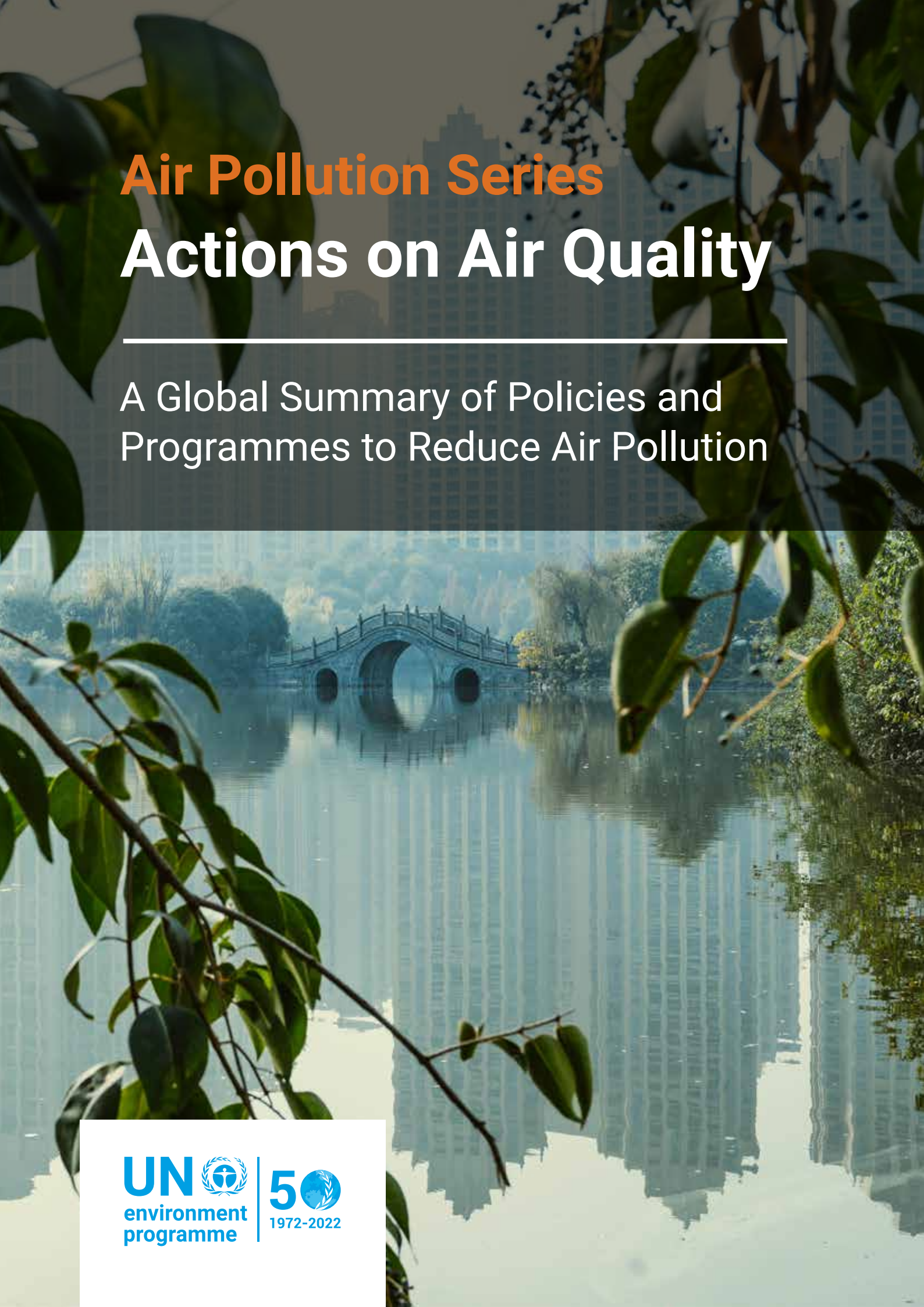

Air Pollution Series

Actions on Air Quality

A Global Summary of Policies and Programmes to Reduce Air Pollution

UN environment programme

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Actions on **Air Quality** A Global summary of **policies** and **programmes** to reduce **air pollution**

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List of abbreviations and acronyms

AAP	ambient air pollution
AAQS	ambient air quality standards
ALRI	acute lower respiratory infection
AQM	air quality management
ASEAN	Association of Southeast Asian Nations
CA	conservation agriculture
CCAC	Climate & Clean Air Coalition
CLRTAP	Convention on Long-range Trans-boundary Air Pollution
CO_2	carbon dioxide
COPD	chronic obstructive pulmonary disease
DIMAQ	Data Integration Model for Air Quality
DPFs	diesel particulate filters
EECCA	Eastern Europe, the Caucasus and Central Asia
ESMAP	Energy Sector Management Assistance Program (of the World Bank Group)
GBD	the Global Burden of Disease project
GDP	gross domestic product
GHG	greenhouse gas
HAP	household air pollution
IHME	Institute for Health Metrics and Evaluation
LMICs	low- and middle-income countries
LPG	liquefied petroleum gas
MECS	modern energy cooking services
MMT	million metric tons
NDC	nationally determined contribution
NOX	nitrogen oxides
OECD	Organisation for Economic Co-operation and Development
$PM_{2.5}$	fine particulate matter with an aerodynamic diameter of less than 2.5 microns
PM_{10}	fine particulate matter with an aerodynamic diameter of less than 10 microns
PPP	purchasing power parity
SLCP	short-lived climate pollutant
SO2	sulphur dioxide
WB	World Bank
WHO	World Health Organization
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme

Executive summary

Context

In 2019, 92 per cent of the world's population experienced $PM_{2.5}$ concentrations in excess of the World Health Organization (WHO) guideline of 10 µg/m³ (chapter 1A). Without policy interventions, exposure to $PM_{2.5}$ would increase by 50 per cent by 2030 (chapter 1A), severely compromising quality of life and risking lives worldwide.

This report reviews countries' policy actions with regards to the mandate provided by United Nations Environment Assembly (UNEA) resolution 3/8 on Preventing and reducing air pollution to improve air quality globally (chapter 1C). It builds on the United Nations Environment Programme (UNEP) 2016 report titled Actions on Air Quality (chapter 1C), which provided an overview of actions undertaken by countries around the world, focusing on a set of measures that – if adopted – would significantly improve air quality.

This new report is based on data collected in 2020 through a detailed survey shared with countries, which was supplemented with relevant literature documenting key actions being undertaken by governments around the world to improve air quality. The report is complemented by regional reports documenting more in-depth actions in key sectors, as well as regional trends and priorities.

In its aforementioned 2016 report, UNEP found that countries had adopted a substantial number of policies, standards and regulations to reduce air pollution. However, the report also revealed cross-cutting challenges to addressing air pollution. These included: ineffective implementation and enforcement of existing policies and regulations; limited cooperation between national and city administration; the universal need for monitoring and assessment; and the importance of behavioural change and public participation through awareness-raising and stakeholder involvement.

Status and trends

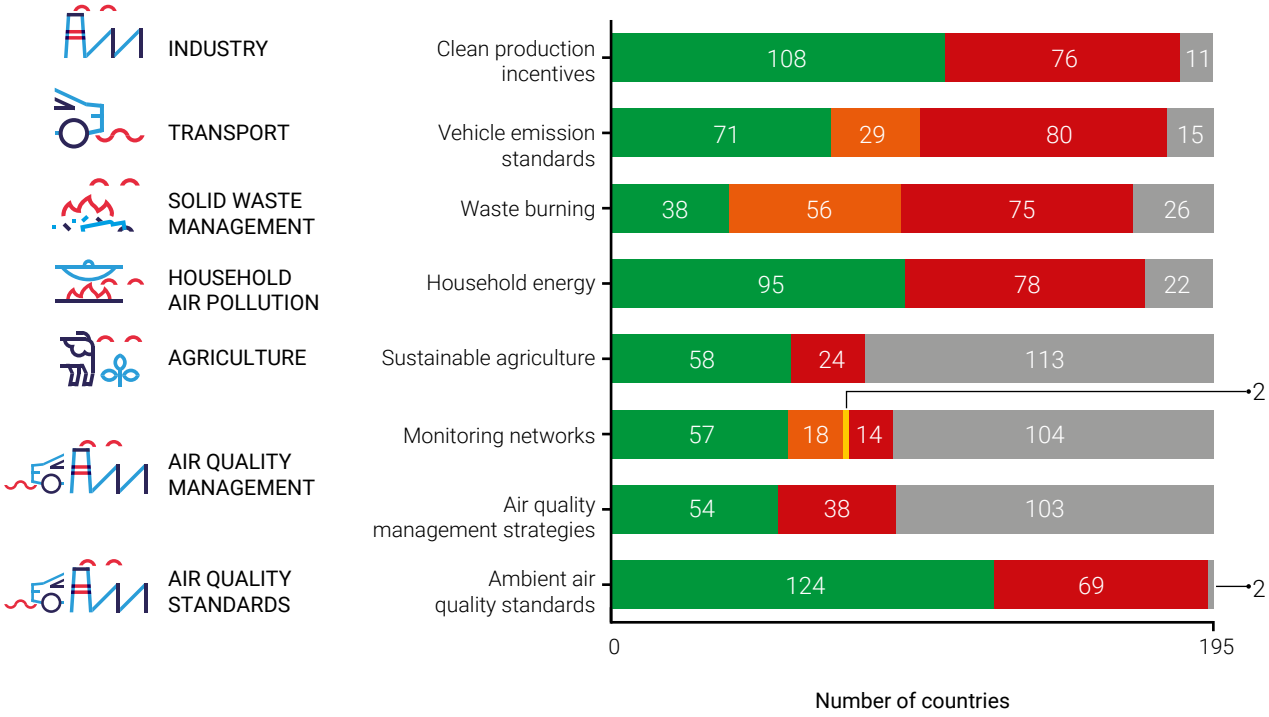
This 2021 report assesses actions in key sectors that contribute to air pollution, focusing on industrial emissions, transportation, solid waste management, household air pollution and agriculture emissions. It also provides an overview of non-sectoral air quality management actions, including air quality frameworks, strategies, standards and monitoring.

Overall, there is progress towards adoption of key actions that can significantly improve air quality

Figure ES.1 shows the progress towards adoption of key actions that can significantly improve air quality.

Figure ES.1 Progress towards adoption of key actions that can significantly improve air quality[1]

Where is the world in taking action to improve air quality?



Source: UNEP survey data

Sectoral Measures

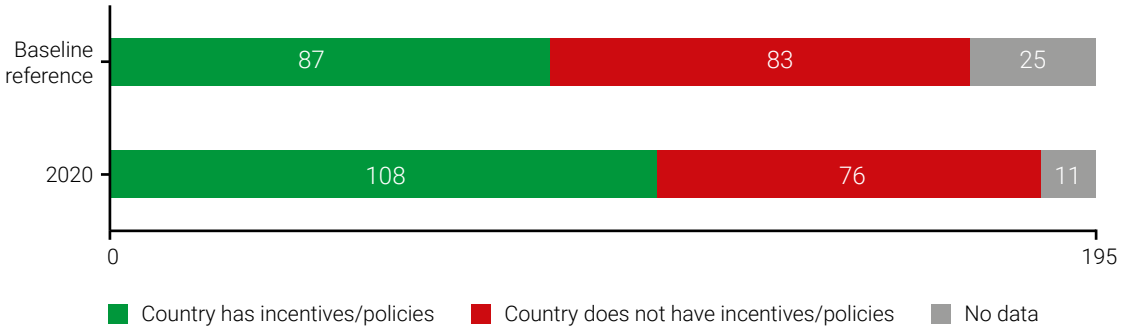
More countries have incentives or policies promoting cleaner production, energy efficiency and pollution abatement for industries

In the **industrial sector**, the 2021 report indicates growing uptake of policy incentives for cleaner production and energy efficiency relative to the baseline reference analysis of 2016. While some of this progress may reflect a reduction in data gaps relative to the baseline data, increases are noted in some regions (Figure ES.2).

View to cityscape and Industrial Zone with Oil Refineries in Haifa, Israel. Photo credit: © Shutterstock/Max Zalevsky

[1] From the analysis of UNEP data, a set of key policy actions were identified that, if adopted, would significantly improve air quality. The figure indicates how many countries have adopted these policies (green), are on their way to adopting them (orange/yellow) or have yet to adopt or implement them (red). Grey indicates that no data were available.

Figure ES.2 Countries with incentives or policies promoting cleaner production, energy efficiency and pollution abatement for industries



Source: UNEP survey data

More countries are meeting the Euro 4/IV vehicle emission standard

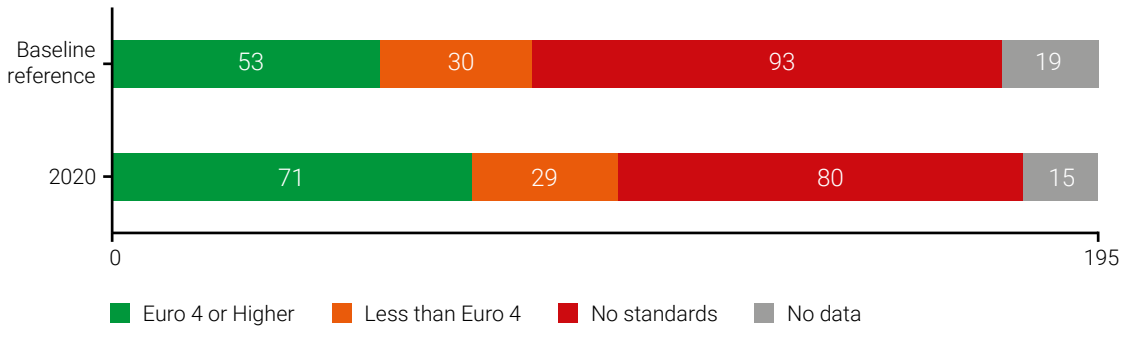
Policies to reduce emissions from the **on-road transportation sector** remain critical in countries (especially their urban areas) around the world. The past five years have shown progress, with 18 additional countries adopting emission standards equivalent to Euro 4/IV or higher, bringing the total to 71 countries. Twenty-nine countries have vehicle standards in place, but they are not yet up to the Euro 4/IV standard (Figure ES.3).

UNEP tracks progress on tailpipe standards as well as fuel quality, which is a key aspect of successful implementation of vehicle emission standards. However, as the report highlights, there is still significant progress to be made with regards to fuel quality.

More countries regulate open burning of solid waste, but it is still a widespread practice

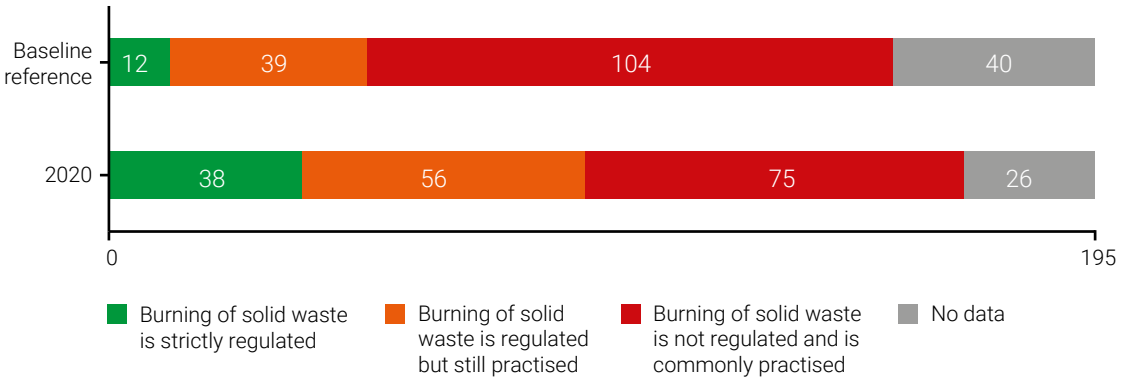
The number of countries that regulate **open waste burning** has increased significantly since 2016, although 75 countries still do not have regulations in place. Ninety-four countries (43 more than in 2016) now regulate burning, but only 38 of these countries have strict regulations in place. Despite the progress in this area since 2016, open burning is still practised in many countries, even those where regulations exist (Figure ES.4). Survey data indicate that the governments of the 94 countries that regulate burning have taken actions ranging from urban or national waste management plans to waste management regulations and more advanced strategies, such as landfill gas capture and improved collection, separation and environmentally sound waste disposal methods.

Figure ES.3 Countries meeting Euro 4/IV vehicle emission standard



Source: UNEP survey data

Figure ES.4 Countries with solid waste burning regulations



Source: UNEP survey data

More countries are adopting clean energy programmes for residential heating and cooking

In terms of **household air pollution**, the world has seen increased availability of cleaner fuels and an estimated global reduction in the burden of disease associated with residential heating and cooking sources since 2016. An additional 13 countries now have national programmes to promote clean energy in residential heating and cooking (Figure ES.5).

Survey data show that governments are implementing various measures in this sector, with the highest level of uptake for increased energy efficiency in residential appliances and lighting, followed by improved access to green technologies for residential heating, the adoption of low-emission cooking stoves and fuels, and increased use of liquefied petroleum gas (LPG).

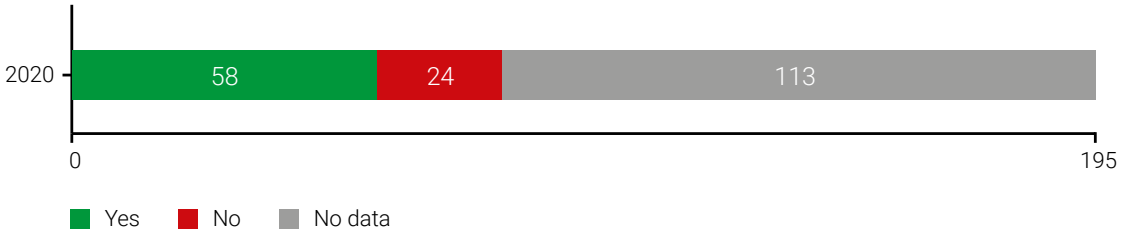
There is limited evidence of incentives to promote sustainable agricultural practices

Fifty-eight countries reported having incentives in place to promote **sustainable agricultural practices** (Figure ES.6). Measures include alternatives to open burning of agricultural residues, improved livestock manure management, and composting to reduce food waste. The survey found that among those countries with incentives for sustainable agricultural practices, nearly one quarter of respondents provide alternatives to open burning of agricultural waste and nearly one quarter support closed storage and improved livestock manure management. Approximately 20 per cent of respondents indicate using methane capture for energy use, while 18 per cent have measures to reduce food waste.

Figure ES.5 Countries with national clean residential energy programmes

Source: UNEP survey data

Figure ES.6 Countries with incentives to promote sustainable agriculture practices (such as livestock manure management and use of organic fertilizers)



Source: UNEP survey data

Non-sectoral air quality management actions

Whereas action across the key sectors listed above is likely to significantly reduce air pollution, sectoral measures need to be supported by enabling policy frameworks (including air quality standards) and air quality management capacities. The 2016 assessment found gaps in terms of the accompanying laws and regulations that would facilitate the implementation and enforcement of air pollution standards and strategies. In order to address these gaps and assess progress going forward, the 2021 report introduces two key air quality management aspects into its analysis: (i) air quality management strategies, and (ii) air quality monitoring. Further, the UNEP Regulating Air Quality report (2021) provides information on the uptake of air quality standards in national legislation, which allows for a comparison with the UNEP 2016 report.

For the two new elements, i.e. air quality management strategies and air quality monitoring, it is not possible to measure progress made over the past five years.

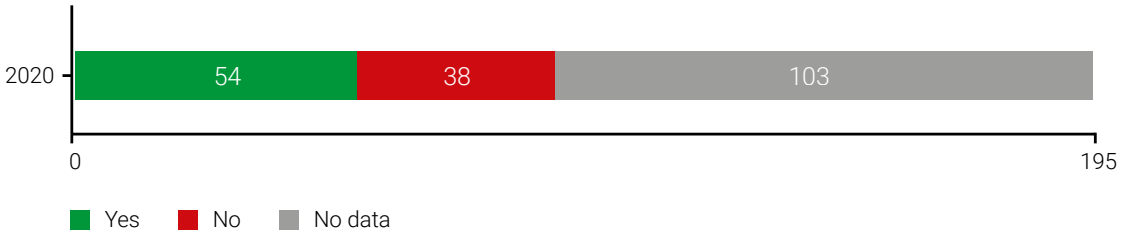
More than a quarter of countries have a national air quality management strategy

The survey responses to this question do not provide a comprehensive picture of how many countries have a dedicated national air quality management strategy. The responses received indicate that three key approaches are being used to implement air quality management strategies: most commonly a national air quality action plan, followed by sectoral plans, clean air acts and other approaches, sometimes combined (Figure ES.7).

A significant majority of countries have legal instruments containing ambient air quality standards

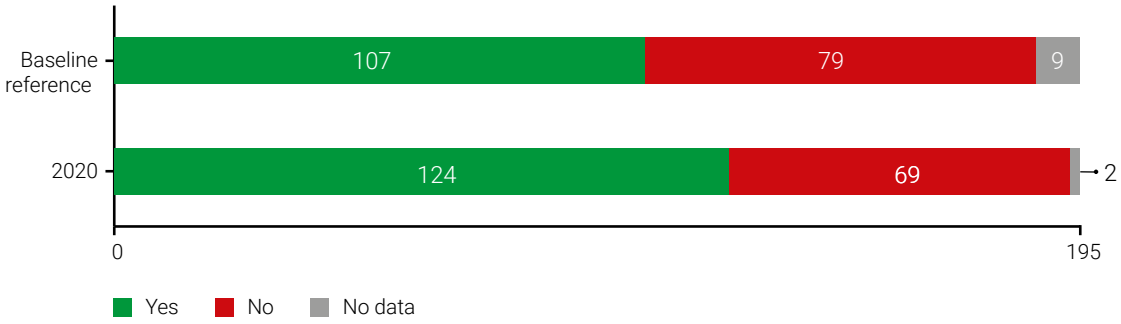
In 2020, 124 countries (about two thirds) were found to have ambient air quality standards, compared with 107 countries in the 2016 report. More than one fifth of countries are in the process of reviewing or updating those standards and nearly another fifth have plans to introduce standards in legislation in the near future (Figure ES.8).

Figure ES.7 Countries with a national air quality management strategy/framework/plan of action in place



Source: UNEP survey data

Figure ES.8 Countries with ambient air quality standards embedded within a legal instrument



Source: UNEP survey data

Air quality monitoring is expanding through a variety of approaches, but many countries still lack reliable routine networks

Countries are increasingly establishing air quality monitoring networks, with most using a combination of mobile and stationary reference monitors, though some are reliant on low-cost sensors and others use a hybrid of mobile and stationary reference monitors. The 34 countries without "continuous monitoring" and the 104 with no data represent existing data and capacity gaps which hinder global action on air quality (Figure ES.9).

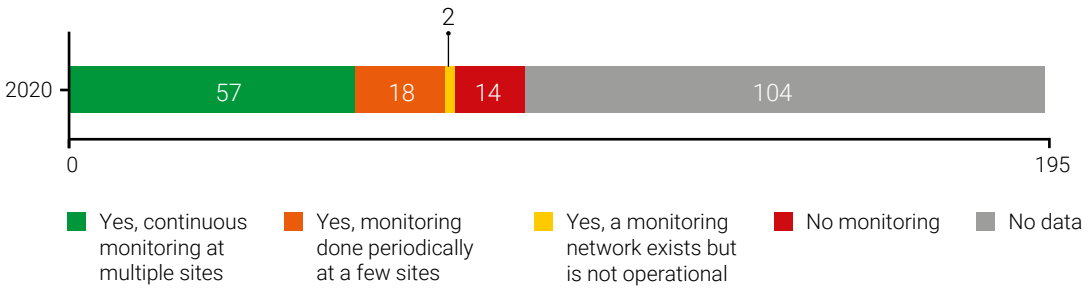
Conclusions

The findings of this report indicate that while progress can be observed across the sectors in adopting key policies and actions that are known to reduce air pollution, significant gaps remain.

The analysis quantifies the extent of uptake of key measures by countries, but it does not take into account implementation or lack thereof. This edition of the Actions on Air Quality report nevertheless acknowledges the barriers in day-to-day implementation of air quality management programmes, including staff retention, capacity gaps, and affordability and maintenance challenges of air quality monitoring equipment. Countries are also facing larger, systemic challenges such as financing gaps that can result in an inability to invest in data analysis, and a lack of enforcement capacity when policies and actions are adopted.

UNEP will continue to track efforts to improve air quality. This report seeks to set benchmarks in assessing current and future progress in policy action towards cleaner air. As such, it is subject to continuous improvements in underlying data and methodology.

Figure ES.9 Countries with national ambient air quality monitoring networks



Source: UNEP survey data

Continuous tracking of progress in taking action to improve air quality is important, as it helps inform and promote accelerated action. It can be used to catalyse support to address the identified capacity gaps at the national, regional and global levels, including efforts undertaken in response to UNEA resolutions, the 2030 Agenda for Sustainable Development, international agreements, and other relevant frameworks for action, including the International Day of Clean Air for blue skies and as part of global efforts and coalitions to promote integrated policies on air quality and climate.

A waste picker is collecting reusable or rec
Photo credit: © Shutterstock/ MOHAMED ABDULRAHEEM

Photo credit: © Shutterstock/nmedia

1. AIR QUALITY POLICY ACTIONS WORLDWIDE

A. Introduction

The single greatest environmental risk factor for premature death globally is air pollution, which is also the fourth-highest risk factor for premature death after high blood pressure, tobacco and diet. In 2019, more than 92 per cent of the world's population lived in areas that exceeded the WHO guideline for healthy air (Health Effects Institute and Institute for Health Metrics and Evaluation 2020). In 2016, 94 per cent of air pollution-related premature deaths occurred in low- and middle-income countries (World Health Organization [WHO] 2018d).

Estimates of the scale of the impact vary due to the complexity in extrapolating health data across the globe, especially in regions where air quality monitoring is inconsistent or non-existent (Ostro *et al.* 2018). Current estimates are based on the World Health Organization's Data Integration Model for Air Quality (DIMAQ) (WHO 2018a) and the Global Burden of Disease (GBD) project, led by the Institute for Health Metrics and Evaluation (IHME).[2] These data sources estimate that more than 4 million premature deaths (approximately 4.2 million according to WHO 2018b or 4.1 million according to the Health Effects Institute and Institute for Health Metrics and Evaluation [HEI and IHME] 2020) are caused every year by ambient (outdoor) air pollution.[3]

In addition to this risk – as highlighted in chapter 6 of this report – an estimated 2 to 4 million premature deaths (3.8 million according to WHO 2018c or 2.3 million according to HEI and IHME 2020) are attributable to household air pollution in or near the home as a result of residential biomass burning and kerosene use for cooking, heating and lighting. Women and children may be disproportionately affected.

The combined effects of ambient and household air pollution leads to an estimated 7 million deaths each year (7.0 million, WHO 2018d; 6.7 million, HEI and IHME 2020), including half a million infants in their first month of life (HEI and IHME 2020).

These burden of disease calculations include stroke, heart attack, chronic obstructive pulmonary disease (COPD), lung cancers, acute lower respiratory infections (ALRI), type 2 diabetes mellitus, and the recently added associations with low birth weight and short gestation (Global Burden of Disease 2019 Risk Factor Collaborators 2019). Left out of these statistics are the serious health consequences that have been associated with air pollution in the scientific literature, but for which data and/or methods do not yet exist in order to estimate attributable disease burdens on a global scale, or for which more research is needed to establish causal attribution in a rigorous and statistically robust way. For example, studies have identified associations between air pollution and asthma (Khreis *et al.* 2017, Anenberg *et al.* 2018, Achakulwisut *et al.* 2019), cognitive decline (Power *et al.* 2016, Peters 2018) and dementia in later life (Carey *et al.* 2018), pregnancy loss (Ha *et al.* 2018, Kioumourtzoglou *et al.* 2019) and infant mortality (Heft-Neal *et al.* 2018). As the research continues to develop, and more of these health outcomes are incorporated into the GBD estimates, the air pollution-related disease burden is likely to change over time.

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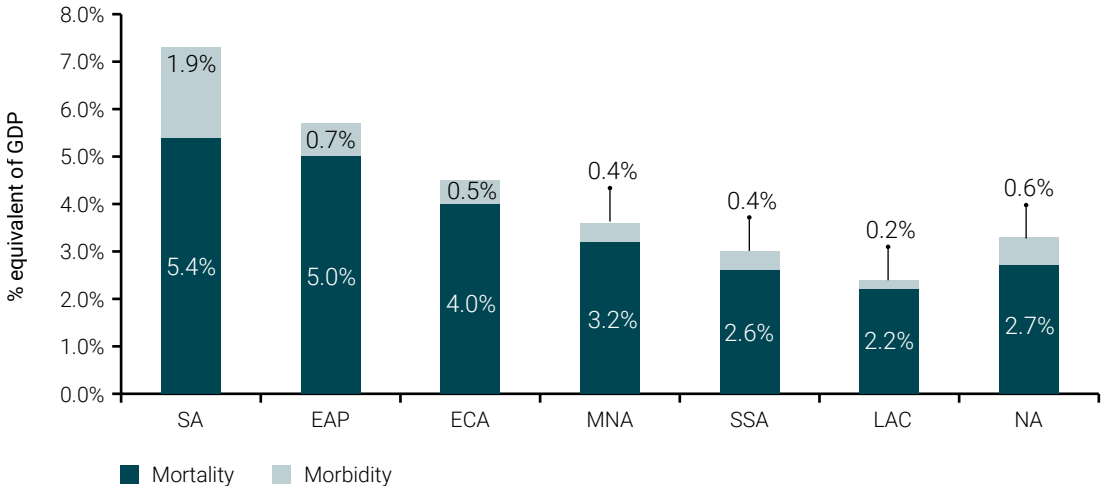
2 The current report will rely on both GBD and WHO data, noting that the relatively small differences arise due to methodological choices of pollutant concentrations, baseline disease rates, and relative risk estimates. The fact that these two estimates are so similar is an indication of confidence in the large magnitude of the burden.

3 The burden listed is due to ambient concentrations of fine particulate matter with a diameter of 2.5 micrometres or smaller (i.e. fine particle pollution). This represents the vast majority (approximately 92 per cent) of the burden currently estimated for all air pollution. Ground-level ozone contributes a significantly smaller burden (around 8 per cent). Other air pollutants contribute to the burden of disease but are not assessed in global statistics that are readily available.

Figure 1. Annual global health cost of mortality and morbidity caused by exposure to $PM_{2.5}$ air pollution in 2016, represented as a percentage of GDP, by region for 2016



Note: EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and the Caribbean; MNA = Middle East and North Africa; NA = North America; SA = South Asia; SSA = Sub-Saharan Africa.
Source: Reproduced from World Bank 2020a

In addition to its serious consequences for public health, air pollution has negative effects on welfare costs and economic activity. The annual global welfare (non-market) costs of premature deaths from outdoor air pollution, calculated using estimates of the individual willingness-to-pay to reduce the risk of premature death, have been estimated at between USD 3 trillion (Organisation for Economic Co-operation and Development [OECD] 2016) and USD 5.7 trillion (World Bank 2020a)[4] in 2016. They are projected to rise to between USD 18 trillion and 25 trillion in 2060 (OECD 2016).

The World Bank figure of USD 5.7 trillion is equivalent to 4.8 per cent of global gross domestic product (GDP).[5] By region, the cost in 2016 ranged from an equivalent of 2.3 per cent of GDP in Latin America and the Caribbean to 5.7 per cent in East Asia and the Pacific and 7.3 per cent in South Asia (Figure 1).

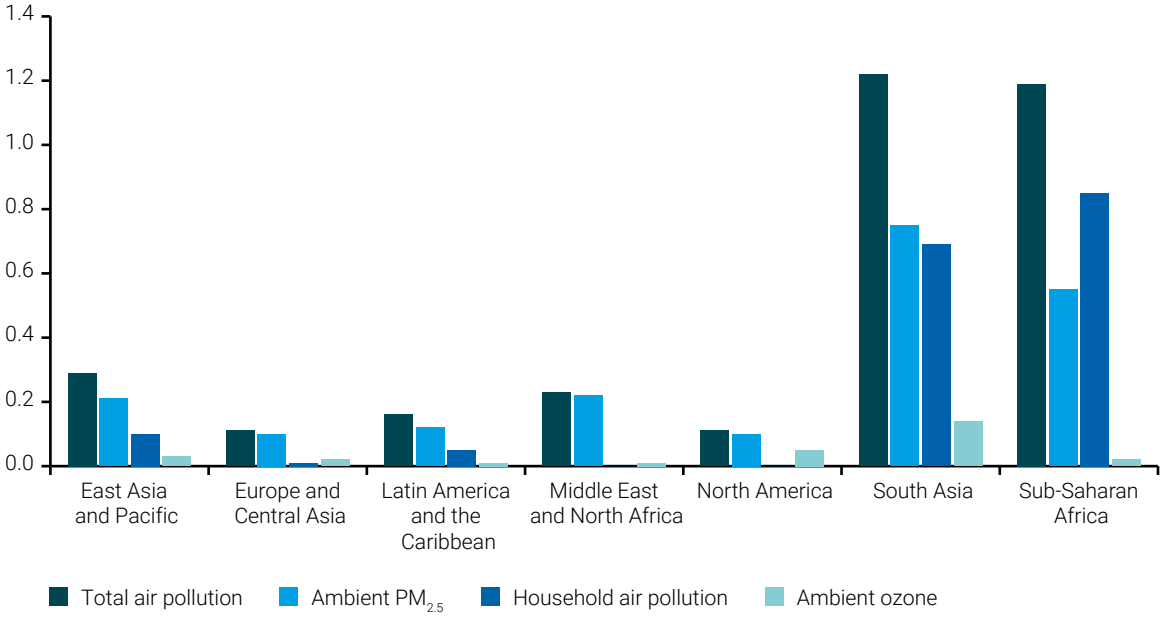
Air pollution has large welfare costs to governments around the world

Using an alternate methodology – not accounting for the welfare value that the public places on living healthy lives – and focusing only on the direct impact to financial flows associated with losses in worker productivity and earned income as a result of air pollution, the World Bank has developed an adjusted net savings metric (Lange, Wodon and Carey 2018) that measures the loss of actual GDP due to fine particle air pollution ($PM_{2.5}$) and shows serious economic harm in the regions that can least afford it (Figure 2).

4 The OECD methodology includes market and non-market effects of fine particles and ozone on health (mortality and morbidity) and agriculture (reduced crop yield) based on 2013 baseline data in 2010 purchasing-power-parity (PPP)-adjusted USD ("international dollars", see next footnote). In contrast, the World Bank approach includes mortality and morbidity due to fine particle pollution only. However, the World Bank methods are based on updated 2016 exposure-response functions from the GBD 2016, which show quantitatively larger risk of health damage (mortality of 4.1 million) relative to 2013 (mortality of 2.9 million), and are expressed in 2011 PPP-adjusted USD. Both reports use a similar value of a statistical life (USD 3 million versus USD 3.8 million based on OECD member states), with slightly different benefits transfer approaches.

5 Global health cost and GDP are stated in PPP-adjusted USD. GDP in PPP-adjusted USD allows for a comparison of the purchasing power of GDP of different countries. Here, the welfare-related global health cost is expressed as a percentage of GDP only to provide a convenient sense of relative scale.

Figure 2. Annual labour income losses due to air pollution, represented as a percentage of GDP, by region for 2015



Note: GDP = gross domestic product; $PM_{2.5}$ = = particulate matter with a diameter of less than 2.5 microns.
Source: Reprinted from Lange, Wodon and Carey 2018, Figure 9.7

Air pollution also has large direct costs to governments around the world

Against these costs of inaction, the costs of action should be considered, which have been shown to be far less. Regional and global analyses have shown action on air quality to be extremely cost-effective (United Nations Environment Programme [UNEP] 2018; Markandya *et al.* 2018), with benefits sometimes exceeding costs by a factor of 30 (United States Environmental Protection Agency [US EPA] 2011).

These statistics make the imperative for action clear. Recognizing the growing global threat of air pollution, the United Nations Environment Assembly (UNEA) adopted resolution 1/7 on *Strengthening the role of the United Nations Environment Programme in promoting air quality* in June 2014. The third session of UNEA built on this commitment through resolution 3/8 on *Preventing and reducing air pollution to improve air quality* globally, which requested, in its paragraph 7(j) inter alia, that UNEP "undertake an assessment of progress being made by countries to adopt and implement key actions that can significantly improve air quality, in time for UNEA-5 and thereafter, synchronized with the Global Environment Outlook cycle."

UNEP's Actions on Air Quality report (UNEP 2016) provided an overview of actions undertaken by countries around the world, focusing on a set of measures that, if adopted, would significantly improve air quality. Building on that report, UNEP has since developed this updated global assessment of policy action using a detailed survey questionnaire of countries. This is supplemented by a set of six regional reports (Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, North America and West Asia) documenting, in greater detail, the status of key actions being undertaken by governments in these regions to improve air quality. Annex A to this report provides methodological details of the survey development and administration as well as the approach taken to develop this global report and the regional reports.

B. Trends in sectoral and non-sectoral air quality management actions

This report provides an assessment of actions in key sectors that contribute to air pollution in most countries,[6] including industrial emissions (chapter 3), transportation (chapter 4), solid waste management (chapter 5), household air pollution (chapter 6) and agriculture (chapter 7). Each of these chapters begins with a box identifying the trends in policies and programmes that address each sector.

Whereas action across the key sectors listed above is likely to significantly reduce air pollution, sectoral measures need to be supported by enabling policy frameworks (including air quality standards) and air quality management capacities. The 2016 assessment found gaps in terms of the accompanying laws and regulations that would facilitate the implementation and enforcement of air pollution standards and strategies. In order to address these gaps and assess progress going forward, the 2021 report introduces two key air quality management aspects in its analysis: (i) air quality management strategies, and (ii) air quality monitoring. Further, the UNEP Regulating Air Quality report (2021) provides information on the uptake of air quality standards in national legislation, which allows for a comparison with the UNEP 2016 report.

For the two new elements (air quality management strategies and air quality monitoring), it is not possible to measure progress made over the past five years.

The survey responses to this question do not provide a comprehensive picture of how many countries have a dedicated national air quality management strategy. The responses received are examined in chapter 2. They indicate that three key approaches are being used to implement air quality management strategies: most commonly a national air quality action plan, followed by sectoral plans, clean air acts and other approaches, sometimes combined.

Box 1: Fiscal policy reform and pollution: A focus on subsidies

A recent focus of policy interest has been the evaluation of government fiscal policies that may have been well-intended when implemented, but which nevertheless have a role in encouraging pollution, spanning all sectors. Motivated by Sustainable Development Goal (SDG) indicators that examine fossil fuel subsidies, many institutions – including UNEP (2019b), UNEP, OECD and the International Institute for Sustainable Development (IISD) (2019) and the OECD (Elgouacem 2020) – have looked at ways that fiscal policies can reduce pollution and accelerate progress toward cleaner technologies, including in the context of fiscal recovery from the effects of COVID-19 (International Monetary Fund [IMF] 2020).

Often, these policies are complementary to other sector-specific regulations or policies and can synergistically encourage behavior change and technology shift depending on the elasticity of demand, availability of alternatives and a given policy framework (UNEP 2019b). While the most obvious examples include reducing fossil fuel subsidies, each sector has an opportunity to examine fiscal policies that could incentivize energy-efficient industries, electrify vehicle fleets, finance sanitary waste collection and disposal, or reduce fertilizer use. Aligning fiscal policy to support action to improve air quality across all sectors can shift consumer and business behavior towards greater sustainability and cleaner air.

[6] Wildfires are also a significant transient, intermittent source of air pollution in specific regions (such as California, Australia and Russia), whereas forest fires and peatland fires are a more routine contribution to air pollution in the Asia and the Pacific region. This aspect is explored in greater detail in the regional report.

In 2020, 124 countries (about two thirds) were found to have ambient air quality standards, compared with 107 countries in the 2016 report. More than one fifth of countries are in the process of reviewing or updating those standards and nearly another fifth have plans to introduce standards in legislation in the near future.

Countries are increasingly establishing air quality monitoring networks, with most using a combination of mobile and stationary reference monitors, though some are reliant on low-cost sensors and others use a hybrid of mobile and stationary reference monitors. The 34 countries without "continuous monitoring" and the 104 with "no data" represent existing data and capacity gaps which hinder global action on air quality.

C. Objective and approach of the present report

The objectives of this report are to provide an update on trends in policy actions that countries have taken since 2016 and to highlight some of the barriers and challenges that states are facing in implementing these measures. UNEP intends to update this report at regular intervals, consistent with the mandate under resolution 3/8. The next update is planned for 2024. UNEP is considering whether more frequent reporting is useful and feasible. If resources are available, it will undertake more regular tracking and use an online data platform to help identify gaps and needs for accelerated action towards cleaner air.

This report does not present a baseline assessment of air pollution conditions, emissions trends nor modelling of air pollution concentrations and impacts. The reader is directed to UNEP's comprehensive report Global Environment Outlook – GEO-6: Healthy Planet, Healthy People to find this information (UNEP 2019a).[7]

A survey that was shared with countries in 2020 forms the basis for this report. To complement the survey data, which are somewhat limited by country response, additional context is presented for each sector. This relies on a variety of global metrics and sources that reinforce the findings of the survey data, providing additional insights and paving the way to build on the survey data in subsequent updates.

The pollution detector station of the Chief Inspector of Environmental Protection, Warsaw, Poland, November 17, 2018 r. Poland has some of the most polluted air in the European Union. Photo credit: © Shutterstock/HAL-9000

[7] The GEO-6 report goes beyond air quality (chapter 5), outlining the current state of the environment, illustrating possible future environmental trends, analysing the effectiveness of policies, and identifying remaining knowledge and data gaps.

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2. GLOBAL AND REGIONAL STATUS OF AIR QUALITY POLICY

A. Status of ambient standards

Countries – along with their relevant stakeholder organizations – have taken a wide variety of governance approaches and employed various policy instruments to help mitigate the impacts of air pollution (UNEP 2019a). These include:

- planning regimes, such as binding action plans and agreements to achieve standards or emission ceilings through environmental assessments (e.g. U.S. State Implementation Plans and multi-state regional planning organizations, the European Union's Clean Air Policy Package, the Convention on Long-range Transboundary Air Pollution (CLRTAP, see text box), the Association of Southeast Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution)
- "command and control" performance standards that require accountability frameworks for tracking progress (e.g. the United States Environmental Protection Agency (US EPA) New Source Performance Standards, the European Union's Industrial Emissions Directive 2010, the Korean Emission Limit Values for point sources)
- market interventions including taxes, fees, subsidy reform or market-based permit allocations (e.g. the European Emissions Trading System, the US EPA Acid Rain Program, China's new national emissions trading scheme)
- public information, including product labelling, national monitoring programmes and air quality forecasting, and citizen science initiatives (e.g. the US EPA ENERGY STAR labelling programme, the World's Air Pollution: Real-time Air Quality Index, OpenAQ), and
- cooperative frameworks and partnerships between countries and across sectors to voluntarily reduce emissions (e.g. the 2019 United Nations Clean Air Initiative, the UNEP International Declaration on Cleaner Production, the Global Methane Initiative, the Climate & Clean Air Coalition, BreatheLife)

While there are successful examples of each of these approaches, the traditional approach to emissions control through technology standards (the command and control standards listed above) has been highly effective where regulatory authority and enforcement capacity exist (UNEP 2019) and continues to serve as a primary policy tool. Especially in the area of household air pollution (chapter 6), public information campaigns have a larger role to play, given the need for greater awareness of the disproportional impact on women and girls (see text box in chapter 6).

Since the last assessment, 17 more countries have adopted legal instruments containing ambient air quality standards, thereby increasing the portion of the globe with this basic protection in place. Much of this progress was in Africa and Latin America, but some Eastern European countries have also added a standard for at least one pollutant (see Figure 3).

UNEP recently completed a comprehensive assessment of the legal status of all countries ambient air quality standards (UNEP 2021), which found that approximately 64 per cent of the 194 states (and the European Union) reviewed[8] include their ambient standards within a legal instrument. The review also notes that more than one fifth of countries are in the process of reviewing or updating those standards, while nearly another fifth have plans to introduce standards in legislation in the near future (UNEP 2021).

[8] That review included all United Nations Member States, plus the observer states of the Holy See and State of Palestine.

Case study 1: Convention on Long-range Transboundary Air Pollution (CLRTAP)

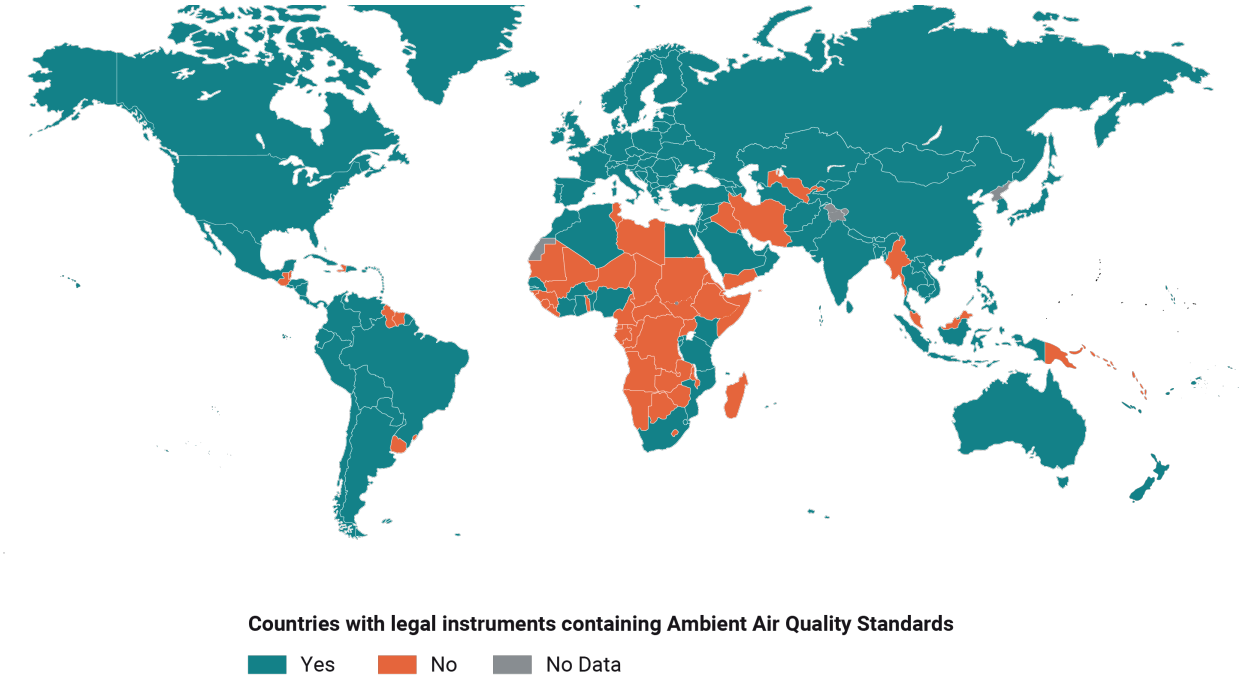
This 1979 convention was the first multilateral agreement to address transboundary air pollution. It created a regional framework to address environmental problems in the United Nations Economic Commission for Europe (UNECE) region related to transboundary air pollution and to better understand air pollution science. With 51 parties across the northern hemisphere at present, CLRTAP has contributed to a dramatic decline in air pollution emissions (particularly sulphur emissions) in the region, and economic growth and air pollution trends have been progressively decoupled.

More than 40 years after it was introduced, the convention continues to adapt successfully. This includes through amendments that have strengthened many of the protocols that parties to the convention continue to ratify and implement.

The convention's solid scientific underpinning was important in terms of air pollution abatement. It was established by developing a common knowledge base, including scientific infrastructure aimed at joint monitoring and modelling programmes, which includes an extensive international network of scientists from various disciplines. By providing a platform for scientists and policymakers to exchange information, the convention has led to innovative approaches and created mutual trust and learning. A new coordinating group of the countries in the Eastern Europe, the Caucasus and Central Asia (EECCA region) has enhanced these countries' joint efforts to ratify CLRTAP protocols. A capacity-building programme has resulted in notable progress in the EECCA countries' involvement in the convention's work, building on the long history of progress under CLRTAP.

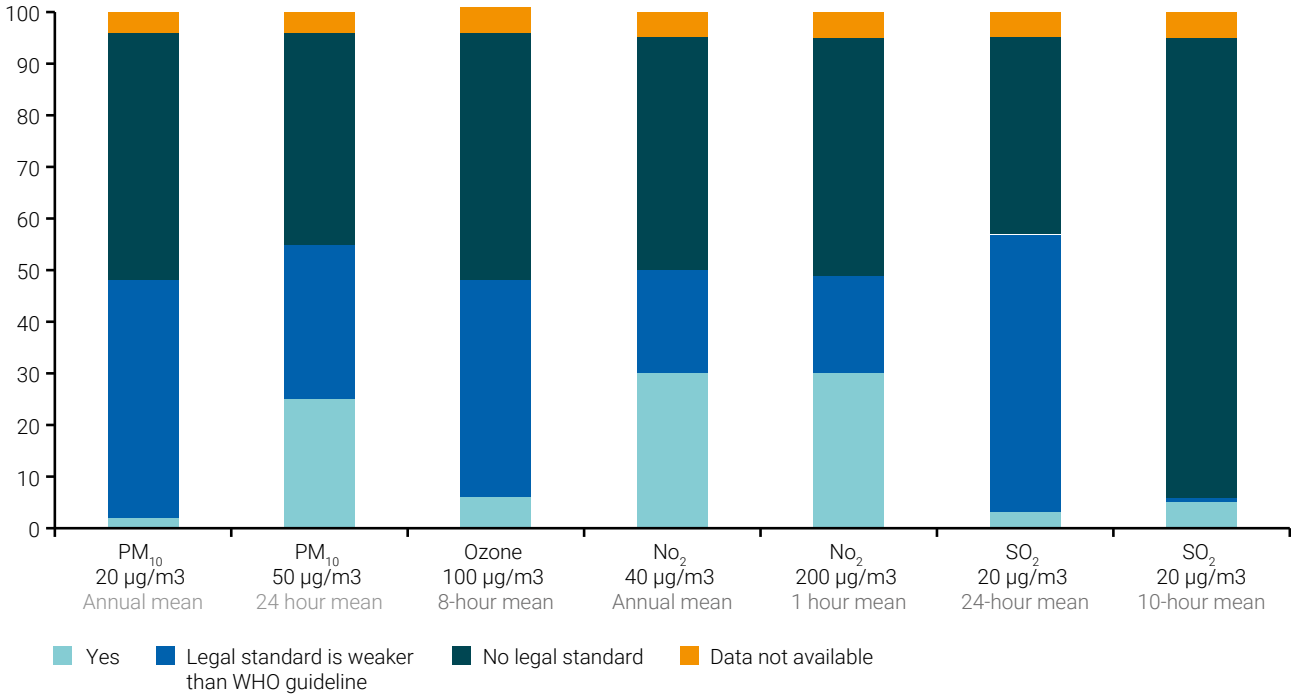
(Source: US Department of State, UNECE's European Regional Report)

Figure 3. Countries with national ambient air quality standards in 2020



Source: Reproduced from UNEP 2021

Figure 4. Legal incorporation of 2005 WHO air quality guidelines (AQGs) into national ambient air quality standards

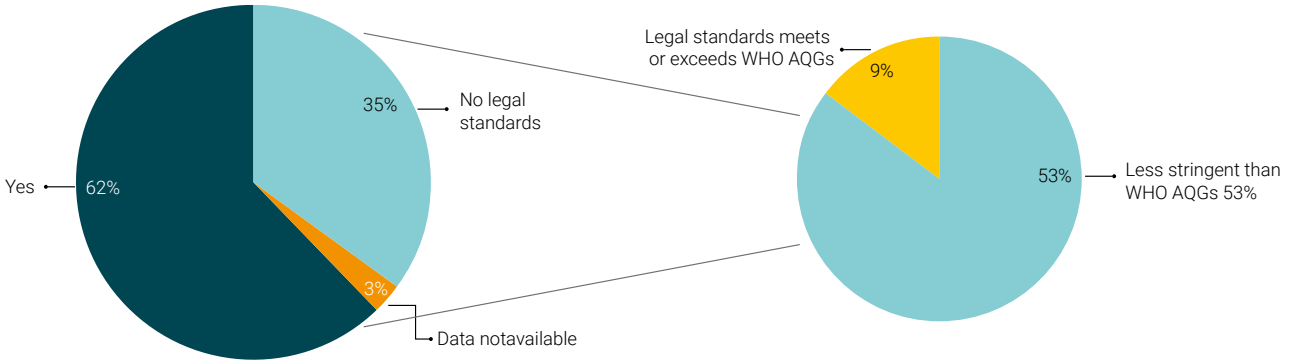


Source: Reproduced from UNEP 2021

More than 95 per cent of countries with ambient air quality standards are regulating PM_{10}, ozone, nitrogen oxides (NOx) and sulphur dioxide (SO_2) and 90 per cent are regulating $PM_{2.5}$, which is the largest contributor to the long-term public health burden from ambient air pollution. However, relatively few of these standards are as stringent as the WHO air quality guidelines (see Figure 4, reproduced from UNEP 2021). Adoption of WHO guidelines varies by pollutant, with WHO guidelines for NO_2 being more likely to be adopted in law than that guidelines for ozone – despite ozone's devastating impact on both health and ecosystems.

The results for $PM_{2.5}$ are set out separately in Figure 5, since the incorporation of WHO guidelines for $PM_{2.5}$ has been noted as being an issue of particular concern in air quality policy globally. Around 9 per cent of countries have ambient air quality standards for $PM_{2.5}$ that meet WHO guidelines.

Figure 5. Legal incorporation of WHO air quality guidelines (AQGs) for $PM_{2.5}$ into national ambient air quality standards



Source: Reproduced from UNEP 2021

Many countries may benefit from setting standards consistent with WHO interim targets and moving progressively towards full compliance with WHO guidelines over time.

While progress towards establishing ambient air pollution standards is encouraging, UNEP survey data indicate that more than 20 per cent of respondents from Latin America and the Caribbean, Africa, and Asia and the Pacific do not yet have these standards in place.

B. Finance for comprehensive air quality management planning

Even when standards are in place, there are practical limitations on their enforcement, often as a result of inadequate public funding for air quality management planning efforts in municipal, state and national governments. According to Eurostat data, European countries – where enforcement programmes are relatively successful at curbing exceedances of national standards – on average invest about 0.25–1.0 per cent of GDP in environmental protection, including waste management and enforcement capacity (Figure 6). The lack of this level of investment by some countries reflects the competing development priorities that they face. Reframing air quality management efforts to consider the multiple development benefits associated with emission reductions and cleaner air could motivate further investment (World Bank and ClimateWorks Foundation 2014).

Governments in Europe spend between 0.25 per cent and 1 per cent on environmental protection, enabling enforcement

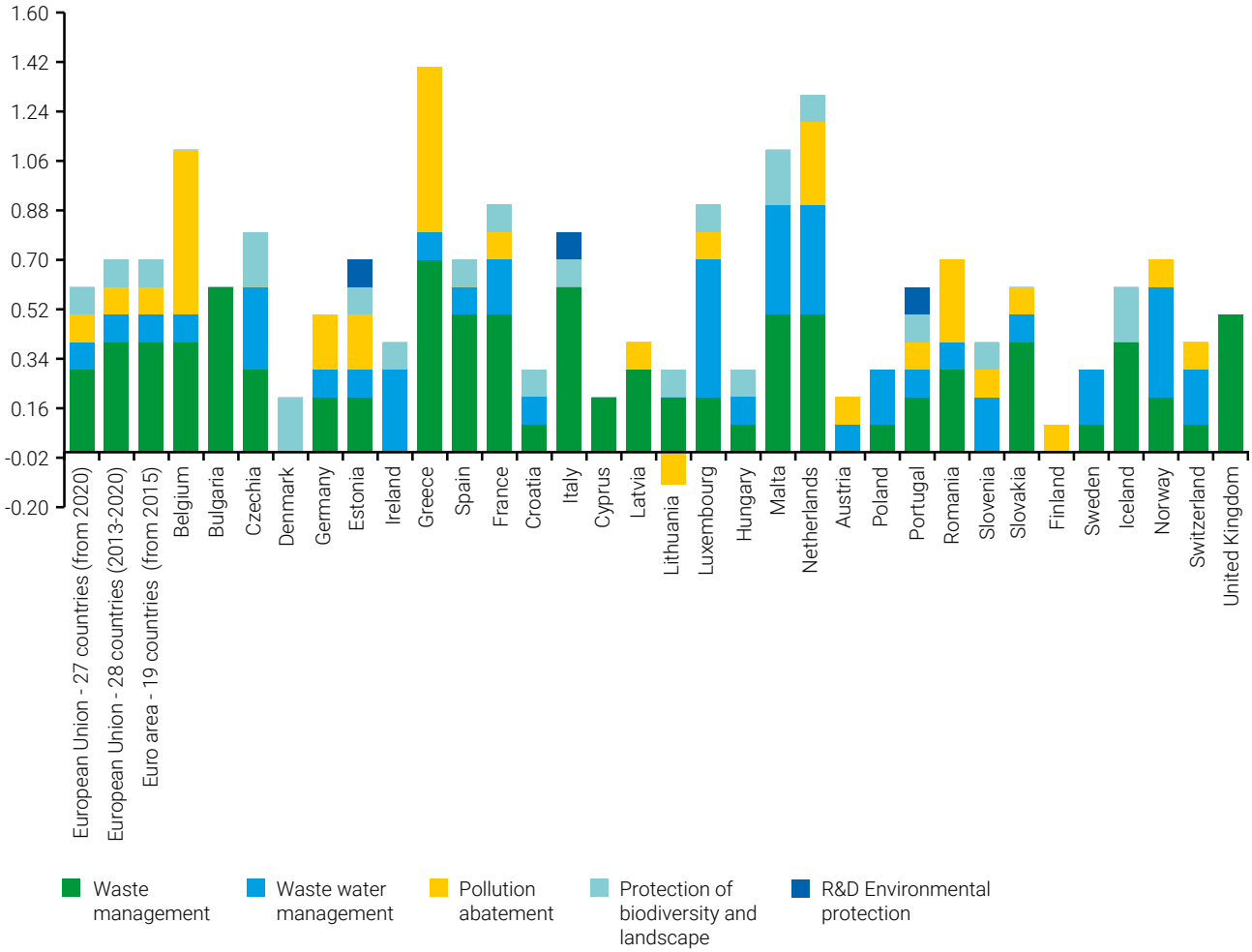
Adequate funding and resources is only one of the requirements for effective air quality management planning, which also requires effective policy design that includes public processes with stakeholder engagement and that considers implementation issues such as financing of measures, the appropriate level of authority to implement measures (i.e. national or municipal) and enforcement capacity. Comprehensive air quality management planning includes air quality monitoring, emission inventory development, source attribution and modelling, health impact assessment, and decision-support analysis (e.g. cost-benefit or cost-effectiveness analysis) that examines the multiple benefits of emission reductions. While a complete discussion of each aspect of air quality management planning is beyond the scope of this report, the recent survey undertaken by UNEP did include questions about air quality monitoring and air quality management, which are key to understanding the magnitude of the challenge that many countries face.

C. Air quality monitoring and management: implementation approach

As noted in chapter 1, many countries have established air quality monitoring networks, with most using a combination of mobile and stationary reference monitors, though some are reliant on low-cost sensors and others use a hybrid of mobile and stationary reference monitors. Survey data suggest that increased use of low-cost sensors and greater awareness of air pollution resulting from access to these sensors and other data are also playing a role in increasing public demand for enhanced global action on air quality. Satellite observations are also increasingly used to provide information on air pollution levels in countries worldwide, though they still need to be validated using ground-level monitoring (Alvarado *et al.* 2019).

As Figure 7 shows, a number of countries (predominantly in Africa, Latin America and the Caribbean, and Asia and the Pacific) either have no monitoring in place or are limited to periodic monitoring at only a few sites. Some countries that have continuous monitoring at multiple sites still do not have enough monitors to adequately characterize exposure for the size of the population. In fact, 60 per cent of countries, accounting for 1.3 billion people (18 per cent of the global population), have no routine, annual ground-based monitoring of $PM_{2.5}$ at all. Monitor density is particularly low in Africa, averaging just 0.03 per million inhabitants – far too low for air quality management for these 1.2 billion people (Martin *et al.* 2019).

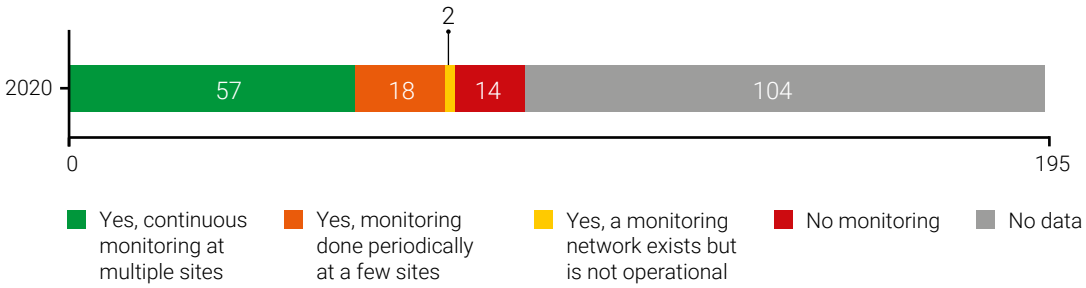
Figure 6. Total general government expenditure on environmental protection in the European Union, 2018 (as a percentage of GDP)



Time frequency Annual
Unit of measure Percentage of gross domestic product (GDP)
Sector General government
Classification of the functions of government (COFOG 1999) Environmental protection
National accounts indicator (ESA 2010) Total general government expenditure

Source: European Union 2018

Figure 7. Countries with national ambient air quality monitoring networks



Source: UNEP survey data

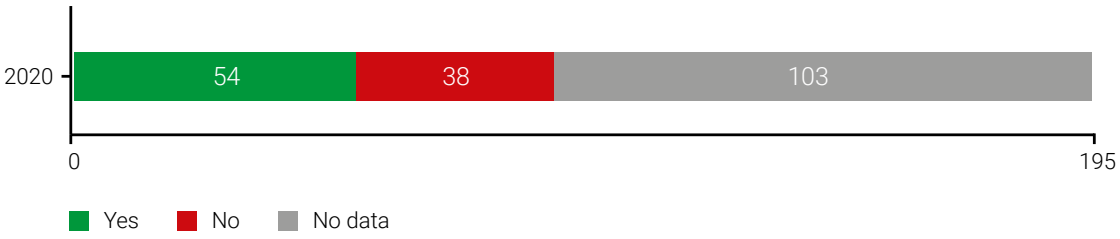
With respect to more general air quality management implementation, the survey responses to this question do not provide a comprehensive picture of how many countries have a dedicated national air quality management strategy. The responses received indicate that three key approaches are being used to implement air quality management strategies: 40 per cent of responding countries implement their programmes through a national action plan, while the remaining 60 per cent is roughly split between a clean air act (legislation), sectoral plans or some other means, often at the subnational level (see Figure 8 and text box on **subnational action**).

D. Non-financial barriers or obstacles to air quality action

While public awareness is growing and many governments around the world have directed energy and resources towards monitoring air pollution, there remain serious barriers that prevent many countries from achieving greater progress on air quality action. Significant capacity gaps remain for many low- and middle-income countries (LMICs) and guidance is needed across the range of air quality management components mentioned above (e.g. inventory, modelling, regulatory design). This guidance must be differentiated by capacity level, so that those countries that are just beginning air quality management planning can find the level of instruction and support that is appropriate to their existing level of engagement.

As disparities in exposure are also correlated with disparities in socioeconomic development status, environmental justice is also a key issue for inclusion in such guidance. On a global level, the resource constraints that LMICs face – as well as other capacity challenges – are evidenced in the disparities in monitoring discussed above. Emission inventory development is far less expensive than air quality monitoring, yet a lack of guidance and a lack of government transparency may be barriers to developing this relatively simple means of tracking and addressing pollution. Guidance can be developed to overcome these challenges and ensure adequate air quality knowledge in ministries where institutional memory is short due to rapid turnover of key staff.

Figure 8. Countries with a national air quality management strategy/framework/plan of action in place



Source: UNEP survey data

Case study 2: Subnational action on air quality

While many countries are establishing comprehensive air quality management planning programmes, many states, cities and businesses are taking action on their own. This has resulted in a wide array of air quality plans, citizen-science air quality initiatives, and integrated planning efforts that are sometimes breaking new ground for national governments to follow as "laboratories for innovation". For example:

- The C40 Cities network established "Deadline 2020", a routemap for their network members to set climate action plans, many of which include an Air Quality Annex that quantifies health co-benefits.
- The EuroCities network of 139 cities in 39 countries across Europe supports cities in their efforts to improve the environment and work towards achieving sustainable development by sharing knowledge and expertise. The network has piloted innovative approaches to cleaner air, including low emission zones, socio-spatial pollution mapping, non-motorized transport and climate-neutral transportation zones.
- Twelve north-eastern US states launched the Transportation and Climate Initiative, a market-based cap and trade approach to reduce transportation emissions. This complements the ten eastern US states that have had a regional cap and trade programme on power generation since 2009.
- An ever-increasing number of global businesses are seeing the opportunity in the zero-carbon economy and are making various low-carbon commitments through coalitions and partnerships such as: the We Mean Business Coalition, Ceres (Coalition for Environmental Responsible Economies), The Ambition Loop, the World Business Council for Sustainable Development, and the Carbon Pricing Leadership Coalition.

Girl child traveler alone sitting relaxing on rock in calm green rain forest far from the city away from pollution, Kerala, India. Taking deep breath with open hands in yoga pose inhale fresh air .Photo credit: © Shutterstock/Santhosh Varghese

Photo credit: © Shutterstock/Bildagentur Zoonar GmbH

3. INDUSTRIAL EMISSIONS

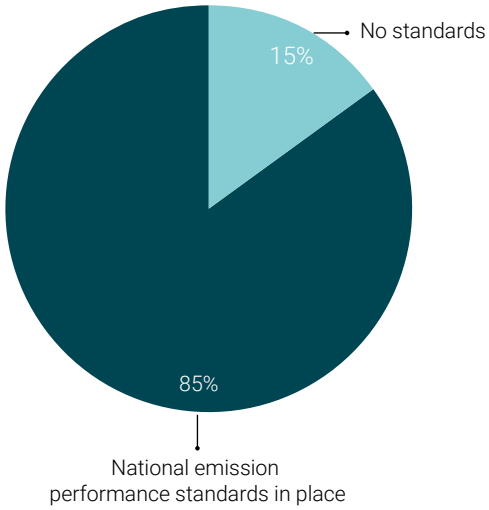
Chapter findings

In the **industrial sector**, the report indicates growing uptake of policy incentives for cleaner production and energy efficiency relative to the baseline reference analysis of 2016. While some of this progress may reflect a reduction in data gaps relative to the baseline data, increases are noted in some regions.

The most common approach to addressing industrial point source emissions (including thermal power generation stations) are emission performance standards. These standards are typically established at the national or state level with the issuance of an operating permit that establishes individual emission rates at the unit level and enables enforcement through continuous or intermittent stack emission monitoring. On top of these standards, a variety of other measures are used to reduce industrial emissions, including: (i) investment in renewable energy or energy efficiency, (ii) policies on efficient resource use, (iii) policies and legal structures to promote cleaner production (e.g. subsidy reform), and (iv) use of environmental impact assessments to regulate industries. The use of these instruments , which will vary by the fuel structure (e.g. gas versus coal) and industrial sectors (e.g. brick kilns versus chemicals) of individual countries, is explored in greater detail in the regional reports.

Survey data indicate that a high proportion of countries have national emission performance standards in place for the industrial sector (Figure 9).[9] However, there is room for further progress in some regions (Asia, Africa, and some European nations). Future surveys may also establish an independent focus on the power generation sector that is independent from policies that are specific to manufacturing industries, given the large share of fuel combustion that is consumed for electricity generation at present.

Figure 9. Percentage of responding countries with national emission performance standards in place for the industrial sector

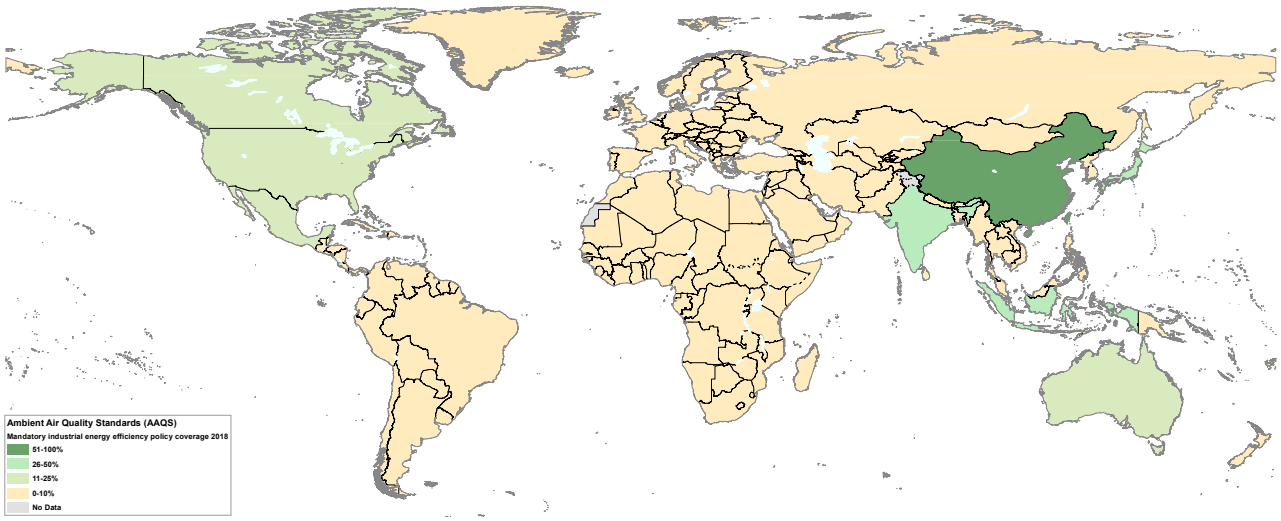


Source: UNEP survey data

While performance-based emission standards are critical to reducing emissions, a mandatory energy efficiency standard is an important complement to achieve further progress. In this regard, the

[9] Note that as the survey questionnaire did not specify between power generation and other industrial sectors, the more generic term "industrial sources" was used. Future versions of the survey may distinguish between these sources.

Figure 10. Coverage of mandatory industrial energy efficiency policies as a percentage in 2018



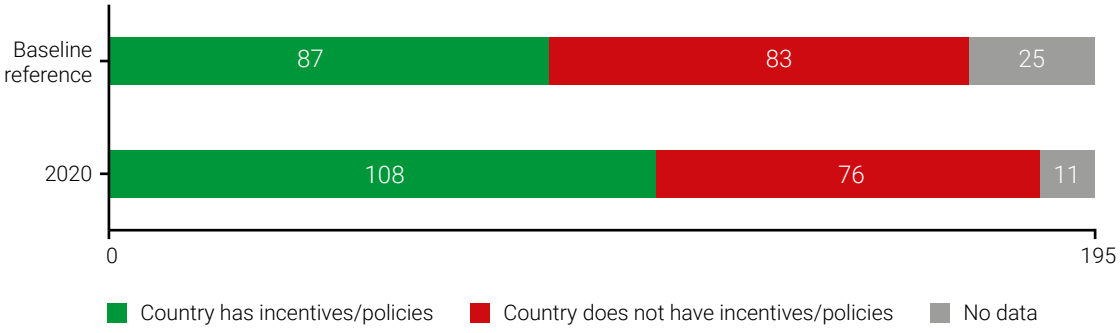
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.
Source: IEA 2020

International Energy Agency has found that far fewer regions have mandatory policies in place, as shown in Figure 10. In 2018, mandatory policy-driven energy efficiency targets and standards covered less than 50 per cent of total industrial energy use in most regions, with no major increases in coverage relative to the previous year (International Energy Agency [IEA] 2020).

Relatively few countries push industrial sources beyond standards through mandatory efficiency goals

While mandatory efficiency standards would help further reduce criteria pollutant emissions, and may be necessary to achieve carbon neutrality goals, the trend has been towards supporting voluntary efforts in the past four years. New UNEP survey data show growing uptake of policy incentives for cleaner production and energy efficiency relative to the baseline reference analysis of 2016 (see Figure 11), which relied on survey responses and a desk review.

Figure 11. Countries with incentives or policies promoting cleaner production, energy efficiency and pollution abatement for industries



Source: UNEP survey data

While some of this progress may reflect a reduction in data gaps relative to the baseline data (i.e. Europe), other increases are noted in Africa and in Asia and the Pacific. Countries report measuring the impact of these policies mostly through air quality monitoring and emission inventories.

Case study 3: Industrial pollution taxes in Chile

In September 2014, the Government of Chile approved a law that assesses taxes based exclusively on the PM, NOx, SO_2 and carbon dioxide (CO_2) emissions from industrial sources and thermo electric plants, setting minimum threshold emissions of 100 tons of PM and 25,000 tons of CO_2. The law aimed to make the existing tax structure "greener" by eliminating inequities for installed thermal power (> 50 thermal MW) that may have high seasonal emissions versus installed power, the emissions of which are more even throughout the year. The impact has been fairly dramatic, with nearly USD 390 million raised during 2017 and 2018 and PM levels dropping by approximately 7 per cent from the regulated industries. In addition, generators have agreed not to develop new coal-fired plants and to phase out existing ones.

(Source: IMF-UNEP-GIZ Green Fiscal Policy Network)

Case study 4: National Cleaner Production Centre South Africa (NCPC-SA)

The NCPC-SA is a national government programme that promotes the implementation of resource-efficient and cleaner production methodologies to assist industry to lower costs by reducing energy, water and materials usage and managing waste. It is hosted by the Council for Scientific and Industrial Research (CSIR) on behalf of the Department of Trade and Industry. The availability of this resource – coupled with the financial incentives introduced through the carbon tax in South Africa – has encouraged many industries to undertake process changes rather than simply implementing end-of-pipe controls to comply with minimum emission standards for SO_2.

Photo credit: © Shutterstock/moreimages

4. ON-ROAD TRANSPORT

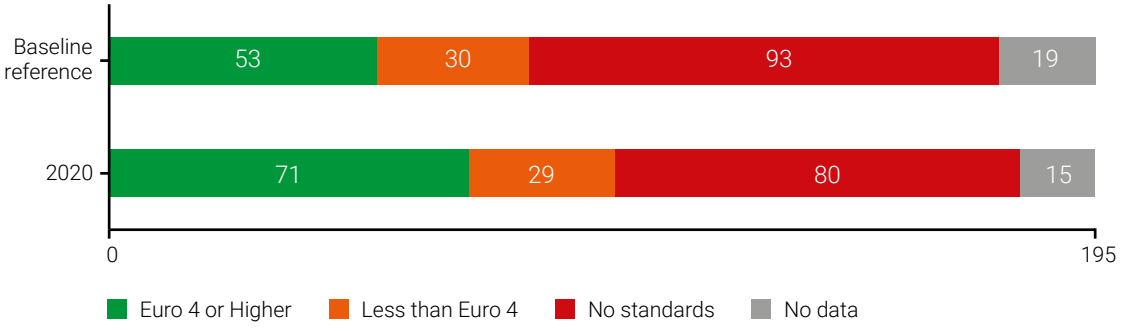
Chapter findings

Policies to reduce emissions from the **on-road transportation sector** remain critical in countries, especially their urban areas, around the world. The past five years have shown progress, with 18 additional countries adopting emission standards equivalent to Euro 4/IV or higher, bringing the total number of countries to 71. Twenty-nine countries have vehicle standards in place, but they are not yet up to Euro 4/IV stringency. UNEP tracks progress on tailpipe standards as well as fuel quality, which is a key aspect of successful implementation of vehicle emission standards. There is still significant progress to be made with regards to fuel quality, as highlighted in **chapter 4**. Electric mobility and active mobility (walking and cycling) are emerging as low-carbon mobility options for countries and cities, contributing to both air pollution reduction and climate change mitigation.

Modern transportation services – including on-road traffic – represent a large source of air pollution (approximately 25 per cent of fine particle pollution), especially in urban areas where concentrated emissions and a dense population can lead to significantly increased human exposure (Anenberg *et al.* 2019; Karagulian *et al.* 2015; Apte *et al.* 2012). Thus, policies to reduce emissions from the on-road transportation sector remain critical in countries, and especially their urban areas, around the world. The past five years have shown progress, with 18 additional countries adopting emission standards equivalent to Euro 4/IV or higher, bringing the total to 71 countries. Twenty-nine countries have vehicle standards in place, but they are not yet up to the Euro 4/IV standard (see Figure 12).[10] This still leaves tremendous room for progress over the coming years, as countries target the adoption of Euro 5/V and 6/VI vehicle emission standards to improve their urban air quality.

UNEP tracks progress on tailpipe standards as well as fuel quality, which is an important aspect of heavy-duty vehicle standards. Analysis (UNEP 2020a, shown

Figure 12. Countries meeting Euro 4/IV vehicle emission standard



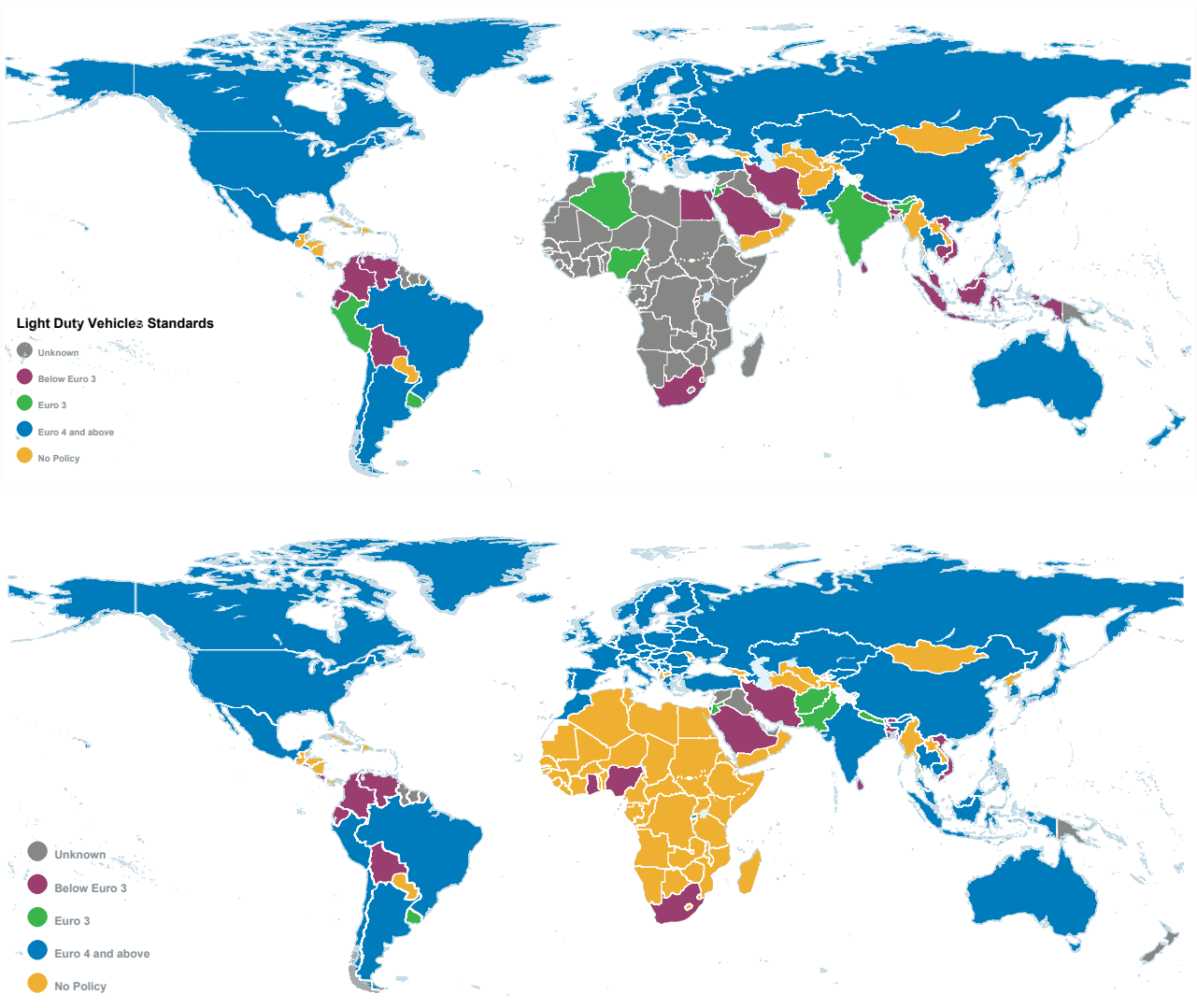
Source: UNEP survey data

[10] Light-duty vehicle emission standards are indicated using numerals (e.g. Euro 4), whereas heavy-duty vehicle emission standards are denoted with roman numerals (e.g. Euro IV). The survey instrument did not distinguish between them, so self-reported level of control is indicated as Euro 4/IV but may differ in some instances.

in Figure 13) demonstrates that the survey data are robust, with approximately half of the globe currently achieving Euro 4 levels for light-duty tailpipe standards for new vehicles. In addition, this analysis shows where progress has been achieved over the last four years, such as in India and Indonesia. The impact will depend on the turnover of the vehicle fleets from older vehicles to new vehicles.

Fuel quality is a key aspect of successful implementation of tailpipe standards. For Euro 6/VI, in particular, fuel sulphur content is a critical element of policy success since sulphur in fuels can foul the catalyst used in diesel particulate filters (DPFs) for heavy-duty vehicles as part of the Euro VI standards. Figure 14 demonstrates the progress made between 2016 and 2020 (note lower levels of sulphur in, for example, China, India, Southern and Western Africa). However, the figure (lower panel representing 2020) also shows that there is still significant progress to be made with regard to fuel quality, as a few places in Western and Southern Asia and much of Africa and Latin America still allow sales of fuel with higher than 500 parts per million (ppm) sulphur. This effectively prevents the adoption of Euro 6/VI tailpipe standards.

Figure 13. Map of light-duty tailpipe standards in 2016 (Top) and 2020 (Bottom)

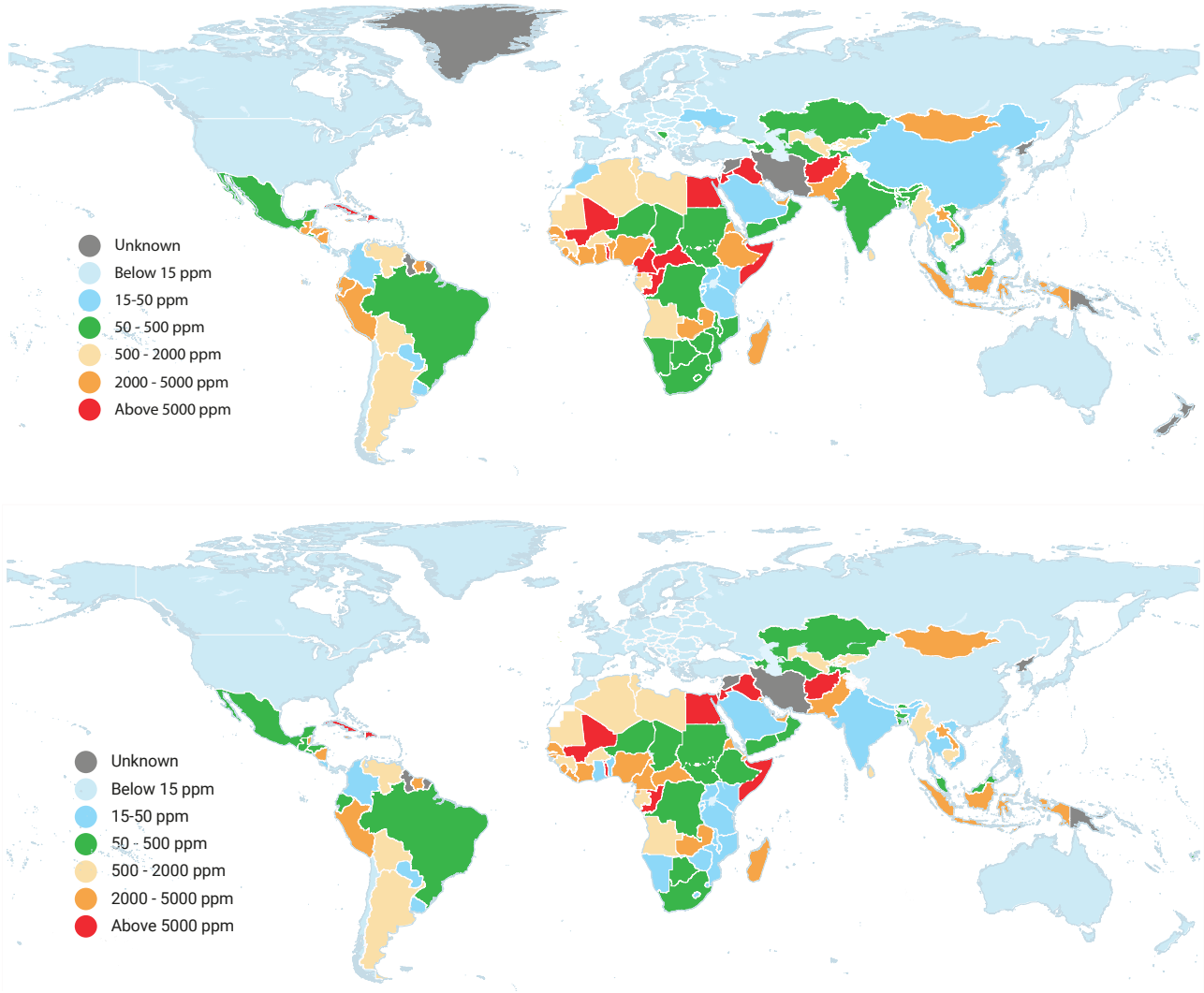


Source: UNEP 2020a

Most developing countries have limited or no regulations governing the emissions standards of imported used vehicles

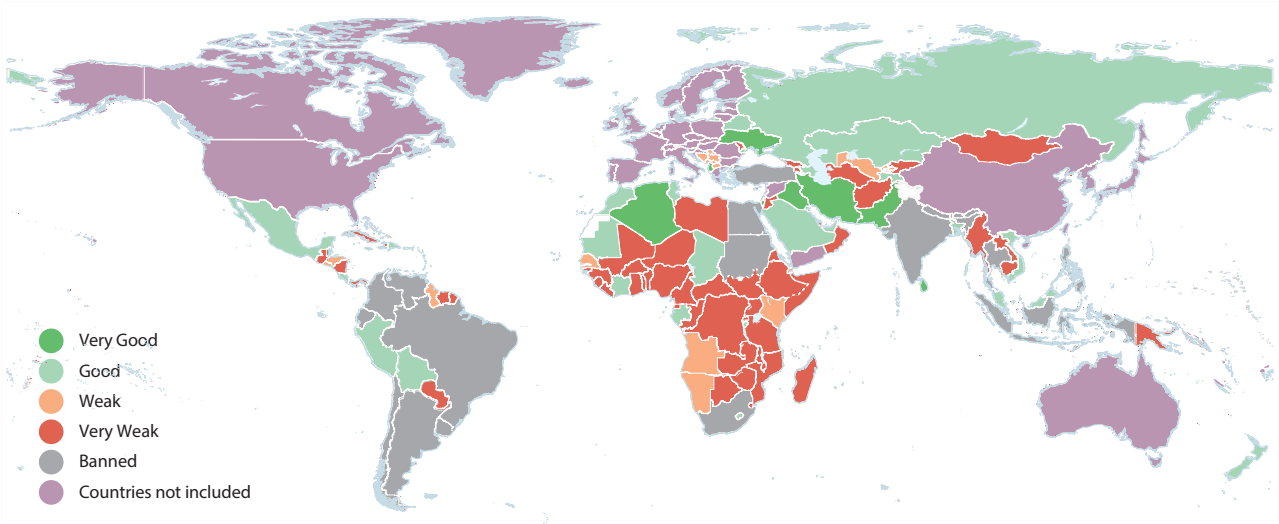
Another risk for air pollution from vehicle fleets comes through the secondary market, with UNEP's new analysis of used vehicle markets globally (UNEP 2020b) demonstrating that the large majority of used vehicles exported to Africa do not meet Euro 4/IV requirements (Figure 15). Finally, electric mobility and active mobility (walking and cycling) are emerging as low-carbon mobility options for countries and cities, contributing to both air pollution reduction and climate change mitigation.

Figure 14. Map of maximum allowed diesel sulphur content in 2016 (Top) and 2020 (Bottom)



Source: UNEP 2020a

Figure 15. Used car regulatory environment by country (UNEP 2020b)



*Note: "Banned" means the country adopted a complete ban on the import of used vehicles.
Source: UNEP 2020b

Case study 5: Used vehicle import regulation in Peru

In 2020, the Ministry of Transport adopted regulations that reduced the maximum age allowed for importing used vehicles from five to two years, aiming to reduce the age of the vehicle fleet, improve air quality and reduce emissions. Additionally, the government created the scrap bond programme to provide incentives for citizens to remove or "scrap" old polluting vehicles.

In the first stage, the programme had a budget of PEN 80 million (approximately USD 22 million) to finance economic or non-economic incentives for someone with a vehicle over 20 years old to change it for a new one. It is estimated that some 10,250 vehicles (including taxis, buses and cargo vehicles) could be recycled each year between 2021 and the programme's end date of 2030 within the framework of Peru's nationally determined contributions in the transport sector.

Box 2: Climate & Clean Air Coalition heavy-duty vehicle initiative

Fine particles and black carbon from diesel vehicles and engines can be virtually eliminated through technologies that are present on half of new heavy-duty vehicles sold today. The Climate & Clean Air Coalition's Soot-Free Urban Bus Fleets project promotes soot-free engine technologies in 20 major cities, home to a combined 234 million people, in order to prevent 3,700 early deaths and up to 6.6 million metric tons (MMT) carbon dioxide equivalent (CO_2e) by 2030.

car-free day. woman riding bike on a road in desert
Photo credit: © Shutterstock/ Mila Supinskaya Glashchenko

Photo credit: © Shutterstock/Phatara

5. WASTE

Chapter findings

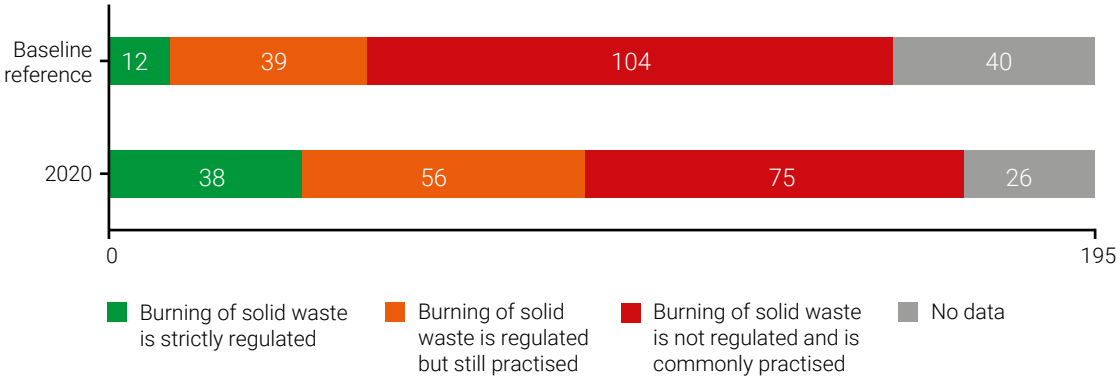
The number of countries that regulate **open waste burning** has increased significantly since 2016, although 75 countries still do not have regulations in place. Ninety-four countries (43 more than in 2016) now regulate burning, but only 38 of these countries have strict regulations in place. Despite the progress in this area since 2016, open burning is still practised in many countries, even those where regulations exist. Survey data indicate that the governments of the 94 countries that regulate burning have taken actions ranging from urban or national waste management plans to waste management regulations and more advanced strategies, such as landfill gas capture and improved collection, separation and environmentally sound waste disposal methods.

Open burning of solid waste is a significant source of air pollution linked to open dumps of waste. Another large source of air pollution is seasonal burning of agricultural residue in fields after crops have been harvested. This source is covered in chapter 7, which addresses agriculture.

While most combustion results in some degree of both primary fine particle pollution and secondary organic particle pollution (from condensation of semi-volatile organic combustion products and chemical formation in the atmosphere), open burning is associated, in particular, with secondary organic particulate formation. This varies depending on the composition and relative ratio of organic to inorganic waste in individual countries and regions. Thus, the overall magnitude also varies between regions.

Figure 16 demonstrates that 94 countries (43 more than in 2016) now regulate burning, but only 38 of these countries have strict regulations in place. Despite the progress in this area since 2016, open burning is still practised in many countries, even those where regulations exist, and at least 75 countries still do not have regulations in place. Survey data indicate that the governments of the 94 countries that regulate burning have taken actions ranging from urban or national waste management plans to waste management regulations and more advanced strategies, such as landfill gas capture and improved

Figure 16. Countries with solid waste burning regulation



Source: UNEP survey data

collection, separation and environmentally sound waste disposal methods.

A primary cause of emissions from municipal solid waste is inadequate sanitary waste collection and disposal options. This has been well documented by the World Bank in their What a Waste series of reports. The latest report, published in 2018, provides statistics on the estimated 2 billion tons of waste generated globally in 2016 and shows that 33 per cent of this total was openly dumped (Kaza *et al.* 2018). These open dumps often self-ignite or are set ablaze, resulting in significant air pollution in urban centres where human exposure is greatest. Although incinerators in high-income countries also burn waste, they are typically regulated and therefore have much lower harmful emissions.

When burned, waste is a significant source of black carbon (a short-lived climate pollutant). It is also the third-largest human-made source of methane (another short-lived climate pollutant), which contributes to climate change and ground-level ozone pollution. When unsustainably managed, waste is also a large source of other pollutants and toxins and a breeding ground for microbes that contaminate the air, soil and water.

Case study 6: Brazil closes mega dump outside Brasilia

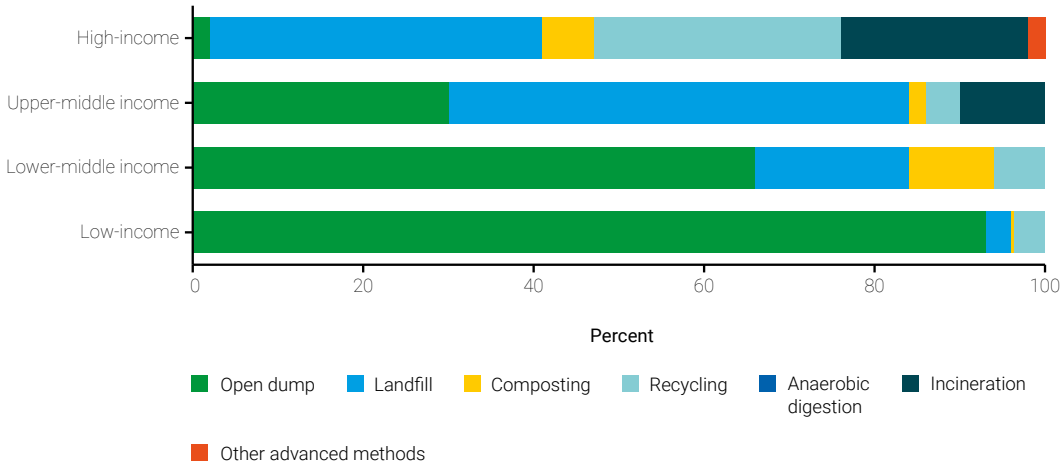
A few miles from the gleaming modernist capital of Brasilia sits a mountain of waste covering more than 300 acres, considered to be the second largest open dump in the world. Piles of waste would frequently catch fire, leading to significant air pollution. In 2011, a federal court deemed the dump illegal and ordered its closure. In 2018, it was finally shut down, with all new garbage from Brasilia that cannot be recycled going to a large, new landfill located far outside the city.

Many low-income countries still use open dumps linked to air pollution, especially in South Asia and sub-Saharan Africa

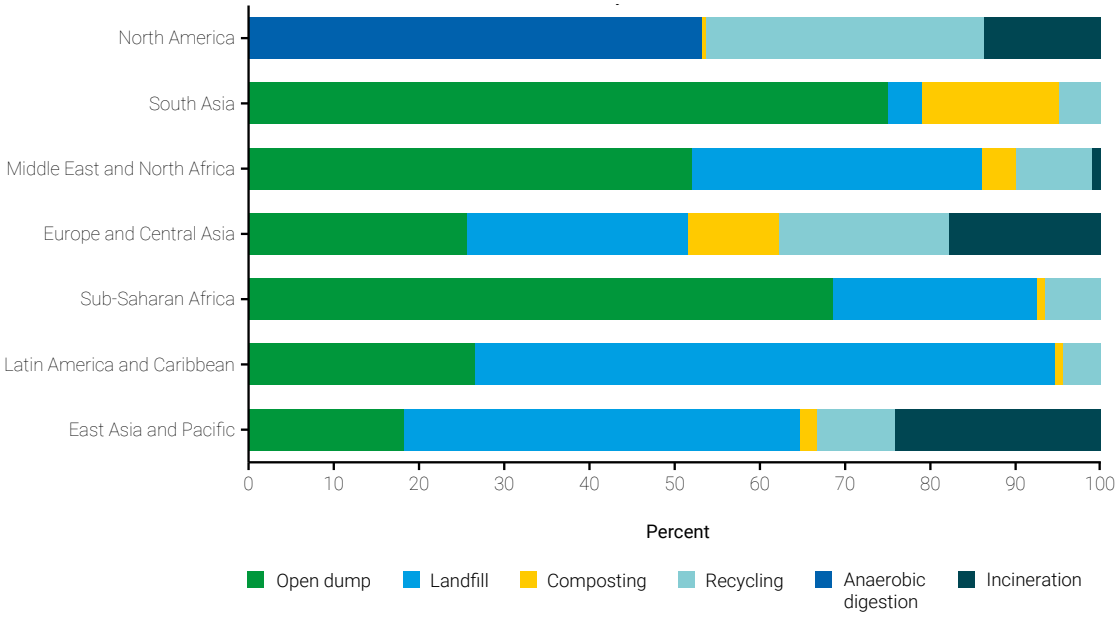
Figure 17 shows how open dumping of waste varies by income group (93 per cent of waste in low-income countries is dumped, compared with only 2 per cent of waste in high-income countries) and regionally. This information is a key input when designing and targeting air quality strategies, including campaigns for public behaviour change and increased waste collection programmes.

Figure 17. Disposal methods by income and region

a. By income level



b. By region



Source: Kaza *et al.* 2018

Photo credit: © Shutterstock/Phatara

6. RESIDENTIAL (HOUSEHOLD AIR POLLUTION)

Chapter findings

In terms of **household air pollution**, the world has seen increased availability of cleaner fuels and an estimated global reduction in the burden of disease associated with household fuel sources. An additional 13 countries now have national programmes to promote clean energy in residential heating and cooking.

Survey data show that governments are implementing various measures in this sector, with the highest level of uptake for increased energy efficiency in housing, followed by improved access to green technologies for residential heating, the adoption of low-emission cooking stoves and fuels, and increased use of liquefied petroleum gas (LPG). True access to cleaner cooking and heating goes beyond the availability of fuels, however, and requires an increased focus on the affordability, convenience and safety of fuel options for both the rural and urban poor.

Household air pollution is a health hazard due to both the direct impact of household air pollution on people living and breathing air in impacted households, as well as the cumulative contribution of household air pollution from many households to ambient air pollution as it diffuses across the neighbourhood and the city (Chafe *et al.* 2014).

On a global scale, the burden of disease from household air pollution has decreased steadily over the past decade (between 2010 and 2020), with total deaths attributable to household air pollution falling by 23.8 per cent (HEI and IHME 2020). This trend has been driven by large reductions in South Asia (-24.5 per cent) and East Asia and the Pacific (-31.8 per cent). Across sub-Saharan Africa, the decline has been much smaller (-12.6 per cent), reflecting less progress across much of the continent.

Figure 18 shows that an additional 13 countries (relative to the 2016 baseline) now have national programmes to promote clean residential energy, while a country that previously had "no data" now states that it does not have such a programme.[11] Survey data show that governments are implementing various measures in this sector, with the highest level of uptake for increased energy efficiency in residential appliances and lighting, followed by improved access to green technologies for residential heating, the adoption of low-emission cooking stoves and fuels, and increased use of LPG.

The Climate & Clean Air Coalition's Household Energy Initiative is working with many countries to address this gap in two ways: i) through programmes on residential cooking, heating and lighting sources that account for more than half of global anthropogenic black carbon emissions and that contribute a significant share of ambient air pollution in the developing world, and ii) through working towards cleaner technologies in high northern latitude/mountain countries, where the use of solid fuels for heating is common.

[11] The new numbers are not perfectly aligned with these changes. This is, in part, because the question was worded differently in 2020 than in 2016 and some countries have clarified that they did not have such a programme in 2016, but had indicated yes to the question as posed in 2016.

Figure 18. Countries with national clean residential energy programmes

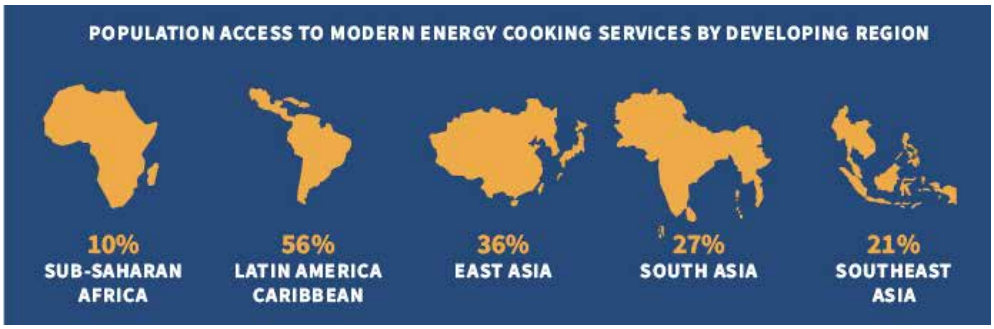
Source: UNEP survey data

Box 3: Clean cooking and gender

Gender and socioeconomic inequalities are also an important consideration when addressing household air pollution. In many communities, women and children are at higher risk of exposure and injuries from solid fuel stoves due to regularly taking responsibility for cooking. Policymakers and decision makers should recognize the impact of household air pollution on women, including how regulation might impact daily household routines beyond cooking. These considerations should also be extended to the wider community, ensuring a sense of collaboration between community members and decision makers. This allows decision makers to determine who a regulation will affect and what policy will be needed during transitional phases.

In order to truly address energy access, there is growing consensus among practitioners that the definition and measurement of access to clean fuels should reflect a continuum of improvement. The continuum should focus not only on fuels but also on the influence of the cookstove users' experience and contextual factors, such as convenience, affordability, safety, fuel availability, exposure and efficiency (Energy Sector Management Assistance Program [ESMAP] 2020). Using this more comprehensive definition of household energy access and cooking solutions, the rate of access to modern sources of energy for cooking stands at only 10 per cent in sub-Saharan Africa, 36 per cent in East Asia and 56 per cent in Latin America and the Caribbean (see Figure 19). Clearly more progress is needed in this sector, given that it also makes a large contribution to ambient air pollution (Chafe *et al.* 2014).

Figure 19. Access to modern energy cooking services by developing region



Source: ESMAP 2020

Case study 7: India LPG initiative

Switching to a cleaner fuel for residential cooking, for example moving from biomass or coal to kerosene or LPG (and in the long term to solar or induction cookers), is looking more promising in India. The central government and some state governments have launched programmes to implement fuel switching among low-income households in urban and rural areas. Such programmes have improved access to – and use of – cleaner cooking in recent years via a government subsidy for LPG. This resulted in a doubling of LPG connections (from 106 million to more than 263 million) between 2009 and 2018. Income limits prevent those with high incomes from using the subsidy. In 2015, the Government of India launched the Give It Up campaign to encourage those who could afford to pay the market price for LPG to give up their subsidy to enable a greater share of support for the poor.

Smoking chimneys in Szczecin city at sunrise indicate burning of wood and coal in old home heating systems. Residents in many Polish cities complain of increasing health problems due to air pollution. Photo credit: © Shutterstock/ Maciej Bledowski

Photo credit: © Shutterstock/Smileus

7. AGRICULTURE

Chapter findings

Fifty-eight countries reported having incentives in place to promote **sustainable agricultural practices**. Measures include alternatives to open burning of agricultural residues, improved livestock manure management, and composting to reduce food waste. The survey found that among those countries with incentives for sustainable agricultural practices, nearly one quarter of respondents provide alternatives to open burning of agricultural waste and nearly one quarter support closed storage and improved livestock manure management. Approximately 20 per cent of respondents indicate using methane capture for energy use, while 18 per cent have measures to reduce food waste. Although each of these approaches is important for different aspects of the agricultural air pollution challenge, they do not directly address the significant challenge of ammonia emissions due to excess fertilizer use. Fertilizers often benefit from government subsidies that could be curtailed or better targeted to avoid overuse.

Burning of agricultural fields – introduced in chapter 5 – is a major source of air pollution in some regions. While agricultural residue burning often occurs in more rural areas, with high exposure for agricultural workers, meteorological transport means that it can have significant contributions to urban air pollution in nearby cities.

Agricultural air pollution also comes in the form of ammonia, which enters the air as a gas from heavily fertilized fields and livestock waste. It then combines with pollutants from combustion – mainly nitrogen oxides and sulphates from vehicles, power plants and industrial processes – to create aerosols. Agricultural emissions from farms (including the ammonium fraction of secondary inorganic aerosol attributable to fertilizer use and livestock agriculture; nitrate from combustion sources on farms and; fugitive dust emissions from tilling and preparing fields) outweigh all other human sources of fine particulate air pollution in much of the United States, Europe, Russia and China (Bauer, Tsigaridis and Miller 2016).

Livestock and the degradation of manure are significant sources of methane that exacerbates ground-level ozone if released or results in a source of captive power generation if captured. However, combustion of biogas through internal combustion

Figure 20 Countries with incentives to promote sustainable agriculture practices (such as livestock manure management and use of organic fertilizers)

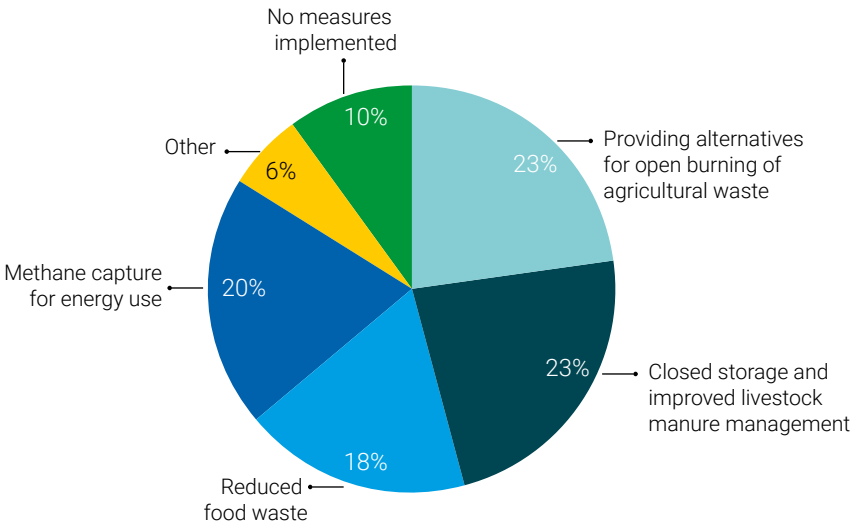
Source: UNEP survey data

engines may require added attention to maintenance schedules and control costs to avoid air quality trade-offs.[12]

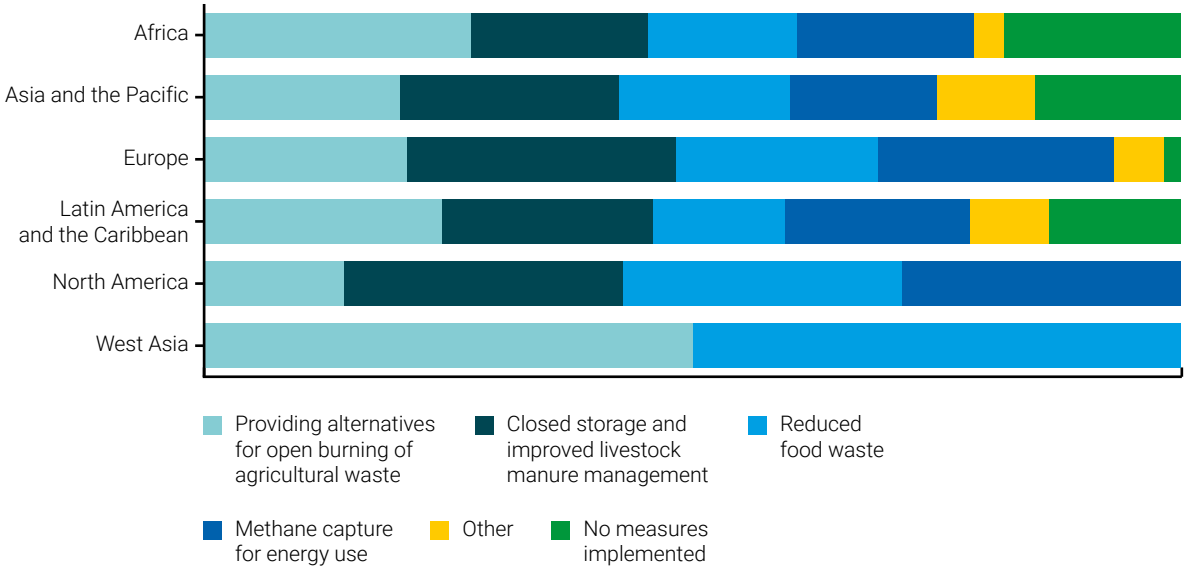
Fifty-eight countries have reported having incentives in place to promote sustainable agricultural practices. However, further effort is needed to understand the extent of incentives in more than half of all countries (see Figure 20).

Countries are employing a wide variety of policy approaches in the agriculture sector, including

Figure 21. Policy approaches in the agriculture sector in the past five years (2015–2019): aggregated (Top) and disaggregated by region (Bottom)



Note: The numbers are for each measure adopted. Many countries have adopted more than one of the options.



Source: UNEP survey data

[12] Siloxane removal systems capable of meeting the requirements of selective catalytic reduction (SCR) engines can greatly increase the initial costs of a biogas power plant and the demand for on-site maintenance (including siloxane monitoring) (South Coast Air Quality Management District [SCAQMD] 2020).

alternatives to open burning of agricultural waste, improved livestock manure management, and composting to reduce food waste (Figure 21). The survey found that among those countries with incentives for sustainable agricultural practices, nearly one quarter of respondents provide alternatives to open burning of agricultural waste and nearly one quarter support closed storage and improved livestock manure management. Approximately 20 per cent of respondents indicate using methane capture for energy use, while 18 per cent have measures to reduce food waste. Although each of these approaches is important for different aspects of the agricultural air pollution challenge, they do not directly address the significant challenge of ammonia emissions due to excess fertilizer use. Fertilizers often benefit from government subsidies that could be curtailed or better targeted to avoid overuse.

Conservation agriculture comprises the practical application of three interlinked principles, namely: no or minimum mechanical soil disturbance, biomass mulch soil cover and crop species diversification (Kassam *et al.* 2018). The reduction of fertilizer use through conservation agriculture is a key means of reducing excess ammonia emission, while also reducing greenhouse gas emissions and even increasing soil carbon sequestration. Kassam *et al.* (2018) have documented the steady increase in conservation agriculture across the globe, with a 15 per cent increase between 2013 and 2016. However, these gains are uneven, with uptake of conservation agriculture in Africa and Asia underrepresented in global statistics but expected to accelerate in the coming years. Government policies have been shown to support base-level initiatives, as in Kazakhstan and China, leading to rapid growth rates (Kassam 2018).

Aswaraopeta,Bhadradri Kothagudem,Telangana,December 03,2019, A farmer burns the remains of his Sugar Cane crop causing heavy smoke and air pollution,Stubble Burning.
Photo credit: © Shutterstock/Abdul Munaff

Case study 8: US EPA and Department of Agriculture AgSTAR Program

The AgSTAR Program promotes the use of biogas recovery systems to reduce methane emissions from livestock waste. AgSTAR assists those who enable, purchase or implement anaerobic digesters by identifying project benefits, risks, options and opportunities. Biogas can be collected from manure and burned to meet on-farm energy needs such as electricity, heating and cooling. Surplus electricity or biogas can be sold to neighbouring operations or the utility grid.

By August 2017, AgSTAR estimates that 250 manure anaerobic digester biogas recovery systems were in operation at commercial livestock facilities in the United States. However, the potential is thought to be far greater, with US EPA identifying more than 8,100 candidate farms. While this approach is seemingly a triple win for climate, air quality and rural economic development – which is an urgent development priority for many governments – care is needed to ensure that biogas digesters are implemented within a solid regulatory framework to ensure clean combustion of the biogas that does not result in excess NOx emissions.

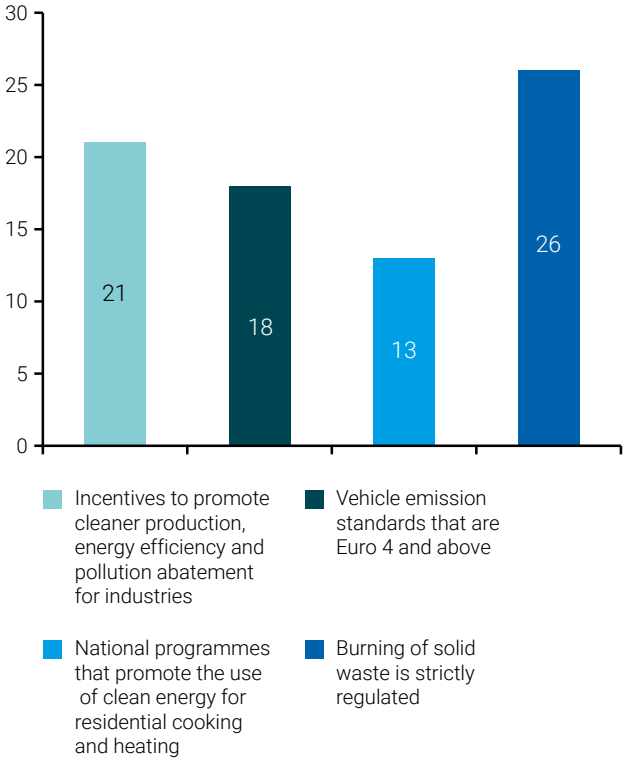
Photo credit: © Shutterstock/PopTika

8. GLOBAL SNAPSHOT

A. Global progress

The survey data from countries reveal steady progress on clean air policies, yet more action is being taken in some sectors than in others. Figure 22 shows that 21 countries have added policies or incentives for cleaner production, 18 countries have added new vehicle tailpipe emission standards that are equivalent to Euro 4/IV or higher, 23 countries have added programmes promoting clean cooking (however, as some countries had programmes in place in 2016 that have since come to an end, the net increase is only 13) and 26 more countries strictly regulate burning of solid waste.[13] Despite these new clean air policies in countries worldwide and the steady decline, in some regions, of the burden of disease from household air pollution, health statistics suggest that ambient air pollution remains a leading global health risk factor.

Figure 22. Relative net increase in key sectoral air policies over four years



Source: UNEP survey data

Finally, it is important to note trends in policy approaches as well as progress in specific policies. Since 2016, countries, non-governmental organizations and intergovernmental organizations have increasingly begun efforts to harmonize air quality policy with climate action planning, recognizing not only the common emission sources that mostly define both problems, but also the synergies of addressing both problems simultaneously. The climate mitigation community has shifted its stance from a concerted focus on the public health co-benefits of climate action to the multiple development benefits of emission reductions (see, for example, the Climate & Clean Air Coalition's Multiple Benefits Pathway Framework and the C40's climate and air quality integration framework). Similarly, air quality protection agencies (at both the national and municipal level) are often best placed to implement the sort of emission reduction programmes that require dedicated emission tracking and enforcement programmes (see, for example, the recently approved World Bank Greater Cairo Air Pollution Management and Climate Change Project). This trend is exemplified by the Climate & Clean Air Coalition, whose membership has grown since 2016 and whose focus on short-lived climate pollutants has led many countries to establish integrated inventories and claim short-lived climate pollutant/air pollutant credit under their nationally determined contributions to the Paris Agreement (e.g. Côte d'Ivoire, Chile, Colombia, Ghana, Mexico).

[13] Since the 2016 assessment did not track agricultural policies, there is no comparable statistic to track progress in the agricultural sector.

B. Conclusion

The findings of this report indicate that while progress can be observed across the sectors in adopting key policies and actions that are known to reduce air pollution, significant gaps remain. The analysis quantifies the extent of uptake of key measures by countries, but it does not take into account implementation or lack thereof. This edition of the Actions on Air Quality report nevertheless acknowledges the barriers in day-to-day implementation of air quality management programmes, including staff retention, capacity gaps, and affordability and maintenance challenges of air quality monitoring equipment. Countries are also facing larger, systemic challenges such as financing gaps that can result in an inability to invest in data analysis, and a lack of enforcement capacity when policies and actions are adopted.

UNEP will continue to track efforts that improve air quality. This report seeks to set benchmarks in assessing current and future progress in policy action towards cleaner air. As such, it is subject to continuous improvements in underlying data and methodology.

Continuous tracking of progress in taking action to improve air quality is important, as it helps inform and promote accelerated action. It can be used to catalyse support to address the identified capacity gaps at the national, regional and global levels, including efforts undertaken in response to UNEA resolutions, the 2030 Agenda for Sustainable Development, international agreements, and other relevant frameworks for action, including the International Day of Clean Air for blue skies and as part of global efforts and coalitions to promote integrated policies on air quality and climate.

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ANNEX A – METHODOLOGICAL NOTES

Methodological details of survey development and administration, as well as the approach taken to developing the global and regional reports

This report provides an update on trends in national air quality policy action since 2016 as a response to UNEA resolution 3/8, which requests in paragraph 7(j) that UNEP regularly "undertake an assessment of progress being made by countries to adopt and implement key actions that can significantly improve air quality." As a global thematic report on the key actions taken by governments to improve air quality, this report uses globally comparable data from the survey results of a detailed survey questionnaire that was sent to countries. National policy targets are used to gauge progress in priority action areas.

Determining priority action areas

The first step in developing this report was to determine priority action areas that aim to address the most common air quality challenges. Similar to the 2016 report, challenges were defined as major driving forces that alter atmospheric composition and exert environmental pressures on air quality. Five key sources of air pollution were therefore identified as the most important drivers of air pollution: (i) industrial point source emissions (including thermal power generation facilities); (ii) transport; (iii) waste; (iv) residential, and; (v) agriculture.

Table 1. Coverage of key sources in 2016 (baseline) and 2020 assessment

2016 baseline	2021 report	Rationale
Industrial activities	Industrial (including power generation) point source emissions	Remains largely the same
Road transport	Road transport	Remains largely the same
Open waste burning (municipal and agricultural)	Solid waste management	Terminology changed following expert review of questionnaire in order to focus on a clearly defined stream of waste as opposed to a broad focus on "other forms of waste" (see next section for process)
Indoor air pollution (from cooking and heating)	Residential (household air pollution)	Broadened to include clean energy initiatives for household cooking and heating
-	Agriculture	Introduced due to growing consensus on the sector's contribution to air pollution (ammonia-induced particulate matter and methane – the main precursor of tropospheric ozone)

Building on the 2016 baseline assessment, it was determined that the same key sectors continue to dominate contributions to air pollution in most countries, with some slight differences in categorization, as shown in Table 1.

In addition to these emission sources, non-sectoral governance approaches employed by governments to help mitigate the impacts of air pollution were included in the survey. These include: (i) air quality strategy development; (ii) setting air quality standards, and; (iii) air quality monitoring.

Development of questionnaire for countries

To take stock of the progress being made by countries in adopting and implementing key actions that can significantly improve air quality, UNEP developed a detailed survey questionnaire, with the response data forming the basis of this report. The development of the questionnaire involved collaboration both within UNEP (sectoral and thematic experts) and between UNEP and its network of air quality experts and stakeholders, all of whom contributed their valuable time and knowledge to the process. The process is described in detail as follows:

- A **first draft** of the questionnaire was developed based on the catalogue templates used for the 2016 report. The result was a two-part questionnaire, with Part A covering non-sectoral governance approaches and Part B focusing on sectoral actions.
- The **second draft** of the questionnaire was developed following internal review with UNEP sectoral leads working on transport, waste, agriculture, ecosystems and climate. Thematic experts working on air quality monitoring and legislation were also consulted. The review resulted in a broadened approach for sectors such as residential and a targeted approach in the case of waste, in order to focus on a clearly defined stream. Subject matter experts were requested to review the proposed list of actions in their respective sectors for completeness. The introduction of sections on air quality monitoring and strategy development was welcomed by reviewers.
- A **web version** of the questionnaire was then developed using the survey tool SurveyGizmo. This online version was subjected to external review by experts, including government representatives in all UNEP regions, in order to test such metrics as ease of use, completeness and the survey logic for mandatory and optional questions.
- The **final online version** of the questionnaire was embedded in the UNEP website, from which countries were invited to take the survey. Offline versions were made available in PDF format and translated on-demand to Arabic, French, Russian and Spanish.
- The **survey remained open** from 24 June 2020 until 31 August 2020 and was extended for an additional month, until 30 September 2020, at the request of some countries. UNEP received 96 questionnaire responses in total, which corresponds to a 50 per cent response rate.

Measuring progress towards cleaner air

For each of the top actions presented in this report, countries are assigned to one of four categories, based on their survey response. These are as follows:

→ Green to indicate policy target met.

Based on survey response, this classification denotes countries that have adopted policies or similar instruments to help achieve desired air quality improvements.

→ Orange to indicate policy target on track but acceleration needed.

Based on survey response, this classification denotes countries that are on the way to adopting policies and strategies for air quality improvement.

→ Red to indicate policy target not met.

Based on survey response, this classification denotes countries that have no policy or similar instrument in place to achieve desired air quality improvements.

→ **Grey** to indicate no data available.

In certain cases, data from desktop research were used to supplement survey responses. This classification denotes instances where no internationally comparable data were available for a country or, when available, these data were not deemed recent enough to use in the analysis.

Progress was measured against the 2016 baseline as an incremental count of the number of countries moving from one category to the other in the five-year 2015–2019 period.

Limitations of the approach

Neither the survey nor this report capture every source of air pollution or every action that can be taken to tackle the problem. Rather, the report builds on the 2016 baseline to develop and strengthen globally relevant indicators of progress towards improved air quality. Similarly, natural sources of air pollution such as wildfires, sandstorms and dust storms are not addressed in this report.

Whereas green is used to indicate countries for which policy targets are met, the analysis does not take into account implementation or lack thereof. The survey design does not allow for this either. This edition of the Actions on Air Quality report does, however, acknowledge the implementation barriers. The report is also limited by the response rate of Members States, which varied by region, but it still allows for an overall global picture of where countries stand collectively.

Way forward: Considerations for future reports

While UNEP acknowledges the limitations above, this report seeks to set benchmarks in assessing current and future progress in policy action towards cleaner air. As such, it is subject to continuous improvements in underlying data and methodology.

To strengthen the data-collection process, UNEP intends to develop an online "Action Tracker" in order to: (i) allow countries to update their data continuously, and not necessarily within the production schedules of future reports, and; (ii) allow countries ample time to consult within government agencies and with relevant external institutions, thereby promoting a multi-stakeholder reporting process.

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