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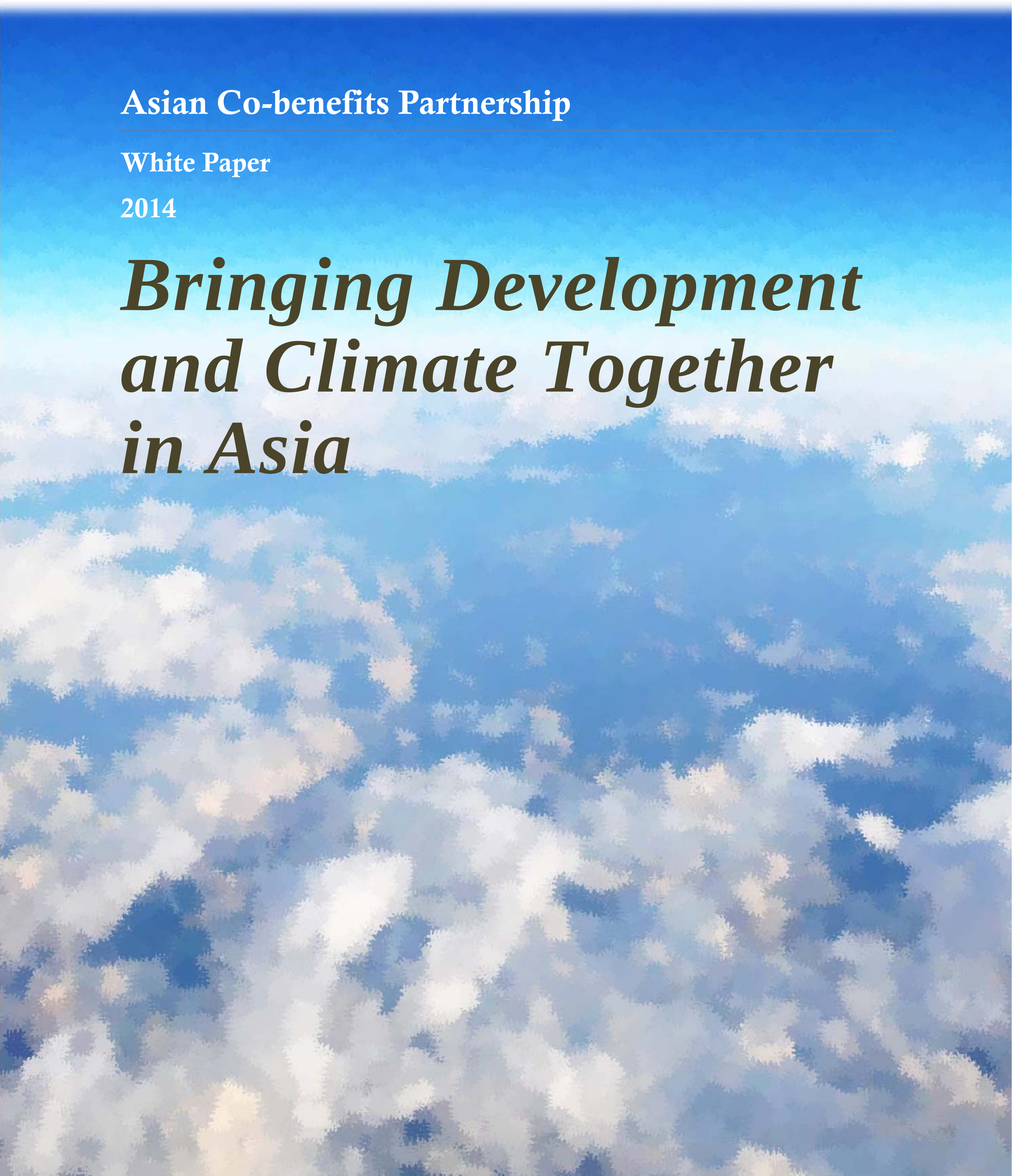
White Paper

2014

Bringing Development and Climate Together in Asia



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Asian Co-benefits Partnership (ACP) White Paper 2014
Bringing Development and Climate Together in Asia

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Secretariat of the Asian Co-benefits Partnership (ACP)

Bringing Development and Climate Together in Asia

ACP White Paper I

2014

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Foreword

Almost five years ago, discussions began at the first International Forum for a Sustainable Asia and the Pacific (ISAP) in Hayama, Japan that would lead to the creation of the Asian Co-benefits Partnership (ACP). At the time, it was recognized that many countries in Asia could save resources by aligning climate concerns with development priorities. It was also recognized that mainstreaming co-benefits had significant potential in Asia. However, improved stakeholder dialogue would be needed to realise this potential. The recognition of this need led more than 80 stakeholders from 15 countries and 14 international organizations to support the development of a mechanism to improve dialogue on co-benefits during a "Seminar on a Co-benefits Approach" in Bangkok, Thailand. This support paved the way for launching the ACP at the Better Air Quality (BAQ) workshop in November 2010.

Since November 2010, the ACP has helped to raise the profile of co-benefits in many parts of Asia. Moreover, several ACP members have contributed to global efforts to promote co-benefits from short-lived climate pollutants (SLCPs). The emergence of SLCPs has also generated yet another need: namely, understanding where co-benefits from short-lived climate pollutants (SLCPs) fit with co-benefits from greenhouse gases (GHG). The ACP White Paper hence stands at critical juncture. It underlines the importance of SLCPs by placing them in a wider context that includes GHGs. It further does so in Asia, a region with the most to gain from unifying these two perspectives together. As the co-chairs of the ACP, we firmly believe that the ACP white paper will make an important contribution to moving co-benefits forward in Asia.

Katsunori Suzuki and Supat Wangwongwatana

Co-chairs of the ACP

Preface

Mitigating climate change can be accomplished through policies, programmes or projects conceived specifically for that purpose. It can also be achieved with policies, programmes or projects that meet development priorities while taking into account climate concerns. Policies, programmes, or projects that consider development and climate objectives simultaneously can deliver co-benefits.

In recent years, many stakeholders in Asia have demonstrated that integrating co-benefits into decisions can reduce greenhouse gas (GHG) mitigation costs or bring carbon finance to development needs. However, the absence of a mechanism to share information and coordinate stakeholders on these possibilities has made it difficult to mainstream co-benefits into national development strategies and plans as well as sectoral policies, programmes or projects in Asia.

In June 2009, during the first International Forum for a Sustainable Asia and the Pacific (ISAP) in Hayama, Japan, policymakers and experts proposed creating an informal network to improve stakeholder cooperation and knowledge management on co-benefits in Asia. After ISAP 2009, representatives from leading international organisations and government agencies held follow-up meetings in Bangkok, Thailand to further define the goals, membership, functions and implementing arrangements for a regional co-benefits partnership. Based upon the support received at those meetings, the Asian Co-benefits Partnership (ACP) was launched at the Better Air Quality 2010 conference at the initiative of the Ministry of the Environment, Japan.

Over the past three years, the ACP has shared information on climate and development co-benefits in Asia. It also has discussed ways to cooperate on co-benefits in a variety of contexts (especially air quality management). The value of the ACP as an informal and interactive platform to improve information sharing and stakeholder coordination in Asia has been noted in many fora.

The ACP White Paper is designed as the first in a series of efforts to disseminate information on ACP activities and inform the latest discussions on co-benefits in Asia. We hope that this White Paper serves as a useful reference for those interested in an approach that recognises the full range of benefits from a more integrated approach to climate and development decisions.

March 2014
Secretariat of the ACP

Executive Summary

More than two decades ago, researchers analysing the costs of mitigating greenhouse gases (GHGs) determined that some climate change strategies deliver additional local air quality and public health benefits. Researchers would later coin the term "co-benefits" to refer to these additional benefits. In the years that followed, researchers would estimate the value of a variety of co-benefits (including but not limited to improved air quality and public health). These studies demonstrated that accounting for co-benefits could offset GHG mitigation costs, thereby allaying one of the chief concerns confronting policymakers when considering climate actions. More recently still, the air pollution community has begun to use co-benefits to capture the multiple gains from mitigating species of air pollution that warm the climate over relatively short atmospheric lifetimes, known as short-lived climate pollutants (SLCPs).

The above research has evolved against a backdrop of important policy discussions. These discussions initially concentrated on the developmental co-benefits from the Clean Development Mechanism (CDM) projects. They have since expanded to include the climate and development co-benefits from an assortment of policies. The transition of co-benefits from a quantity estimated on paper to an outcome pursued on the ground has considerable potential to transform policymaking in Asia. No other region could gain more from explicitly integrating both climate and development benefits into decision-making processes. In fact, a series of high-profile reports on SLCPs highlight that Asia would see more than 60 percent of the co-benefits from introducing a set of priority technical mitigation measures. Yet there is also considerable scope before this potential is realised.

This Asian Co-benefits Partnership (ACP) White Paper—the partnership's initial flagship publication—is organized around realising this potential in Asia. The White Paper's first chapter opens by outlining differing views on co-benefits, noting the recent emergence of SLCPs, and highlighting possible entry points for work on co-benefits in Asia. The second chapter looks at key drivers for co-benefits, pointing to important findings and possible applications. The third chapter summarizes science on GHGs and air pollutants as well as modelling frameworks and quantitative research that can estimate co-benefits. The fourth chapter narrows its focus on national policies and regional and international support mechanisms that can promote action on and enhance the implementation of measures with co-benefits (focusing on black carbon control measures). A concluding chapter reiterates key findings and points to ways forward, suggesting more work is needed on poorly characterised emission sources, stakeholder-centred approaches to co-benefits, and multi-issue nexuses.

The main messages of the White Paper include:

- Some view co-benefits broadly as the multiple environmental and development benefits from a single action. Others focus more narrowly on reductions in air pollution species that warm the climate known as SLCPs, including black carbon, tropospheric ozone and methane.
- The latter air pollution view on co-benefits has gained attention because implementing a suite of 16 SLCP priority measures in Asia could help reduce global mean warming by ~0.3°C by 2050. The same measures could help avoid approximately 0.3 to 3 million annual premature deaths and boost annual crop yields by approximately 20 to 100 million tonnes in 2030 (and beyond) in Asia.
- Improved cookstoves are the SLCP measures with the greatest mitigation potential in Asia; clean diesel is the technical measure with the second most benefits and least uncertainty over its warming effects.
- Countries in Asia would not only realize co-benefits from implementing SLCP measures. They could also find solutions to other pressing environmental problems—such as air pollution crises—by recognizing that taking action on SLCPs is one but not the only step to a more integrated approach to air pollution and climate change policy.
- In Asia, such an integrated approach could develop to include recognizing the varying impacts of black carbon, tropospheric ozone, methane as well as non-methane precursors of ozone and cooling

pollutants (sulphur dioxide (SO_2) across space and time. It would also look at the varying temporal and spatial impacts from mitigating GHGs in line with other pollutants such as nitrogen oxides (NO_x).

- But accommodating existing regulatory and policy frameworks to this integrated approach will be difficult as policymakers and the institutions within which they work tend to be organized around achieving one objective at a time. Many countries in Asia could nonetheless draw upon experiences with air pollution and climate initiatives that support multiple objectives.
- Indeed, Asia is home to a variety of air pollution and climate change initiatives that can provide technical and financial support for a more integrated approach. The Clean Development Mechanism (CDM) and the Gold Standard, for instance, offer many useful illustrations of how climate and other development objectives can be pursued in parallel. The United Nations Framework Convention's (UNFCCC) Green Climate Fund that could allocate some portion of 100 billion dollars per year by 2020 for nationally appropriate mitigation actions (NAMAs) may also help countries move toward a more integrated approach to climate and development. The recently launched Climate Change and Clean Air Coalition (CCAC) may also help advance a more integrated approach to climate and development.
- The Asian Co-benefits Partnership is well placed to support the knowledge management, awareness raising, and capacity building activities needed to bring climate and development together in Asia.

Overall, the White Paper suggests that both researchers and policymakers have come a long way from the early work on co-benefits. And given that Asia is the region with the most to gain from considering co-benefits, much of the progress in narrowing this gap will play out in the region. The ACP hopes to be at the forefront of these efforts.

Chapter 1: Introduction: Setting the Context

Asia has experienced rapid economic growth and the environmental stresses associated with that growth. These stresses include expanding waste streams, congested streets, fast-rising energy use, and rapidly escalating greenhouse gas (GHG) emissions. Many of the challenges pose downstream threats to public health, agriculture yields, and ecosystem services. The costs of these problems are becoming increasingly clear in Asia. Indeed, the World Health Organization (WHO) recently warned that particulate matter (PM) with a diameter less than 2.5 micrometers (PM2.5) may be a cause of cancer (IARC, 2013). More broadly, taking a low carbon, sustainable development path in Asia will require addressing both development priorities and climate concerns.

Development goals and climate change mitigation need not be at odds. An integrated approach that addresses these twin concerns in tandem can deliver co-benefits. If meaningfully integrated into decision-making processes, co-benefits present an opportunity for realising win-win synergies and cost-savings. In fact, a United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) report, *Low Carbon Green Growth Roadmap for Asia and the Pacific: Turning Resource Constraints and Climate Crisis into Economic Growth Opportunities,* contains an assortment of innovative win-win policy options and practical implementing strategies as well as examples of successful practices (ESCAP, 2012). It is precisely these types of options, implementing strategies and practices that can bring momentum to international policymaking processes, including negotiations over a future climate regime under the United Nations Framework Convention on Climate Change (UNFCCC) as well as the post-2015 Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).

While there is general agreement that co-benefits hold considerable promise, different organisations view co-benefits differently. The broadest definitions come from organisations such as ESCAP that see the co-benefits of green growth as not limited to environmental benefits but also resource efficiency, job creation, social inclusiveness, and economic competiveness. Narrower definitions concentrate on linking development objectives with climate mitigation considerations. Even narrower definitions point to capitalizing upon linkages between climate change and air pollution. This White Paper concentrates chiefly on the synergies between climate change and air pollution, recognising that there are indeed other useful definitions of co-benefits (See Box 1).

Box 1: Defining Co-benefits

There are a wide variety of definitions of co-benefits; the below provides a few examples.

- ✓ Benefits that accrue as a side effect of a targeted policy (Pearce, 2000).
- ✓ The benefits of policies that are implemented for various reasons at the same time — including climate change mitigation — acknowledging that most policies designed to address GHG mitigation also have other, often at least equally, important rationales (e.g., related to objectives of development, sustainability, and equity) (IPCC, 2001).

  Note: the Fourth Assessment Report of the IPCC (2007) uses the same definition for co-benefits.
- ✓ The potentially large and diverse range of collateral benefits that can be associated with climate change mitigation policies in addition to the direct avoided climate impact benefits (Bollen et al., 2009).
- ✓ In the process of controlling GHGs, the benefits from other pollutants that are also abated (e.g., SO_2, NO_X, PM). In the process of abating air pollution, the benefits from CO_2 and other GHGs that are also mitigated. Policy Research Center for Environment and Economy (PRCEE), China.

Co-benefits from mitigating air pollution and climate change are not in fact new. Over the past two decades, research on air-climate linkages have developed in parallel with work on long-lived GHGs (Ramanathan et al., 2001). In recent years, the lack of ambition in international climate negotiations has generated interest in pragmatic complements to GHG mitigation. In consequence, species of air pollutants that have wide ranging effects on climate systems have appeared on the climate policy agenda (Ramanathan et al., 2007). These species of air pollutants, since termed short-lived climate pollutants (SLCPs), include black carbon, methane, tropospheric ozone and some hydrofluorocarbons (HFCs).

The heightened interest in SLCPs has been particularly evident in Asia. This is partially because Asia is where research first began on the Atmospheric Brown Clouds (ABC) of warming and cooling particulates that appear with growing regularity above the region. It is also because Asia has a chance to play an integral role in translating research on SLCPs into action on the ground. This potential is underlined in a set of recent UNEP reports that demonstrate that more than 60 percent of the benefits from 16 priority mitigation measures for SLCPs would accrue to Asia (UNEP: UNEP/WMO 2011). The same UNEP reports helped bring together a group of countries to form the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC). However, while these developments are encouraging, there remains a significant gap between research and policy on co-benefits in Asia.

The Asian Co-benefits Partnership (ACP) was created to fill that gap. The ACP engages in knowledge management, awareness-raising, and capacity building activities that aim to strengthen the link between research and policy on co-benefits. This White Paper, the flagship product of the ACP, has the following objectives:

1. To survey relevant research and policy on co-benefits, with a particular emphasis on Asia;
2. To underline some of the reasons for gaps between research and policy; and
3. To propose recommendations to help close those gaps.

In pursuing these objectives, the White Paper arrives at several key messages:

- Among the varying approaches to co-benefits, work on SLCPs has caught the attention of policymakers.
- Driving this interest are potential gains: Asia could help reduce global mean warming by ~0.3°C by 2050 while avoiding approximately 0.3 to 3 million annual premature deaths and boosting annual crop yields by approximately 20 to 100 million tonnes in 2030 and beyond.
- Countries in Asia would not only realize co-benefits from implementing SLCP measures but could take work on SLCPs as a point of departure for a more integrated approach to air pollution and climate change policy.
- An integrated approach in Asia would bring in non-methane precursors of ozone and warming and cooling pollutants such as sulphur dioxide into a broader effort to understand the varying effects of different pollutants across a range of temporal and spatial scales.
- While policymakers typically encounter difficulties in optimizing multiple benefits, Asia has learned lessons from climate change mechanisms such as the Clean Development Mechanism (CDM) that could help in this regard. The growing number of air pollution and climate change initiatives in the region, including The Climate Change and Clean Air Coalition (CCAC), could also make meaningful contributions to these efforts.
- The ACP—with the support of its membership and guidance of its Advisory Group—aims to advance a more integrated approach to climate and development in Asia.

The remainder of the White Paper is divided into five chapters. Chapter 2 summarises key developments in research on co-benefits. A discussion of science and models of co-benefits follow in Chapter 3, while Chapter 4 outlines lessons learned from some of the policies and support mechanisms for co-benefits, closing with a discussion of black carbon. The final chapter recaps the key points and outlines ways of moving forward.

Chapter 2: Co-benefits as a Driver for Air Pollution and Climate Change Mitigation

Experiences regulating air pollution date back to the early days of the environmental movement. The 1952 London Fog—the thick layer of particulates that enveloped England's capital and led to over 12,000 premature deaths—was one of several milestone events that set in motion a wave of air regulations. In the years that followed, parts of Asia such as Yokkaichi, Japan experienced similar crises. These crises also spurred advances in air pollution regulation. Indeed, many parts of the world have made significant strides managing air pollution problems as the costs of those problems have mounted. In recent years, experiences with air pollution have intersected with research on co-benefits that traces back to early studies on climate policy.

2.1 Early Research on Climate Co-benefits

Since the term "co-benefits" was coined in 1991 as part of those early studies (Ayres and Walters, 1991), researchers have become increasingly adept at quantifying the multiple climate and other benefits associated with a variety possible actions. (Chen, et al., 2001; Joh, et al., 2001; Kan, et al. 2004; National Renewable Energy Laboratory, 2005; EPTRI, 2005; Aunan, et al., 2004, Wang and Mauzerall, 2006; Aunan, et al., 2006; Holdren, 2007). This research has underscored that there are numerous types of co-benefits, ranging from shortened commuting times to induced technology change. Yet most of the current literature traces the linkages between greenhouse gas (GHG) mitigation scenarios to the abatement of criteria pollutants to reduced rates of morbidity and premature mortality. Looking across the body of literature, cleaner air and better health are the co-benefits that have thus far drawn the most attention from researchers (Jochem and Madlener, 2003).

Researchers have also exhibited a growing interest in quantifying co-benefits (IPCC, 2001; Nemet et al., 2010). Nemet et al. surveyed 37 peer-reviewed air quality co-benefits studies. They found that the value ascribed to co-benefits, expressed as the cost per tonne of carbon dioxide (CO_2) reduced, was generally greater in developing than developed countries. For developed countries, estimates from 22 studies spanned a range of \$2-128/tCO_2, with a median of \$31/tCO_2, and mean of \$44/tCO_2. For developing countries, estimates from seven studies spanned a range of \$ 27-196/tCO_2, with a median of \$43/tCO_2, and a mean of \$81/tCO_2. The higher values in developing country studies may be a product of initially higher pollution levels; when air quality is poor, incremental health benefits from abating air pollution tend to be greater. This implies that valuation of air quality co-benefits may be most important in the early stages of climate change mitigation strategy when countries may also lack robust air quality management programmes (Nemet et al., 2010).

2.2 Research on Short-Lived Climate Pollutants (SLCPs)

While the early research quantifying co-benefits looked almost exclusively at reductions in long-lived GHGs in unison with other air pollutants, lately these studies have converged with work on short-lived climate pollutants (SLCPs). SLCPs refer to species of air pollutants with relatively short atmospheric lifetimes that increase radiative forcing in climate systems while threatening public health, crop yields, and other socio-economic services. As such, mitigating black carbon (a component of particulate matter), tropospheric ozone (a secondary pollutant formed through chemical reactions induced by sunlight), and methane (a precursor of ozone and GHG in its own right) have until recently been downplayed in the wider climate change and air quality debate. The potential for policy paths that integrate air quality, climate change and key development concerns to bring mutual benefits began to draw interest with the publication of the UNEP/WMO Integrated Assessment of Black Carbon and Tropospheric Ozone (hereafter the UNEP Assessment) (UNEP/WMO, 2011).

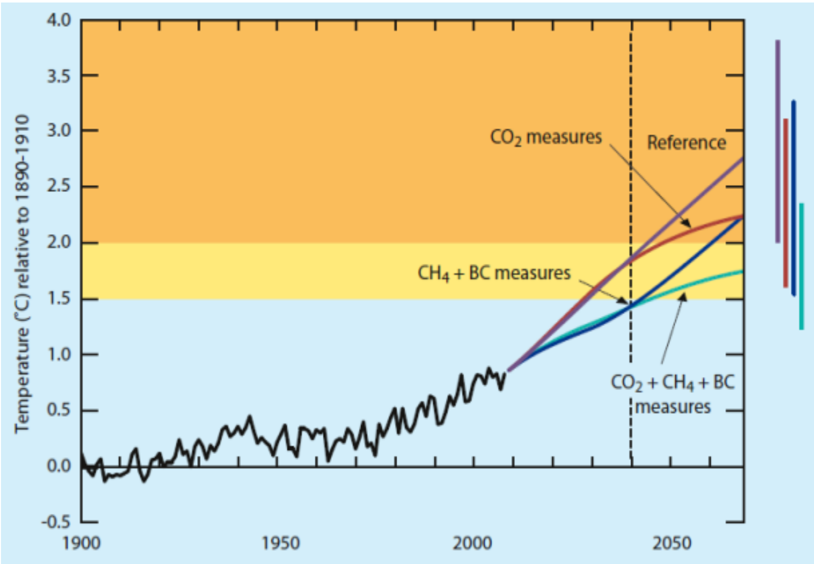
The UNEP/WMO Assessment identified measures most likely to generate combined benefits, taking into account that black carbon and ozone precursors are co-emitted with different gases and particles, some of which cause warming and some of which, such as organic carbon (OC) and sulphur dioxide (SO_2), lead to cooling. The selection criterion in the Assessment was that the technical measure had to provide air quality benefits and be likely to reduce global climate change. Those measures that provided an air quality benefit but increased warming (a climate-air trade-off) were not included. For example, measures that primarily reduce emissions of SO_2 were not included.

The 2011 UNEP/WMO Assessment and related studies, such as the Asian Brown Cloud report (Ramanathan et al., 2008) and the Bounding Black Carbon Study (Bond et al., 2013), highlight the potential for national, regional and global benefits. Shindell et al. underline 14 measures targeting methane (also a precursor of tropospheric ozone) and black carbon emissions that could, if fully implemented around the world:

1. reduce projected global mean warming by ~0.5°C by 2050;
2. avoid 0.7 to 4.7 million annual premature deaths from outdoor air pollution;
3. and increase annual crop yields by 30 to 135 million tonnes due to ozone reductions in 2030 and beyond.

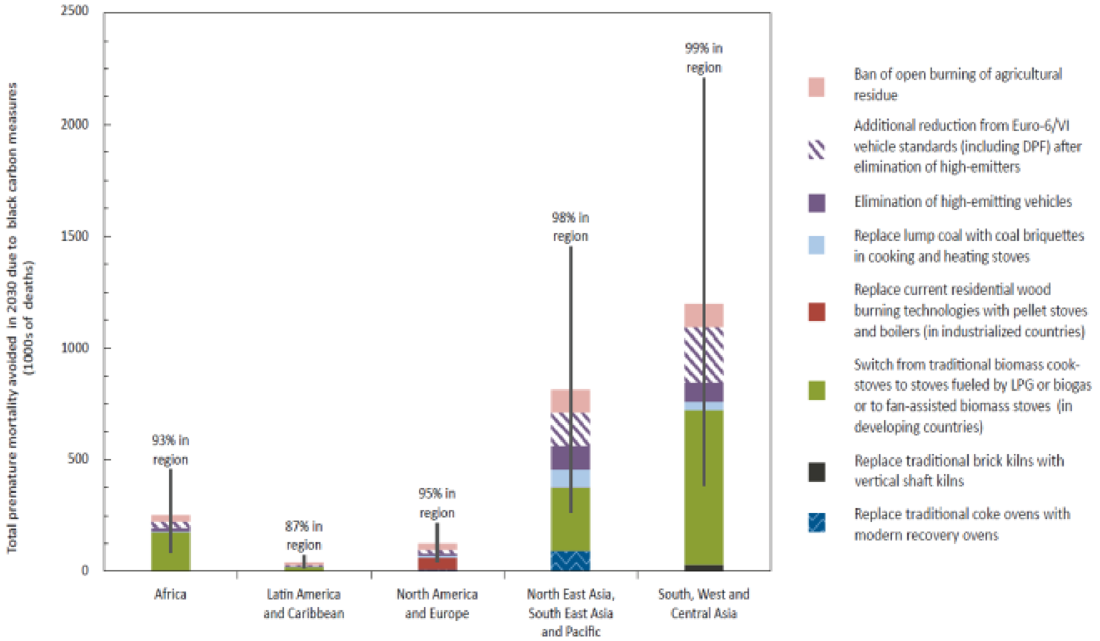
The selected emission reduction measures target different sources and influence climate on shorter time scales than those of CO_2 reduction measures. Implementing both SLCP and CO_2 reduction measures substantially reduces the risks of crossing the 2°C threshold that science warns could lead to catastrophic climate changes (see Figure 2-1). Figure 2-2 shows that a substantial fraction of the premature mortality avoided by implementing the black carbon measures are in Asia. There would also be large health benefits from improved indoor air quality (though not presented in Figure 2.2). Because of limited data, Shindell et al. (2012) only estimated these for India and China, where implementation of all of the black carbon measures could avoid an additional 373,000 premature deaths annually. Estimates like these suggest co-benefits could play an important role in policy in Asia.

Figure 2-1. GHG and SLCP Mitigation Pathways



Source: UNEP (2011)

Figure 2-2. A Regional Comparison of Health Benefits from Mitigating Black Carbon



Source: UNEP (2011)

2.3 Co-benefits in Asia

The recognition of the co-benefits from SLCPs is an important trend in research for Asia. An equally important trend in Asia is the recognition of synergies and trade-offs between climate and air pollution in policy. This is most evident in China's co-control strategy that reflects a growing understanding of those relationships at the national and subnational levels: in more recent years, an emphasis on "savings resources and cutting emissions" (节能减排) has served to give momentum to policies that achieve two objectives in China. Elsewhere in Asia, the recognition of co-benefits is smaller in scale or shorter on specifics. For example, the Philippines, Korea, Indonesia and India have participated in projects that identify linkages between climate change and local air pollution. Many of these initiatives began with support from international organisations or foreign governments but have benefited from domestic champions in leading universities and research institutes.

Box 2-1. Co-benefits Projects in Indonesia

Palm Oil Milling Effluent (POME) for power generation: The Indonesian palm oil industry faces pressure to be environmentally-friendly due to strict standards for crude palm oil (CPO) in the international market. Since 2012, the Indonesia's Ministry of Environment has conducted a survey on the potential emissions from palm oil mills using Life Cycle Assessment (LCA) methods. The survey showed that wastewater discharges from the processing of palm oil have a significant effect on global warming. More specifically, during the production of 25 million tonnes of CPO, approximately 60 million tonnes of POME is produced, which, in turn, generates 2,000 million m^3 of biogas. A system that enables the use of this biogas has already been widely applied in palm oil mills in Indonesia, reducing GHG emissions and water pollution in the process.

While there has been a modest increase in the understanding of the co-benefits of air pollution abatement and climate change mitigation, there is still a significant opportunity to augment the impacts of this work in Asia, especially at the subnational level. Based on a regional survey of nearly 900 Asian cities, only 3% have a plan to tackle climate change and even fewer recognise the co-benefits of air pollution and climate change in existing plans (Clean Air Asia and CDIA, 2012). Surprisingly, of the 29 cities with climate change plans, only five are national capitals: Bangkok, Delhi, Seoul, Singapore and Tokyo. Most plans were developed by cities in India, China and Vietnam. Even at the national level, several environment ministries in Asia noted an 'average' level of awareness on SLCPs and related issues, based on a rapid survey conducted by Clean Air Asia (2013a).

Moreover, in several of the above examples, what is written on paper differs from what is implemented on the ground. Reasons for these implementation gaps range from insufficient compliance incentives to high enforcement costs. Another notable characteristic of Asia's policy frameworks is an ability to adopt innovative approaches and leapfrog outdated approaches. In some instances, however, the capacity to absorb these new approaches outstrips the capacity to enforce them, resulting in the above implementation gaps. An important question then is whether promoting awareness of co-benefits can help strengthen linkages between co-benefits concept and action. A critical first step involves a better understanding of the science and modelling of co-benefits; and how both can be tailored to Asia.

Chapter 3: Science and Models of Co-benefits

3.1 The Science of Co-benefits

As mentioned in previous chapters, two different perspectives have featured in discussions of co-benefits. One perspective focuses on mitigating greenhouse gases (GHGs) while pursuing solutions to other environmental problems; the other concentrates on removing species of short-lived climate pollutants (SLCPs) as a means to protect climate systems, improve air quality, and achieve other benefits. At their core, both approaches draw upon an understanding of science and models of co-benefits. This chapter provides a brief introduction to this science (focusing chiefly on climate change and air pollution) then highlighting a selection of models that have been used to identify and value co-benefits.

3.1.1 Radiative Forcing

The key to understanding climate change (and, by implication, co-benefits) is radiative forcing. The planetary radiation balance determines the earth's climate. It does so by balancing between energy entering at the top of the atmosphere as sunlight and leaving the atmosphere as reflected light and heat back to space. Apart from a handful of natural disturbances such as volcanoes, this balance has remained roughly in equilibrium for the last 10,000 years. The advent of widespread land-clearing and the industrial revolution in the 18th century has seen human-made emissions of GHGs, aerosols and their precursors disrupt that equilibrium. This change has led to enhanced absorption and reflection of incoming light by aerosol particles and clouds, and enhanced absorption of outgoing infrared (IR) radiation by GHGs and, to a lesser extent, by large aerosol particles and clouds. The departure from the pre-industrial energy equilibrium is referred to as radiative forcing.

Radiative forcing is a measure of the change in the energy balance of the earth-atmosphere system with space. It is defined as the change in the net—downward minus upward—irradiance (expressed in Watts per square metre) at the tropopause due to a change in an external driver of climate change. This can occur, for example, with a change in the concentration of CO_2 or the output of the sun (UNEP/WMO, 2011). As of today, less energy is leaving than is coming into the earth's atmosphere. Hence, positive radiative forcing is behind the observed increase in the earth's global mean temperature.

3.1.2 The Kyoto GHGs (Basket of Six)

For much of the past two decades, the climate change agents that have drawn the most attention for altering the radiative balance have been long-lived GHGs. Most GHGs are emitted from energy generation and land use changes. Part of the reason the six GHGs listed in Table 3-1 have drawn this attention is because they are covered by the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. Though these six GHGs similarly absorb positive radiation, the quantity absorbed and their atmospheric lifetime varies. This variation is captured by the global warming potential (GWP). The GWP is indexed to the amount of radiation that would be absorbed over a 20 and 100 year periods relative to CO_2.

Table 3-1. Global Warming Potential (GWP) of Long-lived Greenhouse Gases (GHGs)

GWP values and lifetimes from 2013 (with climate-carbon feedbacks)	Lifetime (years)	GWP time horizon	
		20 years	100 years
Carbon Dioxide (CO_2)	--	1	1
Carbon Tetrafluoride (CF_4)	50,000	4950	7350
Hydrofluorocarbon (HFC-134a)	13.4	3790	1550

Methane (CH_4)	12.4	86	34
Nitrous Oxide (N_20)	121.0	268	298
Sulphur Hexafluoride (SF_6)	3200	16300	23900

Source: UNFCCC, 2014

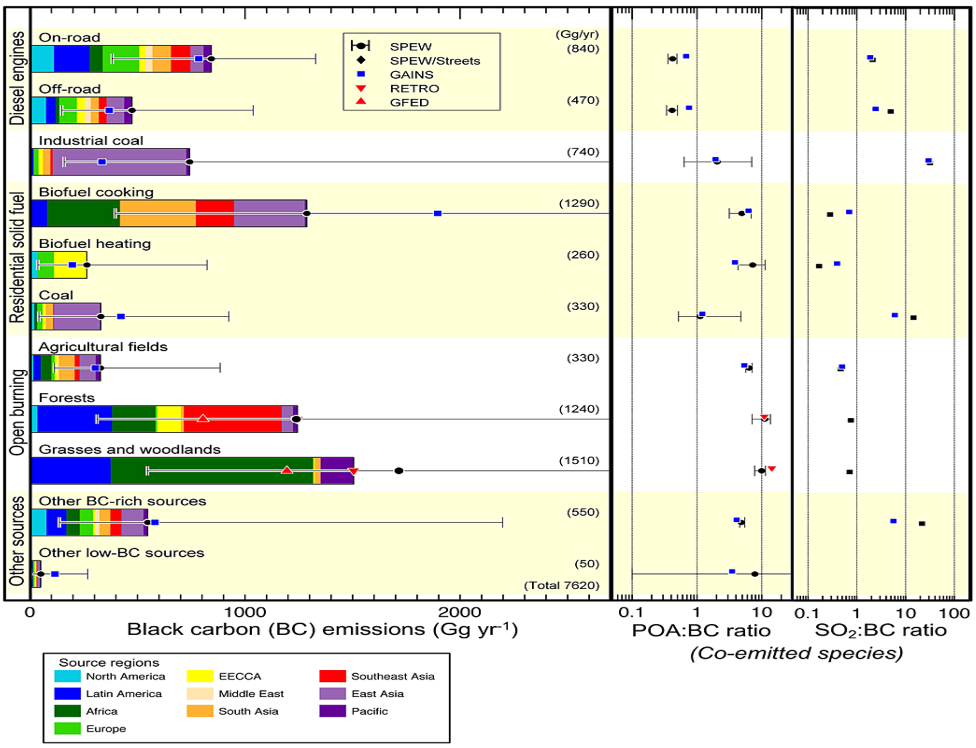
3.1.3 Short-lived Climate Pollutants (SLCPs)

Short-lived climate pollutants (SLCPs) are a species of air pollutants that have a different chemical composition, radiative forcing potential, and shorter atmospheric lifetimes (a few days to a few decades) than long-lived GHGs. The main SLCPs are black carbon, methane and tropospheric ozone; these three SLCPs are widely known as the most important contributors to the human enhancement of the greenhouse effect after CO_2. But SLCPs cannot only destabilize climate systems. SLCPs are also dangerous air pollutants in their own right, with various detrimental impacts on health, agriculture and ecosystems. Other SLCPs include some short-lived hydrofluorocarbons (HFCs). While HFCs are currently present in small quantity in the atmosphere, their contribution to climate forcing could climb to as much as 19% of global CO_2 emissions by 2050 (UNEP, 2011a).

3.1.3.1 Black Carbon

Black carbon is a distinct type of carbonaceous material formed from the incomplete combustion of fossil and biomass-based fuels. Black carbon exists as an aggregate of small spheres in the atmosphere and is a major component of soot. Black carbon is not a GHG but instead warms the atmosphere by intercepting sunlight and absorbing it. Sources whose emissions are rich in black carbon include diesel engines, heavy industry, residential solid fuel, and open burning of biomass (Figure 3-1). black carbon particles not only have a strong warming effect in the atmosphere, but alter melting patterns by darkening snow and influence cloud formation. Other particles may have a cooling effect in the atmosphere and all particles influence clouds (UNEP/WMO, 2011).

Figure 3-1. Black Carbon and Co-emitted Species by Region and Source in 2000



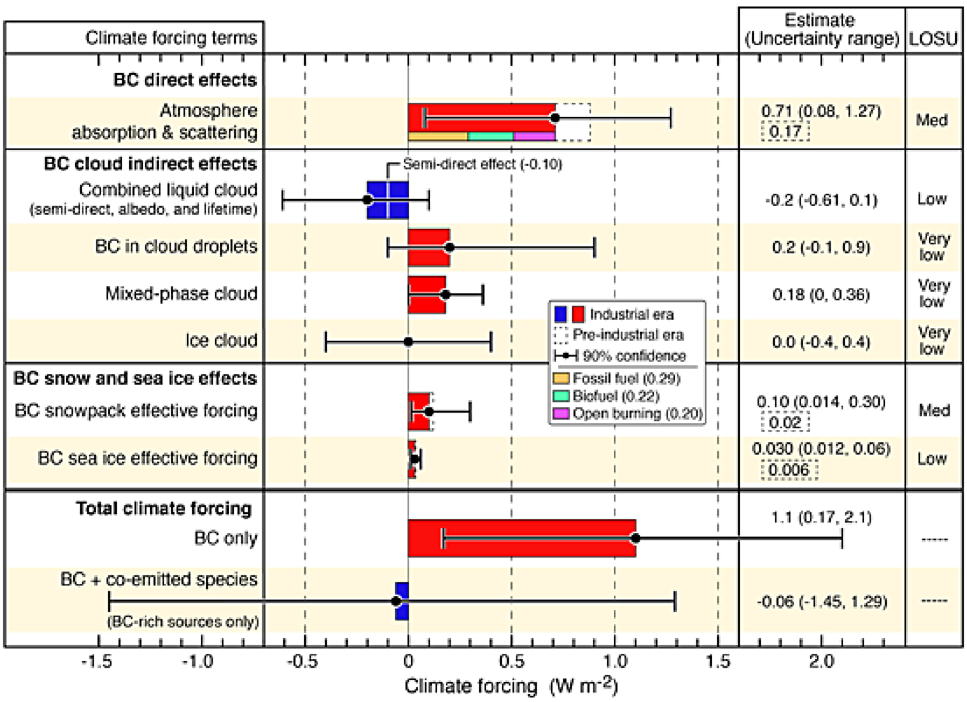
Emission rates of black carbon in the year 2000 by source category and ratios of co-emitted aerosols (e.g., primary organic aerosol, POA) and aerosol precursors (e.g., SO_2) to black carbon. For reference, it is often assumed that the ratio of POA to primary organic carbon (OC) varies from 1.1 to 1.4, depending on the source. SPEW emissions are shown as coloured bars and are described by Lamarque et al. [2010]. GAINS estimates are from UNEP/WMO [2011], and RETRO emissions for open burning are described by Schultz et al. [2008]. Sulphur emissions from Streets et al. [2009] were used for ratios to SPEW.
The atmospheric lifetime of black carbon, its impact on clouds and its optical properties depend on interactions with other aerosol components. Black carbon is co-emitted with a variety of other aerosols and aerosol precursor gases. Soon after emission, black carbon becomes mixed with other aerosol components. This mixing increases light absorption by black carbon, increases its ability to form liquid-cloud droplets, and thereby influences its atmospheric removal rate.

Source: Bond et al. (2013)

A comprehensive evaluation of black carbon climate forcing was made by Bond et al. (2013). That assessment includes all known and relevant processes and provides best estimates and uncertainties of the main forcing terms: direct solar absorption; influence on liquid, mixed phase, and ice clouds; and deposition on snow and ice. Many key points from this assessment are used in this chapter.

Direct radiative forcing of black carbon is caused by absorption and scattering of sunlight. Absorption heats the atmosphere where black carbon is present and reduces sunlight that reaches the surface and that is reflected back to space. Direct radiative forcing from black carbon was evaluated in Bond et al. 2013. Though as of this writing the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report does not allow citation, presentations of likely values are somewhat smaller than the value of +0.51 (+0.06 to +0.91) W m^{-2} estimated by Bond et al. (2013) (Figure 3-2). The same values from Bond et al. (2013) are also significantly greater than the IPCC fourth assessment report's estimated radiative forcing for black carbon: +0.2 [±05 to +0.35] W m−2 (Forster et al, 2007).

Figure 3-2. Global Climate Forcing of Black Carbon and Co-emitted Species in the Industrial Era

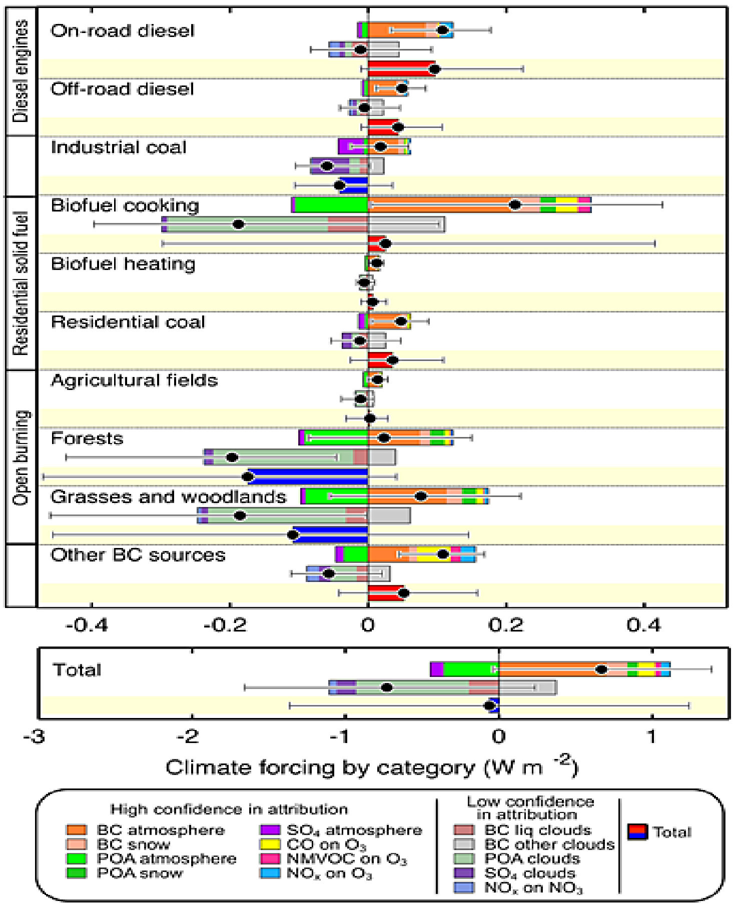


Globally averaged climate forcing in units of W m−2 from black carbon emissions in the year 2005 compared to those in 1750 (pre -industrial era). The bars and whiskers show the best estimates and uncertainties, respectively, of the different climate forcing terms from black carbon acting alone. The exception is the bottom bar which shows the net climate forcing from black carbon and its co-emitted species from black carbon-rich sources. Whiskers represent the assessed 90% uncertainty range (5% to 95%). The three smaller bars immediately below the direct forcing bar and legend display the separate contributions to industrial-era radiative forcing from fossil fuel, biofuel, and open burning emissions. The white line on the combined liquid-cloud forcing bar indicates the −0.10 ± 0.2 W m−2 contribution from semi-direct effects. The additional direct forcing of +0.17 W m−2 shown with the dashed line represents the direct radiative forcing from pre-industrial emissions (i.e., prior to 1750). The combined coloured and dashed bar represents our estimate of the all-source (i.e., natural plus anthropogenic) direct radiative forcing, namely, a +0.88 W m−2 best estimate with a +0.18 to +1.47 W m−2 uncertainty range. Likewise, the dashed line on the snow and sea-ice terms corresponds to their additional climate forcing prior to 1750, and the combined bars give their all source forcing. For snow and ice effects, their adjusted forcing and radiative forcings, respectively, have been scaled by their higher efficacy to give effective forcings as shown. The total climate forcing from all black carbon effects is shown as 1.1 W m−2. The uncertainty for this bar is assessed using a Monte Carlo method that assumes correlated errors in some of the forcing terms. The columns on the right give the numeric value for each climate forcing and its uncertainty; they also present a level of scientific understanding (LOSU) for each forcing term. LOSU follows IPCC practice [Forster et al., 2007] and represents our assessment of confidence in our own evaluation of a given climate forcing.

Source: Bond et al. (2013)

Air Pollution species co-emitted with black carbon influence the magnitude of net climate forcing by black carbon-rich source categories (Figure 3-3), principally organic matter and sulphur species. The net climate forcing of a source sector is a useful metric when considering mitigation options.

Figure 3-3. Climate Forcing by Black Carbon-Rich Source Categories



Total climate forcing for black carbon-rich source categories continuously emitting at year-2000 rates, scaled to match observations in 2005. Three sets of climate forcings are shown for each source as bars with a best estimate (black circle) and uncertainty range. The top bar contains the components for which attribution to particular species is straightforward: direct forcing by aerosol and most gases, and cryosphere forcing by aerosol (including climate feedback). The second bar shows the components for which there is less confidence in apportionment to individual species and, therefore, to sources. These components include all cloud indirect effects and forcing by nitrate from NO_X. Effects of black carbon on liquid clouds include the cloud albedo and semi-direct effects. Other black carbon-cloud forcings represent the effects of cloud absorption, mixed-phase clouds, and ice clouds. The bottom bar in each group shows estimated net climate forcing by each emission source, combining all forcings and their uncertainties.

Source: Bond et al. (2013)

Short-lived forcing effects from black carbon-rich sources are substantial compared with the effects of long-lived GHGs from the same sources, even when the forcing is integrated over 100 years. Climate forcing from changes in short-lived species in each source category amounts to 5-75% of the combined longer-lived forcing by methane and CO_2 over 100 years. The 100 year GWP value for black carbon is 900 times that of CO_2 (120-1800 range) with all forcing mechanisms included. The large range derives from the uncertainties in the climate forcing for black carbon effects.

Mitigation of diesel-engine sources appears to offer the most confidence in reducing near-term climate forcing. Mitigating emissions from residential solid fuels also may yield a reduction in net positive forcing. The net effect of other sources, such as small industrial coal boilers and ships, depends on the sulphur content; net climate benefits are possible by mitigating some individual source types.

3.1.3.2 Tropospheric Ozone Precursors

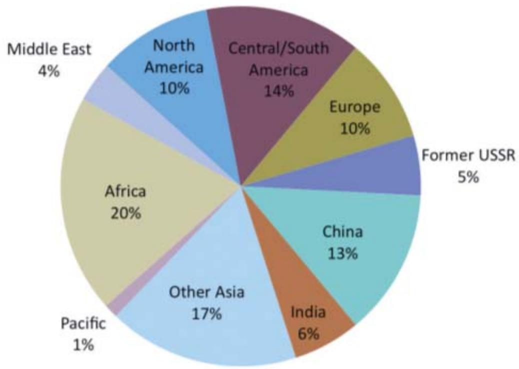
Unlike black carbon, tropospheric ozone is a secondary pollutant formed through chemical processes that transform primary pollutant emissions into secondary ozone. In the case of ozone, this typically involves sunlight reacting with carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and nitrogen oxides (NO_X). The transformation of these elements occurs in the troposphere (between 0 km and 16 km above the surface) as opposed to the stratosphere, where ozone acts as an important filter of ultraviolet radiation (Finlayson-Pitts and Pitts, 2000). Since ozone is a secondary pollutant, measures aimed at limiting its detrimental effects tend to focus on mitigating its precursors—namely methane or CO, NMVOC and NO_X.

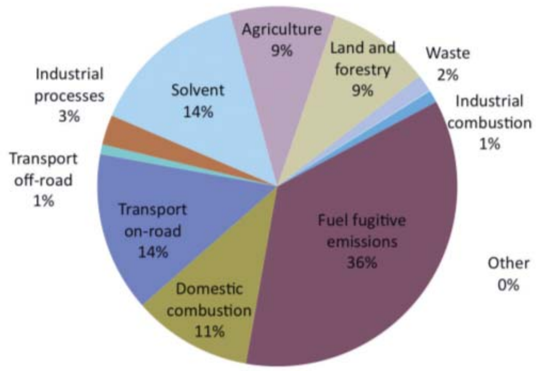
Ozone plays different roles depending on the altitude. In the atmospheric boundary layer (from 0-2 km), the impacts of ozone is more significant from the perspective of air pollution. In the free troposphere (from 2-16 km), ozone plays more roles in relation to the warming effects (Lacis et al., 1990; Forster and Shine, 1997). In addition, sensitivities of precursors such as methane, NO_X and NMVOC differ between the atmospheric boundary layer and the free troposphere due to different lifetimes of different substances (Finlayson-Pitts and Pitts, 2000).

The work driving the recent interest in SLCPs focuses chiefly on methane as an ozone precursor. Methane is indeed an important GHG and ozone precursor and, by virtue of a relatively short lifetime, an SLCP. NOx, including nitrogen dioxide (NO_2), is a conventional pollutant and an ozone precursor. In the troposphere, during daylight, NO reacts with other pollutants to form NO_2, which then reacts with the sunlight to form NO, releasing an oxygen atom that transforms into ozone. NO_X has received relatively less attention in recent SLCP research because its net impact on radiative forcing is small, and changes from negative forcing in the very near term to low positive forcing in the longer run. In Asia, more attention may be warranted because of the large potential increase in emissions from power plants, industrial facilities, and motor vehicles that emit CO_2 and NO_X together (effectively a GHG-centered approach to co-benefits). (Akimoto, 2012).

NMVOCs is catchall term for a set of chemical compounds that include benzene, ethanol, formaldehyde and acetone. NMVOC emissions—which are mainly from transportation, industrial processes and use of organic solvents—are evenly distributed between regions of the world (Figure 3-4, left). Developed countries contribute significantly because of their large industrial sectors, handling substantial volumes of industrial chemicals, as well as their extensive transportation systems, and processing large quantities of oil products. On the other hand, NMVOC emissions are also a significant product of incomplete combustion, typically from traditional cooking and heating stoves, and therefore they are also emitted in developing countries. On balance, Africa (20%) and "Other Asia" (17%) are the two largest emitting regions. North America (10%) and Europe (10%) contribute somewhat less. Fugitive emissions from oil, natural gas and solid fuels (36%) is the largest contributing source category (Figure 3-4, right), with transport (14%) and solvent use (14%) following. Several other source categories (e.g., residential fuel combustion, agriculture, and land use/forestry) are significant contributors to NMVOC emissions.

Figure 3-4. Distribution of global NMVOC emissions in 2005 by world region (left) and by major source type (right), from Emissions Data Base for Global Atmosphere Research (EDGAR) v4.1





Source: UNEP/WMO (2011)

The ozone precursor that has received the most attention internationally is methane. There are sizable emissions of methane in Asia, with China and India accounting for 13% and 9% of global emissions respectively. The primary sources of methane in Asia are: coal mines; flooded rice patties; organic waste; ruminant livestock; and wastewater.

Table 3-2. Top Five Methane-Emitting Countries in 2005

Country	Million MT(Tg) CO_2e	% of World Total
China	853	13
India	548	9
United States	521	8
European Union	449	7
Brazil	389	6

Source: World Resources Institute (2014)

3.2 Select Modelling Tools and Quantitative Research on Co-benefits

While a growing body of science has help identify which pollutants and gases affect radiative forcing, another branch of research has employed economic and energy models to quantify and monetise the benefits from reducing these pollutants. This section focuses on a few select economic models and modelling results to provide a sense of which actions mitigate climate change while abating air pollutants.

3.2.1 GAINS model (IIASA)

The Greenhouse gas–Air pollution Interactions and Synergies (GAINS) model, developed by the International Institute for Applied Systems Analysis (IIASA), explores synergies between the control of air pollutant and GHG emissions. It describes the pathways of atmospheric pollution from anthropogenic driving forces to the most relevant environmental impacts, bringing together information on future economic, energy and agricultural development, emissions control potentials and costs, atmospheric dispersion and environmental sensitivities towards air pollution. The model also addresses threats to human health posed by fine particulates and ground-level ozone, risk of damage to ecosystems from acidification, excess nitrogen deposition (eutrophication) and exposure to elevated levels of ozone, as well as short and long term radiative forcing. These impacts are considered in a multi-pollutant context, quantifying the contributions of sulphur dioxide (SO_2), NOx, ammonia (NH_3), NMVOCs, and primary emissions of fine (PM2.5) and coarse (PM2.5-PM10) particles as well as black and organic carbon. GAINS also accounts for emissions of the six GHGs covered by the Kyoto Protocol (see Section 3.1.2).

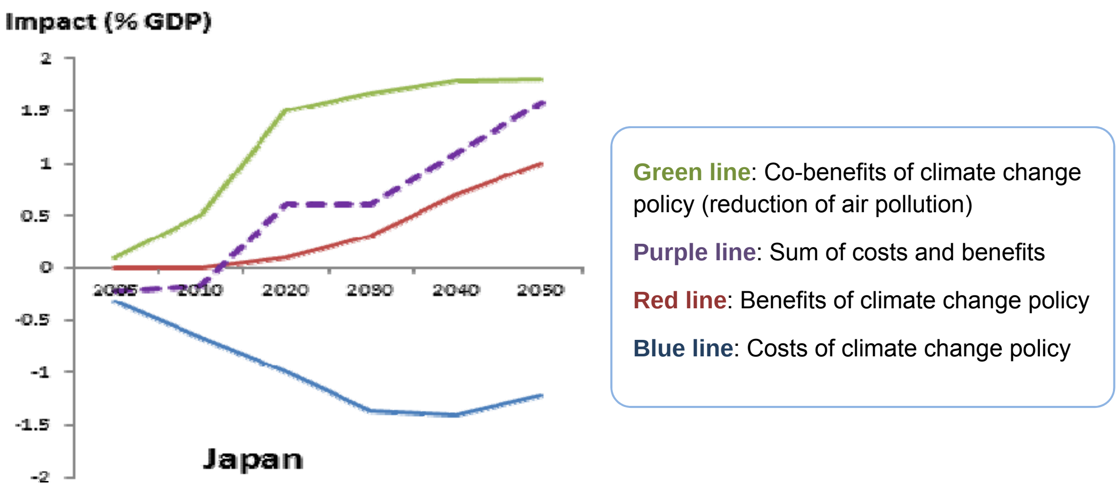
The critical relationships in GAINS (e.g., those describing the dispersion of pollutants in the atmosphere and environmental impacts of pollution) are derived from various models, which are represented in GAINS as reduced-form functional relationships. GAINS holds essential information on all aspects listed above for all world regions, including applications in China, Korea and Japan; it then links this data in such a way that the environmental implications of alternative assumptions on economic development and emission control strategies can be assessed. The GAINS model allows simulation of the costs and environmental impacts of user-defined emission control scenarios. Its optimisation mode balances emission control measures across countries, pollutants and economic sectors in such a way that user-defined target levels on the various environmental impacts are met at least costs (Amann et al., 2011). The GAINS model is implemented as an interactive web-based software tool. Access is freely available online (http://gains.iiasa.ac.at).

3.2.2 Asia MERGE Model (Tohoku University)

The newly-developed Asia MERGE model is an integrated assessment model that draws upon a similar model developed by researchers in the PBL Netherlands Environmental Assessment Agency (NEAA). The PBL NEAA MERGE model is used for global scenarios concentrating on air pollution reductions and climate change mitigation. The Asia MERGE model was designed to understand the cost and benefits of a climate change policy that focuses on reductions of CO_2 and an air pollution policy that focuses on reductions of PM2.5. In terms of the latter, the model marks the first attempt to incorporate the calculation of PM2.5 emissions and transboundary pollution in East Asia.

The main findings of the Asia MERGE model (Lu and Asuka, 2014) are as follows: the air pollution co-benefits of climate change policy are significant and large, while the climate change co-benefits of air pollution policy are relatively insignificant and small in East Asia. In short, the climate benefits of climate change policy are too small by themselves to provide an economic rationale for adopting a climate change policy. It is only when the air quality co-benefits are added into that cost-benefit calculus that climate change policy makes economic sense. Furthermore, while air pollution mitigation is a significant co-benefit of climate change policy, climate change mitigation is merely a small additional benefit of air pollution policy in East Asia.

Figure 3-5. The case of Japan (vertical axis represents the percentage of GDP difference when compared with BAU scenario)



However, when climate change policy and air pollution policy are deliberately implemented together in an integrated manner, both the benefits of reduction in CO_2 and air pollution emissions are significant. The difference in GDP relative to a business-as-usual (BAU) scenario is greater than when each policy is implemented separately. In other words, there is a stronger economic rationale for an integrated approach to both air pollution policy and climate change policy than the implementation of air pollution policy alone.

When transboundary pollution from China to Japan is incorporated into the model, then the costs and benefits do not change for both countries under the climate change policy only scenario, irrespective of whether more PM2.5 is transported or not. But under an air pollution policy scenario (implementation of air pollution policy only) and an integrated policy scenario (implementation of both air pollution and climate change policy) the costs for Japan increase.

3.2.3 PRCEE

Other modelling frameworks focus on ongoing reforms at the city level. A framework developed by the Policy Research Centre for the Economy and Environment (PRCEE) estimates potential reductions from three types of interventions under China's 11th five-year plan (2006-10) in Panzhihua City, Sichuan province and Xiangtan City, Hunan province. The three types of interventions are management reforms, technological improvements, or economic structural changes. Recognising the potential to achieve "win-win" reductions in conventional pollutants and global GHGs, the study suggests that when all three types of interventions are combined, they yield sizable reductions in GHG emissions. But for strategies that focus chiefly on technological improvements, there may be reductions in conventional pollutants but not GHGs.

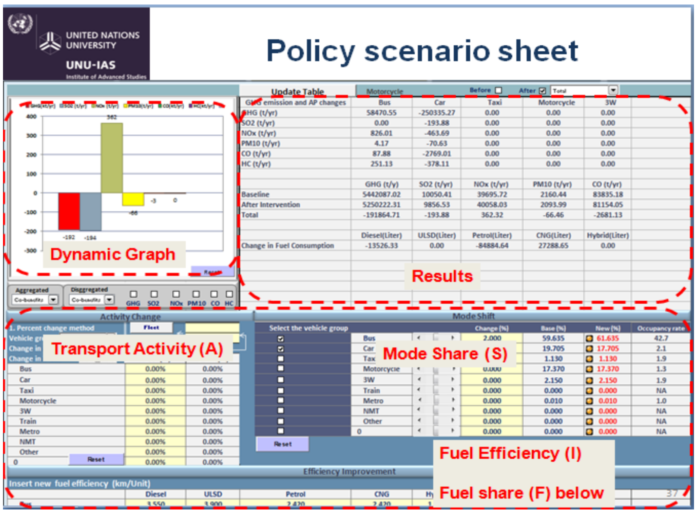
3.2.4 UNU-IAS Model Projects: Urban Development with Climate Co-benefits

Yet a fourth set of models aims to give policymakers the tools needed to analyse the co-benefits of different options in key sectors in cities. The "Urban Development with Co-benefits Approach" project was a multi-year project running from 2009-2013 developed by the Sustainable Urban Futures programme at the United Nations University Institute of Advanced Studies[1] (www.ias.unu.edu/urban) and supported by the Ministry of the Environment, Japan. It took a case study approach to investigating how and why co-benefits occur across different urban sectors in cities in five countries: China, India, Indonesia, Brazil and Japan (Puppim de Oliveira et al., 2013). The research analysed cases where climate co-benefits had already happened in order to understand the best policies to enable their recurrence. Based on these insights, a series of tools was developed to quantify co-benefits in three urban sectors—transport, energy and waste–along with a tool that assesses the governance implications of different policy options, based on a self-assessment of implementing capacities.

The tools are developed in MS-Excel and employ the Avoid-Shift-Improve (ASI) framework commonly found in sustainable transport with extensions to the waste and energy sectors. Each tool requires users to enter local data on their city to build a baseline. This baseline then can be examined to understand the source and magnitude of emissions. Based on this analysis, changes can be made to the system in three ASI areas (see Figure 3-6). Taken together, co-benefits (GHG, air pollution emissions and, in some cases, energy use) are calculated so that different scenarios can be evaluated and compared against each other. The quantitative tools are loosely linked to qualitative governance tools for each sector, which help rank policies based on capacities, or, conversely, analyse the strength of governance capacities needed to effectively implement desired policy options.

[1] As of 1 January 2014, the Institute for Advanced Studies is known as the Institute for the Advanced Study of Sustainability, but retains the same acronym (UNU-IAS).

Figure 3-6. UNU-IAS model projects



Screen shot from the main panel of the transport tool showing the dynamic graph (top left) and results (top right) of policy interventions set in the control panel (lower half)

The ASI framework relates to:

- A: the magnitude of the activity (travel-per km; waste generation; energy demand)
- S: how that activity is performed (e.g., bus/car; landfill/compost; solar panel/mini-hydro, etc.)
- I/F: the efficiency of technologies and/or the fuel used in that activity

At the time of writing, the tools are in the process of being tested with stakeholders and finalised based on user feedback. A fully comprehensive guidebook will accompany each tool. The tools are expected to be released publicly in mid-2014. Beyond this, the idea is to maintain the tools as 'living tools' with periodic updates. Although each tool requires the user to input local data before access, this is also collected in the registration process and will be used to construct databases that can then be accessed by users who may not have complete local data but can estimate their emissions based on a similar city. The next phase of tool development will look at integrating the tools across urban sectors. More information can be found at http://www.ias.unu.edu/urban/.

Chapter 4: Lessons Learned from Efforts to Achieve Co-benefits

The previous chapter underlined that the science and modelling of co-benefits have drawn attention in Asia. Science and models are indeed essential to identifying co-benefits projects and technologies. However, co-benefits cannot be achieved in a vacuum. Projects and technologies need to be supported by enabling environments that can strengthen institutions, engage stakeholders, build capacity, and supply finance at all levels. There are fortunately several ongoing processes and mechanisms that can help enable and scale projects and technologies. This chapter begins by focusing on climate change policies and mechanisms and then turns to air pollution policies and frameworks with the potential to support co-benefits. It closes by highlighting specific examples of black carbon measures that could potentially capitalize on the policies and mechanisms reviewed earlier in the chapter.

4.1 Climate Change Policies and Mechanisms

Climate change policies and mechanisms are the obvious choice for facilitating dialogue and enabling the implementation of co-benefits. In fact, some might argue that the increasing interest in SLCPs is driven by the possibility of accessing climate finance for air pollution control. This section surveys national policies and mechanisms in and outside the United Nations Framework Convention on Climate Change (UNFCCC) that could strengthen support for co-benefits.

4.1.1 Climate Change Policies

Climate change plans and laws are a relatively recent addition to the policy landscape in Asia. Over the past six years, more than a dozen countries in Asia have promulgated plans and/or laws related to climate change. Most contain provisions targeting improved efficiencies in energy and transportation as well as public services, such as waste and wastewater treatment. Notable examples include India's national climate action plan and its eight core missions (solar power, energy efficiency, sustainable habitat, water, Himalayas, afforestation, agriculture and strategic knowledge); Indonesia's climate national action plan and its focus on sustainable forestry and clean energy; and the compilation of industrial, power, and sectoral policies that make up China's national climate change action plan. The actions outlined in these plans are closely related to voluntary GHG targets that India, Indonesia, and China pledged to the UNFCCC as nationally appropriate mitigation actions (NAMAs) in 2010. Many of Asia's smaller countries such as Vietnam, Bangladesh, Thailand, and the Philippines have also adopted climate action plans or laws. These generally emphasise climate change adaptation but also include mitigation measures (see Table 4-1).

There has also been modest progress with climate actions below the national level, especially in Asia's cities. A recent survey of 139 cities in Asia found that 15 have developed climate change plans with policies and measures for GHG reductions in key sectors (energy, transport, buildings, waste and waste water treatment). These include cities in developed countries, such as Tokyo and Seoul, as well as developing countries, such as Bangkok and Delhi (CAI-Asia, 2012). Some cities have formulated plans in response to national government efforts to mainstream new concepts into urban planning such as low carbon development or green growth. China, for instance, has designated five provinces and eight cities as low carbon pilots in 2010 and added one province and 28 cities as a second group of pilots in 2012; Korea has affixed the green growth and low-carbon labels to the development approach being pursued in Seoul.

Table 4-1. Select Plans and Laws Related to Climate Change in Asia

Country	Name of Plan/Laws
Bangladesh	Bangladesh Climate Change Action Plan and Strategy 2008
Cambodia	National Strategic Development Plan (2009-13) Cambodia Green Growth Roadmap
China	National Climate Change Program 12th Five-year Plan (2011-15) China's Policies and Actions for Addressing Climate Change (2011)
India	National Action Plan on Climate Change (NAPCC)-Eight Core Missions run through 2017
Singapore	Sustainable Singapore Blueprint National Climate Change Strategy 2006 (part of Singapore Green Plan 2012)
South Korea	4th Comprehensive National Action Plan for Climate Change (2008-2012) 5-Year National Action Plan for Green Growth Basic Law on Low Carbon and Green Growth
Indonesia	Guideline for Implementing Greenhouse Gas Emission Reduction Plan National Development Planning Mid-term Development Plan (RPJM 2010-2014) Indonesia Climate Change Trust Fund (ICCTF) National Climate Change Action Plan 2007
Philippines	Climate Change Act of 2009 Philippines Energy Plan 2004–2014
Thailand	National Strategic Plan on Climate Change 2008-2012
Vietnam	National Target Programme in Response to Climate Change

Sources: IGES Compilation

The cornerstone of many of the climate change plans and laws are clean energy policies. Throughout Asia, there are a range of efforts to capitalise on renewables or capture untapped efficiencies at the producer or end-user level. With these ends in mind, many countries in Asia have adopted energy efficiency targets, renewable portfolio standards, labelling standards, or feed-in tariffs. Similar to the climate change plans, many of these policies and measures seek to capitalise on a country's natural resource endowments. A salient example is Indonesia's intention to take advantage of large reserves of geothermal energy (ADB, 2009).

4.1.2 CDM Co-benefits Projects

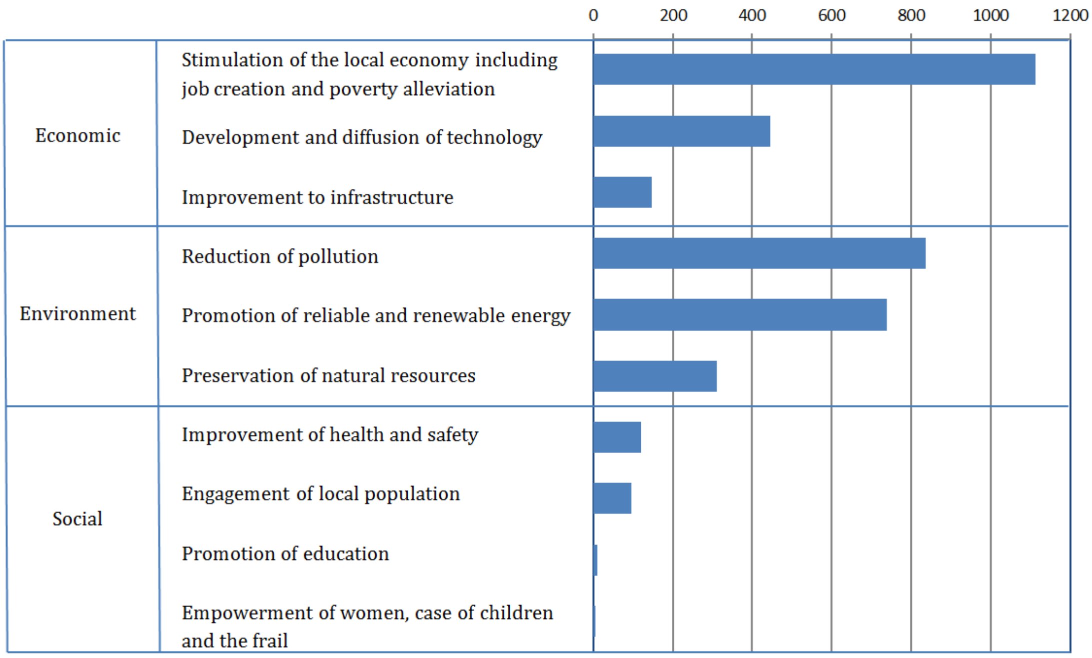
At the international level, the most familiar climate mechanism with the potential to promote co-benefits is the Clean Development Mechanism (CDM). The CDM, introduced under the Kyoto Protocol, is a project-based offset mechanism that enables developed countries to fulfil their national Kyoto targets by implementing GHG mitigation activities in developing host countries. Host countries can earn tradable CERs issued by the CDM Executive Board based on the amount of GHG emissions reduced by the funded projects. As of mid-March 2014, 7,456 CDM projects have been registered; more than 80% of those projects are located in Asia (UNFCCC, 2013a). In this regard, CDM projects have been among the most visible signs of climate actions in the region—but they also may seek objectives above and beyond climate mitigation.

Article 12.2 of the Kyoto Protocol states that the CDM has two equally weighted objectives: to assist in reducing GHG emissions; and to assist in achieving sustainable development in host countries (UNFCCC, 1998). Prior to the ratification of the Kyoto Protocol, hopes ran high that the CDM would substantially contribute to second sustainable development goal. Some felt, for instance, that the CDM would address environmental and social problems while facilitating investment and technology transfer

(Begg et al., 2003). Renewable energy projects were thought to be particularly conducive to generating both climate and other development benefits (Alexeew et al., 2010).

Some projects have indeed lived up to these expectations. For instance, the Indian Bagepalli CDM Biogas Programme (registered in 2005) not only provided clean and smoke-free cooking environment, it also reduced fuel-wood collection, improved health, gave women more time to engage in income-generating activities and shared revenues with the 5,500 women who received biogas units. Looking more broadly across CDM project design documents (PDDs), the majority of projects have a variety of positive effects on sustainable development in host countries (Figure 4-1).

Figure 4-1. Number of Sustainable Development Claims by Indicator



Source: UNFCCC (2012)

These figures notwithstanding, many have been more skeptical about the CDM's contribution to sustainable development. Illustrating this view, Sutter & Parreño (2007) concluded that CDM projects did little to generate employment, improve local air quality, or distribute CDM returns equally. Others who looked across a larger number of cases also concluded that the CDM does not significantly contribute to sustainable development or poverty alleviation in countries like India (Sirohi, 2007). Furthermore, Parnphumeesup and Kerr (2011) point out that some projects actually lead to emissions of air pollutant species like black carbon. Hence, they argue for a rigorous evaluation of sustainable development impacts.

Reflecting concerns that the CDM was not adequately reaching its sustainable development goal, there have also been several efforts to make the mechanism more supportive of high quality projects. Some of these efforts have focused on programmes of activities (PoAs)—an approach that allows a collection of similar, small-scale interventions (such as clean cookstoves) to be grouped, registered, and verified as a single project. This is intended to reduce the transaction costs of processing a number of diffuse, small-scale projects. These are generally the types of projects that have a greater impact on community development, though often have been viewed less favourably by investors and developers because of small returns on investment and high transaction costs. Likewise, PoAs should help give opportunities for least-developed countries to launch CDM activities in their countries, which typically have limited GHG reduction potentials (Kasai, 2012). As of 28 February 2014, 247 CDM PoAs have been registered (UNFCCC, 2013b).

Other efforts have focused on creating a separate certification scheme for high quality projects that could then sell credits into the CDM or voluntary markets. The most notable of these efforts is the Gold Standard. Project representatives seeking Gold Standard certification are required to demonstrate that project activities will have clear sustainable development benefits through a detailed impact assessment. This requirement is above and beyond fulfilling host country environmental and social requirements; a declaration must also be submitted by the project representatives verifying that the project complies with local environmental and social regulations (see Table 4-2 for Gold Standard and other development assessment programs and tools).

For standard CDM projects, host countries' designated national authority (DNA) to evaluate whether a CDM activity contributes to sustainable development. In some cases, countries' designated national authorities (DNAs) have established methods for measuring the developmental contribution of projects prior to their approval. In recent years, these efforts have been supplemented by tools to more systematically evaluate the contribution to sustainable development (Sutter & Parreño, 2007). In fact, last year the CDM Executive Board created a tool to "highlight the co-benefits brought about by CDM project activities and PoAs, while maintaining the prerogative of the Parties to define their sustainable development criteria." Though the tool has been welcomed by some, others have argued its voluntary nature, lack of concrete incentives for use, and absence of monitoring protocols will render it less meaningful (Carbon Market Watch, 2012).

A concern with the CDM and other market mechanisms is that additional screening for co-benefits can increase the transaction costs of moving the project through the approval process. This concern is particularly salient given the current low CER prices (sub €1) and related uncertainties surrounding carbon markets. These concerns notwithstanding, there is some evidence to recommend eligibility and screening criteria to make the CDM and voluntary offset mechanisms more environmentally sustainable and socially inclusive.

In sum, while some contend that the CDM has thus far struggled to promote co-benefits (Olsen, 2007), there have nevertheless been several noteworthy attempts to compensate for the mechanism's shortcomings. The most promising efforts have been aimed at reforming the institutional rules for measuring sustainability and restructuring incentives to achieve these newly defined goals. It is therefore important to consider the design of institutional rules not only for the CDM but for proposals for the post-2020 climate regime.

Table 4-2. Co-benefits Tools

The Developmental Dividend is a research programme that the International Institute for Sustainable Development (IISD) initiated in 2005 to assess the benefits of climate actions "beyond those strictly related to climate change." The ultimate goal of the programme is to increase the quantity of quality CDM projects. Part of achieving that goal is building an evaluative framework to assess the development dividend from projects. The framework is based on an international advisory group's weighting of standard social, environmental, and economic criteria. The framework then uses quantitative and qualitative data from project design documents (PDDs) to arrive at developmental dividend scores for categories of CDM projects. These scores are intended chiefly for the international policy community to assess the developmental benefits of CDM projects, but they also can be employed domestically by designated national authorities (DNAs). More information is available at http://www.iisd.org/climate/markets/dividend.asp
The Gold Standard was initially conceived in 2003 by the World Wildlife Fund (WWF) with support from SouthSouthNorth and Helio International. It offers an "independent best practice benchmark" for investors willing to pay a premium for quality CDM and voluntary projects. To earn Gold Standard certification, CDM projects must meet the usual project approval requirements and pass through additional approval screens, including: strict additionality guidelines; and compliance with

sustainability requirements that include two local stakeholder consultations, conformance with sustainability indicators, and, in some cases, an environmental impact assessment. More information is available at http://www.cdmgoldstandard.org/.
Manual for Quantitative Evaluation of the Co-Benefits Approach to Climate Change is a manual that was developed by Japan's Ministry of Environment to assess co-benefits from waste management, wastewater and air pollution. The manual uses three tiers of indicators as a basis for quantitatively and qualitatively assessing co-benefits. More information is available at http://www.env.go.jp/en/earth/cc/manual_qecba.pdf for more information.
The Transport Emissions Evaluation Model Tool is a spreadsheet based sketch tool for transportation projects that was developed by Clean Air Asia and the Institute for Transport Development Policy (ITDP). The tool is currently being used by the Asian Development Bank and the Global Environmental Facility for transport projects. It is also being updated to include modules for different types of transport interventions as well as co-benefits. More information is available at http://cleanairinitiative.org/portal/TEEMPTool.
The LEDS Global Partnership Development Impact Assessment Toolkit- The low-emission development strategies (LEDS) Development Impacts Assessment (DIA) Working Group (http://ledsgp.org/analysis/impacts) aims to assist institutions in identifying, evaluating, and building awareness of the impacts of LEDS on a country's social, economic, and environmental development goals. Toward that end, partners developed the DIA Toolkit that provides qualitative and quantitative tools, as well as cross-sectoral and sector-specific tools, data, and methods for evaluating the impacts of options on a country's social, economic, and environmental development goals. This web-based, user friendly toolkit equips decision makers with a vehicle to explore policy options and build consensus with stakeholders to achieve low-emission development and support national development objectives. The DIA toolkit can be accessed at http://ledsgp.org/DIA-Toolkit. The DIA Visual Tool helps identify and communicate the impacts (positive and negative) that LEDS actions may have on development priorities and helps decision makers explore potential tradeoffs in policies. The tool is described in "Broadening the Appeal of Marginal Abatement Cost Curves: Capturing Both Carbon Mitigation and Development Benefits of Clean Energy Technologies", found at http://www.nrel.gov/docs/fy12osti/54487.pdf.

4.1.3 Other Climate Change Mechanisms

A set of mechanisms that might become part of the post-2020 regime provide technology, capacity building and financing to support nationally appropriate mitigation actions (NAMAs). The acronym NAMA was first written into the Bali Action Plan (2007)—a framework document that laid a foundation for negotiating a post-2012 climate change agreement but may leave its imprint on the post-2020 regime. The Bali Action Plan stipulates that developing country parties would take NAMAs in the context of sustainable development in exchange for financial, technology and capacity building support in a measurable, reportable, and verifiable (MRV) manner. The interpretation of this text remains contested, but there is an emerging consensus that developing countries could take three different types of NAMAs with corresponding differences in MRV rules: domestically supported NAMAs that are funded by the home country; supported NAMAs that receive some finance, technology and capacity building from the international community; and credited NAMAs that receive financing from the carbon market.

Supported NAMAs may be a particularly attractive vehicle because financing could be indexed to indicators beyond GHG mitigation. The Green Climate Fund (GCF), a fund that will channel an undetermined portion of the promised US$100 billion per year by 2020 (and thus far what seems to be

US$10 billion per year until 2020), could be used to allocate support to NAMAs. Although key decisions were made at the GCF board meeting in February 2014 (e.g., the GCF will aim at a 50:50 balance between mitigation and adaptation activities), the detailed operational rules and modalities for accessing these funds are still under discussion. Other similar efforts for facilitating the implementation of enhanced action on technology development and transfer to support action under the UNFCCC involves the Climate Technology Centre and Network (CTCN), one of the two components of the Technology Mechanism under the UNFCCC, which was established at COP16 in Cancun in 2010.

In recent years, there has also been some discussion of how climate change mechanisms could support the SLCPs discussed elsewhere in the white paper. While SLCPs mitigation has not been involved in decisions or agreements at UNFCCC COPs, it has been discussed as one option to raise the level of near-term ambition for climate mitigation. It nonetheless is important to underline that mitigating SLCPs is a complement not substitute for mitigating long-lived GHGs.

Discussions of SLCPs as a complement began to gain traction in COP17 in 2011 when parties agreed to launch the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP).[2] They continued at COP18 when parties deepened the dialogue on ways of increasing the level of ambition in mitigation, adaptation and international support before 2020. In this connection, some countries[3], demonstrated their intent to support the promotion of SLCPs' mitigation either by recommending SLCPs for discussion, highlighting the importance of co-benefits and/or the efforts of the Climate Change and Clean Air Coalition (CCAC). After the COP 19 negotiations in November 2013, it was decided to accelerate activities on enhancing mitigation ambition, which could possibly prompt more discussion about the mitigation potential of SLCPs and related needs in developing countries.

But even without this agreement, there already are numerous financing mechanisms outside the UNFCCC that could potentially support both co-benefits from the conventional GHG or SLCPs. These include the Climate Investment Funds (CIFs), which are managed by the multilateral development banks, and the Global Environment Facility (GEF), which aims to leverage its finance to transform projects with local benefits to achieve global benefits. The CIFs were created by 2008 when donors, led by the World Bank, pledged over US$6.1 billion to create two funds to provide concessional finance for projects with global and local benefits.

Another choice to support for different types of co-benefits is Official Development Assistance (ODA). This option has the advantages of not requiring an explicit linkage to carbon reductions and including capacity building as larger package of financial and technical assistance. Recent reductions in ODA budgets may nonetheless make this alternative less viable.

Yet another recent window for GHG benefits is Japan's Joint Crediting Mechanism (JCM). Since the mechanism aims to contribute to the sustainable development of developing countries and facilitate the diffusion of low-carbon technologies, it fits the description of many of the abatement technologies. Because the evaluation criteria are agreed between two governments, there is more flexibility than multilateral arrangements to recognize and reward co-benefits.

4.2 Support for Air Quality Co-benefits

4.2.1 National and Sub-national Air Pollution Policies

While the previous section looked at mechanisms that could support co-benefits from a climate change perspective, this section inverts that perspective, looking at opportunities for promoting co-benefits from an air pollution perspective. Clean air policies have a longer history than climate change policies in Asia. In terms of air pollution, there has also been a discernible trend to expand the scope of

[2] The mandate of the ADP is to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties, which is to be completed no later than 2015 in order for it to be adopted at the twenty-first session of the Conference of the Parties (COP) and for it to come into effect and be implemented from 2020. Source: http://unfccc.int/bodies/body/6645.php (Accessed: 2014-01-31)

[3] EU, Norway, Liechtenstein, Mexico, Monaco, Switzerland, the United States, New Zealand, Japan, Canada, Australia (*CCAC partner countries are underlined)

covered pollutants, the forms of regulation, and the types of emission sources targeted. For instance, China is currently working on the fourth revision of its Atmospheric Pollution Control Law (1987, 1995, 2000 and 2013 draft). The new law may focus on fine particulates (such as PM 2.5) and ozone pollution control, place more emphasis on regional air quality management and market-based instruments, and concentrate on curbing emissions from mobile and fugitive sources. The region's air quality standards still lag but are converging with developed countries.

This convergence is most apparent in regional capitals such Beijing and Delhi, where more stringent standards typically precede national roll-outs of comparable standards (see Table 4-3). Many countries in Asia are tightening standards on PM10, while some are also adopting standards for finer PM2.5; in fact, China recently introduced a clean air action plan that targets growing concerns over the impacts of PM2.5 These are generally encouraging trends, especially when combined with the growing knowledge of technical and policy solutions for key sources of PM. Additional efforts will be needed to understand the linkages between air pollution standards and sector specific policies and measures.

Table 4-3 Ambient Air Pollution Standards PM10, PM2.5 (Unit: μg/m^3)

	Countries	$PM_{2.5}$		PM_{10}	
		24 hr	Annual	24 hr	Annual
1	Afghanistan	-	-	-	-
2	Bangladesh	65	15	150	50
3	Bhutan (Industrial)	-	-	200	120
3	Bhutan (Mixed)	-	-	100	60
3	Bhutan (Sensitive)	-	-	75	50
4	Brunei	-	-	150	50
5	Cambodia	-	-	-	-
6	China: Grade I	35	15	50	40
6	China: Grade II	75	35	150	70
	European Union	-	25	50	40
7	Hong Kong	-	-	180	55
7	Hong Kong*	75	35	100	50
8	India	60	40	100	60
9	Indonesia	-	-	150	-
10	Japan	35	15	-	-
11	Lao PDR	-	-	120	50
12	Malaysia	-	-	150	50
13	Mongolia	50	25	150	50
14	Myanmar	-	-	-	-
15	Nepal	-	-	120	-
16	Pakistan	40	25	250	200
17	Philippines*	75	35	150	60
18	Republic of Korea	-	-	100	50
19	Singapore	35	15	150	-
20	Sri Lanka	50	25	100	50
21	Taipei, China	-	-	125	65
22	Thailand	50	25	120	50
	United States	35	15	150	-
23	Vietnam	-	-	150	50
	WHO Interim Target-1*	75	35	150	70

Note:

China: Grade I =applies to specially protected areas, such as natural conservation areas, scenic spots, and historical sites;
China: Grade II =applies to residential areas, mixed commercial/residential areas, cultural, industrial, and rural areas;
PDR = People's Democratic Republic;
Hong Kong SAR* = Proposed air quality objectives
Philippines* = DAO 2013-13 | PM2.5 strengthened in 2016
Interim Target-1*= These targets are proposed by the WHO to mark incremental progress to more stringent air quality guidelines. There are usually two interim targets before achieving the guideline levels.

Source: Clean Air Asia (2013b)

4.2.2 Regional and Global Air Pollution Initiatives

There are numerous networks and institutional arrangements under which co-benefits could be constructively discussed and strategically promoted. There are also a few mechanisms through which finance, technology, or capacity building could be delivered to enable action on co-benefits. This section surveys relevant arrangements and mechanisms, beginning with regional air pollution agreements and moving to sector specific mechanisms (e.g. transport, energy). The main message is that there are few gaps in regional coverage and thematic scope, but a need for better coordination across these initiatives so as not to strain national capacity. In fact, it may be more productive to strengthen the implementation of national actions rather than aspiring for emission targets and compliance mechanisms that are often the desired objective of hard-law international agreements.

One of the earliest mechanisms with potential to promote co-benefits was **The Acid Deposition Monitoring Network in East Asia (EANET).** Between 1993 and 1997, Japan set up four expert meetings on acid deposition in Asia that paved the way for creation of EANET. Today, EANET covers 13 countries and receives technical support from the Asia Centre for Air Pollution Research (ACAP), which acts as the network centre in Niigata, Japan. The Regional Resource Center for Asia and the Pacific (RRC.AP) serves as the EANET Secretariat. EANET has concentrated on compiling, evaluating, exchanging and disseminating data. The network has made progress standardising and strengthening monitoring and building capacity, especially for atmospheric science. There has been some discussion of broadening the scope of EANET to cover pollutants that go beyond sources of acid rain, but they have yet to be approved by all of the 13 country parties.

The ASEAN Agreement on Transboundary Haze was signed by ten 10 ASEAN Member Countries in 2002. The Agreement is the first regional agreement to unite countries in a shared commitment to tackling transboundary haze pollution resulting from land and forest fires. The agreements has helped members draft plans to reduce forest and agricultural fires, established a Haze Pollution Fund, and offered technical assistance to other parties through the ASEAN Coordinating Center on Transboundary Haze. The Agreement's ASEAN Meteorological Specializing Center (ASMC) in Singapore, another area where the agreement is registering progress, provides web-based information on daily hotspots, meteorological predictions of wind speed and direction, and potential smoke-haze coverage.

The Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia (Malé Declaration) is an intergovernmental network involving Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan and Sri Lanka that was formed to help manage transboundary air pollution in South Asia. Since its inception in 1998, the Malé Declaration's National Focal Points and National Implementing Agencies have strengthened air pollution monitoring in member countries; enhanced the impact assessment capacity of national institutions; assessed the impacts of air pollution and their socio-economic implications in participating countries; strengthened the capacity of national implementing agencies to undertake emission inventories; developed integrated assessment modelling; and raised awareness for action. In May 2013, member countries agreed on a sustainable financial mechanism and support for Phase V implementation (2014-16) that aims to promote policy measures for all air pollutants, including SLCPs, and ensure the sustainability and ownership of the Malé Declaration in the region. Malé offers some potential to move toward a more integrated multi-pollutant approach.

The Joint Forum on Atmospheric Environment in Asia and the Pacific (Joint Forum) was established to achieve a clean atmospheric environment through collective actions in Asia and the Pacific region, especially through enhanced cooperation and collaboration among regional and sub-regional networks. The First Joint Meeting of the Intergovernmental Networks on Regional Air Pollution in Asia and the Pacific Region was held in March 2009. It was attended by the representatives of regional and sub-regional networks on atmospheric issues in Asia, including EANET, the Malé Declaration, ASEAN Agreement on Tranboundary Haze Pollution, Central Asian Environment Convention Secretariat, and Pacific Regional Environment Programme (SPREP) Secretariat. A year later, at the meeting of the Joint Forum, the participants adopted the "Joint Plan for Joint Activities on Air Pollution in Asia and the Pacific", highlighting the background for taking up the plan, vision and goals, structure, scope of activities, and future plans. Within the framework of the Joint Forum, the work programme for the initial three years (2010-12) focused on capacity building and the consolidation of information sharing as a basis for subsequent policy measures. This will be further enhanced during the following three-year period (2013-15). The Joint Forum may also move toward a more integrated approach, but the pace of that transition will depend on developments in other underlying agreements.

Long Range Transboundary Pollutants in Northeast Asia (LTP) is a joint research project which was launched to identify long range transport mechanism of air pollutants in Northeast Asia among Japan, South Korea and China. The National Institute of Environmental Research (NIER) in Korea was nominated as an interim secretariat at the 1st Northeast Asian Workshop on Long-rang Transboundary Pollutants held in 1995, and was promoted to the secretariat as the LTP project formally launched at the first working group meeting in 1996. Two sub-working groups on monitoring and modelling were then established in 1997. The project was formally started in 1999. As a chiefly scientific research project, the LTP can demonstrate the benefits of a more integrated approach.

The Atmospheric Brown Cloud (ABC) Project was the direct result of a 1998-99 Indian Ocean Experiment (INDOEX) that revealed aerosol particles can be transported thousands of kilometres away from the source before they are dispersed/removed from the air. It also uncovered that, during the long dry season November to April, a large-scale atmospheric haze of air pollutants covers a large area of continental South Asia and the Indian Ocean. UNEP commissioned the ABC project in 2002 to study this cloud of haze and its impacts as well as provide a scientific basis for informed decision making. Observatories have been set up and impact assessment studies on agriculture, water budgets and human health have been started with three lead regional institutions in India, Singapore and Thailand. The project also links strongly to the international scientific community. The ABC project is premised on a more integrated perspective on atmospheric pollution.

To address the environmental health risks that include those posed by the current air quality status, the **Regional Forum on Environment and Health in Southeast and East Asian Countries** was established in August 2007 in Bangkok, Thailand. The Charter of the Regional Forum identified health implications of air quality as one of the regional priorities for 2007-10, and created a Thematic Working Group (TWG) on Air Quality. The TWG divided the regional workplan into three sub-groups that focus on important air quality issues—urban air pollution, indoor air pollution and transboundary air pollution. The RRC.AP played a vital role in facilitating and coordinating the meetings and discussions among different stakeholders, particularly the member countries' needs and issues. The Regional Forum on Environment and Health in Southeast and East Asian Countries is well positioned to demonstrate the magnitude of the health benefits of a more integrated approach; this knowledge could potentially be used to justified policy action, especially for policymakers looking for examples of benefits.

Clean Air Asia (formerly the Clean Air Initiative for Asian Cities) promotes better air quality and liveable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse emissions from transport, energy, and other sectors. It was established as the premier air quality network for Asia by the Asian Development Bank, World Bank, and United States Agency for International Development (USAID) in 2001. Since 2007, Clean Air Asia is a United Nations recognised partnership of almost 250 organisations in Asia and worldwide and eight country networks (China, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, and Vietnam), and is supervised by a Partnership Council. Clean Air Asia Centre acts as the Secretariat of the Partnership and is a registered non-profit organisation headquartered in Manila, with offices in Beijing and Delhi. Clean Air Asia brings together stakeholders to build knowledge and capacity for improved air quality while simultaneously addressing other development issues, including climate change. It supports integrating the co-benefits of air pollution abatement and climate change mitigation into government policies and programmes. A co-benefits approach features prominently in Clean Air Asia's operational and programmatic objectives.

The North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) was established in 1993 as a comprehensive intergovernmental cooperation programme comprising China, Democratic People's Republic of Korea (DPRK), Japan, Mongolia, South Korea and Russia, in order to jointly address environmental challenges in this sub-region. At the time of formation, sulphur dioxide (SO_2), particularly from coal-fired power plants, was a logical target for NEASPEC activity. NEASPEC has since undertaken first and second phase technical assistance projects to mitigate transboundary air pollution from coal-fired power plants in Northeast Asia. It plans to launch a new programme on transboundary air pollution assessment in 2014. The NEASPEC Secretariat is looking to build synergies with other existing mechanisms, such as EANET. The engagement with other mechanisms and emphasis on concrete projects can help advance actions that are more integrated in nature.

The Global Atmospheric Pollution Forum (GAPF) was established in 2004 by the International Union of Air Pollution Prevention and Environmental Protection Associations (IUAPPA) and the Stockholm Environment Institute (SEI) to serve as overarching global network of regional air pollution networks. GAPF has a steering committee and management committee comprised of representatives from key international organisations and regional air pollution networks. It also has an international advisory panel consisting of 11 recognised air quality management experts. IUPPA and SEI serve as GAPF's secretariat. The overall objective of GAPF is to bring together regional and international organisations to promote dialogue and co-operation on air pollution problems. Recently, its work has focused on three themes relevant to co-benefits: promoting policies that simultaneously address air pollution and climate change; hemispheric transport of air pollution; and ABCs. It also supports strengthening the integration between air pollution regulations and climate change negotiations. Given its international scope, the GAPF is well positioned to communicate important findings on these three themes to stakeholders in Asia; it is also strategically positioned to share experiences from Asia with stakeholders outside the region.

The Partnership for Clean Fuels and Vehicles (PCFV) was launched at the WSSD in 2002 to assist developing countries in reducing mobile source air pollution and is hosted by the UNEP Transport Unit based in Nairobi. It has become the leading global public-private initiative promoting cleaner fuels and vehicles in developing and transition countries. With a global reach of over 72 partner organisations, including major private sector partners in the oil and vehicles sectors, it is the only global forum dedicated to cleaner air and lower GHG emissions from road transport through cleaner fuels and vehicles, ensuring and enabling the transfer of technology and knowledge already successfully applied by industry and governments in developed countries. The activities of the PCFV aim to improve urban air quality—through reduction of harmful emissions such as lead (when leaded petrol is still in use) and fine PM, and contribute to a global reduction of GHG emissions through reduced vehicular emissions of CO, black carbon and NOx. The PCFV provides a range of technical, financial and networking support for governments and other stakeholders to improve urban air quality. The PCFV focuses on two campaigns, namely: 1) the global elimination of leaded gasoline and the adoption of catalytic converters; and 2) reduction of sulphur in vehicle fuels to 50 ppm or below worldwide and the introduction of vehicle emissions standards. Since its inception, the PCFV has directly supported implementation on the ground in over 155 countries in every region of the globe. The PCFV closely collaborates with other initiatives, including the Global Fuel Economy Initiative and the Climate and Clean Air Coalition (CCAC) (see below), on vehicle-fuel economy issues and reducing black carbon and PM from heavy-duty vehicles worldwide. Clean Air Asia is a regional partner for activities in Asia. The PCFV is a good example of a sector-based initiative that understands linkages between multiple pollutants and promotes actions consistent with that understanding.

In 2012, Bangladesh, Canada, Ghana, Mexico, Sweden and the United States – in cooperation with the United Nations Environment Programme (UNEP) and the World Bank – launched a voluntary multilateral initiative entitled the **Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants Initiative (CCAC).** The CCAC was created to promote reductions of SLCP emissions in key sectors and is organised around seven sector-specific initiatives (that reflect the SLCP technical options in section 4.1) and three cross-cutting initiatives (see Figure 4-2).

Figure 4-2. CCAC Initiatives

Sector based initiatives	Cross-cutting initiatives
1. Reducing Black Carbon Emissions from Heavy-Duty Diesel Vehicles and Engines 2. Mitigating SLCPs and Other Pollutants from Brick Production 3. Mitigating SLCPs from Municipal Solid Waste 4. Promoting HFC Alternative Technology and Standards 5. Accelerating Methane and Black Carbon Reductions from Oil and Natural Gas Production 6. Reducing SLCPs from Household Cooking and Domestic Heating 7. Addressing SLCPs From Agriculture	8. Supporting National Planning for Action on SLCPs Initiative (SNAP) 9. Financing Mitigation of SLCPs 10. Regional Assessments of SLCPs

Source: CCAC, 2013

With the support of the CCAC trust fund, Bangladesh became the first country in Asia to develop an SLCP national action plan (NAP) in 2013. The NAP underlined that addressing SLCPs could bring benefits for health, energy, food security, transport, waste management, and climate change. The NAP identified potential abatement measures for black carbon and methane emissions in Bangladesh. Each measure included an estimated impact, technical effectiveness, implementation effectiveness, costs, co-benefits and timing of introduction. The NAP also emphasised that coordinated actions on SLCPs requires national and global support to enhance the institutional capacity needed to effectively implement key measures. The same steps taken to generate the NAP Bangladesh may serve as a model for other CCAC countries in Asia (See Box 4-1).

Box 4-1. Steps Taken for Bangladesh's SLCP National Action Plan (NAP)

These 12 steps were followed to develop the NAP in Bangladesh:

1. Formulating the architecture of the NAP process through consultation among relevant authorities;
2. Review of current status of air pollution and emissions inventory (both air pollutants and GHG);
3. Identification of major sources of black carbon and methane, based on available information;
4. Estimation of SLCP emissions from major sources using upgraded Long range Energy Alternatives Planning (LEAP) model (continuing, with support from Stockholm Environment Institute);
5. Identification of priority measures for reducing black carbon and methane and evaluation of opportunities (e.g., existing policies, projects, programmes) and barriers (e.g., policy, institutional, technology, market, finance, knowledge/information) to their implementation;
6. Presenting the architecture of the NAP process, identified major sources and abatement measures of black carbon and methane to stakeholders at the first stakeholder workshop (on 27 February 2013);
7. Continuing interactions with key stakeholders through one to one interviews to get feedback on

abatement measures and actions needed for their implementation (e.g., identification of actions that could be mainstreamed into existing government programmes/projects including scaling-up and speeding-up current initiatives, and measures that would require new initiatives);

8. Estimation of benefits achievable through implementation of identified measures through application of benefits toolkit (continuing, with support from SEI);
9. Based on 5, 6 and 7, preparing a list of black carbon and methane abatement measures and actions/issues to be addressed for their implementation, and presenting it to stakeholders at the second stakeholder workshop (on 19 March 2013) for feedback;
10. Based on 7 and 9, preparing the Draft NAP for reduction of SLCPs (which includes seven black carbon abatement measures, nine methane abatement measures, a set of specific actions for implementation each measure, and a priority list of measures), and presenting it to the stakeholders at the final stakeholder workshop (held on 11 April 2013) for feedback;
11. Updating the Draft NAP based on 10 and results of activities 4 and 8, and distributing it among key stakeholders for peer review;
12. Finalising the Draft NAP, incorporating feedback from peer review.

There has also been a discussion of conducting a Regional Assessment of SLCPs in Asia under the CCAC. The assessment would address regionally important themes, including, *inter alia*, 1) experiences with key technologies in Asia such as clean cookstoves; 2) major policy developments in the region; 3) regional networks and institutional frameworks for cooperation; and 4) scientific uncertainties related to Asia. It would be complemented by an engagement process that would involve a series of small consultations to enable policymakers to actively participate and thereby help shape the assessment.

4.3. SLCP Co-benefits Technical Measures (Focus on Black Carbon)

Many of the national, regional, and international policymaking processes can help support action on SLCP technical measures. These SLCP technical measures were identified by integrating the scientific and modelling approaches discussed in chapter 3. More specifically, the Institute for Applied Systems Analysis (IIASA) global model, National Aeronautic Space Administration (NASA) Goddard Institute for Space Studies (GISS) model, the Max Plank Institute's ECHAM model (applied by the EU Joint Research Centre), and the FAst Scenario Screening Tool (TM5-FASST) model of the EU Joint Research Centre model identified 16 priority technical measures were that can achieve between a 0.4°C to 0.5°C reduction in global warming by 2050 (UNEP, 2011b). The next section provides additional details on opportunities and constraints for the black carbon measures. In so doing, it underlines a more general point: it will be increasingly important for national, regional, and international policymaking processes to strengthen enabling environments if estimated co-benefits are to be realised (Table 4-4).

Table 4-4. Priority SLCP Mitigation Options

Sector	Measure
Black Carbon	
Transport	1.Standards for the reduction of pollutants from vehicles (including diesel particle filters), equivalent to those included in Euro-6/VI standards, for road and off-road vehicles
	2. Elimination of high-emitting vehicles in road and off-road transport
Residential	3. Replacing lump coal with coal briquettes in cooking and heating stoves
	4. Pellet stoves and boilers, using fuel made from recycled wood waste or sawdust, to replace current wood-burning technologies in the residential sector in industrialized countries[1]

	5. Introduction of clean-burning (fan-assisted) biomass stoves for cooking and heating in developing countries[2, 3]
	6. Substitution of traditional biomass cookstoves with stoves using cleaner-burning fuels (e.g., liquefied petroleum gas or biogas)[2, 3]
Industry	7. Replacing traditional brick kilns with vertical shaft brick kilns[4]
	8. Replacing traditional coke ovens with modern recovery ovens
Agriculture	9. Ban on open burning of agricultural waste[2]
Ozone (Methane)	
Fossil fuel production and transport	10. Extended pre-mine degasification and recovery and oxidation of methane from ventilation air from coal mines
	11. Extended recovery and utilisation, rather than venting, of associated gas and improved control of unintended fugitive emissions from the production of oil and natural gas
	12. Reduced gas leakage from long-distance transmission pipelines
Waste management	13. Separation and treatment of biodegradable municipal waste through recycling, composting and anaerobic digestion as well as landfill gas collection with combustion/utilisation
	14. Upgrading primary wastewater treatment to secondary/tertiary treatment with gas recovery and overflow control
Agriculture	15. Control of methane emissions from livestock, mainly through farm-scale anaerobic digestion of manure from cattle and pigs
	16. Intermittent aeration of continuously flooded rice paddies

1.Note that this is the only measure that applies to developed countries; but there could be more work done on specific countries in Asia such as Japan
2. Motivated in part by its effect on health and regional climate, including its impact on areas of ice and snow
3. For cookstoves, given their importance for black carbon emissions, two alternative measures are included
4. Zigzag brick kilns would achieve comparable emission reductions to vertical-shaft brick kilns

Source: UNEP (2011)

4.3.1 Clean Cookstoves

Approximately 2.6 billion people rely on cookstoves as an essential part of life. In contrast to ranges and ovens common in developed countries, three-stone open-fire or mud, pottery, cement or brick cookstoves are often used in developing countries. The stoves are a prominent feature of everyday life; families depend on them for preparing meals and heating homes. Both processes typically rely on traditional low energy-efficient materials, such as burning animal dung, firewood, and other biomass (IEA, 2006).

When these fuels are incompletely combusted, they release submicron particulates that pose problems for cardiovascular and pulmonary systems. Future projections indicate that without targeted actions or stronger policies, over 1.5 million people will die annually by 2030 due to the harmful effects from exposure to such stoves (IEA, 2006). Ensuring access to improved cookstoves for poor households is therefore critical to avoiding a range of adverse health and environmental impacts. These impacts are a greater concern in developing countries than near term climate change.

Two approaches are commonly pursued to mitigate these impacts: 1) switching from biomass to cleaner fuels; or 2) replacing traditional cookstoves with stoves that use cleaner fuels (e.g., liquefied petroleum gas, or LPG, or renewable options such as biogas, solar cookers or renewably-produced electricity). Variants of both approaches have been tried since the early 1950s with a diversity of rationales motivating action (World Bank, 2011). During the 1980s and the 1990s, most efforts focused on fuel substitution or biomass energy-efficiency to allay concerns over fuel scarcity and deforestation. In the early 1990s, another wave of efforts concentrated on reducing indoor air pollution and adverse health effects. Since the 2000s, GHG emissions from biomass fuel burning became an additional concern. While most studies underline potential for cleaner cookstoves, there are also technical, financial, institutional and social barriers to the uptake of clean cookstoves (Table 4-5).

Table 4-5. Barriers to Uptake of Clean Cookstoves

Category	Barriers
Technical	Inadequate stove design
	Acceptability of technologies
	Lack of local supply-chain and repairs and maintenance services
Financial	High initial costs
	High fuel costs
	Subsidies for fossil fuel and cookstove producers
Institutional	Bureaucratic fragmentation (mostly in central ministries)
	Lack of capacity, training and monitoring systems
	Lack of approved suppliers, entrepreneurs and vendors
Social	Reluctance to abandon accepted practices
	Limited awareness on impacts, alternatives and programmes
	Limited stakeholder engagement

Source: Zusman et al. (2012)

These barriers are important because they do not necessarily disappear with increases in wealth; households tend to use a combination of fuels and technologies at all income levels (Lambe and Atteridge, 2012). For instance, even well-off households in Bangladesh continue to use a mix of traditional and modern energy fuels. Given that increasing incomes are not a solution, the challenge is then to "develop effective policies and programmes to address the problem" irrespective of income growth (World Bank, 2011).

China has arguably had the most success with a full scaled national-level clean cookstove programme. From the late 1970s to the early 1990s, a collection of Chinese government agencies helped to establish the National Improved Stove Program, which has been widely credited with bringing cleaner cookstoves to 129 million households, covering approximately 65% of China's rural population. The success of the programme has been attributed to many factors, including a sustained effort from the Ministry of Agriculture and the discretion given to sub-national agencies to identify locally relevant solutions at the township and village levels. The programme also benefitted from starting small and building to scale, a limited reliance on subsidies, and working with rural energy collectives that were given incentives to produce and maintain improved stoves (Smith et al. 1993). In recent years, there has been a push to reinvigorate China's cookstove programme with new technologies, better oversight programmes, and stronger linkages to policy frameworks with overlapping goals (Smith and Deng 2010).

There is no shortage of international initiatives that seek to replicate this success. Most of these initiatives look to leverage public-private partnerships to support the adoption of new stoves. One of the more visible initiatives that could help in this regard is the Global Alliance for Clean Cookstoves (GACC). The GACC was established as a private–public partnership in 2010 with the goal of increasing the number of clean cookstoves to 100 million by 2020. The GACC works with national governments, non-governmental organisations and the private sector to raise awareness, strengthen scientific evidence, develop standards and labels, and explore innovative financing for clean cookstoves programmes.

Box 4-2. Improved Cookstoves in Bangladesh

Traditional cookstoves can be found throughout rural areas in Bangladesh. According to Bangladesh's most recent census, 77% of the total population, or 131 million people, live in rural areas and use traditional cookstoves for cooking and heating (BBS, 2001). Generally, rural women are able to produce traditional cookstoves free of cost by using locally available construction materials. These traditional cookstoves are designed to use biomass fuels (dry leaves and branches, cow dung, crop residue, rice husks, grass, water hyacinth and hay) as a source of energy. Since the early 1980s, the government of Bangladesh has worked with non-government organisations to introduce clean cookstoves programmes. Two types of improved cookstoves have been disseminated under the government's clean cookstoves programmes: an 'efficiency' cookstove raised combustion efficiency and reduced heat loss, while a 'chimney' cookstove removed smoke from the kitchen via a concrete chimney. Since the start of the programme, many development projects have been implemented by both government and non-government organisations to promote the use of improved cookstoves and to reduce health impacts and pollution from biomass burning.

Recently, the Department of Environment and German Development Corporation developed a unique partnership for distributing improved cookstoves that relies upon the development of a market for stoves. More recently still, Bangladesh's government integrated cookstoves into development goals and policies such as the national MDGs (reduction of infant mortality), the national Total Sanitation Campaign (100% sanitation coverage by 2010) and the Renewable Energy Policy of Bangladesh (2008) that aims to promote market development for improved cookstoves. Although forging these policy linkages have helped increase the use of clean cookstoves, nearly 30 million out of 32 million households still rely on traditional clay biomass-burning cookstoves, and indoor air pollution remains dangerously high for 25 million households.

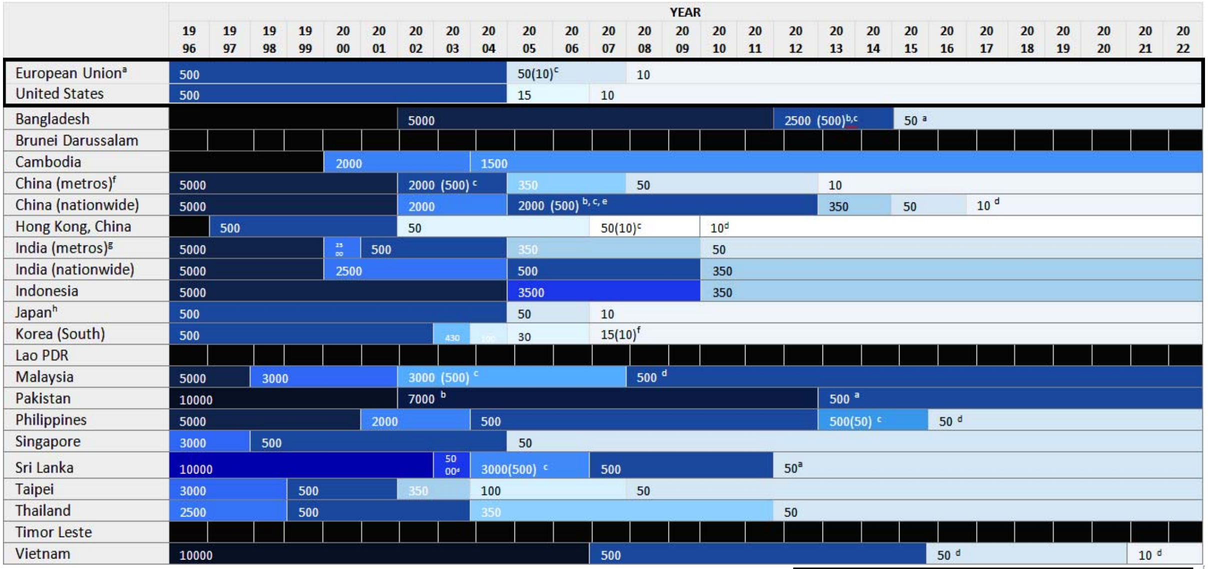
Source: GIZ (2014)

4.3.2 Clean Diesel

Large engines found in trucks, buses, and generators often run on diesel fuel because they require more power. Many countries have addressed the environmental and health impacts of diesel exhaust by tightening emission standards. When coupled with improvements in diesel engine design and **low sulphur** fuel, these measures can offer significant reductions in black carbon emissions. It is nonetheless important to note that desulphurization of diesel has lagged behind developed countries. To illustrate, the permitted sulphur level for diesel in the European, Japanese and US standards is 10 mcg per gram while it is 350 mcg per gram in China and India.

The quality of fuel and engine design is critical factors affecting vehicle exhaust. In 2012, the International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO), classified diesel engine exhaust as carcinogenic (IARC, 2013). As such, upgrading the quality diesel fuel and making diesel engines burn fuel more efficiently can reduce emissions. These measures are complemented by several after-treatment devices such as diesel particulate filters (DFPs) that can trap particulate emissions before they are released into the atmosphere.

Figure 4-3. Fuel Quality Standards-Current and Proposed Sulphur Levels in Diesel

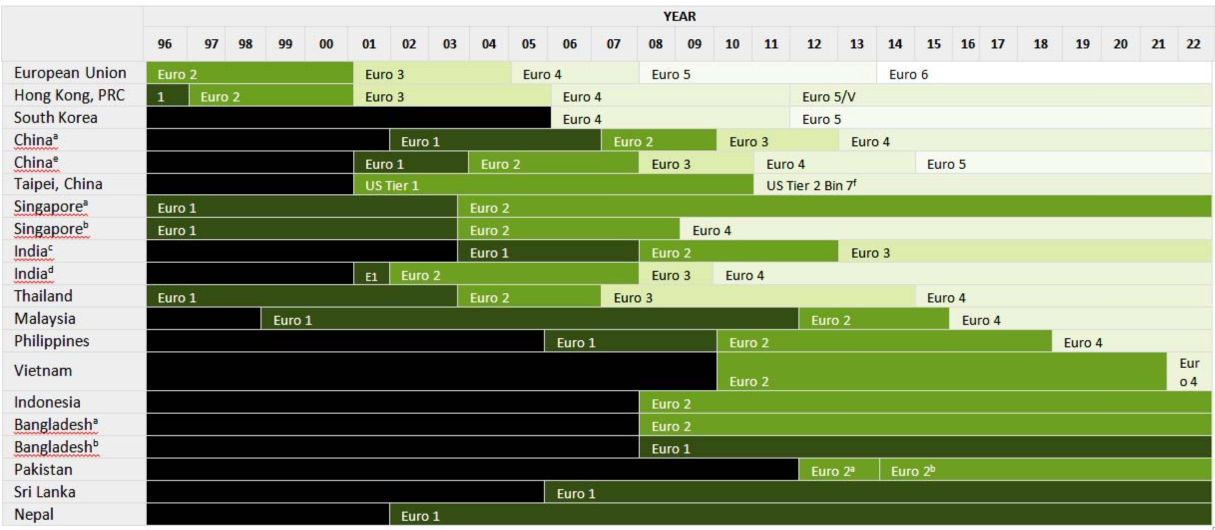


Notes:
a - under consideration/discussion by national government; b – marketed; c - various fuel quality available; d – mandatory as stated in national policy; e - voluntary standard of 500 ppm, however formal standard remains 2000 ppm; f - Beijing, Guangdong, Shanghai; g - Bharat Stage IV norms rolled out initially in 13 cities in 2010 (17 cities in 2013); h - nationwide supply of 50 ppm commenced in 2003 and for 10 ppm in 2005 due to voluntary goals set by the oil industry

LEGEND:
Euro 6: 15ppm and below
Euro 5: >15ppm to 50ppm
Euro 4: >50ppm to 500ppm
Euro 3: >500ppm to 2,000ppm
Euro 2: >2,000ppm to 5,000ppm
Euro 1: >5,000 and above

Source: Clean Air Asia (2013c)

Figure 4-4. Emissions Standards for Light Duty Vehicles



Notes:
*The level of adoption varies by country, but most are based on the Euro emission standards
; a – gasoline; b – diesel; c – Entire country; d – Delhi, Mumbai, Kolkata, Chennai, Hyderabad, Bangalore, Lucknow, Kanpur, Agra, Surat, Ahmedabad, Pune and Sholapur; Other cities in India are in Euro 2; e – Beijing [Euro 1 (Jan 1999); Euro 2 (Aug 2002); Euro 3 (2005); Euro 4 (1 Mar 2008); Euro 5 (2012)], Shanghai [Euro 1 (2000); Euro 2 (Mar 2003); Euro 3 (2007); Euro 4 (2010)] and Guangzhou [Euro 1 (Jan 2000); Euro 2 (Jul 2004); Euro 3 (Sep-Oct 2006); Euro 4 (2010)]; f – Equivalent to Euro 4 emissions standards

Source: Clean Air Asia (2013d)

Regular and effective vehicle inspection and maintenance (I/M) programmes are another critical component of a diesel control programme as better-maintained engines convert fuel into energy more efficiently. The most comprehensive study of the effectiveness of I/M studies found an average reduction in PM emission factor of more than 40% from repairs on vehicles exhibiting visible smoke emissions; average per-vehicle repair costs in the study were approximately $1,000 (McCormick et al., 2003). Yet, due to the difficulties of regulating small diffuse sources and capacity constraints, these programmes have often struggled to reach their potential. Some observers maintain that a "phased approach that allows learning, adaptation, and capacity building along the way" can provide a foundation for gradually ratcheting up stringency (Hausker, 2010). For example, the Tokyo Metropolitan Government employed a phased-in approach with grandfathering provisions for older vehicles (Box 4-3).

Switching to cleaner fuels has also become an accepted diesel control strategy in recent years. This was the case in India. Diesel consumption quadrupled between 1984 and 2004 in India, with adverse effects on urban air quality (TERI, 2006). To reduce pollution levels, the Indian Supreme Court issued a decision that required the entire Delhi public transportation fleet—buses, taxis and auto-rickshaws—to switch to compressed natural gas (CNG) (Mehta, 2001). Other governments have also supported CNG as an alternative fuel. In Pakistan, 80% of vehicles run on CNG. However, notwithstanding its environmental benefits, the popularity of CNG is being challenged as Pakistani gas reserves are dwindling. Biofuels are also being explored in many parts of Asia not only to reduce tail-pipe emissions but to also reduce fossil fuel imports and revitalise rural development.

Box 4-3. Reducing emissions from diesel vehicles in Japan

One of the more interesting diesel control programmes was actually initiated not by a national government but the Tokyo Metropolitan Government (TMG). In 1999, before the national government introduced stricter diesel vehicle regulations, the TMG established a "NO Diesel vehicle campaign." This was followed a year later by enactment of the Tokyo Metropolitan Environmental Security Ordinance that had diesel vehicle regulations as its centrepiece. The regulations require in-use diesel vehicles that do not satisfy PM emissions standards to be retrofitted with emission control systems; otherwise the vehicles cannot be driven in Tokyo. This was accompanied by a suite of other measures designed to stop idling; prohibit use of fuel oils that discharge a greater amount of particulate matter (PM); and deploy vehicle pollution regulators to identify violating vehicles. Importantly, similar regulations were enforced by major prefectures and cities in the Greater Tokyo Area, and other prefectural governments (e.g., Osaka Prefecture and Hyogo Prefecture) also adopted comparable measures, leading to complementary national diesel reforms (Rutherford and Ortolano, 2008; DieselNet, 2012).

4.3.3 Brick Kilns

Small and medium-sized brick kilns are also significant sources of black carbon in Asia. A brick kiln is a set of semi-mechanised technologies that supports the firing process that gives bricks strength and permanent hardness. The firing of bricks occurs at 700-1100°C; therefore kilns must withstand high temperatures. To reach high temperatures, kilns consume significant amounts coal and biomass fuels. In many countries in Asia, the kilns generate black carbon, SO_2, NO_X and CO during this process. Because they are often clustered together, they can be a major source of air pollution. For instance, kilns are the primary source of local air pollution for five months of the year in Dhaka, Bangladesh.

Traditionally, the clay bricks are shaped, sun-dried, and readied for firing in "clamps" - a pile of bricks with intermittent layers of sealing mud and fuel. This fuel would vary from agricultural waste to biofuels (like cow dung and wood) to fossil fuels (like coal and heavy fuel oil). The clamp style is a batch process and the most inefficient of the practices. In kilns using a batch process, all the material is fired at once and cooled to draw the bricks. A significant amount of energy is lost during the cooling process, with no possibility of recycling heat for other parts of the process. Small brick kilns have attracted attention because readily available technologies can significantly cut emissions. Vertical shaft kilns and Hoffman kilns with modern recovery ovens offer considerable promise. Their impacts can nonetheless vary greatly across sources, depending upon the make-up of the fuel, the level of baseline technologies, and the operation and maintenance of the new technologies.

Part of the reason that brick kilns have attracted attention is because of the readily available technologies to cut emissions. For much of Asia, reducing emissions involves moving away from the fixed chimney bull trench kiln (FCBTK) to zigzag kilns, vertical shaft brick kilns (VSBK) (the technology of choice in China) and tunnel kilns. The shift to other options has not been easy. In India, FCBTK technologies have been in use for over a century and still account for nearly 70% of the total brick production.

Table 4-6. Summary of Brick Kiln Technologies

Type	Summary of Key Design Features
Fixed Chimney Kiln (FCK)	• Sun-dried bricks are loaded from one end and finished bricks are drawn from the other, allowing for a continuous firing • Fuel saving is achieved by reusing part of the energy that is otherwise lost in clamp kilns • For firing, fuel is stuffed intermittently from the top through the layers of bricks and the kiln is designed such that after combustion, the hot air on its way to the chimney passes through the yet unfired bricks • A major disadvantage of these kilns is they are sensitive to weather – an open caste kiln means they can only be operated outside of monsoon season. Older FCK designs allowed for a moving chimney, but this technology is no longer available anymore due to higher local pollution from low stacks
Zigzag	• Provide a continuous output with the firing circuit bent into a zigzag form across 16 or more chambers • Each chamber is connected to the next by a damper carrying hot gases from the fire • During firing, the hot air is directed into the chamber and passes into the adjacent chamber for preheating the bricks • As the hot air passes from chamber to chamber, it gradually cools, producing a counter-current heat exchange process and a more efficient use of heat and fuel. In principle, they do not differ much from the traditional designs, but the higher rate of fire travel, a strong fan draught system, and better insulation provides for more efficient heating
Vertical shaft brick kilns (VSBK)	• Reduces the fuel consumption and toxic emissions compared to FCKs via higher heat efficiency in a multi-shaft architecture • This architecture provides a better ratio of land used to production output • The sun-dried bricks and combustion fuel are stacked in batches to the top of the shaft, which progressively move from the pre-heating, firing, and cooling zones before reaching the bottom of the shaft for periodic removal • These kilns can also be designed for all weather conditions as they can be protected by a roof
Hybrid Hoffman Kilns (HHK)	• Has better insulation provided by the thick walls to reduce heat loss • Flue gas scrubbing in drying tunnels can further reduce particulate emissions • The fire zone moves similar to the FCKs
Tunnel Kilns (TKs)	• Has better insulation provided by the thick walls to reduce heat loss • Flue gas scrubbing in drying tunnels can further reduce particulate emissions • The fire zone moves similar to the FCKs • The fire zone is fixed and bricks are moved in trolleys • Automated processes make the kiln operational under all-weather conditions

Source: Guttikunda and Khaliquzzman (2013)

Best practice requires more than shifting from FCBTK to a more efficient alternative – it requires policy frameworks and enabling environments that facilitate the uptake of new technologies. The government's role is particularly important because many of the benefits of alternative technologies accrue to society at large, not the kiln owner. Vietnam has achieved these benefits through a sustainable building policy. Bangladesh has proposed a time-bound phasing out of FCBTK technology. There is nonetheless still limited information on the track record of these programmes. One of the possible stumbling blocks in evaluating their performance is that the kilns function in the informal sector where there is a lack of systematic data on their use and emissions. Fortunately, data gaps are shrinking; Table 4-7 provides some indication of the costs and benefits for a generic set of technological solutions.

Table 4-7. Comparison of technical and operational benefits and constraints of current and alternative brick manufacturing technologies

Technology	Fuel consumed per 100,000 bricks	Investment and operational costs (million USD) [f]	Brick production capacity (million/kiln)	Number of kilns required to produce 3.5 billion bricks	Average tons of CO_2 produced per 100,000 bricks	Average reduction in PM emissions compared to FCK
FCK	20-22 tons coal	1.7	4.0	1000	50	
Zigzag [b]	16-20 tons coal	1.6	4.0	1000	40	40%
Hoffmann [c]	15,000-17,000 m^3 NG	5.7	15.0	270	30	90%
Hoffmann [d]	12-14 tons coal	5.7	15.0	270	30	60%
VSBK [e]	10-12 tons coal	1.6	5.0	800	25	60%

a. FCK = fixed chimney bull trench kiln; NG = natural gas; VSBK = vertical shaft brick kiln
b. Some zigzag pilot kilns are in operation, listed as poor to medium performance. Any improvement in the efficiency of operations can lead to further reductions in coal consumption
c. Manufacturing period for Hoffmann kilns is year-round, compared to the current seasonal operations for the other kilns, thus increasing the land and raw material requirements; Link to natural gas grid and continuous fuel supply is a major constraint
d. Initial investments are higher for Hoffmann kilns
e. Operational models are available in India and Kathmandu (CAI-Asia, 2008)
f. Costs include initial investment, land, building, operational, and taxes estimates (World Bank, 2011)

Source: Guttikunda and Khaliquzzman (2013)

4.3.4 Open Burning (Crop Residue)

Open burning of various biomass materials includes the burning of forest vegetation, grass, crop residue and municipal solid waste. This combustion is often incomplete: hence a large amount of black carbon, precursors for tropospheric ozone formation, and toxic air pollutants are emitted. Solid waste OB is often practiced in many urban and suburban areas where waste management is not efficient and is usually done in three locations: backyard (at generation site), transfer depot, and landfills/dumping sites. This source emits a large amount of black carbon and toxic air pollutants but is poorly characterised.

Crop residue open burning is by far the largest source of the emissions, often more than ten times as much as forest fires in many Asian developing countries. Although making up a relatively small proportion of the global total of black carbon emissions, open burning of agro residue is a significant source of precursors for ozone formation as well as other toxic air pollutants.

There tends to be uncertainties over the global climate impacts of agro residue open burning (i.e., rice straw, sugar cane, and slash and burn agriculture) because of the co-emissions of organic carbon. This mix tends to vary from source to source depending on the make-up of the agricultural biomass; at the regional level, there is less uncertainty in these impacts due to the aforementioned interferences with weather patterns (Bond et al., 2004; Ramanathan and Carmichael, 2008; Bice et al., 2009).

Abating these emission sources is challenging because it is difficult to enforce burning bans, especially when farmers that use them for land clearing depend on the practice for subsistence agriculture. This has led some to argue that programmes need to use market-based instruments beyond restrictions and bans to incentivise changes in the practice (Oanh, 2011).

4.3.5 Other Sources of Black Carbon

There are also several other sources of black carbon in the UNEP reports that sparked the interest in SLCPs. It is possible that the reason they were not included is that the lack of good measurement of their contributions. Additional efforts are required to understand the magnitude and impacts of these sources.

Among the most frequently mentioned sources are diesel generator sets used to back up unstable power supplies or provide energy to off-grid locations. Kerosene lamps are another notable source, as are rice parboiling units. Diesel powered gardening equipment, such as lawn mowers and leaf-blowers (which are of increasing use in urban and suburban areas) and other scattered sources worth considering are charcoal making facilities, agricultural and construction machines, and local river boats.

4.3.6 Other Sources of SLCPs

Black carbon is not the only SLCP; methane and ozone are also defined as SLCPs and there are also several priority technical measures that can mitigate methane. While there are indeed merits to tackling methane and other important precursors of ozone such as NOx and VOCs (which may be more important for the reduction of peak ozone concentration), they too often require finding a good fit between technology and behavioural change. They also would benefit from enabling environments that can strengthen institutions, build capacity and supply finance at all levels. A potentially useful model for Asia down the road is the European Commission's recent Clean Air Policy Package that proposed national emission ceilings for methane (for air quality purposes, independent from climate policies), to address the role of methane as an ozone precursor, to make a first step for a global solution to the issue, and to institutionalise co-benefits with climate change policies (European Commission, 2013). As implied elsewhere in the chapter, there are also growing number of air pollution policies, initiatives, and support mechanisms in Asia that could eventually institutionalise co-benefits.

Chapter 5: Looking Back and Moving Forward

5.1 Looking Back

The final section concludes by reiterating some key points and outlining ways forward. The white paper began by noting that definitions of "co-benefits" vary. Some view the term broadly as all of the environmental and development benefits stemming from a single policy or action. Others see it more narrowly as the multiple benefits from mitigating SLCPs.

Recent research has demonstrated removing SLCPs can deliver significant climate change, public health, and food security co-benefits. Implementing a suite of 14 to 16 priority technical measures can reduce projected global mean warming by 0.5°C by 2050; avoid 0.7 to 4.7 million premature deaths from outdoor air pollution annually by 2030; and increase annual crop yields by 30 million to 135 million tonnes by 2030. A significant proportion of these estimated benefits could accrue to countries in Asia. The region's policymakers are therefore likely to seek pragmatic responses to these findings. There are a few scientific and institutional considerations they should take into account as they craft those responses.

The first is that black carbon is often co-emitted with other aerosols and precursor gases such as organic carbon; some of the co-emitted substances cool the atmosphere. Similarly, some conventional pollutants with heavy concentrations in Asia such as SO_2 cool the atmosphere. Removing cooling agents and pollutants can unmask hidden warming. Mitigating additional SLCPs or GHGs can compensate for this hidden warming; this would nonetheless require a view of air pollution and climate change that includes—but is not limited to—SLCPs , to see the varying temporal and spatial dimensions of different impacts. A second set of considerations involving the still significant presence of non-methane ozone precursors in Asia also warrants considering the synergies and trade-offs between several options. There are a growing number of models that could help inform an integrated approach; there are also several policymaking processes that could reflect that modelling. Making these models a basis for national and sub-national decision making processes would bring many countries in Asia closer to that integrated ideal.

The two options that have significant potential and fewer uncertainties in Asia are shifting to cleaner cookstoves and removing high-emitting vehicles. The first makes sense purely on economic grounds; the public health benefits alone are sizeable enough to justify investments in cleaner alternatives, though there are significant uncertainties in climate change effects owing to a host of factors that affect the black carbon/organic carbon (BC/OC) ratio. Removing diesel vehicles makes sense since the emissions come from black carbon-rich sources with significant warming potential. While there have been successful examples of clean cookstoves and diesel vehicle removal, they often require a bottom-up approach to identifying context appropriate solutions. As such, national governments, regional initiatives, and international organisations may be better positioned to carry forward locally identified good practices. Strengthening the links between technical options and existing air pollution and climate change policymaking processes could help greatly in this regard. There is a wealth of experience with climate change initiatives—most notably the Kyoto Protocol's Clean Development Mechanisms (CDM)—on reforms that can enable the delivery co-benefits. From an air pollution perspective, the recently launched CCAC is well placed to help strengthen institutional linkages between air quality and climate change co-benefits.

5.2 The Way Forward

There are also several areas where work on co-benefits is needed. The first involves improving measurements of existing emission sources that both harm the climate and air quality. Differences in emissions sources within and across sub-regions will play an increasingly important role in mitigation strategies. Poorly characterised (non-regulated) sources such as kerosene wick lamps, methane flaring, and off-road vehicles will become more important over time.

A second area of need involves nexus issues. Both researchers and policymakers are increasingly recognising interlinkages and feedbacks across issue areas. For example, water management practices are likely to both affect and be affected by climate and energy policy. Similarly, a drier climate could exacerbate short-term air pollution episodes. Clarifying and simplifying these multi-directional feedbacks for policymakers is likely to be increasingly important in a climate constrained world.

A third area of potentially fruitful inquiry involves bringing stakeholders into the analysis of co-benefits. Many times, these analyses concentrate on the aggregate level as opposed to the distribution of different benefits. By looking more carefully at these distributional issues, it should be easier to understand why some options with significant co-benefits do not garner anticipated support. An additional advantage of a stakeholder-centred approach to co-benefits could be that considerations such as the usability of technologies are weighed in policy recommendations. Even the most efficient cookstoves, for instance, are unlikely to generate estimated benefits if they are not well aligned with user needs and lifestyles.

A fourth and final area involves the recognition that a more integrated approach to policymaking in Asia will require recognising that work on SLCPs is part of larger picture. That larger picture also includes a long history of co-benefits from GHG mitigation as well as multiple impacts from air pollution regulation. Asia has the unique opportunity to situate the work on SLCPs in this broader context; in so doing, it is hoped that action on SLCPs can help motivate action on multiple pollutants at varying temporal and spatial scales. The ACP will be well situated to track and simultaneously contribute to that development.

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Appendix: Summary of ACP activities

The Asian Co-benefits Partnership (ACP) is an informal and interactive platform designed to improve information sharing and stakeholder dialogue on co-benefits in Asia. The ultimate goal of the ACP is the mainstreaming of co-benefits into sectoral development plans, policies and projects in Asia.

Goals

Since the launching in 2010, the ACP has envisioned the following outcomes:

- ✓ Knowledge base and information clearinghouse on co-benefits strengthened and is regularly used by various stakeholders in Asia, especially policymakers;
- ✓ Effective communication structures for co-benefits have been created and consistently disseminate information to major organisations and initiatives promoting a co-benefits approach;
- ✓ National and sectoral policies in Asia incorporate co-benefits and result in increased number of specific co-benefits projects; and
- ✓ Cooperation among countries in Asia for further promotion of mutually-beneficial co-benefits approach/projects has been strengthened.

Structure and Members

The ACP is consists of an Advisory Group, Partners and the Secretariat. To manage the ACP's activities and ensure that the priorities of Asian countries are adequately reflected in the partnership programming, the Advisory Group meets each year to discuss the annual Work Plan and relevant activities. The Work Plan and proceedings of the meetings are posted on the ACP website for open access (http://www.cobenefit.org/). The current Secretariat has been served by IGES, Japan.

Since the ACP is an informal platform, the membership is opened to various stakeholders working on co-benefits in Asia, including government agencies, international development organisations, academe, civil society, etc, including the following Advisory Group Members; the Asian Development Bank (ADB), Clean Air Asia, the Global Atmospheric Pollution Forum (GAPF), the Regional Resource Center for Asia and the Pacific (RRC.AP), the Economic and Social Commission for Asia and the Pacific (ESCAP), Ministry of Environment, Pollution Control Department (PCD) of Thailand, Ministry of the Environment of Japan, Ministry of Natural Resources and Environment of Indonesia, the Policy Research Center for Environment and Economy (PRCEE) in China, and the United Nations University-Institute of Advanced Studies (UNU-IAS). Individual Partners total 300 since launch.

Focus

Views on co-benefits are inherently diverse. Some groups are interested in the linkages between climate change and development, while others focus on linkages between climate and particular sectors (energy, transport, and industry) or environmental media (air, water, and waste). To ensure the inclusive character of the ACP, co-benefits will be viewed in a broad sense – that is, co-benefits between development and climate. Reflecting the current interests of the members in the ACP, a higher priority is placed on co-benefits between environmental pollution and climate change, with several members focusing specifically on mitigating air pollution and climate change effectively through reducing emissions of short-lived climate pollutants (SLCPs).

History

2009
✓ **Plenary Session at the International Forum for a Sustainable Asia and the Pacific (ISAP 2009) in Hayama, Japan:** Began discussions on creating a network to promote co-benefits in Asia / Discussions focused chiefly on bridging different views on co-benefits (climate, development, and air pollution) ✓ **Meeting on a Co-benefits Network in Bangkok, Thailand:** Deepened discussions with potential participants in the network / Decided to draft a scoping report on related networks to make sure there was limited replication with existing networks
2010
✓ **Seminar on a Co-benefits Approach in Bangkok, Thailand:** Shared idea of creating a network with policymakers and other key stakeholders / Developed key messages for dissemination in key international processes / Decided to draft a work plan for the Partnership that would focus on information dissemination, knowledge management and mainstreaming
✓ **Meeting on a Co-benefits Partnership at the International Forum for a Sustainable Asia and the Pacific (ISAP 2010) in Yokohoma, Japan:** Drafted the 2010-11 Work plan and solicited the inputs / Work plan broke up the network activities into 1) information sharing; 2) communication; 3) projects and policies; and 4) regional cooperation / Decided to launch the Asian Co-benefits Partnership (ACP) at the Better Air Quality Conference (BAQ) 2010 in Singapore
✓ **Official launching of ACP at the Better Air Quality (BAQ) Conference in Singapore:** Distributed the draft 2010-11 Work Plan, solicited the inputs and finalised / Officially launched the ACP
2011
✓ **1st ACP Advisory Group Meeting in Kitakyushu, Japan:** Advisory group and co-chairs nominated in preparation for endorsement at ISAP 2012 in Yokohama, Japan / Participants reviewed the status of their activities for the 2010-11 Work Plan and discussed future plans and fundraising
✓ **UNU-IAS, IGES, ACP Joint Meeting on Greening Growth in Asia: Making Co-benefits Mainstream in Yokohama, Japan:** 40 participants from government agencies, international organisations, and research institutions discussed 1) the linkage between green growth and co-benefits; 2) a researchers' perspective on co-benefits; and 3) a policymakers' perspective on co-benefits
✓ **2nd ACP Advisory Group Meeting at the International Forum for a Sustainable Asia and the Pacific (ISAP 2011) in Yokohoma, Japan:** Develop key messages for dissemination in COP17, Rio+20; Joint Forum on Atmospheric Environment in Asia and the Pacific and other international processes with a sectoral focus (energy, transport, waste, and etc.) / Discuss progress, dissemination strategies and future plans for 2012-13
2012
✓ **International Workshop on a Co-Benefits Approach: A Dialogue between Policy Makers and Researchers in Hayama, Kanagawa, Japan:** Over 45 policymakers, researchers, and representatives of civil society organisations from Japan, China, India, Europe and the United States 1) reviewed and shared the latest trends in co-benefits policy and research; 2) discussed ways to further promote co-benefits policy and research / Agreed follow-up opportunities to meet in the next year

✓	**3rd Advisory Group Meeting in Yokohama, Japan:** Agreed to 1) finalise the ACP Work Plan 2012-13; 2) form a small group to work collaboratively on projects focusing on (SLCPs); and 3) share progress on those collaborative projects during the next ACP Advisory Group meeting at the Better Air Quality (BAQ) 2012 conference in Hong Kong
✓	**Informal Advisory Group Meeting at the Better Air Quality (BAQ) 2012 in Hong Kong, China:** Shared information on 1) updates of policies and projects related to co-benefits: 2) activities and endorsement of the ACP Work Plan 2012-13 / Much of the discussion focused on collaboration on SLCPs, the Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants (CCAC), and an upcoming regional meeting on SLCPs in Asia sponsored by the CCAC
2013	
✓	**Participated as co-operator in the Regional Intergovernmental Consultation on Near–Term Climate Protection and Clean Air Benefits in Asia and the Pacific organised by the CCAC, the UNEP Regional Office for Asia and the Pacific (ROAP) and the Stockholm Environment Institute (SEI) in Bangkok, Thailand**
✓	**Seminar on Translating Co-benefits Research into Action in Asia: Science, Models, Projects, and Policies in Hayama, Kanagawa, Japan:** Around 30 researchers and policymakers discussed 1) recent developments in science, modelling, projects and policies on air pollution and climate change in Asia and 2) challenges and opportunities in Asia on to improving the integration on research and policy on co-benefits
✓	**4th Advisory Group Meeting in Yokohama, Japan:** Agreed to 1) complete a revision of organisation of the first flagship publication, white paper, and initiate the production process; 2) keep close communication on forming concrete linkages between the ACP and CCAC; 3) initiate a process for developing the next ACP Work Plan 2014-15; and 4) strengthen collaboration among the member organisation by introducing thematic work streams to be led by one member organisation

Progress

- ✓ **Knowledge base and information clearing house on co-benefits have been established to disseminate information to various stakeholders in Asia, especially policymaker**s: The ACP has established a regularly updated website to compile and disseminate knowledge products: factsheets, newsletters and others
- ✓ **Effective communication structures on co-benefits have been created which include all major organisations and initiatives promoting a co-benefits approach:** Representatives from the ACP have presented at various international conferences and meetings (i.e., BAQ, UNFCCC COP side events, ISAP, etc).
- ✓ **National and sectoral policies in Asia incorporate co-benefits and result in increased number of specific co-benefits projects:** Several countries have calculated co-benefits for a project or policy
- ✓ **Cooperation among countries in Asia for further promotion of mutually-beneficial co-benefits approach/projects has been strengthened:** Several countries are partnering on co-benefits projects

ACP ASIAN Co-benefits Partnership

Asian Co-benefits Partnership

White Paper 2014

Bringing Development and Climate Together in Asia

Asian Co-benefits Partnership (ACP) is a voluntary information sharing platform. The ACP seeks to collaborate with organisations working to mainstream co-benefits into decision making processes in Asia.

This biannual report presents stock-taking of the history and knowledge of the ACP targeting the latest information on co-benefits in Asia.