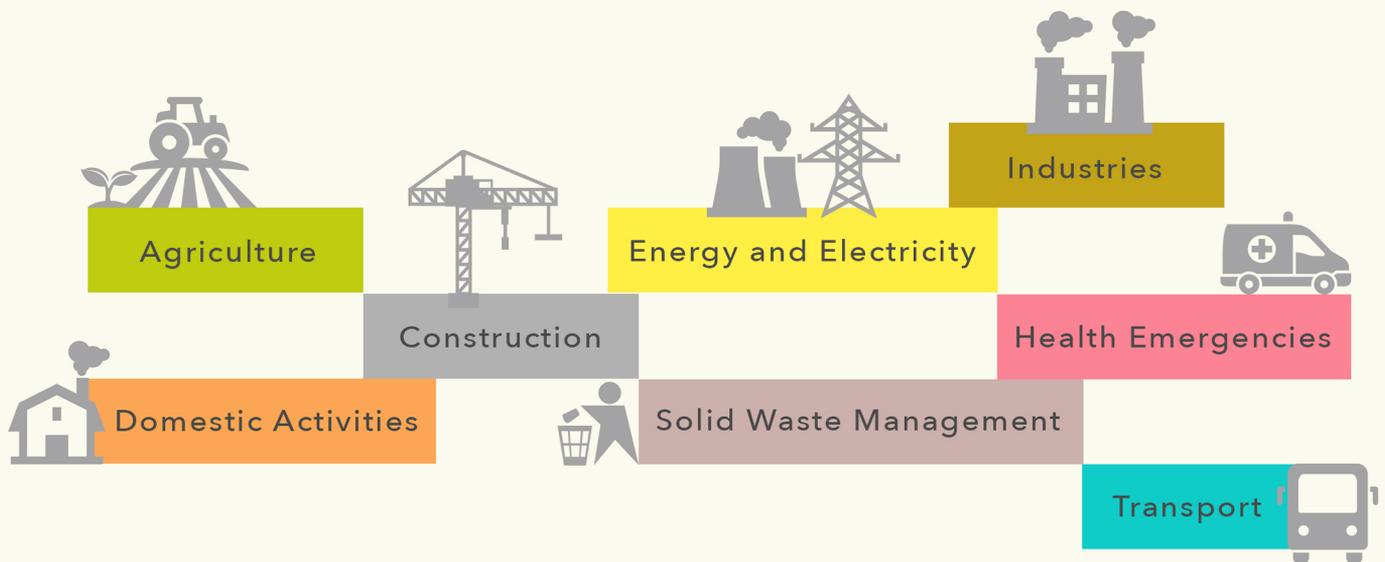


Berlin/ Hanoi 2020

# AIR QUALITY MANAGEMENT ACTION IN VIETNAMESE PROVINCES AND CITIES

## Local Air Quality Management – Manual for combined use with the AQMA-Table



Sarah Kovac

Dr. Heidi Stockhaus

Nicole Wozny

Dr. Michael Zschiesche



UfU  
Independent Institute for  
Environmental Issues



Contracted by :

**giz** Deutsche Gesellschaft  
für Internationale  
Zusammenarbeit (GIZ) GmbH

## Imprint

© 2020 Independent Institute for Environmental Issues, Berlin

### Publisher

Unabhängiges Institut für Umweltfragen - UfU e.V.  
Independent Institute for Environmental Issues

Greifswalder Str. 4  
10405 Berlin, Germany  
Phone: + 49 (30) 428 49 93-0  
E-Mail: [mail@ufu.de](mailto:mail@ufu.de)  
Webseite: [www.ufu.de](http://www.ufu.de)

### Design Director

Nour Alnader  
Nur Kreativ  
E-Mail: [info@nurkreativ.de](mailto:info@nurkreativ.de)  
Webseite: [www.nurkreativ.de](http://www.nurkreativ.de)

### Citation

Sarah Kovac, Heidi Stockhaus, Nicole Wozny, Michael Zschiesche (2020): Local Air Quality Management – Manual for combined use with the AQMA-Table. Independent Institute for Environmental Issues and Ecologic Institute. Berlin.

**This publication** was developed as part of the GIZ project Integrated Air Quality Management and Climate Change Mitigation.

**The project** is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative based on a decision of the German Parliament.

Webseite:  
[www.international-climate-initiative.com](http://www.international-climate-initiative.com)

### Project Duration

2018 - 2020

---

On behalf of:



Federal Ministry  
for the Environment, Nature Conservation  
and Nuclear Safety

of the Federal Republic of Germany

---

# Content

1. Presenting the Local Air Quality Management – Manual .....	4
---	---

## PART 1 - UNDERSTAND THE AQMA-TABLE

2. The AQMA-table - Structure and Use .....	7
Sectors .....	7
Column A: Objective .....	11
Column B: Number (N°).....	11
Column C: Activities .....	11
Column D: Short description of the activity .....	12
Column E: Policy Tool Categories.....	12
Column F and G: Main cost factors.....	13
Column H and I: Effectiveness.....	18
Column J: Time span.....	20
Column K: Examples.....	21
Column L: Joint Implementation with .....	21
Column M: Supporting Activity at the National Level.....	22

## PART 2 - FROM THE AQMA-TABLE TO LOCAL AIR QUALITY MANAGEMENT PLANS

3. From the AQMA-table to local air quality management plans - A manual for public authorities .....	24
A) Become familiar with the AQMA-Table.....	25
B) Define your province's category of emissions inventory and air quality modelling	25
C) Identify most relevant emission sources in your province or city.....	27
D) Identify AQM-activities which correspond to the main emission sources .....	32
E) Tailor AQM-activities to your province or city.....	32
F) (Preliminary) Cost-Effectiveness-Analysis for Prioritization .....	33
G) Evaluation of social impacts of preliminary prioritized activities.....	39
H) Integration of AQM-activities into Air Quality Management Plans.....	40
4. A chapter on emergency measures .....	42
Sources.....	44
List of abbreviations .....	46
Appendix: Format of AQM-measures for air quality management plans .....	47

# Presenting

## the Local Air Quality Management – Manual

Air pollution is a pressing issue in Vietnam, which will likely have a severe impact on human health and adverse effects on the environment. Especially in urban areas and Vietnam's major cities, such as Hanoi or Ho Chi Minh City, air pollution has increased significantly throughout the last years. Industrial facilities, power generation, road traffic, burning of rice straw and waste, cooking and heating as well as livestock farming are among the point and non-point emission sources contributing to air pollution. Besides the collection of data on major emissions as information basis, the examination of potential measures for air quality management is a central step for the identification of prioritized measures for air quality management planning.

The National Assembly adopted the revised Vietnamese Law on Environmental Protection (LEP) in November 2020. The revised Law on Environmental Protection provides a legal basis for air quality management planning at provincial level. According to the revised LEP, the provincial level People's Committees will be responsible for the development and approval of provincial air quality management plans including the determination of management measures.

The current draft of the Technical Guideline on Air Quality Management Planning by MONRE outlines the process and technical requirements for the development of air quality management plans at the provincial level. The Technical Guideline proposes a three-step approach for the identification of priority measures for the plans. According to it, potential air quality measures for specified emission sources are to be determined in a first step. In a second step, a Cost-Effectiveness Analyses (CEA) of the measures have to be carried out followed by a final selection of prioritized measures based on the CEA as well as their feasibility and suitability to local conditions and other regional management plans. However, there is only limited guidance for the provinces on which measures to choose and implement.

The publication series **AIR QUALITY MANAGEMENT ACTION FOR VIETNAMESE PROVINCES AND CITIES** supports the development process of local Air Quality Management Plans with three publications for policy- and decision-makers. The **Air Quality Management Activities-Table (AQMA-table)** gives an overview over suitable activities to reduce emissions of air pollutants and their impacts on people's health. The **Local Air Quality Management Manual** is directly related to the AQMA-table. It serves as handbook for the table and provides information on how to read and use the AQMA-table. Furthermore, this manual makes suggestions on how priority activities can be chosen among the proposed activities by provincial authorities in due consideration of a cost-effectiveness-analysis as outlined in the Technical Guideline of the Ministry of Natural Resources and Environment (MONRE). The third resource of the series is the **Toolbox of Immediate Action**.

The manual is divided into two main parts. The first part elaborates on the structure and information provided in the table and draws attention to aspects that should be considered when planning and designing the measures. The second part outlines the necessary steps from the air quality assessment to the implementation of priority measures. Moreover, a small digression on emergency measures follows at the end of the second part of this manual.

# PART 1

## UNDERSTAND THE AQMA-TABLE

## 1. The AQMA-table - Structure and Use

The Air Quality Management Activity-Table (AQMA-table) provides proposals for air quality management activities (AQM-activities) for provincial air quality management plans as prescribed in the LEP. Generally, two groups of AQM-activities can be distinguished, those that reduce emissions and those that reduce the negative impact of being exposed to emissions. To the greatest extent, the table focusses on activities that have the potential of reducing emissions.

However, the last part of the table sheds light on a few emergency activities to reduce the exposure to emissions in times of severe pollution, when emissions have already been released and the ambient air quality is poor. Those measures focus on reducing negative impacts on human health. They should always be given special consideration when drawing up air quality management plans.

The proposed activities in the table are not adapted to the individual contexts of the provinces and still need to be tailored to the respective provinces in the light of emission sources, impacts, weather, topography, etc. Only once the activities are tailored to the regional circumstances, they are to be chosen for the provincial air quality management plans. Furthermore, the table provides only a first selection of possible measures and is by far not complete. The authorities in the provinces are responsible for independently thinking of further measures that are relevant for the province. Regional and sectoral air quality management plans of other provinces and countries, international best practice examples or research literature can serve as sources for identifying further AQM-measures. Finally, the table also lists some measures that may require the national level to act first.

The following subchapters elaborate on the structure of the table, the meaning of the table's columns and what information they contain as well as information at which points the provincial authorities need to tailor the activities.

### Sectors

The proposed activities are classified according to the sector in which the action is taken. Each spreadsheet of the table presents proposed activities in another sector. In the following sectors, activities have been identified:

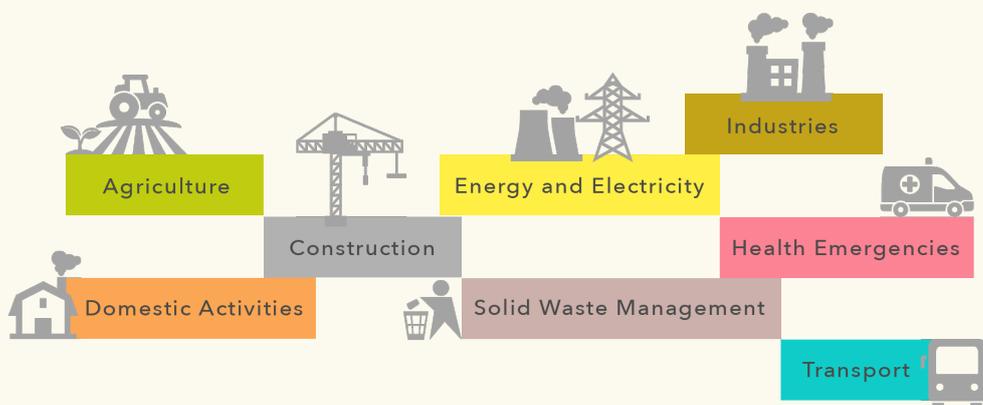


Figure 1: Overview of focus sectors for AQM-activities

For AQM-activities in some sectors, special conditions apply. If not referred to in the AQMA-table, they are shortly described below.

Please keep in mind that the revised LEP provides a legal framework for air quality management activities in some sectors. This means that some measures merely need to be specified or implemented, such as the ban on the burning of by-products from crops. Provinces should identify their and take ambitious action.

## AGRICULTURE

Most measures in the agricultural sector, such as regulatory activities to reduce the burning of crop residues, come along with burdens for farmers. Changes in production processes like in the use of fertilizer might be only successful when farmers receive the necessary information to introduce alternatives. Therefore, agricultural AQM-activities should always be carried out in combination with additional capacity-building measures or projects to introduce alternatives. Activities in the agricultural sector should be carried out in cooperation with the Department for Agriculture and Regional Development (DARD).

## CONSTRUCTION

Activities in the construction sector should not only consider emission reductions during construction works, i.e. emissions from construction sites and the use of construction machinery, but also air quality measures related to the planning process of construction projects. This refers mainly to the design of buildings and their surrounding landscapes. Therefore, also architects, civil engineers, garden and landscape planners must be included in air pollution control activities. Even though such activities are likely less effective in reducing emissions, they play an important role in reducing negative health impacts and are therefore equally important as measures during construction works. Activities in this sector should be closely coordinated with the Department of Construction (DOC) and the Department of Planning and Investment (DPI).

## DOMESTIC ACTIVITIES

Air quality management activities related to cooking and heating technologies, methods and fuels directly target households and families. It is therefore not advisable to introduce bans, but to rather focus on incentives promoting the acceptance, and thereby the use of alternative options. This way, emissions are reduced indirectly, but for a long time. Changes in domestic and commercial habits are worth more than twice, because they go along with various co-benefits: The reduction of emissions, improved health, environmental and climate protection, less expenses in the long-term, improved livelihoods, or the empowerment of women are only some out of many.

In order to exploit all potential co-benefits, the provincial Departments for Natural Resources and Environment should cooperate and coordinate AQM-activities for households with local women's unions or similar non-governmental organizations.

## ENERGY AND ELECTRICITY

The power and energy sector is among the largest contributors to current emissions in Vietnam and will have an even larger share in the future.<sup>1</sup> It is therefore crucial to consider this sector in national and local air quality management plans. Most measures to reduce emissions from large-scale energy plants are under the responsibility of public authorities at the national level. This is for example the case for retrofitting activities and the enforcement of existing emission limits for large power plants (Activities D2, D5, D7 and D9-12). These activities are mentioned in the table because they would have large positive impact on current and future emissions.

Provincial authorities can carry out a number of supplementary activities to support the implementation of these AQM-activities. This includes, for example, initiatives to reduce the electricity and energy demand in the province or to foster the change towards renewable energies. These activities have a high potential to reduce emissions indirectly, e.g. by making the one or other new (coal) power plant redundant.

Energy and electricity generation and use are cross-sectoral issues. Therefore, some AQM-activities related to energy and power are not listed under this section, but under the AQM-activities in other sectors such as agriculture or domestic activities.

Many AQM-activities in the energy and power sector should be implemented in coordination with public authorities at the national level, such as the Ministry of Power (MOP) and MONRE.

## INDUSTRY

The emissions of air pollutants of production and combustion processes differs significantly between industrial sectors. It is therefore recommended to initiate AQM-activities in those industrial sectors strongly contributing to air pollutant emissions. These industries include heavy industries such as metal and steel production, cement production, mineral-based production, chemical and fertilizer production, as well as pulp and paper production.

Crucial for all regulatory AQM-activities in the industrial sector is the comprehensive and regular monitoring and enforcement of the compliance with national regulations. Non-compliance shall be penalized consequently and by a progressive fine system making non-compliance always more costly than the costs associated with the establishment of the necessary equipment and structures to meet existing standards. For monitoring and enforcement activities and for retrofitting initiatives (E6 and E13-17), it is advisable for provincial authorities to closely work together with public authorities at the national level. At the provincial level, a cooperation with the Department of Industry and Trade is important.

## SOLID WASTE MANAGEMENT

The emissions of air pollutants from the disposal and treatment of solid waste greatly differ in terms of the type of solid waste. The provincial authorities should therefore develop and select further waste type-specific measures in addition to the proposed

---

<sup>1</sup> Amann et al. (2019)

measures in the table. Special measures needs to be developed for agricultural waste, municipal waste, construction waste, industrial waste, medical waste, packaging waste, hazardous waste, electronic waste, etc. However, some measures may only be taken at national level.

In addition, the activities concerning the technology of waste disposal must be specified, i.e. for different types of landfills, incinerators, mechanical-biological waste treatment plants, recycling plants, pre-treatment, and collection and transport methods.

Some AQM-activities related to solid waste can also be found under other sectors within the AQMA-table, such as industries or agriculture. This is e.g. the case for waste-to-heat technologies or bio-digesters for farmers and rural households.

## TRANSPORT

The proposed activities in the table focus for the most part on road traffic. However, if it is of relevance for the provinces, measures for waterways, rail and air traffic have to considered, too. In addition, the activities regarding the respective vehicle can be significantly refined, e.g. special measures for motorcycles, heavy duty vehicles, transport and shipping companies, vehicle fleets, etc. The measures should also be refined with regard to year of manufacture, engine type, fuel type or emission class.

Also in the transport sector it is crucial that AQM-activities do not only comprise bans and penalties for exceeded emission limits, but that action is supplemented with initiatives to support environmentally friendly transport as alternative. While emission limits will usually be defined at national level, provinces can regulate the traffic and can, for example, prohibit emission intensive vehicles in certain streets or areas.

## EMERGENCY HEALTH

For further details on emergency measures to prevent or reduce negative health impacts, please go to chapter 4.

## Column A: Objective

Within each sector, emissions are released through different processes. Column A: Objective presents the objective, usually an emission reduction, which can be reached by implementing one or more of the proposed air quality management activities outlined in the Column C: Activities.

A	B	C	D	E	F
Objective	N°	Activity	Short description of the activity	Policy Tool Category	Main cost for the Public Authority
Reduce emissions from crop residue burning	A1	Partial ban on crop residue burning	Ban clearly defined for certain areas or times, dependent on season, weather and region and quantity of emissions	Regulatory	<ul style="list-style-type: none"> <li>Monitoring &amp; enforcement (Operation)</li> <li>Coordination</li> </ul>
	A2	Organization and implementation of regulated, scheduled burning of crop residues	Define and establish in coordination with the local farmer's union a schedule on the burning of crop residues. Monitor the compliance with regular control patrols or drones.	Planning	<ul style="list-style-type: none"> <li>Capacity building</li> <li>Coordination</li> <li>Monitoring &amp; enforcement (Operation)</li> </ul>
	A3	Information events about hazards of crop residue burning	Information event for farmers about the negative impacts of crop residue burning as complementary to farmer's union meetings.	Educational	<ul style="list-style-type: none"> <li>Coordination</li> </ul>
	A4	Pilot project of biochar production as alternative to crop residue burning.	Pilot project with the regional farmers union, an agricultural university for expertise and VEPF or a regional company as fund for equipment. Start in and near densely populated areas.	Planning	<ul style="list-style-type: none"> <li>Administration</li> <li>Cooperation</li> </ul>
		Information events and courses about alternative uses of agricultural	Regular courses with the regional farmers union and an agricultural university for expertise about ploughing, composting,		<ul style="list-style-type: none"> <li>Administration</li> <li>Coordination</li> <li>Further employees</li> </ul>

Figure 2: Column A lists the emission reduction objectives for each sector

## Column B: Number (N°)

Each listed AQM-activity possesses an individual number indicated in Column B: N°. The number is comprised of the sector of the AQM-activity (A-H) and the number within the category (starting from 1). This enables a quick search for the AQM-activity when other columns refer to it.

## Column C: Activities

The Column C: Activities presents different air quality management and health protection activities. Most activities are designed to be implemented by public

authorities at the provincial and the city level, except for some activities in the energy and industry sector.

A	B	C	D	E	F
Objective	N°	Activity	Short description of the activity	Policy Tool Category	Main Category for the Public Authority
Reduce emissions from crop residue burning	A1	Partial ban on crop residue burning	Ban clearly defined for certain areas or times, dependent on season, weather and region and quantity of emissions	Regulatory	<ul style="list-style-type: none"> <li>Monitoring &amp; enforcement (Operation)</li> <li>Coordination</li> </ul>
	A2	Organization and implementation of regulated, scheduled burning of crop residues	Define and establish in coordination with the local farmer's union a schedule on the burning of crop residues. Monitor the compliance with regular control patrols or drones.	Planning	<ul style="list-style-type: none"> <li>Capacity building</li> <li>Coordination</li> <li>Monitoring &amp; enforcement (Operation)</li> </ul>
	A3	Information events about hazards of crop residue burning	Information event for farmers about the negative impacts of crop residue burning as complementary to farmer's union meetings.	Educational	<ul style="list-style-type: none"> <li>Coordination</li> </ul>
	A4	Pilot project of biochar production as alternative to crop residue burning.	Pilot project with the regional farmers union, an agricultural university for expertise and VEPF or a regional company as fund for equipment. Start in and near densely populated areas.	Planning	<ul style="list-style-type: none"> <li>Administration</li> <li>Cooperation</li> </ul>

Figure 3: Column C describes lists the names of the general AQM-activities which can contribute to reach the objective

### Column D: Short description of the activity

In addition to Column B, Column D: Short Description gives in one sentence more details about the activity or solution.

The authors have deliberately not included a detailed description of each activity. It should be the responsibility of the province and city authorities to fill this empty space with a more detailed description and planning of this activity. This planning shall also pay tribute to the individual circumstances in each province and city.

### Column E: Policy Tool Categories

AQM-activities use different policy tools to reach their objective. Sometimes, they even use a combination of different policy tool categories. The main category of policy tool used is indicated in Column E: Policy Tool Category. If a measure combines different policy tools, both are listed.

With this column, it is possible to reduce proposed AQM-activities to activities only using a pre-defined category of policy tools. The individual categories of policy tools are defined as:

### IN DETAIL: POLICY TOOL CATEGORIES

- **Regulatory** policy tools are rules made by a government or other authority to control activities leading to emissions. This includes, among others, bans, limits and thresholds, or sanctions.
- **Economic/incentive-based** policy tools use markets, price, and other economic variables to provide incentives to reduce or eliminate emissions. Examples are subsidies, taxes or certificates.
- **Information/communication** policy tools seek to reduce emissions by informing polluters and affected persons and groups about sources and effects of emissions.
- **Educational** policy tools are initiatives or programs having the target to reduce or eliminate emissions by sharing knowledge how emissions can be reduced within existing activities and about alternative activities being less emission-intensive. This includes trainings for polluters, environmental audits, as well as Life-Cycle-Assessments.
- **Participatory/cooperative** policy tools aim to establish (voluntary) commitments from polluting actors to improve their environmental performance regarding the emission of air pollutants. Instruments to reach this are, among others, round tables or mediation processes.
- **Planning** tools, such as air quality planning and other management plans, organize production and (land) development processes with a special consideration of (future) impacts of emissions sources, thus aiming to reduce the emissions and their impacts.

Figure 4: Descriptions of different categories of policy tools as basis for the categorization indicated in Colu

## Column F and G: Main cost factors

The implementation of air quality management activities usually correlates with additional costs – not only for the responsible public authority, but also for the affected entity. Column F and column G provide hints about the most relevant cost factors of the implementation of each activity. Costs can vary greatly even within each one of the proposed activities. This is because each activity needs to be tailored to specific circumstances within each province and city, thus leading to varying use of personnel, equipment and other. The table therefore only mentions main cost factors for the public authority and the affected entity or entities.

### i. Main cost factors for the public authority

According to the Technical Guideline on Air Quality Management Planning, the implementation costs for the public authority responsible to carry out air quality

management activities at the provincial level consists of investment costs and of operational costs needed to successfully implement the measure.

Both, the costs of investment and the costs of operation can again be divided into further categories, or cost factors. Cost factors include costs for the necessary equipment, transport or personnel to implement the activity. Related to costs for the public authority, the following cost factors have been identified:

#### IN DETAIL: MAIN COST FACTORS FOR THE PUBLIC AUTHORITY

COST OF INVESTMENT	COST OF OPERATION
<ul style="list-style-type: none"> <li>ADMINISTRATION PERSONNEL COSTS TO BUILD UP THE NECESSARY ADMINISTRATION AND REPORTING STRUCTURE TO CARRY OUT THE ACTIVITY</li> </ul>	<ul style="list-style-type: none"> <li>ADMINISTRATION PERSONNEL COSTS TO REPORT AND ADMINISTER THE ACTIVITY</li> </ul>
<ul style="list-style-type: none"> <li>CAPACITY BUILDING COSTS FOR CAPACITY-BUILDING ACTIVITIES TO PROVIDE EMPLOYEES IN THE PUBLIC AUTHORITY WITH THE NECESSARY SKILLS AND KNOWLEDGE TO CARRY OUT THE ACTIVITY</li> </ul>	<ul style="list-style-type: none"> <li>-</li> </ul>
<ul style="list-style-type: none"> <li>COORDINATION PERSONNEL AND MATERIAL COSTS FOR THE COORDINATION WITH OTHER PUBLIC AUTHORITIES AND WITH STAKEHOLDERS AT PROVINCE, LOCAL AND NATIONAL LEVEL</li> </ul>	<ul style="list-style-type: none"> <li>COORDINATION REGULAR PERSONNEL AND MATERIAL COSTS FOR THE COORDINATION WITH OTHER PUBLIC AUTHORITIES AND WITH BUSINESSES AT PROVINCE, LOCAL AND NATIONAL LEVEL</li> </ul>
<ul style="list-style-type: none"> <li>EQUIPMENT ONE-TIME MATERIAL COSTS TO PROVIDE THE NECESSARY EQUIPMENT FOR THE OPERATION</li> </ul>	<ul style="list-style-type: none"> <li>EQUIPMENT REGULAR COSTS OF EQUIPMENT AND TRANSPORT COSTS TO CARRY OUT THE ACTIVITY</li> </ul>
<ul style="list-style-type: none"> <li>FURTHER EMPLOYEES PERSONNEL COSTS FOR EMPLOYEES FROM OTHER PUBLIC OR PRIVATE ENTITIES WHICH NEEDS TO BE HIRED BY THE PUBLIC AUTHORITY TO PREPARE THE ACTIVITY</li> </ul>	<ul style="list-style-type: none"> <li>FURTHER EMPLOYEES PERSONNEL COSTS FOR EMPLOYEES FROM OTHER PUBLIC OR PRIVATE ENTITIES WHICH NEEDS TO BE HIRED BY THE PUBLIC AUTHORITY TO IMPLEMENT THE ACTIVITY</li> </ul>
<ul style="list-style-type: none"> <li>NEW REGULATION PERSONNEL COSTS TO DRAFT, ESTABLISH OR CHANGE NEW OR EXISTING REGULATIONS OR DECREES AT THE LOCAL/PROVINCE LEVEL</li> </ul>	<ul style="list-style-type: none"> <li>MONITORING &amp; ENFORCEMENT PERSONNEL COSTS NECESSARY TO CONTROL IF POLLUTERS AND AFFECTED PERSONS FOLLOW THE ESTABLISHED RULES</li> </ul>

Figure 5: Descriptions of different cost factors for public authorities as basis for Cost-Effectiveness analysis, as indicated in Column F

The cost factors above might not be complete and may also partly overlap and therefore merely function as basis for a detailed cost-benefit analysis.

The accompanying table seeks to indicate especially relevant cost factors in the preparation and operation phase of an activity: In Column F: Main cost factors for the public authority, one or two cost factors which are seen as most relevant for the overall budget of the activity are listed.

Please consider that the listed main cost factors are only based on a preliminary estimation. Due to the unique circumstances in every province, city and public authority, other cost factors might be more relevant when the same activity is implemented in different provinces or cities. These individual characteristics could not be considered in the present table. It is therefore advisable to use the information in the table only as a first overview, and to carry out a more detailed cost-benefit analysis before priority activities for air quality management are chosen. In chapter 3, you find further information about this part of the cost-benefit analysis.

C	D	E	F	G
Activity	Short description of the activity	Policy Tool Category	Main cost factors	
			for the Public Authority	for the Affected Entity
<b>Energy-efficiency check for public buildings</b>	Appoint an energy agent who assesses the energy efficiency (heating and cooling) of public buildings and identifies cost-efficient modernization measures and/or renewable energy alternatives. Public buildings include schools, administrative buildings, universities and other.	Planning	<ul style="list-style-type: none"> <li>Administration</li> </ul>	
<b>Installation of an insulation in public buildings</b>	Starting with old buildings in which a heating and cooling system is installed	Planning	<ul style="list-style-type: none"> <li>Equipment (Investment)</li> </ul>	<ul style="list-style-type: none"> <li>Equipment (Investment)</li> </ul>
<b>Exchange of old and leaking windows and exterior doors in public buildings</b>	Starting with old buildings in which a heating and cooling system is installed	Planning	<ul style="list-style-type: none"> <li>Equipment (Investment)</li> </ul>	<ul style="list-style-type: none"> <li>Equipment (Investment)</li> </ul>
<b>Capacity-building activities about energy-saving measures</b>	Courses to learn energy-saving ventilation of public buildings. Target group are civil servants, caretaker of public buildings and teachers on schools and universities.	Information/communication	<ul style="list-style-type: none"> <li>Capacity building (Investment)</li> <li>Coordination (Operation)</li> </ul>	
<b>Energy efficiency standards for the procurement of new heating and cooling systems in public buildings.</b>	Code of conduct, making it a necessary part of public tenders for administrative buildings, schools and universities.	Planning	<ul style="list-style-type: none"> <li>Equipment (Investment)</li> <li>Administration (Investment)</li> </ul>	<ul style="list-style-type: none"> <li>Equipment (Investment)</li> <li>Administration (Investment)</li> </ul>

Figure 6: Column F lists the main cost factors for the public authority during the preparation and implementation of the AQM-activity

## ii. Main cost factors for the affected entity

Although the reduction of air pollutant emissions has many (co-)benefits for the population and local industries, air quality management activities also lead to direct and indirect costs for the affected entities. Affected entities comprise farmers, households, owners of small, medium and large businesses and workers.

The revised LEP and the related Technical Guideline on Air Quality Management Planning do not explicitly mention cost factors for affected entities. It is nonetheless advisable to take them into consideration. As for the cost factors for public authorities, also the implementation costs for affected entities can be organized into costs of investment and cost of operation.

Both, the costs of investment and the costs of operation can again be divided into further categories, or cost factors. Ideally, cost factors include all added, personnel and material costs that are necessary to meet the new standards defined by the air quality management activity.

This includes one-time work for preparation and organizational measures and material costs for equipment and machinery to meet new standards (cost of investment). It also includes the personnel costs for regular added work and regularly incurred material costs (cost of operation). Related to costs for the affected entity, the following cost factors have been identified:

The cost factors above do not represent the whole range of cost factors related to air quality management activities. Especially indirect costs could not be considered. Some cost factors may also (partly) overlap and therefore merely function as basis for a detailed cost-benefit analysis.

The accompanying table seeks to indicate especially relevant costs arising when new standards defined by the activity are met: In Column G: Main cost factors for affected entities, one or two cost factors which are seen as most relevant are listed.

### IN DETAIL: MAIN COST FACTORS FOR AFFECTED ENTITIES

- **ADMINISTRATION COSTS** PERSONNEL COSTS TO BUILD UP AND OPERATE THE NECESSARY ADMINISTRATION, SELF-MONITORING AND REPORTING STRUCTURE TO MEET AND CONTROL COMPLIANCE WITH NEW STANDARDS TO GAIN PERMITS OR TO PREVENT PENALTIES
- **CAPACITY BUILDING COSTS** FOR CAPACITY-BUILDING ACTIVITIES TO PROVIDE RESPONSIBLE PERSONS WITH THE SKILLS AND KNOWLEDGE NEEDED TO CARRY OUT THE NECESSARY CHANGES TO MEET NEW STANDARDS
- **CONTINGENT COSTS:** COSTS THAT NEEDS TO BE PAID IN A FUTURE POINT IN TIME AS DIRECT RESULT OF A NEW STANDARD (E.G. CLEAN-UP COSTS)
- **COORDINATION COSTS:** PERSONNEL AND MATERIAL COSTS FOR THE COORDINATION WITH PUBLIC AUTHORITIES AND OTHER ENTITIES NEEDED TO MEET THE NEW STANDARDS
- **EQUIPMENT COSTS:** COSTS FOR THE NECESSARY EQUIPMENT TO MEET THE NEW STANDARD. THIS INCLUDES TECHNOLOGY, SOFTWARE, NEW MACHINERY, ETC. ALSO COSTS FOR EQUIPMENT FOR REGULAR OPERATIONS AND FUTURE EQUIPMENT ARE INCLUDED

*Figure 7: Descriptions of different cost factors for affected entities as basis for Cost-Effectiveness analysis, as indicated In Column G*

Please consider that the listed main cost factors are only based on a preliminary estimation. Due to the unique circumstances in every province, city and public authority, other cost factors might be more relevant when the same activity is implemented in different provinces or cities. The information in the table should therefore only be used as a first overview. Before priority activities for the air quality management plan are chosen, a more detailed cost-benefit analysis should be carried out. In chapter 3, you find further information about this part of the cost-benefit analysis.

C Activity	D Short description of the activity	E Policy Tool Category	F Main cost factors		G
			for the Public Authority	for the Affected Entity	
Energy efficiency check of public buildings	Appoint an energy agent who assesses the energy efficiency (heating and cooling) of public buildings and identifies cost-efficient modernization measures and/or renewable energy alternatives. Public buildings include schools, administrative buildings, universities and other.	Planning	• Administration		
Installation of a heating and cooling system in public buildings	Starting with old buildings in which a heating and cooling system is installed	Planning	• Equipment (Investment)		• Equipment (Investment)
Replacement of old and leaking windows and doors in public buildings	Starting with old buildings in which a heating and cooling system is installed	Planning	• Equipment (Investment)		• Equipment (Investment)
City-building courses about energy-saving measures	Courses to learn energy-saving ventilation of public buildings. Target group are civil servants, caretaker of public buildings and teachers on schools and universities.	Information/communication	• Capacity building (Investment) • Coordination (Operation)		
Energy efficiency standards for the procurement of heating and cooling systems in public buildings.	Code of conduct, making it a necessary part of public tenders for administrative buildings, schools and universities.	Planning	• Equipment (Investment) • Administration (Investment)		• Equipment (Investment) • Administration (Investment)
Information events on	Carry out information courses about		• Administration		

Figure 8: Column G lists the main cost factors for affected entities during the preparation and implementation of the AQM-activity

## Column H and I: Effectiveness

The implementation of Air quality management activities leads to various effects. In the AQMA-table, two aspects of the effectiveness of AQM-measures are presented: Effectiveness in Emission Reduction and Co-Benefits.

### i. Effectiveness in Emission Reduction (Type)

Column H indicates what kind of air pollutant emissions this measure can reduce. It is here assumed that the AQM-activity is fully and effectively implemented.

E	F	G	H	I	J
Policy Tool	Main cost factors		Effectiveness		Time Span
Category	for the Public Authority	for the Affected Entity	Emission Reduction (Type)	Co-Benefits	
Regulatory	<ul style="list-style-type: none"> <li>Monitoring &amp; enforcement (Operation)</li> <li>New local regulation (Investment)</li> <li>Coordination (Operation)</li> </ul>	<ul style="list-style-type: none"> <li>Capacity building costs</li> </ul>	Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH2	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	SHORT
Regulatory	<ul style="list-style-type: none"> <li>Monitoring &amp; enforcement (Operation)</li> <li>Coordination</li> </ul>	<ul style="list-style-type: none"> <li>Capacity building costs</li> </ul>	Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH3	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	SHORT
Planning	<ul style="list-style-type: none"> <li>Capacity building</li> <li>Coordination</li> <li>Monitoring &amp; enforcement (Operation)</li> </ul>	<ul style="list-style-type: none"> <li>Capacity building costs</li> <li>Contingent costs</li> </ul>	Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH4	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	MEDIUM
Educational	<ul style="list-style-type: none"> <li>Coordination</li> </ul>	Does not apply.	If farmers reduce the crop residue burning afterwards, then ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH3	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	MEDIUM

Figure 9: Column H gives an overview over the air pollutant which can be reduced when the AQM-activity is fully and successfully implemented

## ii. Co-benefits

Apart from effects regarding emission reduction, AQM-activities can also have indirect benefits in other sectors, so-called Co-Benefits.

In Column I, the most relevant Co-Benefits of each AQM-activity are listed if they apply. Co-Benefits nearly always include the reduction of negative health impacts, but might also go further to other sectors.<sup>2</sup> Please consider that the co-benefits listed present only a small insight, and by no means a complete overview over the benefits of the proposed air quality management activities.

<sup>2</sup> IASS/UfU/GreenID (2020)

E	F	G	H	I	J
Policy Tool	Main cost factors		Effectiveness		Time Span
Category	for the Public Authority	for the Affected Entity	Emission Reduction (Type)	Co-Benefits	
Regulatory	<ul style="list-style-type: none"> <li>Monitoring &amp; enforcement (Operation)</li> <li>New local regulation (Investment)</li> <li>Coordination (Operation)</li> </ul>	<ul style="list-style-type: none"> <li>Capacity building costs</li> </ul>	Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH2	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	SHORT
Regulatory	<ul style="list-style-type: none"> <li>Monitoring &amp; enforcement (Operation)</li> <li>Coordination</li> </ul>	<ul style="list-style-type: none"> <li>Capacity building costs</li> </ul>	Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH3	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	SHORT
Planning	<ul style="list-style-type: none"> <li>Capacity building</li> <li>Coordination</li> <li>Monitoring &amp; enforcement (Operation)</li> </ul>	<ul style="list-style-type: none"> <li>Capacity building costs</li> <li>Contingent costs</li> </ul>	Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH4	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	MEDIUM
Educational	<ul style="list-style-type: none"> <li>Coordination</li> </ul>	Does not apply.	If farmers reduce the crop residue burning afterwards, then ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH3	<ul style="list-style-type: none"> <li>Climate protection</li> </ul>	MEDIUM

Figure 10: Column I gives an overview over the most relevant Co-Benefits which can be mobilized when the AQM-activity is fully and successfully implemented

### Column J: Time span

Column J: Time span gives a first, rough estimation about the time span that the local AQM-activity might need to be effective. The indications in this column express/indicate an average period of time that passes between the first preparatory actions for carrying out the air quality management activity and an actual emission reduction.

- If this period of time is less than 6 months, it is indicated as SHORT
- If the period is between 6 months and 2 years, it is indicated as MEDIUM
- If the period is longer than 2 years, it is indicated as LONG.

Please note that the values in Column H are only rough estimations based on average and experience values. These rough estimations also assume that all preparatory and organizational tasks to carry out the AQM-activity run smoothly.

It is important to consider that the length of the actual time interval between first preparatory actions and an emission reduction is dependent on factors such as the scope at which the measure is carried out, the number of stakeholders involved and the permits needed. These factors are in turn related to the unique

circumstances in each province and thus the reason why the indicated time span may differ greatly from the actual time span needed at different provinces.

H		I	J	K	L	M
Effectiveness			Time Span	Example	Joint implementation with	Support Activity at the National Level
Emission Reduction (Type)	Co-Benefits					
Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH2	• Climate protection		SHORT	<a href="#">Rice Straw Burning Ban near Hanoi</a>	E6: Courses about alternative uses of agricultural residues	
Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH3	• Climate protection		SHORT	<a href="#">Rice Straw Burning Ban near Hanoi</a>	E6: Courses about alternative uses of agricultural residues	
Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH4	• Climate protection		MEDIUM			

Figure 11: Column J indicates an average time span needed from initiating preparative measures to the occurring of emission reduction effects.

### Column K: Examples

Examples are often a great help to get a first impression of what a local air quality management activity may look like, how it can be implemented and what is important to take care of during its preparation and implementation.

If there are good examples for a local AQM activity, the authors included a link to further information in Column K: Examples. The examples mostly include policies, programs and further initiatives from other countries. Thus, the links will lead you to English websites.

### Column L: Joint Implementation with

Some activities are only effective, or much more effective if implemented in tandem with other AQM-activities. If this is the case, or a joint implementation generates positive synergies, then the number of the respective AQM-activity is listed in Column L. Through the search function, the AQM-activity can be found in the AQMA-table.

H	I	J	K	L	M
<b>Effectiveness</b>		<b>Time Span</b>	<b>Example</b>	<b>Joint implementation with</b>	<b>Support Activity at the National Level</b>
<b>Emission Reduction (Type)</b>	<b>Co-Benefits</b>				
Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH2	• Climate protection	SHORT	<a href="#">Rice Straw Burning Ban near Hanoi</a>	E6: Courses about alternative uses of agricultural residues	
Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH3	• Climate protection	SHORT	<a href="#">Rice Straw Burning Ban near Hanoi</a>	E6: Courses about alternative uses of agricultural residues	
Ability to reduce emissions of PM10, PM2.5, CO, CO2, SO2, NOx, NH3, CH4	• Climate protection	MEDIUM			

Figure 12: Column I gives an overview over the most relevant Co-Benefits which can be mobilized when the AQM-activity is fully and successfully implemented

## Column M: Supporting Activity at the National Level

Often, air quality management activities at the province level are more effective if they are backed or supported by national incentives or activities. Also, for some activities, the competence may rest with the national level. These national incentives and activities include, for example, supporting laws or regulations, taxes and other fiscal incentives, or the distribution of knowledge and data.

If a proposed measure would significantly benefit from an accompanying air quality management incentive at the national level, this national activity is listed in Column M: Support Activity at the National Level.

## PART 2

### FROM THE AQMA-TABLE TO LOCAL AIR QUALITY MANAGEMENT PLANS

## 2. From the AQMA-table to local air quality management plans - A manual for public authorities

Due to personnel, budget and time limitations, it is usually not possible to carry out all of the proposed activities at the same time. Rather, among all proposed activities, a number of priority activities need to be chosen. How can this be done in a way that ensures the most effective and cost-friendly activities are chosen to be priority AQM-activities listed in the local Air Quality Management Plan?

This chapter seeks to give public authorities in Vietnamese provinces first guidelines.

Figure 13 gives a summary of the necessary steps from the AQMA-table to priority activities in the local Air Quality Management Plans.

### FROM THE AQMA-TABLE TO PRIORITY AQM-ACTIVITIES IN LOCAL AIR QUALITY MANAGEMENT PLANS

#### STEP BY STEP

	<b>Activity</b>	<b>PRODUCT</b>
<b>Step A</b>	Become familiar with the table of AQM activities	TABLE OF AQM-ACTIVITIES
<b>Step B</b>	Define your province's category in <i>Emissions inventory and air quality modelling</i>	
<b>Step C</b>	Identify most relevant emission sources in your province	PRELIMINARY EMISSION INVENTORY
<b>Step D</b>	Identify AQM-activities which correspond to these emission sources	SHORT LIST OF AQM-ACTIVITIES
<b>Step E</b>	Tailor the AQM-activities at the short list to your provinces demands	SHORTLIST OF INDIVIDUALIZED AQM-ACTIVITIES
<b>Step F</b>	Carry out a Preliminary Cost-Effectiveness-Analysis to identify those activities suitable for the Air Quality Management Action Plan for your province	(PRELIMINARY) PRIORITIZED ACTIVITY LIST (PRELIMINARY) COST-EFFECTIVENESS OVERVIEW FOR THE AQM PLAN
<b>Step G</b>	Evaluate the most prioritized AQM-activities regarding their indirect and social costs and impacts and modify aspects of those activities when this type of costs is too high	PRIORITIZED ACTIVITY LIST
<b>Step H</b>	Detailed planning and implementation of the AQM-activity	

Figure 13: Steps to identify and tailor priority AQM-activities for the local Air Quality Management Plan

## Step A) Become familiar with the AQMA-Table

Take a look at the proposed activities in the related AQMA-table to get familiar with the activities being promising for the Air Quality Management Plan of your province or city.

## Step B) Define your province's category of emissions inventory and air quality modelling

The Technical Guideline on Air Quality Management Planning defines that a Cost-Effectiveness-Analysis (CEA) should be used to select the AQM-activities to be included in the local Air Quality Management Plans. The actual effectiveness of each AQM-measure can however only be exactly defined on the base of an emission inventory and continuous ambient air quality data. It can be observed that among the public authorities in Vietnamese province and city authorities, this current technology and data standards differ widely. We therefore propose a slightly different approach as defined in the Technical Guideline to identify priority AQM-activities in the provinces. This approach is simpler and more practice-oriented than the approach in the Technical Guidelines. However, it so enables especially provinces without an emission inventory and regular ambient air quality data to develop a local Air Quality Management Plan and to take necessary and suitable action even without a broad data base. The suggested approach starts with the definition of your province's status regarding the existing data base to monitor emissions from different sources and the quality of the ambient air. Based on proposed measurement methods of the official

Technical Guideline, figure 14 shows criteria according to which the provinces can be classified into different categories.

### CLASSIFICATION OF EMISSION AND AIR QUALITY MONITORING STATUS FOR PROVINCES

<b>Category A</b>	<ul style="list-style-type: none"> <li>• No emission inventory (EI) has ever been compiled</li> <li>• There is no ambient air quality monitoring system.</li> <li>• PM source profile data are not collected and receptor-based SA is not conducted</li> <li>• Pollution dispersion has not been modelled/mapped</li> </ul>
<b>Category B</b>	<ul style="list-style-type: none"> <li>• An initial EI or a rapid EI is available for criteria and/or other air pollutants covering major sources (e.g. those using the <a href="#">Global Air Pollution Forum (GAPF)</a> rEI Methodology approach)</li> <li>• An ad hoc EI may have been compiled using a top-down EI approach with default EFs and surrogate activity data</li> <li>• Ambient air quality monitoring and meteorological monitoring systems are developed and considered for emission-exposure-impacts modelling</li> </ul>
<b>Category C</b>	<ul style="list-style-type: none"> <li>• EI for criteria pollutants of major sources and sources with increasing importance are regularly compiled based on a mixed top-down and bottom-up approach</li> <li>• Default EFs and EFs obtained from local academic research are used</li> <li>• Receptor-based SA for PM and VOCs/semi-VOCs is conducted on an ad hoc basis by research/academic institutions</li> <li>• QA/QC procedures for EI and SA are regularly implemented</li> <li>• Simple steady-state dispersion models are used to estimate pollutant concentrations using meteorological measurement input</li> <li>• EI, SA, and dispersion modelling results are used in identifying air quality policies or measures</li> </ul>

Figure 14: Categories of different emission inventory status in cities and provinces. The indicators for the classification into the categories are listed on the right.

In Step C until Step F, provinces of different categories should also use distinct approaches and methods in their prioritization process for AQM-activities for the local Air Quality Management Plans. We therefore propose to the reader to refer at Step C and Step D to the subchapters for their category.

## Step C) Identify most relevant emission sources in your province or city

The Technical Guideline on Air Quality Management Planning defines that priorities among AQM-activities shall be set by comparing their costs with their effectiveness regarding the reduction of air pollutant emission and negative health effects. This can only be realized if a province has a (detailed) overview over the emission sources within its area. According to the Technical Guideline, mobile as well as area sources should be considered in the Emissions Inventory (figure 15).

### TECHNICAL GUIDELINE ON AIR QUALITY MANAGEMENT PLANNING

#### Emissions inventory

##### Perform emission inventory for mobile sources

###### - Define mobile sources

###### (1) On-road sources

- Passenger car (< 9 seats): using gasoline, diesel, LPG, CNG
- Light-duty vehicles (< 3,5 tons): using gasoline, diesel
- Heavy-duty vehicles (> 3,5 tons) and bus: using oil, CNG
- Motorcycles (2 wheels): using gasoline

###### (2) Non-road sources

- Aircrafts
- Railways
- Vessels [...]

##### Perform emission inventory for area sources

- **Define the scope of the inventory:** including the pollutants, geographic boundaries, sources, and end uses. Area sources include the following groups of processes:

- Commercial and consumer organic solvent usage;
- Stationary fuel combustion (heating, including waste oil combustion);
- Material storage and distribution;
- Waste treatment and disposal;
- Miscellaneous industrial manufacturing operations;
- Gasoline service stations;
- Hospital and laboratory sterilizers;
- Biomass burning (agricultural, domestic)
- Miscellaneous sources (agricultural/forest burning, mining or construction, for example).

Figure 15: The Technical Guideline on Air Quality Management Planning on the emission sources that should be considered in the emission inventory

## Category B and Category C provinces and cities

The provinces or cities categorized as Category B or Category C already possess an inventory of emission sources. If your province is within this category, you can continue reading at Step D).

## Category A provinces and cities:

Category A provinces do not have an emission inventory at hand. To get at least a rough estimation of the most important emission sources, it is advisable to carry out a preliminary emission inventory. To develop it, you should orientate on an existing emission sources inventory of a Vietnamese province with similar characteristics as yours and complement the picture with the biggest point sources that you know within your province/city, such as (coal) power plants and major heavy industries.

Please define if your province is characterised as urban area, peri-urban area or predominantly rural area.

- Urban area: Densely populated area with large business districts and industrial complexes, and/or power plants and intense traffic and road network.
- Peri-urban: Areas less densely populated than in city areas, yet influenced from nearby urban center(s). Often industries and (coal) power plants supporting the neighbouring cities are also located in these areas.
- Rural area: Not densely populated areas in which agricultural activities and tourism dominates.

For Northern Vietnam, Hanoi, Bắc Ninh and Hung Yen have been defined as urban areas (figure 16), while the provinces coloured in purple ("D" in the map) are defined as peri-urban and yellow areas ("E") as predominantly rural.

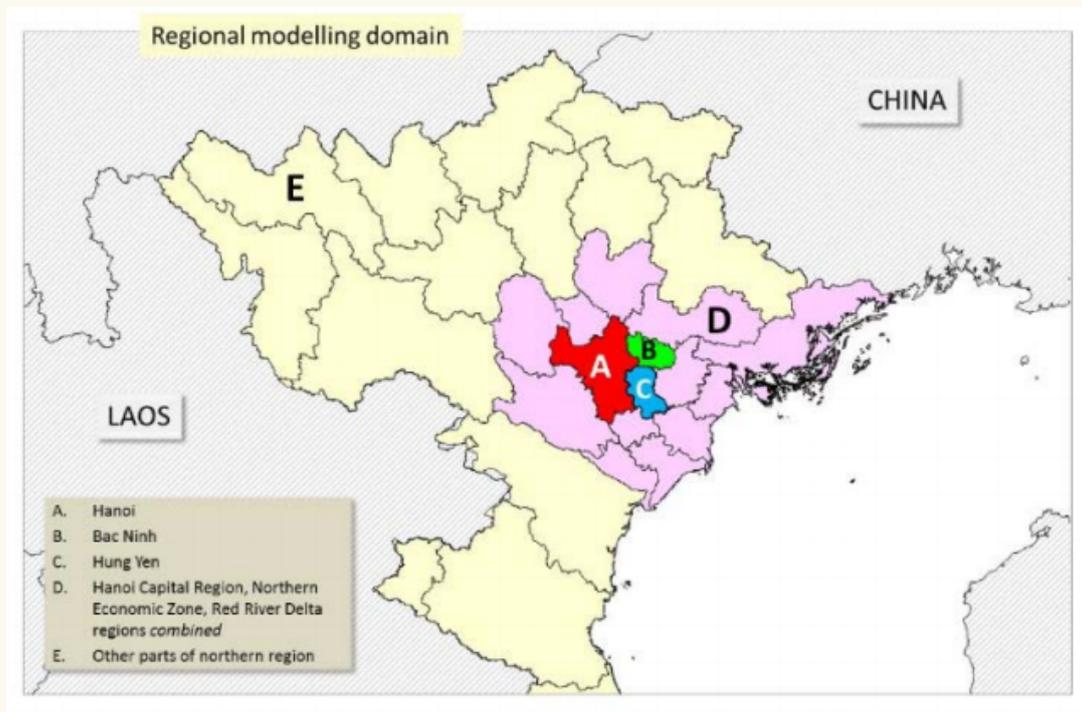


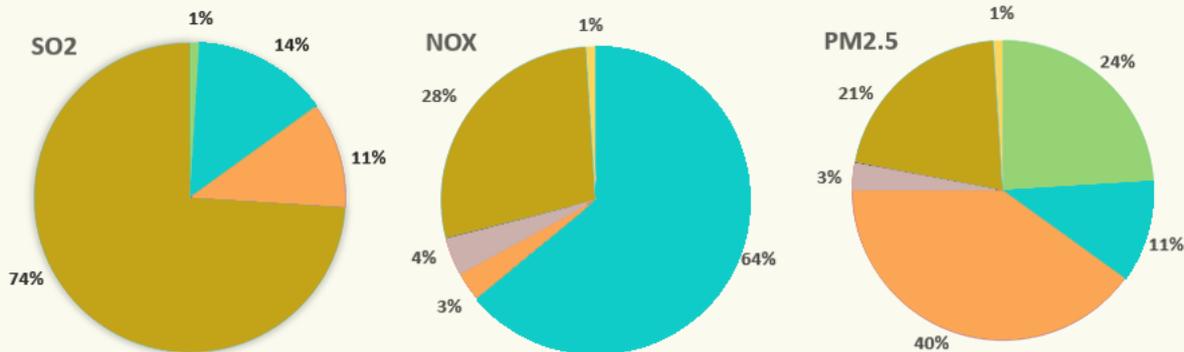
Figure 16: Provinces in Northern Vietnam defined as urban (A, B and C), peri-urban (D) and predominantly rural (E). Map based on Amann et al. (2019)

In Bắc Ninh, no (coal) power plant is located. In Greater Hanoi (pink provinces in figure 16) a total of 15 power plants are located, having produced in sum 58,989 GWh in 2019. In other Northern Vietnam provinces (yellow), only one power plant is located in Na Dương in the province of Lạng Sơn (837 GWh in 2019).<sup>3</sup> Please take the number of (coal) power plants into consideration when taking a look at the following examples for emission sources in (peri-)urban and rural provinces. Emissions from power generation might vary accordingly and needs to be weighted differently related to the number of power plants located in your province or city. Information about of the location and capacity of power plants can be found in the yearly Report of the National Load Dispatch Center.<sup>4</sup>

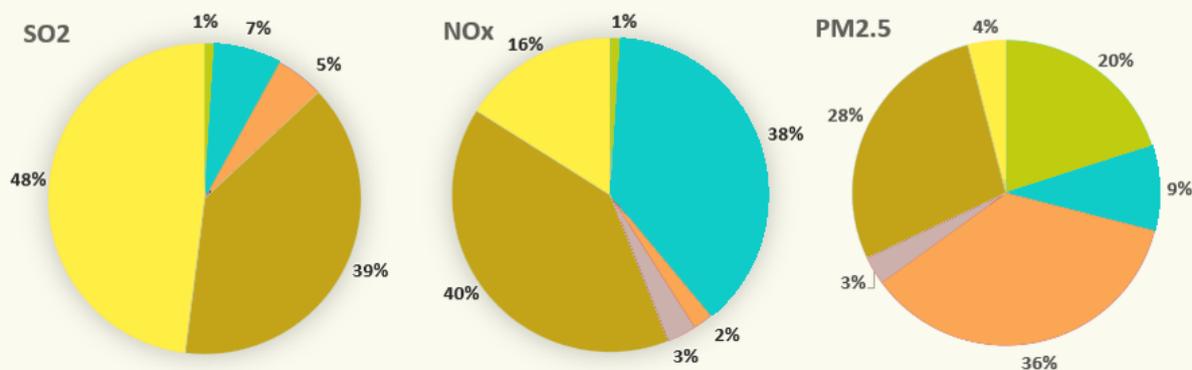
<sup>3</sup> National Load Dispatch Center (2020)

<sup>4</sup> National Load Dispatch Center (2020)

### EXEMPLARY EMISSION SOURCES OF AN URBAN AREA (BAC NINH)



### EXEMPLARY EMISSION SOURCES OF PERI-URBAN (GREATER HANOI)



### EXEMPLARY EMISSION SOURCES OF RURAL AREAS (NORTHERN VIETNAM)

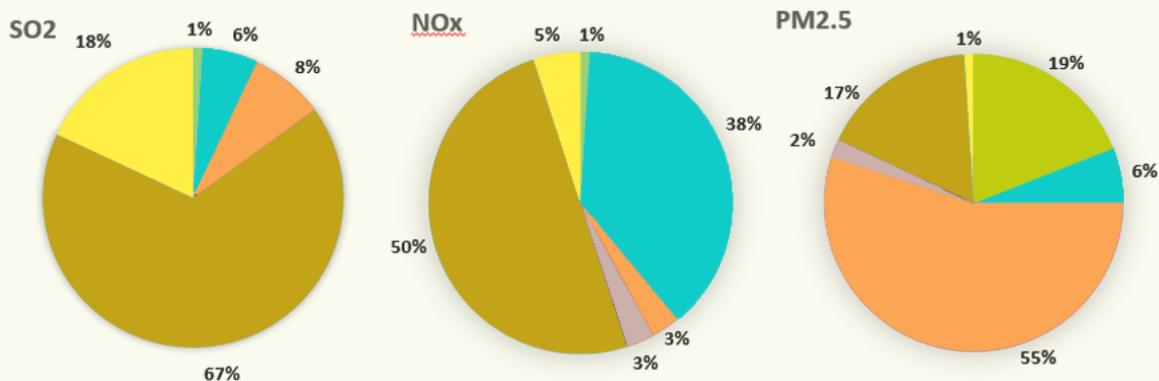


Figure 17: Exemplary emission sources in an urban area (Bac Ninh), for a peri-urban area (Greater Hanoi) and rural areas (Northern Vietnam) as orientation for provinces/cities of Category A to define sectors which might need to be focused on in the prioritization of AQM-activities to reduce certain kinds of air pollutants. Own graphs based on Amann et al. (2019)

- Agriculture incl. crop residue burning
- Transport
- Domestic/Residential
- Waste management
- Industry (industrial processes and industrial combustion)
- Power generation

Note that the emission sources presented are merely rough overviews of likely contribution rates in some provinces and only serve to get a first impression of possible main emission sources in your province.

As a second step it is suggested to evaluate if mayor complexes of potentially emission-intensive industries are located within the province. Potentially emission-intensive industries are<sup>5</sup>:

### INDUSTRIES WITH HIGH RISK TO CONTRIBUTE TO THE EMISSIONS OF AIR POLLUTANTS

- **METAL AND STEEL PRODUCTION** TSP, PM<sub>10</sub>, PM<sub>2,5</sub>, CO
- **(COAL) POWER PLANTS** TSP, PM<sub>10</sub>, PM<sub>2,5</sub>, SO<sub>2</sub>, NO<sub>x</sub> (NO<sub>2</sub>), CO
- **CEMENT PRODUCTION** TSP, PM<sub>10</sub>, PM<sub>2,5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, (NO<sub>2</sub>)
- **CHEMICAL/ FERTILIZER PRODUCTION:** HCl, HNO<sub>3</sub> (NO<sub>x</sub> (NO<sub>2</sub>)), H<sub>2</sub>SO<sub>4</sub> (TSP, SO<sub>2</sub>), NH<sub>3</sub>
- **MINERAL PRODUCTS** TSP, PM<sub>10</sub>
- **PULP AND PAPER PRODUCTION** PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>x</sub>

Figure 18: Heavy industries and main air pollutants related according to EMEP/EEA (2019)

Especially in peri-urban and rural provinces, it needs to be considered that these industries will increase their contribution in the estimated share of industrial and power generation within the province in the future. They also should be considered accordingly in the choice of priority AQM-activities by attributing them a higher effectiveness in emission reduction.

For the Air Quality Management Plan, a more detailed air pollutant emission inventory is needed. Therefore, it is crucial for provinces classified as Category A to build up the necessary structures and to carry out an initial emission inventory or a rapid emission inventory (rEI) for criteria and/or other air pollutants covering major sources. Suitable approaches and working aids are e.g. the [Global Air Pollution Forum \(GAPF\) EI Methodology](#) or the WHO Rapid Inventory Assessment (RIAS) approach.

#### Please note:

For the Air Quality Management Plan, a more detailed air pollutant emission inventory is needed. This makes it crucial for provinces classified as Category A to build up the necessary structures and to carry out an initial emission inventory or a rapid emission inventory (rEI) for criteria and/or other air pollutants covering major sources. Suitable approaches and working aids are e.g. the [Global Air Pollution Forum \(GAPF\) EI Methodology](#) or the WHO Rapid Inventory Assessment (RIAS) approach.

<sup>5</sup> EMEP/EEA (2019)

## Step D) Identify AQM-activities which correspond to the main emission sources

To identify the AQM-measures corresponding to the main emission sources in your city or province, it is suggested to identify the type of emission which exhausts the national technical regulation on ambient air quality (SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>...) in your province/city.

It is then suggested to use the information from your (preliminary) emission sources inventory to identify the main contributing sectors or processes to the release of this air pollutant. For the provinces or cities of different categories, the information sources are:

The AQM-activities identified as targeting main contributors to main types of pollutant exceeding the limit values in your city or province are listed in a short list.

### INVENTORIES AND INFORMATION SOURCES

- **CATEGORY A PROVINCE** Preliminary inventory of emission sources as established in Step C
- **CATEGORY B PROVINCE** Initial emission inventory or the rapid emission inventory
- **CATEGORY C PROVINCE** Default EFs or EFs from local academic research

*Figure 19: Information source for emission sources for cities or provinces of different categories.*

## Step E) Tailor AQM-activities to your province or city

Each province and city possess highly individual features regarding its socio-economic, landscape and climatic conditions, its pollution sources and ambient air quality. It is therefore necessary that the province's public authorities tailor each of the short-listed AQM-activities in the AQMA-table to these specific circumstances before they are further compared with a Cost-Effectiveness analysis.

The proposed activities in the AQMA-table are listed as non-specific activities. They can and need to be individualized and tailored by adjusting one or many of the following leverage points:

### KEY LEVERAGE POINTS TO INDIVIDUALIZE AQM-ACTIVITIES

- **SPATIAL RANGE**, e.g. carry out a district-specific pilot activity for especially affected areas instead of a province-wide activity
- **NUMBER OF STAKEHOLDER**, e.g. reduce or broaden the stakeholder, persons and groups affected by the activity
- **FOCUS INDUSTRIES/SECTORS**, e.g. establish the policy tools for certain focus sectors, mostly those having the biggest impact
- **TEMPORARY (PILOT) PHASE**, e.g. an initial test phase of a pre-defined length that enables a better estimation of investment and operational costs
- **TWIN ACTIVITIES**: Identify and jointly consider those AQM-activities, which needs to be complemented by another AQM-activity to be effective.
- **CO-BENEFITS AND SYNERGIES**: Identify synergies, (monetary) co-benefits and indirect monetary gains based on the activity to balance the costs of its implementation

*Figure 20: Possible leverage points that should be considered to tailor AQM-activities of the AQMA-table to the individual circumstances in your province or city.*

The outcome of this individualization process is a Shortlist of Individualized AQM-Activities for your city or province.

## Step F) (Preliminary) Cost-Effectiveness-Analysis for Prioritization

With the establishment of a Shortlist of Individualized AQM-Activities for your city or province, a preliminary prioritization of possible AQM-activities targeting main emissions and the most pressing issues has been made.

In STEP F, the individualized AQM-activities should now be analysed and ranked according to their costs and effectiveness. The Technical Guideline on Air Quality

## TECHNICAL GUIDELINES ON AIR QUALITY MANAGEMENT PLANNING

### COST-EFFECTIVENESS ANALYSIS FOR AQM MEASURES

Cost-effectiveness analysis for AQM measures can be done by one of the following methods

- Calculation to estimate cost-effectiveness of AQM measures
- Application of GAINS model

#### Method 1: Calculation to estimate cost-effectiveness of AQM measures

- Estimate cost: total annual cost (investment, operation, labor, and other costs) to implement AQM measures;
- Evaluate effectiveness of emission reduction: calculate emission amount reduced annually for air pollutants when implement AQM measures in comparing to BAU case;
- Cost-effectiveness of the AQM measure is calculated as the total annual cost divided by the reduced emission amount

#### Method 2: Application of GAINS model

GAINS model can be applied to assess AQM measures with least cost while consider other factors (i.e. health impact, ecosystem and GHG mitigation)

GAINS Asia model can be accessed online (free of charge) at: [https://gains.iiasa.ac.at/gains/ASN/index.login?logout=1&switch\\_version=v0](https://gains.iiasa.ac.at/gains/ASN/index.login?logout=1&switch_version=v0)

### 3. Developing matrix for cost-effectiveness analysis for AQM measures

*Figure 21: Annex 5 of the Technical Guideline on Air Quality Management Planning on the cost-effectiveness analysis as approach to identify priority AQM-measures*

Management Planning suggests to use a Cost-Effectiveness Analysis as method to evaluate the individualized AQM-activities.

Related to Air Quality Management, a Cost-Effectiveness Analysis evaluates the costs to plan and implement AQM-activities against their contribution towards the objectives to reduce the emissions of air pollutants and related health impacts.<sup>6</sup>

Due to the existing differences in experiences with Air Quality Management Planning within Vietnamese provinces and cities, it is recommended to use the different Methods as indicated in the Technical Guideline, in accordance to the Category of your province or city.

### Category B and Category C provinces and cities:

Category B and Category C provinces already possess an emission inventory. They can use Method 2: Application of [GAINS](#) model. Together with the [AirQ+](#) model from the World Health Organization these computer-based models support to carry out a Cost-Effectiveness Analysis. Another suitable model is [LEAP-IPC](#). For data input,

<sup>6</sup> Amann et al. (2004), Amann et al. (2011), Voß et al. (1992)

provinces and cities can use their emission inventory and additional data regarding health and costs. Level 2 and Level 3 provinces can continue reading at Step G.

### Category A provinces and cities:

Category A provinces and cities might not possess yet the necessary input data to carry out a CEA with programs such as GAINS, LEAP-IPC or WHO AirQ+. They should therefore opt for Method 1: Calculation to estimate cost-effectiveness of AQM measures

However, a detailed CEA taking into account all effects and costs of all activities needs high amounts of working time and personal. It is therefore suggested to carry out a Preliminary Cost-Effectiveness Analysis to pre-define suitable AQM-activities. Different from the detailed CEA, the Preliminary CEA is a relatively rough estimation of costs and effects, but still serves as a good method to compare different AQM-activities. However, also within this rough estimation, it must be ensured that no major cost factor and effect is forgotten.

#### i. Effectiveness

Category A provinces and cities should consider three objectives when evaluating the effectiveness of AQM-measures: Most important, the effectiveness of emission reduction, then the effectiveness to reduce negative impacts on human health and possible co-benefits.

#### Effectiveness of emission reduction

According to the Technical Guideline, the effectiveness of emission reduction shall be evaluated based on the emission reductions achieved from the start of the activity compared to a business-as-usual emission output scenario without the implementation of the activity in question. Types of air pollutants that shall be considered are PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, CO, and O<sub>3</sub>.

With the activities at the Shortlist of Individualized AQM-Activities, activities and solutions having the potential to reduce main emission sources and types of pollutants at the individual province or city have already been identified.

There are however, two variables which might need to be considered when evaluating the effectiveness of the AQM-activities in the individualized shortlist:

- Changes in main contributors to future emissions

The Technical Guidelines define that the effectiveness of emission reduction shall also consider the future impacts of the AQM-activity related to emission reduction.

A recent study from Amann et al. (2019) concludes that "emissions from the power sector will be responsible for the largest increase in ambient PM<sub>2.5</sub> in northern Vietnam between 2015 and 2030". Regarding the actual economic development in Vietnam and the energy planning described in the PDP7 revised, it is likely that this is also true for

other provinces, especially those near to or being part of urban conglomerations. One might follow from this that besides the activities to reduce currently exceeded air pollutants, it is advisable to also focus on those AQM-activities for the industrial and power sector having the potential to prevent high emission outputs in future industries and power plants.

- Policy tools and emission reduction effectiveness

Within a preliminary analysis of the effectiveness of AQM-activities, it also needs to be considered that the type of policy tool used has an effect on the effectiveness of emission reduction in terms of quantities, its costs and the time in which the emission reduction is achieved. For example, regulatory AQM-activities might, if carried out suitably, lead to a quick and broad emission reduction, but with higher costs, while economic/incentive-based and participatory/cooperative AQM-activities need more time to be effective. Planning tools can be highly effective but need longer time until the emission reduction takes place. The last is also true for educative policy tools.

### Reduce negative impacts on human health

Health benefits are the most direct benefits from emission reductions of air pollutants. They are usually measured in mortality and morbidity effects. For Category A provinces and cities, it is suggested to focus on the improvement of ambient air quality and estimate the reduction of negative health impacts as directly dependent on air quality improvements.

Furthermore, there are also AQM-activities which do not aim to reduce emissions but target the reduction of health effects once emissions are released. With a CEA, they are difficult to compare with AQM-activities aiming to reduce emissions. For the priority setting using Method 1, it is suitable to consider them as an additional argument in favour of certain AQM-activities.

### Co-benefits

AQM-activities might also have positive effects in other sectors. The introduction of tele-monitoring advices in industrial stacks for example might lead to a support of new innovations in industries planning to produce such equipment. Other important co-benefits are related to Vietnam's goals related to climate protection in the form of Nationally Determined Contributions ([NDCs](#)). Such indirect effects need to be considered in a CEA, for example by giving AQM-activities with the potential of a high emission reduction and similar co-benefits priority over alike AQM-activities without co-benefits.

## ii. Costs

For Category A provinces, the Technical Guideline on Air Quality Management Planning give a first description of the elements which shall be considered within the calculation of costs and benefits for the individual AQM-activities. For costs it defines:

### TECHNICAL GUIDELINES ON AIR QUALITY MANAGEMENT PLANNING

#### COST-EFFECTIVENESS ANALYSIS FOR AQM MEASURES

[...]

##### Method 1: Calculation to estimate cost-effectiveness of AQM measures

- Estimate cost: total annual cost (investment, operation, labor, and other costs) to implement AQM measures;

*Figure 22: Annex 5 of the Technical Guideline on Air Quality Management Planning on Method 1 for a cost-effectiveness analysis as approach to identify priority AQM-measures*

The Guideline differentiates between investment, operation, labour and other costs needed for the successful implementation of each activity.

It is additionally suggested to consider the costs for two stakeholders: for the responsible authority and for the affected entities.

#### Costs for the responsible authority

As already stated, costs arising for the responsible authority to successfully implement the AQM-measure are investment costs and operational costs.

They can be further determined by using different cost factors, which cover personnel and other:

#### MAIN COST FACTORS FOR THE PUBLIC AUTHORITY

COST OF INVESTMENT	COST OF OPERATION
• ADMINISTRATION	• ADMINISTRATION
• CAPACITY BUILDING	• -
• COORDINATION	• COORDINATION
• EQUIPMENT	• EQUIPMENT
• FURTHER EMPLOYEES	• FURTHER EMPLOYEES
• NEW REGULATION	• MONITORING & ENFORCEMENT

*Figure 23: Overview of cost factors for public authorities as basis for Cost-Effectiveness analysis*

You will find a short definition of each main cost factor in chapter 2.

The cost factors above might not be complete and may also partly overlap. Therefore, they merely function as basis for a detailed cost-effectiveness analysis.

To receive a rough outline of the costs for the public authority, the individual steps necessary to carry out the activity needs to be identified. This includes preparatory measures such as planning, capacity-building and the establishment of the necessary administration, the operational steps as such, as well as monitoring and reporting. Then, it needs to be estimated if one or some of the cost factors apply for each of the implementation steps. Then, the expenditure needs to be roughly estimated in person-days (personnel) or in monetary value (transport and equipment costs).

Working time for the necessary coordination with other authorities or affected stakeholders is often forgotten or highly underestimated in the calculation of personnel costs. Considering that nearly all AQM-activities are inter-sectoral measures which demand the cooperation between different departments on the province level, it is important to include this cost factor in the overall calculation.

The combined equipment costs and [working-days](#) (which might be also expressed in personnel cost) give a rough overview of the possible expenses related to the activity.

### Costs for Affected Entities: Compliance costs

The consideration of added costs for stakeholder affected by the AQM-activity is crucial even when carrying out only a Preliminary Cost-Benefit-Analysis. As outlined in chapter 3f, a cost-analysis for affected entities includes direct and indirect costs that occur to stakeholders when they need to meet the new standard. These compliance costs<sup>7</sup> should be defined for the most relevant groups of stakeholders, e.g. farmers, households, owners of small, medium and large businesses, workers and others.

The Technical Guidelines on Air Quality Management Planning does not explicitly mention cost factors for affected entities. It is nonetheless advisable to take them into consideration.

The following table shows factors for compliance costs for affected entities. The definition of each cost factor can be found in chapter 2:

- **ADMINISTRATION COSTS**
- **CAPACITY BUILDING COSTS**
- **CONTINGENT COSTS**
- **COORDINATION COSTS**
- **EQUIPMENT COST**

*Figure 24: Overview of cost factors for affected entities as basis for Cost-Effectiveness analysis*

In the Preliminary CEA for Category A provinces and cities, the compliance costs should be calculated in absolute, aggregate terms. Costs which are optional (e.g.

---

<sup>7</sup> Oosterhuis et al. (2006)

either entities pay for the new equipment, or they pay the fine) shall be calculated as if they prefer to meet the new standards. Indirect costs such as opportunity costs and social costs are for methodical reasons also not included in the preliminary cost analysis. Some cost factors may also (partly) overlap, which needs to be taken into account accordingly.

If a promising AQM-activity is identified as very cost intensive, it is suggested to evaluate if it can be modified by using different policy tools leading to the same objective. The leverage points to do this were already presented in chapter 2:

### IMPACTS OF POLICY TOOLS ON COSTS

- **Spatial range of the activity**
- **Number and type of stakeholder**
- **Focus industries/sectors**
- **Temporary (pilot) phase**
- **Co-benefits and synergies**

*Figure 25: Policy tools having an impact on the actual costs of Air Quality Management activities*

The modified AQM-activity can then be considered by the prioritization of the shortlisted, individualized AQM-activities.

At the end of the implementation of Step E stands...

- for Category A provinces/cities a Preliminary Prioritized AQM-Activity List and a related Preliminary Overview of Costs and Effects of AQM-activities for the local Air Quality Management Plan.
- For Category B and Category C provinces/cities an optimized Cost-Effectiveness Analysis for different policy options based on GAINS and AirQ+

### **Step G) Evaluation of social impacts of preliminary prioritized activities**

The proposed AQM-activities in a (preliminary/optimized) Cost-Effectiveness Analysis now needs to be analysed according to possible additional costs for individual stakeholder groups. A special focus should here be laid on less advantaged groups such as poor households and small farmers.

To identify also hidden social costs, it is strongly recommended to carry out a participatory workshop with stakeholder groups and hear their proposals and feedback for individual AQM-activities.

If social costs are identified and found as being too high or disproportionate, it is strongly suggested to tailor the related AQM-activity to a more favourable scheme with less social costs.

## Step H) Integration of AQM-activities into Air Quality Management Plans

Once the prioritized measures have been identified, their implementation details as well as their integration into the air quality management plans have to be planned. The description of the activities in the management plans should contain all relevant information for the implementation of the measure, in order to make the provinces plan each measure properly, to facilitate the follow-up of the activities, and to provide sufficient information to all parties interested in the management plans.

The following format is recommended when describing the priority measures in the air quality management plan:

### EXEMPLARY FORMAT TO DESCRIBE PRIORITY MEASURES IN AIR QUALITY MANAGEMENT PLANS

- Short title with the essence of the activity
- Field of action
- Objective of the activity
- Authorities in charge of the implementation: Department(s) + sub-department(s)/teams
- Short description of the measure
- Target group
- Sub-measures + implementation schedule (schedule if needed, especially for pilot projects)
- Milestones and Timescale of their implementation
- Implementation monitoring (Key performance indicators for implementation)
- Expenses
  - Investment costs (One-time costs, at least rough estimation)
  - Operating costs (Running costs, at least rough estimation)
- **(Potential) Funding source** (Grant from third parties)
- Effectiveness (Emission reduction potential)
- Further information (Details on the implementation plan, e.g. a link to a separate document or to a website, or a reference to an appendix)

Figure 26: Exemplary structure to describe priority measures in Air Quality Management Plans

The air quality management plan should not be a wish list with possible activities that remain on paper, but a basis for action that will be implemented in practice within the respective period envisaged by the plan. It therefore needs to be sufficiently precise and the mandate to the competent authority or the requirement for citizens or businesses needs to be clear.

For two AQM-activities selected from the AQMA-table, one from the industrial sector and one from the transport sector, the appendix demonstrates how AQM-activities need to be described in the provincial air quality management plans. These two

examples can serve as a template for other AQM-activities and give further orientation as to the detail of information necessary.

The two exemplary AQM-activities from the transport and industrial sector are:

- A) Quarterly roadside vehicle emission tests (TRANSPORT SECTOR)
- B) Pilot project to support industrial plants in retrofitting to use waste-to-heat with flue-gas cleaning equipment (INDUSTRIAL SECTOR)

### 3. A chapter on emergency measures

The revised LEP explicitly mentions emergency measures as a further policy tool besides the local Air Quality Management Plans that shall be implemented in the provinces and cities.

The LEP and the related Technical Guideline do not include further descriptions or definitions of emergency measures. The revised LEP also merely refers to the term serious pollution as a trigger for emergency measures.

In general, emergency measures can be defined as safeguard measures in a state of a critically exceeded quantity of harmful air pollutants in the ambient air, thus having the aim to limit negative health impacts for the population by either rapid emission reductions and/or the prevention of serious health impacts.

If used in air quality management, emergency measures can be divided in two types:

#### 1. Emergency measures for a rapid emission reduction

This type of emergency measures is used for a short period of time to reduce the emissions and therewith the sources of air pollutants within a province or city. It usually consists of bans and needs to be accompanied with a coordinated dissemination of information and comprehensive monitoring and enforcement activities.

Emergency measures responding to emission reduction can be found in the

#### PROFILE: EMERGENCY MEASURES FOR A RAPID EMISSION REDUCTION

- **MAIN COST FACTORS FOR THE PUBLIC AUTHORITY:** High monitoring and enforcement costs, high coordination costs for the promulgation of the orders
- **MAIN COST FACTORS FOR THE AFFECTED ENTITY:** Due to the suspension of activities, this type of emergency measures go along with losses due to the interruption of business and production activities, and an associated loss of income.
- **CO-BENEFITS** Usually only short-term health co-benefits, e.g. a reduction of health impacts from strongly exceeded air pollutant concentrations in the ambient air
- **TIME SPAN:** Measures are directly implemented. Usually result in a prompt emission reduction if implemented entirely and consequently.

*Figure 27: Characteristics of emergency measures for a rapid emission reduction*

AQMA-table within different sectors. They usually include temporary measures such as temporary bans of operation of industrial facilities and power plants, of agricultural residue burning, temporary driving bans for cars and related

compensatory measures (e.g. offering more public transport if cars are temporarily not allowed).

## 2. Emergency measures for the reduction of health impacts for citizens

This type of emergency measures usually consists of restrictive measures and the dissemination of information about behavioural advices to reduce the health impact of strongly exceeded air pollutant values in the ambient air. A coordinated dissemination of information with a special focus on high risk groups is here crucial.

### PROFILE: EMERGENCY MEASURES TO PROTECT CITIZENS' HEALTH

- **MAIN COST FACTORS FOR THE PUBLIC AUTHORITY:** High coordination costs for the promulgation of the behavioural advices, added by monitoring and enforcement costs.
- **MAIN COST FACTORS FOR THE AFFECTED ENTITY:** This type of emergency measure might go along with restrictions of daily activities including income-generating activities.
- **CO-BENEFITS** Usually only short-term Co-benefits, e.g. a possible reduction of health impacts
- **TIME SPAN:** Measures are directly implemented and have direct effects.

Figure 28: Characteristics of emergency measures to reduce health impacts

Emergency issues to protect citizens' health can be found in the AQMA-table under EMERGENCY HEALTH. However, the threshold of serious pollution introduced by the revised LEP that triggers emergency measures needs to be further defined.

Emergency measures to reduce negative health impacts should be part of the local Air Quality Management Plans. Nonetheless, it is suggested that the local AQM-Plans focus on preventive AQM-activities to reduce emissions of air pollutants, while emergency measures should only complete the package of AQM-activities.

The green box gives you further information on a possible emergency response plan, as it is established by the government of India.

### CASE STUDY: INDIA'S GRADED RESPONSE ACTION PLAN

India introduced a 4-stage emergency action plan, depending on the exceedance of limit values for PM<sub>2.5</sub> and PM<sub>10</sub>.

The plan defines limit values, as well as immediate activities and the entity responsible for its implementation in case that they are exceeded. Emergency activities reach from measures to reduce emissions in transport, industry, construction, agriculture, to health protection measures.

More information in [India's National Clean Air Programme](#) (up from page 79)

## Sources

Amann, Klimont, An Ha et al. (2019): Future air quality in Ha Noi and Northern Vietnam. Available online: <http://pure.iiasa.ac.at/id/eprint/15803> (31.10.2020)

Amann, M., I. Bertok, J. Borken-Kleefeld, J. Cofala, C. Heyes, L. Höglund-Isaksson, Z. Klimont, B. Nguyen, M. Posch, P. Rafaj, R. Sandler, W. Schöpp, F. Wagner and W. Winiwarter (2011): Cost-effective control of air quality and greenhouse gases in Europe: Modeling and policy applications. In: Environmental Modelling & Software26: 1489-1501

Amann, M., J. Cofala, C. Heyes, Z. Klimont, R. Mechler, M. Posch and W. Schöpp (2004): RAINS REVIEW 2004 -The RAINS model. Documentation of the model approach prepared for the RAINS peer review 2004: 1-156

EMEP/EEA (2019): EMEP/EEA air pollutant emission inventory guidebook 2019: Technical guidance to prepare national emission inventories. Available online: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019> (05.11.2020)

IASS/UfU/GreenID (2020): Making the Paris Agreement a success for the planet and the people of Vietnam. Unlocking the co-benefits of decarbonising Vietnam's power sector. COBENEFITS Policy Report. Potsdam/Hanoi. [www.cobenefits.info](http://www.cobenefits.info)

Government of India (2019): India's National Clean Air Programme. Available online: [http://moef.gov.in/wp-content/uploads/2019/05/NCAP\\_Report.pdf](http://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf) (05.11.2020)

Government of Vietnam (2020a): Revised Law on Environmental Protection

Government of Vietnam (2020b): Technical Guideline on Air Quality Management Planning

Government of Vietnam (2015): Intended Nationally Determined Contribution of Viet Nam. Available online: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Viet%20Nam%20First/VIETNAM'S%20INDC.pdf> (06.11.2020)

IIASA GAINS Asia model. Available online: [https://gains.iiasa.ac.at/gains/ASN/index.login?logout=1&switch\\_version=v0](https://gains.iiasa.ac.at/gains/ASN/index.login?logout=1&switch_version=v0) (06.11.2020)

National Load Dispatch Center (2020): Annual Reports. Available online: <https://en.evn.com.vn/c3/gioi-thieu-l/Annual-Report-6-13.aspx> (10.11.2020)

Oosterhuis et al. (2006): Ex-post estimates of costs to business of EU environmental legislation Final report. Berlin: Ecologic Institute. Available online: [https://www.ecologic.eu/sites/files/project/2013/1750-01\\_final\\_report.pdf](https://www.ecologic.eu/sites/files/project/2013/1750-01_final_report.pdf) (05.11.2020)

Stockholm Environment Institute (SEI): Low Emissions Analysis Platform and LEAP-IPC model. Available online: <https://leap.sei.org/default.asp?action=introduction> (06.11.2020)

Voß, Alfred; Schmid, Günter (1992): Cost-effectiveness analysis of air pollution control measures. Available online: <https://core.ac.uk/reader/147539655> (05.11.2020)

World Health Organization: AirQ+ software. Available online: <https://www.euro.who.int/en/health-topics/environment-and-health/air-quality/activities/airq-software-tool-for-health-risk-assessment-of-air-pollution> (06.11.2020)

## List of abbreviations

AirQ+	Air Quality Plus model
AQM	Air Quality Management
AQMA	Air Quality Management Activities
BAU	Business-As-Usual
CEA	Cost-Effectiveness Analyses
CO	Carbon monoxide
DARD	Department of Agriculture and Rural Development Vietnam
DOC	Department of Construction Vietnam
DONRE	Department of Natural Resources and Environment Vietnam
DPI	Department of Planning and Investment Vietnam
EIA	Environmental impact assessment
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies
GHG	Greenhouse gas
GreenID	Green Innovation and Development Centre
HCl	Hydrogen Chloride
H <sub>2</sub> SO <sub>4</sub>	Sulfuric acid
HNO <sub>3</sub>	Nitric acid
IKI	International Climate Initiative
LEAP	Low Emissions Analysis Platform
LEP	Law on Environmental Protection
MARD	Ministry of Agriculture and Rural Development Vietnam
MOH	Ministry of Health Vietnam
MOIT	Ministry of Industry and Trade Vietnam
MONRE	Ministry of Natural Resources and Environment Vietnam
MOP	Ministry of Power
MPI	Ministry of Planning and Investment Vietnam
MW	Megawatt
NDC	Nationally Determined Contributions
NH <sub>3</sub>	Ammonia
NO <sub>x</sub>	Nitrogen Oxides
O <sub>3</sub>	Ozone
PDP7 rev.	Power Development Plan 7 revised
PM	Particulate Matter
PV	Photovoltaic
RE	Renewable Energy
SO <sub>2</sub>	Sulfur Dioxide
TSP	Total Suspended Particles
UfU	Independent Institute for Environmental Issues
VND	Vietnamese Dong
WHO	World Health Organisation

## Appendix: Format of AQM–measures for air quality management plans

### Quarterly roadside vehicle emission tests

<b>Field of action</b>	Road traffic	No.	M1
<b>Objective</b>	Emission control of road vehicles		
<b>Responsible authority</b>	Department of Natural Resources and Environment, People's Committees of districts and cities		
<b>Target group</b>	Private and commercial drivers of cars, motorcycles and trucks		
<b>Description</b>	On-road testing of vehicle emissions, potentially as part of the regular vehicle inspections. The tests will be carried out every three months at major streets within the province. Drivers are asked to pull off the road and approach an inspection point close to the road. Trained staff tests the emission levels of exhaust gases with portable emission analysis devices. Depending on the vehicle's emission levels, vehicle owners will receive information, pay monetary fines, or are obliged to repairs, upgrades or vehicle exchanges.		
<b>Sub-measures</b>			
M1.1	Determination of responsible staff or team in charge of carrying out the emission tests.		
M1.2	Capacity-building of responsible staff on: <ul style="list-style-type: none"> <li>National legal context (Decision No. 909 / QD-TTG Scheme on controlling emissions of motorcycles and motorcycles in traffic in provinces and cities)</li> <li>National technical standards (National standard TCVN 6208: 2014 on Vehicle emissions measuring instruments; National standard TCVN 6438: 2018 on Road vehicles - Permitted maximum limit of exhaust gas)</li> <li>Types of emission measuring instruments and their use</li> <li>Other.</li> </ul>		
M1.3	Set emissions to be tested and emission levels for vehicles if not prescribed by the nation technical standards. Aim at measuring carbon monoxide, carbon dioxide, hydrocarbons, oxygen, diesel smoke (Black Carbon), and preferably nitrogen oxides.		
M1.4	Specify awareness raising measures, incentives and sanctions for different levels of measured emissions defined in M1.3.		

	Consider and specify, for example, the following system: Vehicle owners with low emission results may continue driving and will be provided with a certificate that will exempt them from further emission tests in the next 2 years. Vehicle owners with medium emissions will be provided with information material on the impacts and harms of exhaust emissions, clean fuels and vehicles, repair, low-smoke lube oils, and on existing subsidy programs. In addition, vehicle owners will be encouraged to carry out minor repairs such as tuning, cleaning air filters, and cleaning or replacing spark plug. Vehicle owners with high emissions will be provided with information material, and are informed that in the future, access with this type of vehicle access to inner city areas might not more be possible in the future. Finally, vehicle owners with very high emissions are obliged to compulsory repairs or upgrades.
M1.5	Preparation of information material for awareness raising.
M1.6	Establish cooperation with vehicle manufacturers, oil product manufacturers, service stations, leasing companies, or environment/energy funds for incentivizing products or programs, such as free lube oil, free tune-ups, coupons for repairs, remissions on insurances, subsidy programs, etc.
M1.7	Purchase of portable emission measuring devices or identification of lending possibilities.
M1.8	Planning and logistics for the roadside emission testing days: Define locations, choose date, define the type and amount of vehicles to be tested, organize emission measuring instruments, organize equipment and materials for inspection points, organize and hire staff for emission testing days, develop a shift plan for all involved staff, and other.
M1.9	Carrying out roadside emission tests for two days every three months.
M1.10	Collect data from all districts (type of vehicle and engine, emission testing results, number of distributed information leaflets, collected fines, ordered repairs, vehicle confiscation) and centralize data collection in the DONRE.

### Milestones and timescale for their implementation

No.	Milestone	Planned to be implemented until:
1	Coordination team for quarterly roadside emission tests has been established and trained	Enter date
2	A province-wide plan on the emissions to be tested, emission levels, and incentives and sanctions for each tested level has been formulated and disseminated to the districts	Enter date
3	An operating and logistics plan for the quarterly emission testing events has been developed by the DONRE and the competent district authorities	Enter date
4	A database for the collection of the data of all emission testing events and sites has been established at the DONRE	Enter date

5	The first quarterly emission testing events throughout the province took place	Enter date
---	--	------------

### Implementation monitoring: Key performance indicators

Indicator A:

At least 3 portable emission measuring devices have been purchased by the province's DONRE

Indicator B:

x (e.g. 500) vehicles have been tested in one day at one testing site, i.e. 1000 vehicles during the duration of the 2-day testing event

Indicator C:

The testing sites have been installed and used for x days per year.

Indicator D:

At least x vehicle owners have been informed about on the impacts of exhaust emissions, clean fuels, clean vehicles, repairs, low-smoke lube oils, and on existing subsidy programs per day at one testing site, i.e. 700 vehicle owners during the duration of the 2-day testing event.

Unit	Baseline at the start of the activity	Target value
Number of portable emission measuring devices	X devices	Y devices
Number of tested vehicles	X per day per testing site	y per day per testing site
Number of days of testing with emission measuring devices	X days per device	Y days per device
Number of disseminated information material	X per day per testing site	y per day per testing site

### Costs

#### Investment costs

Investment	Planned expenses	Comments
Portable emission measuring devices	x VND per device	

Equipment for inspection points	Enter estimated costs	
Other (please add)	Enter estimated costs	
Operation Costs		
Activity	Planned expenses	Comments
Printing costs for information material	Enter estimated costs	
Staff during testing days	Enter estimated costs	
Other (please add)	Enter estimated costs	
<b>Funding</b>	If funding was secured from the national level, companies or (inter)national funds, enter the information here	
<b>Effectiveness (Emission reduction)</b>	<p>Ability to reduce emissions of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>x</sub>.</p> <p>Emission potential can be estimated based on the target value of vehicles tested per testing site (Indicator B) times days of emission testing devices used (Indicator C) multiplied by the average emission reduction potential per vehicle if repaired, under consideration of a factor estimating how many of the tested vehicles will be repaired as average.</p>	
<b>Further information</b>	E.g. implementation plan for the proposed action as a separate document, other main documents, e.g. link to the website, etc.	

## Pilot project to support industrial plants in retrofitting to use waste-to-heat with flue-gas cleaning equipment

Field of action	Industry	No.	E22
Objective	Reduce emissions of industrial plants by introducing new fuels for power, heat and energy generation		
Responsible authorities	Department of Natural Resources and Environment, Department of Industry and Trade, Department of Planning and Investment, People's Committees of districts and cities		
Target group	Private and public companies		
Description	Pilot project to support the retrofitting of industrial plants in the use of waste-to-heat with flue-gas cleaning equipment instead of conventional fuels. Suitable fuel substitutes are low-pollutant, high calorific value mass wastes such as waste oil, sewage sludge, animal meal/animal fat, organic solvents, plastic waste, used tires or wood waste. The pilot project can focus – dependent on the individual conditions in each province - on voluntarily participating industrial plants of one industrial sector with high emissions or located at an industrial area near to an urban area. The pilot project should combine awareness-raising activities with supporting measures for the retrofitting with waste-to-heat with flue-gas cleaning equipment, such as support in the procurement of suitable technologies and their providers, training courses for plant managers and the combination of subsidies for participating companies with a co-payment from the company.		

The immediate action's character as a pilot project makes it necessary to divide the sub-measures into two categories: The project planning and the project implementation. The local Air Quality Management Plan aims to share information related to both aspects. Thus, it is highly recommended to start this AQM-activity already as an immediate action before the local AQM Plan is finalized. Only this way, information regarding the implementation planning can be integrated into the plan.

Sub-measures	
<b>1. Sub-measures: Project planning</b>	
E 1.1	Establish a project management team consisting of staff members from DONRE, DIT, DPI, the Provincial/City People's Committee and other necessary authorities

E 1.2	Development of a project plan including project duration, targets, indicators, milestones, the assignment of responsibilities, budget planning, timetable and necessary capacity-building activities	
<b>2. Sub-measures: Project implementation</b>		
E 2.1	Define responsible staff for the implementation of different working packages of the projects and carry out capacity-building activities (or carry out the necessary research) related to: <ul style="list-style-type: none"> <li>• Legal context and technical standards</li> <li>• Existing technologies</li> <li>• Project management</li> <li>• and other</li> </ul>	
E 2.2	Establish contacts to technical experts in universities and other supporting the project with technological knowledge	
E 2.3	Establish and regularly updated list of suitable technologies and manufacturers for waste-to-heat and flue-gas cleaning equipment	
E 2.4	Identify and establish funding options and financial schemes for the state subsidies (VEPF, MPI, MOF, other) and for the companies (banks, VEPF small funds, other).	
E 2.5	Identify, prepare and establish "soft" incentives for local companies to take part in the pilot project (website, award, positive publicity...)	
E 2.6	Develop a planning guideline with step-by-step activities how interested companies are supported from showing interest to the installation and monitoring of the equipment	
E 2.7	Specify an awareness-raising campaign, prepare, publish and distribute information material	
E 2.8	Define and identify suitable companies for the pilot project and establish contacts with them	
E 2.9	Prepare and carry out administrative and technological workshops and information events for company managers and technical staff from interested companies	
E 2.10	Implement the planning guideline and install equipment at interested companies	
	...	
<b>Milestones and timescale for their implementation</b>		
No.	Milestone	Planned to be implemented until:
1	A detailed project plan has been developed by the project team	Date
2	A list of suitable technologies and manufacturers is developed	Date
3	1 funding option for public authority and 2 financial schemes for the participating companies are established	Date
4	Brochures and information about the pilot project and advantages of waste-to-heat technologies have been distributed to x companies	Date
5	X workshops with x participants from local companies have been carried out	Date

6	X interested companies are formally participating in the pilot project	Date
---	--	------

**Implementation monitoring: Key performance indicators**

Unit	Baseline at the start of the activity	Target value
A) 1. Number of companies taking part in workshops	0	y
A) 2. Number of companies having received information material	0	y
B) Number of companies with waste-to-heat and flue-gas cleaning equipment	x	y

Indicator A:  
 X companies have been informed about advantages, finance options, technical options and soft incentives of retrofitting with waste-to-heat technologies with flue-gas cleaning equipment, out of which x companies through workshops (1) and x companies through brochures (2)

Indicator B:  
 X companies have retrofitted their heat generation with waste-to-heat and flue-gas cleaning equipment

**Costs (Public authority)**

**Investment costs**

Investment	Planned expenses	Comments
Capacity-building activities	To be defined.	
Material costs and costs of distribution for the awareness-raising campaign	To be defined.	
Other (please add)		

**Operation costs**

Activity	Planned expenses	Comments
Personnel costs for project management (added personnel within public authority)	To be defined.	

Contracting of external experts	To be defined.	
Other (please add)	...	
Funding	If funding was secured from the national level, companies or (inter)national funds, enter the information here	
Effectiveness (Emission reduction)	<p>Potential to reduce a broad range of emissions.</p> <p>Emission potential can be calculated based on target value of companies to be retrofitted, average emission values of companies with comparable size, production and output when using previous technology, compared with average emission values/emission reduction potential of waste-to-heat technologies with flue-gas cleaning equipment.</p>	
Further information	Include the project plan into the Management Plan, include other information material, e.g. in the annex or as separate document	



contracted by:

