Bottom-up Inventory of Air Pollutants Emissions from Power Generation in Thailand

Pham Thi Bich Thao[1], Agapol Junpen[1], Penwadee Cheewapongphan[1], Thanonphat Boonman[1], Savitri Garivait[1*], Satoru Chatani[2], Kazunori Kojima[3]

[1]The Joint Graduate School of Energy and Environment (JGSEE), King Mongkut's University of Technology Thonburi, and Center of Excellence on Energy Technology and Environment (CEE), S&T Post Graduate Education and Research Development Office (PERDO), Commission on Higher Education, Thailand
[2]Environment & Energy Lab., Toyota Central R&D Labs., Inc., Japan
[3]Energy Affairs Department, Toyota Motor Corporation, Japan
*Corresponding Author: savitri_g@jgsee.kmutt.ac.th

ABSTRACT

To support the fast growing economic development, Thailand's energy consumption has rapidly increased during the last two decades, which led to 198 million tons of carbon dioxide (CO_2), representing about 70% of the total national greenhouse gas emissions in 2011. Among all energy related emission sources of CO_2, power generation constitutes the top emitter with more than 40% of the total. However, a national detailed emission inventory in this sector, which appropriately supports air quality management and planning, is still very scarce. In this study, we developed a bottom-up inventory of emissions from power generation in Thailand in 2010. Pollutants of interest include NO_x, SO_2, CO_2, CO, NMVOC, NH_3, CH_4 N_2O, PM_{10}, $PM_{2.5}$. Activity data were collected from official statistics and reports. Energy conversion and emission control technologies in use data were gathered by plant survey in order to appropriately select emission factors. The preliminary overall results showed that in 2010 the power generation in Thailand emitted 92.0 Gg of NO_x, 57.5 Gg of SO_2 , 6.3 Gg of NMVOC, 20.9 Gg of CO, 30.3 Gg of PM_{10}, and 18.7 Gg of $PM_{2.5}$, 50.2 Gg CH_4, 0.8 N_2O, and 87.6 CO_2. Emissions were then analyzed vs. fuel consumption, energy conversion technology, and emission control technology. For all investigated pollutants, the results are displayed in the form of 10 km x 10 km gridded map to enable a visualization of spatial distribution of the emissions, and a direct use for air quality modeling. Finally, a comparison to regional and global inventories such as REAS and IIASA_GAINS is presented and discussed.

METHODOLOGY

Emission Estimation following GAINS approach (Amann, 2008)

$$E_{i,p} = \sum_{k}\sum_{m} A_{i,k}\, ef_{i,k,m,p}\, X_{i,k,m,p}$$

Where,

- *i, k, m, p*: Country *i* , activity type *k*, abatement measure *m* , pollutant *p*
- $Ei_{,p}$: Emissions of pollutant *p* in country *i*
- $A_{i,k}$: Activity level of type *k* in country *i*
- $ef_{i,k,m,p}$: Emission factor of pollutant *p* for activity level of type *k* in country *i* after application of control measure *m*
- $X_{i,k,m,p}$: Share of total activity of type *k* in country *i* to which a control measure *m* for pollutant *p* is applied

Table 1. Information Used for Emissions Estimation

Information	Description	Sources
Activity Data	**Fuel Consumption for Whole Country**	**(DEDE, 2011)**
	Plant's Characteristic (Commission Year, Capacity, Fuel Type, Control Technology, and Province)	**(EGAT, 2012 and EPPO, 2011)**
	Boiler Type & Control Technology	**EIA Database (ONEP, 2012)**
Emissions Factor	**Uncontrolled EFs**	**JULY2013 (IIASA, 2013)**
	Control Efficiency	**JULY2013 (IIASA, 2013)**

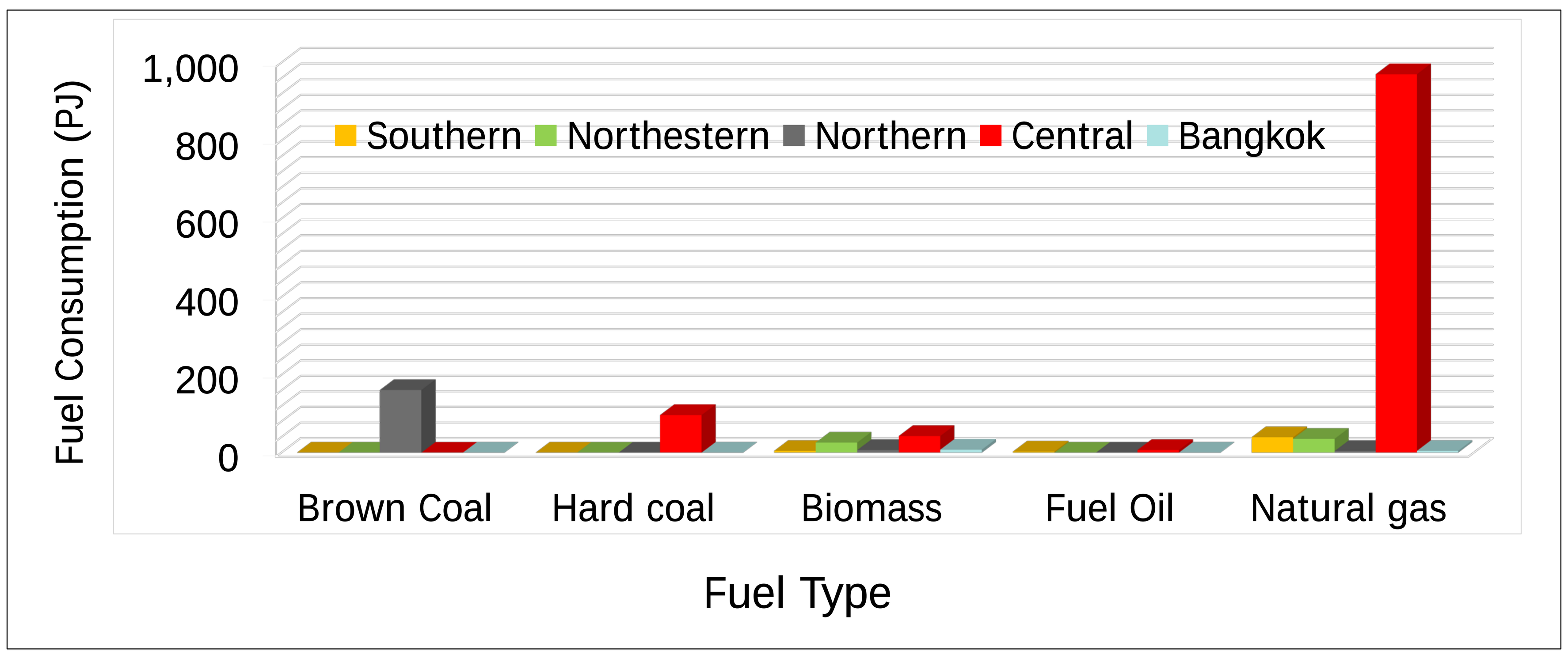


Figure 1. Fuel Consumption for Thermal Power Plant in Thailand

Fuels used in thermal power plants in Thailand include brown coal (i.e., lignite), hard coal (i.e., sub-bituminous), biomass, fuel oil, and natural gas. Among regions, power plants located in the Central region shared largest fuel consumption, followed by Northern region. Among fuel, the use of natural gas was dominant in Thailand, followed by brown coal and hard coal.

RESULT and DISCUSSIONS

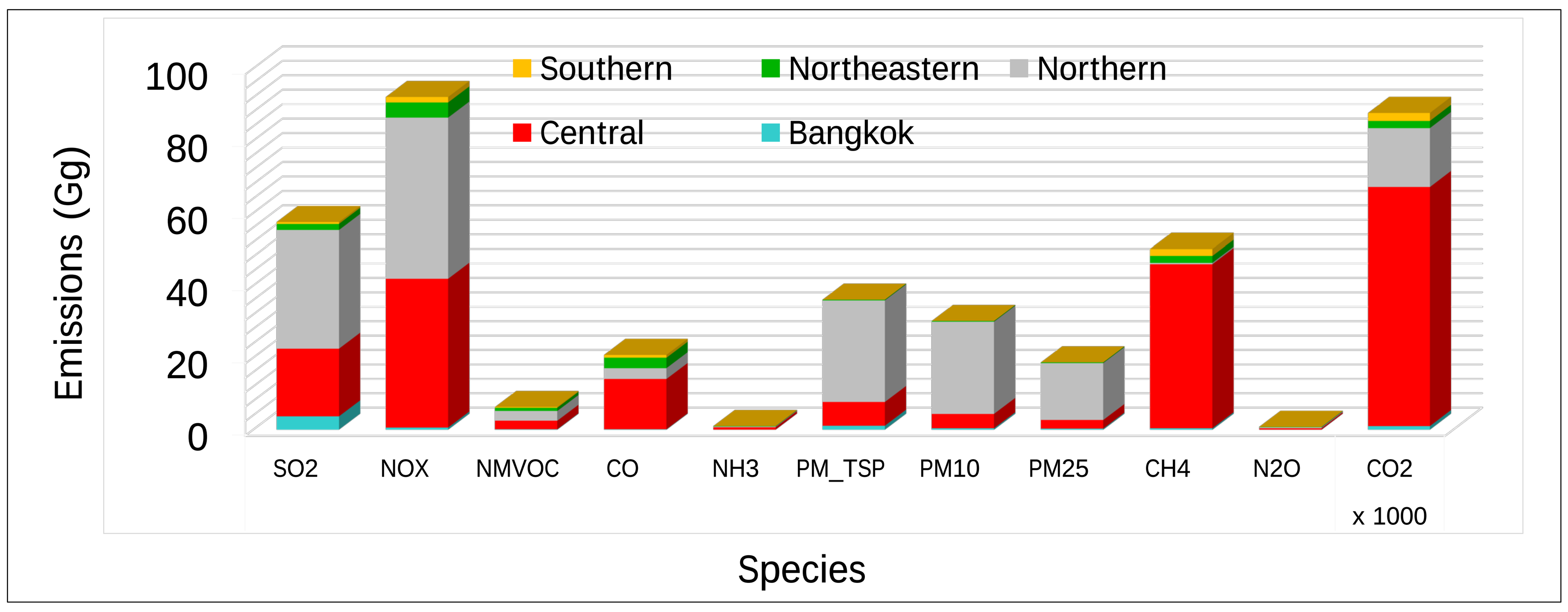
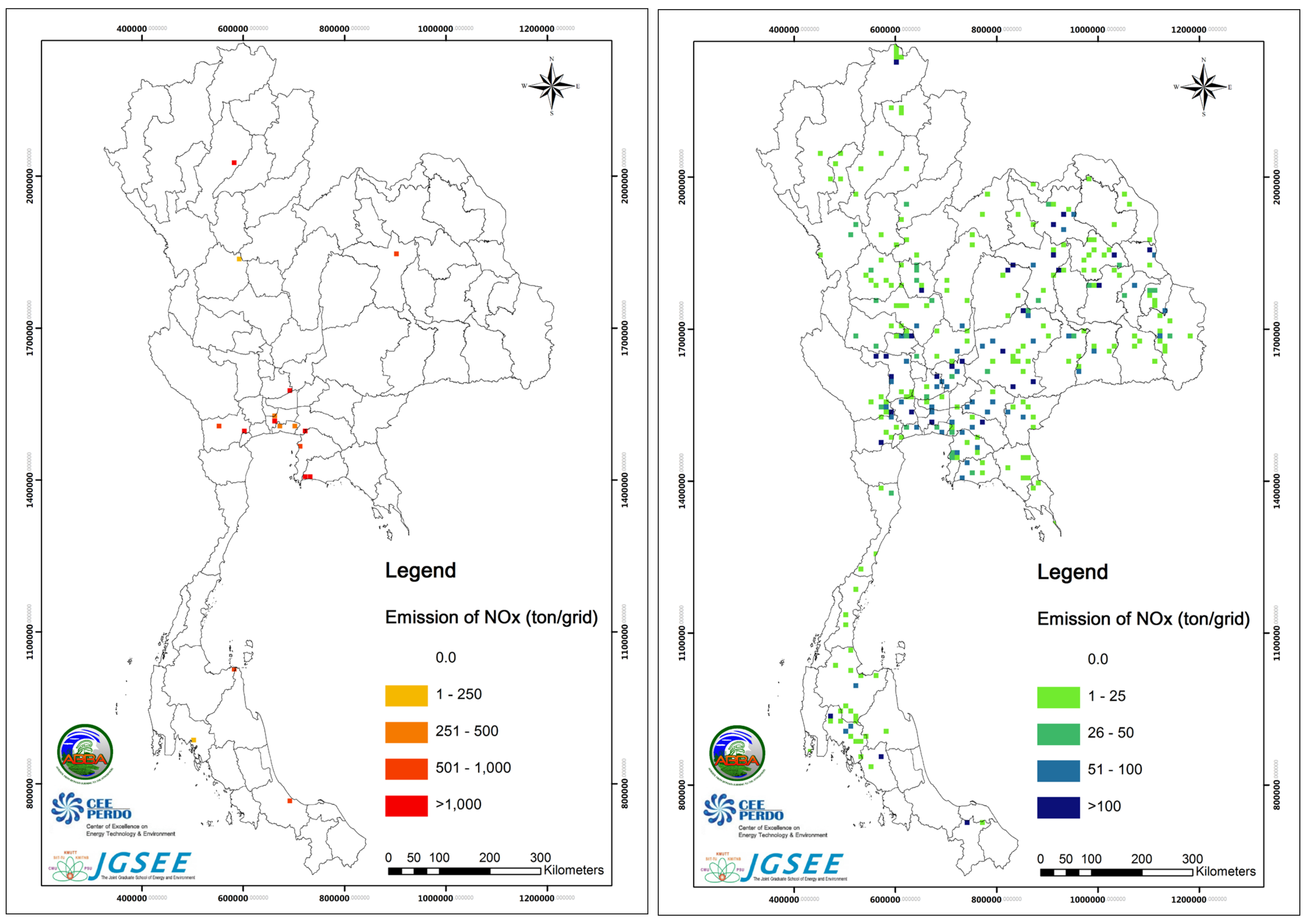


Figure 2. Emissions from Thermal Power Plants by Region

In 2010, thermal power plants in Thailand emitted 92.0 Gg of NO_x, 57.5 Gg of SO_2 , 6.3 Gg of NMVOC, 20.9 Gg of CO, 30.3 Gg of PM_{10}, and 18.7 Gg of $PM_{2.5}$, 50.2 Gg CH_4, 0.8 N_2O, and 87.6 CO_2 (Figure 2). For CO, CH_4 and CO_2, the Central region had the largest share of the total emissions. while for SO_2, NO_X, PM_TSP, PM_{10} and $PM_{2.5}$, the Northern region represented the top contributor.



(a) Large power plants **(b) SPP and VSPP**

Figure 3. Spatial Distribution of NO_X Emission from Thermal Power Plants

From Figure 3, the high NO_x emissions from thermal power plants are found in the Central, and Northern regions resulted from SPP and VSPP. Despite the presence of only one large plant using brown coal and pulverized firing technology in the North of the country, the contribution of this region in NO_x emission is the highest (Figure 2 vs. Figure 3).

Table 2. Comparison of Emissions in This Study with Other Emissions Databases

	Emissions (Gg)			Ratio		
	REAS (2008)	IIASA (2010)	This work (2010)	This study/IIASA	This study/REAS	IIASA/REAS
SO_2	345.7	247.8	57.5	**0.23**	**0.17**	0.72
NO_X	199.9	125.5	92.0	**0.73**	**0.46**	0.63
NMVOC	66.3	5.0	6.3	**1.27**	**0.09**	0.07
CO	369.8	44.4	20.9	**0.47**	**0.06**	0.12
NH_3	5.9	0.5	1.1	**2.26**	**0.19**	0.09
PM_TSP	-	98.8	36.2	**0.37**	**-**	-
PM_{10}	213.7	46.5	30.3	**0.65**	**0.14**	0.22
$PM_{2.5}$	63.0	18.8	18.7	**1.00**	**0.30**	0.30
CH_4	17.2	50.2	50.2	**1.00**	**2.92**	2.92
N_2O	1.7	1.1	0.8	**0.73**	**0.47**	0.65
CO_2 (x1000)	87.0	90.7	87.6	**0.97**	**1.01**	1.04

It was found that for SO_2, NO_X, CO, PM_TSP and PM10, our estimates are much lower than those provided in IIASA and REAS. This can be explained by the difference in the efficiency of control technology accounted in IIASA and REAS compared to the country-specific data obtained from plant surveys on control technology: the efficiency of control technology currently in use in Thailand is higher than what was assumed in IIASA and REAS.

CONCLUSIONS

This work constitutes the first bottom-up inventory of air pollutants emissions from electricity generation in Thailand. The use of country-specific data of activity and control technology enabled to improve the accuracy of the estimate up to 50% comparatively to those provided in global or regional emission inventories. These latter captured well the emissions of compounds, for which none control technology is applied. Fuel type and control technology playing an important role on the composition and intensity of the emissions, it is recommended for future study to document in details the type of fuel used in SPP and VSPP, as well as the efficiency of the control technology applied to these groups of thermal power plants., especially those related to the use of biomass as fuel since it represents the major resource of the country.

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