WORLD ECONOMIC FORUM

Clean Air Actions in Cities

GLOBAL FUTURE COUNCIL ON CLEAN AIR 2023-24

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Contents

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Introduction

Air pollution is complex, but many solutions to addressing urban air pollution are well established so that cities with similar contexts can learn from each other.

This paper explores nine actions for air quality already being deployed by various cities around the globe to target specific challenges. It showcases actions across various sectors that influence urban air pollution, demonstrating sector-specific practices through case studies.

This paper is a guide for city decision-makers to adapt and adopt actions for clean air to ensure healthier environments in their cities, based on the thought leadership and work of the Global Future Council on Clean Air during 2023-2024. The nine actions do not comprise an exhaustive list of global actions, but present examples of successful practices against pollution sources that cities have influence over.

High-level actions offer opportunities to address challenges beyond air pollution, though not all actions may be appropriate for each city.

The problem of air pollution in cities

Air pollution is the greatest environmental risk to health,[1] responsible for an estimated 7 million premature deaths globally each year.[2] Outdoor (ambient) air pollution causes an estimated 4.2 million premature deaths,[3] inflicting significant damage on human health and well-being, the environment, the climate and the economy.

The problem of air pollution is complex and is particularly pressing in cities. Globally, pollution concentrations vary widely between and within cities. There are also inequities in exposure, emissions, data collection, monitoring and capacity to address the problem.

Urban populations are expected to continue to grow, with nearly 70% of people projected to live in urban areas by 2050.[4] As urban populations increase, so do the concentrations of air pollutants such as nitrous dioxide (NO_2).[5] Air pollution concentrations in cities are dependent on a number of factors: hyper-local sources at a street level, local sources across the city and regional sources beyond the city boundary all affect the concentration of air pollution at any given location and time.

Pollution concentrations can also be affected by geographical factors such as topography and meteorology, which affect the dispersion of pollutants.

Benefits of addressing urban air pollution

Addressing urban air pollution can reap a myriad of benefits for cities. Around the world, practices to improve clean air have produced impressive results through cross-sector collaboration. Actions for air pollution can enable progress towards climate, social, economic and wider environmental goals for cities.

This paper focuses on four key benefits of city-level actions to curb air pollution:

- Emissions reduction and environmental gains
- Improved health, safety and well-being
- Economic benefits
- Progress towards equity

Emissions reduction and environmental gains

Clean air can benefit the environment through the preservation of biodiversity, protection of water and soil, and mitigation of climate change impacts.

Improved health, safety and well-being

Reduction of air pollutant emissions reduces risk of asthma, cardiovascular disease, stroke, dementia and other diseases.

Economic benefits

Clean air action delivers economic benefits mainly through increased productivity, reduced health bills and increased crop yields. Action on clean air also contributes to new jobs, and reduced costs associated with fuel use, traffic congestion and building corrosion.

Progress towards equity

Designing cities for cleaner air especially helps vulnerable populations, including children, the elderly and often people living in lower-income neighbourhoods. Action on air quality reduces exposure to pollution and improves overall economic and societal mobility.

Transport

Active and public transport

Actions which promote a reduction of private motorized transport and encourage the uptake of public transport or human powered mobility. This can include walking, cycling and micromobility methods, such as e-bikes and scooters.

Vehicular technology

Policies that regulate vehicular technology, either indirectly or directly reducing air pollution emissions from transport by making vehicles more efficient.

Energy

Renewable power generation

Actions that promote the generation of renewable energy over the burning of fossil fuels, including wind, solar, wave, geothermal, tidal, hydro and ocean thermal. (*Biomass is not considered here as it contributes to air pollution emissions.)

Industry

Clean energy for industries

Industrial innovations that either change the manufacturing process to be less polluting, or create products that produce less air pollution.

Materials

Waste, burning and dust pollution

Actions that reduce air pollution from waste management and prevent the need for burning of waste.

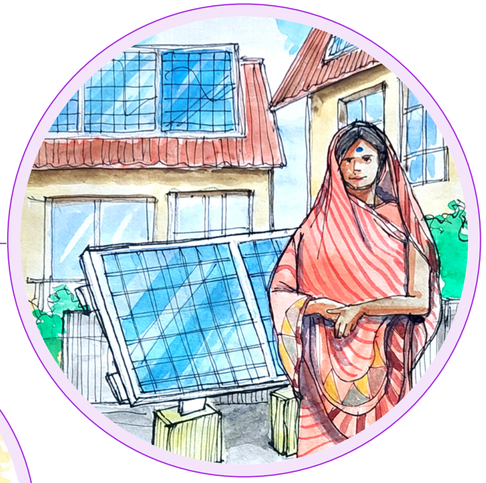
Built Environment

Urban planning

The strategic integration of land use and design to mitigate air pollution and limit air pollution exposure, including green design.

Buildings

The design and technology used in buildings to mitigate exposure to both ambient and indoor air pollution.



Cooking, heating and cooling technologies

Actions that encourage a shift from combustion for residential temperature control and cooking, ultimately focusing on electrification (or transitions from solid fuel burning where electrification is not feasible).

Circularity

Shift towards reducing the use of materials and resources, decoupling growth from resource consumption of finite resources, which in turn reduces emissions from processes including waste and manufacturing.

ACTION 1

Active and public transport

Definition: Actions which promote a reduction of private motorized transport and encourage the uptake of public transport or human-powered mobility.[6] This can include walking, cycling and micromobility methods such as e-bikes and scooters.

A key contributor to ambient air pollution worldwide is road transportation, with motor vehicles responsible for many major air pollutants and greenhouse gas (GHG) emissions. Even with the electrification of vehicle fleets, traffic continues to emit particulate matter (PM) via non-exhaust emissions, making motor traffic a challenge in many urban environments. The dependency on motor transportation affects physical and mental well-being beyond air pollution exposure, contributing to stress, noise, traffic-related injuries and fatalities, as well as physical inactivity.

The best practices for promoting active and public transportation have produced impressive results. Active travel particularly offers opportunities for city leaders to address transport and physical health together. These actions are improved when enacted simultaneously through integrated policy packages.

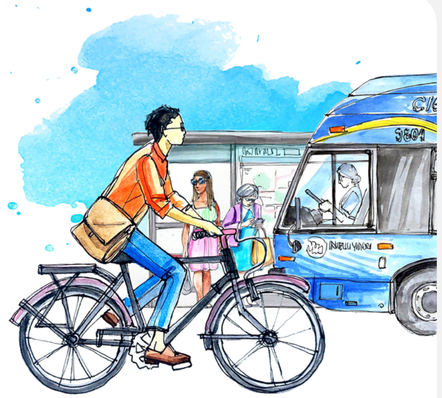
CASE STUDY 1

Curitiba, Brazil –
Integrated transport network[7]

Curitiba uses a mix of public transport provision and incentives to reduce congestion on roads. The Bus Rapid Transit (BRT) system combines express routes with suburban connection routes and cycle lanes to make public transport acceptable to all neighbourhoods.

The city offers incentives to low-income and vulnerable populations to use public transport systems, including reduced fares for the elderly, children, students and those with limited mobility. An electronic ticketing system has increased convenience and efficiency.

These steps are accompanied by dynamic traffic management using global positioning system (GPS) technology and smart infrastructure to manage bus routing to avoid congestion and to give priority to public transport at intersections. In 2016, 80% of travellers in Curitiba were using the BRT system and fuel needs had been reduced by 35%. The system has been replicated in over 150 cities worldwide.



CASE STUDY 2

Seoul, South Korea –
Seoul Walkable City Projects[8]

Seoul's swift economic development resulted in rapid growth in population and vehicles in its limited urban space. The city has implemented several projects under its Walkable City Plan. To reduce private car usage and to promote walking, the "Downtown Road Diet" project reduced the number of lanes for cars and converted existing lanes into pedestrian sidewalks and cycling lanes. Trees reduced the urban heat-island effect by providing shade.

Seoul transformed an old overpass into an elevated walking path, Seoul 7017, and built a pedestrian network connecting it to many areas. From its opening in 2017 until 2021, 31 million people had visited Seoul. Increased pedestrian traffic boosted the local economy. Local communities, including professionals and activists, took part in the urban regeneration activities. Funding came from national, city and district budgets as well as private investment.

Benefits of action

Emissions reduction and environmental protection

Limited use of private cars reduces exhaust and non-exhaust pollution emissions.[9]

Improved health, safety and well-being

Increased physical activity reduces lifestyle-related diseases such as cardiovascular diseases, obesity and diabetes.[10]

Economic benefits

Reduced healthcare costs from air quality-related and physical activity-related diseases.[11]

Progress towards equity

Having fewer cars creates more areas suitable as community spaces. Active and public transport infrastructure provides connectivity to those who cannot afford cars.

ACTION 2

Vehicular technology

Definition: Policies that regulate vehicular technology, either indirectly or directly, reducing air pollution and GHG emissions from transport.

Technological innovations in transport offer the potential to reduce air pollution and emissions while enhancing mobility. Innovations can include new types of vehicles and also enable adjustments and retrofits to existing vehicles to make them more efficient.

Technological solutions can be used in synergy with active and public transport to reduce urban transport emissions (see Action 1).

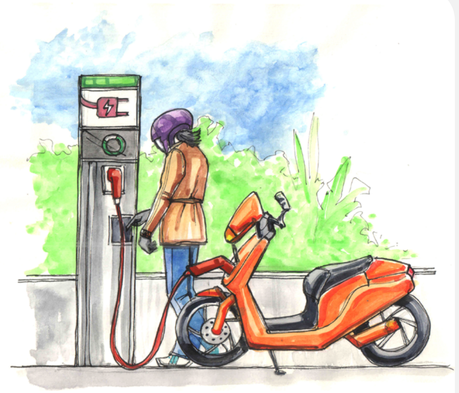
CASE STUDY 3

London, United Kingdom – Ultra Low Emission Zone (ULEZ)[12]

ULEZ in London has been highly effective at cleaning up the city's air by reducing the number of older and more polluting combustion engine vehicles. It has accelerated an uptake of cleaner vehicles over and beyond the natural vehicle turnover. ULEZ covers 1,500 square kilometres and has a population of 9 million people. Currently, it is the largest ULEZ in the world.

A daily charge of £12.50 is levied on the cars, vans, minibuses and motorcycles driving into ULEZ that do not meet its emissions criteria. There are exemptions and discounts for certain groups, and a scrappage scheme.

ULEZ was implemented in phases across three geographical areas and is accompanied by other air quality policies. A report on the first six months of the operation of the London-wide ULEZ found the compliance rate of vehicles to be 96.2%, up from 39% in February 2017 (when changes associated with ULEZ first began. This equates to a reduction of 90,000 in the number of older, more polluting vehicles driving into ULEZ on an average day. Comparing a scenario with and without ULEZ and its expansions, harmful roadside NO_2 concentrations are estimated to be 53% lower in central London, 24% lower in inner London and 21% lower in outer London.



CASE STUDY 4

Cairo, Egypt – Taxi trade-in scheme[13]

Cairo launched a taxi trade-in scheme, in which owners have the opportunity to trade-in older vehicles for newer vehicles that use cleaner fuel. In 2015, before the scheme, 68% of Cairo vehicles were more than 15 years old. To promote a newer taxi fleet, the government removed sales tax on eligible newer vehicles. Participating car companies offered a discount on cleaner vehicles and banks offered loans with lower interest rates for buying vehicles.

Legislation supported the scheme, making cars older than 20 years ineligible for taxi licences in cities. In 2015, the programme had a 94% success rate with more than 40,000 taxis replaced with newer, cleaner vehicles.

Benefits of action

Emissions reduction and environmental gains

Electric vehicles (EV) and cleaner fuels remove the tailpipe emissions from vehicles.[14] Reduced black carbon emissions from vehicles curb their global warming effect.[15]

Improved health, safety and well-being

Reduced emissions from shifting to EVs curb air pollution-related diseases.[16]

Economic benefits

Technological advances decrease the costs of technology and make it more affordable.[17]

Progress towards equity

Charging schemes for heavy vehicles can ensure companies pay for the air pollution they cause. Reduced vehicular emissions alleviate the effects of traffic-related air pollution on communities that live near busy traffic routes.

ACTION 3

Renewable power generation

Definition: Actions that promote the generation of renewable energy over the burning of fossil fuels, including wind, solar, wave, geothermal, tidal, hydro and ocean thermal.

(*Biomass is not considered here as it contributes to air pollution and emissions.)

Nearly 80% of the world's energy needs are currently met with fossil fuels.[18] As cities expand and energy demands soar, the reliance on fossil fuels for power generation exacerbates air quality degradation. Currently, cities are responsible for 67%-76% of the world's total energy consumption, and power plants are an important source of sulphates and nitrates. Fossil fuel-based power plants account for ~14% of global population exposure to PM2.5 and ozone.[19]

The transition to renewable power sources such as solar, wind, hydro and nuclear represents a pivotal strategy in mitigating urban air pollution to create a cleaner, healthier environment in cities.

CASE STUDY 5

Portland, USA – Portland Clean Energy Community Benefits Fund (PCEF)[20]

PCEF is a government-led project which invests in local incentives and community-led programmes to promote clean energy, which includes renewable energy and energy efficiency programmes. Endorsed by over 150 organizations – including businesses, faith leaders and community groups – PCEF is the first major environmental policy being led and created by communities of colour. It generates $30 million a year in new revenues to be used for energy efficiency upgrades, renewable energy generation, job training and green infrastructure.

PCEF ensures that at least 50% of the projects for energy efficiency and renewable energy benefit low-income residents. At least 20% of all its grants are awarded to non-profit organizations that benefit economically disadvantaged citizens. So far, 248 grants have supported over 170 non-profit organizations. Thirty-three of these have focused on energy efficiency and renewable energy. The fund is estimated to have generated 65,812 kilowatt-hour (kWh) of renewable energy.

CASE STUDY 6

Santiago, Chile – Renewable energy for public buildings[21]

In 2017, over 50% of Santiago's electricity was generated from imported diesel and gas. Due to the city's topography, surrounded by mountains, air pollution builds up. This would cause the city to temporarily "shut down" due to toxic concentrations of air pollutants.

Between 2015 and 2018, the city planned investments of nearly $5 million for upgrading public buildings with rooftop solar power generation and building retrofits. This programme reduced energy bills and emissions from publicly-owned buildings. The 15 public rooftop solar systems installed saved an estimated $140,000 annually.

Santiago also has a Regional Strategy of Resilience, which aims to reduce energy consumption and to source energy from alternative renewable sources locally.

Benefits of action

Emissions reduction and environmental protection

Emissions reduction contributes to climate change mitigation.

Improved health, safety and well-being

Utilizing renewables can overcome fuel poverty and create comfortable, warm and safe homes for all.

Economic benefits

Shifting energy generation closer to the point of consumption reduces strain on distribution systems, enabling cost savings. Increased demand for renewables creates jobs across the supply chain.

Progress towards equity

Affordable renewable energy for lower-income households reduces reliance on fluctuating fossil fuel prices, reducing fuel poverty.

ACTION 4

Clean energy for industries

Definition: Industrial innovations that either change the manufacturing process to be less polluting, or create products that produce less air pollution.

Industrial activity can release air pollutants and GHGs, including carbon dioxide (CO_2), sulphur oxide (SOx), nitrogen oxides (NOx), particulate matter, volatile organic compounds (VOCs) and heavy metals. These not only damage the environment but can also be particularly harmful to human health.[22] There are many sources of industrial pollution including (but not limited too) commercial transport, energy generation, petrochemical plants, refineries, material production (such as cement and metals) and agriculture.[23]

In Europe, between 2010 and 2022, the industrial release of air pollutants reduced while economic contributions from industrial activity increased, demonstrating that emissions can be decoupled from industrial and economic growth.[24]

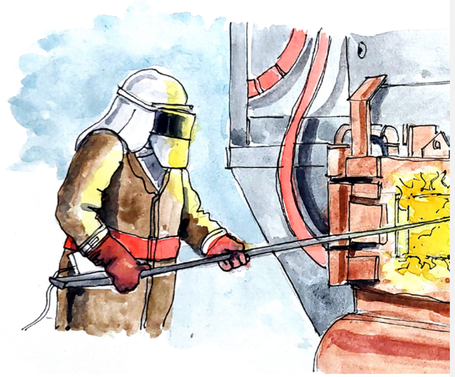
CASE STUDY 7

Barcelona, Spain – Electrification of ports[25]

The "Nexigen" project was launched in Barcelona city in 2024 to improve ambient air quality, both in the port and the city. Through a new Onshore Power Supply technology, ships can connect to electricity on the quay and switch off the auxiliary engine when at berth. The emissions of NOx and CO_2 from berthing ships are expected to shrink by 38%.

Electrification of docks is complex, requiring a high-voltage energy supply through electrical substations. In Barcelona, the infrastructure needed includes a 220 kilovolts (kV) high-voltage line via 240 kilometres (km) of underground cables and 20.5 km of pipes from the substation to the docks.

The shipping industry and ports are already taking steps to improve air quality and reduce emissions under international regulations. They are shifting towards cleaner fuels and alternative energy sources, deploying electrical technologies where feasible, undertaking ship modifications including exhaust cleaning systems, and using engine modifications and efficient design for new-built ships.[26]



CASE STUDY 8

Amsterdam, Netherlands – Lower-emission freight zones[27]

Amsterdam introduced Milieuzone Lower Emission Zone in 2020, which restricts entry for the most polluting passenger and commercial vehicles. The national government passed legislation that enables cities to introduce zero-emission zones for planning as part of its Urban Logistics Implementation Agenda, which also complements existing environmental zones in the Netherlands.

The agenda aims to improve air quality by reducing, changing and making the traffic movements of vans and trucks more sustainable. From 2025, all new vans and trucks driving within Amsterdam's ring road must be zero-emission, with transitional arrangements for newer vehicles. The restrictions for passenger diesel vehicles and mopeds will tighten to exclude more polluting vehicles.

Benefits of action

Emissions reduction and environmental gains

Making industry sustainable by limiting the combustion of fossil fuels curbs pollution of land, air and water.

Improved health, safety and well-being

Implementing cleaner and energy-efficient workplaces improves air quality, reduces noise pollution and improves conditions for employees and citizens living close by.

Economic benefits

Investment in local clean energy industries catalyses economic growth and creates new jobs.

Progress towards equity

Democratizing access to clean energy resources and empowering marginalized communities ensures citizens have more equitable access to, and control over, cleaner air.

ACTION 5

Urban planning

Definition: The strategic integration of land use and design to mitigate air pollution and limit exposure, including green design.

Urban planning plays a pivotal role in influencing air quality in urban areas, as it has the potential to improve air quality in the long term by strategically strengthening cities' structure to minimize pollution, especially by locating potential pollution sources away from vulnerable and exposed populations. The configuration of buildings, streets and public spaces can significantly affect the flow of air and dispersion of pollutants. Poorly designed urban areas can exacerbate exposure to poor air quality by locating people and pollution sources together, encouraging emissions or by designing spaces that trap pollutants and increase concentrations.

CASE STUDY 9

Accra, Ghana – Greening and beautification project[28]

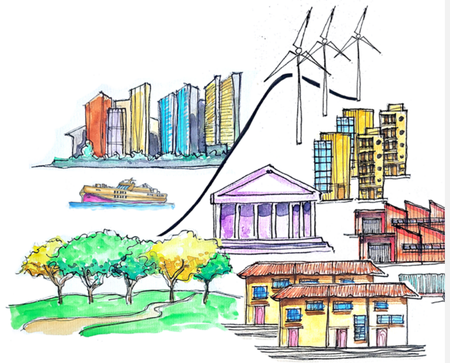
Accra identified the economic, climate and health gains from urban greening projects as part of its national climate resilience strategy. The greening of public spaces improves air quality, prevents flooding by increasing permeable spaces, and improves natural biodiversity.

Accra first launched a pilot project with an "adopt a space" campaign that encouraged public-private partnership, whereby private stakeholders had the opportunity to bring forward proposals to green a public space around their workplace or place of business. If chosen, an agreement was signed between the city and the selected company that was "adopting" a space. The agreement specified who would provide the financing, the procurement of contractors, and the responsibility of the companies to maintain the space after completion. As this project has been successful, the city is trialling similar approaches, for example in rooftop urban farming on public-sector buildings.

CASE STUDY 10

Barcelona, Spain – Barcelona Superilla/ Superblock Urban Design[29]

"Superilla/Superblock" was first introduced in Barcelona in 2016, as a local, urban design initiative that refined the use of public space by prioritizing spaces for pedestrians, public transport and bicycles, and placing citizens and communities at the centre of city design and development. The aim has been to reduce pollution (air, traffic and noise) through the creation of open green spaces. These spaces improve opportunities for local communities to carry out daily activities together, such as exercising and socializing.



Every "superblock" limits the traffic in each neighbourhood, which opens up streets to pedestrians and cyclists. It also encompasses a gradual model of change starting with "basic" actions (e.g. small functional changes such as parking restrictions and change of street directions), going on to "tactical" changes (i.e. low-cost, temporary actions such as adding benches, planters and painting road spaces) and "structural" changes (e.g. more permanent transformations of street spaces). Results show a reduction in air pollution in the superblock in central Sant Antoni market in Barcelona, with a 25% decrease in nitrogen dioxide (NO_2) levels and a 17% decrease in PM10 particulate levels.

Benefits of action

Emissions reduction and environmental gains

Improved biodiversity through the integration of green and blue spaces in urban environments.
Limited urban heat-island effect by building green spaces into cities, such as parks and green roofs.

Improved health, safety and well-being

Reduced exposure to ultraviolet (UV) rays for citizens thanks to shade from trees and plants in urban areas.
Decreased noise pollution and associated stress through urban planning that limits citizens' exposure to noise.

Economic benefits

Increased citizen access to educational services, businesses and employment with city design that makes services safely and easily accessible.

Progress towards equity

Community-friendly infrastructure design ensures that citizens' mobility and community cohesion are not restricted (for instance by major highways segregating neighbourhoods).

ACTION 6

Buildings

Definition: The design and technology used within buildings to mitigate exposure to both ambient and indoor air pollution.

Buildings are an integral part of any city, and building design can contribute to both indoor and ambient air pollution exposure. Construction can contribute to ambient air pollution, and building efficiency can impact emissions. Indoor air pollution can be affected by activity and ventilation and, much like ambient air pollution, can impact human health.[30]

People spend 60-90% of their lives indoors[31] and thus it is imperative that buildings be designed to promote health and well-being. Building design can also impact ambient air pollution by affecting energy demand.[32]

CASE STUDY 11

Salvador, Brazil – Sustainable building certification and tax rebate[33]

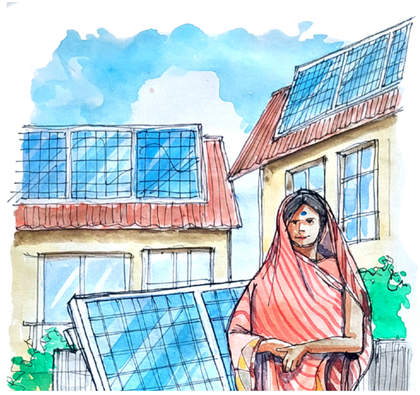
An initiative under the Salvador IPTU Verde programme uses tax discounts to incentivize individual, commercial and industrial developments. It encourages sustainable building practices aligned to the city's Climate Action Plan by awarding points: projects are then certified as bronze, silver or gold, and are entitled to tax discounts of 5%, 7% and 10%, respectively.

Examples of sustainable solutions include the use of water-saving equipment, solar panels and bicycle racks. The city government has formed partnerships with other groups including the Union of the Construction Industry of the State of Bahia and the Association of Real Estate Market Executives of Bahia to jointly establish industry-informed criteria for IPTU Verde.

CASE STUDY 12

Yokohama, Japan – Yokohama Smart City Project[34]

Yokohama's rapid urbanization is creating challenges of increased energy use and GHG emissions. In 2010, the city introduced the Yokohama Smart City Project (YSCP). This was initially a five-year pilot but has since been deployed across the entire city.



One aspect of the project is the installation of energy management systems for homes and buildings, using smart grid systems. By 2015, energy management systems had been installed in 4,200 homes, which reduced energy consumption by 20%. This worked by enabling consumers to visualize their energy use and encouraged them to limit their electricity use. In commercial buildings, use of energy management systems achieved a 20% reduction in peak energy consumption.

The project also has an educational aspect for citizen participation; for example, the Yokohoma Eco School project educates the public on climate change and has hosted over 400 lectures, reaching 35,000 participants and over 120 organizations. This educational outreach has led to increased use of home energy management systems, storage batteries and PV generation systems.[35]

Benefits of action

Emissions reduction and environmental protection

Increased energy efficiency from smart building technology reduces the energy consumption of buildings, and thereby, emissions.

Improved health, safety and well-being

Smart buildings help keep vulnerable populations, such as the elderly and children, safer by supporting health monitoring, fall detection and activity recognition.[36]

Economic benefits

Centralized infrastructure and maintenance associated with district cooling can reduce operational costs.[37]

Progress towards equity

Incentives can support lower-income families by making solutions affordable.

ACTION 7

Cooking, heating and cooling technologies

Definition: Actions that encourage a shift from combustion for residential temperature control and cooking, ultimately focusing on electrification (or transitions from solid fuel burning where electrification is not feasible).

The use of solid fuel and open fire for cooking and heating in homes can have economic, social, environmental and health impacts, and is particularly challenging in developing countries. An estimated 2.3 billion people worldwide depend on open fires or inefficient stoves for cooking,[38] and smoke from cooking and household air pollution is associated with nearly 3.7 million premature deaths annually.[39]

Clean solutions can mitigate smoke-related illness, limit its contribution to climate change and improve air quality while supporting progress towards Sustainable Development Goal 7 (access to affordable, reliable, sustainable and modern energy).[40]

CASE STUDY 13

Warsaw, Poland –
Ban on burning fossil fuels at home[41]

Warsaw introduced this ban in October 2023, which included domestic burning of coal. Domestic heating is a major source of pollution in the region. Over 10,000 people including government officials, doctors, scientists, decision-makers and citizens came together to campaign for the ban. Social media campaigns were used to dispel misinformation about the coal burning ban.

Warsaw was able to replace 85% of coal boilers in municipal buildings with alternative heating technologies including district heating, heat pumps and electric heat sources. Moreover, in collaboration with C40 (a network of non-governmental organizations and city policy-makers addressing climate change in cities), the Carbon-Neutral and Affordable Retrofits for Everyone in Need (CARE) project generated data to support efforts for prioritizing clean heating retrofits for those most in need, reducing energy poverty and ensuring cost-effective climate mitigation.

CASE STUDY 14

Beijing, China –
Policy measures to limit coal burning[42]

Beijing implemented measures to limit smoke from burning coal in homes. This included a switching policy to support gas rather than coal. Homeowners received subsidies to switch from coal-fired to gas boilers to reduce PM2.5 emissions. Alongside targeting residential PM emissions, Beijing also targeted industry with financial rewards for reducing pollution and emissions, encouraging the installation of scrubbers which filter out particles. Between 2013 and 2021, the atmospheric PM2.5 was reduced by 63%.

Benefits of action

Emissions reduction and environmental protection

Reduced wood burning reduces the amount of deforestation, protecting biodiversity and limiting climate impacts.

Improved health, safety and well-being

Fewer premature deaths and diseases associated with polluting indoor fuels.[43]

Economic benefits

Increased profits for related businesses, such as those that supply clean cooking equipment (in 2023, revenues of such companies exceeded $100 million).[44]

Progress towards equity

Use of clean cooking fuels improves women and children's health, as they spend disproportionate amounts of time near the domestic hearth.[45]

ACTION 8

Waste burning and dust pollution

Definition: Actions that reduce air pollution from waste management and prevent the need for burning of waste.

Waste burning is a source of unhealthy pollution including carcinogens, and is also a source of black carbon, a super pollutant that contributes to climate change. Open waste burning is often caused by a lack of waste management facilities. It is a complex challenge and can occur at many levels from burning at landfills or dumpsites to burning in individual homes.[46]

CASE STUDY 15

Dar es Salaam, Tanzania – Waste reduction scheme[47]

Solid waste contributes to 54% of methane emissions in Dar es Salaam, and emissions are projected to increase by over 90% between 2024 and 2040. Collaborations between the private and public sectors and the World Bank are employing established technologies at scale to tackle emissions from the burning of solid waste. This can improve air quality, as it is possible to reduce solid waste emissions by up to 80%. Food waste processing is one example of this. Nipe Fagio, a local environmental organization, is using insects for processing food waste.

The black soldier fly larvae can turn food waste into compost. Reducing household food waste through composting, recycling and at-source segregation can curb methane emissions too.

CASE STUDY 16

Hanoi, Vietnam – Recycling of school milk cartons[48]

Hanoi is a city experiencing fast population growth and consequently, burgeoning waste generation. Nearly 95% of Hanoi's waste ends in landfill, with the rest being incinerated or recycled. Emissions from incineration generate air pollution and sending waste to landfill is resource-intensive, takes up space and money, and impacts the environment and social well-being. Plastic pollution, in particular, accounts for 8-10% of daily waste generated in Hanoi and the country is ranked fourth in the world for its contribution to ocean plastic pollution.

In 2019, the city collaborated with packaging company Tetra Pak, recycling company Lagmon Vietnam and social enterprise NHC to create a programme that helped schools recycle milk cartons. Schools offer subsidized milk and large volumes of milk cartons are discarded every day, only to end up in landfills.

From a pilot project that began in 2017 and was scaled up in 2019, the programme had grown from 800 primary schools in 16 Hanoi districts to 1,400 across both Hanoi and Ho Chi Minh City within two years. It will eventually expand to 4,000 schools across all Hanoi districts.

The programme also engages with students to promote environmental awareness, with engagement activities such as exchanging cartons for trees and education on how to sort and store cartons for waste collection. The aim is to save 111 tonnes of methane emissions (the equivalent to 740 gas-powered vehicles driven for one year, as per the EPA calculator) by reducing the need for 1,000 tonnes of milk cartons annually.

Benefits of action

Emissions reduction and environmental gains

Lesser soil and water contamination from improved waste management. This reduces the amount of hazardous compounds (e.g. methane) entering the environment, which can damage biodiversity and ecosystems and enter human food chains.[49]

Improved health, safety and well-being

Reduced risk of infectious and vector-borne diseases (for example diarrhoea, cholera and malaria) and non-communicable diseases (such as heart disease and cancer) associated with poor waste management.

Economic benefits

Reduction in negative socio-economic effects and hence improvement in living standards, economic growth potential and community relations.[50]

Progress towards equity

More equitable health outcomes since waste burning and dust pollution disproportionately affect vulnerable populations including the elderly, children, marginalized populations, newborns and pregnant women.[51]

Circularity

Definition: Shift towards reducing the use of materials and resources, decoupling growth from resource consumption of finite resources,[52] which in turn reduces emissions from processes including waste and manufacturing.

Unsustainable production and consumption of natural resources is a cause of air pollution, climate change and biodiversity loss.[53] The circular economy works to decouple economic growth from the consumption of finite sources. By shifting towards a circular economy for food, 290,000 lives could be saved from outdoor air pollution annually.[54]

CASE STUDY 17

Cleveland, USA – Circular economy[55]

Cleveland in Ohio is a focal point for various industries including transportation, manufacturing, steel and iron. Despite the industrial economic opportunity, pollution and poor air quality remain major issues for the city. In 2023, Cleveland was ranked the fourth worst US city for asthma sufferers, and there is concern for the city's children after high levels of lead were found in their blood samples.

Circular Cleveland is a local project comprising multiple public-private partnerships, which seeks to promote a circular economy and reduce the effects of pollution and waste on citizens. The goals of the project are "to redesign [waste and pollution] systems to use natural resources more efficiently, create jobs and investment opportunities, [and] support and protect a healthier environment for residents now and in the future".

Through various initiatives such as "fix-it workshops", composting projects, community ambassador projects, small business grants and a Circular Cleveland Roadmap, the City of Cleveland and community development intermediary Cleveland Neighbourhood Progress are engaging with community leaders and organizations to create a healthy, equitable and sustainable city.

CASE STUDY 18

Bangkok, Thailand – Circular economy[56]

Pollution is an increasing threat in Thailand, where the capital Bangkok is working to leverage public-private partnerships to create a circular economy system. An initial steering committee was established in 2018, which began work in the Khlong Toei district, with "PPP Plastic" as a mixed-ownership company (private and public) to co-design waste systems with large companies and buildings.

The city, its community stakeholders and PPP Plastic collaborated to:

1. Connect buyers and sellers of recyclable and organic waste materials by innovation through digital tools.
2. Carry out research and awareness campaigns.
3. Encourage the pre-sorting of waste by designing easy-to-use drop-off sites.

A handbook was developed based on the Khlong Toei model, so that other city areas could replicate or adapt it even if they lacked extensive resources. By increasing the efficiency of waste management, companies can reduce waste management fees by 10-15% and improve their reputation with investors and consumers.

Benefits of action

Emissions reduction and environmental gains

Circular approaches can assist in building natural capital by placing value on nature and helping reverse degradation (for example biodiversity loss and soil depletion).[57]

Improved health, safety and well-being

A transition to circular approaches provides a major opportunity for potentially substantial health benefits while also contributing to a number of Sustainable Development Goals.

Economic benefits

Circular approaches promote local businesses and new partnerships that boost private-public-philanthropic collaboration in urban areas.

Progress towards equity

By educating and engaging communities throughout the implementation of actions, such approaches can limit the impact on vulnerable populations such as children.

Contributors

Lead authors

Nicole Cowell
Post-Doctoral Research Associate, Imperial College London; Hoffman Fellow, Clean Air, World Economic Forum

Sophie Punte
Co-Founder and CEO of Life-Links; Founder and Board Member, Smart Freight Centre

World Economic Forum

Aoife Kirk
Project Lead, Clean Air

Roderick Weller
Manager, Clean Air

The following members of the Global Future Council on Clean Air 2023-24 made this paper possible:

Maria Glynda Bathan-Baterina
Deputy Executive Director, Clean Air Asia

Gregga Baxter
General Manager, Gulf International Bank

Jane Burston
Chief Executive Officer, Clean Air Fund

Bruno Carrasco Garcia
Director-General, Climate Change and Sustainable Development Department, Asian Development Bank

Sangu Delle
Chairman and Chief Executive Officer, CarePoint

Peter Justice Dery
Director, Environment, Ministry of Environment, Science, Technology and Innovation of Ghana

Marcela Escobari
Special Assistant to the President of the United States, National Security Council (NSC)

Arunabha Ghosh
Chief Executive Officer, Council on Energy, Environment and Water (CEEW)

Angel Hsu
Associate Professor, University of North Carolina

Iyad Kheirbek
Director, Air Quality Program, C40 Cities Climate Leadership Group

Amit Mehra
Managing Director (2016-2024); Global Lead Sustainability, Accenture

Magdalena Młochowska
Director Coordinator, Green Warsaw, City of Warsaw

Hu Min
Executive Director and Founder, Institute for Global Decarbonization Progress (iGDP)

Tolu Oni
Clinical Professor, Global Public Health and Sustainable Urban Development, University of Cambridge

Juan Jose Pocaterra
Co-Founder and Chief Executive Officer, ViKua

Sophie Punte
Co-Founder and CEO of Life-Links; Founder and Board Member, Smart Freight Centre

Shirley Rodrigues
Member of Board, C40 Cities Climate Leadership Group

Jessica Seddon
Senior Fellow, Jackson School for International Affairs, Yale University

Kevin Urama
Chief Economist and Vice-President, Economic Governance and Knowledge Management, African Development Bank

Young Sunwoo
Professor, Department of Civil and Environmental Engineering, Konkuk University

Production

Mirna Colmenares and Design Team
Illustrator, ViKua

Bianca Gay-Fulconis
Designer, 1-Pact Edition

Oliver Turner
Designer, Studio Miko

Madhur Singh
Editor, World Economic Forum

Endnotes

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