Chapter 5:

National-scale Action

There is a wide spectrum of actions that can be taken to reduce short-lived climate forcers (SLCFs) and in the following chapters reasons for pursuing them at all levels – national, regional and global - are explained. That being said, there are also good arguments for giving special priority to the national level. Firstly, the greatest public health benefits will accrue close to emission sources. Secondly, each country has its own particular mix of emission sources and acting at the national level can best take into account this unique mix. Thirdly, many countries already have institutions that deal with air pollution and climate change, and these institutions can serve as effective platforms for action on SLCFs. Fourthly, policies and measures for reducing SLCFs can, and should, be linked to national priorities for sustainable development. On the other hand, acting at the national level does not preclude regional or global action. In fact, regional and global actions can strongly support national activities as explained in following two chapters.

Many countries have already seen the added value of acting nationally. In the United States of America, the Congress has requested that the US Environmental Protection Agency prepare a 'Report to Congress on Black Carbon'[12]. Meanwhile, India has justified a new programme of cookstove replacement[13] based on the public health threat posed by black carbon and particulate matter emissions, and their link to regional climate issues. South Africa has taken the lead with legislation that allows integration of air pollution and climate policies[14] and Mexico is promoting an SLCF-mitigation plan to accompany its greenhouse gas reduction plans[15].

This chapter reviews a variety of topics important to national action on SLCFs. It first explains why action on SLCFs should be integrated into existing national policy frameworks. It then reviews the opportunities and barriers to implementing a wide range of practical measures for reducing black carbon and methane emissions, including the 16 measures introduced earlier in Chapter 3. It then lists some of the enabling activities that can help overcome the identified financial, institutional, and socio-political barriers, and presents other considerations that should be taken into account when planning national actions. Finally, it presents the basic outline of possible national action plans that would consolidate activities for mitigating SLCFs.

5.1 Integrating SLCFs into existing policy and regulatory frameworks

In most countries various decision-making processes and policy and regulatory frameworks already exist within which SLCF mitigation could be incorporated. These include:

i) air quality management institutions and programmes;
ii) national climate change programmes; and
iii) sectoral and cross-sectoral policies and plans.

Countries need to determine which of these processes and frameworks offer the best opportunity to implement SLCF measures. In some countries it may be necessary to enhance governance systems, for instance, by strengthening coordination among agencies.

For countries with effective environmental governance and regulatory systems, a natural choice might be to locate SLCF policy coordination in their air quality management institutions and to integrate SLCF mitigation in existing air quality legislation and regulations, because

12. Interior Department and Further Continuing Appropriations, Fiscal Year 2010, Public Law 111–88—Oct. 30, 2009, at p. 36. Available from: <http://www.gpo.gov/fdsys/pkg/PLAW-111publ88/pdf/PLAW-111publ88.pdf>

13. Ministry of New and Renewable Energy, India. Available from: <http://mnre.gov.in/press-releases/press-release-02122009.pdf>

14. National Environmental Management: Air Quality Act, No. 39 of 2004. Available from: <http://www.info.gov.za/view/DownloadFileAction?id=67978>

15. Also see Co-Chairs Summary, Ministerial Meeting on Short Lived Climate Forcers from <http://mce2.org/SLCF workshop>

these are likely to already address black carbon and methane emissions as part of their management of particulate matter and ground-level ozone. These institutions and regulatory instruments provide a good platform for SLCF mitigation because: (i) they typically regulate the issuance of permits to significant emission sources, as well as include regular inspection and monitoring, (ii) they sometimes provide economic instruments and education and behavioural change programmes to support emission reductions.

While one option is to embed SLCF policies within air quality management programmes, another option is to incorporate these policies into national climate action plans. They could also be included in 'Nationally Appropriate Mitigation Actions' (NAMAs)[16].

Considering the development co-benefits that are associated with SLCF mitigation, there could be opportunities to incorporate some measures into national development planning. For instance, methane capture in waste-water treatment, waste management and agriculture could lead to economic gains and result in renewable and decentralized energy production opportunities. Replacing traditional biomass cookstoves with cleaner burning cookstoves will reduce exposure to particulate matter with its consequent health risks, and thereby remove a barrier to economic development. Replacement stoves will also be more fuel efficient leading to reduced time spent collecting firewood.

Introducing certain SLCF mitigation measures as part of broader development processes would also encourage the involvement of all concerned actors and facilitate access to multiple sources of funding. For example, any action including restrictions on the burning of agricultural residues would require the involvement of the Ministry of Agriculture. Even if a national action plan is formulated outside the development planning process, many of the proposed actions will still need to be consistent with development goals. Hence, it is advisable that the development of a national SLCF action plan be coordinated with broader national development planning.

5.2 Implementing emission reductions: opportunities and barriers

A wide range of opportunities exist for reducing black carbon and methane emissions. In this section we review these opportunities in seven sectors, and identify some of the barriers that could slow implementation.

5.2.1 Residential combustion

Globally, developing countries account for the largest total emissions of black carbon and co-emitted pollutants from cooking and heating using biomass. However, in a number of developed countries, the use of biomass for heating has increased, making it the largest projected source of black carbon emissions in North America and Europe in 2030 (Chapter 3).

In developing countries, two tracks are being pursued for reducing black carbon emissions from household stoves. Firstly, there are programmes that promote the replacement of stoves with improved ones having better fuel efficiency and lower emissions (World Bank, 2011). Secondly, there are programmes to replace stoves using 'dirty', smoke-producing fuels (fuelwood, charcoal, crop residues and dung) with stoves that use 'cleaner' fuels (e.g. liquefied petroleum gas (LPG) or renewable options such as biogas, solar cookers or renewably produced electricity) that produce less fumes and smoke and would almost eliminate black carbon emissions. While such a strategy is a massive undertaking, given the billions of people using biomass, if achieved it would greatly reduce the major public health risk posed by smoky cookstoves, especially in Africa and Asia.

The promotion of cleaner substitute fuels for households has been a common strategy among many developing countries, most commonly implemented in the form of a fuel and/or equipment subsidy, but experience has been mixed. Attempts to increase the use of LPG and kerosene in Africa have largely failed due to costs and complexities, including fuel supply, transport and use. Even in fossil-fuel-rich countries of Africa, such as Nigeria, Gabon or Angola, biomass and fuelwood accounts for the bulk of energy consumption (IEA, 2009a). But there are also success stories. For example many households in urban areas of Botswana, Ghana, and Senegal, have successfully shifted from charcoal to LPG for cooking. By 2000 most households in Dakar and other main urban areas of Senegal owned LPG stoves. This was achieved by lowering costs, initially by exempting butane stoves from customs duties, and later with fuel subsidies. Another feature of the successful projects was that the technology supplied was adapted to the local conditions and situations.

Factors that will facilitate switching to cleaner fuels include:

- a long-term information and awareness-raising campaign;

16. Nationally Appropriate Mitigation Action (NAMA) refers to mitigation action by developing countries and was first introduced in the Bali Action Plan as part of the Bali Road Map agreed at the United Nations Climate Change Conference in Bali in December 2007, which in particular referred to "Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner".

- linking improved cookstove programmes to national goals of poverty alleviation and greater access of the poor to modern energy sources;
- political will and long-term political commitment;
- the adoption of technology appropriate to local conditions;
- the implementation of regulations and appropriate price and fiscal policies;
- attractive incentives for the various stakeholders involved;
- the guarantee of a reliable and effective supply system;
- monitoring and evaluation of the impacts of implemented policies; and
- building required capacity for successful implementation.

Ethanol cleaner cookstove

Photograph courtesy of Gaia Association

Cleaner cooking and heating stoves

Several regional programmes, introduced primarily in response to health concerns, have demonstrated the technical feasibility of introducing cleaner biomass cooking and heating stoves in Africa and Asia. Hundreds of millions of stoves have been introduced globally in countries such as China and India; but success in terms of a sustainable change has proven difficult in many regions due to cultural and financial barriers at the household level (World Bank, 2011). Some recent projects are explicitly considering black carbon emissions (Box 5.1).

Achieving wider deployment of cleaner-burning biomass cookstoves is likely to require more effective and widespread public awareness of the health impacts of emissions from traditional practices and other benefits such as reduced fuelwood usage. Financing schemes are also needed to overcome up-front capital costs. In addition, it is necessary to ensure that the designs adapted are effective in reducing black carbon emissions, such as fan-assisted models.

Fan-assisted biomass cookstove

Photograph courtesy of Surya project

Pellet stoves and boilers in the residential sector in industrialized countries

One way to hasten the replacement of old stoves and boilers with newer equipment would be to implement a stringent emission standard for black carbon together with appropriate enforcement mechanisms. This should be implemented alongside public awareness campaigns and financial incentives to assist the transition to cleaner technologies. This is likely to require a high level of political commitment, which international cooperation, through the Convention on Long-range Transboundary Air Pollution, the European Union or the Arctic Council, could help achieve (Chapter 6).

5.2.2 Agriculture and forestry

The technical mitigation options offering the greatest methane reduction potential in agriculture include measures for livestock, manure management, and intermittent aeration of continuously flooded rice paddy fields.

For black carbon, banning or limiting open-field burning of agricultural residues and the introduction of no-burn methods, such as conservation tillage or soil incorporation, have been demonstrated as effective means of reducing associated emissions. Similarly, a campaign on the prevention of wildfires and management of prescribed forest and other vegetation burning, and greater resources devoted to fire monitoring and prevention would result in reduced emissions of black carbon and co-emitted substances.

Banning the field burning of agricultural residue

In the 1970s a number of European countries implemented regulations limiting and prohibiting open burning of

Box 5.1: Project Surya

One of the most innovative cleaner cookstove projects in the world is Project Surya in India, which began in 2009 in the state of Uttar Pradesh and combines cookstove replacement with innovative data collection and monitoring techniques. Project Surya is part of the second phase of UNEP's Atmospheric Brown Cloud project. Unlike other similar initiatives, Surya documents the impact on climate forcing, regional air quality, and indoor and outdoor human exposure to particulate matter by using advanced surface, balloon and satellite monitoring platforms[17].

Photograph courtesy of Surya project

agricultural crop residues. Wider implementation of such bans in other countries can be successfully achieved, but will require awareness raising, investment by farmers, and adoption of appropriate technology. In Brazil's largest sugar cane producing state, São Paulo, the daytime burning of cane fields has been banned from 1 June to 30 November because of human health concerns[18]. In China, implementation of regulations to ban open-biomass burning is supported by a website and satellite-derived images which can identify fire spots on a day-to-day basis during harvest seasons (SEC, 2011). When it is strictly enforced, the regulation has been effective at reducing crop residue burning around large cities.

Intermittent aeration of continuously flooded rice paddies

Examples demonstrate that it is technically feasible to apply intermittent aeration – at least one aeration period of more than three days during the cropping season – to rice fields that are currently continuously flooded as a methane mitigation measure (IPCC, 1996). As with field burning of agricultural residues, however, widespread implementation may require demonstration projects, outreach programmes and attention to other crop management issues. For example, visible success of a water saving technology called alternate 'wet-dry irrigation' in pilot farms and specific training programmes for farmers in the Philippines have helped dispel the widespread misconception of possible yield losses in non-flooded rice fields (Bouman *et al*., 2007).

Methane emissions from livestock and manure

One of the available measures to control methane emissions in the agricultural sector is anaerobic digestion of manure from cattle and pigs. Anaerobic digestion, together with feed modification, is a readily available option to reduce methane emissions, mainly in intensive agriculture in North America and Europe. In Africa, for example, applying anaerobic digestion may be applicable to large farms; but there is also the potential to more broadly reduce methane emissions, with the added benefit of improving the quality and quantity of milk and meat production by improving the diet of livestock. In addition, examples from developing countries suggest that household-size anaerobic digesters with utilization of the generated biogas for cooking stoves are a promising option that also would reduce emissions from biomass burning, making this a 'win-win' solution.

Barriers to wider methane capture from manure management include lack of information, high up-front capital costs, unsatisfactory reliability of technology, and low rates paid by some utilities for the electricity generated through the recovered methane. For example, there are relatively few anaerobic digesters in the United States of America mainly due to their high capital costs. Policies to promote these measures should therefore consider development of demonstration projects, outreach, capacity building and appropriate financing.

Some other mitigation measures from the agricultural sector, such as reducing emissions from the digestion process of ruminant animals, are proving more difficult to realise and are not included as measures in this report.

17. http://www.projectsurya.org

18. http://www.enn.com/top_stories/article/37041

Box 5.2: Rice paddy mid-season drainage

Between 1980 and 2000, shifting to the practice of draining rice paddies mid-season has already reduced methane emissions from China's rice fields by about 5 million tonnes each year (Li *et al*., 2002). It is also practised in other Asian countries including the Philippines and Japan.

Photograph courtesy of UN photo/S. Rotner

Some progress could be achieved by changes in people's diets leading to a reduction in livestock numbers and changing animal feed from roughage to a cereal-grain base, although this introduces other issues such as greenhouse gas emissions related to increased cereal production.

5.2.3 Industrial processes

Brick and coke production in small-scale traditional kilns and ovens has been estimated to contribute a sizable fraction of black carbon emissions in, for example, South Asia. Furthermore, poor quality coal, fuelwood, and waste are used to fuel these inefficient kilns resulting in high pollutant emissions. Viable mitigation options are available and have been demonstrated for both activities.

Replacing traditional brick kilns with cleaner and more efficient kilns

Traditional brick kilns, such as clamp kilns, are still widespread in South Asia and Central and South America. They are based on old technology and are inefficient, in addition to being labour intensive and a health risk to workers. A number of Asian countries including China and Vietnam have managed a successful transition to much cleaner and more fuel efficient brick-kiln technologies, for example, vertical shaft, zig-zag, and Hoffman kilns. Demonstration projects have also been implemented in India and Bangladesh. In Latin America, Brazil's recent programme of modernization is seen as a successful example of what can be achieved through training and technology transfer.

Although the number of brick kilns in some regions is large, it is possible to achieve rapid progress in shifting to cleaner technology. Readily available, cost-effective technical solutions could be deployed in developing countries, through, in some cases, the transfer of technology and exchange of experience between countries. Furthermore, the number of stakeholders that need to be involved in such a shift is relatively small. In addition to promoting the shift to cleaner technology in this sector, for example by using mandatory standards, governments could also consider training and awareness-raising programmes for those involved in brick production and distribution. Governments and other institutions could also help establish mechanisms to finance cleaner kilns.

Replacing traditional coke ovens with modern recovery ones

Clean production of coke has been demonstrated in industrial countries over the past few decades. Currently, major coke producing capacity exists in China where many coke plants are still using old, polluting technology. However, fast-growing demand has already resulted in rapid technological development and new plants are now built to international standards. Speeding the phase-out of old, polluting technology by regulation or use of incentives appears to be a promising option.

5.2.4 Transport

The most promising approaches for national action on black carbon in the transport sector are the elimination of high emitting vehicles from the diesel road- and non-road-vehicle fleet and the introduction of Euro-6/VI emissions standards for new vehicles, which include the use of diesel particle filters. Other measures are to adopt policies that promote petrol or ethanol vehicles, rather than diesel vehicles, or to introduce electric cars which would also eliminate particulate emissions.

Elimination of high-emitting vehicles

Numerous studies show that in many countries a small share of the vehicle fleet – high polluting vehicles or 'super-emitters' – causes a high proportion of total emissions. In several countries, such vehicles are being phased out through a combination of import restrictions on second-hand vehicles and engines, restricting access of high-emitting vehicles to urban areas, engine replacement

Box 5.3: Improved brick kilns

Initiatives to reduce air pollution from traditional kilns, through a combination of health regulations and economic incentives, have proven effective. For example, in Ciudad Juarez, Mexico, improved kiln designs boosted fuel efficiency by 50 per cent and reduced particulate pollution by 80 per cent (TCEQ, 2002; Bruce *et al*., 2007).

Photograph courtesy of Robert Marquez

Photograph courtesy of Alba Corral Avitia

A traditional brick kiln (left) and an improved kiln (right) operating in Mexico

and conversions, and scrappage programmes. The most appropriate policy mechanism to control emissions from vehicles currently in use is the wider adoption of vehicle inspection and maintenance programmes. Many countries have such programmes, but their establishment and/or effectiveness in other countries are hampered by the lack of enforcement, infrastructure and institutional capacity.

Diesel particle filters for road and off-road vehicles

Current legislation in many industrialized countries requires installation of diesel particle filters on diesel cars, buses and trucks and, more recently, also on non-road machinery as a measure to reduce particulate matter emissions, including black carbon. Diesel particle filters can be built into new vehicles or retrofitted on to currently - used vehicles and machinery. Their relatively high costs have not inhibited their introduction in industrialized countries because of the significant health benefits resulting from emission reductions.

A prerequisite for introducing diesel particle filters is the use of fuel that meets certain standards, in particular diesel with 50 ppm sulphur or less. This fuel standard is, for instance, required under Euro-4/IV, and even lower sulphur levels are required under the more stringent Euro-5/V (15 ppm) and Euro-6/VI (10 ppm) standards.

Box 5.4: Big reductions from the transport sector

Virtually all new diesel trucks for use on-road in the United States of America, as of 2007, have been equipped with diesel particle filters. The USEPA estimates that the new standards under the Clean Air Non-road Diesel Rule will cut particulate and black carbon emissions from off-road diesel engines by over 90 percent[19].

UNEP Photo

19. http://www.epa.gov/nonroaddiesel/

Standards for the reduction of pollutants from vehicles have long been present in some countries and regions (e.g. a series of standards, up to the current Euro-6/VI in the European Union). The key issue now is the adoption of vehicle emission standards worldwide. Many developing countries are introducing Euro standards to varying degrees. The progress achieved in this area in the European Union over several decades is now being repeated in some developing countries within the span of about ten years. To guide governments in improving standards and seeking regional alignment, the *Roadmap for Cleaner Fuels and Vehicles in Asia* was prepared through a multi-stakeholder approach involving government agencies, oil companies, vehicle manufacturers and other institutions[20].

Introducing more stringent emission standards for new vehicles is attractive because compliance monitoring of these standards would be relatively easy. However, there are problems to be overcome. One is the cost of upgrading refineries to produce fuel to the required standards, and another is setting up proper inspection and maintenance programmes to ensure that emission standards are achieved in practice. Efforts should thus focus on overcoming these barriers through collaboration between different countries and stakeholder groups.

Shipping

There is only limited experience with measures that reduce black carbon emissions from ship engines. However, a recent review by Corbett *et al*., (2010) indicates a range of options available in the next decade ranging from existing slide-valve technology to diesel particle filters. The International Convention for the Prevention of Pollution from Ships (MARPOL) does not expressly cover black carbon emissions. However, developments are taking place in this area as discussed in Chapter 7.

5.2.5 Fossil-fuel production and distribution

Addressing the fossil-fuel production and distribution sector presents important opportunities for large reductions in methane emissions. Several effective measures have been identified (see Chapter 3, Table 3.1). In many industrialized countries more than 90 percent of the methane associated with oil and gas production is recovered and used. However, due to the necessary significant up-front investments, this percentage is typically less than 20 percent in developing countries, although it would be technically feasible in these countries to recover the gas at large-scale facilities and control fugitive emissions (EIA, 2010).

In addition to the introduction of relevant regulations, partnerships between governments and the private sector can offer an important opportunity to reduce emissions from fossil-fuel production and distribution. These are usually restricted to a limited number of facilities in each country, which are often owned by multi-national companies with access to the necessary financial and technical resources.

Pre-mining degasification of surface and underground coal mines, especially as a measure to ensure occupational safety, is currently applied at large scale facilities in many industrialized countries, including the United States of America, European Union countries and Australia. Given its success in many regions, there are opportunities for widespread implementation of this measure. It is considered technically feasible to control about 50 per cent of the ventilation-air methane (VAM) emitted from underground coal mines in many countries. Due to increasing demand for methane as a fuel, especially in the rapidly developing countries of Asia, methane extraction from coal mines is an increasingly valuable resource.

There may also be opportunities for reducing black carbon emissions by controlling gas flaring. Although emissions from this sector are very uncertain, the few available measurements (Johnson *et al*. 2011), remote sensing data (Elvidge *et al*. 2009) and GAINS model estimates indicate it could be a significant source. Existing practice on improving flare performance, for example, from Norway and other countries, could be used to assess

Gas flaring in Nigeria

UNEP Photo

20. Road Map for Cleaner Fuels and Vehicles in Asia; Clean Air Initiative for Asian Cities, 2008. Available from: http://cleanairinitiative.org/portal/node/3632

Box 5.5: Coal mine methane

Countries like India, Mexico and the United States of America are investigating further reductions in coal-mine methane emissions. China is a leader in coal-mine methane projects with 39 registered with the Clean Development Mechanism, including the world's largest at the Sihe Mine in Jincheng City, Shanxi Province[21], which is projected to avoid around 3 million tonnes of carbon dioxide equivalent of methane emissions per year (IEA, 2009b).

the potential and means for future reductions of these emissions.

Barriers to controlling gas flaring include legal issues, high capital costs for equipment, low electricity prices for produced energy, and restricted pipeline capacity for transporting recovered methane. However, these barriers are surmountable, as has been demonstrated in India and other countries.

There may also be considerable opportunities for further reductions of gas leakage from long-distance transmission pipelines through the implementation of improved equipment and inspection and maintenance programs.

5.2.6 Waste management

Landfill

Significant methane reductions can be achieved through waste management measures, including landfill gas collection (see Chapter 3, Table 3.1). While in most countries regulations are in place for large landfills, many smaller ones are not yet regulated. In many developed countries, however, voluntary programmes are in place such as the 'landfill methane outreach program' in the United States of America. These programmes are designed to encourage industries to capture and sell methane for energy production, and have achieved some level of success in slowing the rate of emission increases. Barriers to additional landfill-gas capture may include high capital costs, low rates paid for the gas captured and/or electricity generated, complex permit requirements, and liability concerns. Further regulation may therefore be needed to support wider implementation of this measure.

Separation and treatment of biodegradable municipal waste

Broader measures in the field of waste management, including a comprehensive cradle-to-grave approach that promotes recycling and composting, especially of biodegradable municipal waste, would achieve multiple environmental benefits in addition to reducing methane emissions. Many countries have introduced legislation to divert biodegradable waste from landfills through separation and treatment by recycling, composting or incineration and to equip existing landfills with gas recovery. Based on this wide experience, diversion of all biodegradable waste away from landfills should

Box 5.6: Landfill gas capture

The BENLESA plant, the first renewable energy project in Mexico using the biogas from landfill as fuel, has an installed capacity of 17 MW and by February 2010 had avoided the release of more than 81 000 tonnes of methane, equivalent to the reduction in emissions of 1.7 million tonnes of carbon dioxide. The project is a partnership between the government and a private company[22].

Photograph courtesy of J. Saldaña

21. http://cdm.unfccc.int/Projects/projsearch.html

22. http://seisa.com.mx/index.php?option=com_content&task=view&lang=en&id=54&Itemid=65

be technically feasible in many countries. Wider implementation requires sufficient financial resources and functioning institutions – clearly a challenge in countries lacking the necessary infrastructure.

Upgrading primary wastewater treatment

Primary treatment of centrally collected wastewater is carried out to varying extents in both developed and developing countries and can be a major source of methane emissions. It should be technically possible by 2030 to upgrade all primary wastewater treatment to secondary or tertiary treatment including methane recovery, which reduces emissions considerably, although the costs may be high. Municipalities around the world are applying biogas-treatment technologies to wastewater, such as anaerobic-aerobic activated sludge processes, to mitigate methane emissions and generate energy. For example, wastewater methane reduction projects under the Clean Development Mechanism[23] have been undertaken in India, Indonesia, Morocco (UNEP/WMO, 2011).

5.2.7 Other sources

There are a large number of control measures that reduce particulate matter emissions from large-scale combustion and production processes, including electrostatic precipitators and fabric filters, but in most cases the sources concerned emit only small amounts of black carbon (Bond *et al.*, 2004).

Stationary diesel generators are another source of black carbon which are frequently operated in harsh conditions and are rarely subject to regulation of emissions. Emissions can be reduced by retrofitting or replacing engines. However, the emission reduction potential is quite uncertain because of the lack of statistical data on fuel consumption and actual equipment in use. Lastly, some additional black carbon sources, such as open domestic waste burning, could in the future become targets for mitigation.

5.3 Enabling activities

The previous sections of this chapter have described many opportunities for introducing SLCF mitigation measures in different sectors at the national level. They also described some of the barriers that may hinder their widespread implementation and possible ways to surmount these.

Table 5.1 summarizes the 16 identified priority measures with their attendant barriers and proposed enabling activities. Note that the set of financial, institutional, and socio-cultural barriers in Table 5.1 is not exhaustive. For example, it does not include technical barriers, which in many situations could be important. It should also be noted that socio-cultural barriers in particular are often not anticipated. Nevertheless, they may become extremely important if they surface in the form of public opposition to an emission reduction measure. Successful implementation requires that community concerns be understood and addressed through outreach and awareness-raising activities. Moreover, outreach should be a two-way street: it is equally important to adapt technologies to the needs of the communities as it is to communicate the potential benefits of new technologies to communities. This exchange will yield the best results if it is based on sustained interactions between communities and outreach providers and wide public participation in decision-making.

The last column of Table 5.1 provides a long, but not exhaustive, list of enabling activities that would help surmount the barriers identified. One lesson from the implementation experience described in Section 5.2 is that benefits from SLCF policies and measures will only be realized if they are embedded in an enabling environment that can overcome financial, institutional, and socio-cultural barriers.

5.4 Other considerations for national actions

National governments have a wide choice of mitigation options for SLCFs, and a wide choice in the ways they can be implemented and the policies that would encourage their implementation. This section draws on the international experience reviewed in this chapter to suggest a number of general conclusions and implications that could provide a starting point for national strategies and action plans.

Developed countries have already accomplished substantial reductions in black carbon and methane emissions but mainly as a positive side-effect of other actions, for example, improving energy efficiency or reducing particulate matter pollution. This situation is expected to continue. However, some emission sources are not being reduced on their own, and require specific policy attention. Included here are wood burning stoves, as an example.

Overall, however, barriers to further mitigation of black carbon emissions in developed countries are not major. Furthermore, the climate for further mitigation continues to be good as industrial processes are upgraded, vehicle fleets are replaced, and new technology spreads. The

23. http://cdm.unfccc.int/Projects/Validation/index.html

Table 5.1: Major measures, barriers and enabling reforms to facilitate implementation of the package of 16 SLCF mitigation measures

Sectors	Measures	Barriers	Enabling activities
Residential combustion	Fuel switching	• High fuel and technology costs • Limited fuel supplies	• Tax incentives, subsidies • Facilitated access to alternative fuels
	Improved cookstoves	• Low awareness of health impacts of established cooking practices • Limited durability of improved stoves • High cost of technology for the poor	• Awareness raising and community outreach • Improved technology • Subsidies or loans
	Pellet stoves/boilers industrialized countries	• Lack of awareness • Lack of harmonised standards	• Public education and outreach • Introduce harmonised black carbon emission standards
Agriculture and forestry	Banning the burning of agricultural residues	• Weak enforcement of regulations	• Enhanced enforcement capacity
	Intermittent aeration of continuously flooded rice paddies	• Low stakeholder awareness	• Outreach and demonstration projects
	Emissions from manure (farm-scale anaerobic digesters)	• Adherence to traditional practices	• Outreach and demonstration projects
	Methane emissions from livestock	• High costs of modified feed	• Economic incentives
Industrial processes	Cleaner and more efficient brick kilns	• Limited access to finance and skilled personnel	• Economic incentives • Capacity building and training
	Modernisation of coke ovens	• Limited community awareness • Lack of relevant regulation and enforcement	• Outreach and demonstration projects • Issuance of relevant regulation • Enhanced enforcement capacity
Fossil fuel industry	Pre-mine gasification	• High upfront investment	• Economic incentives
	Oxidation of ventilation air methane from coal mines	• Technical constraints	• Improved technology • Technology transfer
	Recovery of vented methane from production of oil and natural gas	• Lack of infrastructure • Lack of nearby markets	• Economic incentives
	Reducing leaks from long-distance natural gas transmission pipelines	• Cost of monitoring and maintenance	• Strengthened regulations and enforcement procedures • Enhanced enforcement capacity
Transport	Diesel particle filter as part of Euro 6/VI standards	• Unavailability of ultra-low sulphur fuels	• Government regulations to require ultra-low sulphur fuels
	Removing high-emitting vehicles	• Lack of regular inspection/ enforcement	• Introduction and enforcement of inspection and maintenance programmes • Scrappage schemes
Waste management	Separation of bio-degradable solid waste, and generation and recovery of methane	• High capital costs • Low prices for methane • Complex permitting schemes and liability issues	• Economic incentives including financial mechanisms • Introduction of clear legislation
	Upgrading primary wastewater treatment	• High cost	• Further legislation requiring secondary or tertiary treatment

potential gains from controlling black carbon and methane emissions could even be seen on the national level as a new impetus for further accelerating these processes.

The reduction of methane emissions in the energy, mining, landfill and agricultural sectors represents a major opportunity to achieve benefits from voluntary programmes, partnership schemes and tighter regulations. Particularly rapid progress can be achieved when the application of best technologies and practices is required across an industry.

Addressing agricultural methane emissions, especially from livestock and, in Asia, continuously flooded rice paddies, is another important area for action, notwithstanding the possible difficulties in the near term due to the traditionally slower development pace of agricultural technology and practices. While benefits from changes in management and husbandry of livestock may be relatively limited, they may become more important with the expected increases in consumer demand for meat products. Clearly, any overall reductions in meat consumption could have an immediate effect on emissions. However, other opportunities are more readily available in the agricultural sector to reduce black carbon emissions, notably through banning or restricting open burning of agricultural crop residues, and introducing waste management measures to create viable alternatives to such practices.

In many developing countries the effectiveness of options and strategies will depend on a different set of factors: limited resources and competing priorities, lack of appropriate infrastructure, and institutional and regulatory challenges, such as how to adequately monitor and enforce regulations to control emissions. However, at all stages of development there are cost-effective measures that can be implemented successfully, so long as they take into account local culture and sustainability priorities, and are aligned with national development goals for such issues as energy, transport and agriculture.

In developing countries, SLCF strategies can also take advantage of the pivotal role that major cities play in environmental concerns. Urban centres can benefit from the fact that they provide a critical mass of people and know-how to rapidly diffuse new technologies and new management approaches. Particularly in Asia and Latin America, cities have become proving-grounds for advancements in air quality management. For example, Beijing and Shanghai have introduced tighter vehicle emission standards some years ahead of the rest of China. The same pattern has been observed in Indian cities, particularly with respect to the introduction of cleaner fuels. Some cities in Latin America, including São Paulo, Santiago de Chile and Mexico City have pioneered effective controls of air pollution sources (Molina *et al.*, 2004).

5.5 Elements of a national action plan

As shown in previous chapters, the current state of knowledge is sufficiently robust to justify immediate action at the national scale to reduce SLCF-related emissions. Countries can be confident that multiple benefits will be achieved if they begin now to implement reduction measures for obvious emission sources. Of the many steps that can be taken on the national level, one of the most useful might be to develop a National Action Plan which would consolidate and prioritize a larger number of national actions. The action plan would build on existing institutions and policies, including those concerned with air quality management and climate policy. The plan would have specific connections to other country-wide plans for sustainable development and other national priorities. A National Action Plan could include:

- *Characterizing sources and opportunities for emission reductions.* Countries with well- functioning air quality management institutions could add the assessment of SLCF-related emissions to their activities. Those countries without such institutions could set up a special expert group(s) to carry out this work.
- *Planning awareness-raising activities* to inform government, business, and civil society about the benefits and costs of controlling SLCFs and the steps to implement measures.
- *Assessing the relative benefits and costs of action,* either based on international analyses, such as the ones outlined in this report, or by conducting economic analysis to develop more local/national estimates.
- *Determining the political feasibility of implementation* to identify which options are likely to be easiest to implement, and which will require additional effort.
- *Undertaking an inventory of current policy and legislation* that is already used to implement related measures.
- *Identifying further policies, where there are gaps,* to make more rapid progress in implementing the control of SLCF-related emissions.
- *Taking cost-effective action* on obvious SLCF sources.

While there are many good arguments for giving priority to national actions, these actions can also be supported by other policies and measures at the regional and global scales. That is the subject of the next two chapters.