UN environment programme

Hidden assets

The economic and health case for climate and clean air action.

CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

a UNEP convened initiative

Global Economic Assessment of
Integrated Climate and Clean Air Action

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The individuals listed below contributed to the production of this report. They are mentioned in their individual capacities, and their affiliations are included for identification purposes only. Names are listed in alphabetical order by last name.

Assessment Co-Chairs
Simon Dietz (London School of Economics and Political Science), Elliott Harris (Independent), Drew Shindell (Duke University) and Shuxiao Wang (Tsinghua University).

High-Level Panel
Joseph E. Aldy (Harvard University), Jane Burston (Clean Air Fund), Valerie Hickey (World Bank), He Kebin (Tsinghua University), Jiang Kejun (Hong Kong University of Science and Technology), Debra Roberts (University of KwaZulu-Natal and University of Twente), Roberto Schaeffer (Federal University of Rio de Janeiro), Priyadarshi R. Shukla (Ahmedabad University), Youba Sokona (Intergovernmental Panel on Climate Change) and Steven Stone (UNEP).

Authors
Cameron Andrews (The University of Texas at Austin), Kaoru Akahoshi (Institute for Global Environmental Strategies - IGES), Chiara Ballam (The University of Texas at Austin), Nathan Borgford-Parnell (CCAC Secretariat, UNEP), Suruchi Bhadwal (TERI), Enkhuun Byambadorj (Breathe Mongolia), Christopher Cambridge (The University of Texas at Austin), Simon Dietz (London School of Economics), David Eaton (The University of Texas at Austin), Greg Faluvegi (NASA Goddard Institute for Space Studies and Center for Climate Systems Research, Columbia University), Oliver Fricko (IIASA), Sarath Guttikunda (Urban Emissions), Elliott Harris (Independent), Tatsuya Hanaoka* (National Institute for Environmental Studies, Japan), Charles G. Heaps (Stockholm Environment Institute - SEI), Matthew Hengesbaugh (IGES), Kevin Hicks (SEI, University of York), Lena Höglund-Isaksson (International Institute of Applied Systems Analysis - IIASA), Michael Holland* (Independent), Omokayode Ipaye (Carbon Limits Nigeria), Katrin Kaltenegger (IIASA), Gregor Kiesewetter (IIASA), Younha Kim (IIASA), Zbigniew Klimont* (IIASA), Volker Krey (IIASA), Lovisa Kuehnle-Nelson (IIASA), Johan C.I. Kuylenstierna (SEI, University of York), Florian Lindl (IIASA), Li Liping† (Policy Research Center for Environment and Economy, Ministry of Ecology and Environment of the People's Republic of China), Christopher S. Malley (SEI, University of York), Jordan McCrackin (Carbon Limits Nigeria), James Ogunleye (Carbon Limits Nigeria), Shonali Pachauri (IIASA), Setu Pelz (IIASA), Amanda Pfeil (The University of Texas at Austin), Pallav Purohit (IIASA), Adriana Gomez-Sanabria (IIASA), Scarlett Quinn-Savory (Wellcome Trust), James Rising* (University of Delaware), Yang Rupu† (Policy Research Center for Environment and Economy, Ministry of Ecology and Environment of the People's Republic of China), Robert Sander (IIASA), Drew Shindell* (Duke University), Joseph V. Spadaro (Independent), Sydney Svagerko (The University of Texas at Austin), Mette Taber (The University of Texas at Austin), Ramón Carlos Torres Enríquez (National Institute of Ecology and Climate Change), Willem van Caspel (MET Norway), Shuxiao Wang* (Tsinghua University), Fabian Wagner (IIASA), Pu Wang (Chinese Academy of Sciences), Wilfried Winiwarter (IIASA), Yulia Yamineva (University of Eastern Finland), Jingyi Ye (CCAC Secretariat, UNEP), Xiuming Zhang (IIASA), Shaohui Zhang (IIASA) and Eric Zusman* (IGES)

* Coordinating Lead Author
† Contribution to Chapter 4 only

Expert reviewers
Iniobong Abiola-Awe (Federal Ministry of Environment, Department of Climate Change, Nigeria), Stefan Åström (Anthesis), Hermann Aubié (University of Eastern Finland), A. Patrick Behrer (World Bank), Andrew Beirne (Clean Air Fund), David Birchby (Logika Group), Olivier Chanel (CNRS & Aix-Marseille School of Economics), Jack Corscadden (Environmental Investigation Agency), Amanda Curry-Brown (CCAC Secretariat, UNEP), Gabrielle Dreyfus (IGSD), Stela Drucioc (Independent), Andrea Hinwood (UNEP), Lemesa Hirpe (Ethiopian Environmental Protection Authority), Ruijan Li (EDF), Nicklas Löther (University of Eastern Finland), Amani Maalouf (University of Oxford), Rob Maas (Independent), Avipsa Mahapatra (Environmental Investigation Agency), Marcelo Mena (Global Methane Hub), Wenjun Meng (Max-Planck-Institute for Chemistry), Carolina Monsalve (World Bank), Helena Naber (World Bank), N. Fatou Ndiaye (Senegalese Ministry of Environment), Tom Nickson (Environmental Investigation Agency), Lilian Fátima Nunes Salas (Independent), Ilissa Ocko (Spark Climate Solutions), Martina Otto (CCAC Secretariat, UNEP), Clare Perry (Environmental Investigation Agency), Reginald Quansah (University of Ghana School of Public Health), Arindam Roy (Clean Air Fund), Marcus Sarofim (Independent), Ndakize Joseph Sebaziga (Independent), Jan Selby (University of Leeds), Jessica Slater (Barcelona Supercomputing Center), Sophie Szopa (Laboratoire des Sciences du Climat et de l'Environment), Wenxin Qiao (World Bank), Ines Urman (Environmental Investigation Agency), Cosmos S. Wemegah (University of Energy and Natural Resources) and Hidemichi Yonezawa (OECD).

Project coordination
Ava Bahrami (CCAC Secretariat, UNEP), Nathan Borgford-Parnell (CCAC Secretariat, UNEP), Katy Brooke (SEI, University of York, UK), Kevin Hicks (SEI, University of York, UK), Scarlett Quinn-Savory (CCAC Secretariat, UNEP) and Jingyi Ye (CCAC Secretariat, UNEP).

Editing
Bart Ullstein (Banson)

Publishing
UNEP Publishing Unit

Cover design
Beverley McDonald

Layout and visuals
Kerry Gilhar

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Executive summary

This Assessment provides the most complete picture to date of the benefits and costs of integrated climate and clean air action, complemented by an empirically grounded analysis of how these benefits can be delivered quickly enough to avoid premature deaths and disease and improve the lives of many of the world's most vulnerable people. The world has entered a new phase of planetary and economic challenges. Exceeding 1.5 ºC of warming is now widely assessed as unavoidable (UNEP 2026), and governments face mounting economic costs from climate change and air pollution simultaneously, at a time when fiscal space is sharply constrained and returns on public investment are under intense scrutiny. The policy debate is also shifting: the question is no longer only what needs to be done to reduce emissions, but how to implement proven solutions quickly enough to avert planetary and economic crises, and how to generate returns that justify private investment. This Assessment demonstrates how the response to these challenges can be transformed into an economic opportunity.

One of the keys to unlocking that economic opportunity is recognizing that climate change and air pollution are inextricably linked. They share many of the same drivers and sources, above all fossil-fuel combustion, and certain agricultural practices and industrial processes. Many pollutants cause both climate change and air pollution, and their impacts compound one another, harming human health, ecosystems and economic activity. Despite these linkages, climate change and air pollution are often analysed separately, leading to incomplete assessments of their economic costs and benefits and, in many cases, avoidable trade-offs. In consequence, heads of state, finance ministers, business leaders, and affected communities often have a partial picture of the massive economic benefits of integrated solutions and the enabling reforms needed to achieve these gains.

This Assessment draws on the latest science and models and evaluates a package of 25 proven solutions based on existing technologies and practices spanning energy and fossil fuel systems, industry, transport, agriculture and food systems, residential cooking and heating, and waste management (Table ES2). The 25 integrated solutions have been assessed by previous United Nations Environment Programme (UNEP)/ Climate and Clean Air Coalition (CCAC) integrated assessments at global and regional levels, but in different combinations and not in a full economic context as in this Assessment. They comprise four long-term climate actions targeting deep carbon dioxide reductions, delivering co-benefits for air pollution and large longer-term benefits, and 21 solutions targeting super pollutants that deliver rapid improvements in air quality, health outcomes and near-term climate impacts. The analysis finds that integrated action delivers greater economic and health benefits than acting on climate change or air pollution alone, and that these benefits materialise quickly enough to outweigh costs within the first decade. It further shows that the chief obstacles to capturing these gains are often neither technical nor economic but institutional: reforms of enabling frameworks that determine the speed, scale and effectiveness of implementation are frequently overlooked in economic assessments because they are difficult to quantify. This Assessment addresses that gap directly.

Unless otherwise stated, ranges in parentheses represent 95 per cent confidence intervals for economic and temperature estimates, and interquartile ranges for health estimates. Ranges are shown alongside central estimates in the text, figures and tables.

Integrated action on climate and clean air is one of the highest-return investments available to governments today

Every dollar invested in the 25 solutions generates around 15 dollars of economic benefits, with market returns exceeding implementation costs within ten years and an internal rate of return of 60 per cent.

The 25 solutions, if implementation begins immediately, could generate economic benefits equivalent to about 2.8 (2–4) per cent of global gross domestic product (GDP) by 2035, 4.5 (3–6) per cent by 2050, and approximately 11.4 (8–14) per cent by 2100 (Figure ES1). Implementation costs are approximately 0.7 per cent of global GDP in the coming decade, declining to approximately 0.5 per cent by the end of century, meaning global economic benefits exceed implementation costs by a ratio of 15 to 1. For context, global spending on explicit fossil fuel subsidies was 2.18 per cent of GDP in 2022, and total government spending on education was 3.5 per cent and on health care was 9.3 per cent of GDP in 2023.

Even excluding non-market welfare gains entirely and counting only measurable market benefits, such as reduced healthcare spending, higher labour productivity, and avoided physical damage, the 25 solutions return approximately US$ 4 for every dollar invested.

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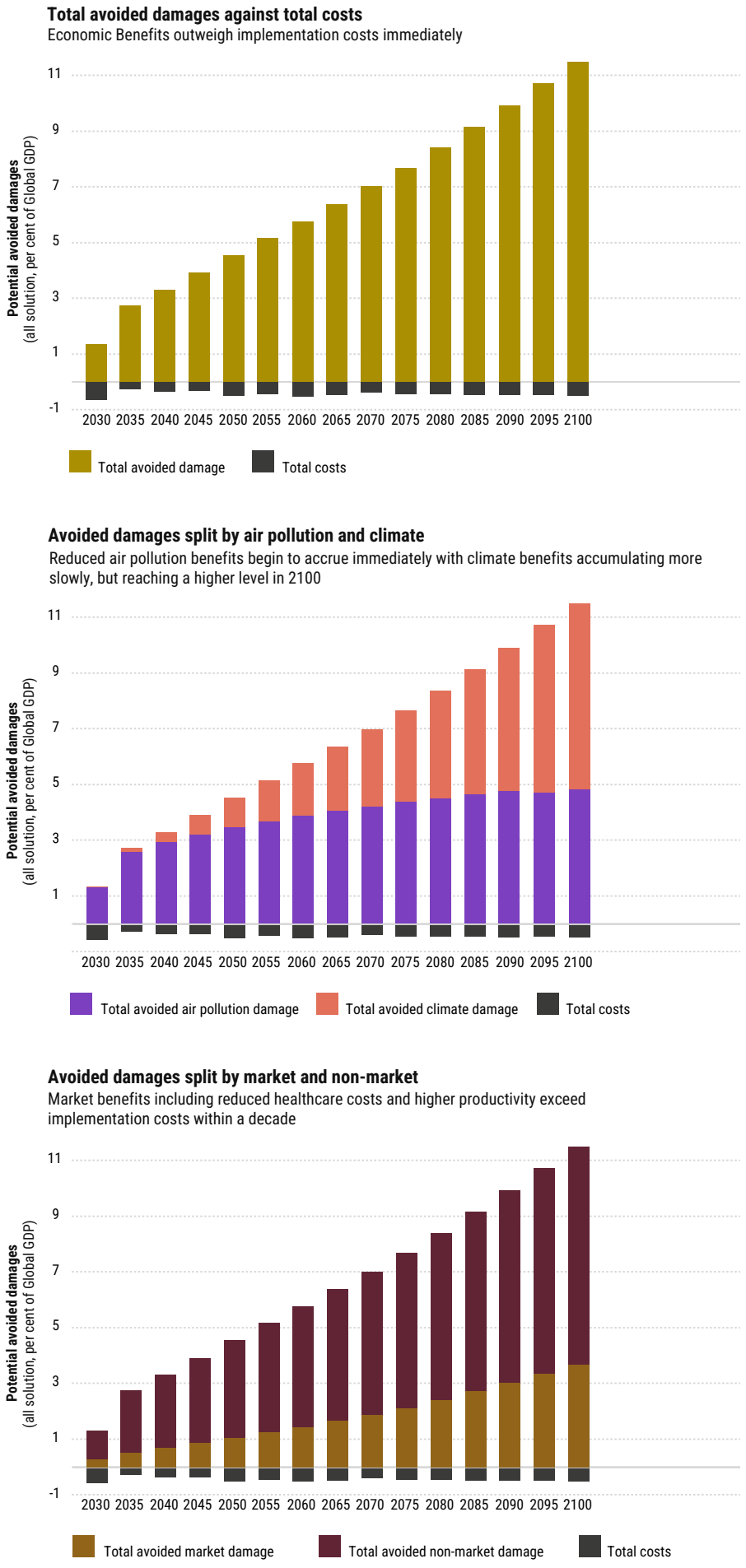
Figure ES1:
Avoided damages, shown in total (top, gold), split into air pollution (purple) and climate change (pink) benefits (middle), and into market (light brown) and non-market (dark brown) damages (bottom), alongside total implementation costs (dark blue), 2025–2100, per cent of global gross domestic product.

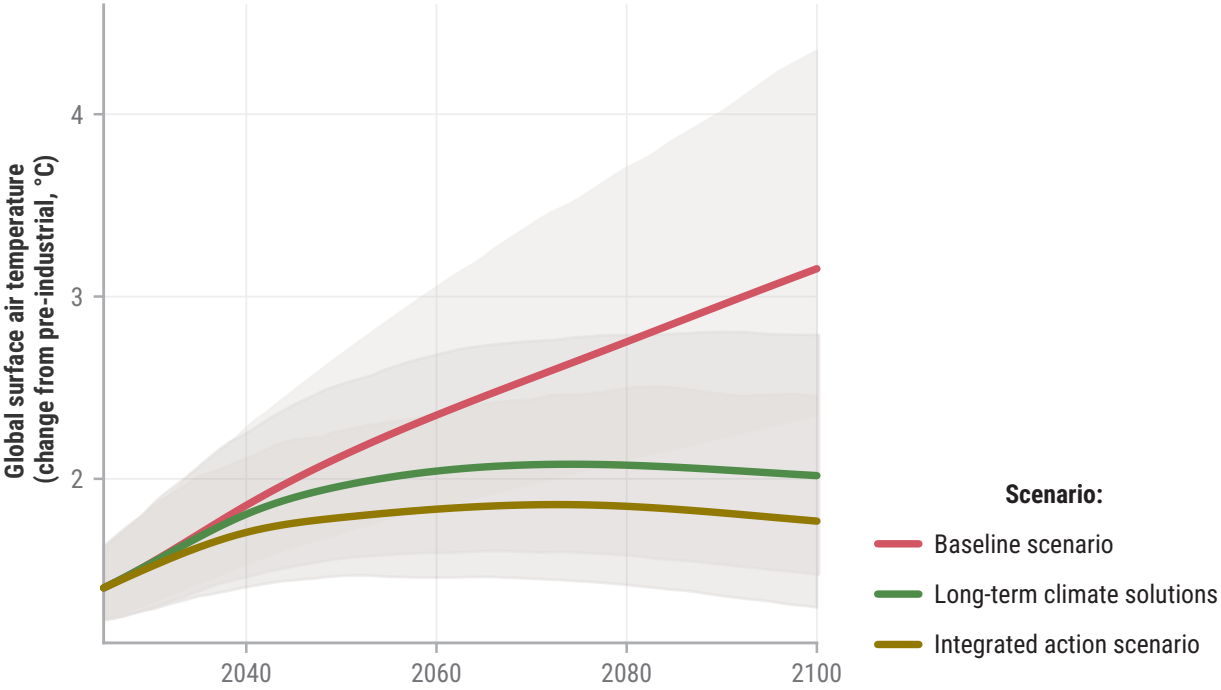


The economic value of avoided air pollution damage exceeds that of avoided climate damage in early years after the implementation of the 25 solutions and remains nearly 45 per cent of the total economic benefit in 2100 (Figure ES1). Considering only the costs of climate impacts therefore misses almost half of the economic benefits of action, underlining the importance of the integrated approach.

Pursuing climate and air quality action together rather than separately generates approximately 0.2 per cent of GDP in additional economic benefits. These gains arise because many benefit channels – avoided climate damage, reduced healthcare expenditure, higher labour productivity and quality-of-life improvements linked to reduced morbidity and mortality – only materialise fully when the climate and clean air agendas are pursued together. These benefits are captured (but not shown) in Figure ES1.

The 25 solutions could avoid approximately 0.34 °C (0.1–0.6) of warming by 2050 and approximately 1.4 °C (0.9–2.1) by 2100 (Figure ES2). Since temperatures over land rise faster than the global average, the benefits of the 25 solutions are larger at the regional level than global figures suggest, with avoided warming of approximately 0.1 °C in 2035, 0.5 °C in 2050 and 1.5–2 °C in 2100 in most regions.

Figure ES2: Changes in global surface temperature for the baseline, the four long-term climate solutions and the full 25 integrated solutions (integrated action scenario) relative to pre-industrial levels, 2020–2100, degrees Celsius.



Note: bands show the 95 per cent confidence interval.

Air pollution is a macroeconomic risk, not an environmental add-on

The morbidity and mortality effects of air pollution, including through lost productivity and rising healthcare costs, already represent several percentage points of GDP annually and are projected to grow without stronger action.

This Assessment finds that in 2025, anthropogenic ambient (outdoor) fine particulate matter ($PM_{2.5}$) and ozone together caused an estimated 6.4 (5.2–7.3) million premature deaths worldwide. Indoor $PM_{2.5}$ contributed an additional estimated 2 (1.8–2.2) million premature deaths, 300,000 (260,000 to 330,000) of which were children. Ambient $PM_{2.5}$ exposure alone is associated annually with millions of new cases of childhood asthma, millions of heart attacks, chronic obstructive pulmonary disease (COPD), diabetes, stroke, dementia, and lung cancer (Table ES1).

Table ES1: Number of new cases of disease linked to anthropogenic fine particulate matter exposure and proportion of all instances globally, 2025.

Disease	New cases Millions	Per cent of all new cases
Childhood asthma	5.5 (4.7–6.2)	22 per cent
Heart attacks	4.2 (3.3–4.9)	20 per cent
Chronic obstructive pulmonary disease (COPD)	3.8 (3.2–4.3)	21 per cent
Diabetes	3.3 (2.6–3.9)	15 per cent
Stroke	2.5 (2.0–2.9)	20 per cent
Lung cancer	0.5 (0.4–0.6)	19 per cent
Dementia	2.0 (1.6–2.3)	19 per cent

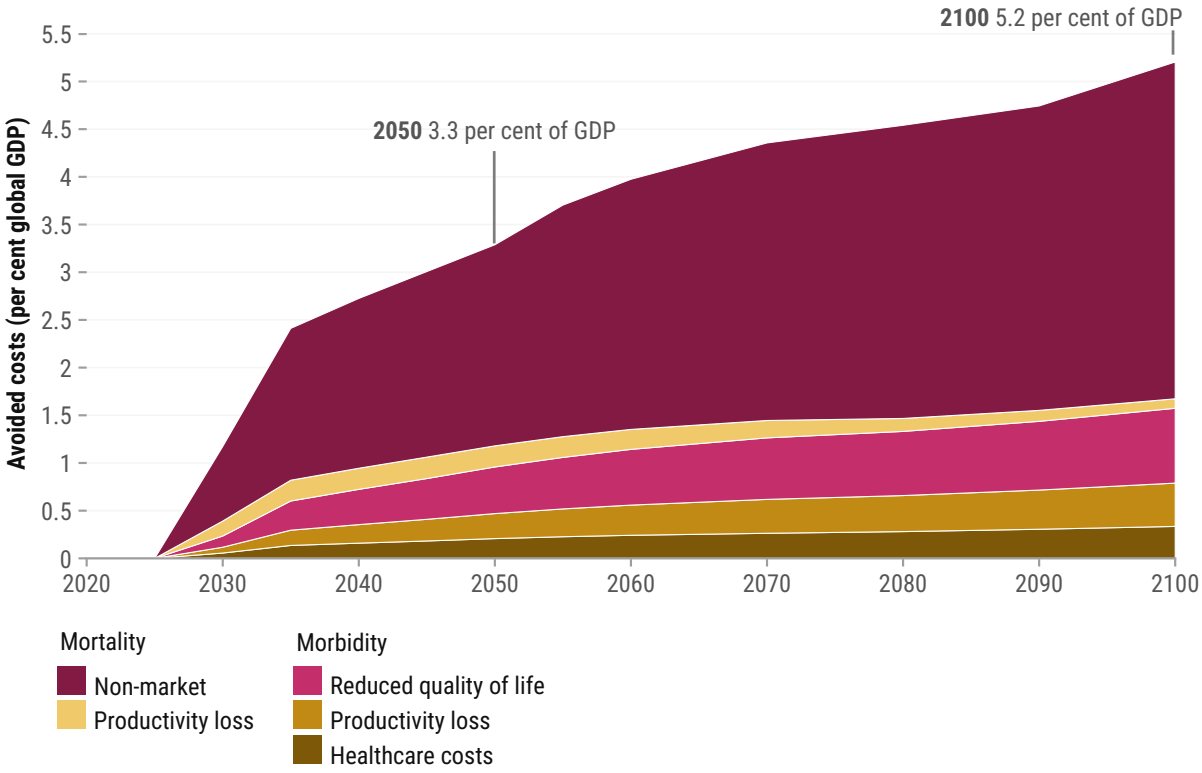
Note: numbers in brackets show the Interquartile range (IQR).

Cumulatively, by 2050, the 25 integrated solutions would avoid hundreds of millions of cases of chronic diseases and an estimated 144 million premature deaths from ambient and household $PM_{2.5}$ exposure plus ozone exposure. This is made up of an estimated 62 (37–77) million cases of childhood asthma, 87 (65–103) million acute myocardial infarctions (heart attacks), 63 (50–73) million cases of COPD, 56 (39–68) million cases of diabetes, 45 (37–51) million cases of stroke, 36 (29–42) million cases of dementia, 7 (5.4–8.2) million cases of lung cancer, 96 (80–109) million premature deaths attributable to ambient $PM_{2.5}$, 43 (38–48) million premature deaths from household $PM_{2.5}$ exposure, and 5 (4.0–5.8) million premature deaths from exposure to ozone (See Figure ES4).

Many prior economic assessments of air pollution have focused on premature mortality, leaving the broader costs of illness unvalued. This Assessment incorporates the latest evidence across a substantially expanded set of health conditions and breaks down their cost implications, making the costs and benefits of action more visible and directly comparable. By 2050, the 25 solutions could avoid market healthcare expenditures and productivity losses equal to 0.7 per cent GDP. These benefits increase markedly when the quality-of-life (non-market) benefits of reduced morbidity and mortality are also considered (Figure ES3). The avoided market costs are comparable in magnitude to the full cost of implementing all 25 solutions, and the economic case strengthens further once non-market welfare losses are included.

Without further action, emissions of greenhouse gases, air pollutants and their precursors are projected to keep rising globally, particularly in rapidly developing regions. Without additional policy, the share of the global population exposed to the most dangerous $PM_{2.5}$ concentrations rises from 27 per cent in 2025 to 34 per cent by 2050. Combined with ageing populations, this will increase the disease burden from air pollution and raise pressure on public finances and constrain economic growth in exactly the countries that can least afford it. Full implementation of the 25 solutions would avoid 60 to 70 per cent of the total air pollution health burden annually.

Figure ES3: Annual morbidity and mortality air-pollution-related costs avoided by implementing all 25 solutions, 2025–2100, per cent of global gross domestic product.



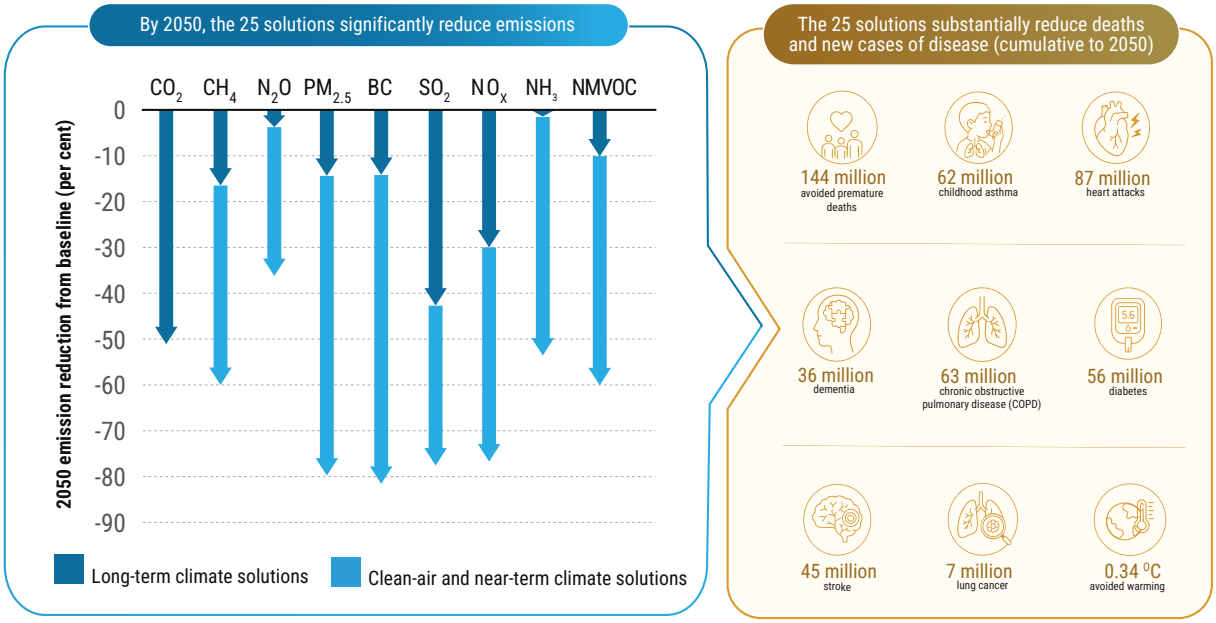
Greater than the sum: integration increases returns

Tackling shared sources of climate change and air pollution through an integrated package boosts net economic benefits to approximately 11.4 per cent of global GDP by 2100, more than either achieves alone.

Because climate change and air pollution share partly the same emission sources, the 25 integrated solutions can simultaneously reduce greenhouse gases, cut air pollution, and generate compounding economic returns across health, productivity and avoided climate damage (Figure ES4). Integrating the two agendas means that in all regions the combined benefits of action offset costs in the near term, and substantially more so over the long term. Integrated action allows impacts to be reduced more quickly, effectively and at a lower overall cost compared to the situation pursuing each of the agendas separately with uncoordinated timelines and stakeholder involvement hampering fast progress and transformation needed to implement it.

By 2050 the 25 solutions cut global carbon dioxide emissions by half, methane by 60 per cent, and black carbon and $PM_{2.5}$ precursors including sulphur dioxide and nitrogen oxides by 70 per cent (Figure ES4). By 2100 carbon dioxide emissions are net-negative and $PM_{2.5}$ precursors fall by up to 85 per cent. Solutions targeting air pollution and near-term climate impacts complement long-term decarbonization by delivering immediate economic gains, including reductions in public healthcare costs, productivity gains, and increased workforce participation.

Figure ES4: Global emission reductions attributed to the implementation of (i) the long-term climate solutions and (ii) the clean-air and near-term climate solutions of key greenhouse gases and air pollutants in the integrated action scenario compared to the baseline (left) in 2050 (as per cent), and the associated health and climate benefit (right) compared to the baseline in 2050.



Time is money: delay locks in avoidable costs

Near-term action on fast-acting solutions reduces warming, starts to save lives immediately, and generates returns that delayed action cannot recover.

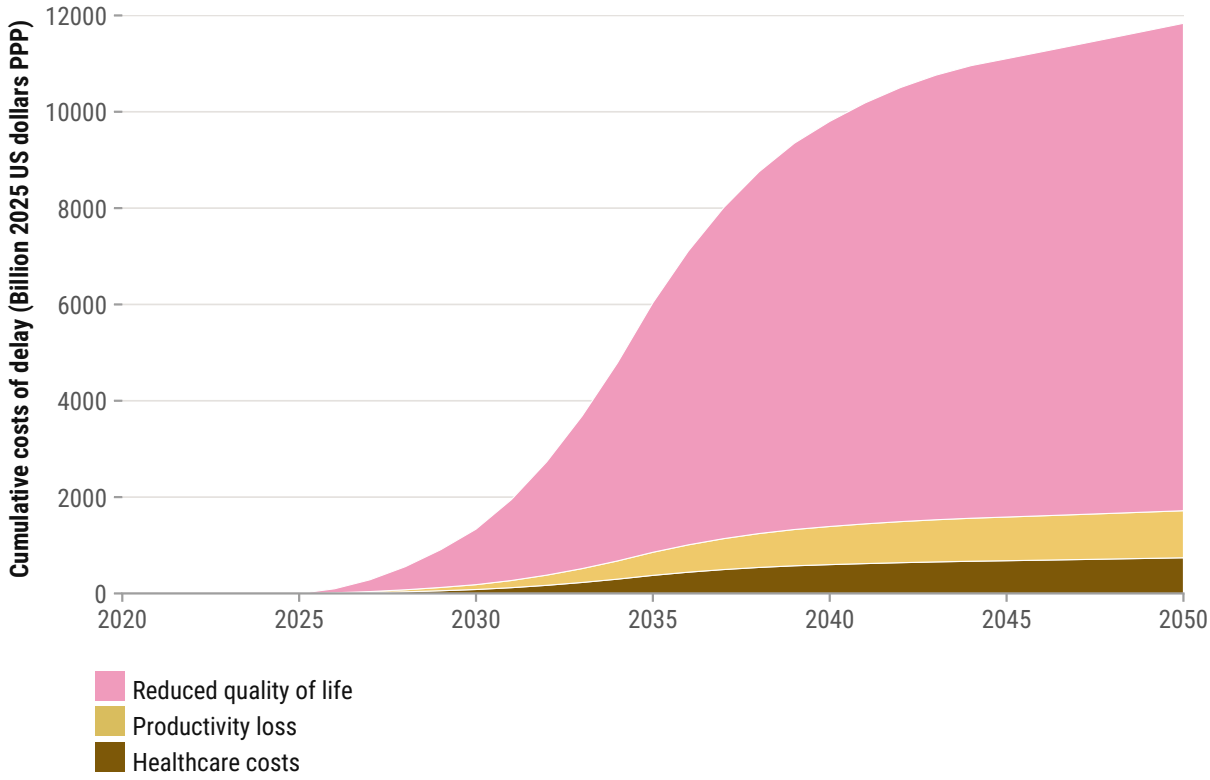
Every year of delay raises cumulative emissions, increases long-term costs and locks in health burdens that cannot be reversed. In terms of health impacts, emissions reductions not achieved in the near-term cannot be compensated for later in the absence of fundamental changes to socio-economic factors such as demand preferences or population relative to the scenarios used in this Assessment, however strong the action that follows. Each year of delay foregoes more than 0.5 per cent of global GDP in benefits, equivalent to more than US$ 1.5 trillion in combined market and non-market value.

This Assessment quantifies what more rapid implementation is worth. Strengthening enabling conditions – economic, social, technological and institutional – can bring all 25 solutions fully into place up to a decade sooner, substantially boosting reductions in $PM_{2.5}$ and ozone precursors over the 2025–2050 period. Implementation delays of 7.5 to 8 years are expected globally on average, with institutional barriers the single largest contributor, accounting for approximately 2.4 years (Figure ES7) over a notional 15-year implementation window. A delay of this scale roughly halves the emissions reductions achievable by 2035. Market and non-market morbidity benefits from enabling reforms that accelerate implementation alone could total up to a cumulative US$ 10 trillion in savings by 2040 (Figure ES5). This is roughly equivalent to one full year of total global spending on health, which reached US$ 10.6 trillion in 2023 (WHO 2025).

The effects of delay are real. In Delhi, India, achieving current national air quality standards on schedule from 2026 would reduce the cumulative $PM_{2.5}$ exposure burden by 20 per cent by 2040. With an eight-year delay, the global average, the reduction is only 10 per cent. Half the benefit is lost.

Investment in sustained capacity-building programmes, air quality monitoring systems, interagency coordination mechanisms and other enabling reforms that accelerate implementation is an often overlooked economic priority in its own right.

Figure ES5: Cumulative costs of delay accounting for air pollution only, morbidity and mortality because of barriers to implementation, 2025–2050, billion 2025 United States dollars, purchasing power parity.



Note: for this cumulative result, future costs are discounted to 2025 at 3 per cent per year.

The benefits materialise everywhere, across all regions and over different timescales

The economic and health returns from integrated action vary substantially across the 15 regions analysed, but every region benefits, and no solution is wasted.

The 25 integrated solutions do not deliver uniform benefits across the world. Benefit-cost ratios (BCRs) range from three in high-income regions such as the European Union, the European Free Trade Association and the United Kingdom of Great Britain and Northern Ireland to 26 in Southern Africa, reflecting the concentration of health and climate risk in lower-income countries in which approximately 95 per cent of premature deaths attributable to air pollution occur. Regions in South Asia, Sub-Saharan Africa and the Middle East face combined pollution and climate risks equivalent to more than 5 per cent of regional GDP by 2100. Even excluding non-market benefits entirely, benefits exceed costs in 8 of the 15 regions. No region should wait for others to move first.

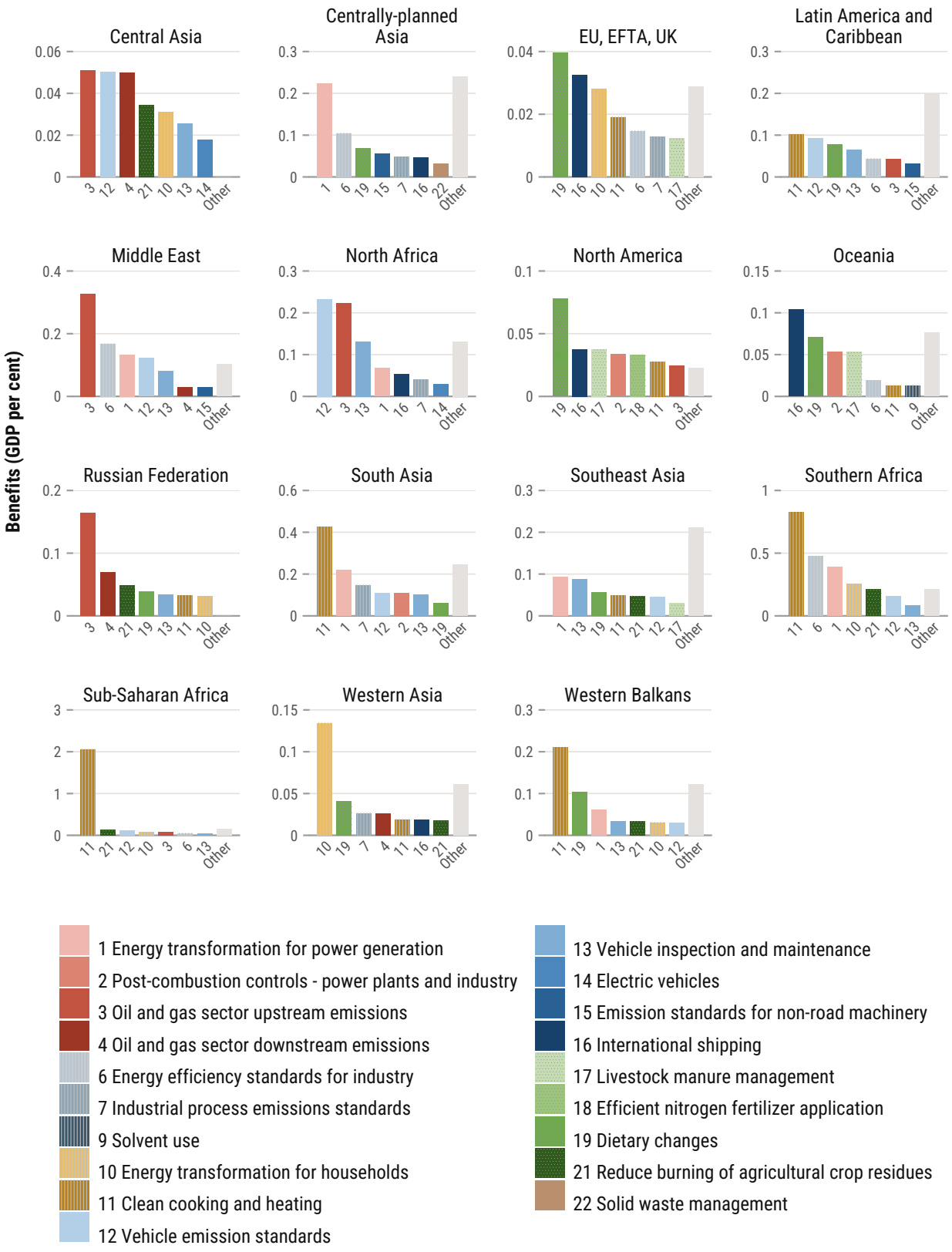
Within the 15 regions analysed, the solutions delivering the largest near-term benefits differ substantially, reflecting each region's energy system, pollution profile and stage of development (Figure ES6). In 2035, five broad groupings emerge where countries gain the most benefit: for high-income regions with mature pollution controls it is from dietary change and emissions controls for international shipping; for developing regions with high indoor air pollution exposure, including Latin America and the Caribbean, South Asia and Sub-Saharan Africa, it is from clean cooking; for oil and gas producing regions in the Middle East, North Africa and Russian Federation it is from controlling methane leakage and flaring; and for rapidly developing regions across Asia it is from power generation and household energy transitions.

These groupings remain broadly stable in 2050, but the relative importance of the four long-term climate solutions grows as near-term air pollution benefits are progressively captured, and dietary change and energy-efficiency standards rise in prominence across most regions. This variation in the benefits that the measures give does not reduce the case for implementing all

25 solutions simultaneously: the synergistic benefits identified only materialise when the full package is pursued.

Well-designed policies amplify these gains; poorly designed policies risk undermining them. For example, in some communities, policies such as targeted transfers, subsidised access to cleaner technologies, and gender-responsive planning may be essential for capturing the full benefit at the community level, not optional additions. Ensuring implementation explicitly reaches vulnerable populations is both an equity imperative and a precondition for realizing the full economic returns that this Assessment identifies.

Figure ES6: Priority solutions by region in 2035 considering air pollution and climate policies, ranked by total market benefit, per cent of regional gross domestic product.



Note: The figure shows the seven solutions delivering the greatest market benefits in each of the 15 regions by 2035, expressed as a percentage of regional GDP and accounting for both air-pollution and climate benefits. The grey bar shows 'other' - the combined effect of the rest of the 25 measures.

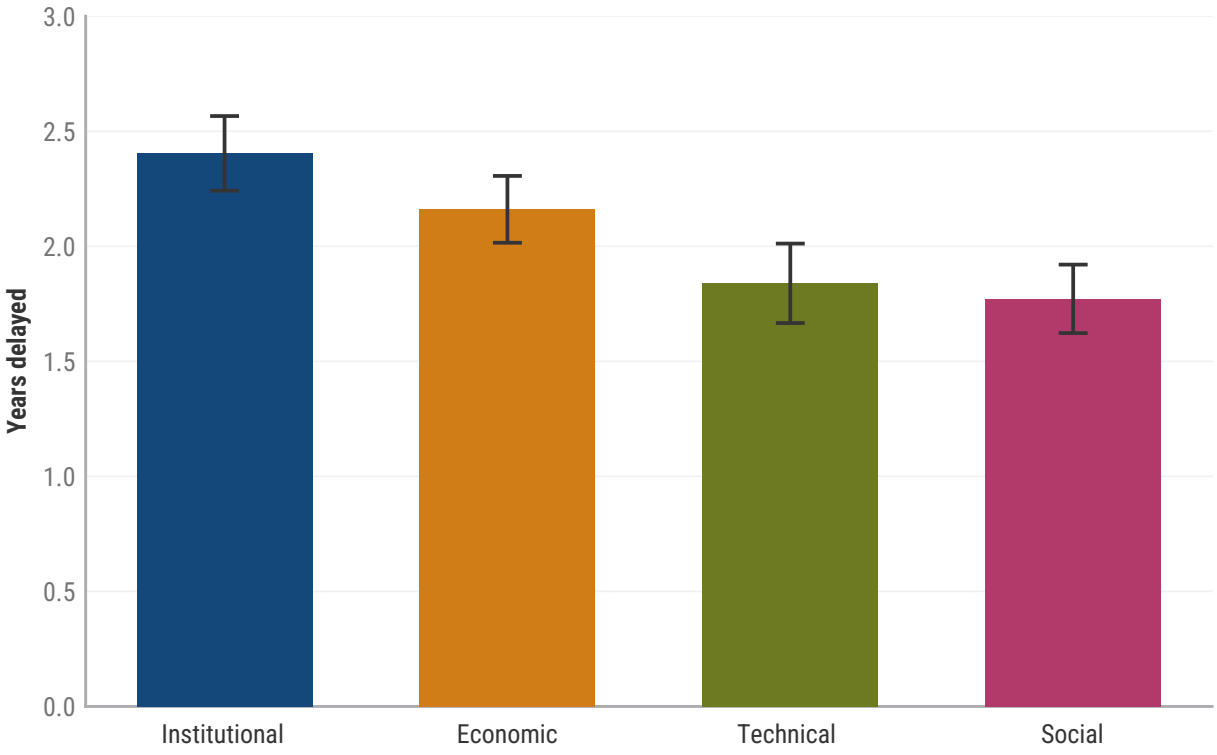
Enabling conditions are as important as technology choices

Access to finance, institutional capacity, governance, and coordination challenges explain why the same policies deliver different outcomes across contexts. Investment in a well-designed enabling environment is essential to bringing full implementation forward by up to a decade.

Most previous economic assessments have focused on which solutions need to be adopted by when, with limited attention on what makes implementation succeed or fail over different time periods. This Assessment addresses that gap directly. It also shows that barriers to implementation are not primarily technical. Siloed decision-making, limited enforcement capacity, inadequate financing and weak cross-ministerial coordination are the constraints that are cited most frequently to explain why proven solutions are not adopted at the speed or scale predicted in models and fail to achieve their technical potential (Figure ES7).

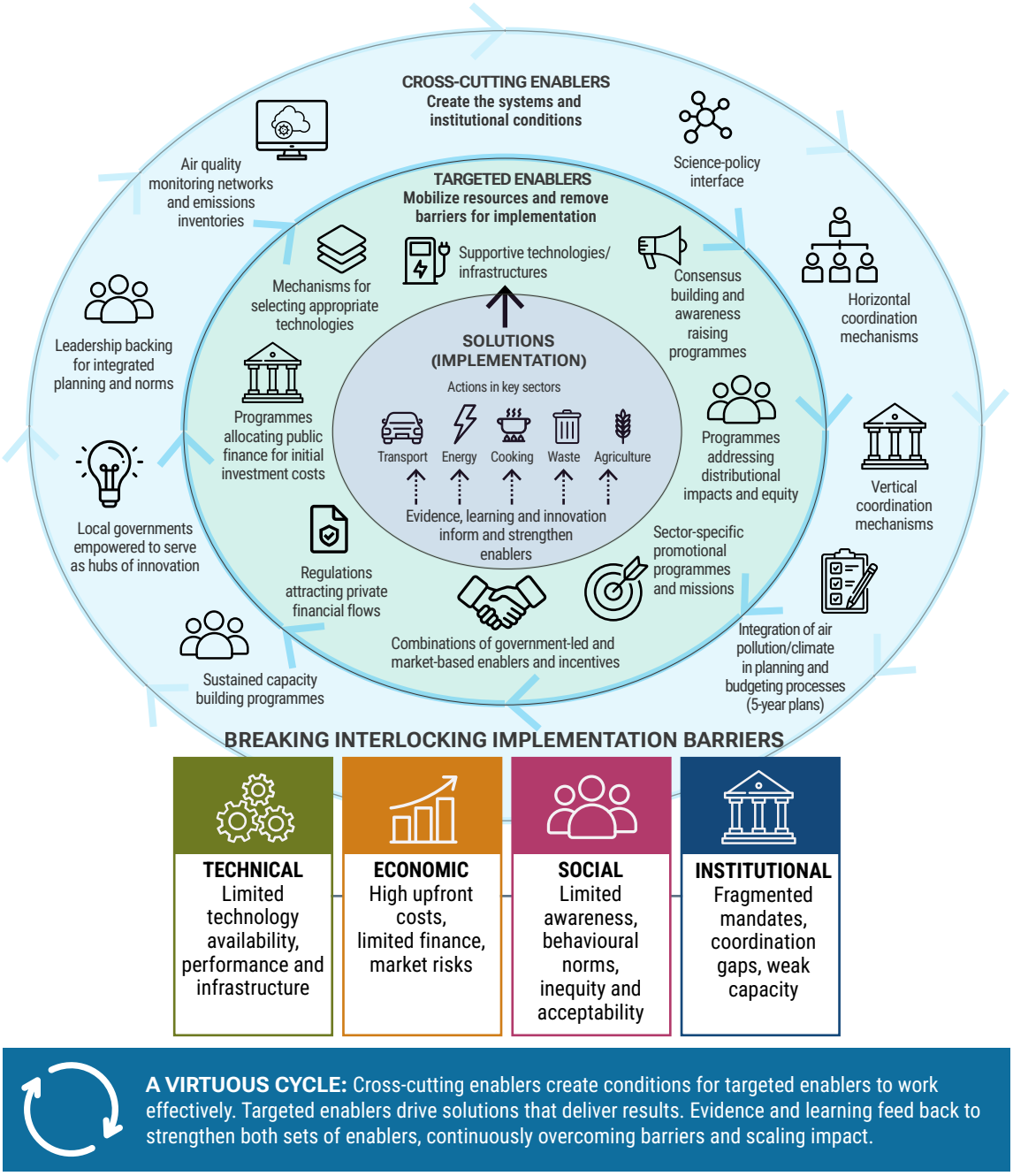
Addressing these barriers through a suite of broader cross-cutting institutional enablers and narrower-sector specific reforms can accelerate implementation substantially (Figure ES8). The 25 solutions span six sectors, each governed by different ministries, regulatory frameworks and financing channels. Realizing the full package of benefits requires institutional architecture capable of coordinating across all of them – and this Assessment shows, for the first time, the economic value of strengthening institutional coordination and equipping regulators with the tools and resources to enforce policies.

Figure ES7: The relative importance of different barriers, years delayed.



Note: The error bars reflect upper and lower ranges of 95 per cent confidence intervals for all solutions for each type of barrier for the 4 countries, China, India, Mexico and Nigeria.

Figure ES8: 16 enablers that break the four implementation barriers to accelerate action.



Country experience shows this is achievable, not aspirational. At the institutional level, China's co-control strategy for air pollution and climate change, Mexico's Intersecretarial Commission on Climate Change, and Nigeria's integration of short-lived climate pollutants into its Nationally Determined Contribution (NDC) illustrate how policy frameworks can be designed to strengthen cross-sectoral implementation.

At the programme level, China's expansion of electric vehicle charging infrastructure, India's clean cooking access programme and solar mission, Mexico's national cookstove projects and national strategy for electric mobility and Nigeria's awareness-raising initiative on open burning and its Rural Women Energy Security programme show that well-designed interventions can drive social as well as technological change.

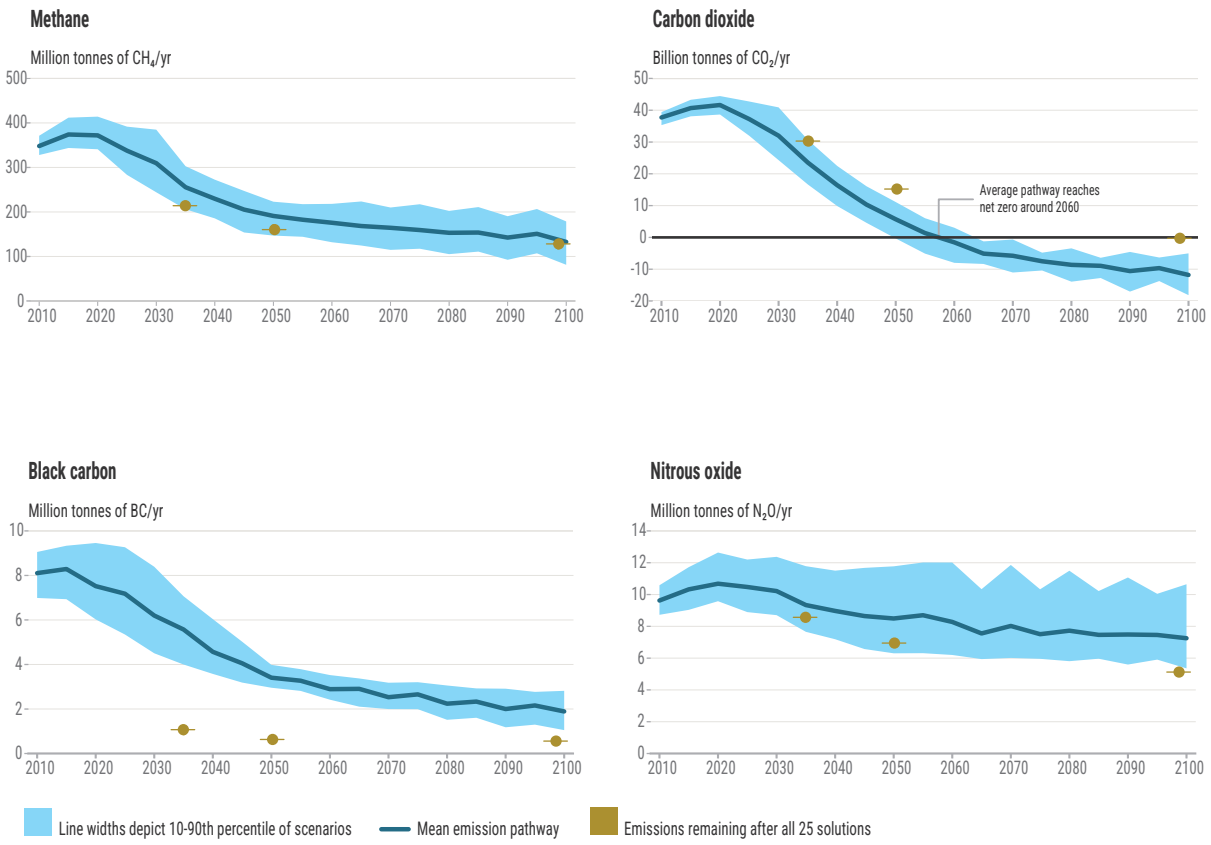
The 25 solutions deliver on governments' existing commitments, not just future aspirations

Full adoption exceeds the pace required to meet the World Health Organization (WHO) 2040 air-quality mortality target and is consistent with Intergovernmental Panel on Climate Change (IPCC) pathways for limiting peak warming.

In May 2025, the World Health Assembly adopted a voluntary target of halving mortality attributable to anthropogenic air pollution by 2040, relative to 2015. Meeting it requires average annual reductions in attributable mortality of approximately 3.3 per cent. Global implementation of the 25 integrated solutions delivers approximately 4 per cent per year over the same period, exceeding the pace the target demands.

In the 2015 Paris Agreement, parties agreed to limit global warming to well below 2 °C and ideally to 1.5 °C. Exceeding the 1.5 °C climate target of the Paris Agreement is now widely assessed as unavoidable; the central challenge is to limit peak warming, reduce the duration of exceedance, and return temperatures below 1.5 °C. For the super pollutants that determine the peak and pace of overshoot – methane, tropospheric ozone, HFCs and black carbon – the 25 integrated solutions reduce associated emissions to levels consistent with, or well below, IPCC overshoot, peak and decline pathways limiting warming to 1.5 °C (Figure ES9). For carbon dioxide, the solutions achieve substantial reductions, reaching net-negative emissions after 2080, but closing the remaining gap to the net-zero by 2060 required by these pathways will require additional decarbonization, land-use change and carbon capture measures that do not meet the criteria for inclusion in the package of 25 solutions. In an era of overshoot, the 25 solutions deliver across all three stages of the response: rapid near-term reductions that slow warming now, sustained decarbonization that limits the peak, and the net-negative carbon dioxide and continued super pollutant reductions that help bring temperatures back down while delivering immediate benefits for public health and the economy.

Figure ES9: Comparison of the key greenhouse gas emissions reduction between the integrated scenario and the Intergovernmental Panel on Climate Change overshoot pathways, 2010–2100, methane, black carbon and nitrous oxide, million tonnes; carbon dioxide, gigatonnes.



Call to action

This Assessment makes a more comprehensive economic case for integrated action on climate and clean air than any previous global analysis. Capturing these returns, at speed and scale, requires deliberate choices across five areas.

- **Make integrated climate and clean air policy a core economic strategy.** Governments should embed air quality and climate action jointly in national growth plans, fiscal frameworks, and investment strategies. Avoided health costs, productivity gains, and reduced fiscal exposure to climate damage are economic objectives in their own right and should be reflected in budget and planning processes.

- **Invest early and consistently in enabling conditions.** Governments should prioritise spending that shortens implementation delays, including affordable finance and risk-sharing instruments, institutional capacity and cross-ministerial coordination, and planning, budgeting and enforcement systems.

- **Target rapid wins to meet near-term commitments.** Solutions including clean cooking, methane controls addressing leaks, venting and flaring, organic waste, and transport and air quality measures are largely within national control and deliver direct economic and health returns in less than a decade. Accelerating these alongside longer-term decarbonization is not only fiscally sound – it is a direct path to meeting the WHO 2040 voluntary target of halving air-pollution mortality and keeping peak warming as low as possible during a period of 1.5 °C overshoot. Governments that move quickly on these solutions will capture near-term fiscal space, build the political foundation for sustained climate action, and demonstrate measurable progress against commitments already made.

- **Align international cooperation with realities of implementation and finance needs.** Global and regional frameworks should be designed to reflect significant differences in impacts and abatement costs across regions. International partners should mobilise finance for institutional strengthening, policy development, technology transfer, and infrastructure investment to address the higher relative burdens and implementation constraints facing developing regions.

- **Invest in the data and monitoring infrastructure that decisions depend on.** This Assessment demonstrates that expanding the health evidence base materially changes the economic conclusions. Governments should treat air quality monitoring networks, emissions inventories and sex-disaggregated health data as core economic infrastructure, not scientific overhead. Future assessments should extend this approach to under-counted damage in agriculture and ecosystems, additional pollutants, and biodiversity and natural capital as well as additional health impacts including mental health. Systematic collection of sex-disaggregated data should be treated as a core evidence investment alongside modelling capacity.

Integrated action on climate and clean air is one of the rare policy agendas that delivers rapid domestic returns, reduces fiscal risk, improves equity outcomes and strengthens long-term growth and prosperity. The 25 solutions make the economic case for taking rapid action with precision. What is required now is moving at a speed and scale that matches it.

Table ES2: The 25 solutions implemented in the 'integrated action scenario'. This includes the two groupings (i) 4 long-term climate solutions ( ) and (ii) 21 clean air ( ) and near-term climate ( ) solutions. For each measure the primary mitigation objective is indicated with as well as the mitigation co-benefit.

Measure	Brief description	Primary mitigation objective	Mitigation co-benefit
Energy and fossil fuel systems			
Energy transformation for power generation	Energy transformation for power generation. Transition to use of wind, solar and hydro power for electricity generation		
Post-combustion controls – power plants and industry	Application of high efficiency flue gas cleaning technology to reduce air pollutants		
Oil and gas sector upstream emissions	Recovery of associated gas to eliminate routine venting and flaring, reduce unintended leaks		
Oil and gas sector downstream emissions	Reducing leaks in long-distance and consumer gas transmission pipelines, and in refineries		
Coal mining	Ventilation air CH_4 oxidation and extended pre-mining recovery of coal mine gas		
Industry			
Energy efficiency standards for industry	More ambitious energy efficiency standards and extended electrification		
Industrial processes emission standards	Improvements in process technology, including adipic acid production		
Efficient brick kilns	Improved efficiency and emission standards		
Solvent use	Low-solvent products, leak detection, etc.		
Residential cooking and heating			
Energy transformation for households	Improved energy efficiency of buildings, lighting, and household appliances		
Clean cooking and heating	Clean alternatives for traditional cooking and solid fuel heating		
Transport			
Vehicle emission standards	More stringent emission limit values and efficiency standards		
Vehicle inspection and maintenance	Early recognition and elimination/repair of high emitting vehicles		
Electric vehicles	Transition to use of electric vehicles		
Emission standards for non-road machinery	More stringent emission limit values and efficiency standards		
International shipping	Low-sulphur fuels, control of particulate matter and NO_x		
Agriculture and food systems			
Livestock and manure management	Control of ammonia and CH_4 from livestock production, including manure application, enteric fermentation, and anaerobic digestion		
Efficient nitrogen fertilizer application	Improving timing and dose, urease inhibitors, etc.		
Dietary changes	Shift to less meat protein in diets		
Rice paddies	Encourage intermittent aeration of continuously flooded paddies		
Reduce burning of agricultural residues	Effective bans and alternatives to burning		
Waste management			
Solid waste management	Efficient waste collection with source separation and recycling. Gas recovery from landfills		
Wastewater treatment	Well-managed two-stage anaerobic followed by aerobic treatment with biogas recovery		
Others			
Prevention of forest and peatland fires	Improved forest, land and water management and fire prevention strategies		
Phasing down the use of hydrofluorocarbons (HFCs)	Further mitigation beyond the Kigali Amendment		

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www.unep.org
unep-communication-director@un.org