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# Improving Emission Regulation for Coal-fired Power Plants in ASEAN

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This report was prepared by the Working Group for the 'Improving Emission Regulations for Coal-fired Power Plants in ASEAN' study under the Economic Research Institute for ASEAN and East Asia (ERIA) energy project. Members of the Working Group, who represent the participating East Asia Summit (EAS) region countries, have discussed emission regulations for coal-fired power plants and the current management system situation. The study is aimed at deriving policy implications, not developed for commercial or business use. The Working Group is not responsible for any loss caused by using the scenarios in the study outcomes.

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## Foreword

Reserved underground in many Association of Southeast Asian Nations (ASEAN) member countries, coal allows power generation at a lower cost than other fuels. In the ASEAN member countries, power consumption has increased along with their economic growth, and further increases in coal-fired power generation are expected. Coal is one of the cheapest power generation fuels in terms of cost, but its demerit is that it emits more air pollutants harmful to human health than other fuels. For this reason, the countries using coal-fired power generation have enacted standards to regulate air pollutants from coal-fired power plants. The bottom line is whether a management system has been established and whether it is functioning for effectively monitoring emission standards. This study examined and compared the emission standards for air pollutants from coal-fired power plants and their management systems in some Organisation for Economic Co-operation and Development (OECD) member countries and the ASEAN member countries. This analysis will provide further policy development options for reducing air pollutants from coal-fired power plants.

It is our hope that the outcomes of this study will serve as a point of reference for policymakers in ASEAN countries and contribute to the improvement of air pollution in the region as a whole.

Ichiro Kutani

Leader of the Working Group

June 2017

## Acknowledgements

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June 2017

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## List of Abbreviations and Acronyms

AEC	ASEAN Economic Community
AQI	Air Quality Index (Australia)
ASEAN	Association of Southeast Asian Nations
APAEC	ASEAN Plan of Action for Energy Cooperation
ASCC	ASEAN Socio-Cultural Community
CAA	Clean Air Act
CEMS	Continuous Emission Monitoring System
CO <sub>2</sub>	Carbon Dioxide
CPP	Coal-fired Power Plant
DEIA	Detailed Environmental Impact Assessment (Malaysia)
DOE	Department of Environment (Malaysia)
EAS	East Asia Summit
EHIA	Environmental and Health Impact Assessment (Thailand)
EIA	Environmental Impact Assessment
EMMS	Environmental Management and Monitoring Scheme (Indonesia)
EMP	Environmental Management Plan (Myanmar)
EPA	Environment Protection Authority (Australia)
EPA	Environmental Protection Agency (United States)
ERIA	Economic Research Institute for ASEAN and East Asia
IEA	International Energy Agency
IED	Industrial Emission Directive
IEEJ	The Institute for Energy Economics, Japan
MoE	Ministry of Environment (Cambodia)
MONRE	Ministry of Natural Resource and Environment (Lao PDR)
NA	not available
NO <sub>x</sub>	nitrogen oxides
NSR	New Source Review
NSW	New South Wales (Australian state)
OECD	Organisation for Economic Co-operation and Development
OEH	Office of Environment and Heritage (Australia)
PM	particulate matter
ppm	parts per million
PSD	Prevention Significant Deterioration
SO <sub>x</sub>	sulphur oxides
WG	Working Group

## Executive Summary

Coal is an optimum power generation fuel for ASEAN countries in terms of both cost and energy security. However, coal combustion emits air pollutants that are harmful to both human health and the environment. As a consequence, residents have started campaigns against coal-fired power plants (CPPs), which have forced some new CPP projects to be suspended or cancelled. For ASEAN countries, minimizing the emission of air pollutants is a precondition for the future use of CPPs. But the problem is regulating the emission of air pollutants from CPPs. In order to reduce the emission of air pollutants, creating regulations and properly managing and operating CPPs are required. Based on this awareness, regulations on the emission of air pollutants (including emission standards and implementation of the regulations) are surveyed in this study.

This survey revealed that ASEAN countries have enacted environmental laws to identify air pollutants to be regulated and to set emission standards. Compared to the Organisation of Economic Co-operation and Development (OECD) countries, however, the emission standards are low in many ASEAN countries. Thus, it is important to raise the current emission standards of air pollutants from CPPs to the equivalent levels in OECD countries. This is because more stringent levels are essential for delivering a proper response to campaigns against CPPs and can reduce the emission of hazardous air pollutants and reduce the health hazards to residents. On the other hand, raising the level of emission standards leads to either an increase in environmental expenses or an increase in electricity tariffs. In consideration of national and government financial capabilities, a gradual tightening of emission standards may be required.

Installing expensive environmental facilities in CPPs imposes a heavy burden, especially on low-income countries. The most desirable method of sharing the cost burden is to increase electricity prices. Passing on increased costs would place a temporary subsidy burden on the government. This is not sustainable in the long term; therefore, it is recommended to stop providing subsidies to electricity consumers as early as possible.

Ways of financing capital expenditure include borrowing from financial institutions and using private funds. For borrowing, there are two options: one is from domestic financial institutions, the other is from international financial institutions. Domestic financial institutions are free from exchange risks; however, they may not have the practical knowledge of large-scale financing for energy. For international financial institutions, long-term borrowings can be made at low-interest rates; however, there are exchange rate risks and loan procedures take time due to strict loan terms. Generally, the installation of environmental facilities can be a good funding destination; however, some financial institutions put restrictions on loans for new CPP construction. Private funding can include funding from independent power producers and private finance initiatives. Using private funds has the advantage of being able to construct new CPPs without increasing public debt, resulting in the promotion of technology transfer through the operation of companies from developed countries.

With emission standards of air pollutants from CPPs raised to the equivalent level in OECD countries, ASEAN countries are required to install environmental facilities in CPPs and to perform the following steps:

1. maintain and/or manage installed facilities for appropriate operation;
2. constantly monitor and/or record the air pollutants concentration level to keep it below the standard; and
3. disclose the measurement results to local governments and residents to inform them of the proper operation of the CPP.

With regard to the first step, continued proper operation of environmental facilities serves as the base to gain support from residents. Regarding the second and third steps, the CPPs need to show evidence of complying with the laws and regulations to gain the trust of residents. Without information disclosure, residents living near a CPP could still raise concerns about the plant even if it is run properly. CPPs are requested to make themselves more open by continually providing transparent data to protect themselves.

Under these circumstances, a highly transparent system is required to monitor the air pollutant concentration levels both for CPPs and local regions. This can be a challenge for countries that have never created such a system. It is recommended to create a system that will monitor the air pollution situation and to establish an international cooperative framework for the proper operation and information disclosure, and to provide training to central and local governments and CPP operators. Cooperation will bring mutual benefits to both ASEAN countries and cooperating countries, which encourages them to build win-win relationships.

Table A shows the emission standards of sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter (PM) for new CPPs in selected countries. In case they differ depending on the plant scale, the large-scale case was adopted. In case they differ depending on the period, the daily basis (or 24 hours) was adopted. SO<sub>x</sub> and NO<sub>x</sub> have different units from one country to another. In the countries where parts per million (ppm) measurement is used, accordingly, it is converted into milligrams per cubic metre (mg/m<sup>3</sup>), regarding them as SO<sub>2</sub> and NO<sub>2</sub>, respectively.

**Table A: Emission standards for new CPPs in selected countries**

Country	SOx	NOx	PM
Australia	SO <sub>3</sub> : 200 mg/m <sup>3</sup>	NO <sub>2</sub> : 800 mg/m <sup>3</sup>	80 mg/m <sup>3</sup>
Germany	SOx: 150 mg/m <sup>3</sup>	NOx: 150 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
Japan	SOx: 50 ppm* (SO <sub>2</sub> : 133 mg/m <sup>3</sup> )	NOx: 200 ppm (NO <sub>2</sub> : 383 mg/m <sup>3</sup> )	100 mg/m <sup>3</sup>
Republic of Korea	SOx: 50 ppm (SO <sub>2</sub> : 133 mg/m <sup>3</sup> )	NOx: 50 ppm (NO <sub>2</sub> : 96 mg/m <sup>3</sup> )	10 mg/m <sup>3</sup>
United States**	SO <sub>2</sub> : 130 ng/J	NOx: 88 ng/J	11 ng/J
Cambodia	SO <sub>2</sub> : 500 mg/m <sup>3</sup>	NO <sub>2</sub> : 1000 mg/m <sup>3</sup>	400 mg/m <sup>3</sup>
China	SO <sub>2</sub> : 200 mg/m <sup>3</sup>	NO <sub>2</sub> : 200 mg/m <sup>3</sup>	30 mg/m <sup>3</sup>
India	SO <sub>2</sub> : 80 mg/m <sup>3</sup>	NO <sub>2</sub> : 80 mg/m <sup>3</sup>	100 mg/m <sup>3</sup>
Indonesia	SO <sub>2</sub> : 750 mg/m <sup>3</sup>	NO <sub>2</sub> : 750 mg/m <sup>3</sup>	100 mg/m <sup>3</sup>
Lao PDR	SO <sub>2</sub> : 320 ppm (SO <sub>2</sub> : 853 mg/m <sup>3</sup> )	NOx: 350 ppm (NO <sub>2</sub> : 670 mg/m <sup>3</sup> )	120 mg/m <sup>3</sup>
Malaysia	SOx: 500 mg/m <sup>3</sup>	NOx: 500 mg/m <sup>3</sup>	50 mg/m <sup>3</sup>
Myanmar	SOx: 200 mg/m <sup>3</sup>	NOx: 400 mg/m <sup>3</sup>	50 mg/m <sup>3</sup>
Philippines	SO <sub>2</sub> : 700 mg/m <sup>3</sup>	NO <sub>2</sub> : 1000 mg/m <sup>3</sup>	150 mg/m <sup>3</sup>
Singapore	SO <sub>2</sub> : 500 mg/m <sup>3</sup>	NO <sub>2</sub> : 700 mg/m <sup>3</sup>	100 mg/m <sup>3</sup>
Thailand	SO <sub>2</sub> : 180 ppm (SO <sub>2</sub> : 480 mg/m <sup>3</sup> )	NOx: 200 ppm (NO <sub>2</sub> : 383 mg/m <sup>3</sup> )	80 mg/m <sup>3</sup>
Viet Nam	SO <sub>2</sub> : 500 mg/m <sup>3</sup>	NO <sub>2</sub> : 650 mg/m <sup>3</sup> ***	200 mg/m <sup>3</sup>

CPP = coal-fired power plant, mg/m<sup>3</sup> = milligram per cubic metre, PM = particulate matter, ppm = parts per million, NO<sub>2</sub> = nitrogen dioxide, NOx = nitrogen oxides, SO<sub>2</sub> = sulphur dioxide, SOx = sulphur oxides. Notes: \* Based on the CPP's location, sulphur content of fuel, stack height, etc. the emission standard varies by CPP. The value is an example of specific CPP based on agreement between CPP and local government.

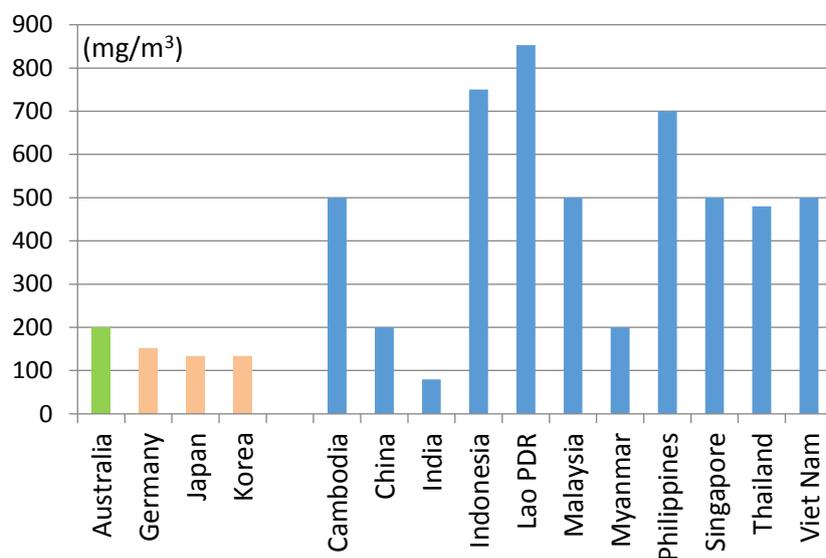
\*\* gross output.

\*\*\* coal volatile content >10%.

Source: Authors.

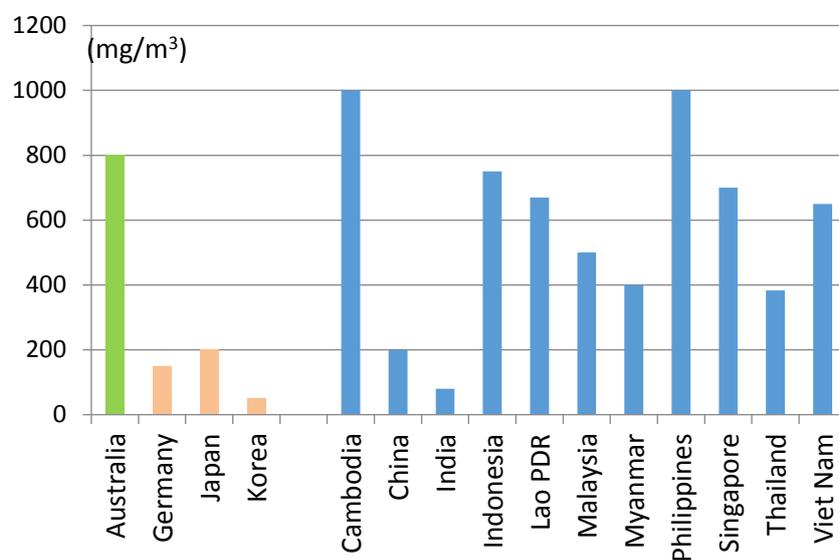
Figures A, B, and C show the comparison of the emission standards of SOx, NOx, and PM for new CPPs in selected countries.

**Figure A: Emission standards for new PPs in selected countries (SOx)**



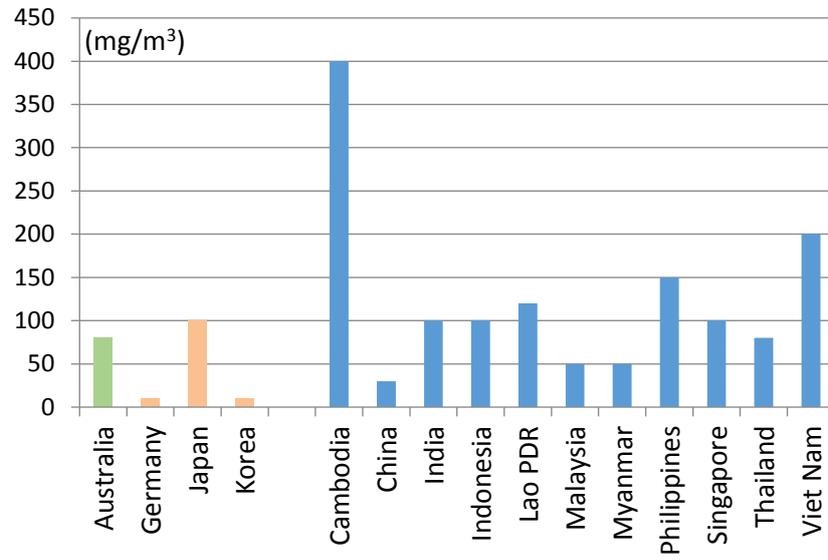
CPP = coal-fired power plant, mg/m<sup>3</sup> = milligram per cubic metre, SOx – sulphur oxides.  
Source: Authors.

**Figure B: Emission standards for new CPPs in selected countries (NOx)**



CPP = coal-fired power plant, mg/m<sup>3</sup> = milligram per cubic metre, NOx—nitrous oxides.  
Source: Authors.

**Figure C: Emission standards for new CPPs in selected countries (PM)**



CPP = coal-fired power plant, mg/m<sup>3</sup> = milligram per cubic metre, PM = particulate matter.

Source: Authors.

# Chapter 1

## Introduction

### **1. Background and objectives of the study**

Reserved underground in many ASEAN member countries, including Indonesia, coal allows power generation at a lower cost than other fuels. In the Association of Southeast Asian Nations (ASEAN) member countries, power consumption has increased along with their economic growth, and further increases in coal-fired power generation are expected. Coal is one of the cheapest power generation fuels in terms of cost, but its demerit is that it emits more air pollutants harmful to human health than other fuels. For this reason, the countries using coal-fired power generation have enacted standards to regulate air pollutants from coal-fired power plants. The bottom line is whether a management system has been established and whether it is functioning properly for monitoring the emission standards.

This study analyses essential elements to increase the effectiveness of emission control regulations for coal-fired power plants in developing countries in ASEAN. In the power sector, air pollution concerns can become a barrier for developing necessary power stations. As such, the appropriate implementation of air pollution control regulations is crucial for the sustainable development of the economy, and hence the study will highlight it.

The study also made a comparative analysis with selected Organisation of Economic Co-operation and Development (OECD) countries. The analysis is expected to derive policy recommendations for ASEAN countries to improve their implementation mechanisms.

The study is consistent with the strategic themes in the 'ASEAN Economic Community (AEC) Blue Print 2025' and its subordinate paper, 'ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 Phase 1', and contributes to the 'Coal and Clean Coal Technology,' study as it dealt with emissions from power plants. In addition, the study is consistent with the goal to create a sustainable society in the 'ASEAN Socio-Cultural Community (ASCC) Blueprint 2025', corresponding to the principles of C.1. Conservation and Sustainable Management of Biodiversity and Natural Resources, C.2. Environmental Sustainable Cities, C.3. Sustainable Climate, and C.4. Sustainable Consumption and Production.

## 2. Study method

### (A) Survey of the Status of Emission Regulations

The study surveyed the status of regulation and execution systems relevant to air pollution (SO<sub>x</sub>, NO<sub>x</sub>, and PM) from coal-fired power plants (CPP). The survey included:

- Existence or non-existence of regulations (central and/or municipal government)

The following items will be only applied to central government regulations

- Emission standards
- Process of regulation development
- Management system of power company (measurement, record, verification, report)
- Management system of regulator (organization, human resources, checking)
- How to enforce (authorization, order, penalty)
- Support for power company (technical guidelines, finance, education)

### (B) Comparative Analysis with Developed Country

The study conducted a comparative analysis of regulations and systems in developed countries such as Australia, Europe, Japan, and the United States. The subjected country and/or region will be selected through a preliminary survey. The study will identify the advantages and disadvantages of existing regulations and systems in ASEAN countries.

Based on each country's situation and/or standards, the study team will propose 'common environmental standards for the coal-fired power generation in the region'.

### (C) Derive Policy Recommendations

The study derived policy recommendations for improving the capability of a country to implement and execute air pollution control regulations for CPP.

(D) Set Up Expert Working Group

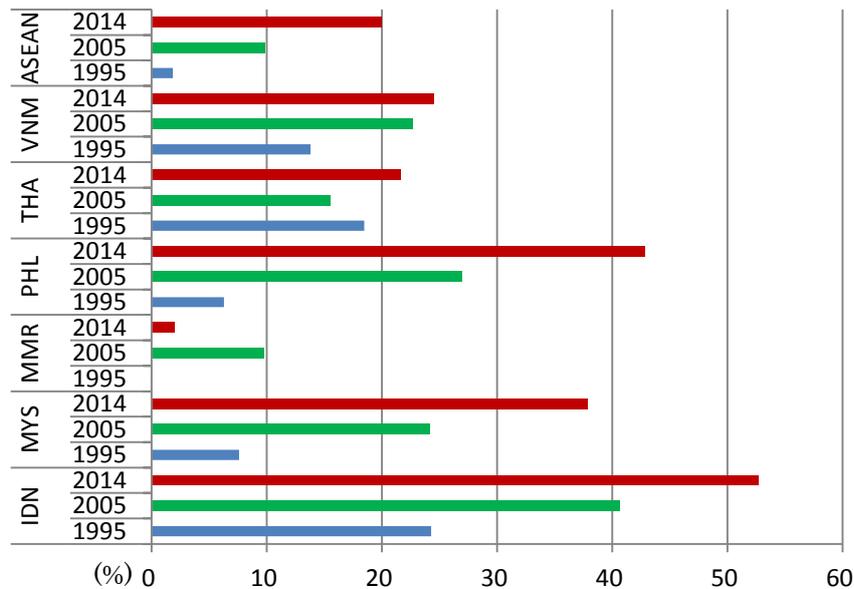
The study was set up an expert working group to discuss the issue and to share the results, hence expects to contribute to improve the effectiveness of policy implementation and execution in the region.

**3. Focus area of fiscal year (FY) 2016 study: survey**

(A) Why focus on air pollution from CPP?

Figure 1 shows the share of coal-fired power generation in total power generation in selected ASEAN countries. Except for Myanmar, the share of coal-fired power generation increased from 1995 to 2005 and 2014.

**Figure 1: Share of coal-fired power generation in selected ASEAN countries**



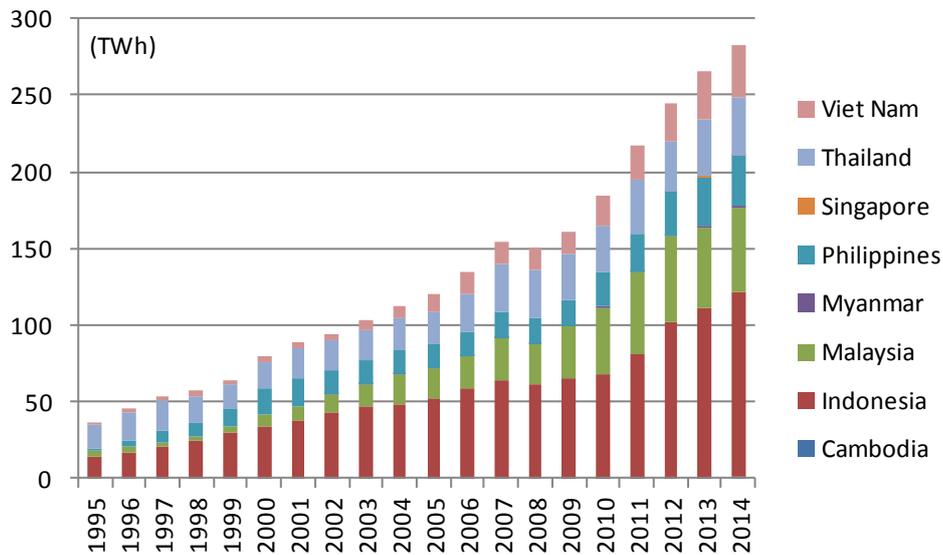
ASEAN = Association of Southeast Asian Nations, IDN = Indonesia, MMR = Myanmar, MYS = Malaysia, PHL = Philippines, THA = Thailand, VNM = Viet Nam.

Source: International Energy Agency (2016), World Energy Balances.

As a result of the increased share of coal-fired power generation, output increased greatly as shown in Figure 2. In the entire ASEAN, from 1995 to 2014 the annual average increase rate of total power generation output was 14%, but that of coal-fired power generation was 29%.

In ASEAN, coal is an important fuel for power generation and its consumption is expected to increase along with higher electricity demand. From a viewpoint of energy security, the use of coal enhances energy self-efficiency in ASEAN because there are coal export countries such as Indonesia.

**Figure 2: Coal-fired power generation in ASEAN**



Notes: Lao PDR is excluded due to no data availability. Brunei Darussalam has no coal-fired power generation.

TWh = terawatt hours.

Source: International Energy Agency (2016). World Energy Balances.

## (B) Necessity to regulate harmful air pollutants

The major harmful air pollutants from coal-fired power plants are sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter (PM). SO<sub>x</sub>, NO<sub>x</sub>, and PM are harmful as follows.<sup>1</sup>

### a) Sulphur dioxide (SO<sub>x</sub>)

Short-term exposure to sulphur dioxide (SO<sub>2</sub>) can harm the human respiratory system and make breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to the effects of SO<sub>2</sub>.

Emissions that lead to high concentrations of SO<sub>2</sub> in the air also lead to the formation of other sulphur oxides. SO<sub>x</sub> can react with other compounds in the atmosphere to form small particles. These particles contribute to PM pollution: particles can penetrate deeply into sensitive parts of the lungs and cause additional health problems.

At high concentrations, gaseous SO<sub>x</sub> can harm trees and plants by damaging foliage and decreasing growth.

SO<sub>2</sub> and other sulphur oxides can contribute to acid rain that can harm sensitive ecosystems.

SO<sub>2</sub> and other sulphur oxides can react with other compounds in the atmosphere to form fine particles that reduce visibility (haze).

The deposition of particles can also stain and damage stone and other materials, including culturally important objects such as statues and monuments.

### b) Nitrogen dioxide (NO<sub>x</sub>)

Breathing air with a high concentration of nitrogen dioxide (NO<sub>2</sub>) can irritate airways in the human respiratory system. Such exposure over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing, or difficulty breathing), hospital admissions, and visits to emergency rooms. Longer exposure to elevated concentrations of NO<sub>2</sub> may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater health risks from the effects of NO<sub>2</sub>.

NO<sub>2</sub> along with other NO<sub>x</sub> react with other chemicals in the air to form both particulate matter and ozone. These are also harmful when inhaled due to the effects on the respiratory system.

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<sup>1</sup> Source: US Environmental Protection Agency (EPA).

NO<sub>2</sub> and other NO<sub>x</sub> interact with water, oxygen, and other chemicals in the atmosphere to form acid rain. Acid rain harms sensitive ecosystems such as lakes and forests.

The nitrate particles that result from NO<sub>x</sub> make the air hazy and reduce visibility. This affects the many national parks that are visited for the view. NO<sub>x</sub> also contributes to the formation of smog and acid rain which are harmful for health.

NO<sub>x</sub> in the atmosphere contributes to nutrient pollution in coastal waters.

#### c) Particulate matter (PM)

Particulate matter includes:

- PM<sub>10</sub>: inhalable particles, with diameters that are 10 micrometres and smaller; and
- PM<sub>2.5</sub>: fine inhalable particles, with diameters that are 2.5 micrometres and smaller.

Particulate matter contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Particles less than 10 micrometres in diameter pose the greatest problems, because they can get deep into people's lungs, and some may even get into the bloodstream.

Fine particles (PM<sub>2.5</sub>) are the main cause of reduced visibility (haze).

### **4. Working Group activities in fiscal year 2016**

To conduct the study, a Working Group (WG) was organized. The WG members consist of experts from the region and a research team as a secretariat from The Institute for Energy Economics, Japan (IEEJ).

In fiscal year (FY)2016, a WG meeting was held in February 2017 in Bangkok, Thailand.

First, the meeting explained this study. and proposed two study items. One is financing because existing and new coal-fired power plants require huge investment for environmental measures. The other is technical aspects because highly-efficient facilities are required for the environmental measures. Since analysis results become complicated if multiple elements are contained, it was acknowledged that FY2016 should focus only on the management system, with the other elements as topics for the next fiscal year onwards. There were also concerns that the tightening of emission

standards might add to the cost of coal-fired power plants, which would cause the loss of cost competitiveness in comparison with other fuels. It was also proposed that the minimum emission standards should be compiled by ASEAN and India.

The management system in the selected OECD countries was then explained. The major opinions are as follows. The technology selection assistance provided by the United States Environmental Protection Agency is a good reference. Japan's method of phased tightening of control in accordance with the operators' capability to cope and technological advancement is valuable information for the ASEAN countries. Also, there were questions on the environmental control cost recovery methods, specific procedures for suspension of operation, and the situation of monitoring posts as with the Japanese cases.

Finally, there were presentations from the member countries, followed by discussions. Major discussion points included the levels of emission standards, emission monitoring systems, relations between the central government and local governments, and the price level of coal and natural gas for power generation to provide competition, among others.



## Chapter 2

### Summary of Management Systems in ASEAN, China, and India

#### 1. Survey of management systems in ASEAN countries

The management systems of coal-fired power emission gases were surveyed in the ASEAN member countries, based on the following items. The survey was conducted by the WG members in each country. In Thailand, a hearing was also held at the Ministry of Environment.

- Legislation
  - National (Federal, Central)
  - Local (State, Municipality, District, City)
- Regulated pollutants (relating to coal-fired power plants)
- Emission standards
- How authorities recognize the existence of facilities that emit air pollutants
- Authority to suspend operation
- Measurement of emissions by operator
- Monitoring
- Reporting
- Inspection
- Archive requirements
- Public announcements
- Compensation for damage and losses
- Penalty
- Assistance (National, Local)
- Ability of local governments
- Relation to local community
- Independent inspector

## 2. Summary of selected ASEAN countries, China, and India

Based on the survey in selected ASEAN countries, the results are summarized covering the legal system and the management system. See Annexes 3, 4, and 5 for the emission standards in each country.

The ASEAN countries have different experiences with coal-fired thermal power. For instance, countries such as Cambodia and Lao PDR started using coal-fired thermal power less than 10 years ago, while Thailand has used coal-fired power since the 1960s.

### 2.1. General

#### (A) Legislation (National)

Cambodia	1. Air Pollution Control Act (Ministry of Environment)
China	Environmental Protection Law (1989)  (Emission standards)  GB13223-2011
India	Prevention and Control of Pollution Act, 1981 (amended in 1987)  Environment (Protection) Act (No. 29 of 1986, 23 May 1986, last amended in 1991)  The implementation of power plant projects requires clearance from the Ministry of Environment, Forest and Climate Change ( <a href="http://envfor.nic.in/">http://envfor.nic.in/</a> ) via an environmental impact assessment. These can be stricter than the national emission standards. In addition, emission standards set by the State Pollution Control Boards can be stricter than those set by the Central Pollution Control Boards (CPCB).
Indonesia	a. Law No. 32/2009 Regarding the Protection and Management of Environment b. Law No. 30/2009 Regarding Electricity c. Government Regulation No. 14/2012 Regarding Business of Electricity Supply d. Government Regulation No. 27/2012 Regarding Environmental Licenses e. Government Regulation No. 41/1999 Regarding Air Emission Control f. Ministry of Environment Decree No. 21/2008 Regarding Static Emission Sources Quality Standard for Business and/or Activities of a Thermal Power Plant

Lao PDR	Lao PDR National Environmental Standard
Malaysia	1. Environmental Quality Act 1974 2. Environmental Quality (Clean Air) Regulations 2014
Myanmar	Environmental Conservation Law 2012 Environmental Conservation Rule 2014 National Environmental Quality (Emission) Guideline (2015) Environmental Impact Assessment Procedure 2015
Philippines	The Philippines Clean Air Act of 1999 (Republic Act No. 8749) (Emission standards) DENR Administrative Order No. 2000 - 81, 7 Nov 2000)
Singapore	Environment Pollution Control Act (1 Apr 1999) Environmental Protection and Management Act (1 Jan 2008) (Emission standards) Environmental Protection and Management (Air Impurities) Regulations (1 Jan 2001, as revised in 2002 and 2008)
Thailand	Environmental Act Factory Act There is no conflict between the two Acts.
Viet Nam	Emission standards are set by the Ministry of Natural Resources and Environment. Emission standards for thermal power plants were released on 16 November 2009 and replaced the 2005 standards.

**(B) Legislation (Local)**

Cambodia	1. Air Pollution Control Act allows CPPs to set their own emission standards but follow the government standard to establish regulations relating to air pollution emissions.
Indonesia	According to the Ministry of Environment Decree No. 21 Year 2008, local governments may set:  a. Emission quality standards for business and/or activities of a thermal power plant with the provisions of the same standards or more stringent than the standards that have been set nationally.  b. Additional parameters outside the emission quality standards for business and/or activities of a thermal power plant after the approval of the minister in the environmental field.
Lao PDR	Local authorities are involved in providing their recommendation for state of feasibility study, construction, and operation of coal-fired power plants.
Malaysia	Not available
Myanmar	Environmental Conversation Law 2012 Environmental Conversation Rule 2014 National Environmental Quality (Emission) Guideline (2015) Environmental Impact Assessment Procedure 2015
Thailand	The law gives local governments power to establish their own emission standards. But to date, no local government has set its own emission standards.

**(C) Regulated pollutants**

Cambodia	Air Pollution Control Act: SO <sub>x</sub> , NO <sub>x</sub> , PM Potentially affect the living environment: SO <sub>2</sub> , NO <sub>2</sub> , CO, particulates
China	Particulates, SO <sub>2</sub> , NO <sub>x</sub> , mercury and mercury compounds, opacity
India	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub> , PM <sub>2.5</sub> , CO
Indonesia	SO <sub>2</sub> , NO <sub>x</sub> stated as NO <sub>2</sub> , total particulates (particulate matter), opacity.
Lao PDR	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub> , and PM <sub>2.5</sub>
Malaysia	SO <sub>x</sub> (SO <sub>2</sub> and SO <sub>3</sub> ), NO <sub>x</sub> (NO and NO <sub>2</sub> ), hydrogen chloride, hydrogen fluoride, carbon monoxide, total particulate matter, mercury, PCDD/PCDF

Philippines	SOx, NOx, PM
Singapore	SO <sub>2</sub> , NOx, PM
Myanmar	SOx, NOx, PM, CO, CO <sub>2</sub> , TVOC (hydrocarbon), O <sub>3</sub> , lead
Thailand	PM, SO <sub>2</sub> , NOx
Viet Nam	SOx, NOx, PM

**(D) The way to recognize the facilities of emitting pollutants**

Cambodia	<p>Legislation</p> <ul style="list-style-type: none"> <li>- Government standards and Ordinance of Ministry of Environment</li> </ul> <p>Voluntary</p> <ul style="list-style-type: none"> <li>- Agreement between local government with power plant operator</li> <li>- Internal targets of power plants (operational standards)</li> </ul>
Indonesia	<p>Government Regulation No. 14 Year 2012 Article 13 Paragraph (1): Business licence</p> <p>Government Regulation No. 27 Year 2012 Article 1 and 2: Environmental licence</p> <p>The authority recognizes the power plant facility that emits pollutants based on the environmental documents (Environmental Impact Analysis or <a href="#">Environmental Management and Monitoring Scheme</a>) and the environmental licence.</p>
Lao PDR	<p>The central and local government authorities recognize the information during their environmental impact assessment of coal-fired power plants and mitigation plans and periodic reports of the plants.</p>
Malaysia	<p>All coal fired power plants are required to install continuous emission monitoring systems (CEMS) that are linked to the Department of Environment (DOE) in real-time.</p>
Myanmar	<p>The owner or occupier of any business, material, or place that causes a point source of pollution shall install or use an on-site facility or controlling equipment to monitor, control, manage, reduce, or eliminate environmental pollution.</p>

Thailand	<p>Power plants with capacity between 10MW and 100MW are required to have an environmental impact assessment (EIA)</p> <p>Power plants with capacity 100MW and more are required to have an environmental and health impact assessment (EHIA)</p> <p>Emission permit: not to exceed national standard.</p>
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**(E) Authority to suspend operation**

Cambodia	Based on an agreement between local government and the power plant operator, the CPP can only restart operations after the government considers that improvements have been satisfactorily made.
Indonesia	Authority to suspend operation due to violation of environmental regulation is given to the licensor of the environment licence: minister in the environmental field/governor/regent/mayor.
Lao PDR	The central government (prime minister) and governors of the provinces have full power to suspend the operation of the facilities if the pollutants emitted are above the regulations allowed, based on a daily monitoring unit at the CPP.
Malaysia	Department of Environment (DOE)
Myanmar	The government department and government organization have the power to cancel the issued licence, permit, or registration, or suspend it for a limited period.
Thailand	Ministry of Industry has the power to order partial or full suspension of CPP operations.

**(F) Measurement of emission by operator**

Cambodia	Air Pollution Control Act obligates operators to install public screen monitors to show emission measurements automatically (SO <sub>x</sub> , NO <sub>x</sub> , PM) and to transmit to the public through telemeters.
Indonesia	<p>Ministry of Environment Decree No. 21/2008, Article (9)</p> <p>- For the CPP with capacity above 25 megawatts (MW) or below 25 MW but using coal that has sulphur content above 2%, emissions are measured using a continuous emission monitoring system (CEMS) that is installed in power plant's chimney.</p>

	-For power plants that do not have a CEMS installed, manual measurement is required and it must be done by the accredited laboratory with minimum measurement frequency of once every per 6 months.
Lao PDR	<p>CPP and provincial operator measure the quantity or concentration of air pollutants, and keep records.</p> <p>- Frequency of measuring: SOx: more than every 3 months (total emission controlling area: continuously [24 hours, 7 days]); NOx: more than every 2 months; PM: more than every 2 months.</p>
Malaysia	Malaysian Standards MS1596 or MS 1723 or the Methods published by United States Environmental Protection Agency or any other standards as determined by DOE.
Myanmar	National Environmental Quality (Emission) Guideline (2015)
Thailand	<p>Licensed third party selected by operators check emission data twice a year.</p> <p>- Monitoring station: 5 kilometres away from CPP</p> <p>- Monitored pollutants: PM and SO<sub>2</sub></p> <p>Operators should send emission monitoring data to Ministry of Industry with automatic method.</p>

**(G) Assistance (National, Local)**

Cambodia	MME and MoE explanatory notes provide financial assistance, technical advice, or other assistance.
Indonesia	National and local government provide technical assistance to the CPP owner.
Lao PDR	Air Pollution Control Act stipulates: The (national) government shall endeavour to provide the financial assistance, technical advice, other assistance.
Malaysia	Not available
Myanmar	The (national) government shall endeavour to provide the technical advice, other assistance.
Thailand	When a regulation is to be enhanced, the central government holds a meeting with stakeholders before amendment.

**(H) Relation to local community**

Cambodia	Environmental Impact Assessment Act requires operator to hold a meeting and publish hearings with residents for explanation and discussion before they get a licence. Construction of a new CPP will continue only after residents agree.
Indonesia	Based on Government Regulation No. 27/2012 Article 9, the CPP owner must hold a meeting and public hearing with residents for explanation and discussion before preparing the EIA document.
Lao PDR	Base on concession agreement for CPP
Malaysia	Approval of the Detailed Environmental Impact Assessment (DEIA) is a mandatory requirement in new coal-fired power plant development.  The law does not require periodical meetings with local community. However, community outreach programmes are usually performed by plant operators as part of their corporate social responsibility.
Myanmar	The law does not require periodical meetings with local community.  Ministry and operator to hold stakeholder meetings and public hearings with residents for explanation and discussion on the site of the coal-fired power plant.
Thailand	Regular meetings between CPP and residents are held every 3 months.

**(I) Ability of local government**

Cambodia	The implementation is varied based on ability of officers or experts in local government to judge/interpret the measure or method of measurement.
Indonesia	Not available
Lao PDR	Ministry of Energy and Mines (MEM) and Ministry of Natural Resource and Environment (MONRE) had establishment steering committees for CPP
Malaysia	Any issue related to development in the specific local area including CPP can be addressed by local government/council. However, all environmental compliance monitoring and enforcement activities are conducted by the Department of Environment (DOE) through headquarters and state and branch offices.
Myanmar	State and regional governments are participating in public consultation, monitoring, inspection, and meetings with residents.
Thailand	There is an expert in local university.

## 2.2. Management system flow

### (A) Monitoring

Cambodia	Prefectural governors shall continuously monitor the status of air pollution.
Indonesia	Irregular monitoring by local government.
Lao PDR	Provincial authorities shall continuously monitor the status of air pollution. Local governments have observing stations.
Malaysia	Department of Environment (DOE)
Myanmar	The ministry and state and regional governments shall continuously monitor the status of air pollution. The owner or occupiers of any business have a duty to monitor the environmental pollution.
Thailand	CPP submit EIA report to Ministry of Environment, Ministry of Natural Resources, and Ministry of Energy. Report: CPP → Central Government → Local Government Local government has a power to check emission data, but this rarely occurs.

### (B) Reporting to authority

Cambodia	According to an agreement with the government, power plant operator submits data of air pollution emission every month generally, although CPPs automatically send data through to telemeter.  Ministry of Environment conducts integrated survey of quantity of air pollution emission every 3 years.  [Archive Requirement]  All CPP operators should keep important data permanently (6 monthly) after measuring emissions.
Indonesia	Government Regulation 21/2012, Article 9  The responsibility of the power plant is obliged to:  a. Report the results of monitoring and measurement of emissions every 3 months for power plants that are equipped with CEMS to the regent/mayor with a copy to the governor and minister in the environmental field.

	<p>b. Report the results of monitoring and measurement of emissions every 6 months for power plants that manually measure emissions to the regent mayor with a copy to the governor and minister in the environmental field.</p> <p>c. Report annual total pollutants (ton/year) emitted for NO<sub>x</sub>, SO<sub>x</sub>, and CO<sub>2</sub> to the regent/mayor with a copy to the governor and minister in the environmental field.</p> <p>[Archive Requirement]</p> <p>Most CPP owners keep important data permanently.</p>
Lao PDR	<p>Ministry of Natural Resource and Environment (MoNRE) or provincial authorities (EMU) jointly with CPP operators report the status of air pollutant emissions. MoNRE conducts integrated surveys of quantity of air pollutant emissions every 6 months.</p> <p>According to an agreement between CPP operator and local government, an operator submits the report to local government every month, although CPP automatically send data through telemeter continuously.</p> <p>[Archive Requirement]</p> <p>3 years.</p>
Malaysia	<p>Continuous Emission Monitoring Systems (CEMS)</p> <p>[Archive Requirement]</p> <p>Environmental Quality (Clean Air) Regulations 2014:</p> <p>- The records shall be kept for at least 3 years.</p>
Myanmar	<p>The project proponent shall submit a monitoring report to the ministry not less frequently than every 6 months, as provided in a schedule in the Environmental Management Plan (EMP), or periodically as prescribed by the ministry.</p> <p>Ministry of Electricity and Energy shall require operator to report the status of air pollutant emissions.</p> <p>[Archive Requirement]</p> <p>Coal-fired power plant operators keep the important data permanently in the form of paper and electronic files.</p>
Thailand	<p>Twice a year</p> <p>[Archive Requirement]</p> <p>The law does not require keeping archives.</p>

### (C) Inspection

Cambodia	<p>Ministry of Environment or government should conduct inspection on each CPP through the telemeter basically.</p> <p>[Independent inspector]</p> <p>Air Pollution Control Act stipulates operators have a special environmental technician for controlling emissions in the plants.</p>
Indonesia	<p>Law 32/2009, Article 72</p> <p>Ministry of Environment or governor/regent/mayor are obliged to conduct supervision, and may conduct on-site inspections.</p> <p>Law 30/2009, Article 46</p> <p>Government (Ministry of Energy and Mineral Resources) or regional government in accordance with authority to provide guidance and supervision of the electricity supply business in terms of compliance aspects of environmental protection, and may conduct on-site inspection.</p> <p>[Independent inspector]</p>
Lao PDR	<p>Environmental management unit joint with provincial authorities conduct official inspection.</p> <p>[Independent inspector]</p> <p>Based on concession agreement for CPP</p>
Malaysia	<p>Department of Environment (DOE)</p> <p>[Independent inspector]</p> <p>The law does not require an independent inspector.</p>
Myanmar	<p>Screening team, which is organized by the ministry, inspect frequently.</p> <p>Inspection team is organized by the relevant ministries and/or organizations.</p> <p>[Independent inspector]</p> <p>The law does not appear to have a requirement for an independent inspector.</p>
Thailand	<p>Department of Estate, Ministry of Industry inspects every industry plant.</p> <p>If CPP is large, there is no site-visit.</p> <p>In case of a severe accident, Ministry of Environment inspects.</p> <p>Local government has a power to inspect, but there is no case.</p>

	<p>[Independent inspector]</p> <p>Independent inspector is not required.</p>
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#### (D) Public Announcements

Cambodia	Ministry of Environment or government collect environment data from various facilities and publish the status of air pollution on screen monitors.
Indonesia	Ministry of Environment and Forests is currently developing an online reporting system, where the results of such reporting can be accessed by the public. Currently the Directorate General of Electricity is also developing information systems for monitoring power plant emissions by taking a pilot project of one power plant site (CPP Cirebon 1 x 660 MW).
Lao PDR	Provincial authorities and EMU make public the status of air pollution within the prefecture.
Malaysia	Announcement through official portal (website) of Department of Environment and newspapers.  Regular updates of Malaysia Air Pollutant Index (API)
Myanmar	Coal-fired power plants publish the status of air pollution on LED screens in front of their power plants (example of Tigyit Coal-fired Thermal Power Plant).
Thailand	Operators' annual report.  Local government does not publish emission data.

#### (E) Penalty

Cambodia	<p>Violation of Air Pollution Control Act requires CPP operator to pay a fine or CPP licence could be cancelled or plant shut down.</p> <p>[Compensation for Damage and Losses]</p> <p>Strict Liability</p>
Indonesia	<p>Based on Law No. 32/2009, penalty:</p> <ul style="list-style-type: none"> <li>- Administrative sanction</li> <li>- Fine and imprisonment</li> </ul> <p>Anyone who violates the emissions quality standards shall be punished with</p>

	<p>imprisonment of 3 years and a maximum fine of Rp 3 billion. Criminal offence can only be imposed if administrative sanctions that have been imposed are not complied with or the offences are committed more than once.</p> <p>[Compensation for Damage and Losses]</p> <p>Strict Liability</p> <p>Law 32/2009, Article 54</p> <p>Anyone who pollutes and damages the environment is obligated to do environmental recovery.</p>
Lao PDR	<p>Bases on concession agreement</p> <p>[Compensation for Damage and Losses]</p> <p>Strict Liability</p>
Malaysia	<p>Any person who contravenes or fails to comply with any provisions of Environmental Quality (Clean Air) Regulations 2014 shall be liable to a fine not exceeding RM100,000 or imprisonment for a term not exceeding 2 years or both.</p> <p>[Compensation for Damage and Losses]</p> <p>Environmental Quality Act 1974:</p> <p>Section 46E: ‘the person so convicted to pay the other person the costs and expenses incurred or compensation for loss or damage to the property and any other costs, in the amount as the court considers fit’.</p>
Myanmar	<p>Environmental Offences and Penalties</p> <p>Penalties</p> <p>US\$2,500 to US\$10,000 or equivalent kyats</p> <p>Specific Administrative Punishment of the Ministry</p> <ul style="list-style-type: none"> <li>-Issue Enforcement Notice</li> <li>-Suspension of Approval of EMP, EMP-CP, or EMP-OP in whole or in part</li> <li>-Revocation of Approval of EMP, EMP-CP, or EMP-OP in whole or in part</li> </ul> <p>[Compensation for Damage and Losses]</p> <p>Failure to take reasonable steps to prevent an imminent threat of damage to the environment, social, human health, livelihoods, or property, where applicable based on the EMP, EMP-CP, EMP-OP</p>

Thailand	<p>Industry Act</p> <p>Ministry of Industry can pose fines, maximum B200,000.</p> <p>[Compensation for Damage and Losses]</p> <p>Central government requires CPP to pay compensation, but there is no case to date.</p> <p>(It is difficult to find responsibility of air pollution and evaluate damage and losses.)</p> <p>Operators pay damages and losses voluntarily, i.e. hospital expenses, medical examination, etc.</p>
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### 2.3. Summary

The following discussion outlines the survey results of the selected ASEAN countries.

#### (A) General

- At the central government-level in each country, environment-related acts have been enacted, regulated air pollutants have been identified, and emission standards have been stipulated. Cambodia, Indonesia, and Thailand authorize their local governments to enact the emission standards. As with Japan, Cambodia has further set the emission standards voluntarily with the CPP operator.
- Authority to suspend operation varies as follows.
  - Central government: Malaysia, Myanmar, Thailand
  - Central and local government: Indonesia, Lao PDR
  - Local government: Cambodia (based on agreement between CPP and local government)
- Periodical meeting with a local community after starting CPP operation
  - Lao PDR: Dependent on an agreement with the CPP
  - Thailand: Implemented every 3 months
  - Other countries: Not obligated

#### (B) Management process

- The local governments implement regular monitoring in Cambodia, Lao PDR, and Myanmar. In these countries, coal-fired power generation started after the 2000s.
- Reports should be submitted as follows.

- Central government: Cambodia, Malaysia, Myanmar, Thailand
- Central and local government: Indonesia, Lao PDR
- Local government: None

Archive requirements are not enacted by law, except in Thailand.

- As with submission of reports, inspection agencies vary as follows.
  - Central government: Cambodia, Malaysia, Myanmar, Thailand
  - Central and local government: Indonesia, Lao PDR
  - Local government: None
- Public announcements vary as follows.
  - Cambodia: Central government publishes it through screen monitors.
  - Indonesia: Central government is developing an online system.
  - Lao PDR: Local government publishes the status.
  - Malaysia: Central government's website
  - Myanmar: CPP publishes the status on LED screen in front of the plant
  - Thailand: CPP operator's annual report
- The following compares the national emission standards from the CPPs in the selected ASEAN countries. Where the standards differ depending on the start year of operation of the plant, the case of a newly constructed CPP was adopted. Where they differ depending on the plant scale, the large-scale case was adopted. Where they differ depending on the period, the daily basis (or 24 hours) was adopted. SO<sub>x</sub> and NO<sub>x</sub> have different units from one country to another. In the countries where parts per million (ppm) measurement is used, accordingly, it is converted into mg/m<sup>3</sup>, regarding them as SO<sub>2</sub> and NO<sub>2</sub>, respectively.
- Like Cambodia and Lao PDR, some countries have been regulating pollutants more strictly than the national emission standards, based on the agreements concluded between the CPP and the local government.

**Table 1: Emission standards for CPP in selected ASEAN countries, China, and India**

Country	SOx	NOx	PM
Cambodia	SO <sub>2</sub> : 500 mg/m <sup>3</sup>	NO <sub>2</sub> : 1000 mg/m <sup>3</sup>	400 mg/m <sup>3</sup>
China	SO <sub>2</sub> : 200 mg/m <sup>3</sup>	NO <sub>2</sub> : 200 mg/m <sup>3</sup>	30 mg/m <sup>3</sup>
India	SO <sub>2</sub> : 80 mg/m <sup>3</sup>	NO <sub>2</sub> : 80 mg/m <sup>3</sup>	100 mg/m <sup>3</sup>
Indonesia	SO <sub>2</sub> : 750 mg/m <sup>3</sup>	NO <sub>2</sub> : 750 mg/m <sup>3</sup>	100 mg/m <sup>3</sup>
Lao PDR	SO <sub>2</sub> : 320 ppm (SO <sub>2</sub> : 853 mg/m <sup>3</sup> )	NOx: 350 ppm (NO <sub>2</sub> : 670 mg/m <sup>3</sup> )	120 mg/m <sup>3</sup>
Malaysia	SOx: 500 mg/m <sup>3</sup>	NOx: 500 mg/m <sup>3</sup>	50 mg/m <sup>3</sup>
Myanmar	SOx: 200 mg/m <sup>3</sup>	NOx: 400 mg/m <sup>3</sup>	50 mg/m <sup>3</sup>
Philippines	SO <sub>2</sub> : 700 mg/m <sup>3</sup>	NO <sub>2</sub> : 1000 mg/m <sup>3</sup>	150 mg/m <sup>3</sup>
Singapore	SO <sub>2</sub> : 500 mg/m <sup>3</sup>	NO <sub>2</sub> : 700 mg/m <sup>3</sup>	100 mg/m <sup>3</sup>
Thailand	SO <sub>2</sub> : 180 ppm (SO <sub>2</sub> : 480 mg/m <sup>3</sup> )	NOx: 200 ppm (NO <sub>2</sub> : 383 mg/m <sup>3</sup> )	80 mg/m <sup>3</sup>
Viet Nam	SO <sub>2</sub> : 500 mg/m <sup>3</sup>	NO <sub>2</sub> : 650 mg/m <sup>3</sup> *	200 mg/m <sup>3</sup>
(Reference) Germany	SOx: 150 mg/m <sup>3</sup>	NOx: 150 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>

ASEAN = Association of Southeast Asian Nations, CPP = coal-fired power plant, mg/m<sup>3</sup> = milligrams per cubic metre, NO<sub>2</sub> = nitrogen oxide, NOx = nitrogen oxides, PM = particulate matter, SO<sub>2</sub> = sulphur dioxide, SOx = sulphur oxides.

Note: \*coal volatile content >10%.

Source: Authors.

## Chapter 3

### Summary of Management Systems in Selected OECD Countries

#### 1. Survey of management systems in OECD countries

Based on the same survey items as in the ASEAN countries, a survey was conducted on the management systems for emission gases from coal-fired power plants in the selected OECD countries. See Section 1 chapter 1 for survey of management systems in ASEAN countries for the survey items. The surveyed selected OECD countries include Australia, Germany, Japan, the Republic of Korea, and the United States. The survey was conducted by referring to the websites, among others, of the related agencies in each country. In the case of Japan, hearings were held with coal-fired power plant operators.

#### 2. Summary of selected OECD countries

Australia, Germany, Japan, and the United States are summarized for each survey item. The Republic of Korea was also surveyed, but its management system was omitted in this study because it is similar to the one in Japan. Because the survey is mainly focused on the regulations of the central government, the situation of local governments are<sup>1</sup> surveyed in a limited manner.

First, general items including the legal systems are described, followed by the management systems. See Annexes 3, 4, and 5 for the emission standards in each country.

##### 2.1. General

##### (A) Legislation (National)

Australia	- National Environment Protection (National Pollutant Inventory) Measure 1998 - National Environment Protection (Ambient Air Quality) Measure
Germany	- Air quality regulation is aligned with the European Union (EU) air quality legislation

	<ul style="list-style-type: none"> <li>- Industrial emission is regulated under the Directive 2010/75/EU or Industrial Emission Directive (IED)</li> <li>- Federal Emission Control Act (in German, BImSchG)</li> </ul>
Japan	<p>Air Pollution Control Act (Ministry of the Environment)</p> <p>(A CPP which is authorized by the Electricity Business Act is exempted from the Air Pollution Control Act.)</p>
United States	<p>Clean Air Act (CAA)</p> <ul style="list-style-type: none"> <li>- Section 108: Air quality criteria and control techniques</li> <li>- Section 111: Standards of performance for new stationary sources</li> <li>- Section 112: Hazardous air pollutants</li> </ul>

### **(B) Legislation (Local)**

Australia	Each state establishes environmental legislation. Procedures vary from state to state.
Germany	Provisions on air quality control at federal state level
Japan	Local governments can establish necessary regulations relating to air pollutant emissions (in general more stringent than that of the central government).
United States	Not available

### **(C) Regulated pollutants**

Australia	SO <sub>2</sub> , NO <sub>2</sub> , PM <sub>10</sub> , and PM <sub>2.5</sub>
Germany	SO <sub>2</sub> , NO <sub>x</sub> , PM, carbon, metals, volatile, asbestos, cyanides, chlorine, asbestos, etc.
Japan	<p>SO<sub>x</sub>, NO<sub>x</sub>, PM</p> <p>(example Yokohama: Ordinance relating to living environment (cadmium, chlorine, lead, etc.))</p>
United States	CO, lead, NO <sub>2</sub> , O <sub>3</sub> , PM, SO <sub>2</sub> , mercury, etc. 189 pollutants (Sections 108, 111, 112)

**(D) The way to recognize the facilities of emitting pollutants**

Australia	Each occupier of a facility is to be required to provide information. (example, NSW state: through licensing)
Germany	- Permit of authorities must take into account the whole environmental performance of the plant.  - Operators shall submit to the authority a baseline report before starting operation of an installation.
Japan	CPPs shall notify items (facility structure, pollutant control way etc.) to the prefectural governor.
United States	Not available

**(E) Authority to suspend operation**

Australia	(ex) NSW state: Protection of the Environment Operations Act 1997  Clean-up, Prevention and prohibition notices are provided for under the legislation. Only the minister can issue a prohibition notice on the recommendation of the Environment Protection Authority (EPA).
Germany	The authority may decide to suspend activities of a plant in whole or in part.
Japan	Local governor has power to order emitters to suspend operation when they violate the regulations.  When it continuously emits more than limit, local governor can order for improvement until it is completed.
United States	Title V of CAA requires major sources of air pollutants to obtain and operate in compliance with an operating permit. Sources with 'Title V permits' are required by the CAA to certify their permits at least annually.

**(F) Measurement of emission by operator**

Australia	Australian Standards
Germany	According to the Technical Instruction on Air Quality Control, SO <sub>2</sub> , NO <sub>2</sub> , PM shall be measured continuously.
Japan	Operator shall measure the quantity or concentration of air pollutant more than every 2 months, keep records.

	(In actual) Data are being monitoring continuously, and automatically transmitted to local governor through telemeter.
United States	Follows EPA Regulation 40 CFR Part 60 Subpart Da under CAA Section 111.

**(G) Assistance (National, Local)**

Australia	Not available
Germany	State shall encourage the development and application of emerging techniques.
Japan	The (national) government shall endeavour to provide financial assistance, technical advice, other assistance.  Local governments also convene explanatory meetings to CPP operator when the law is amended.
United States	New Source Review (NSR) and Prevention of Significant Deterioration (PSD) require large industrial facilities to install state-of-the-art air pollution controls when they build new facilities or make modifications.

**(H) Relation to local community**

Australia	(ex) NSW state: The law does not require periodical meetings with local community.
Germany	Relations take place at the measuring and monitoring stage, which gathers from local <a href="#">Länder</a> and federal agency.
Japan	Air Pollution Control Act does not require periodical meeting with local community.  Another law requires CPP developers to hold meetings with residents before new construction of CPP.
United States	The regulation does not require periodical meetings with local community.

### (I) Ability of local government

Australia	(ex) NSW state: The EPA offers a 2-day course which has been designed to equip authorized officers to fulfil their responsibilities as outlined in the Protection of the Environment Operations Act 1997.
Germany	The mid-level administrative bodies have permitting authority.
Japan	Generally high, there are experts of measuring method in local government.
United States	Not available

## 2.2. Management system

### (A) Monitoring

Australia	Areas with populations greater than 25,000 are required to install monitoring stations.  (ex) NSW state: The Office of Environment and Heritage (OEH) operates air quality monitoring network.  Data from network is presented online as an index (air quality index, AQI) based on hourly data and stored in a searchable database.
Germany	- Monitoring networks are operated by (i) German Federal Environment Agency, which measures stations far away from cities and (ii) German's Lander monitoring networks, which monitor the quality of the populated areas.  - The data from the two monitoring networks provide the foundation of the country's air quality.
Japan	- Prefectural governors shall continuously monitor the status of air pollution.  - Local governments have observing stations.
United States	(ex) PM: Operator of a facility shall install, calibrate, maintain, and operate opacity monitoring systems (COMS), and record the output of the system for measuring the opacity of emissions discharged to the atmosphere.

### (B) Reporting to authority

Australia	(ex) NSW state. The law does not require licensees to report emission data to EPA periodically. Instead, licensees are required to publish pollution monitoring data.
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	[Archive Requirement]: Not available
Germany	Operator shall supply the monitoring results to the authority regularly and at least annually.  [Archive Requirement]  Publications shall be lodged in the archives of the German Patents Office for safe custody and reference.
Japan	National and local governors may require operator to report the status of air pollutant emissions.  (In actual) According to an agreement, operator submits the report to local governments every month generally, although CPP automatically send data through telemeter continuously.  [Archive Requirement]  3 years. (In actual) most operator keeps important data permanently.
United States	Performance test data from the continuous monitors must be reported to the administrator. The owner or operator of the facility shall submit a signed statement.  [Archive Requirement]  Record-keeping requirements

### (C) Inspection

Australia	(ex) NSW state: Protection of the Environment Operations Act 1997 Operators must notify pollution incidents. Mandatory audits may be required as a condition of licence if the EPA reasonably suspects.  [Independent inspector]  The law does not require it.
Germany	The law requires mandatory environmental inspections to be done at least every 1 to 3 years.  Each inspection plan shall include a general assessment of relevant significant environmental issues.  [Independent inspector]  The law does not require it.

Japan	<p>National and local governor may conduct official inspection.</p> <p>On-site inspection by national governor: On an irregular base, every 5 or 6 years.</p> <p>On-site inspection by local governor: it depends on an agreement between CPP operator and local government, one inspection per year generally, in Environment Month typically.</p> <p>[Independent inspector]</p> <p>The law does not require it.</p>
United States	<p>EPA's policy: Incentives for self-policing (discovery, disclosure, correction, and prevention)</p> <p>On-site visit by EPA, civil investigations, record reviews, information requests</p> <p>[Independent inspector]</p> <p>The law does not require</p>

#### (D) Public Announcements

Australia	<p>(ex) NSW state: Requirements for publishing pollution monitoring data</p> <ul style="list-style-type: none"> <li>- The law requires licensees to publish pollution monitoring data instead of reporting.</li> <li>- There are offences for failure to publish monitoring data and for publishing false or misleading data.</li> </ul> <p>It is necessary monthly meaningful summary of monitoring data on website, or required frequency where monitoring occurs less than monthly.</p>
Germany	<p>All data on air quality are published on the internet shortly after they are gathered, providing information on current pollution level.</p> <p>The EU Pollutant Release and the Transfer Register (E-PRTR) is a public register intended to provide environmental information and include data on emissions as reported by the state.</p>
Japan	<p>Local governments collect environmental data from various facilities and publish the status of air pollution at screen monitors in their city hall. Everyone can see the situation in anytime.</p> <p>Local governments also publish environmental report periodically.</p>

United States	Everyone can access the air monitoring results on website. ( <a href="https://www.epa.gov/outdoor-air-quality-data">https://www.epa.gov/outdoor-air-quality-data</a> )
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### (E) Penalty

Australia	(ex) NSW state Environmental Offences and Penalties [Compensation for Damage and Losses] Strict liability
Germany	Severe cases of non-compliance can result in criminal liability. Criminal sanctions include imprisonment and fines (up to €50,000). [Compensation for Damage and Losses] Strict liability
Japan	Violation of Air Pollution Control Act including disclosure of name of subjected operator. Punishment includes imprisonment and fine. [Compensation for Damage and Losses] Strict Liability
United States	- If a civil defendant is found liable or agrees to a settlement: monetary penalty, injunctive relief, additional actions to improve the environment. - If a criminal defendant is convicted or pleads guilty: monetary fine, restitution, incarceration. [Compensation for Damage and Losses] Strict liability.

### 3. Summary

- The OECD countries have effective and comprehensive regulation and management systems.
  - Consistency of legislation from national to local government, wide scope of regulating air pollutants, precise and transparent monitoring, reporting and public announce system.
  - Local emission standards are likely more stringent than the national standard.

- In general, local governors are stricter than central governors in regulating air pollutant emissions. It may reflect the importance of the actual management system nearby residents and the local governor's abilities of controllership.
- In general, periodical meetings with local communities are not required, except before the new construction of a CPP, which is stipulated by another law.
- The penalties for violating air pollution control acts are strict. Penalties include suspending power generation facilities, imprisonment, and/or fines.
- Overall, except for the regulation standards for air pollutants, the OECD countries have stricter regulation standards and systems to monitor the air pollution status and publish it for the residents.
- Table 2 compares the national emission standards from the CPPs in the selected OECD countries. Where the standards differ depending on the operation start year of the plant, the case of a newly constructed CPP was adopted. Where they differ depending on the plant scale, the large-scale case was adopted. Where they differ depending on the period, the daily basis (or 24 hours) was adopted. SO<sub>x</sub> and NO<sub>x</sub> have different units from one country to another. In the countries where ppm is used, accordingly, it is converted into mg/m<sup>3</sup>, regarding them as SO<sub>2</sub> and NO<sub>2</sub>, respectively.

**Table 2: Emission standards for CPP in selected OECD countries**

Country	SOx	NOx	PM
Australia	SO <sub>3</sub> : 200 mg/m <sup>3</sup>	NO <sub>2</sub> : 800 mg/m <sup>3</sup>	80 mg/m <sup>3</sup>
Germany	SOx: 150 mg/m <sup>3</sup>	NOx: 150 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
Japan	SOx: 50 ppm <sup>*1</sup> (SO <sub>2</sub> : 133 mg/m <sup>3</sup> )	NOx: 200 ppm (NO <sub>2</sub> : 383 mg/m <sup>3</sup> )	100 mg/m <sup>3</sup>
Republic of Korea	SOx: 50 ppm (SO <sub>2</sub> : 133 mg/m <sup>3</sup> )	NOx: 50 ppm (NO <sub>2</sub> : 96 mg/m <sup>3</sup> )	10 mg/m <sup>3</sup>
United States <sup>*2</sup>	SO <sub>2</sub> : 130 ng/J	NOx: 88 ng/J	11 ng/J

CPP = coal-fired power plant, mg/m<sup>3</sup> = milligrams per cubic metre, ng/J = nanogram per joule,

NO<sub>2</sub> = nitrogen oxide, NOx = nitrogen oxides, OECD= Organisation for Economic Co-operation and Development, PM = particulate matter, ppm – parts per million, SO<sub>2</sub> = sulphur dioxide, SOx = sulphur oxides.

Notes: <sup>\*1</sup> Based on the CPP's location, sulphur content of fuel, stack height, etc. emission standards vary by CPP. The value is an example of a specific CPP based on an agreement between the CPP and local government.

<sup>\*2</sup> gross output.

Japan and Republic of Korea: More stringent standards in agreements between the CPP and local government than the national standard.

Source: Authors.

## Chapter 4

# Comparison of Management Systems between Selected ASEAN and OECD Countries: Similarities and Differences

This chapter selects several survey items to compare the situation in the selected OECD countries and selected ASEAN countries.

### 1. General

#### (1) Legislation

As with the selected OECD countries, the selected ASEAN countries have enacted environment-related acts and regulation standards for air pollutants. In many countries, the regulation values are sorted for each sector, regulating power generation as a sub-sector.

In the selected OECD countries, the local governments are generally authorized to enact stricter emission standards than national ones. In the selected ASEAN countries, Cambodia, Indonesia, Myanmar, and Thailand grant such authority to their local governments. In Thailand, however, no local government has actually set its own emission standards to date.

In Japan and the Republic of Korea among the OECD countries, coal-fired power plants (CPP) and local governments have concluded agreements to set stricter emission standards than the national ones. Among the ASEAN countries, Cambodia and Lao PDR are following suit. In both countries, the coal-fired power plants started operation less than 10 years ago. However, Cambodia and Lao PDR seem to be rare cases that follow Japan's experience to allow a CPP and local government to conclude an agreement to set stricter emission standards than the national ones.

#### (2) Regulated pollutants

All the countries have set national emission standards for the typical air pollutants emitted from the CPPs, namely SO<sub>x</sub>, NO<sub>x</sub>, and PM.

#### (3) Authority to suspend operation

Where the CPPs violate the emission standards in the selected OECD countries, the local

governments generally have the authority to suspend operation. In the selected ASEAN countries, on the other hand, the central government has the authority to suspend operations in Malaysia, Myanmar, and Thailand, while both the central and local governments have the authority in Indonesia and Lao PDR, and the local government has it in Cambodia.

#### (4) Relation to local community

When a new CPP is constructed, many countries require holding an advance meeting with the local community. Once the CPP starts operation, however, it is presumed that few countries request for a periodical meeting with the local community. In the selected OECD countries, once the CPP starts operation, it is not legally required to hold a periodical meeting with the local community. In the selected ASEAN countries, it was confirmed in Thailand that the CPP holds periodical meetings with the local community every 3 months. In Lao PDR, the CPP has to hold periodical meetings with the local community according to the agreement with the local government.

#### (5) Summary

When comparing the selected OECD and ASEAN countries, there are a few differences in the general sections of the legislation, despite the existence of some cases where the central or local government has authority.

## **2. Management systems**

### (1) Monitoring

In the selected OECD countries, monitoring is conducted by the central government, local government, or the CPP. This is also the case with the selected ASEAN countries. Monitoring is conducted by the local government in Cambodia and Lao PDR. In Indonesia, the local government conducts it irregularly. In Malaysia, it is conducted by the central government. In Myanmar, it is conducted by both the central government and local government. In Thailand, the CPP conducts the monitoring and submits the results to the central government.

### (2) Reporting to authority

In the selected OECD countries, the situation differs from one country to another. In the case of New South Wales in Australia, it is not obligated to report emission data. Accordingly, it is not obligatory to keep the emission data. Instead, the CPP must publish the air pollution status. In Germany, a CPP operator must periodically report the monitoring results. In Japan, the central or

local government may require the CPP operator to report the status of air pollutant emissions. In the United States, the CPP operator must report the continuous monitoring status. The situation varies among the selected ASEAN countries as well. In Cambodia and Lao PDR, the CPP must submit the emission data every month based on the agreement with the local government. In Indonesia, the CPP must submit the emission data to the central and local governments based on the law. The frequency of submission is every 3 months when continuous emission monitoring systems (CEMS) are used, and every 6 months when manually measuring. Malaysia has a CEMS. In Myanmar, the CPP must submit the emission data to the central government at least every 6 months based on the law. In Thailand, the CPP must submit data twice a year.

Archive requirements also vary among the selected OECD and ASEAN countries. Australia and Thailand for example, have no archive requirements. Even in the countries with archive requirements, the archiving period varies from 6 months to 3 years.

### (3) Inspection

The situation differs among the selected OECD countries. In NSW, Australia, mandatory audits may be required as a condition of a licence if the Environment Protection Authority (EPA) reasonably suspects violation of emission standards. In Germany, the law requires mandatory environmental inspections to be done at least every 1 to 3 years. In Japan, the national or local government may conduct official inspections. In the United States, the EPA's policy is self-policing.

Among the selected ASEAN countries, the central government inspects with telemeters in Cambodia. In Indonesia and Lao PDR, inspections are conducted by the central and local governments. In Malaysia, Myanmar, and Thailand, inspections are conducted by the central government.

No independent inspector is legally requested in either the selected OECD or ASEAN countries.

### (4) Public announcement

Air pollutants are emitted from industrial boilers and vehicles as well as CPPs. Accordingly, the regional air pollution status consists of a combination of different emission sources of air pollutants. The selected OECD countries regulate the regional air pollution status as well as emissions of air pollutants from the CPP. This is also the case with the selected ASEAN countries.

In regulating the air pollutants, it is important for the local community to always know the air pollution status. In the selected OECD countries, the central or local government generally publishes the air pollution status through websites or on screen monitors. The situation differs among the

selected ASEAN countries. In Cambodia, the central government publishes the air pollution status through its website, while in Malaysia the status is published on a screen monitor. In Lao PDR, the local government publishes the regional air pollution status. In Myanmar, the CPPs publish the air pollution status inside the plants. In Thailand, the air pollution status is published in the annual report submitted by the CPP's operator. In Indonesia, the central government is developing a data collecting and publishing system.

#### (5) Summary

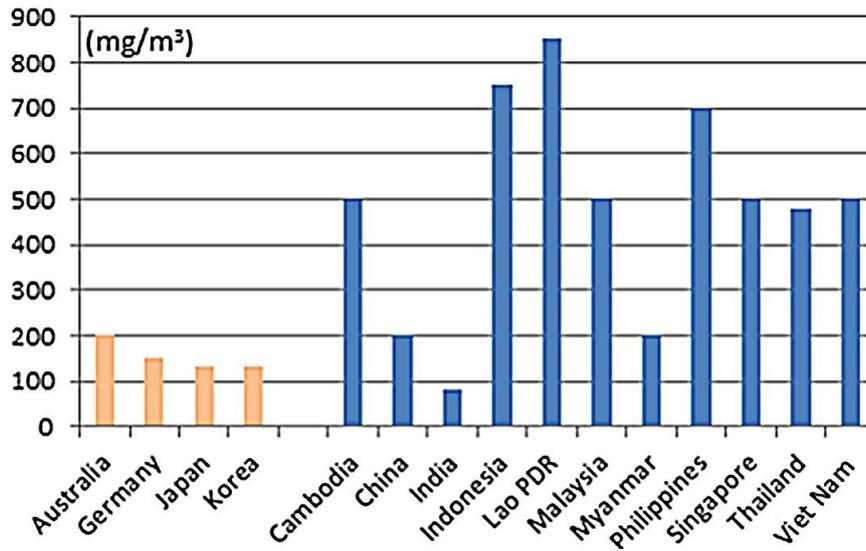
The management system status differs among the selected OECD and ASEAN countries.

### **3. Emission standard for CPPs**

Figures 3 to 5 compare the national emission standards for CPPs for SO<sub>x</sub>, NO<sub>x</sub>, and PM. It is necessary to note that the data are not actual emission values. Where the standards differ depending on the operation start year of the plant, a newly constructed CPP was adopted. Where they differ depending on the plant scale, the large-scale case was adopted. Where they differ depending on the period, the daily basis (or 24 hours) was adopted. SO<sub>x</sub> and NO<sub>x</sub> have different units from one country to another. In the countries where ppm is used, accordingly, it is converted into mg/m<sup>3</sup>, regarding them as SO<sub>2</sub> and NO<sub>2</sub>, respectively.

SO<sub>x</sub> is higher in the selected ASEAN countries than in the selected OECD countries. NO<sub>x</sub> is lower in the selected OECD countries except for Australia. For PM, the regulation values in the selected ASEAN countries are approximately the same as those in Australia and Japan, except for Cambodia.

**Figure 3: Comparison of emission standards in selected countries (SOx)**

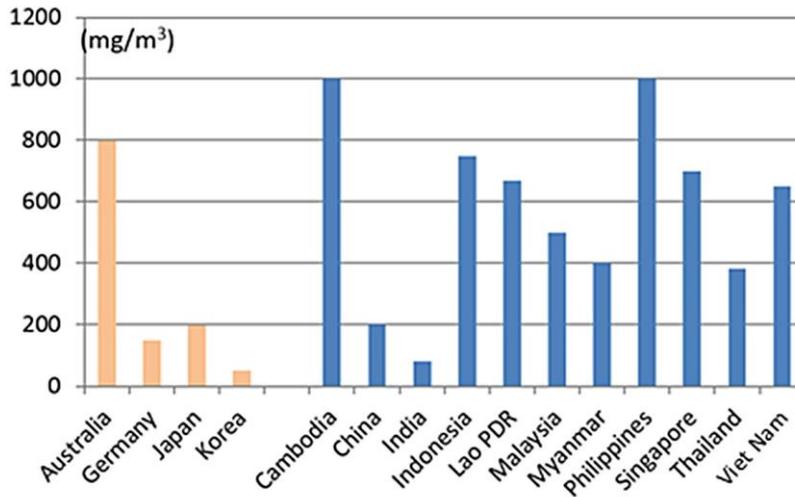


mg/m<sup>3</sup> = milligrams per cubic metre, SOx = sulphur oxides.

Note: Japan: Example of Agreement of specific CPP. China: Regulation in key region.

Source: Authors.

**Figure 4: Comparison of emission standards in selected countries (NOx)**

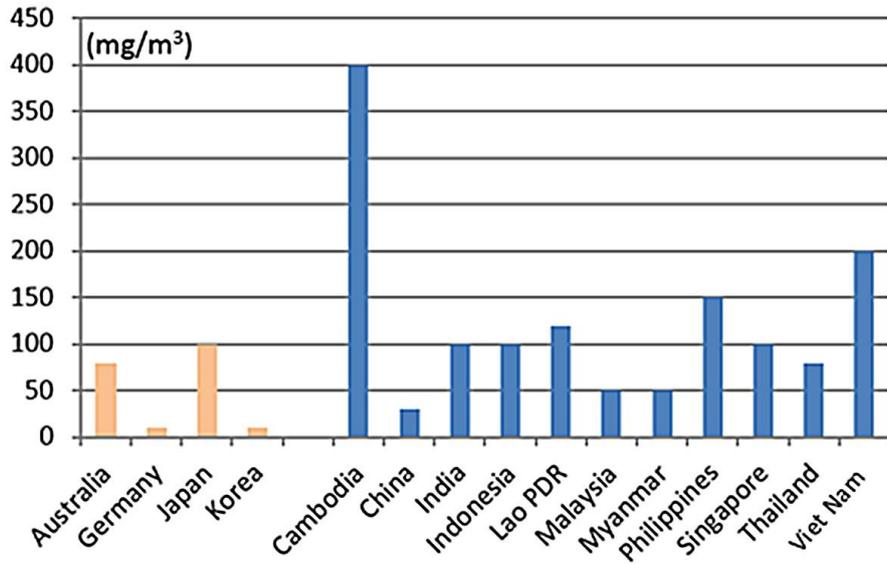


mg/m<sup>3</sup> = milligrams per cubic metre, NOx = nitrogen oxides.

Note: China: Regulation in key region.

Source: Authors.

Figure 5: Comparison of emission standards in selected countries (PM)



mg/m<sup>3</sup> = milligrams per cubic metre, PM = particulate matter.

Note: China: Regulation in key region.

Source: Authors.

## Chapter 5

### Policy Recommendations

#### **1. Campaign against CPPs**

The merit of coal is that it is less expensive than other fuels and can generate power at low cost. In countries with a low electrification rate, coal is an optimum power generation fuel for enhancing the electrification rate at low cost. Furthermore, the world's largest thermal coal export country, Indonesia, is in the ASEAN region and the world's second largest thermal coal export country, Australia, is located close to ASEAN.<sup>2</sup> With lignite included, many ASEAN member countries have coal reserves. From a viewpoint of energy security, coal is a procurable fuel in the ASEAN region or from a neighbouring country; its utilization helps enhance self-sufficiency in the ASEAN region.

Thus, coal is an optimum power generation fuel for ASEAN in terms of both cost and energy security. However, the combustion of coal emits air pollutants, such as sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter (PM), harmful to human health and the environment. Consequently, campaigns against existing CPPs have been launched, and have started other campaigns against the construction of new CPPs, forcing some new projects to be halted or cancelled. For ASEAN countries, minimizing the emission of air pollutants is a precondition for the future use of CPPs. But here the problem is regulating the emission of air pollutants from CPPs. To reduce the emission of air pollutants, it is required to create regulations and properly manage and operate them.

Based on this awareness, this study surveys the regulations on the emission of air pollutants (including emission standards and implementation of the regulations).

#### **2. More stringent level of emission standards of air pollutants from CPPs**

This survey revealed that in ASEAN countries environmental laws have been enacted to identify the air pollutants to be regulated and to set emission standards. The problem is the emission standard

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<sup>2</sup> Source: International Energy Agency, Coal Information 2016.

level. Compared to OECD countries, the emission standards are low in many ASEAN countries depending on the country or the type of air pollutants.

Thus, it is important to raise the current emission standards of air pollutants from CPPs to the level equivalent to OECD countries. This is because a more stringent level of emission standards is essential for responding properly to the campaign against CPPs occurring in ASEAN countries. Additionally, making the level of emission standards more stringent can reduce the emission of hazardous air pollutants from CPPs and contribute to the reduction of health hazards to residents.

However, a gradual tightening of emission standards may be required according to each country's capability. Raising the level of emission standards can lead to an increase in environmental expenses or an increase in electricity tariffs. The importance of strengthened regulations cannot be understated, but national and government financial capabilities also need to be considered.

### **3. Finance and international cooperation**

Expensive environmental facilities need to be installed in CPPs to reduce hazardous air pollutants by tightening the emission standards of air pollutants. This imposes a heavy burden, especially on low-income countries in the ASEAN region. The most desirable method of sharing the cost burden is to pass on additional costs to end-consumers according to their electricity consumption. If passing on increased costs is difficult, it may put a temporary subsidy burden on the government. This is not sustainable in the long term; therefore, it is recommended to stop providing subsidies to electricity consumers as early as possible.

There are several ways of financing capital expenditure. For borrowing, there are two options: one is from domestic financial institutions, the other is from international financial institutions. Domestic financial institutions are free from exchange risks; however, they may not have the practical knowledge of large-scale financing for energy. For international financial institutions, long-term borrowings can be made at low interest rates; however, there are exchange rate risks and loan procedures sometimes take time due to strict loan terms. Generally, the installation of environmental facilities can be a good funding destination. On the other hand, financial institutions have their own view of loans for coal-fired power generation alone. Some financial institutions put restrictions on loans for new CPP construction, which may limit the funding sources. There are many types of loans and there is no one special way. A careful decision is required in view of the circumstances including the factors mentioned in this document.

A combination of financing options can be used to construct new coal-fired power plants. For example, private funds such as independent power producers and private finance initiatives can be used for construction. These approaches have the advantage of constructing a new CPP without increasing public debt, resulting in promoting technology transfer through the operation of developed countries' companies.

#### **4. Monitoring system**

Raising emission standards of air pollutants from the CPPs to the level equivalent to OECD countries and installing environmental facilities in the CPPs will not be the end of the matter. As a first step, the installed facilities need to be maintained/managed for proper operation. Second, constant monitoring and recording are required to ensure that the facilities can provide guaranteed performance and the air pollutants concentration level is kept below the standard. Third, measurement results need to be released to local governments and residents for assuring proper operation of the CPPs.

The first step is nothing special; however, some facilities cannot guarantee performance in the CPPs in developing countries due to the lack of operational experience and maintenance. The continued proper operation of environmental facilities serves as the base to gain an understanding of residents.

Regarding the second and third steps, the CPPs need to show evidence of complying with the laws and regulations to gain the trust of residents. Without information disclosure, residents living near a CPP have no means of knowing if the air pollutants emission level is kept below the standard. Therefore, the residents may still raise concerns about the CPP, even if they run properly. Hazardous air pollutants are emitted not only from CPPs but also from industrial boilers and automobiles. A negative image of CPPs, however, prevents residents from distinguishing among these pollution sources. CPPs are requested to continually provide transparent data to protect themselves.

Under these circumstances, a highly transparent system is required to monitor the air pollutants concentration level both for CPPs and local regions. This can be a challenge for countries that have never created such a system. It is recommended to create a system to monitor the air pollution situation and to establish an international cooperative framework for proper operation and information disclosure on the system, and to provide capacity building for central and local governments and CPP operators. Cooperation will bring mutual benefits to both ASEAN countries and cooperating countries, encouraging them to build a win–win relationship.



# Annex 1

## Environmental Legislation in Selected Countries

### OECD Countries

#### Australia

The National Environment Protection (Ambient Air Quality) Measure (1998)

Amendment: 2003, 2011

National Environment Protection (National Pollutant Inventory) Measure (2008)

#### Germany

Germany (Federal)

Federal Emission Control Act (1990)

Latest amendment: 2000

European Union (EU) Directive

Industrial Emission Directive (IED – 2010/75/EU)

Large Combustion Plant Directive (LCPD – 2001/80/EC)

National Emission Ceilings for Certain Atmospheric Pollutants Directive (NECD – 2001/81/EC)

European Union Emissions Trading Scheme (EU ETS 2009/29/EC)

#### Japan

Basic Law for Environmental Pollution Control (1967)

Basic Environment Law (1993)

Latest amendment: 1998

#### Republic of Korea

Environmental Protection Law (1978)

Basic Law for Environmental Policy (1991)

(Emission standards)

NO (1979)

CO, NO<sub>2</sub>, dust, ozone, hydrocarbon (1983)

Lead (1991)

Sulphurous acid gas, hydrocarbon (new standard, 1993)

**United States**

Clean Air Act (CAA) of 1963 and its 1970 amendments  
Clean Air Act Amendment of 1977

**ASEAN, China, and India****Cambodia**

Law on Environmental Protection and Natural Resources Management (1996)  
Law on Standards of Cambodia (2007)  
Sub-decree on Air Pollution and Noise Disturbance (2000)  
The Sub-decree on Environment Impact Assessment (1999)

**Indonesia**

Law No. 32 Year 2009 Regarding the Protection and Management of Environment  
Law No. 30 Year 2009 Regarding Electricity  
Government Regulation No. 14 Year 2012 Regarding Business of Electricity Supply  
Government Regulation No. 27 Year 2012 Regarding Environmental License  
Government Regulation No. 41 Year 1999 Regarding Air Emission Control  
Ministry of Environment Decree No. 21 Year 2008 Regarding Static Emission Sources Quality Standard for business and/or activities of a Thermal Power Plant

**Lao PDR**

Environmental Protection Law (1999)  
National Environmental standard (2009)

**Malaysia**

Environmental Quality Act 1974  
Environmental Quality (Clean Air) Regulations (1978)  
Latest amendment: 2014

**Myanmar**

Environmental Conversation Law 2012  
Environmental Conversation Rule 2014  
National Environmental Quality (Emission) Guideline (2015)  
Environmental Impact Assessment Procedure 2015

**Philippines**

Philippines Clean Air Act of 1999  
National Emission Standards (DENR Administrative Order No. 2000 - 81, 7 Nov 2000)

**Singapore**

Environment Pollution Control Act (EPCA) (1999)

Environmental Protection and Management Act (EPMA) (2008)

Clean Air (Standards) Regulations (1978)

Environmental Protection and Management (Air Impurities) Regulations (2001)

Amendment: 2002, 2008

**Thailand**

Enhancement and Conservation of National Environmental and Quality Act (1992)

Ambient Air Standards (1995, 2004, 2010)

Emission standard from Coal-fired power plants (1996, 2001, 2010)

**Viet Nam**

Environmental Protection Law (2006)

Emission standards for Industrial sources (1995)

Emission standards for thermal power plants (2005 replaced by 2009)

**China**

Environmental Protection Law (1989)

Emission standards for air pollutants from coal-fired power plants (GB13223-2011) (2012)

**India**

Prevention and Control of Pollution Act (1981) (amendment: 1987)

Environment (Protection) Act (1986) (Latest amendment: 1991)

National Ambient Air Quality Standards (2009)

## Annex 2

### Survey Sheet (Selected OECD Countries)

#### Australia

##### Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation, red letters: example of New South Wales state)

###### **Legislation**

###### National (Federal, Central)

National Environment Protection (National Pollutant Inventory) Measure 1998

National Environment Protection (Ambient Air Quality) Measure

###### Local (State, Municipality, District, City)

Each state establishes environmental legislation. Procedures vary from state to state.

###### **Regulated pollutants (relating to coal-fired power plants)**

SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub>

###### **Emission standards**

Details are described in an annex.

###### **How can authorities recognize the existence of facilities that emit air pollutants?**

The occupier of each reporting facility is to be required to provide information.

(Example of New South Wales [NSW] state)

Licensing.

###### **Authority to suspend operation**

(Example of NSW state, Protection of the Environment Operations Act 1997)

Clean-up notices, prevention notices, and prohibition notices are the environment protection notices that are provided for under the legislation. Only the minister can issue a prohibition notice, on the recommendation of the Environment Protection Authority (EPA).

## Measurement of emission by operator

Methods for pollutant monitoring: Australian standards

## Monitoring

The law requires monitoring stations to be installed in areas with populations greater than 25,000.

(Example of NSW state)

The Office of Environment and Heritage (OEH) operates a comprehensive air quality monitoring network to provide the community with accurate and up-to-date information about air quality.

Air quality monitoring sites are set up in Sydney and regional areas of NSW.

Data from the monitoring network are presented online as ambient concentrations and air quality index (AQI) values which are updated hourly and stored in a searchable database.

In 2010, OEH, in partnership with the Upper Hunter coal and power industries, established the Upper Hunter Air Quality Monitoring Network.

## Reporting

(Example of NSW state)

The law does not require licensees to report emission data to EPA periodically. Instead of reporting, the law requires licensees to publish pollution monitoring data.

## Inspection

(Example of NSW state, Protection of the Environment Operations Act 1997)

Duty to notify pollution incidents

The act provides that mandatory audits may be required as a condition of a licence if the EPA reasonably suspects.

Powers of investigation: Authorized officers' powers include powers to require information or records, powers of entry and search of premises, powers to question and identify persons, powers to disable intruder alarms, and powers with respect to vehicles and vessels.

## Archive Requirement

(Example of NSW state)

Unknown.

<p><b>Public Announcements</b></p> <p>(Example of NSW state, Requirements for publishing pollution monitoring data)</p> <p>Pollution monitoring data that is required to be collected by a licence condition must be published by the licensee. There are offences for failure to publish monitoring data and for publishing false or misleading data.</p> <p>Publish monthly meaningful summary of pollution monitoring data on website, or required frequency where monitoring occurs less than monthly.</p> <p>NSW EPA publishes the current situation of air quality on the website.</p>
<p><b>Compensation for Damage and Losses</b></p> <p>Negligence</p>
<p><b>Penalty</b></p> <p>(Example of NSW state)</p> <p>Environmental Offences and Penalties</p>
<p><b>Assistance (National, Local)</b></p> <p>(Example of NSW state)</p> <p>Unknown.</p>
<p><b>Ability of local governments</b></p> <p>(Example of NSW state)</p> <p>The EPA offers a 2-day course which is designed to equip authorized officers within local government with the necessary competencies to fulfil their responsibilities as outlined in the Protection of the Environment Operations Act 1997.</p>
<p><b>Relation to local community</b></p> <p>(Example of NSW state)</p> <p>The law does not require periodical meeting with local community.</p>
<p><b>Independent inspector</b></p> <p>(Example of NSW state)</p> <p>The law does not require independent inspector.</p>

## Detail of Emission Standards

(Relating to coal-fired power plant)

### Australia

#### Standards for pollutants

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
NO <sub>2</sub>	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None
SO <sub>2</sub>	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None
PM <sub>10</sub>	1 day	50 µg/m <sup>3</sup>	None
	1 year	25 µg/m <sup>3</sup>	None
PM <sub>2.5</sub>	1 day	25 µg/m <sup>3</sup>	None
	1 year	8 µg/m <sup>3</sup>	None

#### Goal for Particles as PM<sub>2.5</sub> by 2025

Pollutant	Averaging period	Maximum concentration
NO <sub>2.5</sub>	1 day	20 µg/m <sup>3</sup> by 2025
	1 year	7 µg/m <sup>3</sup> by 2025

## (Example of NSW state)

### Outline of Protection of the Environment Operations (Clean Air) Regulation 2010

Schedule 3 Standards of concentration for scheduled premises: activities and plant used for specific purposes

#### Electricity generation

Air impurity	Activity or plant	Standard of concentration	
PM	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel	Group 1	400 mg/m <sup>3</sup>
		Group 2, 3, or 4	250 mg/m <sup>3</sup>
		Group 5	100 mg/m <sup>3</sup>
		Group 6	50 mg/m <sup>3</sup>
NO <sub>2</sub>	Any boiler operating on a fuel other than gas, including a boiler used in connection with an electricity generator that forms part of an electricity generating system with a capacity of 30 MW or more	Group 1, 2, 3, or 4	2,500 mg/m <sub>3</sub>
		Group 5	800 mg/m <sub>3</sub>
		Group 6	500 mg/m <sub>3</sub>

Schedule 4 Standards of concentration for scheduled premises: general activities and plant

#### General standards of concentration

Air impurity	Activity or plant	Standard of concentration	
SO <sub>3</sub>	Any activity or plant	Group 1	200 mg/m <sup>3</sup>
		Group 2, 3, 4, 5 or 6	100 mg/m <sup>3</sup>

An activity carried out, or plant operated

Group 1: Before 1 January 1972

Group 2: After 1 January 1972 and before 1 July 1979

Group 3: After 1 July 1979 and before 1 July 1986

Group 4: After 1 July 1986 and before 1 August 1997

Group 5: After 1 August 1997 and before 1 September 2005

Group 6: After 1 September 2005

## Germany

### Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

#### Legislation

- German regulations on air quality are aligned with the provisions adopted by the European Union (EU) air quality legislation. Current standards are contained in the Directive 2008/50/EC (European Parliament (EP) & Council of European Union (CEU), 11 June 2008) on ambient air quality and cleaner air for Europe, and the Fourth Daughter Directive 2004/107/EC (EP & CEU 2004), relating to arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air.
- Industrial emissions within the EU are regulated under the **Directive 2010/75/EU** or Industrial Emissions Directive (**IED**) aiming to reduce harmful industrial emissions across the EU basically through a better application of Best Available Techniques (**BAT**). According to the IED, Member States (MS) may choose to grant a permit to one responsible operator for each installation or to split the responsibility amongst several operators of different parts of an installation. The provision of emission permits depends on the evaluation of plants based on BAT.
- Entered into force on 6 January 2011, the IED was to be adopted in MS national legislation by 7 January 2013. The IED provides an integrated permitting procedure (covering also issues related to water, soil, waste management, energy efficiency, and accident prevention) that allows to coordinate different permits and permitting procedures and to achieve the protection of environment as a whole, avoiding the transfer of pollution to other media.

#### National (Federal, Central)

**Federal Immission Control Act**<sup>3</sup> (Bundes-Immissionsschutzgesetz, **BImSchG**). Long title: Act on Prevention of Harmful Effects on the Environment caused by Air Pollution as amended and promulgated on 14 May 1990 (Federal Law Gazette I. p. 880), as last amended by Art. 1 of the Act of 3 May 2000 (Federal Law Gazette I. p. 632).

Four strategies to control emissions:

- Laying down environmental quality standard
- Emission reduction requirements according to the BAT
- Product regulations
- Laying down emission ceilings

<sup>3</sup> Even though the word “Immission” may sound strange here, it is used in the English version of the Act as in appears in several official government websites. In particular, the Federal Ministry of the Environment, Nature Conservation, Building and Nuclear Safety explains the use of the word Immission instead of Emissions in its website: “Immission relates to the effects of emissions on the environment” (<http://www.bmub.bund.de/en/topics/air-mobility-noise/air-pollution-control/general-information/>).

Local (State, Municipality, District, City):

In addition to the [BImSchG](#), there are also provisions on air quality control at Federal State levels. Basically, they represent the local enforcement of the [BImSchG](#) legal measures.

**Regulated pollutants (relating to coal-fired power plants)**

Target values are established by the IED 2010/75/EU, Annex II.

AIR

- SO<sub>2</sub> and other Sulphur compounds
- NO<sub>x</sub> and other nitrogen compounds
- Carbon monoxide
- Volatile organic compounds
- Metals and their compounds
- Dust including fine particulate matter
- Asbestos (suspended particulates, fibres)
- Chlorine and its compounds
- Fluorine and its compounds
- Arsenic and its compounds
- Cyanides
- Substances and mixtures which have been proved to possess carcinogenic or mutagenic properties which may affect reproduction via the air
- Polychlorinated dibenzodioxins and polychlorinated dibenzofurans

According to the IED, different approaches of controlling emissions into air, water, or soil separately may encourage the shifting of pollution from one environmental medium to another. The IED favours an integrated approach to prevent and control pollutants and includes among the polluting substances also those affecting water (for a detailed list on water pollutants see Annex II of IED - 2010/75/EU).

**Emission standards**

- The emission limit values (mg/Nm<sup>3</sup>), i.e. concentrations that must not be exceeded in a given period, are established by the EU legislation (IED 2010/75/EU) and ensure that, under normal conditions, emissions do not exceed the emission levels associated with the BAT. The limit values are determined through standards stipulated in European air pollution control directives and then transposed into German law.
  - Emission limit values shall apply at the point where the emissions leave the installation, and any dilution prior shall be disregarded. Setting of emission limit values must not exceed the levels associated with BAT.
- Alternatively, different emission limits, in terms of values, periods of time and reference

conditions, can be set. In this case, the competent authority shall assess results at least annually to ensure that emission levels do not exceed those associated with BAT.

### **How can authorities recognize the existence of facilities that emit air pollutants?**

- According to the IED regulation, competent authorities in the MS shall grant a permit if the installation emits polluting substances listed in Annex II and other polluting substances, as required by the IED, Art. 14, para. A), and undertaking the industrial activities listed in Annex I of the IED. Usually, they are industrial installations that have the potential to impact air quality and cause air pollution (mainly iron, steel, coal, cement, chemicals, machinery, vehicles, machine tools, electronics, automobiles, food and beverages, shipbuilding, textiles).
- The permits must take into account the whole environmental performance of the plant, in accordance with the integrated approach of the IED regulation.
- Operators shall submit to the competent authority a baseline report before starting operation of an installation. The report shall contain the information necessary to determine the state of soil and groundwater contamination.
- The permit conditions are based on BAT as defined by the BAT Reference Documents (BREFs) set after consultations of experts from MS, industry and environmental organizations. The conclusions reached in BREFs are adopted by the Commission as Implementing Decisions and constitute the reference for setting permits conditions.

### **Authority to suspend operation**

Operators are required to suspend operations in case of non-compliance with requirements. According to **BImSchG**, Art. 20, the competent authority may decide to suspend activities of a plant in whole or in part. The competent authority shall order the closure of an installation built without necessary authorization or if it cannot guarantee the adequate protection of the neighbouring environment.

### **Measurement of emission by operator**

**Methods:** The Technical Instructions on Air Quality Control (Technische Anleitung zur Reinhaltung der Luft, TA Luft) lay down requirements for calculations, which are based on the Lagrangian particle dispersion model and computed through a computer programme called AUSTAL2000.

- The analytical methods used are standardized internationally, with air quality data gathered by international data centres and used for computer modelling. The Federal Republic of Germany cooperates with other countries in the framework of the Convention on Long-range Transboundary Air Pollution (CLRTAP): the international control instrument under this framework is the European Monitoring and Evaluation Programme (EMEP), which measures transboundary air pollution from 25 countries.

#### **Compliance** with emissions limit values (IED, Part 4):

- If continuous measurements are required, compliance depends on:
  - No validated monthly average exceeding limit values;
  - No validated daily average exceeding 110% of limit values;
  - In case of combustion plants using coal with a total rated thermal input below 50 MW, no validated daily average exceeding 150% of limit values;
  - 95% of all the validated hourly average values over the year not exceeding 200% of limit values.
- If continuous measurements are not required:
  - Compliance if the results of each of the series of measurements do not exceed the limit values.

For example, for fine dust (PM<sub>10</sub>) a maximum permitted average annual level of 40µg/m<sup>3</sup> and a maximum permitted daily level of 50µg/m<sup>3</sup>, with a maximum of 35 exceeding days per year.

#### **Frequency of measures**

- The concentrations of SO<sub>2</sub>, NO<sub>x</sub>, and dust shall be measured continuously. The **German Federal Environment** and the **Agency German's Länder monitoring networks** measure data on ambient air quality several times a day.
- For combustion plants firing coal or lignite, the emissions of total mercury shall be measured at least once per year.

#### **Monitoring**

According to IED, Part 6, sampling and analysis of all polluting substances including dioxins and furans as well as the quality assurance of automated measuring systems and reference measurement methods to calibrate them shall be carried out according to CEN-standards.<sup>4</sup> If CEN standards are not available, ISO, national or other international standards which ensure the provision of data of an equivalent scientific quality shall apply.

Air quality is measured by a sophisticated national air quality monitoring network. German air monitoring networks are operated by:

- **German Federal Environment Agency** (Umweltbundesamt [**UBA**]), which measures stations far away from densely populated areas and cities. Situated in rural areas, the stations of the Federal Environmental Agency (so-called background stations) collect concentration and deposition data for the investigation of widely dispersed air pollution in rural areas and measure the quality of air masses transported over long distances and across national frontiers. (UBA monitoring sites: Westerland; Zingst, Neuglobsow; Waldhof; Schmücke; Langen; Schauinsland; Zugspitze).
- **German's Länder monitoring networks**, which monitor the quality of the air comprehensively. They operate measuring stations in cities, in conurbations, in areas with high traffic density as well as in rural regions, to monitor and determine local and regional air quality.

<sup>4</sup> Comité européen de normalization (CEN) or European Committee for Standardization.

The data from the **UBA** and the **Länder** monitoring networks provide the foundation for the presentation of the country's air quality. They are gathered in the centre of air monitoring situated in Langen (Hesse) near Frankfurt/Main.

### **Reporting**

According to the IED, installations operating in accordance with a permit shall supply the competent Authority regularly, and at least annually, with information on the basis of results of emission monitoring (measurement methodology, frequency and evaluation procedure) in order to enable the authority to verify compliance with permit conditions.

### **Inspection**

The IED requires mandatory environmental inspections to be done at least every 1 to 3 years (usually 1 year maximum for installations posing the highest risks and 3 years for installations posing the lowest risks).

According to the **BImSchG** the Federal Government is authorized, with the consent of the Bundesrat, to organize the inspections.

Each inspection plan shall include a general assessment of relevant significant environmental issues; the geographical area covered by the inspection plan; a register of the installations covered by the plan; procedures for drawing up programmes for routine environmental inspections; procedures for non-routine environmental inspections; provisions on the cooperation between different inspection authorities.

### **Archive Requirement**

Publications shall be lodged in the archives of the German Patents Office for safe custody and reference. The ordinance shall indicate the date of publication and full particulars of the source reference (BImSchG, Art. 7).

### **Public Announcements**

All data on air quality are published on the internet shortly after they are gathered in Langen, providing information on current pollution level.

MS shall ensure that the public has effective opportunities to participate in the procedures of granting a permit for new installations, following any substantial change or updating (Art. 24). When a decision on permits is taken, it shall be available to the public, including on the internet.

The IED ensures to the public the right to participate in the decision-making process and to be informed on its consequences by having access to permit applications, permits and the results of the monitoring of releases (IED, Annex IV).

<p>The EU Pollutant Release and the Transfer Register (E-PRTR) is a public register intended to provide environmental information on major industrial activities and include data on emissions as reported by MS. The register contributes to transparency and public participation. It implements for the EU Community the UN/ECE PRTR Protocol to the Aarhus Convention on Access to Information, Public Participation on Decision-making and Access to Justice in Environmental Matters.</p>
<p><b>Compensation for Damage and Losses</b></p> <p>Clean-up of soil, water, or damaged goods can be requested if there is a causal connection between the air pollution and the damage. If the responsible party is unwilling or unable to execute the clean-up, the authorities can do so at the polluter's cost.</p>
<p><b>Penalty</b></p> <p>Severe cases of non-compliance can result in criminal liability. Criminal sanctions include imprisonment and fines (up to €50,000).</p>
<p><b>Assistance (National, Local)</b></p> <p>MS shall ensure that operators afford the competent authorities all necessary assistance to enable those authorities to carry out any site visits to gather the information necessary (IED, Art. 23).</p> <p>MS shall encourage the development and application of emerging techniques, in particular for those emerging techniques identified in BAT documents.</p>
<p><b>Ability of local governments</b></p> <ul style="list-style-type: none"> <li>- Germany is a Federal Republic with 16 federal states whose competent bodies may differ since each federal state has its own laws regulating the administration. As a rule, the mid-level administrative bodies of the federal states (Landratsamt or Regierungspräsidium) have permitting authority.</li> </ul>
<p><b>Relation to local community</b></p> <p>The most relevant relation between local and national authorities takes place at the measurement and monitoring stage, which gathers data from local Länder and German Federal Environment Agency monitoring networks.</p>
<p><b>Independent inspector</b></p> <p>Independent inspections are not required.</p>

# Detail of Emission Standards

(Relating to coal-fired power plant)

## Germany

According to IED (Annex V), all emissions limit values shall be calculated at a temperature of 273,15 K, a pressure of 101,3 kPa and after correction for the water vapour content of the waste gases and at a standardized O<sub>2</sub> content of 6% for solid fuels, 3% for combustion plants, other than gas turbines and gas engines using liquid and gaseous fuels, and 15% for gas turbines and gas engines.

a) For permits granted before 7 January 2013 (for details see IED, Art. 30, par.1), emission limit values are the following:

### 1. SO<sub>2</sub>

Emission limit values (mg/Nm<sup>3</sup>) for SO<sub>2</sub>

Total rated thermal input (MW)	Coal and lignite
50–100	400
100–300	250
>300	200

### 2. NO<sub>x</sub>

Emission limit values (mg/Nm<sup>3</sup>) for NO<sub>x</sub>

Total rated thermal input (MW)	Coal and lignite
50–100	300 (400 in case of pulverized lignite combustion)
100–300	200
>300	200

### 3. DUST

Emission limit values (mg/Nm<sup>3</sup>) for dust

Total rated thermal input (MW)	Coal and lignite
50–100	30
100–300	25
>300	20

b) For all permits not covered by paragraph 2 (IED, Art. 30, par. 3), emission limit values are the following:

### 1. SO<sub>2</sub>

Emission limit values (mg/Nm<sup>3</sup>) for SO<sub>2</sub>

Total rated thermal input (MW)	Coal and lignite
50–100	400
100–300	200
>300	150 (200 in case of circulating or pressurized fluidized bed combustion)

### 2. NO<sub>x</sub>

Emission limit values (mg/Nm<sup>3</sup>) for NO<sub>x</sub>

Total rated thermal input (MW)	Coal and lignite
50–100	300 (400 in case of pulverized lignite combustion)
100–300	200
>300	150 (200 in case of pulverized lignite combustion)

### 3. DUST

Emission limit values (mg/Nm <sup>3</sup> ) for dust Total rated thermal input (MW)	Combustion plants using solid or liquid fuels except gas
50–300	20
>300	10

# Japan

## Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

### Legislation

#### National (Federal, Central)

1. Air Pollution Control Act (Ministry of the Environment, MoE), which includes relevant Cabinet Order and Ordinance of MoE.
2. Following cases will be exempted from application of Air Pollution Control Act.
  - Coal-fired power plant (CPP) which has an authorization of Electricity Business Act. (Ministry of Economy, Trade and Industry, METI) \*
  - Event of accidents

\* The Electricity Business Act implies the same level of emission standard.

#### Local (State, Municipality, District, City)

1. Air Pollution Control Act allows prefectures to set their own emission standards (which in general more stringent than that of the central government).
2. Air Pollution Control Act allows local governments to establish necessary regulations (Ordinance) relating to air pollutant emissions.
3. Local governments can establish their own ordinance which is not directly regulating but potentially affect air emission of CPP.
  - e.g. Yokohama city where Isogo CPP locate, establishes ordinance relative to living environment.

### Regulated pollutants (relating to coal-fired power plants)

Air Pollution Control Act: SO<sub>x</sub>, NO<sub>x</sub>, PM

Yokohama city (Ordinance relating to living environment):

- Cadmium/cadmium compound
- Chlorine/hydrogen chloride
- Fluorine
- Hydrogen fluoride
- Silicon fluoride
- Lead/lead compound
- Ammonia
- Cyanogen compound
- NO<sub>x</sub>
- SO<sub>2</sub>
- Hydrogen Sulphide

## **Emission standards**

Regal mandate: Details are described in an annex

1. Ordinance of MoE (general)
2. Local government ordinance (specified areas, more stringent)

Voluntary:

3. Agreement between local government and power plants operator (more stringent)
4. Internal targets of power plants (operational standards, most stringent)

Standards for Controlling the Total Emissions

Air Pollution Control Act stipulates that prefectural governor shall set standards for controlling the total emissions in an area with a concentration of factories or workplaces.

## **How can authorities recognize the existence of facilities that emit air pollutants?**

Coal-fired power plants shall provide the following items to the prefectural governor.

- Name and address
- Location
- Type of air pollutant
- Structure of facilities
- Way of disposing of air pollutants, etc.

## **Authority to suspend operation**

Prefectural governors have the power to order emitters to suspend the operation of facilities when they violate the regulation.

Order for Improvement

Prefectural governors have the power to order a CPP to improve performance when it continuously emit more than regulated limit.

Based on an agreement between local government and CPP operator, when CPP is going to restart after the order for improvement, the local government can resist its restart until improvement has been satisfactorily made. This mechanism lets the CPP operator to comply with voluntary target to avoid receiving order for improvement by the local government.

## **Measurement of emission by operator**

CPP operator shall measure the quantity or concentration of air pollutant, and keep its record.

- Frequency of measuring:
  - SOx: more than every two months (Total emission controlling area: continuously(24hr-7d))
  - NOx: more than every two months
  - PM: more than every two months
- Measuring methods are stipulated in Law.

Coal-fired power plants set observing stations, for example, 10km, 20km, 30km away from CPP, to monitor the emission continuously. The data is automatically transmitted to local government through telemeter.

CPP operator signed agreement with local government, which stipulates, in most cases, stringent emission standards and more frequent measurement. For example:

SOx: monitor quantity and concentration continuously

NOx: monitor quantity and concentration continuously

PM: every month

### **Monitoring**

Prefectural governors shall continuously monitor the status of air pollution.

Local governments have observation stations.

### **Reporting**

MoE or governor of prefecture may require CPP operator to report the status of air pollutant emissions.

MoE conducts integrated survey of quantity of air pollutant emission every three years.

According to an agreement between CPP operator and local government, an operator submits the report to local government every month, although the CPP automatically sends data through telemeter continuously.

### **Inspection**

MoE or a prefectural governor may conduct official inspection.

On-site inspection by METI: On an irregular base, every 5 or 6 years.

On-site inspection by local government depends on an agreement between CPP operator and local government, once in a year generally, in Environment Month typically.

### **Archive Requirement**

3 years.

Generally, most CPP operators keep important data permanently.

**Public Announcements**

Prefectural governors shall make public the status of air pollution within the prefecture.

Local governments collect environmental data from various facilities and publish the status of air pollution at screen monitor in their city hall. Everyone can see the situation in anytime. Local governments also publish environmental report periodically.

In case of accident, CPP operator publishes the status of air pollutant emissions through a press release.

**Compensation for Damage and Losses**

Strict Liability

**Penalty**

Violation of Air Pollution Control Act including disclose of name of subjected operator.

Punishment includes imprisonment and fine.

**Assistance (National, Local)**

Air Pollution Control Act stipulates the following.

The (national) government shall endeavour to provide financial assistance, technical advice, other assistance.

MoE, in collaboration with Ministry of Economy, Trade and Industry (METI) in some cases, convenes explanatory meetings with CPP operator when the law is amended.

Local governments also convene explanatory meetings with CPP operator.

MoE and local government post explanatory documents and application/report forms on their website for easy download.

**Ability of local governments**

Ability of officers in local government is high. There are experts of measuring method in local government.

**Relation to local community**

Air Pollution Control Act does not require periodical meeting with local community.

Another law requires companies to hold a meeting with residents for explanation and discussion when they apply Environmental Impact Assessment before new construction of a CPP.

### Independent inspector

Air Pollution Control Act does not require independent inspector.

If a coal-fired power plant has ISO 14001 certification, the plant is audited every year.

## Detail of Emission Standards

(Relating to coal-fired power plant)

### Japan

#### 1. SO<sub>x</sub>

Air Pollution Control Act

$$q = K * 10^{-3} * H_e^2$$

q: Maximum permissible limit of SO<sub>x</sub> (m<sup>3</sup><sub>N</sub>/h)

H<sub>e</sub>: Adjusted height of the Outlet (m)

K: Area of classification

General regulation K: from 3.0 to 17.5

Special regulation (new construction, specified area) K: from 1.17 to 2.34

$$H_e = H_o + 0.65 (H_m + H_t)$$

$$H_m = 0.795 \sqrt{Q * V} / \{1 + (2.58/V)\}$$

$$H_t = 2.01 * 10^{-3} * Q * (T - 288) * \{2.30 \log J + (1/J) - 1\}$$

$$J = (1/\sqrt{Q * V}) [1460 - 296 * \{V/(T - 288)\}] + 1$$

H<sub>e</sub> Adjusted height of the Outlet (m)

H<sub>o</sub> Actual height of the Outlet (m)

Q Quantity of emission at 15°C (m<sup>3</sup>/s)

V Discharge rate of emission (m/s)

T Temperature of emission (absolute temperature)

Life Environment relevant ordinance (Yokohama City)

Sulphur content in emission: 4 SO<sub>2</sub> equivalent grams/1 fuel oil equivalent kg combustion

## 2. NO<sub>x</sub>

Air Pollution Control Act

200ppm (O<sub>2</sub>: 6%)

Life Environment relevant ordinance (Yokohama City)

NO<sub>2</sub>: 100ppm

NO<sub>x</sub>: 200ppm

## 3. PM

Air Pollution Control Act

100mg/m<sup>3</sup><sub>N</sub> (O<sub>2</sub>: 6%)

Life Environment relevant ordinance (Yokohama City)

0.05g/m<sup>3</sup><sub>N</sub>

# Republic of Korea

## Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

### **Legislation**

#### National (Federal, Central)

1. Air Pollution Control Act (Ministry of the Environment [MoE]), which includes relevant Cabinet Order and Ordinance of MoE.
2. Basic Environment Act (MoE) also stipulates the air emission standards which is not directly regulating the air emission of CPP but potentially affect the living environment.

#### Local (State, Municipality, District, City)

1. Air Pollution Control Act allows prefectures of the more than 500,000 population to set their own emission standards (which in general more stringent than that of the central government).
2. Air Pollution Control Act allows local governments to establish necessary regulations (Ordinance) relating to air pollutant emissions.
3. Air Pollution Control Act stipulates that local governments should report to the MoE and take necessary measures to enable stakeholders to know when their own emission standards are set and amended.

### **Regulated pollutants (relating to coal-fired power plants)**

Directly regulating the air emission of CPP (Air Pollution Control Act)

- SO<sub>x</sub>, NO<sub>x</sub>, PM

Potentially affect the living environment (Basic Environment Act)

- Sulphur dioxide (SO<sub>2</sub>)
- nitrogen dioxide (NO<sub>2</sub>)
- Carbon monoxide (CO)
- Micro-dust (PM)
- Ozone (O<sub>3</sub>)
- Lead (Pb)
- Benzene

### **Emission standards**

Legal mandate: Details are described in annexes 4, 5, and 6

1. Ordinance of MoE (General)

\* In matters of the special measure areas, MoE can set the more stringent emission standards than the general emission standards.

2. Local government ordinance (more stringent than the central government's standards)

#### Voluntary

3. Agreement between local government and power plants operator (more stringent)

4. Operator's internal targets of power plants (operational standards, most stringent)

#### Standards for Controlling the Total Emissions

Air Pollution Control Act stipulates that MoE can set standards for controlling the total emissions in an area if the air pollution condition exceeds the standards or it is concentrated at factories or workplaces.

### **How can authorities recognize the existence of facilities that emit air pollutants?**

Coal-fired power plants should report the following items to the prefectural governor.

- Name and address
- Location
- License of facilities
- Type of air pollutant
- Structure of facilities
- Planning of controlling the air pollutant, etc.

### **Authority to suspend operation**

Prefectural governor has the power to order emitters to all or partially suspend the operation of facilities when they violate the regulation.

### Order for Improvement

Prefectural governor has the power to order CPP for improvement within 1 year\* when it continuously emit more than regulated limit.

\* In case of not improving within 1 year with the force majeure, the operator should apply for the extension of 1 year more to prefectural governor.

Based on an agreement between local government and CPP operator, when CPP is going to restart after the order for improvement, local government can resist its restart until the government regard improvement has been satisfactory made. This mechanism let CPP operator to comply with voluntary target to avoid receiving order for improvement by the local government.

### Measurement of emission by operator

Air Pollution Control Act obligates operators to install the telemeter in the stack of CPP for measuring emission automatically and continuously.

- Telemeter installation object: Power generation plant (hydro, nuclear power is exemption)
- Measuring pollutants: SO<sub>x</sub>, NO<sub>x</sub>, PM

CPP operator signed an agreement with local government, which stipulate, in the most cases, very stringent emission standards and real-time measurement.

### Monitoring

The central and prefectural governors shall continuously monitor the status of air pollution.

Local governments should monitor through the own observing stations and report to the MoE the monitoring results.

### Reporting

MoE or prefectural governor may require operators to report the status of air pollutant emissions.

According to an agreement between CPP operator and local government, an operator submits the report to local government if necessary anytime, although CPP automatically send data through telemeter continuously.

### Inspection

Prefectural governor should conduct inspection on every CPP through the telemeter basically and report to the MoE by the end of March every year.

On-site inspection by local government: it depends on an Agreement between CPP operator and local government.

**Archive Requirement**

For 6 months after measuring the emission.

Generally, most CPP operators keep the important data permanently in the form of electronic files.

**Public Announcements**

Air Pollution Control Act stipulates MoE shall predict the air pollution status and announce the results on press release or in the other ways. For this, MoE may require operators to submit the necessary documents.

Local governments collect environmental data from various facilities and publish the status of air pollution at screen monitor in their city hall and on the road. Everyone can see the situation in anytime. Local Governments also publish environmental report periodically.

In case of accident, CPP operators publish the status of air pollutant emissions through press release.

**Compensation for Damage and Losses**

Strict Liability

**Penalty**

Violation of Air Pollution Control Act: penalties include fine imposed on operator, suspension of operation, cancellation of licence, or plant shutdown.

**Assistance (National, Local)**

Air Pollution Control Act stipulates the following.

The (national) government shall endeavour to provide financial assistance, technical advice, other assistance.

MoE and local government post explanatory documents and application and report forms on their website and everyone can easily download them when the law is amended.

**Ability of local governments**

Ability of officers in local government is generally high. There are experts of measuring method in local government.

### **Relation to local community**

Air Pollution Control Act does not require periodical meeting with local community.

Environmental Impact Assessment Act requires operators to hold a meeting and public hearing with residents for explanation and discussion before they try to get a license and construct a new CPP.

Until the residents agree to construct the CPP, operators should continue such a process.

### **Independent inspector**

Air Pollution Control Act does not require independent inspector. But act stipulates operators to have a special environmental technician for controlling the emission in the plants.

## Detail of Emission Standards

(Relating to coal-fired power plant)

### **Republic of Korea**

#### 1. SO<sub>x</sub>

Air Pollution Control Act

- Established before 1996: 100ppm (O<sub>2</sub>: 6%)
- Established before 2014: 80ppm (O<sub>2</sub>: 6%)
- Established after 2015: 50ppm (O<sub>2</sub>: 6%)

Voluntary (Operators of new CPP)

- In-cheon: 20 to 25ppm (O<sub>2</sub>: 6%)
- Dang-gin: 40ppm (O<sub>2</sub>: 6%)
- Yeou-su: 30 ppm (O<sub>2</sub>: 6%)

#### 2. NO<sub>x</sub>

Air Pollution Control Act

- Established before 1996: 140ppm (O<sub>2</sub>: 6%)
- Established after 1996: 70ppm (O<sub>2</sub>: 6%)
- Established after 2015: 50ppm (O<sub>2</sub>: 6%)

Voluntary (Operators of new CPP)

- In-cheon: 15ppm (O<sub>2</sub>: 6%)
- Dang-gin: 50ppm (O<sub>2</sub>: 6%)
- Yeou-su: 30 ppm (O<sub>2</sub>: 6%)

### 3. PM

#### Air Pollution Control Act

- Established before 2001: 25mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)
- Established after 2001: 20mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)
- Established after 2015: 10mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)

#### Voluntary (Operators of new CPP)

- In-cheon: 5mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)
- Yeou-su: 8mg/Sm<sup>3</sup> ppm (O<sub>2</sub>: 6%)

## United States

### Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

#### **Legislation**

##### National (Federal, Central)

##### Clean Air Act (CAA)

##### Section 108 (Air quality criteria and control techniques)

##### National Ambient Air Quality Standards (NAAQS)

EPA Regulation: 40 CFR part 50

##### Section 111 (Standards of performance for new stationary sources)

##### New Source Performance Standards (NSPS)

EPA Regulation: 40 CFR part 60 subpart Da

Standards of Performance for Electric Utility Steam Generating Units

##### Section 112 (Hazardous air pollutants)

##### National Emission Standards for Hazardous Air Pollutants (NESHAP)

EPA Regulation: 40 CFR part 63

##### Local (State, Municipality, District, City)

#### **Regulated pollutants (relating to coal-fired power plants)**

##### Section 108, CAA (EPA Regulation 40 CFR part 50)

'criteria' air pollutants: six

CO, Lead, NO<sub>2</sub>, O<sub>3</sub>, PM, SO<sub>2</sub>

##### Section 111, CAA (EPA Regulation :40 CFR part 60 subpart Da)

§60.42Da Standards for particulate matter (PM)

§60.43Da Standards for sulphur dioxide (SO<sub>2</sub>)

<p>§60.44Da Standards for nitrogen oxides (NO<sub>x</sub>)</p> <p>Section 112, CAA</p> <p>Currently 189 pollutants</p> <p>EPA's latest regulation: mainly mercury</p>
<p><b>Emission standards</b></p> <p>Details are described in annexes 4, 5, and 6</p>
<p><b>How can authorities recognize the existence of facilities that emit air pollutants?</b></p>
<p><b>Authority to suspend operation</b></p> <p>Title V of CAA (Operating Permits)</p> <p>Title V of CAA requires major sources of air pollutants, and certain other sources, to obtain and operate in compliance with an operating permit. Sources with these 'title V permits' are required by CAA to certify compliance with the applicable requirements of their permits at least annually.</p>
<p><b>Measurement of emission by operator</b></p> <p>40 CFR part 60 subpart Da</p> <p>§60.48Da Compliance provisions</p> <p>§60.49Da Emission monitoring</p> <p>§60.50Da Compliance determination procedures and methods</p>
<p><b>Monitoring</b></p> <p>40 CFR part 60 subpart Da</p> <p>§60.49Da Emission monitoring</p> <p>(Example of PM)</p> <p>An owner or operator of an affected facility must monitor the opacity of emissions discharged from the affected facility to the atmosphere.</p> <p>The owner or operator of an affected facility shall install, calibrate, maintain, and operate an opacity monitoring system (COMS), and record the output of the system, for measuring the opacity of emissions discharged to the atmosphere.</p>
<p><b>Reporting</b></p> <p>40 CFR part 60 subpart Da</p> <p>§60.51Da Reporting requirements</p> <p>For SO<sub>2</sub>, NO<sub>x</sub>, PM, and NO<sub>x</sub> plus CO<sub>2</sub> emissions, the performance test data from the initial and subsequent performance test and from the performance evaluation of the continuous monitors (including the transmissometer) must be reported to the administrator.</p>

(For SO<sub>2</sub> and NO<sub>x</sub>: each 24-hour period)

The owner or operator of the affected facility shall submit a signed statement.

### **Inspection**

EPA's policy: Incentives for Self-policing: Discovery, Disclosure, Correction, and Prevention of Violations

On-site visit by EPA

Civil investigations

Record reviews: EPA, state, or local offices

Information requests

(<https://www.epa.gov/compliance/how-we-monitor-compliance>)

### **Archive Requirement**

40 CFR part 60 subpart Da

§60.52Da Recordkeeping requirements

### **Public Announcements**

Air Monitoring

<https://www.epa.gov/outdoor-air-quality-data>

### **Compensation for Damage and Losses**

- Environmental civil liability is **strict**; it arises simply through the existence of the environmental violation. It does not take into consideration what the responsible party knew about the law or regulation they violated.

- Environmental criminal liability is triggered through some level of intent.

### **Penalty**

If a civil defendant is found liable or agrees to a settlement, the result can be:

- a monetary penalty
- injunctive relief (actions required to correct the violation and come into compliance, e.g., install pollution control equipment), and/or
- additional actions taken to improve the environment

If a criminal defendant is convicted or pleads guilty, the result can be:

- a monetary fine paid to the US Treasury, and/or
- restitution (reimbursing the government for the cost of clean-up or response, compensating for the harm caused by the violation, e.g. paying for medical testing for people exposed to asbestos)
- incarceration

<p><b>Assistance (National, Local)</b></p> <p>New Source Review (NSR) and Prevention of Significant Deterioration (PSD) require certain large industrial facilities to install state-of-the-art air pollution controls when they build new facilities or make modifications to existing facilities.</p> <p>EPA homepage: Investigations of coal-fired power plant sector have identified a high rate of noncompliance with NSR/PSD when old plants are renovated or upgraded.</p> <p>CAA (Section 108) requires EPA to develop information on pollution control techniques.</p> <p>The Clean Air Technology Center</p>
<p><b>Ability of local governments</b></p>
<p><b>Relation to local community</b></p> <p>The EPA regulation does not require periodical meeting with local community.</p>
<p><b>Independent inspector</b></p> <p>The EPA regulation does not require independent inspector.</p>

## Detail of Emission Standards

(Relating to coal-fired power plants)

### United States

#### 40 CFR part 50 (air quality)

Pollutant	Primary/Secondary	Averaging time	Level	Form	
NO <sub>2</sub>	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
	primary and secondary	1 year	53 ppb	Annual Mean	
PM	PM <sub>2.5</sub>	primary	1 year	12.0 µg/m <sup>3</sup>	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m <sup>3</sup>	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m <sup>3</sup>	98th percentile, averaged over 3 years

	PM <sub>10</sub>	primary and secondary	24 hours	150 µg/m <sup>3</sup>	Not to be exceeded more than once per year on average over 3 years
SO <sub>2</sub>		primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

**Primary standards** provide public health protection, including protecting the health of ‘sensitive’ populations such as asthmatics, children, and the elderly. **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

#### 40 CFR part 60 subpart Da (stationary source)

Applicability:

That is capable of combusting more than 73 MW (250 MMBtu/hr) heat input of fossil fuel.

	SO <sub>2</sub>	NO <sub>x</sub>	PM
1971–1978	520 ng/J heat input	300 ng/J heat input	43 ng/J heat input
Sep 1978–1997	520 ng/J heat input and 90% reduction (or 70% reduction where <260 ng/J);	subbituminous: 210 ng/J heat input other coal types: 260 ng/J heat input	13 ng/J heat input
1978–Mar 2005	180 ng/J gross output 65 ng/J heat input	New plant: 200 ng/J gross output Reconstructed: 65 ng/J heat input	
Commenced construction: Mar 2005–May 2011	180 ng/J gross output 95% reduction	130 ng/J gross output	18 ng/J gross output 6.4 ng/J heat input
Commenced reconstruction: Mar 2005–May 2011	180 ng/J gross output 65 ng/J heat input 95% reduction	130 ng/J gross output 47 ng/J heat input	Or: 13 ng/J input and 99.9% reduction
Modified: Mar 2005–May 2011	180 ng/J gross output 65 ng/J heat input 90% reduction	180 ng/J gross output 65 ng/J heat input	18 ng/J gross output 6.4 ng/J heat input Or: 13 ng/J input and 99.8% reduction
Construction or reconstruction after: 3 May 2011	130 ng/J gross energy output 140 ng/J net energy output 97% reduction	88 ng/J gross output 95 ng/J net output	11 ng/J gross output 12 ng/J net output
Modified after: 3 May 2011	180 ng/J gross output 90% reduction	140 ng/J gross output	18 ng/J gross output 6.4 ng/J heat input Or: 13 ng/J input and 99.8% reduction

## Annex 3

### Survey Sheet (Selected ASEAN Countries)

#### Cambodia

##### Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

<p><b>Legislation</b></p> <p><u>National (Federal, Central)</u></p> <ol style="list-style-type: none"><li>1. Air Pollution Control Act (Ministry of Environment [MoE])</li></ol> <p><u>Local (State, Municipality, District, City)</u></p> <ol style="list-style-type: none"><li>1. Air Pollution Control Act allows CPP to set their own emission standards but follow the government standard and follow to establish regulation that relating to air pollution emission.</li></ol>
<p><b>Regulated pollutants (relating to coal-fired power plants)</b></p> <p>Air Pollution Control Act: SO<sub>x</sub>, NO<sub>x</sub>, PM</p> <p>Potentially affect the living environment</p> <ul style="list-style-type: none"><li>- Sulphur dioxide (SO<sub>2</sub>)</li><li>- Nitrogen dioxide (NO<sub>2</sub>)</li><li>- Carbon monoxide (CO)</li><li>- Particulates</li></ul>
<p><b>Emission standards</b></p> <p>Regal mandate details are described in annexes 4, 5, and 6</p> <ul style="list-style-type: none"><li>- The government standard and Ordinance of Ministry of Environment</li></ul> <p>Voluntary</p> <ul style="list-style-type: none"><li>- Agreement between local government with power plant operator</li><li>- Internal targets of power plants (operational standards)</li></ul>
<p><b>How can authorities recognize the existence of facilities that emit air pollutants?</b></p> <p>Coal-fired power plants should report the following items to the prefectural governor</p> <ul style="list-style-type: none"><li>- Name and address</li><li>- Location</li><li>- Type of air pollutant</li></ul>

<ul style="list-style-type: none"> <li>- Structure of facilities</li> <li>- Planning to control air pollutant</li> </ul>
<p><b>Authority to suspend operation</b></p> <p>Based on an agreement between local government with power plant operator, when CPP is going to restart after the order for improvement and local government can stand up to its restart until the government regard improvement has been satisfactory made.</p>
<p><b>Measurement of emission by operator</b></p> <p>Air pollution Control Act obligates operator to install a public screen monitor to show emission measurements automatically (SO<sub>x</sub>, NO<sub>x</sub>, PM) and transmit to the public through a telemeter.</p>
<p><b>Monitoring</b></p> <p>Prefectural governors shall continuously monitor the status of air pollution.</p>
<p><b>Reporting</b></p> <p>According to agreement with the government, a power plant operator submits data air pollution emission every month generally, although CPP automatically send data through to telemeter.</p> <p>Ministry of Environment conducts integrated survey of quantity of air pollution emission every 3 years.</p>
<p><b>Inspection</b></p> <p>Ministry of Environment or government should conduct inspection on each CPP through the telemeter.</p>
<p><b>Archive Requirement</b></p> <p>All CPP operators should be keep the important data permanently every 6 months after measuring the emission.</p>
<p><b>Public Announcements</b></p> <p>MoE or government collect environment data from various facilities and publish the status of air pollution to show on public screen monitor.</p>
<p><b>Compensation for Damage and Losses</b></p> <p>Strict Liability</p>
<p><b>Penalty</b></p> <p>Violation of Air Pollution Control Act: penalties include fine imposed on operator, suspension of operation, cancellation of licence, or plant shutdown.</p>

<p><b>Assistance (National, Local)</b></p> <p>Ministry of Mines and Energy (MME) and Ministry of Finance (MoE) shall provide financial assistance, technical advice, or other assistance.</p>
<p><b>Ability of local governments</b></p> <p>The implementation largely depends on the ability of officers or experts in local government to judge and interpret the method of measuring the compliance of CPP.</p>
<p><b>Relation to local community</b></p> <p>Environmental Impact Assessment Act requires operator to hold a meeting and publish hearing with residents for explanation and discussion before they get a licence and continue the process of constructing a new CPP after the residents agree.</p>
<p><b>Independent inspector</b></p> <p>Air Pollution Control Act stipulates operators have a special environmental technician for controlling the emission in the plants.</p>

## Detail of Emission Standards

(Relating to coal-fired power plants)

### Cambodia

Emission	Unit	Cambodian standard	World Bank standard
Sulphur dioxide (SO <sub>2</sub> ) Dry, 0 <sup>o</sup> c, 1atm, 6% O <sub>2</sub>	mg/Nm <sup>3</sup>	500	2000
Nitrogen oxide(SO <sub>2</sub> ) Dry, 0 <sup>o</sup> c, 1atm, 6% O <sub>2</sub>	mg/Nm <sup>3</sup>	1,000	750
Particulates Dry, 0 <sup>o</sup> c, 1atm, 6% O <sub>2</sub>	mg/Nm <sup>3</sup>	400	50

# Indonesia

## Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

### Legislation

#### National (Federal, Central)

- a. Law No. 32 Year 2009 Regarding the Protection and Management of Environment
- b. Law No. 30 Year 2009 Regarding Electricity
- c. Government Regulation No. 14 Year 2012 Regarding Business of Electricity Supply
- d. Government Regulation No. 27 Year 2012 Regarding Environmental License
- e. Government Regulation No. 41 Year 1999 Regarding Air Emission Control
- f. Ministry of Environment Decree No. 21 Year 2008 Regarding Static Emission Sources Quality Standard for business and/or activities of a Thermal Power Plant

#### Local (State, Municipality, District, City)

According Ministry of Environment Decree No. 21 Year 2008, local government may set:

- a. emission quality standards for business and / or activities of a thermal power plant with the provisions of the same or more stringent than the standard that has been set nationally;
- b. Additional parameters outside the parameters of the emission quality standards for business and/or activities of a thermal power plant after the approval of the minister in the environmental field.

### Regulated pollutants (relating to coal-fired power plants)

Sulphur dioxide (SO<sub>2</sub>), nitrogen oxide (NO<sub>x</sub>) stated as NO<sub>2</sub>, total particulate (particulate matter), and opacity.

### Emission standards

The detail is in annexes 4, 5, and 6

### How can authorities recognize the existence of facilities that emit air pollutant?

- Government Regulation No. 14 Year 2012 Article 13 Paragraph (1) and Government Regulation No. 27 Year 2012 Article 1 and 2

Government Regulation No. 14 Year 2012 states that to obtain a business licence in electricity supply, an applicant must meet the administrative, technical, and environmental requirements. In terms of environmental requirement, in Government Regulation No. 27 Year 2012, it is explained that an environmental licence is a prerequisite to obtain business and/or activity licence. An environmental licence is obtained through several stages of activities including:

1. Preparing the Environmental Impact Analysis (EIA) or Environmental Management and Monitoring Scheme (EMMS) (for power plant < 100 MW in one location)
2. Assessment
3. Application and issuance of environmental licence.

The authority can recognize the power plant facility that emit pollutants based on the environmental documents (Environmental Impact Analysis or EMMS) and the environmental licence, which was drafted at the beginning stages of planning the power plant as well as on the reporting of the implementation of the monitoring of air emissions that are routinely prepared by the company to be submitted to the technical authority.

#### **Authority to suspend operation**

Authority to suspend operation due to violation of environmental regulation is the licensor of environment licence: minister in the environmental field/governor/regent/mayor.

#### **Measurement of emission by operator**

Ministry of Environment Decree No. 21 Year 2008 Article (9)

- For the CPP with capacity above 25 MW or below 25 MW but using coal that has sulphur content above 2%, emissions are measured using Continuous Emission Monitoring System (CEMS) that is installed in power plant's chimney.
- For a power plant that does not have a CEMS installed, manual measurement is required and it must be done by the accredited laboratory with minimum measurement frequency every 6 months.

In practice, even though a CEMS is installed, manual measurement is still required and it is conducted by accredited laboratory every 6 months. The results from manual measurements are used as comparative data and the result is also reported to the regent/mayor with a copy to the governor and minister in the environmental field.

#### **Monitoring**

Irregular monitoring by local government.

#### **Reporting**

Government Regulation 21 Year 2012 article 9

The responsible of the power plant is obliged to

- a. Report the results of monitoring and measurement of emissions every 3 months for the power plant that equipped with CEMS to the regent/mayor with a copy to the governor and minister in the environmental field.

- b. Report the results of monitoring and measurement of emissions every 6 months for the power plant that manually measured the emission to the regent/mayor with a copy to the governor and minister in the environmental field.
- c. Report annual total emission (ton/year) emitted for NO<sub>x</sub>, SO<sub>x</sub>, and CO<sub>2</sub> to the regent/mayor with a copy to the governor and minister in the environmental field.

### **Inspection**

Law 32 Year 2009 article 72

Ministry of Environment or governor/regent/mayor are obliged to conduct supervision, and may conduct on-site inspection.

Law 30 Year 2009 article 46

Government (Ministry of Energy and Mineral Resources) or regional government in accordance with authority to provide guidance and supervision of the electricity supply business in term of compliance aspects of environmental protection, and may conduct on-site inspection.

### **Archive Requirement**

Generally, most CPP owners keeps important data permanently.

### **Public Announcements**

Ministry of Environment and Forests is currently developing an online reporting system, where the results of such reporting can be accessed by the public. The Directorate General of Electricity is also developing information systems for monitoring power plant emissions by taking a pilot project of one power plant location (CPP Cirebon 1 x 660 MW).

### **Compensation for Damage and Losses**

Strict Liability

Law 32 Year 2009 article 54

Anyone who pollutes and damages the environment is obligated to do the environmental recovery.

### **Penalty**

Based on Law No. 32 Year 2009, penalty:

- Administrative sanction
- Fine and imprisonment

Anyone who violates the emissions quality standards shall be punished with imprisonment of 3 years and a maximum fine of Rp3 billion. A criminal offence can only be imposed if administrative sanctions that have been imposed are not complied with or the offences are committed more than once.

<p><b>Assistance (National, Local)</b></p> <p>National and local government provide technical assistance to the CPP owner.</p>
<p><b>Ability of local governments</b></p> <p>Not available</p>
<p><b>Relation to local community</b></p> <p>Based on Government Regulation No. 27 Year 2012 article 9, the CPP owner must hold a meeting and public hearing with residents for explanation and discussion as requirement for preparing an EIA document.</p>
<p><b>Independent inspector</b></p> <p>Not available</p>

## Detail of Emission Standards

(Relating to coal-fired power plants)

### Indonesia

#### Static Emission Sources Quality Standard for CPP

No.	Parameter	Maximum level (mg/Nm <sup>3</sup> )	
		A	B
1.	Sulphur dioxide (SO <sub>2</sub> )	750	750
2.	Nitrogen oxide (NO <sub>x</sub> ) stated as NO <sub>2</sub>	850	750
3.	Total particulate	150	100
4.	Opacity	20%	20%

A. For CPP that has been operation before 1 December 2008.

B. For CPP that has been operation since 1 December 2008.

Notes:

a. Gas volume is measured under standard condition (25°C and 1 atm).

b. Opacity is used as a practical indicator for monitoring.

c. All parameters corrected by O<sub>2</sub>: 7 %.

d. For a CPP with CEMS installed, the imposition of emission quality standard is for 95% of normal operation time for 3 months.

## Lao PDR

### Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

<p><b>Legislation</b></p> <p><u>National (Federal, Central)</u></p> <p>National Environmental standard (Lao national environmental standard)</p> <p><u>Local (State, Municipality, District, City)</u></p> <p>Local authorities are involved in providing their recommendation for state of feasibility study, construction and operation of coal-fired power plants.</p>
<p><b>Regulated pollutants (relating to coal-fired power plants)</b></p> <p>SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub></p>
<p><b>Emission standards</b></p> <p>Details are described in annexes 4, 5, and 6</p>
<p><b>How can authorities recognize the existence of facilities that emit air pollutants?</b></p> <p>The central and local government authorities recognize the information during their review EIA of coal-fired power plants and mitigation plans and periodic reports of the plants.</p>
<p><b>Authority to suspend operation</b></p> <p>The central government (prime minister) and provincial governors have full power to suspend the operation of the facilities if the pollutants emitted are above the regulations allowed based on daily monitoring at the CPP.</p>
<p><b>Measurement of emission by operator</b></p> <p>CPP and provincial operator measure the quantity or concentration of air pollutant, and keep its record. Frequency of measuring: SO<sub>x</sub>: more than every 3months (total emission controlling area: continuously (24hr-7d)) NO<sub>x</sub>: more than every 2 months PM: more than every 2 months</p>
<p><b>Monitoring:</b></p> <p>Provincial authorities shall continuously monitor the status of air pollution.</p> <p>Local governments have observation stations.</p>
<p><b>Reporting</b></p> <p>Ministry of Natural Resource and Environment (MoNRE) or provincial authorities (EMU) jointly with CPP operator to report the status of air pollutant emissions. MoNRE conducts integrated survey of quantity of air pollutant emission every 6 months.</p> <p>According to an agreement between CPP operator and local government, an operator submits the report to local government every month generally, although CPP automatically sends data through telemeter continuously.</p>

<p><b>Inspection</b></p> <p>Environmental management unit jointly with provincial authorities conduct official inspection.</p>
<p><b>Archive Requirement</b></p> <p>3 years.</p>
<p><b>Public Announcements</b></p> <p>Provincial authorities and EMU make public the status of air pollution within the prefecture.</p>
<p><b>Compensation for Damage and Losses</b></p> <p>Strict Liability</p>
<p><b>Penalty</b></p> <p>Base on concession agreement.</p>
<p><b>Assistance (National, Local)</b></p> <p>Air Pollution Control Act stipulates the (national) government shall endeavour to provide financial assistance, technical advice, other assistance.</p>
<p><b>Ability of local governments</b></p> <p>MEM and MONRE have established steering committees for CPPs.</p>
<p><b>Relation to local community</b></p> <p>Base on concession agreement for CPP.</p>
<p><b>Independent inspector</b></p> <p>Base on concession agreement for CPP.</p>

## Detail of Emission Standards

(Relating to coal-fired power plants)

### Lao PDR

#### Ambient Air Quality Standard

Parameters	Symbol	Average time unit (mg/m <sup>3</sup> )					Method of measurement
		Hours			1 month	1 year	
		1hr	8hr	24hr			
Carbon monoxide	CO	30	10.26				Non-dispersive infrared detection
Nitrogen dioxide	NO <sub>2</sub>	0.32					Chemiluminescence method
Sulphur dioxide	SO <sub>2</sub>	0.78		0.30		0.10	UV Fluorescence (1hr, 24hr, 1yr) or Pararosaniline (1hr, 4hr)
Total suspended particulate	TSP	-		0.33		0.10	Gravimetric
Particulate matter less than 10 microns	PM <sub>10</sub>	-		0.12		0.05	Gravimetric of beta ray or taper element oscillating microbalance or dichotomous
Ozone	O <sub>3</sub>	0.20					Chemiluminescence or UV Absorption photometry
Lead	Pb				1.5		Atomic absorption spectrometer

## Air Emission Standard for Power Plants

No.	Type of substances or pollutant	Source	Permitted emission value	
			ppm	mg/m <sup>3</sup>
1	Sulphur dioxide	Coal or gas power plant	ppm	mg/m <sup>3</sup>
		1. With the capacity of not more than 300 MW.	640	NA
		2. With the capacity above 300 MW, not more than 500 MW	450	NA
		3. With the capacity above 500 MW	320	NA
2	Sulphur dioxide	- Natural gas power plant	20	NA
3	Nitrogen oxides	Power plant generating electricity from:		
		1. Coal	350	NA
		2. Fuel	180	NA
		3. Natural gas	120	NA
4	Particulate substances	Power plant generating electricity from:		
		1. Coal	NA	120
		2. Fuel	NA	120
		3. Natural gas	NA	60

# Malaysia

## Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

### Legislation

#### National (Federal, Central)

1. Environmental Quality Act 1974
2. Environmental Quality (Clean Air) Regulations 2014
  - a. Any premises used for any industrial or trade purpose, or on which matter is burnt in connection with any industrial or trade purposes including burning of waste, whether or not the premises are under section 18 of the act;
  - b. Any other premises or process that discharges or is capable of discharging air pollutants into the open air;
  - c. Any industrial plant; and
  - d. Any fuel burning equipment.
3. Environmental Quality (Clean Air) Regulations 2014  
(Obligation to comply on or before the expiry of five years on which Regulations come into operation.)

#### Local (State, Municipality, District, City)

Not available

### Regulated pollutants (relating to coal-fired power plants)

#### Environmental Quality (Clean Air) Regulations 2014

1. SO<sub>x</sub> (SO<sub>2</sub> and SO<sub>3</sub>)
2. NO<sub>x</sub> (NO and NO<sub>2</sub>)
3. Hydrogen chloride
4. Hydrogen fluoride
5. Carbon monoxide
6. Total PM
7. Mercury
8. PCDD/PCDF

**Emission standards**

Environmental Quality (Clean Air) Regulations 2014

Pollutant	Capacity	Limit value
SO <sub>x</sub>	>10 MW <sub>e</sub>	500 mg/m <sup>3</sup>
NO <sub>x</sub>	>10 MW <sub>e</sub>	500 mg/m <sup>3</sup>
HCl	>10–<100 MW <sub>e</sub>	200 mg/m <sup>3</sup>
HCl	≥100 MW <sub>e</sub>	100 mg/m <sup>3</sup>
HF	>10–<100 MW <sub>e</sub>	30 mg/m <sup>3</sup>
HF	≥100 MW <sub>e</sub>	15 mg/m <sup>3</sup>
CO	>10 MW <sub>e</sub>	200 mg/m <sup>3</sup>
PM	>10 MW <sub>e</sub>	50 mg/m <sup>3</sup>
Hg	>10 MW <sub>e</sub>	0.03 mg/m <sup>3</sup>
PCDD/PCDF	>10 MW <sub>e</sub>	0.1 ng TEQ/m <sup>3</sup>

**How can authorities recognize the existence of facilities that emit air pollutants?**

All coal-fired power plants are required to install continuous emission monitoring systems (CEMS) that are linked to the Department of Environment (DOE) in real-time.

**Authority to suspend operation**

Department of Environment (DOE)

**Measurement of emission by operator**

Malaysian Standards MS1596 or MS 1723 or the Methods published by United States Environmental Protection Agency or any other standards as determined by DOE.

**Monitoring**

Department of Environment (DOE)

**Reporting**

CEMS

**Inspection**

Department of Environment (DOE)

<p><b>Archive Requirement</b></p> <p>Environmental Quality (Clean Air) Regulations 2014:</p> <ul style="list-style-type: none"> <li>The records shall be kept for at least 3 years.</li> </ul>
<p><b>Public Announcements</b></p> <p>Announcement through official portal (website) of Department of Environment and newspapers Regular updates of Malaysian Air Pollutant Index (API)</p>
<p><b>Compensation for Damage and Losses</b></p> <p>Environmental Quality Act 1974:</p> <p>Section 46E: 'the person so convicted to pay the other person the costs and expenses incurred or compensation for loss or damage to the property and any other costs, in the amount as the court considers fit'.</p>
<p><b>Penalty</b></p> <p>Any person who contravenes or fails to comply with any provisions of Environmental Quality (Clean Air) Regulations 2014 shall be liable to a fine not exceeding RM100,000 or imprisonment for a term not exceeding 2 years or both.</p>
<p><b>Ability of local governments</b></p> <p>Any issue related to development in the specific local area including CPPs can be addressed by local government/council. However, all environmental compliance monitoring and enforcement activities are conducted by DOE through headquarters and state and branch offices.</p>
<p><b>Relation to local community</b></p> <p>Approval of the Detailed Environmental Impact Assessment (DEIA) is a mandatory requirement in the new coal-fired power plant development, being the prescribed activity under the Environment Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. Potential impact to local community (both positive and negative) and planned interventions will be identified and assessed under DEIA.</p> <p>The law does not require a periodical meeting with the local community. However, community outreach programmes are usually performed by plant operators as part of their corporate social responsibility.</p>
<p><b>Independent inspector</b></p> <p>The law does not require independent inspector.</p>

## Detail of Emission Standards

(Relating to coal-fired power plants)

### Malaysia

Pollutant	Capacity	Limit value
SO <sub>x</sub>	>10 MW <sub>e</sub>	500 mg/m <sup>3</sup>
NO <sub>x</sub>	>10 MW <sub>e</sub>	500 mg/m <sup>3</sup>
HCl	>10—<100 MW <sub>e</sub>	200 mg/m <sup>3</sup>
HCl	≥100 MW <sub>e</sub>	100 mg/m <sup>3</sup>
HF	>10—<100 MW <sub>e</sub>	30 mg/m <sup>3</sup>
HF	≥100 MW <sub>e</sub>	15 mg/m <sup>3</sup>
CO	>10 MW <sub>e</sub>	200 mg/m <sup>3</sup>
PM	>10 MW <sub>e</sub>	50 mg/m <sup>3</sup>
Hg	>10 MW <sub>e</sub>	0.03 mg/m <sup>3</sup>
PCDD/PCDF	>10 MW <sub>e</sub>	0.1 ng TEQ/m <sup>3</sup>

# Myanmar

## Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

<p><b>Legislation</b></p> <p><u>National (Federal, Central)</u></p> <p>Environmental Conversation Law 2012 Environmental Conversation Rule 2014 National Environmental Quality (Emission) Guideline (2015) Environmental Impact Assessment Procedure 2015</p> <p><u>Local (State, Municipality, District, City)</u></p> <p>Environmental Conversation Law 2012 Environmental Conversation Rule 2014 National Environmental Quality (Emission) Guideline (2015) Environmental Impact Assessment Procedure 2015</p>
<p><b>Regulated pollutants (relating to coal-fired power plants)</b></p> <p>SO<sub>x</sub>, NO<sub>x</sub>, PM, CO, CO<sub>2</sub>, TVOC (hydrocarbon), O<sub>3</sub>, lead</p>
<p><b>Emission standards</b></p> <p>Details and describe in annexes 4, 5, and 6</p>
<p><b>How can authorities recognize the existence of facilities that emit air pollutants?</b></p> <p>The owner or occupier of any business, material, or place that causes a point source of pollution shall install or use an on-site facility or controlling equipment to monitor, control, manage, reduce, or eliminate environmental pollution. If it is not practical, it shall arrange to dispose the waste in accordance with an environmentally-sound method.</p>
<p><b>Authority to suspend operation</b></p> <p>The ministry shall, if the person obtained the prior permission who was impose with administrative penalty under section 25 fails to comply with the terms and conditions, inform the relevant government department, government organization authorized to issue licence, permit, or register for the relevant business, work-site or factory, work shop to enable to take action as may be necessary. The government department, government organization that received information under subsection(a) may, after making necessary inquiries, if it is found that any terms and conditions of environmental conservation contained in the prior permission is not complied with, cancel the issued licence, permit or register or suspend it for a limited period.</p>

<p><b>Measurement of emission by operator</b></p> <p>National Environmental Quality (Emission) Guideline (2015)</p>
<p><b>Monitoring</b></p> <p>The ministry and state and regional government shall continuously monitor the status of air pollution. The owner or occupiers of any business have the duty to monitor the environmental pollution.</p>
<p><b>Reporting</b></p> <p>The project proponent shall submit monitoring report to the ministry not less frequently than every 6 months, as provided in a schedule in the EMP, or periodically as prescribed by the ministry.</p> <p>The monitoring reports shall include:</p> <ul style="list-style-type: none"> <li>(a) documentation of compliance with all conditions;</li> <li>(b) progress made to date on implementation of EMP against the submitted implementation schedule;</li> <li>(c) difficulties encountered in implementing the EMP and recommendations for remedying those difficulties and steps proposed to prevent or avoid similar future difficulties;</li> <li>(d) number and type of non-compliance with the EMP and proposed remedial measure and timelines for completion of remediation;</li> <li>(e) accidents or incidents relating to the occupational and community health and safety, and the environment; and</li> <li>(f) monitoring data of environmental parameters and conditions as committed in the EMP or otherwise required.</li> </ul> <p>Ministry of Electricity and Energy shall require operator to report the status of air pollutant emissions.</p>
<p><b>Inspection</b></p> <p>Screening team that is organized by the Ministry inspect frequently. Inspection team that is organized by the relevant ministries and/or organizations.</p>
<p><b>Archive Requirement</b></p> <p>Generally, coal-fired power plant operator keeps the important data permanently in paper and electronic files.</p>
<p><b>Public Announcements</b></p> <p>Coal-fired power plant publish the status of air pollution at LED screen board in front of power plant. (example of Tigyit Coal-fired Thermal Power Plant)</p>

<b>Compensation for Damage and Losses</b>		
<b>Non-compliance</b>	<b>Penalties</b>	<b>Specific administrative punishment of the ministry</b>
Failure to take reasonable steps to prevent an imminent threat of damage to the environment, social, human health, livelihoods, or property, where applicable, based on the EMP, EMP-CP, EMP-OP	US\$2,500 to US\$10,000 or equivalent Myanmar kyats	-Issue Enforcement Notice -Suspension of approval of EMP, EMP-CP, or EMP-OP in whole or in part -Revocation of approval of EMP, EMP-CP or EMP-OP in whole or in part
<b>Penalty</b> Environmental Offences and Penalties		
<b>Assistance (National, Local)</b> The (national) government shall endeavour to provide technical advice, other assistance.		
<b>Ability of local governments</b> State and regional governments participate in public consultation, monitoring, inspection, and meeting with residents.		
<b>Relation to local community</b> The law does not appear to require periodical meetings with local community.  Ministry and operator to hold a stakeholder meeting and public hearing with residents for explanation and discussion of the situation of coal-fired power plant.		
<b>Independent inspector</b> The law does not appear to require an independent inspector.		

## Detail of Emission Standards

(Relating to coal-fired power plants)

### Myanmar

Parameter	Unit	Guideline value
Coal preparation plant		
Conveying, storage, and preparation, gas opacity	%	10
Pneumatic coal cleaning equipment opacity	%	10
Pneumatic coal cleaning equipment particulate	mg/Nm <sup>3a</sup>	40
Thermal dryer gas opacity	%	20
Thermal dryer gas particulate	mg/Nm <sup>3</sup>	70
Ammonia	mg/Nm <sup>3</sup>	30
Carbonyl sulfide + carbon disulfide	mg/Nm <sup>3</sup>	3
Heavy metals(total)	mg/Nm <sup>3</sup>	1.5
Hydrogen sulphide	mg/Nm <sup>3</sup>	10
Mercury	mg/Nm <sup>3</sup>	1
Nitrogen oxides	mg/Nm <sup>3</sup>	200–400 <sup>b</sup>
Particulate matter PM <sub>10</sub> <sup>c</sup>	mg/Nm <sup>3</sup>	30–50 <sup>b</sup>
Sulfide dioxide	mg/Nm <sup>3</sup>	150–200 <sup>b</sup>
Volatile organic compound	mg/Nm <sup>3</sup>	150

<sup>a</sup> Milligrams per normal cubic meter at specified temperature and pressure.

<sup>b</sup> Lower value for plants of >100 MW thermal equivalent, higher value for plants of <100 MW thermal equivalent.

<sup>c</sup> Particulate matter 10 micrometres or less in diameter.

# Thailand

## Regulation of Air Pollutants from Coal-fired Power Plants

(Blue letters: stipulated in law, green letters: actual situation)

<p><b>Legislation</b></p> <p><u>National (Federal, Central)</u></p> <p>Environmental Act</p> <p>Factory Act</p> <p>There is no conflict between two acts.</p> <p>Ministry of environment and Ministry of Industry work with collaboration usually.</p> <p><u>Local (State, Municipality, District, City)</u></p> <p>The law gives local governments power to establish own emission standard.</p> <p>But no local government has set own emission standards to date.</p>
<p><b>Regulated pollutants (relating to coal-fired power plants)</b></p> <p>PM, SO<sub>2</sub>, NO<sub>x</sub></p>
<p><b>How can authorities recognize the existence of facilities that emit air pollutants?</b></p> <p>Power plants with capacity between 10MW and 100MW are required to have an Environmental Impact Assessment (EIA)</p> <p>Power plants with capacity 100MW and more are required to have an Environmental and Health Impact Assessment (EHIA)</p> <p>Emission permit: not to exceed national standard</p>
<p><b>Authority to suspend operation</b></p> <p>Ministry of Industry has power to order suspend CPP operation partially or fully.</p> <p>20 years ago, Mae Moh CPP was ordered to reduce emissions.</p>
<p><b>Measurement of emission by operator</b></p> <p>Licensed third party selected by operators check emission data twice a year.</p> <p>Monitoring station: 5 km away from CPP, monitored pollutants: PM and SO<sub>2</sub></p> <p>Operators should send emission monitoring data to Ministry of Industry with automatic method.</p>
<p><b>Monitoring</b></p> <p>CPP submit EIA report to Ministry of Environment, Ministry of Natural Resources and Ministry of Energy.</p> <p>Report: CPP → Central Government → Local Government</p> <p>Local government has the power to check emission data, but this rarely occurs.</p>

**Reporting**

Twice a year

**Inspection**

Department of Estate, Ministry of Industry inspects every industry plant.

In case of a large CPP, there is no site visit.

In case of severe accident, Ministry of Environment inspects.

Local government has the power to inspect, but there has been no case to date.

**Archive Requirement**

The law does not require keeping archives.

**Public Announcements**

Operators' annual report.

Local government does not publish emission data.

During coal transportation by truck, dust is emitted, which is more problematic than air pollution by CPP in Thailand.

**Compensation for Damage and Losses**

Central government requires CPP to pay compensation, but there is no case.

(It is difficult to find a responsibility of air pollution and evaluate damage and losses.)

Operators pay damages and losses voluntarily, i.e. hospital expense, medical examination, etc.

**Penalty**

Industry Act.

Ministry of Industry can pose fines, maximum B200,000.

**Assistance (National, Local)**

When a regulation is enhanced, the central government holds a meeting with stakeholders before amendment.

**Ability of local governments**

There is an expert at the local university.

**Relation to local community**

Regular meeting between CPP and residents is held every 3 months.

**Independent inspector**

Independent inspector is not required.

**Detail of Emission Standards**

(Relating to coal-fired power plants)

**Thailand**

Type and Size of Power Plant	Emission standard		
	(PM) (mg/m <sup>3</sup> )	(SO <sub>2</sub> ) (ppm)	(NO <sub>x</sub> ) (ppm)
<b>New Power Plant (since 15 January 2010)</b>			
1. Power Plant Size < 50 MW	80	360	200
2. Power Plant Size > 50MW	80	360	200
<b>Power Plant (31 January 1996–15 January 2010)</b>			
1. Power Plant Size > 500 MW	120	320	350
2. Power Plant Size 300–500 MW		450	
3. Power Plant Size < 300 MW		640	
<b>Existing Power Plant (before 31 January 1996)</b>			
<b>1. Mae Moh</b>			
Unit 1–3	180	1300	500
Unit 4–7	180	320	500
Unit 8–13			
Total SO <sub>2</sub> Loading of Mae Moh Unit 1–13 shall not be more than 11 ton/hr			
<b>2. Other Power Plant</b>	320	700	400

## Annex 4

### SOx Regulations

#### 1. Selected OECD countries

##### Australia

##### (A) National<sup>5</sup>

The current standards and goals for the Ambient Air Quality NEPM (National Environment Protection Measure)

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
SO <sub>2</sub>	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None

The National Guidelines for Control of Emission of Air Pollutants from New Stationary Sources 1985

Pollutant	Plant type	Emission limits (mg/m <sup>3</sup> )
sulphuric acid mist and sulphur trioxide (as SO <sub>x</sub> )	fuel-burning equipment sulphuric acid plants or plants producing sulphur trioxide	200 (expressed as SO <sub>3</sub> ) 0.075 kg/t of 100% acid or equivalent

##### (B) (Example of State) New South Wales (NSW)<sup>6</sup>

Schedule 4 Standards of concentration for scheduled premises: general activities and plant

General standards of concentration

Air impurity	Activity or plant	Standard of concentration	
SO <sub>3</sub>	Any activity or plant	Group 1	200 mg/m <sup>3</sup>
		Group 2, 3, 4, 5 or 6	100 mg/m <sup>3</sup>

An activity carried out, or plant operated

Group 1: Before 1 January 1972

Group 2: After 1 January 1972 and before 1 July 1979

Group 3: After 1 July 1979 and before 1 July 1986

Group 4: After 1 July 1986 and before 1 August 1997

<sup>5</sup> Source: IEA Clean Coal Centre.

<sup>6</sup> Source: Outline of Protection of the Environment Operations (Clean Air) Regulation 2010.

Group 5: After 1 August 1997 and before 1 September 2005

Group 6: After 1 September 2005

## Germany<sup>7</sup>

Emission limit values for coal combustion plants in German legislation: TA-Luft 2002

Applicable to plants with a thermal input of less than 50 MW

Pollutant	Plant size (MWth)	Daily emission limit value (mg/m <sub>3</sub> )
SO <sub>2</sub> (SO <sub>2</sub> + SO <sub>3</sub> )	All	1300 (for hard coal)
	All	1000 (other fuels)
	All	3501 (fluidised bed combustion)

Applicable to new plants (in operation after 7 January 2014) with a thermal input of 50 MW or more.

Pollutant	Plant size (MWth)	Emission limit value (mg/m <sup>3</sup> )		
		Daily mean value	Half-hourly mean value	Annual mean value
SO <sub>x</sub> (SO <sub>2</sub> + SO <sub>3</sub> )	50-100	400	800	
		350 (fluidised bed)	700 (fluidised bed)	
	>100-300	200	400	
	>300	150	300	
	200 (circulating or pressurised fluidised bed)	400 (circulating or pressurised fluidised bed)		

Applicable to existing plants (in operation before 7 January 2014) with a thermal input of 50 MW or more.

Pollutant	Plant size (MWth)	Emission limit value (mg/m <sup>3</sup> )		
		Daily mean value	Half-hourly mean value	Annual mean value
SO <sub>x</sub> (SO <sub>2</sub> + SO <sub>3</sub> )	50-100	400	800	
		350 (fluidised bed)	700 (fluidised bed)	
	>100-300	200	400	
	>300	150	300	
	200	400		

<sup>7</sup> Source: IEA Clean Coal Centre.

## Japan

### (A) Air Pollution Control Act

$$q = K * 10^{-3} * He^2$$

q: Maximum permissible limit of SO<sub>x</sub> (m<sup>3</sup>N/h)

He: Adjusted height of the Outlet (m)

K: Area of classification

General regulation                      K: from 3.0 to 17.5

Special regulation (new construction, specified area) K: from 1.17 to 2.34

$$He = Ho + 0.65 (Hm + Ht)$$

$$Hm = 0.795V(Q*V) / \{1 + (2.58/V)\}$$

$$Ht = 2.01 * 10^{-3} * Q * (T - 288) * \{2.30 \log J + (1/J) - 1\}$$

$$J = (1/V(Q*V)) [1460 - 296 * \{V/(T - 288)\}] + 1$$

He            Adjusted height of the Outlet (m)

Ho            Actual height of the Outlet (m)

Q            Quantity of emission at 15°C (m<sup>3</sup>/s)

V            Discharge rate of emission (m/s)

T            Temperature of emission (absolute temperature)

### (B) Life environment relevant ordinance (Yokohama City)

Sulphur content in emissions: 4 SO<sub>2</sub> equivalent grams/1 fuel oil equivalent kg combustion

## Republic of Korea

### Air Pollution Control Act

- Established before 1996: 100ppm (O<sub>2</sub>: 6%)
- Established before 2014: 80ppm (O<sub>2</sub>: 6%)
- Established after 2015: 50ppm (O<sub>2</sub>: 6%)

### Voluntary (Operators of new CPP)

- In-cheon:    20 to 25ppm (O<sub>2</sub>: 6%)
- Dang-gin:    40ppm (O<sub>2</sub>: 6%)
- Yeou-su:    30 ppm (O<sub>2</sub>: 6%)

## United States

### (A) 40 CFR part 50 (air quality)

Pollutant	Primary/ Secondary	Averaging time	Level	Form
SO <sub>2</sub>	primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

**Primary standards** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

### (B) 40 CFR part 60 subpart Da (stationary source)

Applicability:

That is capable of combusting more than 73 MW (250 MMBtu/hr) heat input of fossil fuel.

	SO <sub>2</sub>
1971–1978	520 ng/J heat input
Sep 1978–1997	520 ng/J heat input and 90% reduction (or 70% reduction where <260 ng/J)
1978 Mar 2005	180 ng/J gross output 65 ng/J heat input
Commenced construction: Mar 2005–May 2011	180 ng/J gross output 95% reduction
Commenced reconstruction: Mar 2005–May 2011	180 ng/J gross output 65 ng/J heat input 95% reduction
Modified: Mar 2005–May 2011	180 ng/J gross output 65 ng/J heat input 90% reduction
Construction or reconstruction after: 3 May 2011	130 ng/J gross energy output 140 ng/J net energy output 97% reduction
Modified after: 3 May 2011	180 ng/J gross output 90% reduction

## 2. ASEAN countries, China, and India

### Cambodia<sup>8</sup>

<u>Emission</u>	Unit	Cambodian standard	World Bank standard
Sulphur Dioxide (SO <sub>2</sub> ) Dry, 0 °C, 1atm, 6% O <sub>2</sub>	mg/Nm <sup>3</sup>	500	2000

### China<sup>9</sup>

Emission standards for air pollutants from coal-fired power plants (GB13223-2011)

GB13223-2011 came into force on 1 January 2012, replacing GB13223-2003

Pollutant	Application	Emission limit value	Location of monitoring and emission control
SO <sub>2</sub> , mg/m <sup>3</sup>	New boilers	100	Stack and flue
		200 <sup>a</sup>	
	Existing boilers	200	
		400 <sup>a</sup>	

<sup>a</sup> Emission limits apply to plants in Guangxi Zhuang Autonomous Region, Chongqing Municipality, Sichuan Province, and Guizhou Province.

### Special air pollutant emission control requirements for key regions

Coal-fired power plants located within the key regions should meet the special emission limit values in the following table. The key regions include Beijing City, Tianjin City, Hebei Province, Yangzi River Delta, Pearl River Delta, Central Liaoning Province, Shandong Province, Wuhan City and surrounding areas, Changsha City, Zhuzhou City, Xiangtan City, Chengdu and Chongqing City, coastal areas of Fujian Province, Central and Northern Shanxi Province, Guanzhong Region of Shaanxi Province, Gansu Province, Ningxia Province, and Wulumuqi (Ürümqi, Xinjiang Uyghur Autonomous Region).

Pollutant	Application	Emission limit value	Location of monitoring and emission control
SO <sub>2</sub> , mg/m <sup>3</sup>	all	50	Stack and flue

<sup>8</sup> Source: WG member

<sup>9</sup> Source: IEA Clean Coal Centre

## India<sup>10</sup>

### (A) Stack heights for thermal power plants

Power generation capacity (MW)	Height (m)
<200/210	$H=14(Q)^{0.3}$ where Q is the emission rate of SO <sub>2</sub> in kg/h and H is the stack height in metres
≥200/210–<500	220
≥500	275
Steam generating capacity, t/h	Height, m
<2	half times the neighbouring building height or 9 m (whichever is more)
>2–5	12
>5–10	15
>10–15	18
>15–20	21
>20–25	24
>25–30	27
>30	30 or $H = 14(Q)^{0.3}$ where Q is the emission rate of SO <sub>2</sub> in kg/h and H is the stack height in metres (whichever is more)

### (B) National Ambient Air Quality Standards

Pollutant	Time weighted average	Concentration in ambient air		Measurement method
		Industrial, residential, rural and other areas	Ecologically sensitive area (notified by central government)	
SO <sub>2</sub> , µg/m <sup>3</sup>	Annual	50	20	improved West and Gaeke ultraviolet fluorescence
	24 hours	80	80	

<sup>10</sup> Source: IEA Clean Coal Centre

## Indonesia<sup>11</sup>

### Static Emission Sources Quality Standard for CPP

Parameter	Maximum level (mg/Nm <sup>3</sup> )	
	A	B
Sulphur Dioxide (SO <sub>2</sub> )	750	750

A. For CPP in operation before 1 December 2008.

B. For CPP in operation after 1 December 2008.

Notes:

- a. Gas volume is measured under standard condition (25°C and 1 atm).
- b. Opacity is used as a practical indicator for monitoring.
- c. All parameters corrected by O<sub>2</sub>: 7 %
- d. For CPP with CEMS installed, the imposition of emission quality standard is for 95% of normal operation time for 3 months.

## Lao PDR<sup>12</sup>

### (A) Ambient Air Quality Standard

Pollutant	Average time unit: mg/m <sup>3</sup>					Method of measurement
	Hours			1 month	1 year	
	1 hr	8 hr	24 hr			
SO <sub>2</sub>	0.78	-	0.30	-	0.10	UV Fluorescence (1 hr, 24 hr, 1 yr) or Pararosaniline (1 hr, 4 hr)

### (B) Air Emission Standard for Power Plants

Pollutant	Source	Permitted emission value	
		ppm	mg/m <sup>3</sup>
SO <sub>2</sub>	Coal or Gas Power Plant		
	1. With the capacity of not more than 300 MW	640	
	2. With the capacity above 300 MW, not more than 500 MW	450	
	3. With the capacity above 500 MW	320	

<sup>11</sup> Source: WG Member.

<sup>12</sup> Source: WG Member.

## Malaysia<sup>13</sup>

### Environmental Quality (Clean Air) Regulations 2014

Pollutant	Capacity	Limit value
SO <sub>x</sub>	>10 MW <sub>e</sub>	500 mg/m <sup>3</sup>

## Myanmar<sup>14</sup>

### Air Emission Level

Pollutant	Unit	Guideline value
SO <sub>2</sub>	Mg/Nm <sup>3</sup>	150-200

Lower value for plants of > 100 MW thermal equivalent, higher value for plants of <100 MW thermal equivalent.

## Philippines<sup>15</sup>

### National Emission Standards for Sulphur Oxides for Stationary Sources (DENR Administrative Order No. 2000 - 81, 7 Nov 2000)

	Existing source		New source	
	fuel burning equipment	other source	fuel burning equipment	other source
emission limit, mg/m <sup>3</sup>	1500 as SO <sub>2</sub>	1000 as SO <sub>3</sub>	700 as SO <sub>2</sub>	200 as SO <sub>3</sub>

## Singapore<sup>16</sup>

### Environmental Protection and Management (Air Impurities) Regulations (effective from 1 Jan 2001, as revised in 2002 and 2008)

#### Standards for air pollutants emissions from stationary sources

Pollutant	Plant type	Emission limit value, mg/m <sup>3</sup>
SO <sub>2</sub>	any trade, industry or process (non-combustion sources)	500

The emissions of sulphur dioxide into the air from fuel combustion are controlled by limiting the sulphur content in fuels used by industries to not more than 1% by weight. Industries sited near urban areas are required to use fuel with a lower sulphur content.

<sup>13</sup> Source: WG Member.

<sup>14</sup> Source: WG Member.

<sup>15</sup> Source: IEA Clean Coal Centre.

<sup>16</sup> Source: IEA Clean Coal Centre.

## Thailand<sup>17</sup>

### (1) Emission standard from coal-fired power plants

#### (A) New Power Plant (since 15 January 2010)

Pollutant	Power plant size	Unit	Emission standard
SO <sub>2</sub>	<50 MW	ppm	360
	>50 MW	ppm	180

Notification of the Ministry of Natural Resources and Environment published in the Royal Government Gazette, Vol.127 Part 7, 15 January 2553 (2010).

#### (B) Power Plant (31 January 1996 – 15 January 2010)

Pollutant	Power Plant Size	Unit	Emission standard
SO <sub>2</sub>	>500 MW	ppm	320
	300-500 MW	ppm	450
	<300 MW	ppm	640

Notification of the Ministry of Science, Technology and Environment published in the Royal Government Gazette, Vol.113 Part 9, page 220, 30 January 2539 (1996).

#### (C) Mae Moh Power Plant

Pollutant	Power Unit	Unit	Emission Standard
SO <sub>2</sub>	Unit 1–3	ppm	1300
	Unit 4–7	ppm	320
	Unit 8–13	ppm	300
	Unit 1–13	Total SO <sub>2</sub> Loading not exceed 11 tons/hour	

Notification of the Ministry of Science, Technology and Environment No.3, B.E.2544 (2001), 29 January B.E.2544 (2001), published in the Royal Government Gazette, Vol.118 special Part 24, 16 March B.E.2544 (2001).

### (2) Ambient Air Standards

Pollutant	Average	Emission Standard
SO <sub>2</sub>	1 year	Not exceed 0.04 ppm (0.10 mg/m <sup>3</sup> )
	24 hr	Not exceed 0.12 ppm (0.30 mg/m <sup>3</sup> )
	1 hr	Not exceed 0.3 ppm (780 µg /m <sup>3</sup> )

Notification of National Environmental Board No.10, B.E.2538 (1995) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.112 Part 52, 25 May B.E.2538 (1995).

Notification of National Environmental Board No.24, B.E.2547 (2004) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.121 Part 104 D, 22 September B.E.2547 (2004).

<sup>17</sup> Source: WG Member.

## Viet Nam

Emission standards for thermal power plants were released on 16 November 2009

Vietnam's standards are based on the size of operation and location of the facility. The relevant emission standard for a pollutant is calculated using the following formula:

$$\text{Emission limit in mg/m}^3 = C \times K_p \times K_v$$

where C is the concentration parameter

$K_p$  is the power plant size coefficient

$K_v$  is the region coefficient.

Pollutant	Concentration parameter, mg/Nm <sup>3</sup>	
	Existing plants operating before 17 October 2007 and valid until 31 December 2014	Plants operating since 17 October 2007 and all plants after 1 January 2015
SO <sub>2</sub>	1500	500

Power plant size, MW	$K_p$ coefficient
$P \leq 300$	1.0
$300 < P \leq 1200$	0.85
$P > 1200$	0.7

Zoning area	$K_v$ coefficient
cities, historic, cultural or natural heritage	0.6
inner city and urban suburbs	0.8
industrial zones, suburbs, and outskirts	1.0
rural	1.2
rural mountains	1.4

## Annex 5

### NO<sub>x</sub> Regulations

#### 1. Selected OECD countries

##### Australia

###### (A) National<sup>18</sup>

The current standards and goals for the Ambient Air Quality NEPM (National Environment Protection Measure)

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
NO <sub>2</sub>	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None

The National Guidelines for Control of Emission of Air Pollutants from New Stationary Sources 1985

Pollutant	Plant type	Emission limits, mg/m <sup>3</sup>
Nitrogen oxides (as NO <sub>2</sub> )	power generating boiler >30 MWe	800
	power generating boiler <30 MWe	500
	industrial steam boiler	500

###### (B) (Example of State) New South Wales (NSW)<sup>19</sup>

Schedule 3 Standards of concentration for scheduled premises: activities and plant used for specific purposes

Emission standards for NO<sub>x</sub>

Industry	Activity or plant	Standard of concentration	
		Group	Standard
Power generation	boiler, operating on fuel other than gas, including one used in connection with an electricity generating system with a capacity of ≥30 MW	Group 1, 2, 3, or 4	2500 mg/m <sup>3</sup>
		Group 5	800 mg/m <sup>3</sup>
		Group 6	500 mg/m <sup>3</sup>

<sup>18</sup> Source: IEA Clean Coal Centre.

<sup>19</sup> Source: Outline of Protection of the Environment Operations (Clean Air) Regulation 2010.

An activity carried out, or plant operated

Group 1: Before 1 January 1972

Group 2: After 1 January 1972 and before 1 July 1979

Group 3: After 1 July 1979 and before 1 July 1986

Group 4: After 1 July 1986 and before 1 August 1997

Group 5: After 1 August 1997 and before 1 September 2005

Group 6: After 1 September 2005

## Germany<sup>20</sup>

Emission limit values for coal combustion plants in German legislation: TA-Luft 2002

Applicable to plants with a thermal input of less than 50 MW

Pollutant	Plant size, MWth	Daily emission limit value, mg/m <sup>3</sup>
NO <sub>x</sub> (NO + NO <sub>2</sub> )	≥10	400
	<10	500
	all	300 (fluidised bed combustion)

Applicable to new plants (in operation after 7 January 2014) with a thermal input of 50 MW or more.

Pollutant	Plant size MWth	Emission limit value (ELV), mg/m <sup>3</sup>		
		Daily mean value	Half-hourly mean value	Annual mean value
NO <sub>x</sub> (NO + NO <sub>2</sub> )	50–100	300	600	250
		400 (pulverised lignite)	800 (pulverised lignite)	250
	>100–300	200	400	100
	>300	150	400	100
		200 (pulverised lignite)	300	100
			400 (pulverised lignite)	

<sup>20</sup> Source: IEA Clean Coal Centre.

Applicable to existing plants (in operation before 7 January 2014) with a thermal input of 50 MW or more.

Pollutant	Plant size MWth	Emission limit value (mg/m <sup>3</sup> )		
		Daily mean value	Half-hourly mean value	Annual mean value
NO <sub>x</sub> (NO + NO <sub>2</sub> )	50–100	300	600	
		400 (pulverised lignite)	800 (pulverised lignite)	
	>100–300	200	400	
	>300	200	400	

## Japan

(A) Air Pollution Control Act

200ppm (O<sub>2</sub>: 6%)

(B) Life environment relevant ordinance (Yokohama City)

NO<sub>2</sub>: 100ppm

NO<sub>x</sub>: 200ppm

## Republic of Korea

Air Pollution Control Act

- Established before 1996: 140ppm (O<sub>2</sub>: 6%)
- Established after 1996: 70ppm (O<sub>2</sub>: 6%)
- Established after 2015: 50ppm (O<sub>2</sub>: 6%)

Voluntary (Operators of new CPP)

- In-cheon: 15ppm (O<sub>2</sub>: 6%)
- Dang-gin: 50ppm (O<sub>2</sub>: 6%)
- Yeou-su: 30 ppm (O<sub>2</sub>: 6%)

## United States

### (A) 40 CFR part 50 (air quality)

Pollutant	Primary/ secondary	Averaging time	Level	Form
NO <sub>2</sub>	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb	Annual Mean

**Primary standards** provide public health protection, including protecting the health of ‘sensitive’ populations such as asthmatics, children, and the elderly. **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

### (B) 40 CFR part 60 subpart Da (stationary source)

Applicability:

That is capable of combusting more than 73 MW (250 MMBtu/hr) heat input of fossil fuel.

	NO <sub>x</sub>
1971–1978	300 ng/J heat input
Sep 1978–1997	subbituminous: 210 ng/J heat input; other coal types: 260 ng/J heat input
1978–Mar 2005	New plant: 200 ng/J gross output; Reconstructed: 65 ng/J heat input
Commenced construction: Mar 2005–May 2011	130 ng/J gross output
Commenced reconstruction: Mar 2005–May 2011	130 ng/J gross output; 47 ng/J heat input
Modified: Mar 2005–May 2011	180 ng/J gross output; 65 ng/J heat input
Construction or reconstruction after: 3 May 2011	88 ng/J gross output; 95 ng/J net output
Modified after: 3 May 2011	140 ng/J gross output

## 2. ASEAN countries, China, and India

### Cambodia<sup>21</sup>

Emission	Unit	Cambodian standard	World Bank standard
Nitrogen Oxide (NO <sub>2</sub> ) Dry, 0 °C, 1atm, 6% O <sub>2</sub>	mg/Nm <sup>3</sup>	1000	750

### China<sup>22</sup>

Emission standards for air pollutants from coal-fired power plants (GB13223-2011)

GB13223-2011 came into force on 1 January 2012, replacing GB13223-2003

Pollutant	Application	Emission limit value	Location of monitoring and emission control
NO <sub>x</sub> (as NO <sub>2</sub> ), mg/m <sup>3</sup>	all	100	stack and flue
		200 <sup>a</sup>	

<sup>a</sup> Emission limit applies to arch fired furnaces, existing Circulating Fluidized Bed (CFB) power generating boilers, and power generating boilers commissioned or which received approval for construction before 31 December 2003.

### Special air pollutant emission control requirements for key regions

Coal-fired power plants located within the key regions should meet the special emission limit values in the following table. The key regions include Beijing City, Tianjin City, Hebei Province, Yangzi River Delta, Pearl River Delta, Central Liaoning Province, Shandong Province, Wuhan City and surrounding areas, Changsha City, Zhuzhou City, Xiangtan City, Chengdu and Chongqing City, coastal areas of Fujian Province, Central and Northern Shanxi Province, Guanzhong Region of Shaanxi Province, Gansu Province, Ningxia Province, and Wulumuqi (Ürümqi, Xinjiang Uyghur Autonomous Region).

Pollutant	Application	Emission limit value	Location of monitoring and emission control
NO <sub>x</sub> (as NO <sub>2</sub> ), mg/m <sup>3</sup>	all	100	Stack and flue

<sup>21</sup> Source: WG member.

<sup>22</sup> Source: IEA Clean Coal Centre.

## India<sup>23</sup>

### (A) National Ambient Air Quality Standards

Pollutant	Time-weighted average	Concentration in ambient air		Measurement method
		Industrial, residential, rural, and other areas	Ecologically sensitive area (notified by Central Government)	
NO <sub>2</sub> , µg/m <sup>3</sup>	Annual	40	30	modified Jacob & Hochheiser (Na-Arsenite) chemiluminescence
	24 hours	80	80	

## Indonesia<sup>24</sup>

### Static Emission Sources Quality Standard for CPP

Parameter	Maximum level (mg/Nm <sup>3</sup> )	
	A	B
Nitrogen oxide (NO <sub>x</sub> ) stated as NO <sub>2</sub>	850	750

A. For CPP that have been operated before 1 December 2008;

B. For CPP that have been operated after 1 December 2008.

Notes:

- a. Gas volume is measured under standard condition (25°C and 1 atm).
- b. Opacity is used as a practical indicator for monitoring.
- c. All parameters corrected by O<sub>2</sub>: 7 %
- d. For CPP with CEMS installed, the imposition of emission quality standard is for 95% of normal operation time for 3 months.

<sup>23</sup> Source: IEA Clean Coal Centre.

<sup>24</sup> Source: WG Member.

## Lao PDR<sup>25</sup>

### (A) Ambient Air Quality Standard

Pollutant	Average time unit: mg/m <sup>3</sup>					Method of measurement
	Hours			1 month	1 year	
	1 hr	8 hr	24 hr			
NO <sub>2</sub>	0.32	-	-	-	-	chemiluminescence method

### (B) Air Emission Standard for Power Plants

Pollutant	Source	Permitted emission value	
Oxide of Nitrogen	Power plant generating electricity from:	ppm	mg/m <sup>3</sup>
	1. Coal	350	

## Malaysia<sup>26</sup>

### Environmental Quality (Clean Air) Regulations 2014

Pollutant	Capacity	Limit value
NO <sub>x</sub>	>10 MW <sub>e</sub>	500 mg/m <sup>3</sup>

## Myanmar<sup>27</sup>

### Air Emission Level

Pollutant	Unit	Guideline Value
Nitrogen oxides	Mg/Nm <sup>3</sup>	200-400

Lower value for plants of > 100 MW thermal equivalent, higher value for plants of <100 MW thermal equivalent.

## Philippines<sup>28</sup>

### National Emission Standards for Nitrogen Oxides for Stationary Sources (DENR

Administrative Order No. 2000 - 81, 7 Nov 2000)

	Existing source		New source	
	fuel burning equipment	other source	fuel burning equipment	other source
Emission limit, mg/m <sup>3</sup>	1500 as NO <sub>2</sub>	1000 as NO <sub>2</sub>	1000 as NO <sub>2</sub>	500 as SO <sub>2</sub>

<sup>25</sup> Source: WG Member.

<sup>26</sup> Source: WG Member.

<sup>27</sup> Source: WG Member.

<sup>28</sup> Source: IEA Clean Coal Centre.

## Singapore<sup>29</sup>

Environmental Protection and Management (Air Impurities) Regulations (effective 1 Jan 2001, as revised in 2002 and 2008)

Standards for air pollutants emissions from stationary sources

Pollutant	Plant type	Emission limit value, mg/m <sup>3</sup>
NOx as NO <sub>2</sub>	any trade, industry, process, or fuel burning equipment	700

## Thailand<sup>30</sup>

(1) Emission standard from coal-fired power plants

(A) New Power Plant (since 15 January 2010)

Pollutant	Power Plant Size	Unit	Emission standard
NOx as NO <sub>2</sub>	<50 MW	ppm	200
	>50 MW	ppm	200

Notification of the Ministry of Natural Resources and Environment published in the Royal Government Gazette, Vol.127 Part 7, 15 January B.E.2553 (2010).

(B) Power Plant (31 January 1996–15 January 2010)

Pollutant	Unit	Emission standard
NOx as NO <sub>2</sub>	ppm	350

Notification of the Ministry of Science, Technology and Environment published in the Royal Government Gazette, Vol.113 Part 9, page 220, 30 January B.E.2539 (1996).

(C) Mae Moh Power Plant

Pollutant	Power Unit	Unit	Emission standard
NO <sub>2</sub>	Unit 1-3	ppm	500
	Unit 4-7	ppm	500
	Unit 8-13	ppm	500

Notification of the Ministry of Science, Technology and Environment No.3, B.E.2544 (2001) 29 January B.E.2544 (2001), published in the Royal Government Gazette, Vol.118 special Part 24, 16 March B.E.2544 (2001).

<sup>29</sup> Source: IEA Clean Coal Centre.

<sup>30</sup> Source: WG Member.

## (2) Ambient Air Standards

Pollutant	Average	Emission standard
NO <sub>2</sub>	1 year	Not exceed 0.17 ppm (0.32 mg/m <sup>3</sup> )
	1 hr	Not exceed 0.03 ppm (0.057 mg/m <sup>3</sup> )

Notification of National Environmental Board No.10, B.E.2538 (1995) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.112 Part 52, 25 May B.E.2538 (1995).

Notification of National Environmental Board No.24, B.E.2547 (2004) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.121 Part 104 D, 22 September B.E.2547 (2004).

## Viet Nam

Emission standards for thermal power plants were released on 16 November 2009. Viet Nam's standards are based on the size of operation and location of the facility. The relevant emission standard for a pollutant is calculated using the following formula:

$$\text{Emission limit in mg/m}^3 = C \times K_p \times K_v$$

where C is the concentration parameter

K<sub>p</sub> is the power plant size coefficient

K<sub>v</sub> is the region coefficient.

Pollutant	Concentration parameter, mg/Nm <sup>3</sup>	
	Existing plants operating before 17 October 2007 and valid until 31 December 2014	Plants operating since 17 October 2007 and all plants after 1 January 2015
NO <sub>x</sub> (as NO <sub>2</sub> )	1000	650 with coal volatile content >10% 1000 with coal volatile content ≤10%

Power plant size, MW	K <sub>p</sub> coefficient
P ≤ 300	1.0
300 < P ≤ 1200	0.85
P > 1200	0.7

Zoning area	Kv coefficient
cities, historic, cultural, or natural heritage	0.6
inner city and urban suburbs	0.8
industrial zones, suburbs, and outskirts	1.0
rural	1.2
rural mountains	1.4

## Annex 6

### PM Regulations

#### 1. Selected OECD countries

##### Australia

(A) National<sup>31</sup>

The current standards and goals for the Ambient Air Quality National Environment Protection Measure (NEPM)

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
PM <sub>10</sub>	1 day	50 µg /m <sup>3</sup>	None
	1 year	25 µg /m <sup>3</sup>	None
PM <sub>2.5</sub>	1 day	25 µg /m <sup>3</sup>	None
	1 year	8 µg /m <sup>3</sup>	None

The advisory reporting standards and goals for PM<sub>2.5</sub> are:

Pollutant	Averaging period	Maximum concentration
NO <sub>2.5</sub>	1 day	20 µg/m <sup>3</sup> by 2025
	1 year	7 µg /m <sup>3</sup> by 2025

The review was completed in 2011.

The National Guidelines for Control of Emission of Air Pollutants from New Stationary Sources 1985

Pollutant	Plant type	Emission limits, mg/m <sup>3</sup>
Particulate	power plant boiler	80
	other coal-burning boiler	250
	any other trade, industry process, industrial plant, or fuel-burning equipment	250

<sup>31</sup> Source: IEA Clean Coal Centre.

(B) (Example of State) New South Wales (NSW)<sup>32</sup>

Schedule 3 Standards of concentration for scheduled premises: activities and plant used for specific purposes

Emission standards for particulates

Air impurity	Activity or plant	Standard of concentration	
PM	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel	Group 1	400 mg/m <sup>3</sup>
		Group 2, 3, or 4	250 mg/m <sup>3</sup>
		Group 5	100 mg/m <sup>3</sup>
		Group 6	50 mg/m <sup>3</sup>

An activity carried out, or plant operated

Group 1: Before 1 January 1972

Group 2: After 1 January 1972 and before 1 July 1979

Group 3: After 1 July 1979 and before 1 July 1986

Group 4: After 1 July 1986 and before 1 August 1997

Group 5: After 1 August 1997 and before 1 September 2005

Group 6: After 1 September 2005

**Germany<sup>33</sup>**

Emission limit values for coal combustion plants in German legislation: TA-Luft 2002

Applicable to plants with a thermal input of less than 50 MW

Pollutant	Plant size, MWth	Daily emission limit value, mg/m <sup>3</sup>
Dust	≥5	20
	<5	50

Applicable to new plants (in operation after 7 January 2014) with a thermal input of 50 MW or more.

Pollutant	Plant size, MWth	Emission limit value (ELV), mg/m <sup>3</sup>		
		Daily mean value	Half-hourly mean value	Annual mean value
Dust	all >300	10	20	10

<sup>32</sup> Source: Outline of Protection of the Environment Operations (Clean Air) Regulation 2010.

<sup>33</sup> Source: IEA Clean Coal Centre.

Applicable to existing plants (in operation before 7 January 2014) with a thermal input of 50 MW or more.

Pollutant	Plant size, MWth	Emission limit value (ELV), mg/m <sup>3</sup>		
		Daily mean value	Half-hourly mean value	Annual mean value
Dust	all >300	20	40	10

## Japan

(A) Air Pollution Control Act

100mg/m<sup>3</sup><sub>N</sub> (O<sub>2</sub>: 6%)

(B) Life environment relevant ordinance (Yokohama City)

0.05g/m<sup>3</sup><sub>N</sub>

## Republic of Korea

Air Pollution Control Act

- Established before 2001: 25mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)
- Established after 2001: 20mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)
- Established after 2015: 10mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)

Voluntary (operators of new CPP)

- In-cheon: 5mg/Sm<sup>3</sup> (O<sub>2</sub>: 6%)
- Yeou-su: 8mg/Sm<sup>3</sup> ppm (O<sub>2</sub>: 6%)

## United States

### (A) 40 CFR part 50 (air quality)

Pollutant		Primary/ Secondary	Averaging time	Level	Form
PM	PM <sub>2.5</sub>	primary	1 year	12.0 µg/m <sup>3</sup>	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m <sup>3</sup>	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m <sup>3</sup>	98th percentile, averaged over 3 years
	PM <sub>10</sub>	primary and secondary	24 hours	150 µg/m <sup>3</sup>	Not to be exceeded more than once per year on average over 3 years

**Primary standards** provide public health protection, including protecting the health of 'sensitive' populations such as asthmatics, children, and the elderly. **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

### (B) 40 CFR part 60 subpart Da (stationary source)

Applicability:

That is capable of combusting more than 73 MW (250 MMBtu/hr) heat input of fossil fuel.

	PM
1971–1978	43 ng/J heat input
Sep 1978–1997	13 ng/J heat input
1978–Mar 2005	
Commenced construction: Mar 2005–May 2011	18 ng/J gross output 6.4 ng/J heat input
Commenced reconstruction: Mar 2005–May 2011	Or: 13 ng/J input and 99.9% reduction
Modified: Mar 2005–May 2011	18 ng/J gross output 6.4 ng/J heat input Or: 13 ng/J input and 99.8% reduction
Construction or reconstruction after: 3 May 2011	11 ng/J gross output 12 ng/J net output
Modified after: 3 May 2011	18 ng/J gross output 6.4 ng/J heat input Or: 13 ng/J input and 99.8% reduction

## 2. ASEAN countries, China, and India

### Cambodia<sup>34</sup>

Emission	Unit	Cambodian standard	World Bank standard
Particulates Dry, 0 <sup>0</sup> c, 1atm, 6% O <sub>2</sub>	mg/Nm <sup>3</sup>	400	50

### China<sup>35</sup>

Emission standards for air pollutants from coal-fired power plants (GB13223-2011)

GB13223-2011 came into force on 1 January 2012, replacing GB13223-2003

Pollutant	Application	Emission limit value	Location of monitoring and emission control
Particulate, mg/m <sup>3</sup>	all	30	stack and flue

### Special air pollutant emission control requirements for key regions

Coal-fired power plants located within the key regions should meet the special emission limit values in the following table. The key regions include Beijing City, Tianjin City, Hebei Province, Yangzi River Delta, Pearl River Delta, Central Liaoning Province, Shandong Province, Wuhan City and surrounding areas, Changsha City, Zhuzhou City, Xiangtan City, Chengdu and Chongqing City, coastal areas of Fujian Province, Central and Northern Shanxi Province, Guanzhong Region of Shaanxi Province, Gansu Province, Ningxia Province, and Wulumuqi (Ürümqi, Xinjiang Uyghur Autonomous Region).

Pollutant	Application	Emission limit value	Location of monitoring and emission control
Particulate, mg/m <sup>3</sup>	all	20	Stack and flue

### India<sup>36</sup>

(A) Emission limits for particulate matter (PM) from thermal power plants

Plant size, MW	Emission limit, mg/Nm <sup>3</sup>
<210	350
≥210	150

<sup>34</sup> Source: WG member.

<sup>35</sup> Source: IEA Clean Coal Centre.

<sup>36</sup> Source: IEA Clean Coal Centre.

## (B) National Ambient Air Quality Standards

Pollutant	Time weighted average	Concentration in ambient air		Measurement method
		Industrial, residential, rural, and other areas	Ecologically sensitive area (notified by central government)	
PM <sub>10</sub> , µg/m <sup>3</sup>	Annual	60	60	gravimetric TEOM beta attenuation
	24 hours	100	100	
PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual	40	40	gravimetric TEOM beta attenuation
	24 hours	60	60	

## Indonesia<sup>37</sup>

### Static Emission Sources Quality Standard for CPP

Parameter	Maximum level (mg/Nm <sup>3</sup> )	
	A	B
Total Particulate	150	100
Opacity	20%	20%

A. For CPP that have been operated before 1 December 2008.

B. For CPP that have been operated after 1 December 2008.

Notes:

- Gas volume is measured under standard condition (25°C and 1 atm).
- Opacity is used as a practical indicator for monitoring.
- All parameters corrected by O<sub>2</sub> : 7 %
- For CPP with CEMS installed, the imposition of emission quality standard is for 95 % of normal operation time for 3 months.

<sup>37</sup> Source: WG Member.

## Lao PDR<sup>38</sup>

### (A) Ambient Air Quality Standard

Pollutant	Average Time Unit: mg/m <sup>3</sup>					Method of Measurement
	Hours			1 month	1 year	
	1 hr	8 hr	24 hr			
Total Suspended Particulate	-	-	0.33	-	0.10	gravimetric
PM <sub>10</sub>	.05	-	0.12	-	0	gravimetric or beta ray or taper element oscillating microbalance or dichotomous

### (B) Air Emission Standard for Power Plants

Pollutant	Source	Permitted emission value	
Particulate Substances	Power Plant Generating Electricity From:	ppm	mg/m <sup>3</sup>
	1. Coal	-	120

## Malaysia<sup>39</sup>

### Environmental Quality (Clean Air) Regulations 2014

Pollutant	Capacity	Limit value
PM	>10 MW <sub>e</sub>	50 mg/m <sup>3</sup>

## Myanmar<sup>40</sup>

### Air Emission Level

Pollutant	Unit	Guideline value
PM <sub>10</sub>	mg/Nm <sup>3</sup>	30-50

Lower value for plants of > 100 MW thermal equivalent, higher value for plants of <100 MW thermal equivalent.

<sup>38</sup> Source: WG Member.

<sup>39</sup> Source: WG Member.

<sup>40</sup> Source: WG Member.

## Philippines<sup>41</sup>

National Emission Standards for Particulate Matter for Stationary Sources (DENR Administrative Order No. 2000 - 81, 7 Nov 2000)

	Emission source		
	Fuel burning equipment		Other stationary sources
	Urban and industrial area	Other area	
Emission limit, mg/m <sup>3</sup>	150	200	200

## Singapore<sup>42</sup>

Environmental Protection and Management (Air Impurities) Regulations (effective 1 January 2001, as revised in 2002 and 2008)

Standards for air pollutants emissions from stationary sources

Pollutant	Plant type	Emission limit value, mg/m <sup>3</sup>
Particulate matter	any trade, industry, process, fuel burning equipment or industrial plant (except for any cold blast foundry cupolas)	100

where there is more than one flue, duct or chimney in any scheduled premises, the total mass of the particulate emissions from all such flues, ducts, or chimneys divided by the total volume of such emissions shall not exceed 100 mg/m<sup>3</sup> and the particulate emissions from each of such flue, duct or chimney shall not exceed 200 mg/m<sup>3</sup> at any point of time.

## Thailand<sup>43</sup>

(1) Emission standards from coal-fired power plants

(A) New Power Plant (since 15 January 2010)

Pollutant	Power plant size	Unit	Emission standard
Particulate	<50 MW	mg/m <sup>3</sup>	80
	>50 MW	mg/m <sup>3</sup>	80

Notification of the Ministry of Natural Resources and Environment published in the Royal Government Gazette, Vol.127 Part 7, 15 January B.E.2553 (2010).

<sup>41</sup> Source: IEA Clean Coal Centre.

<sup>42</sup> Source: IEA Clean Coal Centre.

<sup>43</sup> Source: WG Member.

### (B) Power Plant (31 January 1996–15 January 2010)

Pollutant	Unit	Emission standard
Particulate	mg/m <sup>3</sup>	120

Notification of the Ministry of Science, Technology and Environment published in the Royal Government Gazette, Vol.113 Part 9, page 220, 30 January (1996).

### (C) Mae Moh Power Plant

Pollutant	Power unit	Unit	Emission standard
NO <sub>2</sub>	Unit 1-3	mg/m <sup>3</sup>	180
	Unit 4-7	mg/m <sup>3</sup>	180
	Unit 8-13	mg/m <sup>3</sup>	180

Notification of the Ministry of Science, Technology and Environment No.3, B.E.2544 (2001) 29 January B.E.2544 (2001), published in the Royal Government Gazette, Vol.118 special Part 24, 16 March B.E.2544 (2001).

### (2) Ambient Air Standards

Pollutant	Average	Emission standard
Total Suspended Particulate	24 hr	Not exceed 0.33 mg/m <sup>3</sup>
	1 hr	Not exceed 0.10 mg/m <sup>3</sup>
PM <sub>10</sub>	24 hr	Not exceed 0.12 mg/m <sup>3</sup>
	1 hr	Not exceed 0.05 mg/m <sup>3</sup>
PM <sub>2.5</sub>	24 hr	Not exceed 0.05 mg/m <sup>3</sup>
	1 hr	Not exceed 0.025 mg/m <sup>3</sup>

Notification of National Environmental Board No.10, B.E.2538 (1995) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.112 Part 52, 25 May B.E.2538 (1995).

Notification of National Environmental Board No.24, B.E.2547 (2004) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.121 Part 104 D, 22 September B.E.2547 (2004).

Notification of National Environmental Board No.36, B.E.2553 (2010) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992), published in the Royal Gazette No.127 Part 37, 24 March B.E.2553 (2010).

## Viet Nam

Emission standards for thermal power plants were released on 16 November 2009

Viet Nam's standards are based on the size of operation and location of the facility. The relevant emission standard for a pollutant is calculated using the following formula:

$$\text{Emission limit in mg/m}^3 = C \times K_p \times K_v$$

where C is the concentration parameter

$K_p$  is the power plant size coefficient

$K_v$  is the region coefficient.

Pollutant	Concentration parameter, mg/Nm <sup>3</sup>	
	Existing plants operating before 17 October 2007 and valid until 31 December 2014	Plants operating since 17 October 2007 and all plants after 1 January 2015
Particulate matter	400	200

Power plant size, MW	$K_p$ coefficient
$P \leq 300$	1.0
$300 < P \leq 1200$	0.85
$P > 1200$	0.7

Zoning area	$K_v$ coefficient
cities, historic, cultural, or natural heritage	0.6
inner city and urban suburbs	0.8
industrial zones, suburbs, and outskirts	1.0
rural	1.2
rural mountains	1.4