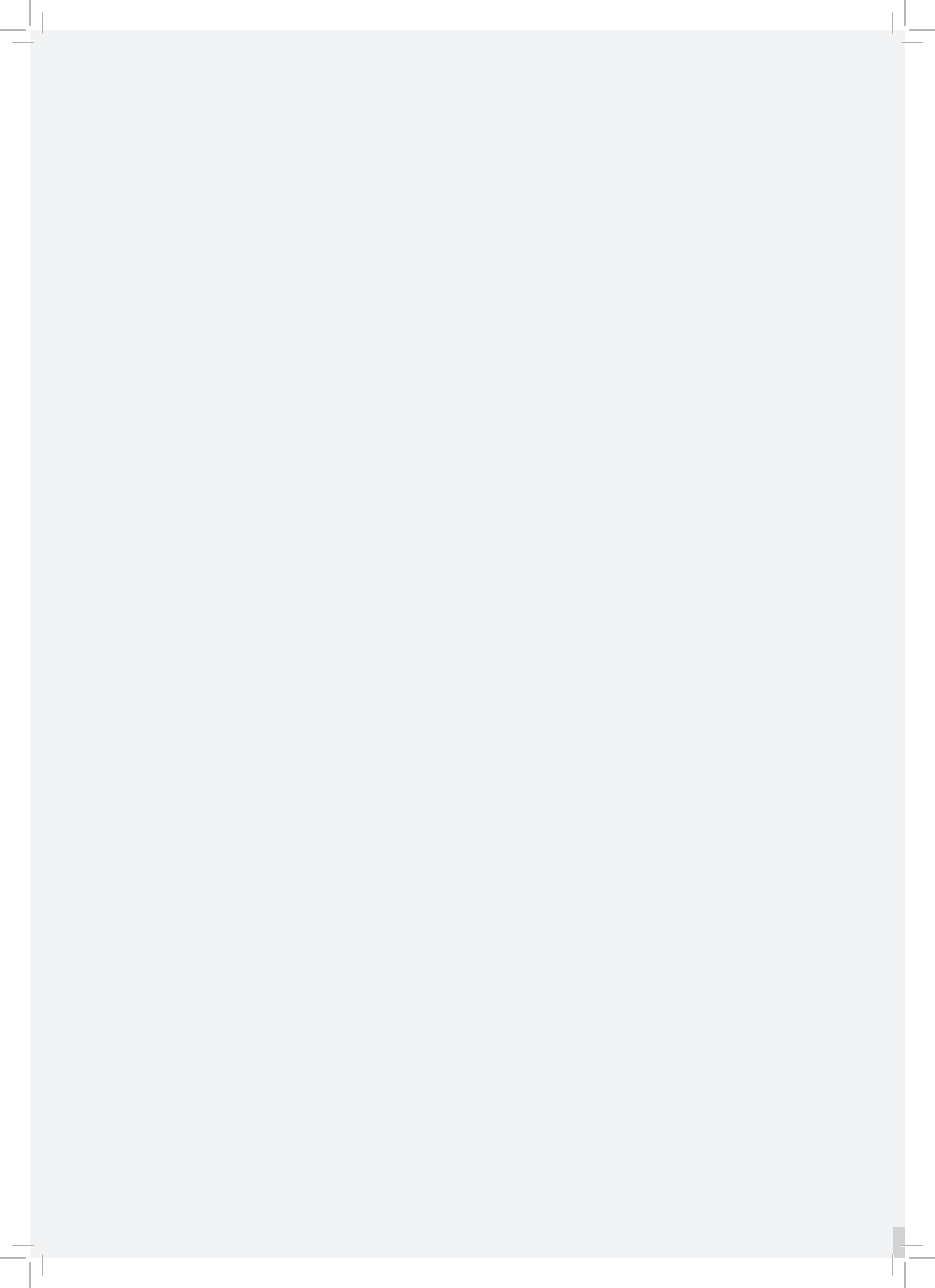


COAL:

A PUBLIC
HEALTH CRISIS
IN MYANMAR





**POSSIBLE
ENVIRONMENTAL
IMPACTS OF RUNNING
A 120-MEGAWATT COAL-
FIRED POWER PLANT
AT TIGYIT TO THE LOCAL
COMMUNITY**



In 2002, the Ministry of Electrical Power built a coal-fired power plant at Tigyit Village, Taunggyi district, in the Southern Shan State. This power plant was a joint venture between the Myanmar government and a Chinese company.

Using lignite coal as fuel, the power plant is projected to generate 120 megawatts of electricity, but in reality it can only generate 20 megawatts.

Though not yet fully operational, the power plant has already created a host of environmental problems. As a result of poor waste management, the plant emits ashes, gases and particulate matters that spread up to a 5 mile radius, contaminating the town's water sources and nearby ecosystems, as well as farmlands and livestock. People, specifically older folk and children, have been suffering from respiratory diseases, such as asthma, as well as other skin problems due to water contamination. There have also been cases of low-birth weight, even miscarriages among women.

Aside from poor health conditions, the town's livelihood is also threatened. Farm animals would also fall ill- in fact, there was a notable decline in pig's birth rate. Due to drinking water mixed with poisoned water come from power plant, cattle are also suffering from strange diseases and die. And organs of the deceased cattle were also decayed within very short time. Villagers who use the contaminated water are also struggling with skin itching, wound and illness. The quality of crops and vegetables also dropped.

The power plant gets its water from the town's main water sources for its operational use. The plant has failed to provide an alternative water source for the impacted communities. To resolve the shortage of drinking water, villagers have dug out ponds and wells, but the water from these sources have also been contaminated by coal ashes from the plant. Villagers now need to process the water they drink, adding to their woes.

**“ BY ANALYZING THE CASE, WE
CAN ASSUME THAT THE MYANMAR
GOVERNMENT RECOGNIZED THE FACT
THAT TIGYIT COAL-FIRED POWER PLANT
WAS DAMAGING THE ENVIRONMENT AND
ADVERSELY IMPACTING THE PEOPLE. “**

OPPOSITION AGAINST THE COAL POWER PLANT

For several months, the villagers have tried to negotiate with power plant officials, but not a single corrective action was taken. With the help from civil society organizations (CSOs), the local movement against the coal power plant was born, with people protesting in the streets, all the way to the Myanmar parliament. Upon the request of villagers, the Ministry of Electrical Power and Energy formed an investigation commission led by the Deputy Minister. The commission ruled that wastes from power plant have indeed damaged the local environment and impacted people's lives and livelihood. The commission then instructed the plant's owners to manage their wastes in a manner that would not harm the environment and ordered to stop any work on the power plant until corrective measures were taken. With the help of civil society organizations, villagers had to

hold protest against coal power plant and demand intervention of Parliament through relevant township parliamentarians.

By analyzing the case, we can assume that the Myanmar government recognized the fact that Tigyit coal-fired power plant was damaging the environment and adversely impacting the people.

As a result, the Chinese company had to relinquish its license, as it couldn't meet the commission's demands. Therefore, the Ministry of Electrical Power and Energy announced its plan to reopen the plant. This time, the Wixi Hua Guang company, owned by a Burmese national, won the bid and the license to operate under following terms: for the operator to upgrade its waste management systems to avoid environmental damage; for the plant to generate 120 megawatts; and for the energy joint venture to last for 22 years.



“ CALCULATING THE IMPACTS OF A 20 MEGAWATT PLANT, WE CAN ESTIMATE THAT FOR THE FIRST THREE YEARS, THE COAL PLANT WILL INFLICT HARM AND DAMAGE WITHIN A 5 MILE RADIUS. IN FIVE YEARS, IT WOULD DAMAGE AREAS WITHIN A 7 MILE RADIUS. “

INITIAL CONSULTATION WITH THE LOCALS

Officials from the Wixi Hua Guang company invited multi-stakeholders, including the union level executive director from the Ministry of Electrical Power and Energy, Shan state Natural Resources and Environmental Minister, the director from the Shan state Environment Conservation Department, members of parliament, local residents, monks, CSOs and media to a consultation meeting concerning the restoration of the coal-fired power plant on 24th April 2016. They also invited E Guard environmental service co.ltd, which they hired to undertake Social Impact Assessment (SIA), Environmental Impact Assessment (EIA), Health Impact Assessment (HIA) behalf of company.

The following questions were asked by locals during consultation meeting and were answered by officials from the power plant and by responsible cabinet members.

- I. Can the Wixi Hua Guang company guarantee that previous mistakes would not repeated again, and could the company assume accountability for operation of plant?
- II. Is that in line with the current legal framework to permit license before SIA, EIA were done.
- III. Was the power plant's License to Operate officially granted by the Myanmar Investment Commission?
- IV. If there are cases of environmental damage by the plant's operation, or if the company failed to implement the agreed rules and regulation, will the company cease its operations?

Responsible cabinet members and responsible persons from the company answered the following questions:

Question I, II, III were answered by U Khin Maung Win, the union level executive director from Ministry of Electrical Power and Energy. Wixi Hua Guang company won the bid under the requirement that the operator needs to upgrade its environmental management systems in accordance with the national framework; that the license was given officially by the Myanmar Investment Commission (MIC) as a joint venture type, with duration of the license to be valid for 22 years; that the power plant will not harm the environment; since this license is to run the old power plant, there is no need to conduct EIA and SIA again.

Question IV was answered by an official from Wixi Hua Guang company as follows: The plant has fully upgraded its waste management system to avoid environmental damages, with plans to change the boiler to a more effective one; the operation of the plant will not harm environment as it will be operating with the same technology that is currently being used in the United States; that the company will conduct SIA, EIA, HIA in accordance with the government's environment conservation law, World Bank standards and other relevant national laws; that the company will strictly follow the rules and regulations, guarantee full accountability for the operation of plant and its impact to environment; if locals can provide concrete evidence of plant activities that are damaging nearby environment, the company will relinquish its license and leave their investment.



ANALYZING THE MUTUAL DISCUSSION

Conducting EIA, SIA for the restoration of Tigyit coal-fired power plant is about assessing the impact of wastes (particulate matter, gases, liquids, etc.), bad smells and noises and about accessing how to control impacts of the plant to the nearby environment and the company’s capacity to control its impacts. Whether the plant is old or new, it is important to examine the technique and process of conducting assessments. So before Tigyit coal-fire power plant starts operating, the EIA, SIA, HIA need to be done in accordance with national laws.

While answering the fourth question, the official from Wixi Hua Guang company said that the company will respond only locals who can provide concrete evidence of damage to ecosystems and crops attributed to the operation of plant. Hence, it is important to collect data with regard to impacts on environment in order to prove concretely.

ACTION NEEDS TO BE DONE BEFORE THE TEST RUN OF THE TIGYIT COAL-FIRED POWER PLANT.

The E-Guard environmental service co.ltd was hired by Wixi Hua Guang company to undertake SIA, EIA, HIA before the restoration of Tigyit coal-fired power plant. It would be remiss of them to put absolute trust in the company that is known to put its own business interests first. Check and balance mechanisms need to be in place. It is advisable to form an independent commission that will represent locals and also invite experts to collect data on the environment (test water quality, soil quality, air quality, crops, health status of humans and animals) before the restoration of the plant. The data should be published and made known to the public. The results of the commission work will be sent to the Shan state government who will

also examine the information from HIA, SIA, EIA service company, harmonizing the significant differences between two set of data. Also setting up basic principles for releasing information.

Local communities and CSOs also need to record the current condition of crops and ecosystems (average production rate, quality of crops), water quality, health status (birth rate, infant health situation, mortality rate, average life span, common disease and patterns of disease) and publish the findings. They should also inform company officials about their findings and send a copy to the service company.

If any damages occur, we can use recorded document as reference to compare with the current situation.

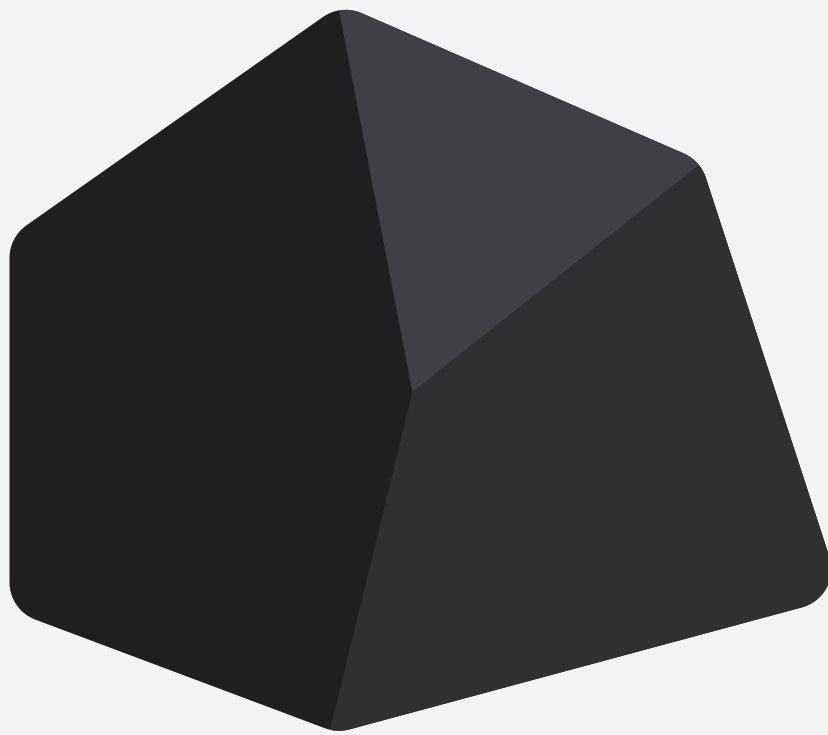
The coal plant company or government should cover the cost of community-based data collection and the results should be recognized by the Commission.

POTENTIAL IMPACT ON ENVIRONMENT

Even operating with improved waste management system, upgraded tools and machines, the Tigyit coal-fired power plant may still harm the environment. If waste management systems fail, the adverse impacts would be tremendous. Calculating the impacts of a 20 megawatt plant, we can estimate that for the first three years, the coal plant will inflict harm and damage within a 5 mile radius. In five years, it would damage areas within a 7 mile radius.

Sein Myint
 Member of Myanmar Green Network (MGN)
 Mining Engineer

**BURDEN OF DISEASE
FROM RISING COAL
EMISSIONS IN
SOUTHEAST ASIA¹**
**NATIONAL RESULTS
FOR MYANMAR**



SUMMARY

Despite being the country with highest air pollution levels in ASEAN, Myanmar is planning a major expansion in coal-fired power generation. If all planned coal-fired power plants were built and operated, Myanmar's SO₂ emissions from energy use would be projected to increase 7-fold, and triple NO_x emissions. The effect would be an increase in particulate matter and ozone pollution levels in Myanmar and neighboring countries, elevating the risk of

diseases such as stroke and lung cancer. We project that the coal power plant emissions would be responsible for a total of 7,100 premature deaths each year, or 280,000 premature deaths if these plants operate for 40 years. The air quality and health impacts are significantly exacerbated by the lack of effective regulation of air pollutant emissions from coal-fired power plants in Myanmar.

INTRODUCTION

According to World Health Organization data, Myanmar has by far the most polluted air in the Southeast Asian region: all of the 10 ASEAN cities with highest particulate matter levels are found in Myanmar.

Coal combustion is one of the major sources of particulate matter pollution globally, emitting much higher levels of SO₂, NO_x and dust, the key contributors to PM_{2.5}, than any other form of electricity generation. Yet, Myanmar is planning a coal power expansion that could almost triple the emissions of these pollutants in the country, along with doubling the country's CO₂ emissions from energy. The planned power plants are particularly problematic because the country lacks meaningful emission standards for coal-fired power generation.

This report on the projected health impacts of new coal-fired power plants in Myanmar is based on atmospheric modeling carried out at Harvard University Atmospheric Chemistry Modeling Group.

PM_{2.5} – THE BIGGEST ENVIRONMENTAL HEALTH RISK IN THE WORLD

Exposure to fine particulate matter pollution is the largest environmental health risk in the world, increasing the risk of lung cancer, stroke, heart disease, chronic respiratory diseases, lower respiratory infections and asthma. PM_{2.5} is estimated to have been responsible for over three million premature deaths in 2010 globally.² The International Agency for Research on Cancer classified particulate matter pollution as carcinogenic to humans in 2013, and designated it as a "leading environmental cause of cancer deaths".³

PM_{2.5} is both emitted directly from power plants, cars, factories and other sources as soot and dust, and formed in the atmosphere from SO₂, NO_x and other gaseous pollutants through chemical processes. The biggest contribution to PM_{2.5} from coal-fired power plants is due to their SO₂ and NO_x emissions, but this effect is often ignored.

Power plant emissions also include large amounts of heavy metals such as mercury, arsenic, lead, cadmium, chromium and nickel.

HEALTH RISKS OF PM_{2.5} AIR POLLUTION LEVELS IN MYANMAR

Myanmar provides no data on PM_{2.5} levels to the World Health Organization, but data contained in the WHO Ambient Air Pollution database on PM₁₀ paints an alarming picture. PM₁₀ is a group of particulate pollution that includes both PM_{2.5} and coarser particles.

Out of the 14 cities and towns included in the data, not even one meets the WHO guideline for annual average PM₁₀ level, and the most polluted one (Pyin Oo Lwin) exceeds the guideline 7-fold. Six of the 14 cities have a higher PM₁₀ level than China's famously polluted capital Beijing.

This high level of pollution has severe consequences for public health – the Global Burden of Disease project estimates that exposure to ambient air pollution was responsible for approximately 45 premature deaths every day in Myanmar in 2015, due to the increased risk of diseases such as lung cancer, stroke and heart disease.

¹ The data and findings in this report are based on the forthcoming article

Burden of disease from rising coal emissions in Southeast Asia

Shannon N. Kopnitz*, Daniel J. Jacob*, Melissa P. Sulprizio*, Lauri Myllyvirta**, and Colleen Reid***

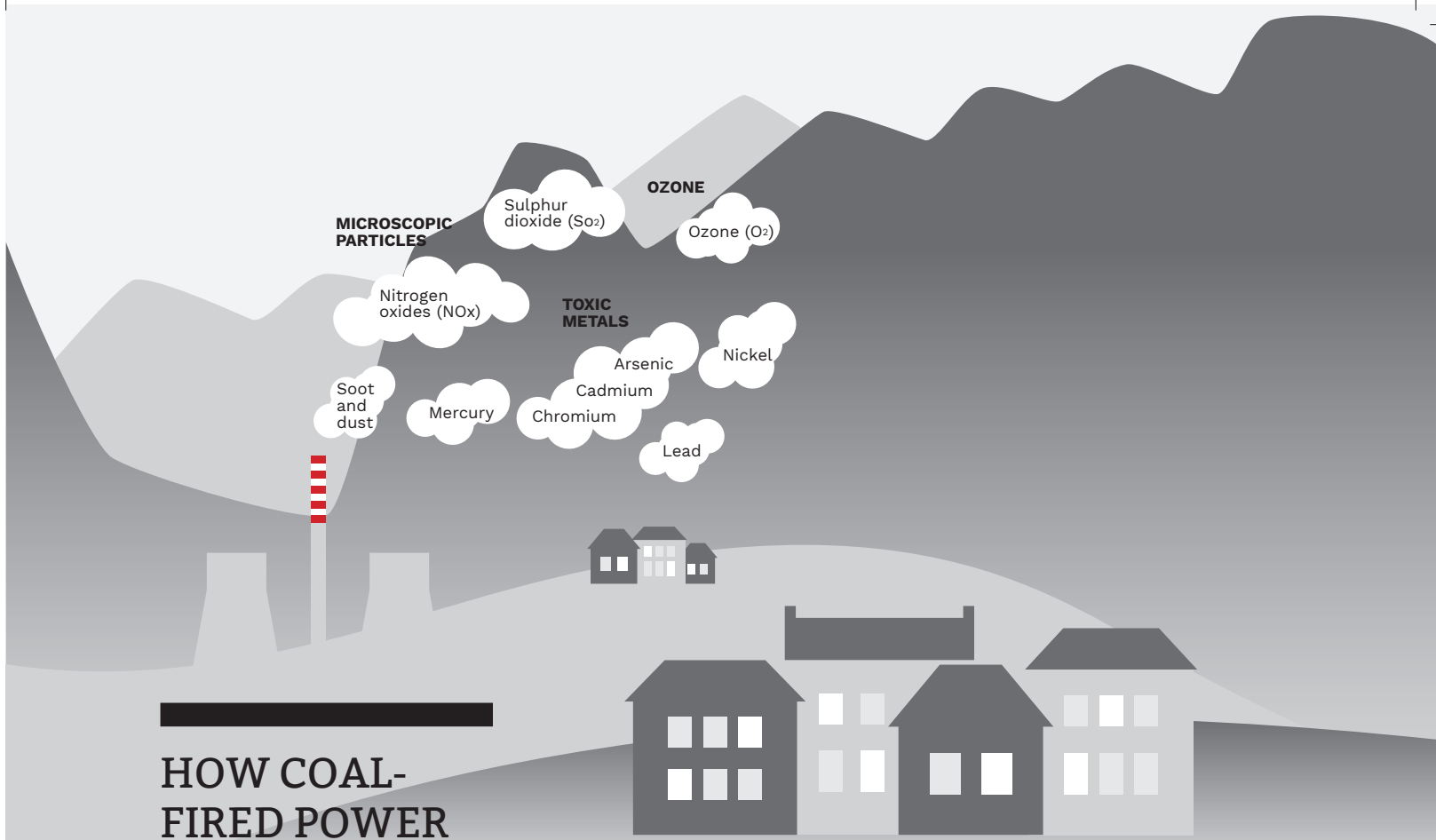
*Department of Earth and Planetary Sciences and School of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts, USA

**Greenpeace International, Amsterdam, the Netherlands

***Harvard School of Public Health

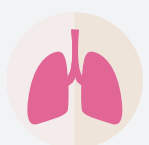
² <http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2812%2961766-8/abstract>

³ <http://www.euro.who.int/en/health-topics/environment-and-health/urban-health/news/news/2013/10/outdoor-air-pollution-a-leading-environmental-cause-of-cancer-deaths>



HOW COAL-FIRED POWER PLANTS CAN MAKE YOU SICK

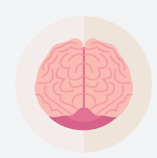
Coal-fired power plants expose people to toxic particles, ozone and heavy metals. The most serious health impacts are due to microscopic particles (PM2.5) formed from emissions of sulphur and Nitrogen oxides, dust and soot. These particles penetrate deep into the lungs and into the bloodstream, causing deaths and numerous health problems.



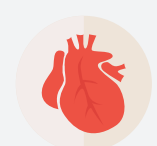
- Lung cancer
- Asthma attacks
- Infections and cough
- Impaired lung function
- Impaired lung growth in children



- Inflammation
- Increased coagulation
- Blood pressure



- Stroke
- Decreased IQ
- Diseases of central nervous system



- Heart attack
- Heart rate variability
- Heart disease



- Lower birth weight
- Impaired foetal growth
- Premature birth
- Impaired mental and physical development
- Decreased sperm quality

Figure 1: Health risks of coal pollution

Annual average PM10 Levels

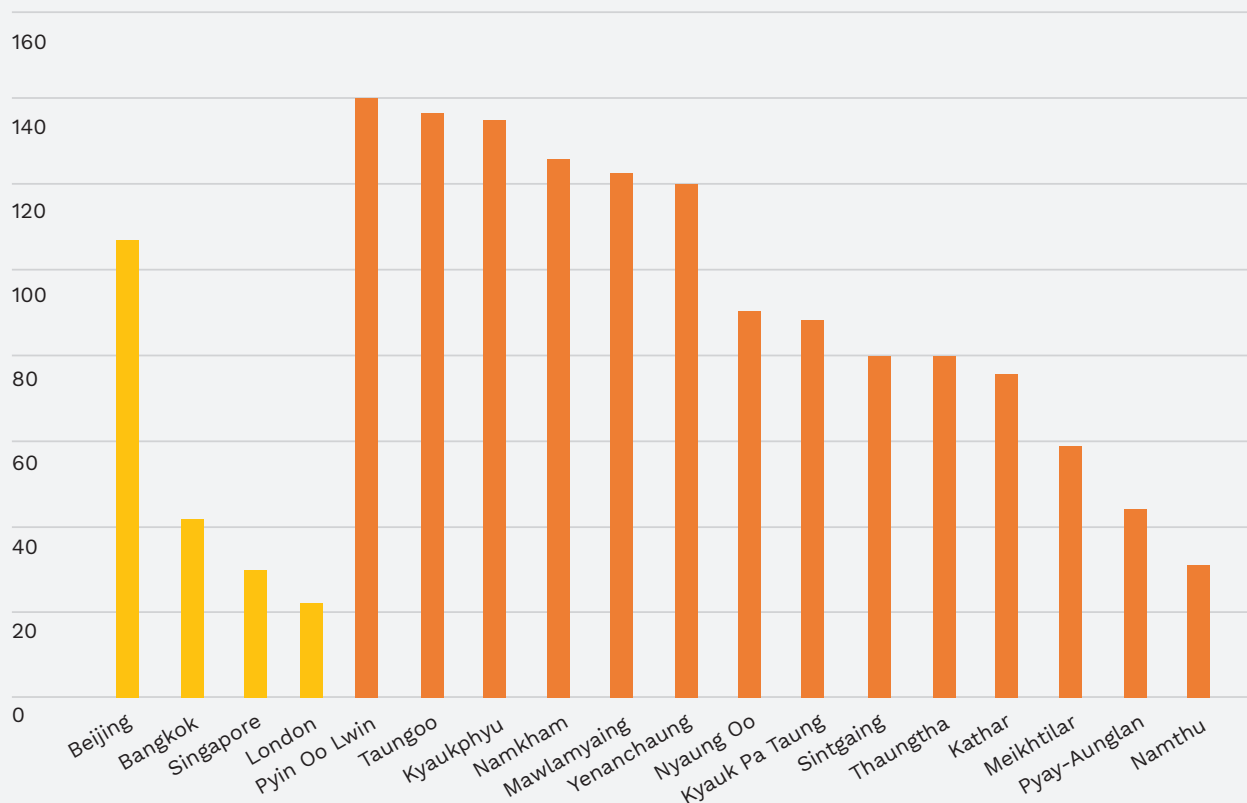


Figure 2. PM10 pollution levels in cities and towns in Myanmar, with some international cities included for comparison. Source: Ambient Air Pollution Database, WHO, May 2016.

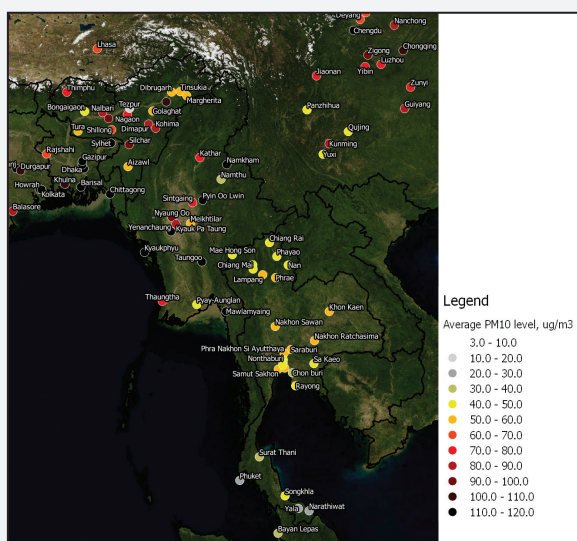


Figure 3: Map of urban PM10 pollution levels in cities with data in Myanmar and surrounding areas. Source: Ambient Air Pollution Database, WHO, May 2016.

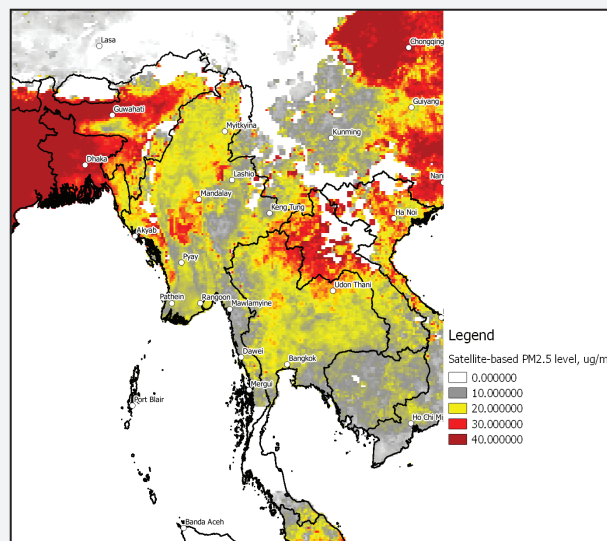


Figure 4. Average PM2.5 levels in Myanmar in 2015 ($\mu\text{g}/\text{m}^3$)⁴

⁴http://fizz.phys.dal.ca/~atmos/martin/?page_id=140

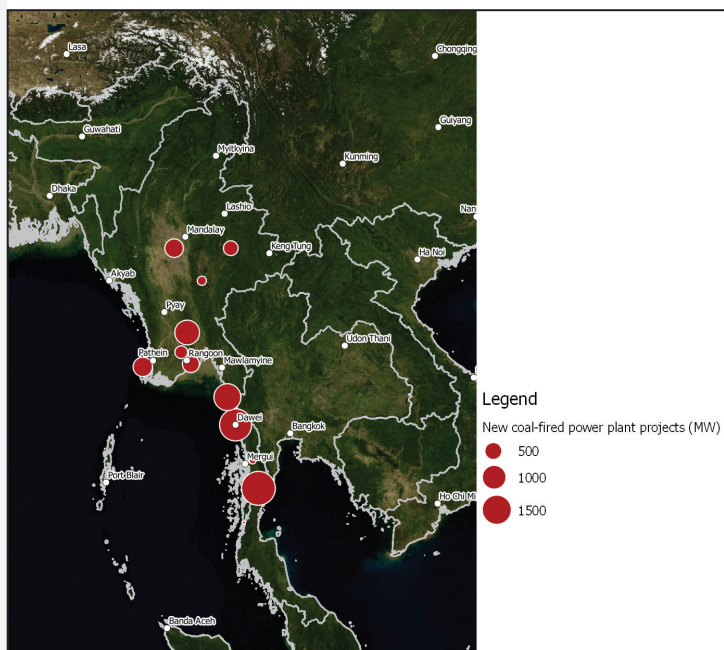


Figure 5: Coal-fired power plant projects included in the health impact analysis in this report.

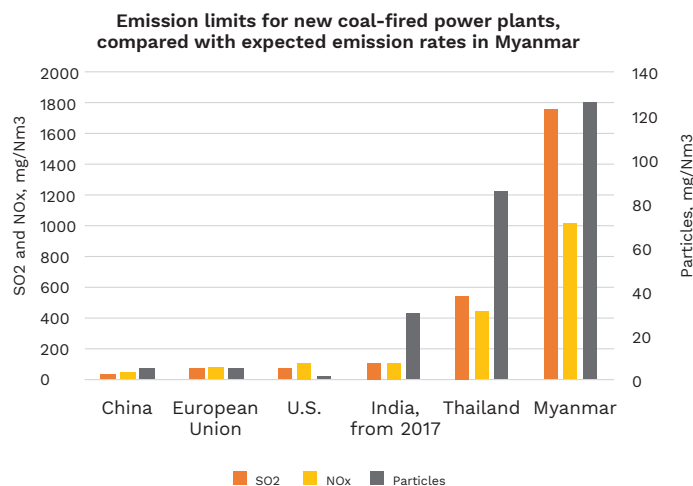


Figure 6: Projected emission rates from new coal-fired power plants in Myanmar compared with emission standards in other countries.

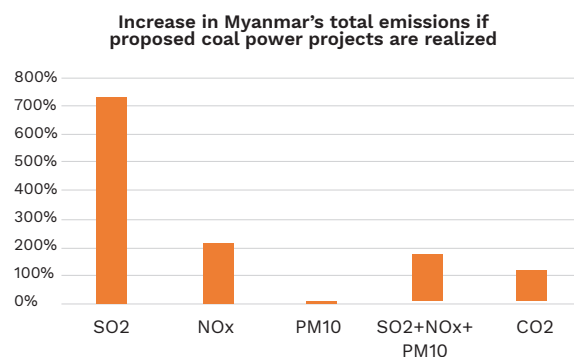


Figure 7

PLANNED COAL EXPANSION AND AIR POLLUTION EMISSIONS IN MYANMAR

Myanmar currently has only two small coal-fired power plants, the Kawthaung and Tigyit plants. However, the plans for expansion are massive, with a total of 10 projects with 8000MW of capacity identified for the health impact analysis presented in this report.

Myanmar is completely unprepared for this dramatic expansion – it is the only country in Asia with significant coal expansion plans that does not have any kinds of emission standards for coal-fired power plants, and therefore project developers are free to apply any standards

they like. As a result, air pollutant emissions from the planned projects are expected to around ten times higher than would be allowed e.g. in China and India.

The planned coal power projects would be projected to increase SO2 emissions from energy use in Myanmar 7-fold, and to triple NOx emissions. The impact on emissions of primary PM2.5 would be much smaller, around 10%, due to very high existing emissions from small-scale fuel use. The total emissions of the three key pollutants contributing to PM2.5 levels in the air – SO2, NOx and dust – would almost triple.⁵

RESULTS

The atmospheric modeling results show that planned coal-fired power plants in Myanmar would expose millions of people to elevated levels of toxic PM2.5 particles and ozone, increasing the risk of diseases such as stroke, heart attack and lung cancer, which are among the leading causes of death in Myanmar. As a result, the coal plants would be responsible for a projected 7,100 premature deaths per year (95%

confidence interval: (3,950-10,130), or a total of 280,000 over a 40-year operating life. Half of these deaths would occur in Myanmar, with the other half taking place in neighboring countries due to the very long range of the impacts. The most affected regions shown in Figures 8 and 9 below.

⁵ Current emission levels based on Kurokawa et al 2013: Emissions of air pollutants and greenhouse gases over Asian regions during 2000-2008: Regional Emission inventory in ASia (REAS) version 2, Atmos. Chem. Phys., 13, 11019-11058.

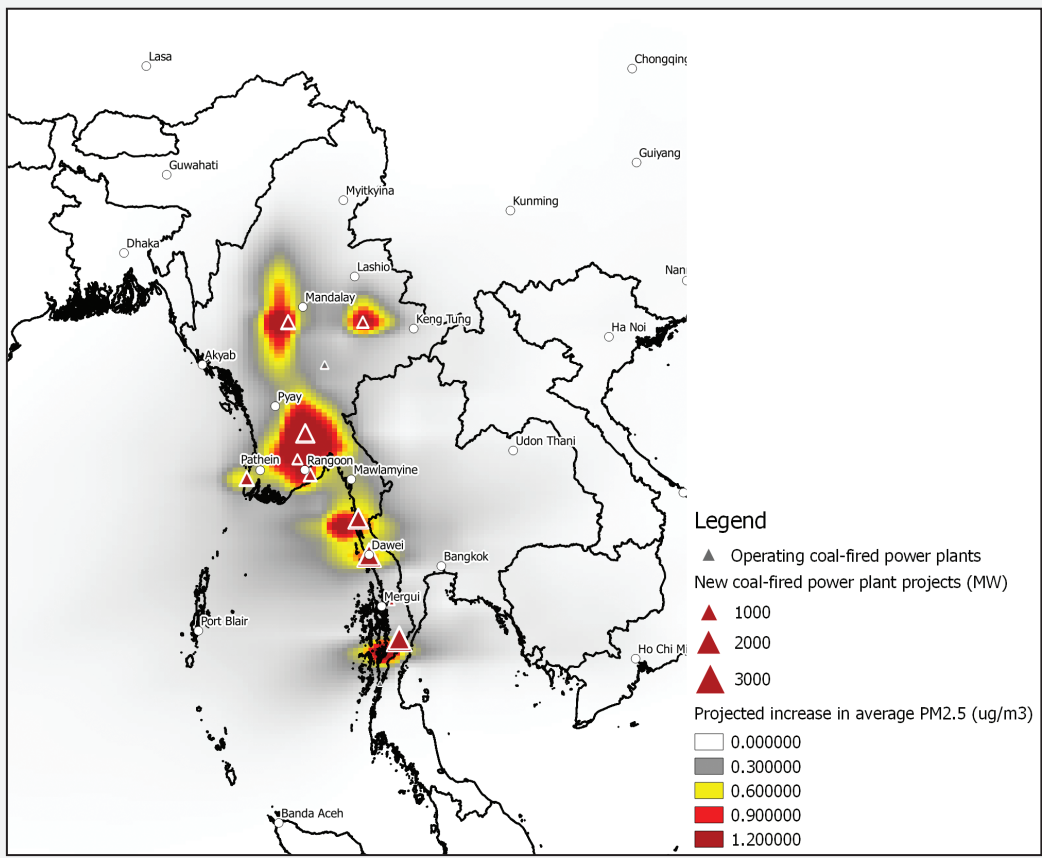


Figure 8: Projected increase in annual average PM2.5 levels if planned coal-fired power plants in Myanmar are built.

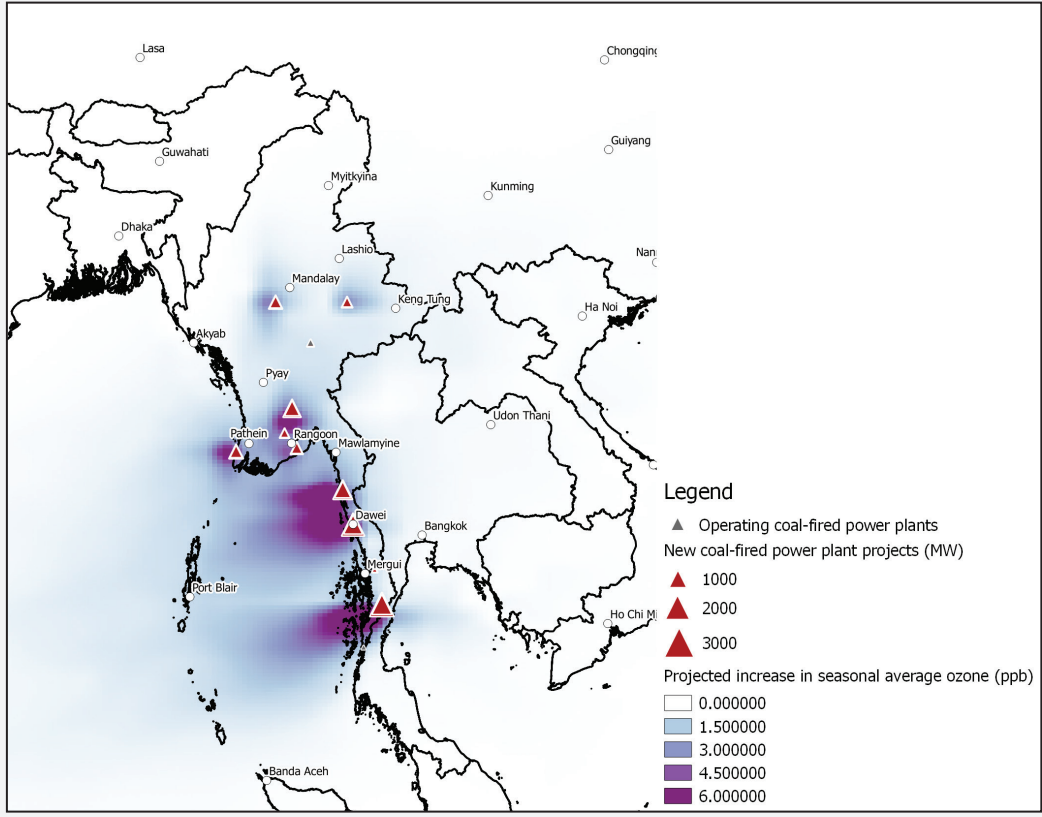


Figure 9: Projected increase in seasonal average ozone levels if planned coal-fired power plants in Myanmar are built.

POLLUTANT AND POPULATION SUBGROUP	CAUSE OF DEATH	PROJECTED FUTURE IMPACTS			
		WITHIN MYANMAR	95% confidence interval	TOTAL	95% confidence interval
PM2.5 exposure to adults	Stroke	870	(530-1200)	1500	(920-2080)
	Ischemic Heart Disease	1130	(730-1540)	2460	(1590-3330)
	Chronic Obstructive Pulmonary Disease	260	(160-360)	710	(430-980)
	Lung Cancer	190	(80-300)	390	(160-610)
	Other cardiovascular and respiratory diseases	340	(210-470)	570	(350-790)
	Total	3070	(1870-4310)	6060	(3700-8470)
PM2.5 exposure to children	Lower Respiratory Infections	50	(10-120)	80	(20-190)
Ozone exposure to adults	Respiratory diseases	430	(110-170)	1000	(250-1660)
Total		3500	(1980-5030)	7060	(3950-10130)

Table 1. Premature deaths NOTE THESE NUMBERS ARE STILL SUBJECT TO CHANGE

Subcritical	38%
Supercritical	41%
Ultrasupercritical	44%
IGCC	42%
No Data	38%

Table 2. Default thermal efficiencies for boiler types.

METHODOLOGY

EMISSION DATA

The study of the health impacts of coal-fired power plants requires information on the location, operation and emissions of the power plants. The emission data used for this study is based on a detailed listing of coal-fired power plants and their technical data. The basis for the listing is the Platts World Electric Power Plants database, complemented by a comprehensive mapping of new power plant projects, the CoalSwarm Global Coal Plant Tracker.

For new power plants, a capacity factor of 80%, representative of new power plants, was assumed. When no explicit data on thermal efficiency was available, the efficiencies given in Table 2 were used, depending on boiler type.

Flue gas volumes were estimated using European Environment Agency default factor for hard coal.

Power plant emission standards for dust are set in terms of total PM. The PM10 and PM2.5 fractions were estimated using US EPA AP-42 PM size distributions for different control technologies on the plant level, when information on technique was available from the Platts database. In other cases, an ESP was assumed.

Very little information on the emission limits set for new projects in Myanmar or emission controls planned to be installed was available. For the Dawei project, emission levels were based on a public announcement that Thailand's emission standards would be followed. For the other projects, an electrostatic precipitator was assumed to be installed, but no dedicated SO₂ or NO_x controls. The emission levels were based on U.S. EPA AP-42 default performance values for such a configuration.

ATMOSPHERIC MODELING

Atmospheric modeling was carried out by the research group of professor Daniel Jacobs at Harvard University. The group used the GEOS-Chem global model of atmospheric composition (www.geos-chem.org) to quantify the surface air concentrations of particulate matter (PM) and ozone resulting from present and future scenarios of coal-fired power plant emissions. GEOS-Chem is a widely used, open-source tool for modeling atmospheric composition on global and regional scales. It describes the transport and chemical evolution of species in the atmosphere and thus serves to relate emissions from specific sources to receptor concentrations.

Professor Jacob's group at Harvard has considerable experience and credentials in global/regional modeling of atmospheric composition for air quality and climate applications. Jacob leads the GEOS-Chem modeling community of over 100 research groups worldwide. The GEOS-Chem model is centrally managed at Harvard by Jacob's group.

The model is first run with all air pollution emissions from different sources included. These baseline emissions are taken from the Emissions Database for Global Atmospheric Research (EDGAR) v4.2 inventory (<http://edgar.jrc.ec.europa.eu>). Then the emissions from the operating coal-fired power plants are eliminated, and the model is run again. The difference in pollution levels in the results of these two model runs is the share of pollution attributable to coal-fired power plants. To estimate air quality impacts of proposed new power plants, the emissions from these plants are added to the total current emissions from all sources, and the model is run with this new emission inventory.

Risk ratio for 10µg/m ³ increase in PM _{2.5} exposure	95% CI,		95% CI,	
	Central	Low	High	Reference
Cardiopulmonary diseases	1.128	1.077	1.182	Krewski et al 2009
Ischemic heart disease	1.287	1.177	1.407	Krewski et al 2009
Lung cancer	1.142	1.057	1.234	Krewski et al 2009
Children's lower respiratory infections	1.12	1.03	1.30	Mehta et al 2011

Table 3. Concentration-response relationships for PM_{2.5} health impact assessment⁷

Risk ratio for 10ppb increase in ozone exposure (November-April average)	95% CI,		95% CI,	
	Central	Low	High	Reference
Respiratory diseases	1.04	1.01	1.067	Jerrett et al 2009

Table 4. Concentration-response relationships for ozone health impact assessment.

HEALTH IMPACTS

The assessment of health impacts from the coal-fired power plants is based on the findings of the largest study ever carried out on the chronic health impacts of air pollution, the American Cancer Society study that tracked the medical histories and residence records of 1.2 million Americans for 18 years, and showed significant differences in the health risks between cities with different pollution levels⁶. To estimate the premature deaths due to coal-related PM_{2.5}, we follow the methods for estimating cause-specific mortality associated with changes in PM_{2.5} concentrations outlined in For each cause of premature death considered (cardiopulmonary disease, ischemic heart disease, lung cancer, and stroke), premature mortality was calculated for each 0.5° x 0.666° gridsquare as a function of the national baseline mortality rate, the cause-specific concentration response function (from Krewski et al., 2009), and the change in PM_{2.5} simulated by GEOS-Chem (Figure 2). Baseline mortality rates for each country were acquired from the Global Burden of Disease 2010 study.

We also estimate the premature mortality due to coal-related ozone. For these calculations, we follow Anenberg et al. (2010) but allow the

seasonal averaging window to vary based on the season of peak ozone exposure (April-September for above 30° N; November-April for below 30° N). Anenberg et al. calculate health outcomes from absolute ozone concentrations, which are highest in the northern mid-latitudes where the April-September window is appropriate. Here we focus on ozone changes occurring largely in Southeast Asia, and therefore allow for variability in the exposure averaging window in order to account for the wide latitudinal range of countries included in our domain.

Southeast Asian populations are becoming more susceptible to the health impacts of air pollution due to aging, lifestyle changes, urbanization, and improvements in health care. For projections of future health impacts, the results take into account projected population growth and change in rates of death from different causes, based on WHO Global Burden of Disease for 2030⁸. World Bank projections of urbanization are used to take into account the change in geographical distribution of population⁹.

⁶ Krewski et al 2009: Evaluating the Effects of Ambient Air Pollution on Life Expectancy. *New England Journal of Medicine*, 2009; Vol. 360, pp 413-415.

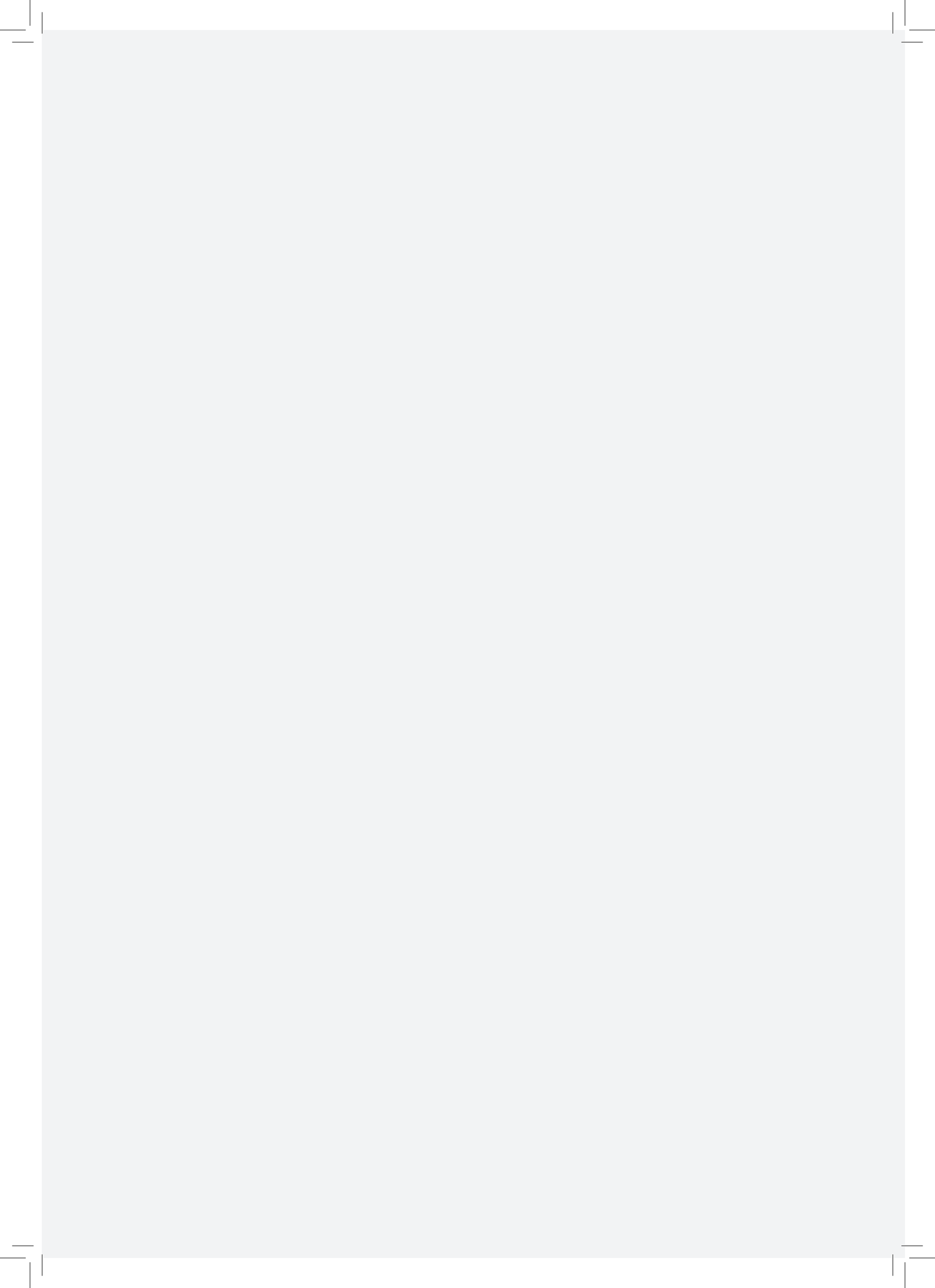
⁷ Krewski D et al 2009: Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. HEI Research Report 140. Health Effects Institute, Boston, MA.

Mehta S et al 2011: Ambient particulate air pollution and acute lower respiratory infections: a systematic review and implications for estimating the global burden of disease. *Air Quality, Atmosphere & Health*. 6(1): 69–83.

Jerrett M, Burnett RT, Pope CA III, et al. Long-term ozone exposure and mortality. *N Engl J Med* 2009;360:1085-95.

⁸ http://www.who.int/healthinfo/global_burden_disease/projections/en/

⁹ World Bank Health Nutrition and Population Statistics: Population estimates and projections data. <http://databank.worldbank.org/data/reports.aspx?source=Health%20Nutrition%20and%20Population%20Statistics:%20Population%20estimates%20and%20projections>



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