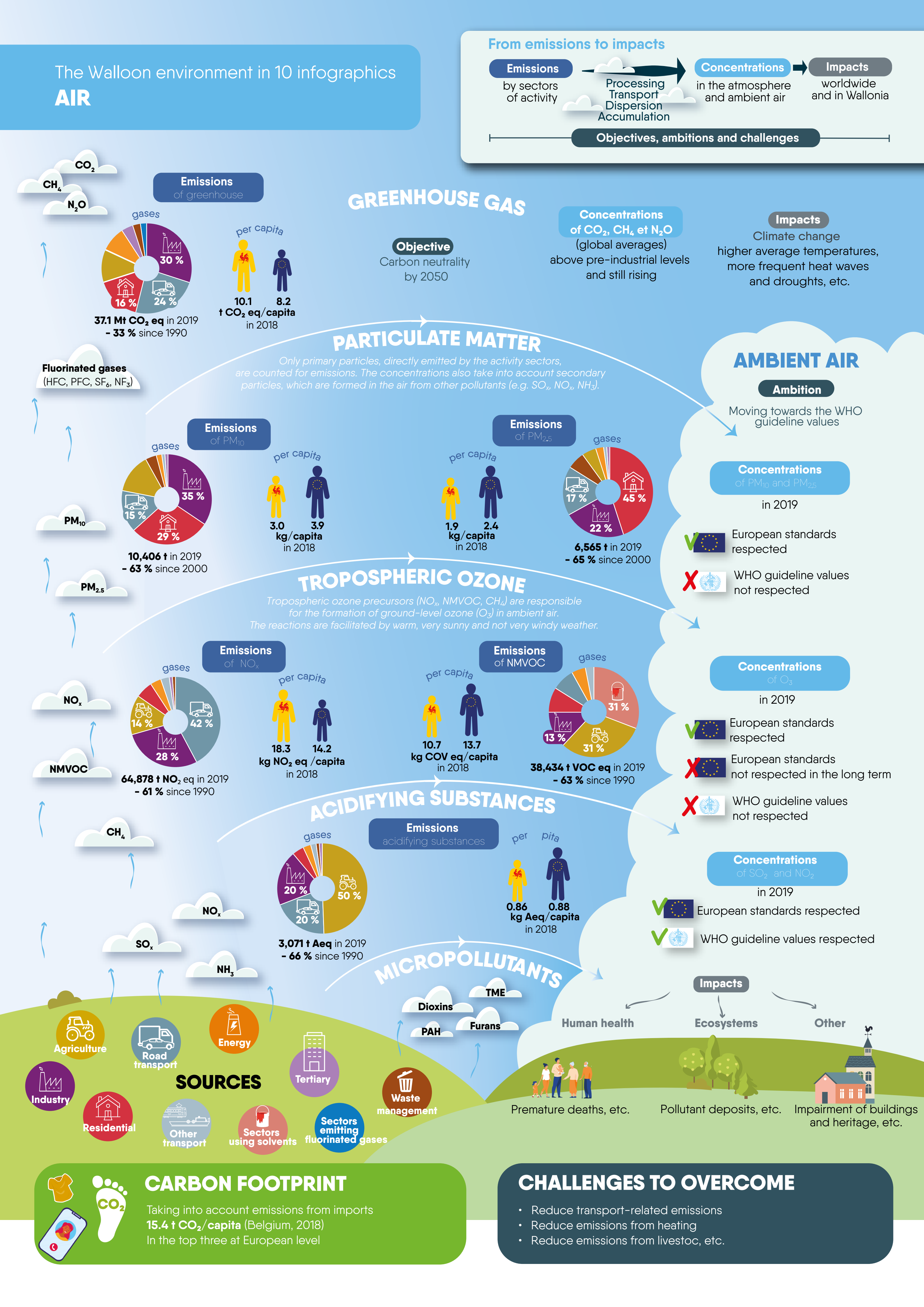
# 6 AIR

The chemical composition of the air has various influences on the environment in the broad sense (climate, water cycle, biological diversity, health of living organisms, the functioning of ecosystems, etc.). Heat waves, droughts, floods, ozone peaks and smog alerts are all phenomena that illustrate climate change and the deterioration of air quality. For several decades now, these issues have mobilised the scientific community. Gradually, they have also attracted media attention and have now become a major concern for society as a whole. Air emissions linked to human activities are the main cause of these phenomena: the production of consumer goods, transport, heating of buildings, etc. Measures to reduce emissions of certain pollutants have led to positive results, such as the restoration of the stratospheric ozone layer or, in our regions, the substantial decrease in acid rain. However, the situation remains critical: in the absence of a significant and rapid drop in greenhouse gas emissions, the global rise in temperature will have irreversible consequences, while air pollution is the leading environmental cause of premature death in Europe (e.g. respiratory and cardiovascular diseases).

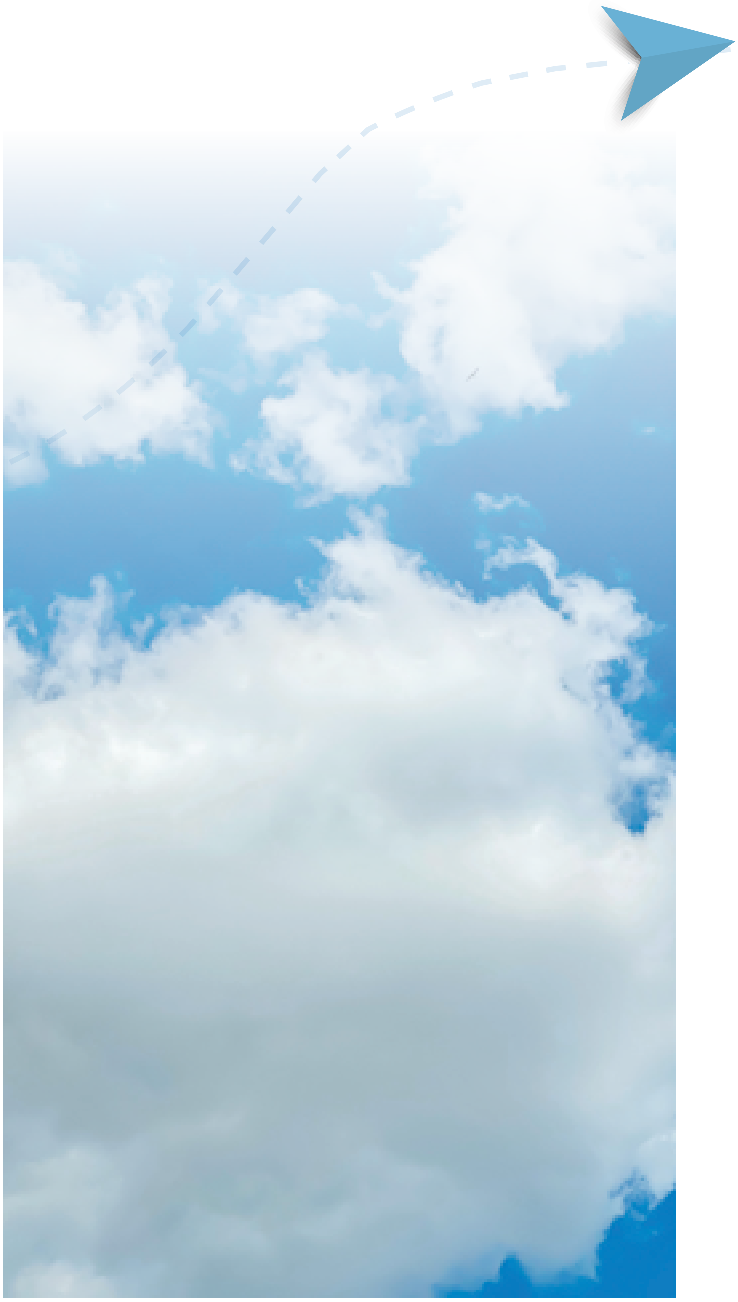

The Walloon environment in 10 infographics
AIR
From emissions to impacts
Emissions
by sectors of activity
Processing
Transport
Dispersion
Accumulation
Concentrations
in the atmosphere and ambient air
Impacts
worldwide and in Wallonia
Objectives, ambitions and challenges
$CO_2$
$CH_4$
$N_2O$
Emissions of greenhouse gases
30 %
24 %
16 %
37.1 Mt $CO_2$ eq in 2019
- 33 % since 1990
per capita
10.1
8.2
t $CO_2$ eq/capita in 2018
GREENHOUSE GAS
Objective
Carbon neutrality by 2050
Concentrations of $CO_2$, $CH_4$ et $N_2O$
(global averages)
above pre-industrial levels and still rising
Impacts
Climate change
higher average temperatures, more frequent heat waves and droughts, etc.
Fluorinated gases
(HFC, PFC, $SF_6$, $NF_3$)
PARTICULATE MATTER
Only primary particles, directly emitted by the activity sectors, are counted for emissions. The concentrations also take into account secondary particles, which are formed in the air from other pollutants (e.g. $SO_x$, $NO_x$, $NH_3$).
AMBIENT AIR
Ambition
Moving towards the WHO guideline values
$PM_{10}$
Emissions of $PM_{10}$
35 %
15 %
29 %
10,406 t in 2019
- 63 % since 2000
per capita
3.0
3.9
kg/capita in 2018
Emissions of $PM_{2.5}$
per capita
1.9
2.4
kg/capita in 2018
45 %
17 %
22 %
6,565 t in 2019
- 65 % since 2000
$PM_{2.5}$
Concentrations of $PM_{10}$ and $PM_{2.5}$
in 2019
European standards respected
WHO guideline values not respected
TROPOSPHERIC OZONE
Tropospheric ozone precursors ($NO_x$, NMVOC, $CH_4$) are responsible for the formation of ground-level ozone ($O_3$) in ambient air.
The reactions are facilitated by warm, very sunny and not very windy weather.
$NO_x$
Emissions of $NO_x$
42 %
14 %
28 %
64,878 t $NO_2$ eq in 2019
- 61 % since 1990
per capita
18.3
14.2
kg $NO_2$ eq /capita in 2018
NMVOC
Emissions of NMVOC
per capita
10.7
13.7
kg COV eq/capita in 2018
31 %
13 %
31 %
38,434 t VOC eq in 2019
- 63 % since 1990
Concentrations of $O_3$
in 2019
European standards respected
European standards not respected in the long term
WHO guideline values not respected
$CH_4$
ACIDIFYING SUBSTANCES
Emissions acidifying substances
20 %
50 %
20 %
3,071 t Aeq in 2019
- 66 % since 1990
per capita
0.86
0.88
kg Aeq/capita in 2018
Concentrations of $SO_2$ and $NO_2$
in 2019
European standards respected
WHO guideline values respected
$NO_x$
$SO_x$
$NH_3$
MICROPOLLUTANTS
Dioxins
TME
PAH
Furans
Impacts
Human health
Ecosystems
Other
Premature deaths, etc.
Pollutant deposits, etc.
Impairment of buildings and heritage, etc.
SOURCES
Agriculture
Road transport
Energy
Tertiary
Industry
Residential
Other transport
Sectors using solvents
Sectors emitting fluorinated gases
Waste management
CARBON FOOTPRINT
Taking into account emissions from imports
15.4 t $CO_2$/capita (Belgium, 2018)
In the top three at European level
CHALLENGES TO OVERCOME
Reduce transport-related emissions
Reduce emissions from heating
Reduce emissions from livestoc, etc.

# FROM EMISSIONS TO CONCENTRATIONS: MEASURE TO UNDERSTAND AND ACT

Climate change due to greenhouse gas emissions and air quality deterioration due to air pollutant emissions are issues that are closely linked. Both phenomena have a common main cause: air emissions linked to human activity. In the atmosphere, both greenhouse gases and air pollutants interact, undergo transformations, are transported over long distances and can accumulate. Due to the fact that these gases and pollutants are dispersed away from the sources of emissions, both issues go beyond the strictly regional context. Although emission reduction measures are decided and implemented at the Walloon level, the results on air quality and climate impact also depend on the actions of other regions and countries. This is why many substances are subject to supranational or even global protocols and agreements.

Knowing emissions levels is the starting point for all policies to mitigate climate change and improve air quality. This is why "emission inventories" have gradually been put in place. These annual inventories, which are drawn up at the regional level, respond to various international commitments depending on the substances in question: 'United Nations Framework Convention on Climate Change' for greenhouse gases, 'Convention on long range transboundary air pollution' for air pollution. They have been tracking emissions since 1990, except for particulate matter which has been tracked since 2000. The methodologies underlying the inventories evolve according to scientific understanding, but certain principles are immutable, such as the principle of territoriality, which specifies that only substances physically emitted within the territory are taken into account. Although open to criticism (see below), this principle makes it possible to avoid double counting of emissions between territories and provides a framework for the main action levers available to countries to reduce their emissions. This is the basis for calculating Walloon emission levels and targets for Belgium and Wallonia.

In addition to emissions, air concentrations are also measured, as they determine the impacts on climate and ambient air quality. They are monitored at the global level for greenhouse gases and at the local and regional level for air pollutants.



# GREENHOUSE GASES AND CLIMATE CHANGE

The greenhouse effect is a natural phenomenon whereby some of the solar energy that reaches the earth is retained, thereby warming the lower atmosphere and maintaining temperatures compatible with life as we know it. This phenomenon is due to the presence of so-called "greenhouse gases". If the concentrations of these gases in the atmosphere increase, the natural greenhouse effect is amplified and, on average, the climate on the earth's surface warms. However, according to studies by the IPCC in 2019, atmospheric concentrations of certain greenhouse gases have not been as high as they now for at least 800,000 years. While most greenhouse gases can be emitted from natural sources, it has been proven that massive emissions of greenhouse gases from human activities (industrial, transport, residential, agricultural, etc.) are the cause of current climate change, the effects of which can already be seen. In concrete terms, according to the IRM, a warming of about 2°C has been observed in Belgium since the end of the 19th century. The year 2020 was the warmest in Uccle since observations began. The rise in temperatures has been particularly marked since the end of the 1980s, leading to a gradual trend towards fewer frost episodes and more heatwaves in summer. Since the 2000s, heavy rainfall events have tended to become more frequent, and this is also the case for spring droughts. Globally, climate change is increasing the frequency and magnitude of natural disasters, contributing to rising sea levels and melting ice and glaciers, disrupting ecosystems, complicating access to clean water for many populations, and spreading disease by expanding the range of parasites and certain disease vectors.

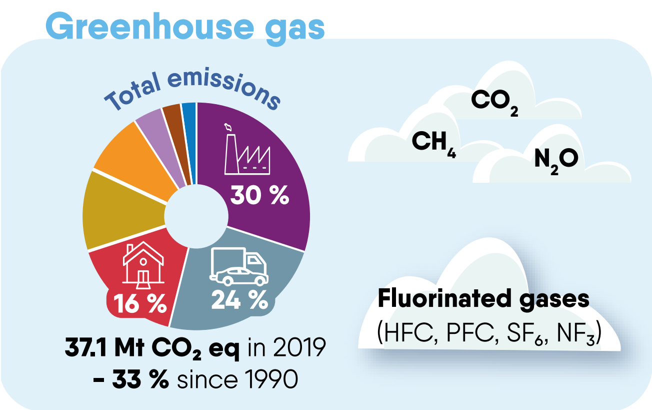
## Despite falling emissions levels, a Walloon emits on average more greenhouse gases than a fellow European.

Greenhouse gases refer to various substances, some of which are included by emission inventories, in particular:

- Carbon dioxide ($CO_2$), mainly emitted during combustion which is intended to meet the energy needs of all sectors (machines, vehicles, boilers, etc.), as well as by certain industrial processes;
- Methane ($CH_4$), mainly emitted by the agricultural sector (the digestion of ruminants and storage of livestock effluents);
- Nitrous oxide ($N_2O$), mainly from the transformation of nitrogen applied to agricultural soils;
- Fluorinated gases (hydrofluorocarbons or HFCs, perfluorocarbons or PFCs, sulphur hexafluoride or $SF_6$, nitrogen trifluoride or $NF_3$), linked to the production and use of certain products (air conditioning, refrigeration, aerosols, etc.).

The contributions of each substance to the greenhouse effect differ from one gas to another, not only because of differences in concentrations in the air (themselves related to the quantities emitted), but also because of differences in the capacity of each of these gases to warm the atmosphere. For example, the global warming potential of one kg of methane is 25 times greater than that of one kg of $CO_2$. In order to compare and aggregate them, the emissions of the different greenhouse gases are converted into "$CO_2$ equivalents". This conversion to "equivalent" is done in a similar way for acidifying substances (acid equivalent), nitrogen oxides ($NO_2$ equivalent) and volatile organic compounds (VOC equivalent) discussed below.

In 2019, Wallonia emitted around 37.1 million tons $CO_2$ equivalent of greenhouse gas, of which 84 % was in the form of $CO_2$ and the rest in the form of $CH_4$ (7 %), N2O (7 %) and fluorinated gases (2 %). The main sources of emissions were industry (30 %), road transport (24 %), residential (16 %), agriculture (12 %) and the energy sector (8 %). With 10.1 tonnes of $CO_2$ equivalent emitted per capita in 2018, Wallonia was above the European average (EU-28: 8.2 tonnes of $CO_2$ equivalent per capita). It should be noted that emissions from biomass combustion are not considered here as they are not taken into account for achieving greenhouse gas reduction targets. International methodologies (Kyoto, Paris Agreements, etc.) consider that, over the whole cycle, the storage of $CO_2$ during the renewal of biomass offsets the $CO_2$ emitted when it is burned.




Between 1990 and 2019, Wallonia's greenhouse gas emissions fell by 33 %, an overall favourable trend that nevertheless conceals contrasting sectoral and time-related trends.

- At the sectoral level, the most notable change is undoubtedly in industry (-58 %). This sector has been marked by decreased production and closures in particularly energy-intensive activities such as steelmaking, but it has also seen significant improvements in energy efficiency, processes and changes in the fuels used (from coal and fuel oil to natural gas and renewable energy sources). In contrast, emissions from road transport rose by 33 % over the same period. This evolution can be explained by ever-growing journey needs (leisure, e-commerce, etc.), by the increase in the number of vehicles and, more recently, by changes in the types of vehicles used (increasingly heavy cars such as SUVs, more vans, etc.) which reduce the beneficial effects of more efficient engines. Other sectors show more or less marked decreases: - 55 % for the energy sector (thanks to the closure of coking plants and coal-fired power plants, technological improvements with "gas-steam turbine" power plants), - 16 % for the agricultural sector (more rational use of fertilizers, decrease in the total number of ruminants, etc.), - 14 % for the residential sector (insulation of buildings, better performance of boilers, increased use of natural gas and renewable energy, etc.)
- In terms of time, the overall decrease in greenhouse gas emissions has not been uniform. The downward trend observed between the early 1990s and the mid-2000s accelerated considerably with the economic crisis of 2008, which had a negative impact on certain heavy industry sectors. The lowest level of greenhouse gas emissions was recorded in 2014, a particularly warm year (2nd warmest year ever in Belgium) and during which heating needs were therefore lower. Since then, emissions have stagnated or even risen slightly.

## Global concentrations continue to rise

From the perspective of greenhouse gas concentrations in the atmosphere, the assessment is made at the global level. However, according to the World Meteorological Organization, global average concentrations of greenhouse gases are continuously rising and are reaching new records year after year. In 2019, concentrations of $CO_2$, $CH_4$ and $N_2O$ were above pre-industrial levels by +48 %, +160 % and +23 %, respectively. Moreover, the rise in $CO_2$ and $CH_4$ levels between 2018 and 2019 were higher than the average rises over the previous 10 years.

## Carbon neutrality as a goal for 2050

In order to meet the climate challenge, the objective of carbon neutrality has started to emerge. Carbon neutrality implies a radical reduction in anthropogenic greenhouse gas emissions and the offsetting of residual emissions by absorptions (agricultural or forestry practices that promote the storage of carbon in the soil or biomass) or by the capture of $CO_2$ from industrial processes or combustion , which is then buried in geological reservoirs[1]. The Paris Agreement, signed in 2015, laid down this objective at the global level for the second part of the 21st century. Since then, the European Union has set a binding target of carbon neutrality by 2050 in the European Climate Law. At the same time, the Walloon government has incorpo-

[1] These processes are still under development and very rarely implemented on an industrial scale.

rated this ambition in its 2019-2024 Regional Policy Declaration: carbon neutrality is targeted by 2050 at the latest, with an intermediate step in 2030 of reducing greenhouse gas emissions by 55 % compared to 1990. Although the progress achieved in Wallonia over the last 30 years is positive and should make it possible to achieve the objectives previously laid down for 2020[2], substantial efforts are still required to achieve the objective of carbon neutrality. Although all sectors need to be mobilised, the challenge is particularly acute in the transport and building sectors. In both of these areas, radical changes will be necessary, both in terms of behaviour (increasing vehicle occupancy rates, accelerating the renovation of buildings, etc.) and in terms of the fuels used: heat pumps, solar panels and the development of electric vehicles. For this last point, however, it must be borne in mind that the environmental impact of electricity consumption depends on the energy sources and technologies used to generate it. However, in the medium term, in a context of the gradual mothballing of nuclear power plants and pending the large-scale exploitation of renewable energy sources, additional natural gas-fired power plants are expected to be built, which will increase $CO_2$ emissions from electricity generation.

## National inventory versus carbon footprint

The emissions data presented above are from national inventories, based on the principle of territoriality. This method has several advantages, including easier access to data sources and comparability across countries. However, by limiting itself to Walloon territory, this method does not take into account the emissions from imports, i.e. the emissions which are generated outside Wallonia to meet the needs of Walloon consumers (extraction of raw materials, processing, production and transport). The concept of "carbon footprint" was developed to address this limitation. It is 'consumption'-oriented and aims to take into account direct household emissions, emissions from domestic production and emissions associated with the production and international transport of goods and services imported into Wallonia, minus emissions from exports. In concrete terms, in the case of offshoring, for example, the emissions inventories only highlight the fall in emissions observed on Walloon territory following the cessation of activity there, whereas the carbon footprint will take into account the emissions of the offshored activity, sometimes in regions of the world where environmental standards are less stringent, for goods that continue to be consumed in Wallonia.

According to data from the Global carbon project, in 2018, Belgium's territorial $CO_2$ emissions (based on national inventories) amounted to 8.7 tons of $CO_2$ per capita, while the emissions from Belgian consumption (based on the carbon footprint calculation) were 15.4 tons of $CO_2$ per capita. The emissions including imports were therefore much higher than the territorial emissions alone. Through its consumption, Belgium was, like many industrialised countries, a net importer of emissions. Belgium was also among the top three European countries in terms of carbon footprint.

Monitoring the evolution of Walloon emissions, as included in the national inventories, is necessary to take stock of the efforts made in Wallonia to achieve the reduction targets. However, monitoring an indicator like the carbon footprint is a reminder that the climate issue is global and that the impact of Walloons on the climate goes beyond greenhouse gas emissions in Wallonia.

[2] Because the data is available with a two year lag, it can only be assessed whether these targets have been achieved in 2022.

# AIR POLLUTANTS AND AIR QUALITY

Besides greenhouse gases, a range of air pollutants are the subject of specific focus owing to their effects on air quality. Ambient air pollution has multiple consequences ranging from impaired human health (respiratory and cardiovascular diseases, premature death, etc.) to the degradation of terrestrial and aquatic ecosystems and biodiversity (eutrophication, particularly damaging to naturally poor environments such as peat bogs or moors, the presence of toxic substances affecting the growth or reproduction of plant and animal species, etc.), including the fouling and even the degradation of buildings.

One way to approach air pollutants is to group them by "family", according to their characteristics or impacts: particulate matter, tropospheric ozone, acidifying substances and micropollutants. This classification, in decreasing order of impact on human health, provides an overview of the issues, but the effects of pollutants are multiple and complex. Sulphur oxides ($SO_X$)[3], for example, are acidifying substances but can also form secondary particulate matter through transformation in the atmosphere. Nitrogen oxides ($NO_X$), which also contribute to acidification, are also eutrophying substances, precursors of tropospheric ozone and precursors of particulate matter.

As for greenhouse gases, emission inventories quantify Walloon emissions of air pollutants according to their sector of origin (industry, transport, households, etc.). These data and their evolution over time can be compared to objectives. Certain air pollutants ($SO_X$, $NO_X$, $NH_3$, NMVOCs, $PM_{2,5}$) are subject to emission reduction targets for 2020 and 2030. Initially defined at the European level for each Member State, they have been split among the Regions at the Belgian level.

In addition, a series of air quality measurement stations, dispersed over the Walloon territory, makes it possible to ascertain the concentrations of pollutants in the ambient air and their daily or hourly evolution. The information, available in real time (http://www.wallonair.be), makes it possible to observe specific pollution peaks (ozone peaks, particulate matter peaks) that may trigger alerts, to calculate average concentrations (hourly, daily, annual, etc.), interpreted by comparison with norms, or even the number of days on which norms are exceeded. In this regard, a distinction must be made between the European standards for the protection of human health and the environment to be met for certain pollutants and the health protection guidelines of the World Health Organization (WHO). The latter guidelines are often more ambitious than the European standards, but Member States are not obliged to meet them. Nevertheless, Wallonia aims to get closer to the WHO guideline values, which were revised in September 2021[4].

The problem of "peaks" of particulate matter or ozone pollution has been the subject of two specific action plans since the mid-2000s, in order to limit their impact on human health. One is specifically aimed at peaks of particulate matter (mostly in winter and spring), the other is dedicated to ozone peaks and heatwaves (mostly in summer). These plans set out action thresholds and envisage an information phase, to report on the situation and reiterate the recommendations, especially for the most vulnerable groups (young children, the elderly, etc.), but also alert phases. These phases envisage more restrictive actions, either to reduce pollution (e.g. limiting vehicle speeds to 90 km/h in the event of a peak in particulate matter), or to limit the effects on human health (e.g. cancelling sports events in the event of an ozone peak).

## Particulate matter: despite the actions undertaken, progress remains to be made

The atmosphere contains microscopic particulate matter (PM) that is suspended in the air. Grouped according to their size ($PM_{10}$ for particles smaller than 10 µm, $PM_{2.5}$ for particles smaller than 2.5 µm, known as "fine particles"), these particles actually form a heterogeneous group: they can be solid or liquid, organic or mineral, of highly variable composition and toxicity depending on the emission sources and their mode of formation. Nevertheless, size is a very important parameter: the

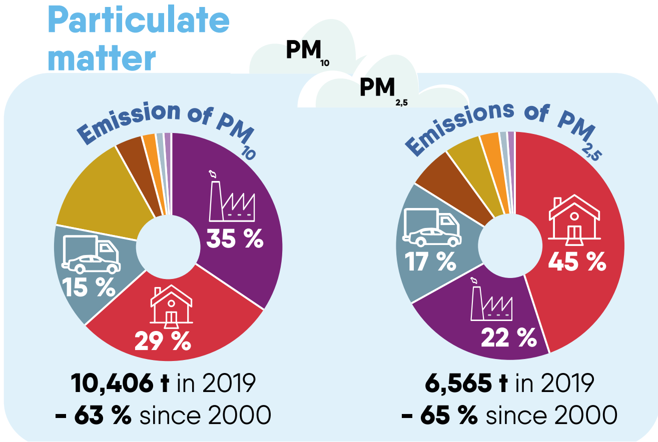
[3] The "x" associated with $SO_x$ and $NO_x$ means that the different chemical formulas of this oxide are considered simultaneously, for example NO and $NO_2$ for $NO_x$.
[4] In the context of this publication, concentrations are compared to the 2005 WHO guideline values..

finest particles tend to stay longer in the atmosphere, travel a greater distance from their source of emission, and penetrate more deeply into the respiratory tract, resulting in increased health problems. For all the particles, the health effects can also be observed in the short term (irritation of the nose, the throat and the eyes, aggravation of the pulmonary and cardiovascular affections, etc.) as in the long term (chronic bronchitis, asthma, lung cancer, etc.). In 2018, the number of premature deaths due to $PM_{2.5}$ in Wallonia was estimated at 2,113. Particles also impact fauna and flora and can lead to diffuse pollution of soils and ecosystems. They make the surface of buildings and monuments turn black.

In Wallonia, most of the PM comes from human activity. We can differentiate between:

- Primary PM, emitted directly by combustion (engines, boilers, etc.), wear and tear (brakes, tyres, road surfaces, etc.) or mining in quarries. We find a higher proportion of primary PM in $PM_{10}$ ;
- Secondary PM, which is formed in the air from other air pollutants, such as $SO_X$, $NO_X$ or $NH_3$. These are more frequent in $PM_{2.5}$.

In 2019, Walloon $PM_{10}$ emissions were 10,406 tons, of which 63 % was $PM_{2.5}$. The most emitting sector of $PM_{10}$ was the industry sector (35 % of emissions) (quarries, cement factories, etc.) followed by the residential sector (29 %) (mostly firewood use), road transport (15 %) (diesel combustion, wear of brakes, tyres and roads, etc.) and agriculture (14 %) (handling of litter and fodder, tillage, harvest, etc.). For $PM_{2.5}$, the most emitting sectors were residential (45 % of emissions), industry (22 %) and road transport (17 %). With 3.0 kg of $PM_{10}$ including 1.9 kg of $PM_{2.5}$ emitted per capita in 2018, Wallonia had emission levels below European levels (EU-28: 3.9 kg of $PM_{10}$ including 2.4 kg of $PM_{2.5}$ per capita). With $PM_{2.5}$ emissions of 6,565 tonnes in 2019, Wallonia was already meeting the reduction targets set for the years 2020 and 2030. There are no reduction targets for $PM_{10}$.




Between 2000 and 2019, Walloon $PM_{10}$ and $PM_{2.5}$ emissions fell by 63 % and 65 % respectively, with marked decreases in the industrial sector (company closures, more efficient filtration systems, particularly in the context of environmental permits, etc.), in the energy sector (replacement of solid fuels by natural gas), in road transport (introduction of increasingly strict EURO standards for new vehicles) and in the residential sector (improved wood heating systems, offsetting their increased use).

From the perspective of ambient air quality, in 2019, Wallonia complied with the European standards for the protection of human health. The assessment of the situation is different if we refer to the WHO guideline values, which are more stringent and which Wallonia intends to align with. In terms of annual average concentrations, the guideline values were exceeded for stations (out of 23) for $PM_{10}$ and for 7 stations for $PM_{2.5}$. As regards the "particulate matter peaks", the number of days of exceedance of the daily guideline values was higher than the maximum number laid down by the WHO for 14 stations for $PM_{10}$ and for all 23 stations for $PM_{2.5}$. The progress made over the last 20 years, in connection with the decrease in particulate matter emissions observed since 2000, is not yet enough and additional measures are needed. The potential for emissions reductions is currently higher for the residential sector than for other sectors. In particular, possibilities include reducing domestic emissions from wood heating by installing more efficient systems and by raising awareness among users (giving priority to dry wood, carrying out regular maintenance of equipment and chimneys, etc.).

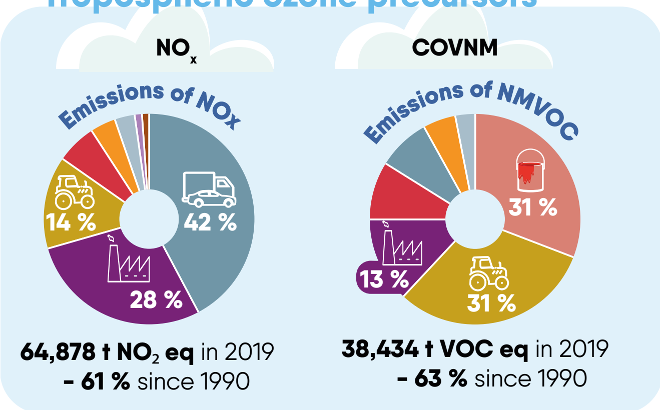
In addition to $PM_{2.5}$, it should be noted that there are very fine carbon particles, called 'black carbon'. These particles are combustion residues primarily from transport and residential wood heating. These emissions are also subject to assessment through inventories, but are not subject to specific reduction targets. As regards ambient air concentrations, which are not subject to any European or WHO standard, Wallonia is in the process of strengthening its measurement systems.

## Tropospheric ozone: increasing concentrations linked to heatwaves

Tropospheric ozone[5] ($O_3$) is a pollutant which is harmful to health. During 'ozone peaks', it primarily affects the respiratory tract, in particular among the most sensitive people (children, elderly people, asthmatics, etc.). In 2018, the number of premature deaths due to ozone in Wallonia was estimated at 140. Ozone can also affect the development of vegetation and can accelerate the degradation of certain types of materials (plastics, paints, etc.). With a few exceptions, tropospheric ozone is not emitted directly into the atmosphere by human activities. It is formed in the ambient air in hot, very sunny and not very windy weather through a series of complex photochemical reactions involving pollutants already present in the ambient air, called "ozone precursors". These precursors are nitrogen oxides ($NO_X$) and volatile organic compounds (VOC: aldehydes, benzene, terpenes, methane, etc.).

In 2019, atmospheric emissions of $NO_X$ and non-methane VOCs (NMVOCs)[6] from human activities amounted to 64,878 tons of $NO_2$ equivalent and 38,434 tons of VOC equivalent respectively in Wallonia[7]. $NO_X$, primarily emitted during combustion, came from road transport (42%) and the industrial sector (28%) (cement plants, glass factories, chemicals, etc.). NMVOCs were mainly emitted by the use of solvents (31%) (paints, glues, degreasers, etc.) and agricultural activities (31%) (livestock manure). With 18.3 tonnes of $NO_2$ equivalent emitted per capita in 2018, Wallonia was above the European average (EU-28: 14.2 kg $NO_2$ -equivalent per capita) while at 10.7 kg VOC-equivalent per capita, Walloon emissions were below the European average (EU-28: 13.7 kg VOC-equivalent per capita).

## Tropospheric ozone precursors




[5] Ozone present in the troposphere, the lowest layer of the atmosphere. Not to be confused with stratospheric ozone, which provides protection against solar UV.

[6] Methane is a volatile organic compound and, as such, is an ozone precursor, but its emissions are only included in greenhouse gas inventories. Only non-methane VOC emissions are considered here.

[7] It should be noted that around 45% of all Walloon NMVOC emissions are naturally produced by vegetation (terpenes), in particular forests, in warm and sunny weather, and partly explain the ozone peaks sometimes observed in the countryside.

As regards the emissions reduction targets, Wallonia was already in compliance in 2019 with the targets set for 2020 and 2030 for NMVOC emissions. For $NO_X$ emissions, Wallonia also met the 2020 target, but additional efforts are needed to reach the 2030 target. The reduction in emissions to be achieved by this date is estimated at -13 % compared to the 2019 level.

Between 1990 and 2019, Walloon emissions of ozone precursors fell by more than 60 %. $NO_X$ emissions decreased by 61 %, with significant falls in the road transport (-64 %), industry (-66 %) and energy (-83 %) sectors. They are the result of the widespread uptake of technological advances (catalytic converters, more efficient boilers, gas-steam turbine power plants, etc.) and, in the industrial sector, modified processes (in particular in the chemical and cement industries). Meanwhile, emissions of NMVOCs fell by 63 %, thanks in particular to the installation of catalytic converters on vehicles, the use of petrol vapour recovery systems when handling fuels in service stations, the use of low solvent products and the application of new operating conditions in certain sectors (printing, dry cleaning, etc.).

As regards ambient air quality, it should be reiterated that the summer of 2019 was particularly hot and sunny (three heatwaves), conditions that are conducive to ozone pollution. The European standard for the protection of human health regarding ozone peaks was respected for all measuring stations (maximum 25 days of exceedance of the target value on average over 3 years), a state of conformity that has been observed since 2007. However, the long-term objective of zero exceedance was not met for any station. Nevertheless, the deadline for this objective has not yet been laid down. Still for 2019, the information threshold, which when exceeded triggers communication to the public, the health actors and the media, was exceeded on 9 days for at least one station of the Belgian territory including 5 days for at least one of the Walloon measuring stations. The alert threshold, i.e. the level beyond which short-term exposure entails a risk for human health, has never been reached in Wallonia.

Tropospheric ozone is also subject to specific European standards for the protection of vegetation. In 2019, the target value was met for all Walloon stations. However, the more restrictive long-term objective was not met for any station. Nevertheless, the deadline for this objective has not yet been laid down.

These results, generally favourable for a warm and sunny year, were undoubtedly obtained thanks to the falls in ozone precursor emissions recorded in recent years. However, ozone pollution remains a persistent problem in Wallonia, on the one hand because climate change accentuates the conditions conducive to ozone peaks (in particular heatwaves) and, on the other hand, because the current concentration levels continue to generate effects on human health and the environment. The WHO recommends a guideline value lower than the European standards, without any day of exceedance. Nonetheless, in 2019, all Walloon stations showed several days of exceedance of this guideline value. Efforts therefore need to be made to reduce $NO_X$ and VOC emissions, especially since these pollutants are involved in the formation of particulate matter. For $NO_X$, the potential for reduction is mainly in transport, buildings and energy, as industries have already significantly reduced their emissions. The measures envisaged include changes in the energy sources used and increasing the share of electric vehicles in the fleet. For VOCs, the main measures aim at making the requirements for companies more stringent via the environmental permit and raising awareness among users of solvents so that they reduce their consumption.

## Acidifying substances: emissions significantly lower

When transported in the atmosphere, some air pollutants can be transformed into acidic or potentially acidifying compounds. This is mainly the case for ammonia ($NH_3$), nitrogen oxides ($NO_X$) and sulphur oxides ($SO_X$). The atmospheric deposition of these acidifying substances, better known as "acid rain" (which in reality can also occur as dry deposition), can acidify soils and surface waters, damage or disrupt plant growth and degrade architectural heritage. Still problematic in the 1990's, acid deposition no longer affects the ecosystems in Wallonia. However, $NH_3$, $NO_X$ and $SO_X$ emissions continue to be the focus of attention, particularly for the other effects these pollutants may have on the environment or human health:

- Nitrogenous pollutants ($NO_X$ and $NH_3$) can lead to eutrophication of certain environments, which is particularly damaging when they are naturally poor environments that are home to specific fauna and flora (moors, peat bogs, etc.). In 2015, 95% of naturally poor semi-natural open environments were still impacted by excess nitrogen deposition;
- acidifying pollutants can cause irritation and inflammation of the eyes, mucous membranes and respiratory system, which can contribute to or aggravate more serious pathologies. In 2018, the number of premature deaths due to $NO_2$ in Wallonia was estimated at 732;
- $NH_3$, $NO_X$ and $SO_X$ are also precursors of particulate matter.

Ammonia ($NH_3$) emissions are mainly associated with agricultural practices (volatilisation from animal manure, its storage and spreading as farmyard manure, or from nitrogenous mineral fertilizers to a lesser extent). Nitrogen oxides ($NO_X$), already mentioned as ozone precursors, are emitted during combustion. Finally, sulphur oxides ($SO_X$) are emitted during the combustion of sulphurous fuels (coal, oil, etc.) but also by certain processes of the chemical industry.

In 2019, total Walloon emissions of acidifying pollutants amounted to 3,071 tons of acid equivalent and were mainly composed of $NH_3$ (48 %) and $NO_X$ (46 %). The main emitting sectors were agriculture (50 %), road transport (20 %) and industry (20 %). With 0.86 kgs of acid equivalent emitted per capita in 2018, Wallonia was slightly below the European average (EU-28: 0.88 kgs of acid equivalent per capita).

## Acidifying substances


**3,071 t Aeq** in 2019
**- 66 %** since 1990

As regards the emissions reduction targets, Wallonia was already in compliance in 2019 with the targets set for 2020 and 2030 for $SO_X$ and $NH_3$ emissions. $NO_X$ emissions in 2019 also met the 2020 reduction target but not the 2030 target as discussed above. Since $NH_3$ is a precursor of particulate matter, reducing its emissions is also intended to reduce $PM_{2.5}$ concentrations. Various specific measures envisaged in the Air Climate Energy Plan for 2030 are therefore aimed at reducing $NH_3$ emissions in the agricultural sector. They include substituting the most emissive forms of mineral fertilizers (urea and nitrogen solution) with less emissive forms (ammonium nitrate), limiting the quantities of nitrogenous fertilizers applied, ensuring rapid burial of livestock manure in the soil or even injecting liquid manure into the soil, developing "low-emission" livestock buildings (air filtration or washing), and limiting the application of nitrogenous fertilizers in the event of a springtime peak in particle pollution.

Air emissions of acidifying pollutants decreased by 66 % between 1990 and 2019. $NO_X$ and $SO_X$ emissions have fallen particularly sharply (by 61 % and 94 % respectively), thanks in particular to technological advances (catalytic converters, more efficient boilers, etc.) and, more specifically in the case of $SO_X$, to the much less frequent use of coal and heavy fuel oil and the reduced sulphur content in diesel and fuel oil. The fall in $NH_3$ emissions, which was more moderate (-25 %), was mainly due to the decrease in the size of the cattle herd (particularly since the beginning of the 2000s) and the reduction in the quantities of nitrogen fertilizers applied (although these have remained fairly stable since 2005).

From the perspective of ambient air quality, for nitrogen oxides, the European standards for the protection of human health ($NO_2$) and for the protection of vegetation ($NO_X$) as well as the WHO guideline values were respected in 2019. This was already the case in previous years. As regards $SO_2$, the European standards for the protection of human health and for the protection of vegetation have also been respected for about 20 years. The stricter WHO guideline value has been met several times in recent years (2016, 2018, 2019). As for $NH_3$, concentrations in ambient air are currently not measured in Wallonia. There are no European standards or guideline values from the WHO. However, Wallonia has procured 3 monitors in the context of the European directive regulating the emission of atmospheric pollutants.

## Micropollutants: sharp fall in emissions but only certain substances are monitored

Some substances, grouped together under the term micropollutants, can, even at very low concentrations in the ambient air (in the order of micrograms or nanograms per m3), lead to undesirable effects on living organisms and thus represent a risk to human health and the environment. These micropollutants mainly comprise trace metal elements (TMEs) and organic compounds (benzene, dioxins and furans, polycyclic aromatic hydrocarbons or PAHs). Their toxicity is reinforced by their capacity to accumulate in different environments (water, soil, etc.) and in living organisms (bioaccumulation). Concentrations of micropollutants can therefore increase along the food chain (biomagnification). Even at very low doses, micropollutants can act on organisms through mechanisms of action that are sometimes still poorly understood and can be the source of cancers or disruptions to the endocrine system, among other things. Only some of these are monitored and have air concentration standards.

In 2019, air emissions of monitored TMEs (arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, and zinc) accounted for 51 tons, of which 43 % came from industry, 29 % from the residential sector, and 19% from road transport. Emissions of dioxins and furans accounted for 10.1 g I-TEQ[8] of which 38 % were related to waste management, 27 % to the residential sector and 14 % to energy. Emissions of PAH represented 2.3 tons, of which 60 % came from the residential sector, 17% from industry and 11 % from road transport.

The overall emissions of micropollutants monitored in Wallonia decreased between 1990 and 2019: - 79 % for TMEs, -89 % for dioxins and furans and -94% for PAHs.

As regards ambient air quality, only certain micropollutants are subject to reference values that must not be exceeded (WHO guideline values, target values/limits of European directives, or quality criteria calculated by the AwAC), established on the basis of the risk that these pollutants represent for health. In 2019, there were no issues identified for lead, cadmium, and arsenic. However, exceedances of the reference values were observed for nickel (urban stations of Charleroi and Lodelinsart, industrial station of Ath), benzene (all 7 urban stations where benzene is monitored) and PAH (4 urban stations out of 5 where PAH are monitored). Currently, dioxins and furans are not a continuously monitored air quality parameter. It should be noted that for carcinogenic substances regularly monitored in Wallonia such as arsenic, nickel, benzene or PAHs, no limit concentration in the air would guarantee the absence of cancer risk (substances without effect threshold). For these substances, the WHO recommends guideline values of zero, which is a stricter criterion than the target/limit values of the European directives and the AwAC quality criteria, based on an acceptable level of risk.

[8] I-TEQ: international toxic equivalent quantity. A sum of the quantities of the 17 toxic dioxin and furan congeners weighted by their toxicity equivalency factors (TEF). Tetrachlorodibenzo-p-dioxin (TCDD) is considered the most toxic and has a TEF of 1.

## MAJOR CHANGES ARE STILL NEEDED TO ADDRESS CLIMATE AND AIR QUALITY ISSUES

In many respects, the evolutions observed in Wallonia in recent years are positive. Numerous improvements have indeed been recorded, both in terms of emission levels, given the significant falls compared to 1990, and in terms of air quality, since the concentrations recorded at the measuring stations (for the substances monitored) have rarely exceeded the European regulatory thresholds in recent years. These positive evolutions should be highlighted but need to be nuanced. The magnitude of the fall in emissions levels is mainly due to factors that will occur less in the coming years: scaled back activities and company closures in the heavy industry sector as well as certain measures whose potential has already been realised (phasing out coal, recovery and valorisation of biogas in landfills, etc.). Nevertheless, Wallonia aims to be carbon neutral by 2050 and will therefore have to drastically reduce its greenhouse gas emissions. This objective requires major and systemic changes: a sharp fall in the consumption of fossil fuels in housing and transport, an acceleration of insulation works on buildings, using active modes of transport (walking, cycling) and public transport, the development of renewable energies and adequate infrastructure for transporting and storing them, etc. In terms of ambient air quality, Wallonia complies with most of the standards of the European directives. And yet it aims to move towards the WHO guideline values, which are generally stricter, because current levels are considered insufficient to protect health to an adequate extent.

The measures envisaged at the Walloon level to respond to these challenges are included to a large extent in the Air Climate Energy Plan for 2030, which is currently being drafted. An integrated vision of energy, climate and air quality issues is indeed necessary given the numerous interactions and potentially contradictory effects of certain measures. For example, the use of wood, pellets and other biomass is encouraged because it helps develop renewable energies, but burning these leads to emissions of atmospheric pollutants, in particular particles.

Many of the measures envisaged in the Air Climate Energy Plan for 2030 aim to control the quantities of energy consumed and to choose energy sources that emit less greenhouse gases and air pollutants. Indeed, a large proportion of Walloon emissions comes from

combustion, and thus from the energy consumption of the various sectors of activity (industry, transport, agriculture, housing, tertiary sector, etc.). This explains, for example, why the significant fall in coal consumption in Wallonia since the 1990s has had positive impacts on greenhouse gas emission levels, but also on sulphur oxides and particulate matter.

As previously mentioned, the energy consumption by the transport sector (goods and people) is a major challenge given that travel needs have been growing in recent years (leisure, e-commerce, etc.) and road transport is still highly dependent on petroleum products. The objectives of the transport measures include a major modal shift to neutral or less environmentally damaging modes of transport, demand management, particularly through territorial development (avoiding urban sprawl), and improving the environmental performance of vehicles by developing new technologies (electric, hydrogen, etc.). Households, companies and communities are also concerned by measures aimed at their heating needs (heating of buildings in particular). The renovation of old buildings and the gradual tightening of standards for the construction of new buildings is one of the major strands of the policy to reduce emissions from buildings, whether in the residential or tertiary sector (businesses, shops, etc.). The sound use of biomass (wood, pellets) is another strand mentioned above. At the level of industry, certain tools are aimed more specifically at reducing greenhouse gas emissions, in particular the sectoral agreements (voluntary partnerships concluded between Wallonia and various federations in the industrial sector with a view to improving energy performance and reducing $CO_2$ emissions) and the European carbon market. This market guarantees a reduction in the total emissions of the companies concerned by setting an overall emissions cap that gradually decreases over time. Emission allowances are allocated to companies, which can trade them for a fee based on their ability to reduce their emissions, but without changing the overall cap set at the European level.

In addition to combustion processes, certain processes or practices are sources of air pollutant emissions and are specifically targeted by measures envisaged in the Air Climate Energy Plan to 2030. These include reducing emissions from livestock production and nitrogen fertilizers, tightening solvent emission standards and raising awareness among the public on the proper use of household solvents, and equipping vehicles with systems to recover particles released during braking.

**Main data sources**

CELINE ; Eurostat ; IRM ; ISSeP ; SPW - AwAC ; Statbel (FPS Économie - DG Statistique)

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