezoneringskaarten', 'energiepotentieelkaarten').
- Mobility, by matching mobility related interventions and the reorganisation of urban and regional planning; and by creating mobility hubs that incorporate renewable energy production systems.
- The cross-sectoral function of urban and spatial planning, being the carrier of all societal functions (cf. supra) with links to economy and industry, nature and agriculture, water management and climate adaptation.

BUILDINGS

- Ban all fossil fuel based heating systems in new build and for major renovations from 2020 on.
- Discourage wood burning from 2020 on. In a principle biomass should only contribute in a minor way to building heating.
- By 2025 all buildings should have a building road map, made out of an extended building pass ('uitgebreide woningpas'). This road map indicates how by 2050 the building can evolve towards a climate neutral status by renovation, adaptations and additions (like a renewable energy system). The Mobiscore (mobility access score), currently being developed by the Flemish government, is included. For every building that changes ownership, the new owner shall perform a set of essential and no-regret energy retrofit measures as indicated in the building roadmap, within 5 years of the acquisition of the building. If a building cannot meet the standards of 2050 in due time, demolition and constructing a new building will be obliged by 2050; where appropriate this will include an urban densification operation or the relocation to a more suitable urban area.
- Initiate a Marshall Plan for public buildings and social housing as of 2020. Based on a 10 year planning these buildings will undergo a profound energetic renovation or be replaced by new buildings meeting the European net zero energy building (NZEB) regulations from 2020 on.
- Taking into account the needed transition effort, the necessary skills in the building sector will be significantly enhanced by government incentives, e.g. in education and in job creation, in order to speed up the high quality renovation rate of the building stock.
- The tax reduction for homeowners ('woonbonus' in Flanders, 'abattement des droits d'enregistrement' in Wallonia) should be converted into an area-sensitive tax reduction for climate friendly renovations serving the double goal of decarbonisation of the building stock and spatial reorganisation.
- Establish revolving funds and/or climate funds to assist with 3rd party financing of energy renovations in buildings and renewable energy production.
- Develop and encourage business models of integrated home renovation services (one-stop-shop renovation offers) are pilot tested and scaled-up by public and private entities to smoothen renovation journeys for citizens.
- Launch a large communication campaign explaining the roadmap for the transition towards climate neutrality. This will support investment and legal security for all stakeholders. This will also stimulate economic development and scientific research focussing on the decarbonisation of the building stock.

SPATIAL PLANNING

- By 2025, develop and enhance all the municipal heating plans or 'gemeentelijke warmtezoneringsplannen', aka area road maps. These plans define which areas are to be all electric (or equivalent) and which areas are to be progressively connected to sustainable heat networks. In the latter situation, people who do not want to connect to a heating network need to prove they will a implement a more sustainable and cost effective alternative.
- By 2025, operationalise a system of tradable development rights ('verhandelbare ontwikkelingsrechten', in order to reorganise the spatial system towards increased sustainability. These allowances enable building owners to relocate their development rights to appropriate urban areas when the building rights are taken away in a certain area.
- The greenfield development moratorium ('betonstop ') is to be installed in Flanders and Wallonia, adopting an accelerated timeline. A progressive and stringent pathway is created from 2020 on and in 2025 the occupation of new open areas in Belgium is to be stopped. By high exception open areas adjacent to urban areas can be used for construction purposes. This can only be done if this is more sustainable than densification of existing areas. Performance based criteria will be added to the regional financing instruments of local authorities to ensure these goals are implemented.

4.3. Industry and materials use

4.3.1. Industry and materials consumption in 2050

By 2050 industry's GHG emissions (direct and indirect) will be 90% lower compared to 2005 levels. To some extent this transition will go hand in hand with the greening of energy used in industrial processes. Alternative processes using electricity, hydrogen, biomass and circular feedstock, for example, have been widely implemented. Where there are remaining emissions that cannot be reduced by these alternative processes, they are captured and used in new products (e.g. building materials) or stored.

Companies have embraced new business models with the aim of maximising the value of materials in the economy, and are making an essential contribution to the overall goal of reducing raw materials consumption (RMC) by 75%. All waste/residue streams are brought back into circulation. The circular economy has almost completely replaced the linear economy.

Industrial processes maximise symbiosis (heat, water, materials, residual flows) with other processes in the neighbourhood and with other sectors in the economy (e.g. buildings (heat), agriculture, energy, etc.). The incineration with only energy valorisation of non-biological materials or waste no longer takes place and for bio-based waste products, added value is first sought in industrial processes before they are incinerated.

4.3.2. Transition to 2050

Innovation in new industrial processes will take time and needs to be demonstrated first. As it concerns a variety of processes, using renewable energy, circular feedstock, biomass and CCU, a broad programme is needed in which new industrial processes can be tested on a large scale and prepared to be applied. This innovation will also be driven by regulation, whereby new industrial process installations must be climate-neutral as from 2030. Older installations will need to be refurbished, and thus integrate low-GHG-emitting technologies. By 2040, only a few older plants and processes in the process of being phased out could still be in operation in parallel with new technologies. Operational costs of new processes need to continue to decrease.

The basic infrastructure to connect new processes (renewable electricity, H_2, CO_2, ...) will need to be ready at the level of the large industrial clusters (e.g. Antwerp, Ghent, Tessenderlo, Feluy but also linked to neighbouring countries e.g. Rotterdam, Northrein Westfalen and Dunkirk) by 2030. By 2040, the energy infrastructure for the industrial transition will need to be completed both in Belgium and the EU level. The indirect emissions will be reduced to almost zero through high levels of renewable electricity driving industrial processes.

Companies are also increasingly working together, both in the industrial clusters and in the value chain. At the level of the industrial clusters, successful symbiosis between several companies and other sectors will have to be proven on a large scale by 2030. This must include large-scale smart demand response and energy storage by industry.

Cooperation in the value chain between companies, and between companies and consumers, aims to realise the circular economy. The techniques and technologies to keep most material flows circular and of high quality will need to be in place by 2030 and already be in application among some important value chains. The supply chain for plastic waste to be used as feedstock for chemical recycling and for mechanical recycling would achieve sustainable volumes. By 2040, circular value chains will need to be operating on a large scale, with only a few residues that are difficult to recycle and still are being incinerated.

INNOVATION

- Develop Industrial Innovation-Moonshots with clear and ambitious Key Performance Indicators (KPIs) (e.g. full plastics circularity).
- Strengthen cooperation between academic institutions to support industrial transition.
- Aim for 10-20 low-CO_2 industrial demonstration projects by 2030 and secure financing through EU ETS innovation fund assisted by new Belgian/Regional investment funds.
- Large industrial clusters have to develop a climate neutral transition plan by 2021 (taking into account value chains and sector coupling with energy transition).
- Develop before 2025 an industrial infrastructure plan (e.g. H_2, CO_2 transport, reinforced electricity systems) that enable the industrial transition infrastructure plan and start implementation asap thereafter.
- Maximise the use of EU funds for industrial innovation and infrastructure through above mentioned transition and infrastructure plans.
- Support R&D and development of circular business models.
- Streamline and integrate the energy transition with the industrial transition, taking into account likely additional electricity demand from industrial sectors.

REGULATION

- Gradually introduce ambitious legislation on circular material use and materials efficiency. 40% of semi-finished and finished goods produced (and consumed) in Belgium must consist of circular raw materials/materials by 2030 (up to 75% by 2040 - 2050). Introduce material efficiency targets for producers of semi-finished/finished products.
- Start ASAP with deposit schemes for plastic bottles and aluminium/steel cans.
- Include in Extended Producer Responsibility regulations the requirement on extending the lifespan of products.
- Create a market for low-CO_2, materials efficient and circular solution through green public procurement at all levels of government. Assist local authorities in developing solid criteria and (life cycle) assessments.
- Prohibit the incineration of non-biological and non-hazardous waste by 2030.
- Large new investments must include a 2050 consistency test in their environmental permit. Conditions can be set by permitting authorities to ensure these installations are forward compatible with climate neutrality (e.g. at time of first major refurbishment).
- Set up Low Regulatory zones for innovative low-CO_2 projects in industry.
- Ensure that options for industrial symbiosis are used through environmental permit conditions.

FINANCE AND FISCAL

- Gradually shift tax and regulatory burdens away from electricity to fossil fuels (e.g. excise duties). The costs of electricity for large consumers will be kept under control, while fossil input will slowly be taxed more heavily.
- Reform corporate taxation to facilitate investments in low-CO_2 processes: e.g. reduction in notional interest in favour of higher (green) investment aid/deduction. Allow new (green) investments to be depreciated faster.
- Introduce a small consumption tax on final products (+1%) to finance innovative climate friendly industrial processes (e.g. 50% better than EU ETS benchmark) that have a higher operational cost compared to incumbent production processes.
- Set up a new investment fund/bank for industrial investments in low-CO_2 production/circular use of materials and energy and materials efficiency. This can include the use Special Purpose Vehicles (SPVs) that secure off balance sheet financing of sustainable investments (e.g. with Internal Rate of Return < 15%).
- Give disincentive to products that are difficult to recycle through higher or additional taxation.
- Use EU ETS auctioning revenues more strategically and aligned with major climate/energy innovation and investment challenges.
- Reduce the VAT and labour taxes on the reparation of products.

4.4. Agriculture, food and forestry

4.4.1. Agriculture, forestry and food in 2050

By 2050, natural and semi-natural forests will have been effectively protected. Other forests will be managed sustainably, thanks to a balance struck between growth and harvest and thus a permanent or growing carbon stock in biomass and soil. Deforestation will have been avoided and where it is unavoidable, it would be compensated with new forest elsewhere.

The Flemish forest area will have increased by 30% or 50,000 ha, which will have been accompanied by a loss of 7% of the agricultural area, mainly as a buffer in the peri-urban zone, on erosion-sensitive slopes or in zones with fertilization limitations or as a buffer to protected nature areas. Large-scale forest and peatland restoration projects will have become an important net sink of carbon.

The cascade use of sustainably produced wood as a renewable raw material will have formed the basis of a circular bioeconomy, and replaced energy-intensive materials. In the circular economy-based construction sector, the sustainable use of wood components will have acquired an important share. Lignin and cellulose-based biorefinery from crop residues, thinning products and waste streams from the agricultural and forestry sector will also be in use extensively in the chemicals industry replacing fossil fuel-based feedstock.

In 2050, GHG emissions from agriculture and livestock farming will be in balance with GHG sequestration. Carbon sequestration in soils will have significantly increased as a result of improved agricultural practices, such as organic farming, precision farming, use of green manuring (i.e. by leaving uprooted or sown crop parts to wither on a field so that they serve as a mulch and soil amendment) and compost, (possibly) reduced tillage and reduced use of external inputs (such as fertilisers, pesticides and herbicides), and possibly other carbon dioxide removal (CDR) technologies such as biochar (bio-based charcoal) and enhanced weathering . Greenhouse horticulture would no longer be using fossil fuels, but relying entirely on green electricity or other sustainable alternatives. Through a combination of less animal husbandry, genetic progress, better manure treatment, more sustainable feeding with grazing, emissions from livestock farming will have been significantly reduced.

Indirect GHG emissions from agriculture and land use, i.e. emissions that are not taken into account in the sector's mitigation efforts, will have also decreased significantly. The share of animal proteins in the consumer's diet would have fallen in favour of vegetable-based proteins. Better coordination between producers and consumers using digital platforms will have enabled the reduction of food losses. The use of packaging and transport in food production also have been significantly reduced.

Adaptation management will have transformed forests into more biodiverse and resilient ecosystems, better adapted to stressors such as droughts, storms, floods, diseases and pests. Farm practices such as increased crop rotation, mixed farming, and increasing soil organic matter will have led to more resilient farming systems that are better adapted to climate change and less reliant on disaster funds or insurance products.

4.4.2. Transition to 2050

In 2030, the first 10,000 ha (+6%) of forest expansion in Flanders will need to have been realised, and a second more ambitious phase of 50,000 ha (+31%) of forest expansion will then need to be initiated. The forest conservation and peat restoration programmes would have to be further developed. Expertise in the field of ecosystems and climate can then become an export product for Belgian consultancy companies. New industrial processes of wood-based biorefinery will need to have been tested on a large scale and in several places in Belgium, and be ready for wide application. The market share of timber construction (timber frame construction, Cross Laminated Timber,...) will need to increase from 7.5 to 25% by 2030 and to more than 50% by 2050. The overall self-sufficiency in wood products of Belgium has increased from 50 to 75%, thanks to improved recycling and cascading. Belgium and its regions should by then be making a substantial contribution to avoiding deforestation and forest restoration worldwide by investing a significant budget in REDD+ and land-use related climate mitigation and adaptation projects in developing countries.

Organic agriculture, precision agriculture, less intensive tillage and the increased use of organic fertilizers will have contributed to a significant increase in the organic matter content and consequently the soil's carbon.

In the greenhouse horticultural sector, all companies will need to have fully switched to alternatives to petroleum by 2030. A new investment wave towards 2050 will be needed to phase out the use of gas and combined heat and power (CHP) in favour of renewable energy sources. This would be supported by innovations in cultivation techniques, energy generation in greenhouses and the use of CO_2 on the one hand and area-specific cooperation and clustering on the other.

In the livestock sector, better farm management in general and better feed management in particular should reduce enteric emissions from cattle in the first phase until 2030. These emissions will need to be further reduced towards 2050 as a result of genetic selection of animals. Manure processing will need to be even more efficient. By 2050, livestock should also be significantly reduced because the consumer's diet should have become more sustainable and healthy as a result of the shift from animal to vegetable protein, an increase in the consumption of fruit and vegetables and a decrease in the consumption of energy-efficient but nutritionally-poor products. Livestock farming would need to import less soya and be based more on protein crops grown in Europe.

Food that is not consumed by humans can be used for other purposes. It is preferred however that excess food is not produced at all. Better coordination between producers and consumers can, on the one hand, ensure that less waste occurs and, on the other hand, that food with cosmetic deviations is still consumed. Packaging would need to be better balanced in terms of healthy and environmentally friendly portions. These efficiency gains will have to be realised through consumers that will be able to share more information with the supply chain via digital platforms that should by then be in place. Packaging is important to prevent food losses (primary packaging), but there also exists a lot of secondary packaging that mainly offers logistical advantages. Primary packaging will need to become considerably more sustainable (e.g. larger packaging and reusable packaging material), while secondary packaging should be reduced. Transportation must become more efficient by abandoning the just-in-time dogma. To this end, a network of food hubs will need to be built in order to provide our cities better and more environmentally efficient supplies and to support shorter supply chains.

With regard to adaptation, all nature management plans (including forest management plans) and water management plans, will need to be subject to a climate-change-robustness check. Management plans who fail to meet this check should no longer have access to government funding.

Farmers who can present climate-resilient measures and results should be entitled to priority support from disaster funds and/or cheaper financial products (loans, insurances). Research leading to improved, biodiversity-friendly farming practices with a massive reduction in the use of biocides (including herbicides, insecticides, fungicides and other biocides) must be supported.

MITIGATION

- Strengthen the deforestation legislation, whereby in Flanders 12,000 ha of valuable ancient forests are definitively protected, with accompanying financial measures.
- Subject the obligatory reporting of the forest balance to Europe under the LULUCF legislation to a methodological check. Deforestation for nature conservation purposes is also included in the forest balance and is fully compensated by forest expansion outside nature reserves.
- Prioritise the 10,000 ha of forest expansion from the mandatory part of the Flanders Spatial Structure Plan by removing legal and political barriers.
- Ban products for which recent deforestation has taken place. All projects financially supported by the Belgian development cooperation will be linked to a 'zero deforestation' guarantee. Belgian development cooperation is focusing more on projects of forest conservation, peat and forest restoration. Flanders is devoting a larger part of its international cooperation to projects of forest conservation and restoration, and is increasing the hollowed-out budget of the existing tropical forest fund tenfold.
- Use the eco-schemes in the new Common Agricultural Policy (CAP) to stimulate carbon sequestration in the soil and to be better equipped against drought and flooding as consequences of climate change.
- Use as a priority for the use of climate-friendly techniques in all sub-sectors of agriculture, the Investment subsidies within the framework of the Rural Development Programmes of the CAP.
- Continue or extend agri-environmental measures within the CAP to support biodiversity and less intensive land use.
- Make available additional research budgets for innovative GHG-reducing techniques in cattle breeding and greenhouse horticulture, for land-based agriculture with a minimum of biocides, for agricultural techniques that increase soil carbon, for local production of proteins and for new value chains based on meat substitutes.
- Develop a livestock buy-out scheme which will be financed by a transition fund.
- Strengthen the legislative framework for the replacement of chemical fertilisers by organic fertilisers.
- Practices and legislation that promote food wastage shall be adapted to avoid this type of wastage..
- Introduce a covenant for the retail and the food industry to actively contribute to the promotion of climate-friendly products.

ADAPTATION

- Introduce a mandatory 'climate-change-robustness' check for forest and nature management in order to optimise the use of forests and nature for climate mitigation and adaptation.
- More research efforts and economic instruments to make agriculture more sustainable and climate resilient.
- Intervention of the Agricultural and Forestry Disaster Fund to be made conditional on minimum mixing, crop rotation and systemic stability conditions.

4.5. Electricity System

4.5.1. The Electricity system in 2050

In 2050, the Belgian electricity system will be highly integrated into the European electricity system and will be GHG emission-free. At times, it will even contribute to carbon dioxide removal (CDR), achieved through a combination of technologies that may involve biomass, synthetic gas combined with Carbon Capture and Usage and/or Storage (CCU/CCS). Electricity will come from renewable and sustainable power sources, originating from both domestic and international sources.

Domestically generated renewable electricity will often be co-owned by citizens, for example via energy communities. Internationally sourced renewable electricity will be developed through cooperation at the European level (e.g. offshore wind).

In 2050 other sectors such as mobility, industry and the built environment will strongly rely on the electricity sector to meet their energy demand. This increased electrification is accompanied by ambitious energy efficiency improvements across all sectors to manage the total electricity demand.

To ensure the security of electricity supply, a range of technologies and systems will complement the weather-dependent renewable sources. First, our electricity system will be strongly interconnected with neighboring systems both physically and via efficient power markets. The electricity system will also be integrated with other energy vectors, like heating & cooling and gas systems, especially on the local level. The integration of electric mobility with the power system will be an important element of the electricity system in 2050 with the large fleet of electric vehicles acting and being managed as a key electricity storage and grid management instrument. Other solutions further facilitate the integration of renewable energy, like gas-fired power plants fuelled by synthetic gas, decentralized and large-scale storage, and different types of demand response. Seasonal and periodic surpluses of renewable electricity production can, if economically viable, be used to turn power into heat, hydrogen or other energy carriers, which can be stored more easily.

4.5.2. The transition to 2050

The exact makeup of Belgium's electricity system in 2050 is currently unclear but that is not a problem. It is important to remain open to innovations as they occur over the coming decades. Nevertheless, as some of the main tenets can be identified, it is crucial that policies are put in place to guide the transition of the electricity system along those lines. Important instruments to address the transition are located at the European level. Belgium's active cooperation in enhancing these tools and swiftly implementing them is of crucial importance.

The main tool to address emissions in the electricity sector is the EU Emissions Trading System (EU ETS). Until 2030, EU ETS targets and rules have been set. Still, Belgium should help ensure that these targets are stringent enough to support the goals of the Paris agreement. Moving beyond 2030, Belgium should help make sure that the EU ETS delivers, among other things, an emission-free electricity sector by 2050 at the latest.

Preparing electricity markets and infrastructure for the large-scale integration of renewables is also a task with an important European character. Security of supply, cost-effectiveness and inclusiveness are best guaranteed through an approach coordinated at the European level. In this regard, it is vital that Belgium swiftly implement the EU's recent Clean Energy for All package, which contains a range of guidelines and directives that prepare electricity markets and regulations for the transition, for example by setting out a framework for local energy communities. Furthermore, given its limited domestic potential for renewable electricity, Belgium should make full use of European cooperation mechanisms for increasing its renewable share, like the Union Renewable Development Platform or the statistical transfers.

Domestically, Belgium should maximise the deployment of renewable electricity, in particular onshore and offshore wind (but also solar and deep geothermal). By 2030, the on- and offshore wind and cost-effective solar potential should be fully developed. In general, policy and regulation should provide a transparent and stable framework for the development of all renewable resources. Any obstacles or bottlenecks should be removed. This will include active collaboration between different levels of government to map renewable potentials, streamline permitting procedures and spatial planning, and set up a stable pipeline of new projects. In the short- to medium-term, as technologies mature to competitive price points (by 2025-2030), financial support may need to be given to ensure business cases.

In terms of infrastructure, Belgium will have to enhance its interconnection with neighbouring systems. The electricity system will also increasingly be integrated with other energy vectors. While in 2030 the reliability of the Belgian electricity system will probably still mostly be guaranteed by gas power plants, beyond then, new technologies supported by the increasing digitization of the electricity system, will increasingly take over this role. To prepare for these changes, appropriate technology-neutral market and regulatory frameworks will have to be put in place in the short-term. Additionally, mission-oriented R&D programs should be set up for multi-energy systems, demand response, decentralized storage, hydrogen, etc. Furthermore, several technologies will need to complement renewables in reducing the emissions of the electricity sector. Some of the candidate technologies - power-to-gas/-fuel/-heat technologies (abbreviated as P2X), CCU/CCS, etc. - require concerted research and demonstration programs if they are to play a significant role in the transition. To enable these technologies, large-scale demonstration projects have to be in place by 2030 and substantial commercial infrastructure has to be up and running by 2040, at the latest. These present great opportunities for innovation, which can build on the strengths of existing Belgian companies and institutes.

4.5.3. Actions to consider now

Realizing this transition is an ambitious, but feasible task. It requires a clear vision towards both the 2030 and 2050 milestones, a well-resourced governance structure to oversee its implementation (including through mission-oriented innovation programmes), to coordinate actions in different sectors, and to ensure that Belgian policy is in line with European policy. In the short-term, priorities centre around supporting renewable development and integration.

STIMULATE DEVELOPMENT OF RENEWABLE ENERGY	• Streamline permitting procedures and spatial planning across government levels and set up a project pipeline for new renewable capacity developments. Facilitate, in particular the development of onshore wind energy (e.g. permitting procedures, development closer to airports). • Swiftly implement the local energy communities framework of the Clean Energy for All Package to allow greater engagement of citizens and local communities in the development of renewable energy. • Make use of European cooperation mechanisms to meet renewable targets (statistical transfers, Union Renewable Energy Development Platform and Union Renewable Energy Financing Mechanism) and integrate these mechanisms in future plans for renewable energy development
PREPARE THE ELECTRICITY SYSTEM FOR LARGE-SCALE RENEWABLE INTEGRATION	• Reform grid tariffs such that they reflect societal costs: policy costs in the tariffs should not harm the profitability of climate-friendly solutions (e.g. heat pumps) • Swiftly implement the Clean Energy for All Package as part of the development of a technology-neutral market and regulatory framework for electrical energy and system services • Increase cross-border connection capacity as part of a coordinated effort with neighboring electricity systems to enhance security of supply and cost-effectiveness • Set-up RD&D programs for required system services, technology neutral where possible, technology-specific when needed to stimulate innovation around flexible technologies (multi-energy systems, storage, demand response, etc.), P2X, CCU and CCS
ENHANCE PUBLIC SUPPORT FOR LARGE-SCALE RENEWABLE DEPLOYMENT	• Run a coordinated information campaign on Belgian climate and energy plans and the role of energy efficiency and renewables in helping achieve its goals • Support opportunities for participation, e.g. through energy cooperatives or other forms of public/private partnerships

4.6. Financing the transition and fiscal reform

Many of the sectoral transition pathways include policy instruments that relate to investments and fiscal measures. It is however important to consider these in a broader context such as the impact on the public budget and fiscal burdens on consumers vis-a-vis the opportunity of behaviour change. Finally, investments and fiscal reform must also be forward looking. While short-term benefits from these instruments can be relevant, it is more important to also embed them into a long-term transition strategy.

Investments are the key towards climate neutrality

It is clear that investments will be instrumental in achieving the transition to climate neutrality. They are essential to offer reliable alternatives to personal car use in the context of mobility (e.g. public transport, bicycle infrastructure, charging stations for electric vehicles, …). But also, the building sector will have to see a disruption in both the size and speed of investments towards highly resource efficient and GHG-neutral buildings. The industrial transition will require major investments not only in new processes but also in supporting infrastructure. Finally, increased levels of electrification in all these sectors will require significant investments in additional supply, reinforcements of power grids and interconnections. Furthermore, these investments will have to be a priority as they facilitate the transition of end-users. A large part of the supporting infrastructure will hence need to be in place by 2030.

It is therefore important that a coordinated investment plan is in place as soon as possible. This plan should cover all relevant levels of governance (e.g. communes, cities, industrial clusters, regions, federal level, neighbouring countries and EU). The plan should contain a transparent time-table and a monitoring instrument to follow the status of implementation.

Next to strategic planning there is also the need for additional investment instruments. Other EU Member States have used and are using national promotional banks to finance strategic long-term investments (e.g. KfW in Germany). In Belgium such large-scale investment vehicles are not really present or used in this manner. These vehicles can assist in leveraging private sector investments by removing part of the risk (e.g. through guarantees) and hence lowering the cost of capital. Setting up such climate funds, investment platforms or other instruments will be important for Belgium to facilitate and accelerate investments in e.g. public transport, safe cycling infrastructure and energy efficient housing. Such funds will in particular also be needed to realise government support and redistribution mechanisms for the implementation of energy and building roadmaps, with a focus on socially weak citizens (socially just transition).

Having a national investment strategy for the transition to net-0 emissions together with national investment instruments will also facilitate access to EU funds that will become available for this purpose as from 2020.

Finally, frontloading a high number of public investments might create a significant budgetary imbalance. This is because possible benefits resulting from these investments will occur later while the full public investment will have to be written off the year it happens. It should be a priority of the Belgian government to advocate strategic public accounting at the EU level. In practice, a list of public investments that assist Member States with the transition to climate neutrality should be allowed to be taken off the public sector's balance sheet and be accounted separately using private sector capital depreciation factors.

Use foresight to develop fiscal instruments

The transition towards more climate-friendly technologies and consumption can have an impact on expected fiscal revenues. On the other hand, current fiscal or regulatory costs might work against the transition of key sectors in the economy. Therefore, the use of fiscal instruments should go beyond trying to price in a negative externality (e.g. GHG emissions) but also be considered from a strategic perspective.

For instance, the shift towards electric vehicles will reduce public revenues from taxes on fossil fuels. This effect can become important even within the next decade with the increase of sales of electric vehicles. To not create additional budgetary deficits an additional or new system of fiscal revenues will have to be implemented. This is why road- or kilometer-charging might become a valuable instrument especially if it also optimises traffic due to the differentiation of charges according to time of use and location.

Electrification (in mobility, buildings and industry) will be one of the major pathways to climate neutrality. However, it is certainly not a given. Unfavourable pricing (due to taxation on electricity vis-a-vis fossil fuels) might slow down or even stop this transition in some sectors. Therefore it is recommended to, during the transition, implement a tax shift away from electricity towards higher taxes on the use of fossil fuels.

Review existing fiscal instruments before new taxation tools are introduced

The Belgian fiscal system is complex and contains elements that favour consumption and specifically consumption of fossil fuels . Before additional taxes are considered, adding to the complexity of the system, it is recommended to first audit the existing fiscal regime. Fiscal support for the consumption of fossil fuels (e.g. in the form of lower tariffs) should gradually be phased out, taking into consideration possible social impacts. As mentioned before, this can include a shift towards lower tariffs (e.g. VAT or public service obligation charges for distribution service operators) on electricity use.

Fiscal reform can also be used to accelerate the transition in certain sectors. For instance, limiting the fiscal support for company and salary cars to only electric vehicles will create a lead market for these vehicles in Belgium, with up to 11% of cars out of total car population becoming electric in Belgium by 2030 through this measure alone.

Existing subsidy or financing instruments must be better aligned with the transition to climate neutrality. For instance, the implementation of the Common Agricultural Policy via support for agriculture in Belgium should be used strategically as an instrument to facilitate the transition of this sector. A similar strategic approach will be needed inside the financing of municipalities in Belgium, with higher emphasis on assisting municipalities with the development of climate friendly infrastructure and/or performance based financing related to climate consistent spatial planning. Another example would be the Flemish tax reduction for homeowners ('woonbonus') , could be turned into a tax reduction for making houses climate friendly . It would help to cover the surplus cost of a climate-fit dwelling, or to pay for retrofit measures that would improve the building's energy performance to the desired standard. This tax break should moreover be coupled with a 'location check' (based on building and area roadmaps) and should not be accorded for buildings that have an unsustainable location.

Finally, the EU ETS has generated a huge amount of revenues (up to EUR 1 Bn since 2013). While these revenues are used to support the reduction of GHG emissions (and to compensate energy intensive industries for higher electricity prices), there is a need for better coordination and strategic alignment of these funds. They can become an important source of capital for the strategic investment plans.

Not all climate policies need to lead to extra taxes

While internalising the external cost of GHG emissions (e.g. through a CO_2 tax) is recognised as an important instrument to mitigate these emissions, it might not always be the most appropriate or effective instrument inside a transition regime. Fiscal measures must be seen as part of a broader toolbox of instruments and not a goal in itself.

This report presents other instruments that will likely prove to be essential for a transition to a climate-neutral economy. The use of standards and regulations have proven to be effective in the past (e.g. the EU obligation to switch from incandescent to LED lighting has been one of the more effective energy savings instruments). In this context, regulation will prove to be very important for a timely transition. In particular regulations that prevent the sales of cars with internal combustion engines by 2030 or fossil fuel-based heating systems, will be needed to avoid locking in GHG emissions up to 2050. As part of the transition to higher levels of material efficiency and circularity, the use of deposit schemes (e.g. for bottles and cans) can be highly effective as shown in some countries that have advanced systems. Such systems can organised in a fiscally neutral manner with minimal impact on final consumers. A final example is the strategic use of public procurement. Local, regional and federal authorities can enable the transition in particular in the buildings, industrial and transport sectors by including conditions related to (life-cycle) emissions in public tenders. They can create lead markets for climate friendly products and hence accelerate the transition outside of the public sector.

4.7. Cross-sectoral transition elements

Transitioning to a climate-friendly economy and society requires managing a range of challenges that touch upon several sectors simultaneously. While some of these were explored in the previous sections, it is relevant to highlight some of the most important cross-sectoral elements to be considered in future policy making.

Electrification

It is very likely that the transition to a 2050 net-0 emissions society will see high levels of electrification in different parts of the economy. This includes high levels of electrification in mobility, buildings (heating and cooling) and industrial production. Therefore, a transition plan or strategy will have to include a high level of sector coupling between the energy sector and the rest of the economy. This integrated and strategic assessment seems absent from current climate and energy planning, which mostly focuses on the short or medium term. In particular there is need for more elaborate assessments of how higher levels of green electricity can be provided from the supply side and how the transition in other sectors might facilitate the demand side in a new (renewables powered) electricity system. This includes the role of battery powered electric vehicles as electricity storage, industrial power storage and demand response and demand flexibility in energy neutral or energy positive buildings.

Following new European market design rules it is very likely that the Belgian power system will be increasingly integrated into a European electricity system. Hence, advanced sector coupling between electricity production and electrification of large parts of the economy must be seen in this context. It is therefore important that Belgium continues (e.g. within the existing BENELUX initiatives) to proactively pursue the transition together with neighbouring EU Member States in a European context.

Spatial planning

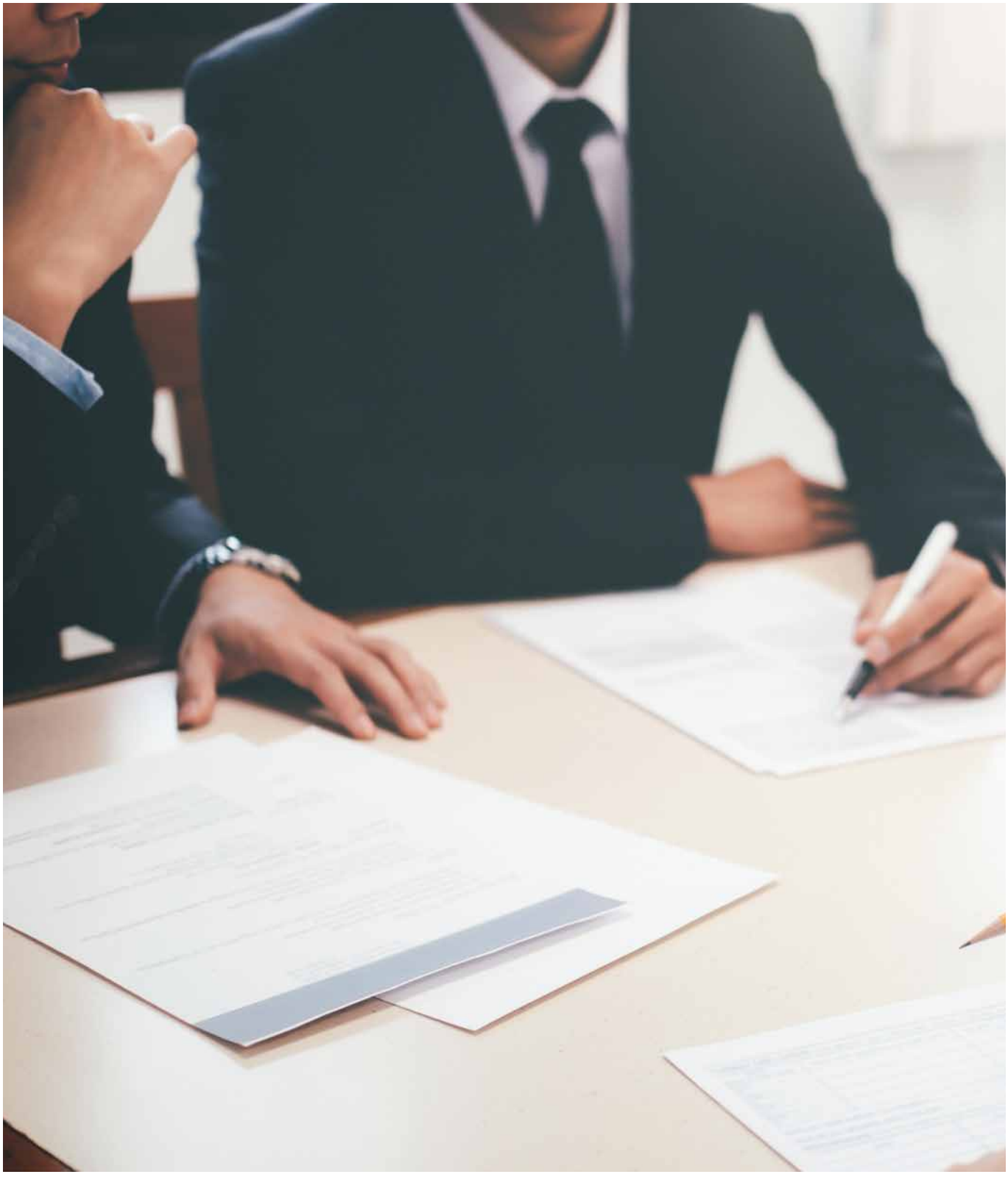
Inefficient (historical and ongoing) spatial planning locks-in higher GHG emissions and hence higher mitigation (and adaptation) costs to society. The impacts can be significant with higher GHG emissions from transport and higher infrastructure costs. Additionally, the more a remaining permeable surface is used to construct buildings and infrastructure, higher will be the risk and costs related to extreme meteorological events (e.g. floodings following heavy downpours and water scarcity during drought periods). Urban and regional planning will hence have to be reorganised by reverting to both a focused urban densification on the one hand and de-densification or phasing out of roads and buildings in sensitive nature areas on the other hand.

Consumption and production

Instead of focussing solely on point source emissions from industrial production or (at the end of the life cycle) emissions from waste incineration, an integrated value chain approach will be required to efficiently address the emissions related to production and consumption. This is one of the reasons why high levels of material efficiency and circular value chains (including new service-based business models) will be critical to achieve deep emission reductions related to basic materials production and consumption.

Mitigation and adaptation

Mitigating GHG emissions will have to be aligned with policies that ensure the adaptation to the effects of climate change in Belgium. Hence, policies and measures, in particular in the areas of forestry, agriculture and spatial planning, should address both elements, creating win-wins.



5. TRANSITION GOVERNANCE

5.1. Introduction

Managing the complexity and interconnectedness of the transition, especially across government levels, while managing interactions with citizens, companies and other stakeholders, and responding to changing political and technological conditions, requires dedicated work and institutions. It is a learning process without a detailed solution from the outset but with a clear mission. The Belgian institutional framework is complex, has responsibilities for climate and energy policy that are scattered across levels and departments, and administrations that are insufficiently resourced to deliver decisive policy efforts.

This chapter seeks to address the overarching governance challenges and actions that can enable such transition. It includes political governance towards a long-term vision and strategy, the strengthening of administrative capabilities and how the academic world can actively contribute through enhanced cooperation.

5.2. Develop long-term and integrated vision and strategy with political commitment and leadership

Belgium lacks a comprehensive and integrated vision for its transition towards a climate-neutral society by 2050. Having such a vision brings a range of benefits. It transparently communicates Belgium's transition ambitions to all stakeholders. It provides clear guidance to public and private investors. It informs research and innovation programs in public, academic and private spheres. It consolidates visions for different sectors (electricity, mobility, etc.), which supports cross-sectoral policy efforts (financing infrastructure, cost sharing, spatial planning, etc.). It helps guarantee the short- and long-term security of supply of the country. Overall, it is a key tool to realize the transition in an effective and efficient way. It is therefore imperative that efforts to formulate this vision start as soon as possible.

The recently submitted draft of the Belgian NECP, which set out Belgium's plans towards 2030, can be a starting point for this vision. However, as mentioned before, the current version of this plan falls short in important ways, including the emission reductions not being in line with the Paris agreement target to limit warming to well below 2 degrees. Much work remains to be done to improve this plan, in particular by extending it with a Paris Agreement consistent strategy to 2050.

Looking at the experience of countries that have set a long-term vision and strategy (e.g. UK, Sweden, Denmark, Spain, …), the starting point will have to be a solid political agreement that outlines long-term goals and the process to bring these about. Given its long-term strategic nature, ideally this agreement is supported not only by the political parties in government but also by a broader coalition. This would ensure a higher chance of regulatory stability with a lower risk of the strategy being dramatically changed later on. Furthermore, it is recommended that the long-term goals and pathways (e.g. under the form of the carbon budget) are therefore enshrined in legislation. This will guide policy makers and stakeholders during the implementation of policy instruments. Finally, a monitoring system should be put in place to track progress towards medium and long term goals. This should be supported through an independent climate expert committee (as is the case in for e.g. the UK and the Walloon Region) which reports on the state of implementation and can offer recommendations to improve the policy framework.

Within the Belgian context - with mixed competences on climate and energy between the regions (with major weight on climate and energy policies) and the federal level - the above mentioned approach is less straightforward. One approach would be to focus on coordination via the federal government as has recently been proposed by a group of Belgian legal scholars . This process will likely be easier if all Belgian regions first set a long-term goal and pathways in their respective decrees or ordonnances - which the Walloon region has already done.

Due to the mixed responsibilities between the federal and regional levels in Belgium, it is highly recommended that future government agreements are coordinated upfront to synchronise and coordinate policy instruments (e.g. road or kilometer charging) and to avoid one level of government putting forward instruments that might impede the successful implementation of policies at another level.

Both the upfront coordination and the legal basis for regional transition pathways should facilitate the necessary coordination between the different levels of government in Belgium e.g. through a federal climate law that includes enhanced coordination instruments.

While high-level instruments that fix long-term targets and pathways are essential, they are most definitely not sufficient to secure the implementation of the same. The sectoral and cross-sectoral approaches as presented earlier in this document will require implementation and preferably with support of the stakeholders involved.

Support and acceptance can be achieved if the decision-making process is transparent and the benefits and costs are shared fairly. The fair distribution of costs and benefits must be interpreted in a broad sense: not only financially, but also spatially and socially for example. There are good instances of developing long-term sectoral strategies and implementing instruments with broad public support of all societal stakeholders. Consider, for example, Ireland's "Citizen's Assembly", Iceland's "Crowdsourced Constitution" or the Netherlands' "Klimaattafels". In this context it is important to also stress the need for support for cities and local authorities that have the goal or are developing plans to achieve net-0 emissions.

Furthermore, it is important to periodically revisit the specifics of the sectoral and cross-sectoral approaches to update ambitions and targets based on political, social, technological and other evolutions.

In practice, following the example of the recent Dutch approach, it is essential that once higher level political goals are set (and legally enshrined), a stakeholder process starts on actual implementation. This cannot be an open-ended process. It must have a solid deadline, defined expected goals or ambition levels and be supported by expert leadership to guide the process. Finally, such a process requires determined and able administrations to support the process (e.g. with quantitative analyses) and for the implementation of the outcomes afterwards.

5.3. Determined and strengthened administrations

To implement the long-term strategies and instruments effectively and efficiently in close collaboration with citizens and companies, government administrations need adequate institutional and financial resources. They need to be able to assist in the development and maintenance of the country's 2050 vision and its translation to policy frameworks and measures. Crucially, they need the ability to coordinate and effect policies across government levels, institutions and stakeholders.

Currently, Belgian national and regional administrations often lack the resources and recognition to do this. For example, they are presently unable to develop and maintain the in-house knowledge required to manage the transition, making them dependent on third parties. Public institutions with analytical and modelling capacity on climate and energy policies such as the Dutch 'Planbureau voor de Leefomgeving (PBL)' or the UK Climate Change Committee are missing in Belgium. These and other shortcomings need to be addressed as soon as possible.

Varied institutional configurations can be devised to do this. They may require, among other things, dedicated climate- and energy departments in the national and regional administrations, as have been created in other European Member States.

Whatever institutional structure is eventually advanced, the following should be considered during its configuration. The cost of setting up the administrative capabilities for developing and implementing transition policy is negligible compared to the investments that have to be made. Strong knowledge and tools lead to better and more cost-effective policies. Focus areas include data collection, the development of partial and general equilibrium models, and so on. A highly capable administration allows governments to respond quickly to changing conditions (e.g. economically or technologically). One or more policy bodies could also oversee several mission-oriented innovation programs that enable the climate and energy transitions. Current research programmes, like that on the energy transition, sometimes lack the strategic vision that is required to maximize the likelihood that innovations come up with the solutions needed to realize the transition. Programs need a clear mission and clearly defined outcomes. Input on research and innovation priorities would be provided by the independent center of expertise (see below).

5.4. An independent academic center of expertise

Academia can engage itself more and in a more coordinated way to support the transition to climate neutrality in Belgium. This is possible through the establishment of an inter-academic independent National Climate Centre. It would provide its unbiased services to the authorities, institutions and citizens concerned. In the long run, it represents an investment that will lead to substantial cost and time savings because, in addition to providing new services, it will also try to streamline a number of existing initiatives and prevent the fragmentation of knowledge. It would hence act as an interface between the various policy levels, scientific institutions and citizens. In countries such as the UK, Germany and the Netherlands, there are already several examples of such independent national climate centres . The complex Belgian state structure in particular means that a strong mechanism must be put in place to achieve optimal cooperation between different policy levels in order to be able to implement a widely supported, efficient and effective climate policy.

The National Climate Centre would ensure the provision of up-to-date, scientifically substantiated information on the climate issue in all its facets (social, technical, climate science, etc.) and the streamlining of the many existing initiatives that often lack coherence because they start from different underlying objectives which causes confusion among the public. It can set up initiatives when necessary to assist with the implementation of measures to promote the transition, to streamline research into sound climate communication and education, and develop a national online platform where all relevant climate information comes together. The National Climate Centre would act as a one-stop shop where policy makers, municipalities and citizens, can obtain independent, factual knowledge, calculation rules, assumptions and clarity about legislation without having to go to separate institutes.

Finally, it is important to stress that this centre seeks to maximise the knowledge and know-how present in existing academic institutions in Belgium and not become a separate academic institution. In practice, this implies that it will be a platform that funnels and streamlines the expertise by researchers present in Belgium. In order to provide objective information to local authorities and citizens, but also to public media and schools, this centre will need some kind of permanent structure.

6. CONCLUSIONS

A net-zero greenhouse gas emissions Belgium in 2050 will be both very different but also very similar compared to today. There will be important changes to the transport and logistics systems with mobility as a service having replaced the private car ownership focussed society of today. Cars, vans and busses will all be powered by electricity. Forward looking spatial planning will have made room for more nature, forests and enhanced biodiversity and a country that is better prepared to deal with the impacts of climate change. Almost all buildings will have become zero-emission due to major energy savings renovations and electrification of heating and cooling. New industrial production technologies together with high levels of materials efficiency (from production to final consumption) and high circular use of materials will have almost eliminated all GHG emissions in these sectors, with the remainder to be used in products or stored. Agriculture will have become more productive (when considering the full value chain) and through smart agricultural techniques, soils will have been restored to contain higher levels of minerals and carbon. Dietary changes and new plant based proteins will have lead to an important reduction in the consumption of meat and new farming techniques would further reduce emissions from livestock. Finally, the power sector will be a crucial driving force behind the society in 2050. Not only will many sectors have seen a switch from fossil fuels to electricity, these sectors will also play an important role in demand side management and storage of electricity. Almost all of the electricity will be produced by renewable energy sources. This electricity will be sourced locally but also through a better interconnected and managed EU-wide electricity system and market.

On the other hand the above-mentioned changes are not radical, in the sense that they will allow the maintenance of welfare and human well-being. Important co-benefits can even secure higher quality of living through for instance lower air pollution and congestion.

Realising net-zero greenhouse gas emissions by 2050 in Belgium is possible. While most of the technologies needed to realise this goal are known in principle, further research, development and especially demonstrations will be needed to ensure timely diffusion and scale-up . Many elements in the proposed pathways are however not technology-dependent (but will often be facilitated by technologies), but depend on the timely deployment of legislation, investments and a conducive fiscal regime.

Realising net-zero greenhouse gas emissions over a period of 30 years will not be easy. For Belgium to succeed, a coordinated long-term goal and strategy will first need to be developed and agreed. It will need to be guided by a robust governance mechanism including the support of well equipped administrations and the Belgian research community. A transition of this scale will be impossible without thorough and continued stakeholder support, hence the implementation of a long-term strategy will require a process that includes broad inputs by all relevant actors in society.

It is clear that the current Belgian approaches towards meeting 2020 and 2030 targets set at the EU level are insufficient, in particular within the context of moving to net-zero greenhouse gas emissions by 2050. This report had the goal to introduce the concept of transition policies. By using (limited) foresight towards a 2050 net-zero greenhouse gas society it is possible to better shape the instruments that will have to be deployed today such as the use of regulation, research and development priorities or financing of investments and fiscal reform. This approach can assist policy makers and stakeholders to better understand the process and key steps and fully leverage Belgian expertise and entrepreneurship towards a net-zero greenhouse gas emissions Belgium.






7. ACTIONS TO BE CONSIDERED NOW

MOBILITY AND LOGISTICS

Regulatory (incl. governance)

- Further and fully align spatial planning with mobility and freight transport: densification, multifunctional development and deployment of the development of regional logistics hubs in order to facilitate the bundling of transport (densification and interweaving).
- Coordinate policy vision and instruments between the federal level and the regions with the goal to maximise synergies and streamlining (or merging) of policy instruments where needed. Enhance the monitoring of transport related CO_2 emissions and align federal and regional data.
- Introduce legislation that prohibits the sales and registration of internal combustion engine vans as from 2025 and cars as from 2030.
- Facilitate the installation of fast charging points for electric vehicles. Set goal for full national coverage for EV charging by 2030 at the latest and set interim targets. Support cities, communes and companies with public parking spaces in the roll out of these facilities.
- Fully electrify public bus transport by 2025 by putting it as a requirement in the governance agreements between regional governments and public bus services (Lijn, TEC, MIVB/STIB).
- Ensure pricing and ticket integration with the different transport operators and combination with subsystems. Ensuring inclusiveness.
- Advocate synthetic (or sustainable bio) fuel standards for aviation at EU environment and transport Councils.
- Buses on bus lanes should be given priority by means of an intelligent traffic lights system.
- Introduce low-emission zones for shipping in all major ports.
- Develop eco-labels for logistics.

Fiscal and financing

- Increase the registration tax (BIV) significantly (cf. Norway) with exemption for electric cars. Alternatively VAT can be used to create differentiation in costs between EV and internal combustion engines. On the other hand, premiums are given for the purchase of electric cars. These must be considerably higher than the current system but also inversely proportional to the value of the car (i.e. higher support for smaller vehicles). As soon as electric vehicles reach cost parity with internal combustion vehicles these premiums will be scrapped. This can already be the case as from 2025.
- From 2020, tax support for company cars and payroll cars should only be provided if they are electric, together with the abolition of the fuel card. In this way, between 2025-2030 the entire company car fleet, i.e. 11% of the total Belgian fleet, will become electric. Companies must also provide charging infrastructure for their employees. Between 2025-2030, the tax benefit for company cars should be phased out completely. Prepare a tax shift by 2025 to make it possible to reduce the tax on labour and thus compensate the loss of income by means of wages.
- Smart road pricing (based on location, time, type of vehicle) should be introduced by 2025 in order to internalise the external costs of transport. This is also important because the growing number of BEVs will reduce tax revenues from diesel/petrol. Strong differentiation in price for the urban environment (e.g. city tolls/congestion charging) and in the environmental friendliness of the car. Mileage charging starts with a low fee but gradually increases over time. This system should replace the existing road tax for cars.
- Abolish professional diesel deduction: this will lead to a reduction in diesel fuel sold of 7% to 18% (based on fuel consumption 2016) and similar reduction of CO_2 emissions. A joint reduction of up to 14% of vehicle kilometres of heavy and light freight transport would be possible. Moreover, this measure leads to state revenues and also makes the playing field for alternative fuels more fair (in 2018 it amounted to 451 million euros).

	• Develop ambitious investments plans for public transport by end of 2020 at the latest with the goal to deliver state of the art: adequate, safe and punctual services by 2025. Use national/regional investment bank, green bonds to finance these investments. • Increase the investment in safe bicycle networks and support bicycle friendly communes and cities. The Belgian and regional governments should ask the European Commission to be more flexible with regard to public sector accounting to allow these investments to be written off over longer time period and hence not overburden the budget. • Support the greening of the inland shipping sector. • Lower VAT for car-sharing services and offer higher subsidies and additional free parking places for car-sharing services that move towards electric vehicles. • Create a level playing field between intra-EU rail and short-haul flights in coordination with neighbouring member states by aligning (higher) VAT, kerosine taxation or other tariffs and by coordinated investments in efficient long distance railway connections.
Innovation	• Invest in R&D to facilitate integration of transport electrification in the electricity system (sector coupling) e.g. bi-directional charging. • Use advanced information technology capabilities to practically enable Mobility as a Service as an alternative to car ownership i.e. the easy combination of different transport modes in one package. e.g. Pricing and ticket integration at the transport operators and combination with mobility sharing services. • Invest in information technology to enable better data on goods (e.g. tracking) with the goal to make optimal use of inland shipping and rail without losing efficiency. • Focus on behavioural change by means of user profiles, nudging techniques and support for campaigns that lowers barriers of adopting the new mobile concepts.

BUILDINGS, THE BUILT ENVIRONMENT AND URBAN AND REGIONAL PLANNING

Buildings	• Ban all fossil fuel based heating systems in new build and for major renovations from 2020 on. • Discourage wood burning from 2020 on. In a principle biomass should only contribute in a minor way to building heating. • By 2025 all buildings should have a building road map, made out of an extended building pass ('uitgebreide woningpas'). This road map indicates how by 2050 the building can evolve towards a climate neutral status by renovation, adaptations and additions (like a renewable energy system). The Mobiscore (mobility access score), currently being developed by the Flemish government, is included. For every building that changes ownership, the new owner shall perform a set of essential and no-regret energy retrofit measures as indicated in the building roadmap, within 5 years of the acquisition of the building. If a building cannot meet the standards of 2050 in due time, demolition and constructing a new building will be obliged by 2050; where appropriate this will include an urban densification operation or the relocation to a more suitable urban area.

	• Initiate a Marshall Plan for public buildings and social housing as of 2020. Based on a 10 year planning these buildings will undergo a profound energetic renovation or be replaced by new buildings meeting the European net zero energy building (NZEB) regulations from 2020 on. • Taking into account the needed transition effort, the necessary skills in the building sector will be significantly enhanced by government incentives, e.g. in education and in job creation, in order to speed up the high quality renovation rate of the building stock. • The tax reduction for homeowners ('woonbonus' in Flanders, 'abattement des droits d'enregistrement' in Wallonia) should be converted into an area-sensitive tax reduction for climate friendly renovations serving the double goal of decarbonisation of the building stock and spatial reorganisation. • Establish revolving funds and/or climate funds to assist with 3rd party financing of energy renovations in buildings and renewable energy production. • Develop and encourage business models of integrated home renovation services (one-stop-shop renovation offers) are pilot tested and scaled-up by public and private entities to smoothen renovation journeys for citizens. • Launch a large communication campaign explaining the roadmap for the transition towards climate neutrality. This will support investment and legal security for all stakeholders. This will also stimulate economic development and scientific research focussing on the decarbonisation of the building stock.
Urban and regional planning	• By 2025, develop and enhance all the municipal heating plans or 'gemeentelijke warmtezoneringsplannen', aka area road maps. These plans define which areas are to be all electric (or equivalent) and which areas are to be progressively connected to sustainable heat networks. In the latter situation, people who do not want to connect to a heating network need to prove they will a implement a more sustainable and cost effective alternative. • By 2025, operationalise a system of tradable development rights ('verhandelbare ontwikkelingsrechten', in order to reorganise the spatial system towards increased sustainability. These allowances enable building owners to relocate their development rights to appropriate urban areas when the building rights are taken away in a certain area. • The greenfield development moratorium ('betonstop ') is to be installed in Flanders and Wallonia, adopting an accelerated timeline. A progressive and stringent pathway is created from 2020 on and in 2025 the occupation of new open areas in Belgium is to be stopped. By high exception open areas adjacent to urban areas can be used for construction purposes. This can only be done if this is more sustainable than densification of existing areas. Performance based criteria will be added to the regional financing instruments of local authorities to ensure these goals are implemented.

INDUSTRY AND MATERIALS

Innovation

- Develop Industrial Innovation-Moonshots with clear and ambitious Key Performance Indicators (KPIs) (e.g. full plastics circularity).
- Strengthen cooperation between academic institutions to support industrial transition.
- Aim for 10-20 low-CO_2 industrial demonstration projects by 2030 and secure financing through EU ETS innovation fund assisted by new Belgian/Regional investment funds.
- Large industrial clusters have to develop a climate neutral transition plan by 2021 (taking into account value chains and sector coupling with energy transition).
- Develop before 2025 an industrial infrastructure plan (e.g. H_2, CO_2 transport, reinforced electricity systems) that enable the industrial transition infrastructure plan and start implementation asap thereafter.
- Maximise the use of EU funds for industrial innovation and infrastructure through above mentioned transition and infrastructure plans.
- Support R&D and development of circular business models.
- Streamline and integrate the energy transition with the industrial transition, taking into account likely additional electricity demand from industrial sectors.

Regulation

- Gradually introduce ambitious legislation on circular material use and materials efficiency. 40% of semi-finished and finished goods produced (and consumed) in Belgium must consist of circular raw materials/ materials by 2030 (up to 75% by 2040 - 2050). Introduce material efficiency targets for producers of semi-finished/finished products.
- Start ASAP with deposit schemes for plastic bottles and aluminium/steel cans.
- Include in Extended Producer Responsibility regulations the requirement on extending the lifespan of products.
- Create a market for low-CO_2, materials efficient and circular solution through green public procurement at all levels of government. Assist local authorities in developing solid criteria and (life cycle) assessments.
- Prohibit the incineration of non-biological and non-hazardous waste by 2030.
- Large new investments must include a 2050 consistency test in their environmental permit. Conditions can be set by permitting authorities to ensure these installations are forward compatible with climate neutrality (e.g. at time of first major refurbishment).
- Set up Low Regulatory zones for innovative low-CO_2 projects in industry.
- Ensure that options for industrial symbiosis are used through environmental permit conditions.

Finance

- Gradually shift tax and regulatory burdens away from electricity to fossil fuels (e.g. excise duties). The costs of electricity for large consumers will be kept under control, while fossil input will slowly be taxed more heavily.
- Reform corporate taxation to facilitate investments in low-CO_2 processes: e.g. reduction in notional interest in favour of higher (green) investment aid/deduction. Allow new (green) investments to be depreciated faster.
- Introduce a small consumption tax on final products (+1%) to finance innovative climate friendly industrial processes (e.g. 50% better than EU ETS benchmark) that have a higher operational cost compared to incumbent production processes.

and Fiscal

- Set up a new investment fund/bank for industrial investments in low-CO_2 production/circular use of materials and energy and materials efficiency. This can include the use Special Purpose Vehicles (SPVs) that secure off balance sheet financing of sustainable investments (e.g. with Internal Rate of Return < 15%).
- Give disincentive to products that are difficult to recycle through higher or additional taxation.
- Use EU ETS auctioning revenues more strategically and aligned with major climate/energy innovation and investment challenges.
- Reduce the VAT and labour taxes on the reparation of products.
- Stimulate longer use of products, e.g. by extending the minimum depreciation periods (accounting) for consumer goods.

AGRICULTURE, FOOD AND FORESTRY

Mitigation

- Strengthen the deforestation legislation, whereby in Flanders 12,000 ha of valuable ancient forests are definitively protected, with accompanying financial measures.
- Subject the obligatory reporting of the forest balance to Europe under the LULUCF legislation to a methodological check. Deforestation for nature conservation purposes is also included in the forest balance and is fully compensated by forest expansion outside nature reserves.
- Prioritise the 10,000 ha of forest expansion from the mandatory part of the Flanders Spatial Structure Plan by removing legal and political barriers.
- Ban products for which recent deforestation has taken place. All projects financially supported by the Belgian development cooperation will be linked to a 'zero deforestation' guarantee. Belgian development cooperation is focusing more on projects of forest conservation, peat and forest restoration. Flanders is devoting a larger part of its international cooperation to projects of forest conservation and restoration, and is increasing the hollowed-out budget of the existing tropical forest fund tenfold.
- Use the eco-schemes in the new Common Agricultural Policy (CAP) to stimulate carbon sequestration in the soil and to be better equipped against drought and flooding as consequences of climate change.
- Use as a priority for the use of climate-friendly techniques in all sub-sectors of agriculture, the Investment subsidies within the framework of the Rural Development Programmes of the CAP.
- Continue or extend agri-environmental measures within the CAP to support biodiversity and less intensive land use.
- Make available additional research budgets for innovative GHG-reducing techniques in cattle breeding and greenhouse horticulture, for land-based agriculture with a minimum of biocides, for agricultural techniques that increase soil carbon, for local production of proteins and for new value chains based on meat substitutes.
- Develop a livestock buy-out scheme which will be financed by a transition fund.
- Strengthen the legislative framework for the replacement of chemical fertilisers by organic fertilisers.
- Practices and legislation that promote food wastage shall be adapted to avoid this type of wastage..
- Introduce a covenant for the retail and the food industry to actively contribute to the promotion of climate-friendly products.

Adaptation	• Introduce a mandatory 'climate-change-robustness' check for forest and nature management in order to optimise the use of forests and nature for climate mitigation and adaptation. • More research efforts and economic instruments to make agriculture more sustainable and climate resilient. • Intervention of the Agricultural and Forestry Disaster Fund to be made conditional on minimum mixing, crop rotation and systemic stability conditions.

ELECTRICITY SYSTEM

Stimulate development of renewable energy	• Streamline permitting procedures and spatial planning across government levels and set up a project pipeline for new renewable capacity developments. Facilitate, in particular the development of onshore wind energy (e.g. permitting procedures, development closer to airports). • Swiftly implement the local energy communities framework of the Clean Energy for All Package to allow greater engagement of citizens and local communities in the development of renewable energy. • Make use of European cooperation mechanisms to meet renewable targets (statistical transfers, Union Renewable Energy Development Platform and Union Renewable Energy Financing Mechanism) and integrate these mechanisms in future plans for renewable energy development.
Prepare the electricity system for large-scale renewable integration	• Reform grid tariffs such that they reflect societal costs: policy costs in the tariffs should not harm the profitability of climate-friendly solutions (e.g. heat pumps). • Swiftly implement the Clean Energy for All Package as part of the development of a technology-neutral market and regulatory framework for electrical energy and system services. • Increase cross-border connection capacity as part of a coordinated effort with neighboring electricity systems to enhance security of supply and cost-effectiveness. • Set-up RD&D programs for required system services, technology neutral where possible, technology-specific when needed to stimulate innovation around flexible technologies (multi-energy systems, storage, demand response, etc.), P2X, CCU and CCS.
Enhance public support for large-scale renewable deployment	• Run a coordinated information campaign on Belgian climate and energy plans and the role of energy efficiency and renewables in helping achieve its goals. • Support opportunities for participation, e.g. through energy cooperatives or other forms of public/private partnerships.

8. CONTRIBUTORS TO THIS PUBLICATION

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Contributed to the chapter on forestry and agriculture.

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Contributed to the chapter on mobility and logistics.

Karel Van Acker is Professor of Circular Economy at the Faculty of Engineering, Department of Materials Science, and at the Faculty of Economics and Business Administration, Centre for Economics and Sustainable Entrepreneurship (CEDON), KU Leuven. He leads the 'Steunpunt beleidsrelevant onderzoek Circulaire Economie' for the Flemish Government. His research focuses on sustainability assessments of materials and material cycles, ranging from bio-based polymers to critical metals, recycling, sub-economy, and on developing strategies for the realisation of the circular economy. He holds a PhD in materials science from KU Leuven, has worked in industry and at VITO, and has been coordinator of the KU Leuven Materials Research Center for the past 12 years. The relationship of materials to a sustainable society is a common thread throughout his activities. He is also chairman of the sustainability board of the KU Leuven.

Contributed to the chapter on industry and materials.

Han Vandevyvere (contributed to the chapter on built environment and spatial ...)is a senior researcher and project manager at VITO-EnergyVille and associate professor of NTNU (Norwegian University of Science and Technology). He does consultancy and manages projects with a focus on the energy transition of the built environment. These mainly include EU funded smart city projects (FP7, Horizon2020) and assignments by the Flemish government and by Flemish cities, such as the climate action plan for the city of Roeselare (2018). He holds a PhD on sustainable urban development and researched and taught sustainable building techniques and sustainable urban design at the engineering faculty of KU Leuven from 2006 to 2013. He served as the scientific coordinator of the city project Leuven Climate Neutral 2030 (2011-2013).

Contributed to the chapter on built environment and spatial planning.

Arne van Stiphout is program manager for Mee Panyar, a social enterprise that works with rural electricians in Myanmar to increase energy access in the country. He holds an MSc (2012) and PhD (2017) in Energy Engineering from KU Leuven. During his PhD, he studied the role of flexibility in the integration of renewable energy and its impact on the long-term planning of the electricity sector. He went on to study multi-energy systems as a postdoctoral researcher with EnergyVille. Thereafter, he obtained an MSc (2018) in Global Governance & Ethics from University College London. In his research there, he studied the political economy of sustainability transitions. Arne is co-founder of Carbon+Alt+Delete, a non-profit that aims to inform and activate people on climate change, including through the compensation of emissions.

Contributed to the chapter on the electricity system.

Frank Venmans is associate professor in environmental economics at the University of Mons. He is also Visiting Fellow at the London School of Economics since 2013. He has investigated the competitiveness effects and investment incentives of the EU Emission Trading Scheme. Other research domains include social discounting (valuation of damages that occur far in the future) and Integrated Assessment Models (economic modelling of optimal emission pathways). Frank Venmans was elected president of the Expert Committee on Climate Change for the Government of Wallonia (Belgium) in 2017.

General contributions, contribution on transition governance and overall review of report.

Kris Verheyen has an MSc (1997) and PhD (2002) in forest and nature management from KU Leuven. He is a full professor of forest ecology and management at UGent, where he is leading the Forest & Nature Lab and the Department of Environment. His teaching duties include vegetation science, forest ecology, silviculture, and environmental sciences. He is internationally renowned for his research on forest ecology and management. Understanding global change effects on forests and finding ways to mitigate them is an important research line at his lab.

Contributed to the chapter on forestry and agriculture.

Pascal Vermeulen, holds a business management degree. As the managing partner of CLIMACT, Pascal contributes to various projects and co-authors CLIMACT studies including the low carbon strategies for Belgian federal level and the three regions, for the European Commission and its member states and for several industrial sectors. He has contributed to the Global calc project, by reviewing the transport and power sectors. He has also contributed to the study on the macroeconomics implications of the low carbon transition in Belgium, with the Federal Plan Bureau and in the design of a carbon pricing framework for non-ETS sectors in Belgium.

Contributed to the chapter on fiscal transition and transition governance.

Sara Vicca is a lecturer and researcher at the biology department of UAntwerp. Her research mainly focuses on the influence of global change on greenhouse gas emissions and carbon cycling in terrestrial ecosystems. She also investigates nature-based solutions for climate change (carbon dioxide removal). Sara is a highly cited researcher in the cross-field domain. She is also co-founder of scientists4climate, a group of scientists who are committed to disseminating knowledge and information on climate change.

Contributed to the chapter on forestry and agriculture and on transition governance.

Tomas Wyns, holds a masters degree in Physics. He is senior researcher at the Institute for European Studies (IES) - Vrije Universiteit Brussel (VUB). His research focuses on industrial greenhouse gas emissions, abatement technologies and related industrial and innovation policies. He recently co-authored reports on industrial low-carbon pathways and policies for the Flemish Government, Industry sectors and non-governmental organisations. This work has been a contribution to the development of the EU's 2050 long-term strategy to climate neutrality.

Coordinator of report and contributor to the chapter on materials and industry.

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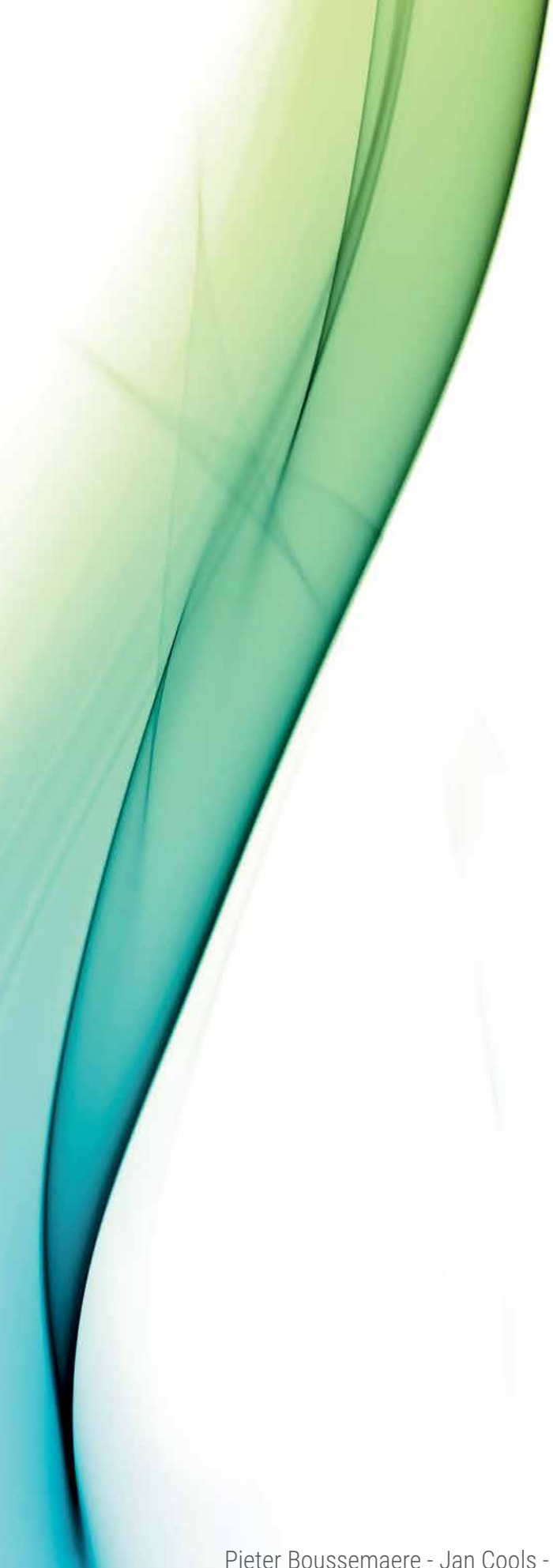

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