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PHITSANULOK MUNICIPALITY

inaugural greenhouse gas emissions annual inventory report 2012/13

Acknowledgements

Low carbon city and city-level GHG inventory development is an extensive exercise involving many persons and stakeholders within the local government, as well as non-government stakeholders such as the private sector.

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If available, additional data and revised materials will be shared online at the project webpage hosted by APN:

http://www.apn-gcr.org/resources/items/show/1913

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Cover Photo: Aerial view of Phitsanulok City (Credit of Facebook-เพจมุมสูงพิษณุโลก Mumsung Phitsanulok)

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Foreword by Mayor of Phitsanulok Municipality

Dear friends,

Climate change is now one of the most pressing challenges confronting humanity. Global warming is already advancing steadily, with predicted long-lasting, and potentially irreversible negative impacts on the quality of life for current and future generations. Hence, urgent and meaningful actions are required by all members of the global community.

With widespread acknowledgement that roughly two-thirds of global greenhouse gas (GHG) emissions from anthropogenic sources may be attributed to the activities in cities and urban areas, **local governments are critical actors in mitigating climate change in cities**. Local governments are well-positioned engage consumers (citizens) directly to mobilise actions based on policies set by national governments. In addition, they also wield a significant degree of influence over several high-emission sectors such as buildings, transport, waste management and others.

Phitsanulok Municipality, Thailand, views itself as a progressive, responsible municipality which is actively engaged in global issues. Through decades of dedicated efforts by our staff and the support of many partners, Phitsanulok Municipality has gained recognition nationally, regionally and globally for our outstanding practices and policies, especially in health management and urban environmental management. Yet, we are not complacent; we believe Phitsanulok Municipality is now ready to contribute to addressing the global challenge of climate change. For that, we have taken a critical first step – establishing the baseline of GHG emissions within our municipality and city, taking into account various emerging global and national standards.

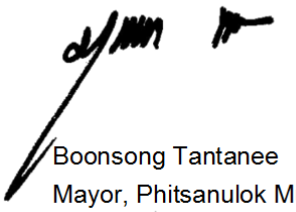
On behalf of Phitsanulok Municipality, it is with great honour and pride that I unveil to you the inaugural publication of Phitsanulok Municipality GHG Emissions Annual Inventory, drawing from data collected by our Low Carbon Municipality Project Committee in 2012 and 2013. This is the product of over one year of hard, dedicated teamwork by our staff, supported by the Institute for Global Environmental Strategies (IGES) and related partners, whom we highly appreciate. It has not been easy as the data collection has been an extensive exercise involving many persons and stakeholders within our municipality teams, various government agencies, as well as non-government stakeholders such as the private sector. Nevertheless, with our creativity and 'can-do' spirit, we

managed to overcome many challenges in producing this publication, earning our place in the small pioneering group of cities, both in this region and worldwide, which have managed to develop local GHG inventories.

I hope that this initiative will provide a crucial foundation for future research work and practical projects relating to sustainable, green, low-carbon city development in Phitsanulok City. In addition, it is hoped that this publication will be helpful to researchers, policymakers and other supporting stakeholders involved in city-level GHG-accounting and MRV.

Finally, we realise that pioneers do not work alone. Together, we can achieve more. Phitsanulok Municipality is eagerly looking forward to work with more and more partners to enhance our existing approaches in GHG Inventory management and low-carbon city project implementation towards being a 'model' for ASEAN and the region.

Yours faithfully,



Boonsong Tantanee
Mayor, Phitsanulok Municipality
Thailand

Executive Summary

Background

In 2011, Phitsanulok City was selected by the national government to be one of Thailand's first batch of 'Model Cities' under the ASEAN ESC[1] Model Cities Programme, which is jointly managed by the ASEAN Secretariat and IGES. In 2012, the programme issued a Call of Interest to recruit candidate ASEAN cities as collaborators in a proposed capacity building project to develop a model framework for 'Measuring/Monitoring, Reporting and Verification' (MRV) of city-level greenhouse gas emissions, to be funded by APN (Asia-Pacific Network for Global Change Research) .

With more than a decade's experience in international cooperation activities and a desire to raise its capacity and profile as a 'Model' city, Phitsanulok City responded to IGES' Call of Interest and was accepted as a collaborator. Subsequently, APN granted funding to the proposed capacity building project, which was implemented by Phitsanulok City from May 2013 – July 2014 in cooperation with IGES.

The project had three main objectives:

i. Raise the capacity of local government officers to implement a MRV framework to account for municipal and city-level GHG emissions;
ii. Through objective (i), establish a baseline municipal/city-level GHG Inventory and feasible institutional arrangements for inventory maintenance and enhancement;
iii. Understand the institutional, administrative and other practical issues (e.g. efficacy of the guidance provided on reporting protocols, how to organise and assign data collection duties among municipal staff, as well as incentives for such initiatives etc.) of municipal and city-level GHG inventory in the context of Thailand and developing countries.

This publication is one of the key tangible outputs from the project.

Methodology

This report presents **two sets of inter-related data** and referred to the following standards/frameworks for both municipal- and city-level GHG inventory development:

- For *municipal-level inventory*
  - **'ICLEI (Local Governments for Sustainability) Local Government Operations Protocol for the Quantification and Reporting of GHG Inventories'** (Version 1.1; May 2010); and
  - **Guidelines on Municipal Carbon Footprint** developed by the Thailand Greenhouse Gas Management Organization (TGO).
- For *city-level inventory*:

[1] 'Environmentally Sustainable Cities' (ESC). This is the term adopted by the ASEAN Working Group on ESC (AWGESC), which was established in 2003 and is mandated by ASEAN Environment Ministers to develop a guiding framework for sustainable cities which accommodates the varied circumstances among ASEAN cities, as well as strategies to address related challenges.

GPC Pilot Version 1.0 (http://www.ghgprotocol.org/city-accounting);

Primary and secondary data were collected by the Phitsanulok City staff, which were reviewed by IGES as well as a 3rd party expert (an independent local consultant who has worked closely with Phitsanulok City for over 10 years on international projects). The data reported for municipal-level GHG inventory covered activities in calendar year[2] 2013, while the data for city-level GHG inventory covered activities in calendar year 2012. **Unless stated otherwise, all activity data reported are sourced from the staff of Phitsanulok City.**

Besides the key activity data required for the GHG emissions inventory report, this report also documents Phitsanulok City's ongoing and upcoming efforts to make the city greener, more energy-efficient and low carbon, towards being a socially, economically and environmentally sustainable city. These initiatives have an influence on GHG emissions in the city and it is hoped that the municipality will develop greater capacity to account for project-level GHG mitigation in the future.

All calculations presented in this report are based on best available data collected by Phitsanulok City staff and IGES researchers as of 23 July 2014. While every effort has been made to ensure data accuracy and completeness, the possibility for error exists as this is the first attempt of Phitsanulok Municipality at developing a municipal and city-level GHG inventory report.

This report does not intend to **present a flawless accounting of Phitsanulok City's GHG emissions**, Rather, it is to provide a basis for: (i) informing low-carbon city policy decisions; (ii) designing future low-carbon city projects (especially in cooperation with international supporting organisations); and (iii) developing future research work. Where data reported has not reached an acceptable level of completeness and accuracy, the assumptions made and data sources are explained to enable those who are interested to assist Phitsanulok Municipality develop its future annual GHG inventory emissions reports with higher quality and accuracy.

Researchers may be interested to refer to:

- Appendix A: A detailed explanation of the data collection process and methodology
- Appendix B: Full table of FY2013 Municipal GHG Emissions
- The excel spreadsheet and research notes for calculating GHG emissions, accessible online at the APN project page (http://www.apn-gcr.org/resources/items/show/1913).

Municipal GHG Emissions

In 2013, the municipal operations of Phitsanulok City emitted approximately **25,149** tCO_2e of GHG.

The main sectors of emissions were: **Solid Waste Facilities** (15,067 tCO_2e), **Water Supply** (4,876 tCO_2e), **Buildings & Other Facilities** (excluding solid waste and water supply facilities) (1,979 tCO_2e) and **Streetlights & Traffic Signals** (1,483 tCO_2e) and **Vehicle Fleet** (1,440 tCO_2e). (Table 1 and Figure 1).

[2] 'Calendar year' refers to the period of January to December. The fiscal year in Thailand begins in October.

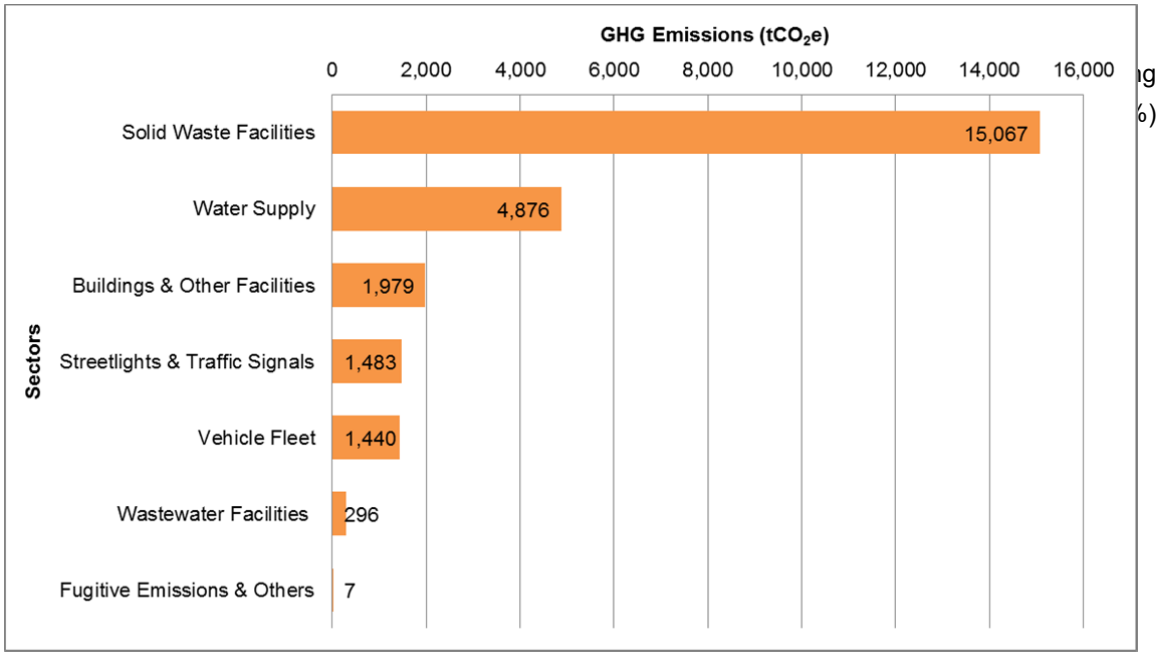


Figure 1:
Phitsanulok City's Municipal GHG Emissions by Sector (2013)

[3] GHG accounting protocol require reporting of emissions according to separated 'scopes' to enable 'double-counted' activities in aggregated data. For example, Scope 2 emissions (purchased electricity) reported by the local government are also reported as Scope 1 emissions by the utility company located outside the city's boundary. Hence, it is recognized that Scope 2 emissions will always be accounted for as Scope 1 emissions by another entity. Reporting emissions by Scopes helps ensure that local governments create a comprehensive emissions profile that reflects the decisions and activities of their operations. Though it is not always the case, local governments may exercise more control over Scope 1 emissions (direct emissions occurring within the city's boundary) compared to Scope 2 and 3 emissions.

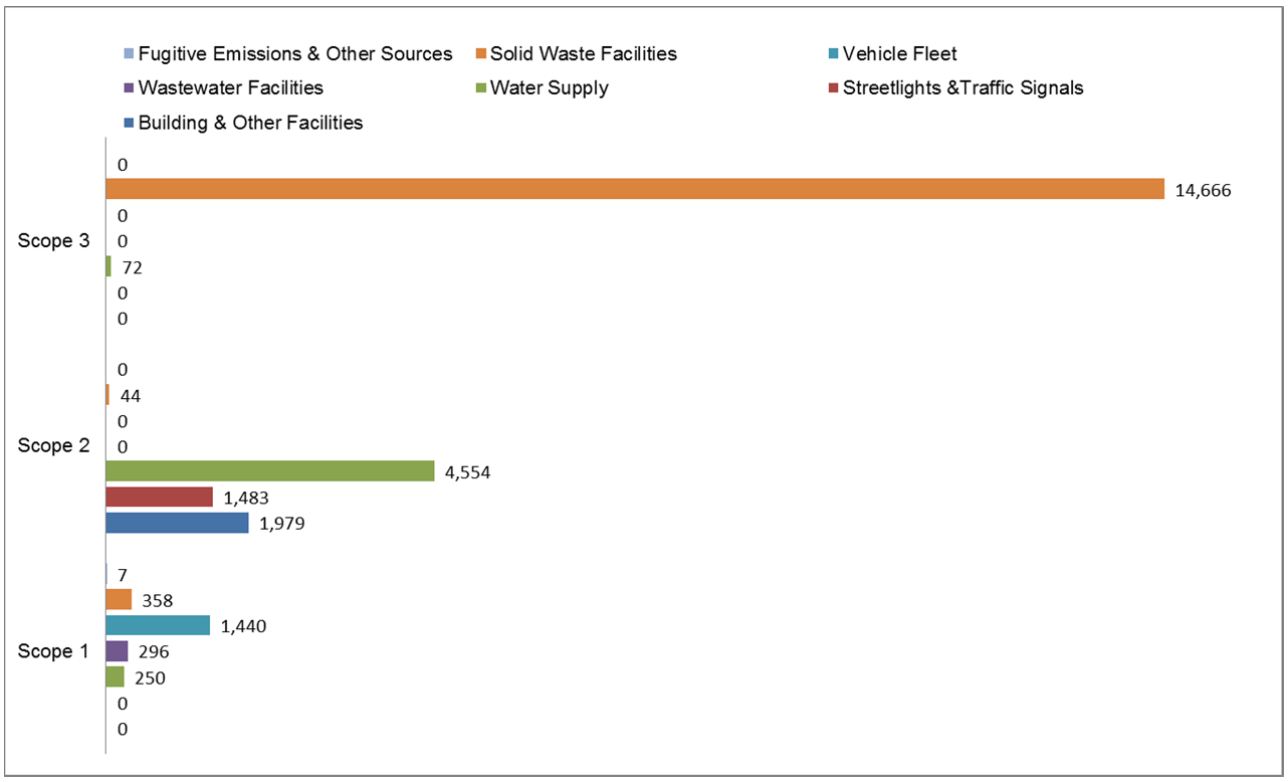


Figure 2:
Phitsanulok City's Municipal GHG Emissions by Scope (2013)

Table 1: Summary of Phitsanulok City's Municipal GHG Emissions (FY2013) (Local Government Operations Protocol for the Quantification and Reporting of GHG Inventories)

Scope	Sector	Amount	Units	Emissions (tCO_2e)
Buildings and Other Facilities				
1	*Stationary Combustion*			
2	Purchased Electricity for Municipal Buildings (excluding water supply and waste management facilities)	3,528,319	kWh	1,979
Streetlights and Traffic Signals				
2	Purchased Electricity	2,643,371	kWh	1,483
Water Supply				
1	*Stationary Combustion*			
2	Purchased Electricity	8,117,072	kWh	4,554
1	Tap Water Treatment (City's own consumption)	9,483,132	m^3	250
3	Tap Water Treatment (Other cities' consumption)	2,719,198	m^3	72
Wastewater Facilities				
1	Septic systems with no treatment, direct discharge	9,483,132	m^3	296
Port Facilities				
Airport Facilities				
Vehicle Fleet				
1	Mobile Combustion			
	- Diesel	495,177	L	1,359
	- Gasoline	3,873	L	8
	- Gasohol	31,376	L	69
	- CNG	77,161	Cu. Ft.	4
2	*Purchased Electricity*			
3	*Employee Commute*			
Power Generation Facilities				
Solid Waste Facilities				
1	*Stationary Combustion*			
1	Composting (at-source)	1,890,000	kg	358
2	Purchased Electricity	77,615	kWh	44
3	Landfilled Waste	26,522,257	kg	14,666
Fugitive Emissions & Others				
1	Fertiliser Use	4,440	kg	4
	N (assume 15% of weight)	666	kg	2
	P (assume 15% of weight)	666	kg	1
	K (assume 15% of weight)	666	kg	0
1	*Refrigerants - Buildings*			
1	*Refrigerants - Vehicles*			
	TOTAL			**25,149**

Note: Items indicated in red are GHG emission sources not covered by in this report due to the unavailability of reliable data or were deemed as not applicable in Phitsanulok City's situation.

Community/City GHG Emissions

The City managed to gather baseline data for 2012 for most sectors required under the GPC protocol. However, it was difficult to obtain reasonably complete and high-quality data for calculating emissions from 'Mobile-Energy' (transport) sector, given the lack of GHG accounting experience/skills as well as the short project timeframe.

For example, the GHG protocol requires the City to differentiate transport patterns according to trips made within the city's boundary and across the city's boundary. This requires a high level of technical capacity, such as traffic modeling, which is beyond the capability of IGES and City's staff.

Although all data could not be collected, useful baseline data and lessons were gained from the attempts at data collection which would inform future endeavours by Phitsanulok City as well as other local governments.

Table 2 below shows a summary of the data that were collected in this report. By referring to this table, the City and supporting stakeholders may identify means of improving and expanding the data available. Items indicated in red are data which were not collected or not applicable in the case of Phitsanulok City.

Table 2: Summary of Data Collected by Phitsanulok City On Citywide GHG Emissions (GHG Protocol Pilot Version 1.0)

Scope	GHG Emissions Sources	Remarks (Data Availability and Recommendations for Future Studies)
	I.) Stationary Units	
	I.1) Residential Buildings	• Electricity sales data was requested from the Provincial Electricity Authority (PEA) (regional utility company).This data needs to be further verified as PEA had difficulties extracting data for buildings only within Phitsanulok City's boundaries. • The 'user categories' in PEA's data do not match the categories under the GHG protocol and needs to be re-interpreted. • Shops/outlets/factories selling LPG (used for cooking in homes and restaurants) were identified and some sales data were sampled. The quality of this data needs to be improved.
1	I.1.1) Direct Emissions (Scope 1)	
2	I.1.2) Indirect Emissions	
	I.2) Commercial/Institutional Facilities	
1	I.2.1) Direct Emissions (Scope 1)	
2	I.2.2) Energy Indirect Emissions (Scope 2)	
	I.3) Energy Generation	
1	I.3.1) Direct Emissions (Scope 1)	
2	I.3.2) Energy Indirect Emissions (Scope 2)	
	I.4) Industrial Energy Use	
1	I.4.1) Direct Emissions (Scope 1)	
2	I.4.2) Energy Indirect Emissions (Scope 2)	
	I.5) Fugitive Emissions	
1	*I.5.1) Direction Emissions (Scope 1)*	

	II.) Mobile Units	
	II.1) On-Road Transportation	
1	II.1.1) Direct Emissions (Scope 1)	• Petrol sales data from 2 out of 8 petrol stations in the city were collected. This data could be helpful as indicative data for estimating total fuel consumption for on-road traffic. • Future studies may focus on gathering quality data on cross-boundary (inter-city) on-road traffic patterns, which is likely a significant portion of on-road traffic because the City hosts the regional bus terminal.
2	II.1.2) Energy Indirect Emissions (Scope 2)	
3	II.1.3) Indirect Emissions from Transboundary On-road Inter-City or International Transportation Trips that Originate and/or Complete their Journey Within the Community	
	II.2) Railways	
1	II.2.1) Direct Emissions (Scope 1)	• Data on the frequency of rail trips, trip length and average fuel consumption were estimated with assistance of the Railway Authority. This data needs to be verified in future studies.
2	II.2.2) Energy Indirect Emissions (Scope 2)	
3	II.2.3) Indirect Emissions from Transboundary Inter-City or International Railway Trips that Originate and/or Complete their Journey Within the Community	
	II.3) Water-Borne Navigation	
1	II.3.1) Direct Emissions (Scope 1)	• The number of boats operating in the City's river, the frequency of trips and average fuel consumption were estimated. Future studies may focus on verifying this data.
2	II.3.2) Energy Indirect Emissions (Scope 2)	
3	II.3.3) Indirect Emissions from Inter-City Inter-City or International Water-Borne Navigation Trips that Originate and/or Complete their Journey Within the Community	
	II.4) Aviation	• The Phitsanulok provincial airport is not located within the City's boundaries. Since Phitsanulok City has many hotels catering to tourists travelling by air to the northern region, it may be useful to look into this in future studies.
1	*II.4.1) Direct Emissions (Scope 1)*	
2	*II.4.2) Energy Indirect Emissions (Scope 2)*	
3	*II.4.3) Indirect Emissions from Inter-City or International Aviation that Originate and/or Complete their Journey Within the Community*	
	II.5) Off-Road	
1	*II.5.1) Direct Emissions (Scope 1)*	
	III.) Waste	
	III.1. Solid Waste Disposal	

1+3	III.1.1) Option-1: First Order Decay (FOD) Method – Direct (Scope 1-Current Year) and Indirect (Scope 3-Pevious Years) Emissions from Landfills Located Within the Community Boundary (excluding emissions due to incoming waste from other communities)	• Weighbridge data of total wastes deposited at the City's landfill is available. • Mechanical-Biological Treatment (MBT) operations at the landfill were significantly expanded in late 2013. The effect of this on GHG emissions need to be accounted for more carefully in future inventories.
1+3	III.1.2) Option-2: Methane Commitment (MC) Method – Direct (Current Year) and Indirect (Scope-3 Future Year) Emissions from Landfills Located Within the Community Boundary (excluding emissions due to incoming waste from other communities)	
3	III.1.3) Indirect Emissions (Scope 3) from Community Wastes Deposited in Landfills Located Outside the Community Boundary	
	III.3) Biological Treatment of Waste	
1	III.3.1) Direct (Scope 1) Emissions from Biological Treatment of Waste in the Community Boundary (excluding emissions due to incoming waste from other communities)	• Several pilot projects on composting market/food waste and food waste from hotels/restaurants were initiated in 2013. These, as well as, existing/future biogas projects, should be accounted for in future studies.
3	*III.3.2) Indirect Emissions (Scope 3) from Biological Treatment of Wastes Outside the Community Boundary*	
	III.4) Incineration & Open Burning	
1	*III.4.1) Direct (Scope 1) Emissions from Incineration and Open Burning of Waste in the Community Boundary (excluding emisisons due to incoming waste from other communities)*	
3	*III.4.2) Indirect Emissions (Scope 3) from Incineration and Open Burning of Wastes Outside the Community Boundary*	
	III.5) Wastewater Treatment and Discharge	• Data on tap water produced by the City's water supply division is available and may serve as indicative data to estimate the volume of wastewater amount. Future studies may investigate this at a deeper level.
1	*III.5.1) Direct (Scope 1) Emissions from WWT and Discharge in the Community Boundary (excluding emissions due to incoming waste from other communities)*	
3	*III.5.2) Indirect Emissions (Scope 3) from WWT and Discharge of Wastes Outside the Community Boundary*	
	IV.) Industrial Process and Product Use (IPPU)	

1	*IV.1) Direct Emissions from Industrial Process*	
1	*IV.2) Direct Emissions from Product Use*	
	V.) Agriculture, Forestry and Land Use (AFOLU)	
1	*V.1) Direct Emissions from AFOLU*	
	VI.) Other Indirect Emissions	
3	*VI.1) All other Scope3 Emissions from all sources*	
3	*VI.2) All transboundary Scope 3 Emissions due to exchange/consumption of goods and services*	

Current and Planned Activities Affecting GHG Emissions

Phitsanulok City has not adopted a specific city-wide GHG mitigation goal, as this is not required by Thailand's national laws. Nevertheless, many of the City's existing and future initiatives have the potential to contribute to long-term reductions in GHG emissions. The City is expected to implement initiatives on energy efficiency and renewable energy in line with national policy.

Recommendations

To Local Governments

- The global community is increasing affirming the critical role of local governments in tackling global climate change as part of achieving overall sustainable development. Being able to account for GHG emissions in a credible manner is the first step towards any GHG mitigation project. In the future, national governments of developing countries may make laws to require city-level GHG accounting by local governments (as in the case of japan). Therefore, local governments may start implementing city-level GHG accounting on a voluntary basis to increase their 'readiness' for complying to such legal requirements.
- A local government who takes initiative on GHG accounting (in the absence of legal mandate) sends a signal to international and national agencies of being 'progressive', 'high-capacity' and 'globally conscious'. This may help attract external investments and assistance to help the local government advance the city's sustainable development.
- In any case, local governments are encouraged to implement city-level GHG accounting as a fundamental measure to help develop fundamental staff skills in data-driven city planning, policymaking and project implementation as well as monitoring and evaluation. These skills are beneficial for any project implementation, not limited only to GHG accounting.
- Much of the data required for a municipal-level GHG Inventory is already available in various formats, with the collection procedures being embedded within pre-existing organisational procedures within the municipality. The critical challenge is to create and sustain a systematic/routine approach to compile all of these data. This needs consideration of the existing organisational culture as well as working relationships within the municipality. A tailored approach is required.
- The model demonstrated by Phitsanulok City may be a useful reference for other municipalities of a similar class (120,000 persons population, service-oriented economy and a

provincial government centre) and organisational characteristics (progressive, aspirational management with motivated working-level staff). Notable good practices of Phitsanulok's model are:

- Sustain and motivate data collection by decentralising the data collection process to individual departments/buildings, and then assigning focal points for each building/department.
- Develop an in-house online energy use reporting system to sustain routine and cross-department data collection. Monitoring energy use is a sensible starting point, since Thailand's national government (as well as many other countries) already promote energy saving, energy efficiency and renewable energy goals in national energy policy.

Policy implications (For National Policymakers and International Supporting Organisations)

- Given the technical complexity of city-level GHG accounting, initiatives by local governments risk being a 'one-off', unsustainable effort. Hence, it is essential to create realistic incentives (legal, financial, reputational benefits etc. in both direct and indirect forms) to encourage local governments in this endeavour.
- In the absence of a legal mandate for city-level GHG accounting, a non-regulatory approach that is facilitated by a higher-level national body or external party may be recommendable. This approach links inexperienced municipalities with more experienced municipalities, rewards notable efforts and conducts benchmarking of performance among similar cities within the country, as well as with other countries.
- The baseline capacity of local governments in developing countries is generally low. Hence, a GHG accounting training programme needs take a long-term perspective. Adequate post-training technical guidance is necessary, and training materials need to be in local languages.
- Ideally, training activities should not only involve local governments, but also engage other stakeholders who are not directly controlled by support data collection efforts by the government, such as the electricity and water utilities, petrol stations etc.
- Current data management IT systems of local, national and relevant agencies are either not able, or well-designed to organise GHG data within a city's geo-political boundaries, as requested by global protocols. Therefore, more in-depth technical support and guidance on data collection and interpretation (beyond what is provided in current global/national protocols), may need to be given to local governments, especially for transport and building sector emissions.

City Overview

City's Geo-Political Boundary

This section intends to clarify the geo-political boundary of Phitsanulok City in the context of Thailand's governance framework. In Thailand, there are a total of 76 provinces. Each province is geographically sub-divided into districts (*amphoe*), sub-districts (*tambon*) and villages (*muban*). There is one 'capital district' (*amphoe mueang*) for every province.

The hierarchy is illustrated below:

Province → District (*amphoe*) → Sub-district (*tambon*) → villages (*muban*) / communities

Phitsanulok Province has 9 districts[4] (Figure 3), and the capital district (*Mueang Phitsanulok)* is divided into 20 sub-districts[5]. One of these 20 sub-districts – **'*Nai Mueang*' –** is under the geo-political jurisdiction of **Phitsanulok City (Municipality)**, which is classified as a 'city municipality'[6] (*thesaban nakhon;* large-size municipality*)* under Thailand's governance framework. Phitsanulok City is divided into 173 villages, which are organised into 64 communities under the national decentralisation framework.

Hence, the reader should note that in this report, **'Phitsanulok City'** refers to 'Phitsanulok Municipality', which governs the geo-political area of **'*Nai Muaeng*' sub-district in Phitsanulok Province**, as (illustrated in Table 3 below)**.**

Table 3:
Phitsanulok City's Geo-Political Boundary Under Thailand's Governance Framework

Levels of Governance	Phitsanulok City's Geo-Political Boundary
Phitsanulok Province ↓ **9 Districts (*amphoe*)** ↓ **93 Sub-districts (*tambon*)** ↓ **Villages (*muban*) / communities**	Phitsanulok Province ↓ *Mueang Phitsanulok* District ↓ ***Nai Mueang* Sub-district (Phitsanulok City)** ↓ **64 communities**

[4] The districts are: *Bang Krathum*, *Bang Rakam*, *Chat Trakan*, *Mueang Phitsanulok*, *Nakhon Thai*, *Noen Maprang*, *Phrom Phiram*, *Wat Bot and Wang Thong*.

[5] The sub-districts are: *Aranyik*, *Ban Khong*, *Ban Krang*, *Ban Pa*, *Nai Mueang*, *Bueng Phra*, *Chom Thong*, *Don Thong*, *Hua Ro*, *Pak Thok*, *Phai Kho Don*, *Makham Sung*, *Ngio Ngam*, *Phlai Chumphon*, *Tha Pho*, *Tha Thong*, *Samo Khae*, *Wat Chan*, *Wat Phrik* and *Wang Nam Khu*.

[6] Municipalities with a population of at least 50,000 and a population density of 3,000 persons per km^2.

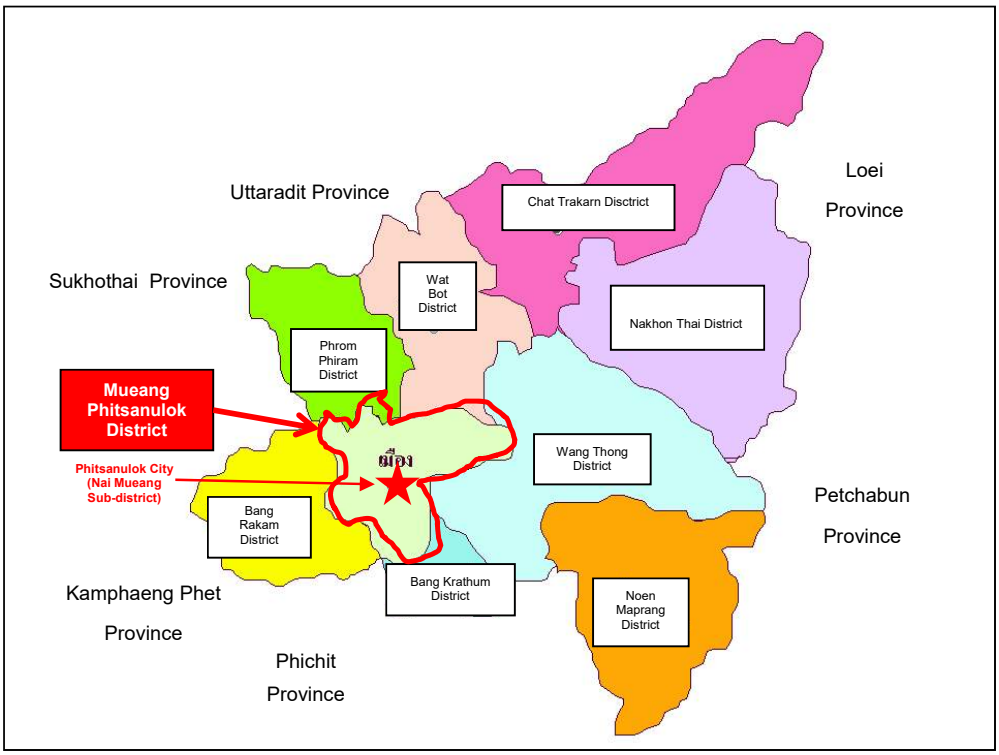


Figure 3:
Map of Phitsanulok Province Showing its 9 Districts, Surrounding Provinces and the Location of Phitsanulok City ('*Nai Mueang*' sub-district) in *Mueng Phitsanulok* District

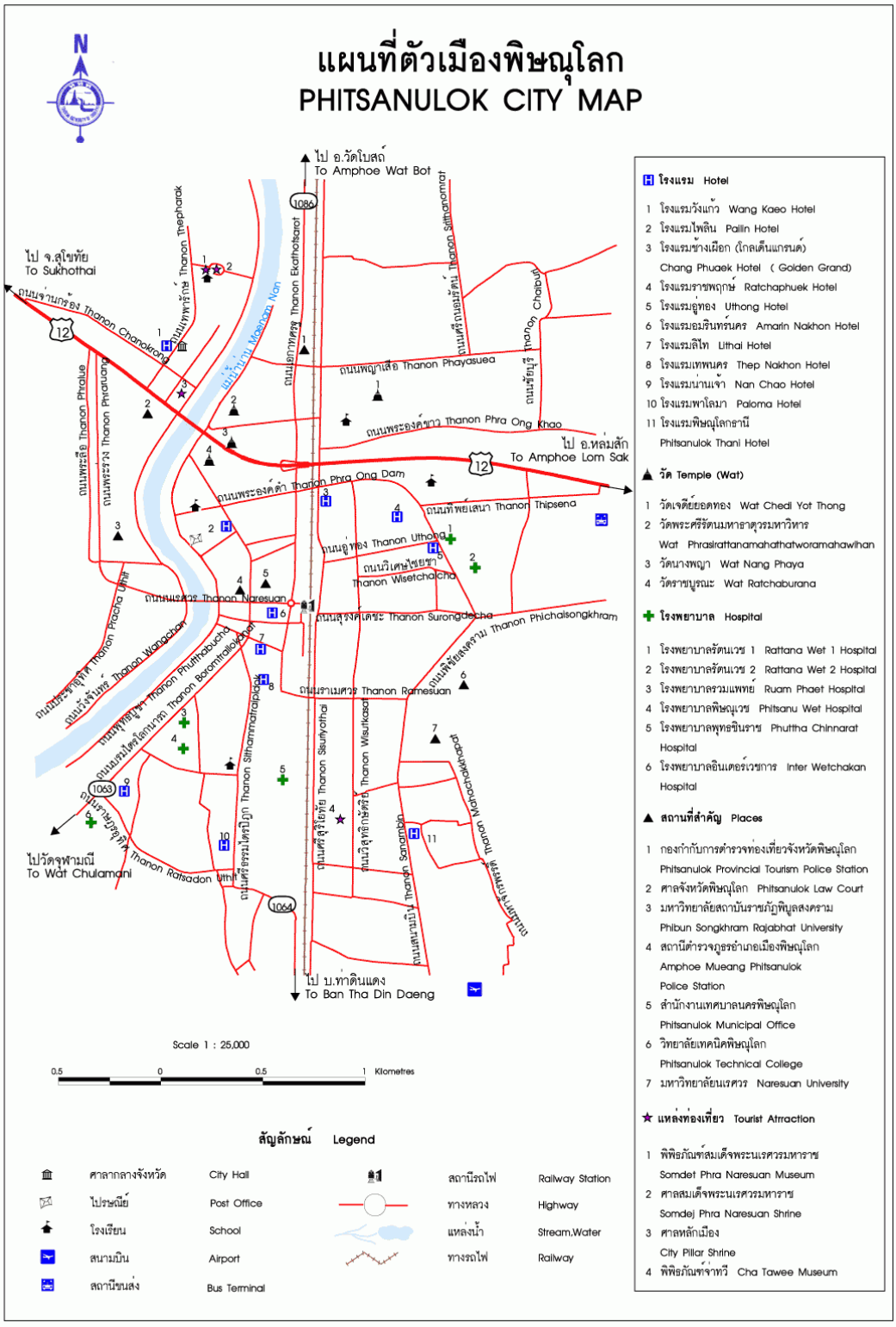


Figure 4:
Map of Phitsanulok City

City Background & Profile

Phitsanulok City is the capital city of Phitsanulok Province and hosts most of the province's government offices. With adequate infrastructure and transportation networks covering road, rail, air and water, Phitsanulok Province is an integral logistics hub of Northern Thailand, as well as of the Greater Mekong-Subregion (GMS)[7], being strategically located at the inter-section of the GMS North-South and East-West Economic Corridors. The province's main economic sectors are in services (62%), industry (10%) and agriculture (28%). According to national government statistics, with a per capita Gross Provincial Productivity (GPP) of Phitsanulok is THB102,060 (Approximately USD3,100 at an exchange rate of 1THB = USD0.033) (2013).

Established more than 600 years ago, Phitsanulok City was once a provincial centre for the Kingdom of Angkor and also briefly the capital of Thailand. It is most well known as the birthplace of King Naresuan, who freed the city from Burmese rulers in the late 16th century. The city spans an area of 18.26km^2 and hosts a registered population of 73,323 persons (as of 2011), while the unregistered population is estimated at around 120,000 persons. A long time ago, Phitsanulok City has historically served as a transportation hub connecting cities such as Danang (Vietnam), Yangon (Myanmar), Kunming (China) and as far as Kuala Lumpur (Malaysia).

In recent years, the municipality has transformed the city into an industrial and commercial core of Thailand's Lower Northern Region, with a concentration of more than 30 branches of commercial banks, 127 hotels, 12 hospitals/healthcare institutes and restaurants in the locality.[8] The city is also the base of five to six major recycling trading companies, including Wongpanit Corporation which operates one of Southeast Asia's largest transboundary recycling business. The two prominent universities in the city are Naresuan University and Pibulsongkram Rajabhat University. The city also hosts a Royal Thai Army base. Presently, the city is the most popular main stop-over point for tourists travelling to visit the Sukhothai Historical Park in the neighbouring Sukhothai Province, a UNESCO World Heritage Site. Besides that, it is also a distribution and trading hub for surrounding agricultural provinces such as Petchabun.

Phitsanulok's City's climate is tropical, with a distinct dry and rainy season. The city is situated at the juncture of the Nan and Yom River, and terrain is generally flat. The Nan River – one of Thailand's four major rivers – is the city's primary source of drinking water, and divides the city into the East and West section (Figure 4). The city is susceptible to flooding during the annual rainy season. During the 2011 Thailand Great Flood, the water level reached nearly 11 metres (from the river bed). On the other hand, the city experiences water stress during the dry season.

[7] http://www.gms-cbta.org/uploads/resources/15/attachment/Transport_and_Logistics_TA-7851_(REG)_Final_1-3_10-Apr.pdf

[8] http://www.clair.org.sg/topics/dispatch_phisanulok2012.html

Photos: (1) The Buddha statue at Phitanulok City's Wat Yai Temple of is well-known as having one of the 'most beautiful Buddha faces' in Thailand; **(2)** The rooster is associated as a lucky animal of King Naresuan, who was born in Phitsanulok,. King Naresuan is a household historical heroic figure among the Thai people; **(3)** A waste sorting assembly line of Wongpanit Corporation (headquartered in Phitsanulok City), one of the most successful recycling companies in the region; **(4)** Scenery of the Nan River bank facing the Wat Yai Temple.

Municipality Organisational Structure and Management

Phitsanulok Municipality's vision is for Phitsanulok to become a '**City of Beautiful Landscape and Cheerful People'**, based on the following strategies [9]:

DEVELOPMENT STRATEGIES OF PHITSANULOK MUNICIPALITY

1. High Quality and High Standard Infrastructure Development
2. Education Development and Human Development for Intellectual Society and Lifelong Learning Society
3. Sustainable Resource and Environmental Development
4. Promotion of Citizen's Good Quality of Life
5. Promotion of People's Participation and Community Building
6. Promotion of Culture and Tourism
7. Good Governance Administration

Phitsanulok Municipality is led by the Mayor and 3 Deputy Mayors, who are responsible for setting the city's development policies with 24 elected city council members. The executive is headed by the Municipal Clerk, whose staff are organised into 8 divisions/bureaus (Figure 5). The Municipality manages an annual budget of approximately THB700,000,000 (USD21 million) (Table 4).

[9] Phitsanulok Municipality website.

Figure 5: Phitsanulok Municipality Organisational Chart

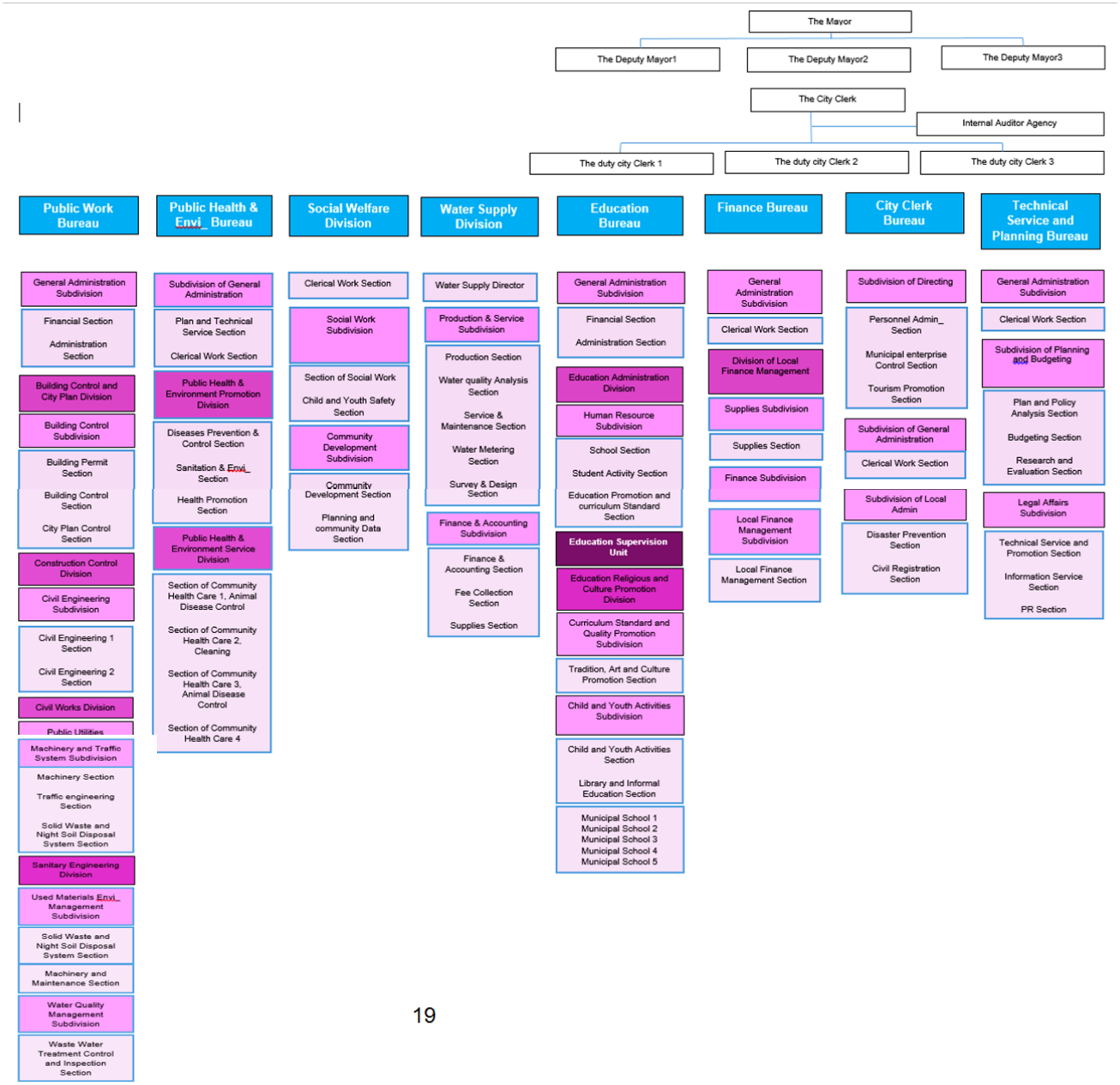


Table 4:

Budget of Phitsanulok Municipality for Fiscal Year 2012 and 2013

Description	FY2012 (THB)	FY2013 (THB)
Income Collected by Phitsanulok Municipality		
Taxes	54,655,902.02	63,027,633.13
Fee, fine, permits	22,482,823.30	20,874,953.32
Income from property	14,866,379.42	16,784,829.78
Income from facilities and enterprises	8,594,443.44	9,431,955.66
Misc.	4,263,709.00	3,278,570.00
Income from the sales of depreciated/retired municipal assets	899,395.00	63,765.00
Total 1	105,762,652.18	113,461,706.89
Income from the Central Government		
Tax allocated from the central government	248,986,326.34	287,848,476.74
Total 2	248,986,326.34	287,848,476.74
Subsidies from the central government		
General subsidy	78,271,613.00	202,284,355.55
Total 3	78,271,613.00	202,284,355.55
Total 1 + 2 + 3	433,020,591.52	603,594,539.18
Other income		
Loans	59,184,643.44	
Ad-hoc subsidies	181,234,692.00	115,800,061.22
Total 4	240,419,335.44	115,800,061.22
Total 1 + 2 + 3 + 4	**673,439,926.96**	**719,394,600.40**

Air Quality

Tasks related to air quality management fall under the purview of the Public Health and Environment Bureau and Public Works Bureau. In Thailand, factories are classified into three types (1, 2 and 3). The task of inspecting and monitoring Type 1 and 2 factories (see 'Buildings' section for details) on the typology of factories) has been decentralised from the Ministry of Industry to the local government. The aspects of monitoring include energy consumption, sanitation, air circulation and general safety measures.

Upon a factory's application for a permit, a preliminary inspection is performed and further inspections being repeated upon permit renewal. Throughout the year, the Municipality may conduct inspections on an *ad-hoc* basis if complaints are received. In a serious case, the Municipality would contact the Provincial Industry Office for assistance to resolve the problems encountered.

The Municipality does not possess any air quality monitoring/measurement equipment. On special occasions such as the World Environment Day, technical experts are invited from relevant organisations to exhibit and demonstrate measures for air quality management and control.

Solid Waste Management (SWM)

Recent SWM statistics in the city are provided in Table 5.

Phitsanulok City generates about 75 tonnes of waste daily, of which about 40% is organic. The Municipality operates waste collection services for the residential and commercial sector in the East (i.e. East side of the Nan River), while services for the West are contracted to a private company (renewed on an annual basis since 2005) as a measure for benchmarking performance.

Collected waste is first brought to the city's sole transfer station, where waste is compacted and delivered to the landfill opened in 1999 in the neighbouring *Baung Kok* sub-district. The landfill accepts waste not only from Phitsanulok City but also other sub-districts. Since 2000, the landfill facility has undergone several phases of upgrading to achieve the management's 'zero landfill' policy by incorporating Material Biological Treatment (MBT) facilities (See 'Buildings' Section for details). The MBT is designed to treat deposited waste into several outputs: i) compost-like substance; ii) landfill daily cover iii) high-calorific segment as feedstock for the production of Refused-Derived Fuels (RDF). Since September 2013, all of the collected waste (of which about 75 tonnes per day are from Phitsanulok City) are sent to the MBT facility. An experimental plant has been established at *Baung Kok* landfill site with investment by the Siam Cement Group (SCG).

Hazardous wastes are separately collected for controlled treatment. The hazardous waste collection service is operated by the private sector (Better World Green Co. Ltd., which is recommended by the Pollution Control Department (PCD), Ministry of Natural Resources and Environment (MoNRE)).

Infectious waste – mainly generated by hospitals, clinics and health facilities – is collected and delivered to an incineration plant in Ayudhaya Province[10].

The city has 89 designated drop-off points for 4 categories of hazardous wastes in various residential, educational and commercial areas. Of the 89, a total of 61 drop-off points are for collecting used mobile phones which are set up in five shopping centres[11].

Table 5:
Recent SWM Statistics of Phitsanulok Municipality

Average waste amount

Daily landfilled waste (Phitsanulok City plus other sub-districts)	*100 tonnes (t)*
Daily landfilled waste (Phitsanulok City only)	*75t*

Estimated operational cost (collection, transfer and disposal cost)

Average treatment costs (without MBT)	*THB 2,000/t (about USD 67/t)**
Average treatment costs (with MBT, projected)	*THB 7,000/t (USD 230/t/t)*
Average collection cost (cost of Phitsanulok Municipality FY 1999)	*THB 700/t (about USD 23/t)*

Fee charged to other organizations

Landfill tipping fee (actual cost is 500++baht)	*THB 385/t (about USD13)*
Transfer station tipping fee	*THB +100/t (about USD3)* *THB 485/t*

* At an exchange rate of USD1:THB30

Water

Phitsanulok City gets it waste supply from the Wat Po water treatment plant located within the city, which was built with a World Bank loan in 1999. The plant sources from the Nan River and has a production capacity of 21,295,014m^3 per day.

Water is supplied to the entire city as well as neighbouring cities/sub-districts. The non-revenue water rate is estimated at 40%. The plant's capacity to serve an ever increasing population and rising water demand is straining the plant's provision capacity.

Wastewater Treatment/Sanitation

Wastewater treatment is under the purview of the provincial and central government (Department of Public Works and Town Planning, Ministry of Interior).

[10] The municipality used to operate a small-scale incinerator which has temporarily suspended operations due to challenges in cost recovery.
[11] 15 spots at Topland Arcade, 2 spots at Topland Plaza, 4 spots at Makro, 35 spots at BigC and 5 spots at Pathumthong.

There is no wastewater treatment facility in the city except at the waste transfer station and *Baung Kok* landfill. Hence, all wastewater runs into the collecting ponds and the Nan River. Under local regulations, all buildings must be fitted with septic tanks, which are maintained by owners and de-sludged by the private sector.

A project to build a centralised wastewater treatment facility about 20km away from the City was initiated around 1999. The construction comprised two parts. The first part was a wastewater treatment plant and wastewater collection system, financed and constructed by the Department of Public Works and Town Planning, Ministry of Interior. The second part was a drainage (trench) system constructed by Phitsanulok Municipality with financial support by the MoNRE. After construction is completed, the system was supposed to be handed over to Phitsanulok Municipality, However, the project had been only partially implemented and eventually discontinued due to technical difficulties, defects and apparently unfeasibly high operation costs, especially for operating the pumps.

Figure 6 shows a typical grease trap in Thailand, and Figure 7 shows two common types of septic systems in Thailand in the city adheres to specifications under national building control regulations The two main legal instruments concerning buildings in Thailand are:

- Building Control Act 1979 (2522)
- Local Ordinances. For instance, the (Bangkok Metropolitan Administration (BMA) Ordinance on Building Control 2001 (2544) requires that treatment systems such as grease traps and wastewater treatment/filtration systems (approved by BMA) to be included in the building construction/rehabiltaion project of a certain size.

Phitsanulok City has enacted an Ordinance on Grease Trap Installation 2008 (2553) and has been in force from 3 November 2008. The ordinance stipulates that all new houses and buildings that release sewage to public water reservoir must install grease traps. Houses and buildings built before the ordinance are required to complete installation of grease traps within 180 days from the date of the Ordinance's enforcement.

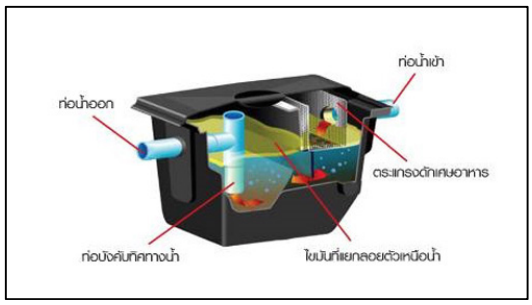


Figure 6: A typical grease trap used in Thailand.

Picture from:
http://office.bangkok.go.th/suanluang/website_WAX/NEW/fight.htm

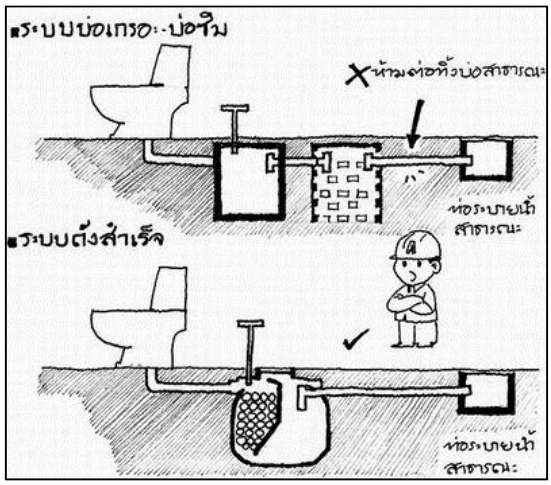


Figure 7: Two common types of septic tank system in Thailand. The first type (upper) is not allowed to directly drain into the main sewers.

Buildings

The Building Construction Control Municipal Ordinance (1994) of the City has been enacted based on the national law, Building Control Act (1979; 1992).

In Thailand, buildings are categorised as 'Condominium', 'Hotel', 'Dormitory', 'Hospital', 'Any Service Place', 'School or Educational Institute', 'Government or Private Office', 'Shopping Centre or Departmental Store', 'Market' and 'Restaurant'. Each category is further divided into 5 types (A – E) (Table 6).

Table 6:
Categories and Types of Buildings in Thailand

Categories of Building	Type A (ก)	Type B (ข)	Type C (ค)	Type D (ง)	Type E (จ)
Condominium	> 500 rooms	100 ≤ 500 rooms	< 100 rooms		
Hotel	> 200 rooms	60 ≤ 200 rooms	< 60 rooms		
Dormitory		> 250 rooms	50 ≤ 250 rooms	10 ≤ 50 rooms	
Any Service		> 5,000m^2	1,000 ≤ 5,000m^2		

Place					
Hospital	> 30 beds	10 ≤ 30 beds			
School or Educational Institute	> 25,000m^2	5,000 ≤ 25,000 m^2			
Government or Private Office	> 55,000m^2	10,000 ≤ 55,000m^2	5,000 ≤ 10,000m^2		
Shopping Centre or Departmental Store	> 25,000m^2	5,000 ≤ 25,000m^2			
Market	> 25,000m^2	1,500 ≤ 2,500m^2	1,000 ≤ 1,500m^2	500 ≤ 1,000m^2	
Restaurant	> 25,000m^2	500 ≤ 2,500m^2	250 ≤ 500m^2	100 ≤ 250m^2	< 100m^2

Note: The Bangkok Metropolitan Administration (BMA) has different typology as it is a special class of local administration.

Source(s) :

- http://infofile.pcd.go.th/mgt/report51NEB_4mgt.pdf?CFID=21026934&CFTOKEN=89587470
- http://cpd.bangkok.go.th/files/admin/gabageMana25-04-13.pdf

There are three categories of factory buildings, based on the energy consumption of installed machinery:

- Category A: < 5 Horse Power;
- Category B: 5 – 50 Horse Power;
- Category C: > 50 Horse Power.

Based on the decentralisation framework[12], Cateogory A and B factories are monitored, controlled and registered with Phitsanulok City, while Category C factories are under the Ministry of the Industry . The City has the authority to conduct inspections of these factories and to act on complains received from the public, as well as report incidents to the local offices of the Ministry of Industry.

[12] By the virtue of section 6 and section 11 paragraph two of the Factory Act B.E. 2535 (1992), the Minister of Industry hereby issues the Ministerial Regulation as follows:

Clause 1 Any one wishes to engage in business of group 2 factory shall notify the competent authority prior to engaging in such business by reporting the required detail in the Form Ror.Ngor.1 annexed to this Ministerial Regulation. Most are factories with not more than 20 horsepower.

Clause 2 The competent authority once being notified on the business under clause 1 shall issue the Form Ror.Ngor.2 annexed to this Ministerial Regulation as proof of such notification. Most are factories with total engine capacity not more than 50 horsepower.

Clause 3 Any factory permit granted prior to the coming into force of the Factory Act B.E. 2535 (1992) or after the coming into force of the Factory Act B.E. 2535 (1992) but prior to the coming into force of this Ministerial Regulation shall be deemed that the factory operator has completed the notification of his business and such permit shall be deemed as the proof of notification document under section 11 of the Factory Act B.E. 2535 (1992). Most are factories with more than 50 horsepower engine capacity. (Source: http://www.jetro.go.jp/thailand/e_survey/factoryact.html)

Transport

The main modes of transport in Phitsanulok City are roads and water. For daily commuting, private motor vehicles (cars and motorcycles) are preferred. Public transport in the city consists of public buses, jeepneys, water vehicles (boats) and about 50 taxis.[13]

City-only statistics are not available, but there are approximately 317,700 vehicles and 19,276 cars registered in the province. Traffic congestion at peak hours is becoming an issue and a significant source of air pollution within the city. On-road traffic is regulated and enforced by the police while the municipality has jurisdiction over the pedestrian and walkways.

The City manages a regional bus terminal. There are about 16 companies, 369 buses, 51 service routes and about 368 shifts[14].

The responsibility of managing the city bus terminal has been transferred from the Provincial Transportation Office, Ministry of Interior to Phitsanulok City since 12 August 2006. Phitsanulok City covers the costs of the terminal's operations by charging service fees. The tasks managed by the Municipality are: (i) security ; (ii) cleaning; (iii) toilets; (iv) food and drink services; (v) terminal fee collection; (vi) luggage deposit; and (vii) taxi services (pick-up trucks, *tuk tuk*, motorbike, etc.); and (viii) public relations and travel information services.

The train passes through the city from Bangkok to Chiang Mai, 35 trips (single-way journey)) per day with a length of 4.65km within the city boundary. Interviews with the Railway Authority revealed that the fuel consumption is about 16.275 litres of diesel per train per day.

The Nan River has a length of 8.93km within the city boundary. River traffic in Nan River has been declining over the years. The construction of three bridges across the river has significantly reduced the demand for water transport.

Three types of boats are operated as shown in Table 7 below:

Table 7:
Boats Operating in the Nan River

Type of boat	No. of boats	Power	Frequency of trips	Fuel consumption
Private services for scattering cremation ashes over the water	Unknown	400 Horsepower	2 trips per day, 10 days per year	200 litres (gasoline) per year
Private boats	30	40	Daily	5 litres (gasoline) per

[13] . Since Oct 2010, Phitsanulok Taxi via call center has been kicked off with 26 taxis (from planned 49 taxis). The taxis have been modified to run on LPG and NGV.

[14] 'A 'shift' means a return journey, although the definition was under clarification at the time of publication.

(mainly for fishing)		Horsepower		day per boat (average)
Tour boats	3	200 Horsepower (1 boat); 270 Horsepower (2 boats)	Daily	60 litres (diesel) per boat per day (average)

Electricity

Electricity in Phitsanulok City is generated by the Electricity Generation Authority of Thailand (EGAT) and distributed by the Provincial Electricity Authority (PEA). The plant facilities are located outside the city's boundary. The energy mix consists of hydropower (Bhumipol Dam, Sirikit Dam, Naresuan Dam), coal (Lampang Province) and power purchased from private sources using biomass and solar energy[15].

Urban Greenery

There are a total of 5 municipality-owned public parks in Phitsanulok City, spanning a total area of 305,900m^2 (Table 8). Furthermore, the general maintenance of additional public areas (Table 9) are outsourced to private companies on 6-month contracts.

The private companies are contracted to conduct maintenance work such as public cleaning, grass cutting, trimming, watering, soil loosening and fertilizer application. Trees and plants are purchased by the City considering the park size, area conditions (e.g. whether the park is close to residential areas or open space) as well as soil quality (e.g. existing soil or new soil from land leveling). The other factors considered are the purposes of the park, i.e. whether the park is for recreation or also has a function of entertainment (where a stage is available).

In addition, 'green road islands' cover 22,441m^2 while 'green foot paths' cover 36,330 m^2.

Table 8: Public Parks in Phitsanulok City

No	Municipality Parks	Year Established	Size (m^2)	Green Area (m^2)
1	Chom Nan Royal Park (Phase 1)	1999	22,000	22,000
2	Royal Park	2006	240,000	173,000
3	Phitsanulok	2013 (still	14,400	--

[15] This requires further verification.

	Central Park	partially under construction)		
4	Chom Nan Park Phase 3	1999	22,000	22,000
5	Chom Nan Park Phase 4	1999	7,500	6,500
		TOTAL	**305,900**	**223,500**

Table 9: Public Areas Outsourced to the Private Sector in Phitsanulok City for General Maintenance

No.	Municipality Parks	Location	Size (m^2)
1	Royal Park	Ruenpae junction	173,000
2	Highway route 12	From SaPanSung bridge to municipality boudary	4,000
3	Chom Nan Park Phase 1	Ekatosaros bridge to Naresuan bridge (east)	27,000
4	Chom Nan Park Phase 3	Ekatosaros bridge to Naresuan bridge (west)	23,000
5	Chom Nan Park Phase 4	Opposite the City Shrine	12,600

Climate Change

Climate change and MRV are relatively new themes in the City's environmental work. A survey conducted by IGES found that participating municipality staff had a basic understanding of the challenges of climate change. A majority of the respondents also think that the local government has a moral responsibility to take steps to address climate change, notwithstanding the obligations of a higher-level framework (such as an international agreement).

Phitsanulok City has not yet adopted specific goals and policies which target mitigating climate change, though many of its environmental initiatives have GHG emission reduction impacts. (See Chapter 'Current & Planned Activities Affecting GHG Emissions').

Since 2010, Phitsanulok City has participated in several training workshops on CDM and GHG accounting organised by the Thailand Greenhouse Gas Management Organisation (TGO) (Table 10), National Municipality League of Thailand (NMLT) and other organisations. The City usually sends one staff from the Bureau of Environment and Public Health to the training workshops, so staff capacity is yet to be evenly developed across all departments.

Table 10:
Participation of Phitsanulok Municipality in
Climate Change and MRV-related Training Activities

Topic	Year	Organised by
Workshop on Programme development, personnel and agencies involved in CDM	2010	TGO
Workshop on Program development, personnel and agencies involved in the Clean Development Mechanism.	2011	TGO and NMLT
Workshop on "Capacity Building on Accounting and Utilising GHG Emission Reduction Measures for Local Waste Management Actors in Developing Asian Countries	2011	National University of Laos(NUOL), Institute for Global Environment Strategies(IGES), Cambodian Education and Waste Management Orgainsation (COMPED), Sirindhorn International Institute of Technology (SIIT) and Thammasat University
Accounting and Utilising GHG emissions Reduction Measures for Local Waste Management Actors in Thailand	2012	SIIT, Thammasat University and IGES
Introduction to GHG Inventory and MRV in Cities	2012	IGES
Intermediate Concepts of GHG Inventory and MRV in Cities	2012	IGES
Low Carbon Cities and Green Buildings	2014	IGES

Municipal GHG Emissions

Municipal Operations FY 2013

The Phitsanulok City's municipal operations GHG inventory is calculated in accordance to the ICLEI's protocol and consists of emissions from operations, facilities or sources wholly owned by the municipality over which the city has full authority to introduce and implement operational, health and safety and environmental policies.[16]

Phitsanulok City's operations are estimated to generate an estimated **25,149 tCO_2e** in FY 2013. This chapter will describe each sector in more detail.

Buildings & Facilities

Phitsanulok City owns and manages 51 buildings (Table 11). The Municipality's electricity bills are subsidised by the government for up to 10% of total electricity consumed by households (buildings classified as 'residential') in the city, except for the electricity used by certain buildings/premises with profit-oriented operations (such as the public markets). Therefore, it is not possible to accurately

[16] Further verification is required on whether all emissions from leased buildings and facilities owned by the municipality have been included in the building list.

account for the total amount of electricity used by referring to electricity bills paid, and the data has to be requested from the distribution agency (PEA).

In 2013, municipal buildings used **3,528,319 kWh of electricity**, which emitted about approximately **1,979 tCO_2e.**

Table 11:
List of Buildings of Phitsanulok City
under each Bureau/Department and Septic Tanks Installed

No.	Buildings & Facilities	Septic Tank Size (m^3)
A. Bureau of Public Health and Environment		
1	Market 1	12
2	Market 2	8
3	Market 3	48
4	Market 4	16
5	Market 5	4
6	Market 6	12
7	Municipal slaughterhouse	128
8	Pracha-utit Health Center	12
9	Animal Hospital rabies Center	2
10	Night plaza	8
11	Food Market	8
12	Panpee Health Center	2
13	Praongkhaw Health Center	8
14	Mahanupap Health Center	12
15	Parking lot	2.8
16	Pet Shelter	1.15
17	Massage Center	1
18	Fitness Center	4
B. Bureau of Public Works		
1	Transfer Station	8.4
2	Landfill	15
3	Sewage disposal station	156
4	Traffic Lights	
5	Street lights	
6	Mechanical maintenance center	5
7	Section of Public Utilities	5
8	Nan river Public park 1	
9	Nan river Public park 2	
10	Nan river Public park 3	
11	Chaloem Phrakiat Public Park	

C. Bureau of Finance		
	Bureau of Finance does not manage any buildings	
D. Bureau of Education		
1	School 1	
2	School 2	
3	School 3	
4	School 4	57
5	School 5	46
6	Basketball Court	
7	Badminton Court	
8	Football Court	4
9	Library	
10	ICT Centre	
11	Child Development Centre	24
E. Office of the Municipal Clerk		
1	Municipal Office Building	60
2	Civil Registration and Identification Card	16
3	Tourist Information Centre1	1.6
4	Tourist Information Centre2	1.6
5	Fire station 2	
6	Bus Terminal	
7	Fire station1	15
8	Section of Safety and Security	2
F. Division of Water Supply		
1	Division of Water Supply	16
2	Pump station at Watpothiyan	
3	(Water distribution station at Watmai	
4	Subdivision of Production and service	
G. Division of Social Welfare		
1	Center of distribution and product community	1

Traffic Signals and Streetlights

The electricity consumer by traffic signals and streetlights were computed from the City's inventory of lights, as it was not possible to obtain a separate electricity bill for the lights (there was no dedicated electricity meter.) The amount of GHG emitted was calculated at **1,483 tCO_2e.**

Vehicle Fleet

City-owned vehicles (including for non-transport purposes such as the use of diesel in fogging, grass cutter and other off-road machines) used **diesel, gasoline, gasohol and CNG**. These accounted for **1,440 tCO_2e**. Fuel consumption for on-road vehicles was calculated from financial records, while fuel consumption for off-road vehicles (e.g. fogging machines, grass cutters, compactors/crushers etc.) were purchased in bulk and thus had to be estimated. Vehicle fleet fuel use data specifically for solid waste management operations could not be reliably separated, and thus is included as part of overall 'Vehicle Fleet' in this report.

The City did not conduct a staff commuting survey in this phase of the report, which is an optional item under ICLEI's reporting protocol.

Water Supply

In 2013, a total of **9,483,132m^3** of water was supplied to municipality buildings and buildings within the boundary of Phitsanulok City. Table 12 below shows the breakdown of water consumers. Water treatment operations used 689 tonnes of alum and 20.6 tonnes of chlorine.

Table 12: Total Water Produced by Phitsanulok City's Water Treatment Plant (2013)

Customers	Amount (m^3)
Neighbouring sub-districts	2,719,198
Phitsanulok City	9,413,919
Phitsanulok Municipality buildings	69,213
Total	**12,202,330**

.

Wastewater

The city's buildings do not have any wastewater treatment systems installed, so all wastewater is directly discharged into the ground and waterways. Septic tanks are installed and their capacity have been estimated in Table 11. However, as many of these buildings are old (10 – 20 years), information from the building plans in records may not be complete or accurate.

Hence, the emissions from wastewater are calculated based on the COD content of wastewater, and emission factor prescribed the TGO is used. The report roughly assumes the value of 0.0005kg/L COD for 12,202,430m^3 (12,202,430,000L) tap water produced. Half of the produced water are discharged as wastewater into drains and 10% of organic fraction are degraded into GHG. Based on these assumptions, about **296 tCO_2e** of GHG were released from untreated wastewater.

Solid Waste

Since the municipality did not record waste arising only from municipal operations and buildings, the data for this sector is the same as described in 'City GHG Emissions'.

Other GHG Emission Sources

The municipality estimated that about 50kg per month of chemical fertilisers are used in the parks and other public green areas. Meanwhile, private contractors use around 320kg (6.4 sacks x @50 kg) of chemical fertiliser and 500kg of soil conditioner per month.

The Municipality was not able to collect data on the amount of refrigerants used in fire extinguishers and air-conditioning units as only the financial values were recorded in normal procedures. However, it was able to collect some preliminary data in the form of sales of refrigerants from manufacturers and shops within the city.

City GHG Emissions

The city-level inventory attempts to capture all direct and indirect emissions from energy used by buildings/stationary sources, on-road transportation and public transit (excluding aviation transport) within the geo-political boundaries administrated by Phitsanulok Municipality. Data collection and reporting framework are based on the GPC Pilot Version 1.0

Phitsanulok Municipality employed a step-wise approach in its inaugural GHG accounting initiative. It first focused on collecting data within the scope of municipal operations, which were than?? then expanded to city-level data. Due to the short project duration, only preliminary data of uneven quality was collected. This section will explain the progress and state of data collected, which can be enhanced in future initiatives.

Energy – Buildings/Stationary Sources

At the time of data collection, the Municipality worked with the PEA to isolate electricity consumption data supplied to buildings within the geo-political boundary of Phitsanulok Municipality. However, PEA's IT systems and database were found not capable of isolating such data.

Energy – Mobile Sources

There are 10 petrol stations in Phitsanulok Municipality area. Sales data for 2013 was requested from 2 petrol stations. This may be used as indicative data for estimating total fuel consumption in future calculations.

Water

In 2013, a total of **12,202,230m^3** of water was produced by Phitsanulok City's Wat Po water treatment plant. See Table 12 under 'Municipal GHG Emissions'.

Solid Waste

GHG emissions were calculated from two points of the waste management stream: (i) small-scale, community-based composting at source; and (ii) landfilled waste. According to Phitsanulok Municipality, about 26.5t of waste (excluding waste collected from areas outside the city boundary) were deposited in the *Baung Kok* landfill during 2013. This is calculated to emit **14,666 tCO$_2$e** of GHG based on the 'Methane Commitment' (MC) method.

The MC method was chosen over First Order Decay (FOD) method because reliable historical records of deposited landfill waste were not available. It must also be noted that a Mechanical Biological Treatment (MBT) system had been implemented in varying phases during 2013, which may actually lower the total amount of GHG emissions. This report does not account for emissions mitigated through MBT due to time constraints, as well as uncertainty over the scale of MBT operations which commenced in late 2013. For more details, see Chapter 'Current & Planned Activities Affecting GHG Emissions' for more details.


NIGHT BAZAAR

Current and Planned Activities To Reduce GHG Emissions

Pilot In-house Online Energy Report System

Picture: Main Menu Page of Pilot In-house Online Energy Report System Developed by Phitsanulok City's IT Department

The pilot in-house (intranet) Online Energy Report System (http://energyreport.phsmun.go.th) was developed by the City's IT Department halfway through the project as a means of data collection for the municipal GHG inventory, as a substitute for the excel form developed by IGES researchers.

It is currently in a prototype phase and covers data from energy (electricity and fuels) as well as the list of electric/electronic appliances, on-road vehicles, on-site motorised machines for each building, organised by each Department/Bureau/Division. Other data collected include staff commuting.

The system has the capability disaggregate data by department and buildings, which is considered very useful for the management.

For each building, the following data is collected:

- Basic information of the building
    - Building area, number of personnel, customers/clients number/day of each Building/Division as well as name of data collection staff and their contact number.

- Electricity meters
    - Year of installation, identification codes, customer codes, voltage and multiplier
- Electrical appliances
    - Quantity and types/brands, wattage/BTU, days of usage and quantity
- Mobile motor (vehicles)
    - Quantity and type of vehicle, amount of fuel used, number plate, frequency/days of usage
- On-site motor (machines/devices)
    - Quantity and type of vehicle, amount of fuel used, number plate, frequency/days of usage
- Installation of renewable energy supply system
    - Types of renewable energy systems installed (solar, biogas or others)
- Waste water treatment system
    - Type and quantity
- Fire extinguishers
    - Type of refrigerant used, quantity and size

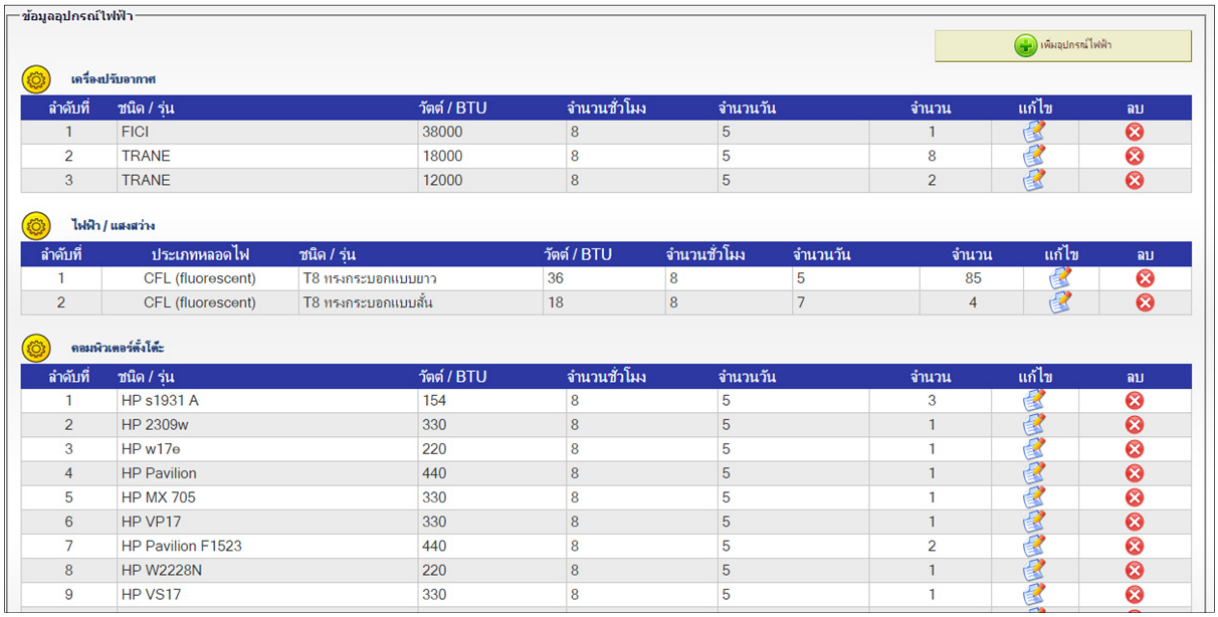
The 'Electricity Consumption' page collects data from the Electricity Authority of Thailand. The data can be broken down to monthly consumption, with parameters such as the fixed cost of electricity, fixed tariff, price with fixed tariffs, net price and price including VAT. Besides that, as means for verification, the page also attaches included scanned invoices from the Electricity Authority.

Similarly, the 'Fuel Consumption' page allows users to collect and track fuel consumption of motorized vehicles and machines by each Divisoin/Department/Bureau per month.

The 'Staff Travel' page collects data of staff commuting, such as means of transport, years of working, home location, distance between home to office, number of travelling companions, type of vehicle, engine size, fuel type and fuel used per month.

For future development, the municipality plans to enhance the system with the following functions:

- Cover all information relevant to GHG Inventory (ideally, it should be a 'live' municipal level GHG inventory database)
- Be bilingual (Thai-English; an external consultant is required to assist with this)
- Have selected data accessible for public viewing
- Include the function to view the supporting documents for the data provided (such as purchase records, electricity bills etc. in scanned format) to fulfil the 'V' (verification) process by 3rd party.


ข้อมูลอุปกรณ์ไฟฟ้า

เพิ่มอุปกรณ์ไฟฟ้า

เครื่องปรับอากาศ

ลำดับที่	ชนิด / รุ่น	วัตต์ / BTU	จำนวนชั่วโมง	จำนวนวัน	จำนวน	แก้ไข	ลบ
1	FICI	38000	8	5	1		
2	TRANE	18000	8	5	8		
3	TRANE	12000	8	5	2		

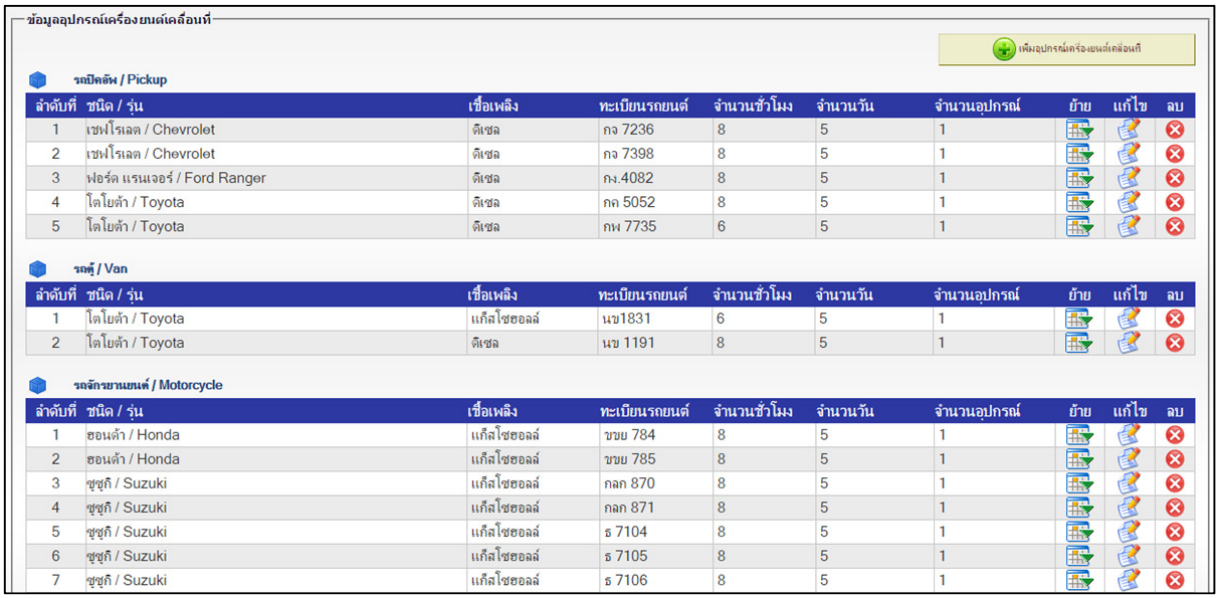
ไฟฟ้า / แสงสว่าง

ลำดับที่	ประเภทหลอดไฟ	ชนิด / รุ่น	วัตต์ / BTU	จำนวนชั่วโมง	จำนวนวัน	จำนวน	แก้ไข	ลบ
1	CFL (fluorescent)	T8 ทรงกระบอกแบบยาว	36	8	5	85		
2	CFL (fluorescent)	T8 ทรงกระบอกแบบสั้น	18	8	7	4		

คอมพิวเตอร์ตั้งโต๊ะ

ลำดับที่	ชนิด / รุ่น	วัตต์ / BTU	จำนวนชั่วโมง	จำนวนวัน	จำนวน	แก้ไข	ลบ
1	HP s1931 A	154	8	5	3		
2	HP 2309w	330	8	5	1		
3	HP w17e	220	8	5	1		
4	HP Pavilion	440	8	5	1		
5	HP MX 705	330	8	5	1		
6	HP VP17	330	8	5	1		
7	HP Pavilion F1523	440	8	5	2		
8	HP W2228N	220	8	5	1		
9	HP VS17	330	8	5	1		

Picture: Screenshot of page displaying data on electric appliances


ข้อมูลอุปกรณ์เครื่องยนต์เคลื่อนที่

เพิ่มอุปกรณ์เครื่องยนต์เคลื่อนที่

รถปิคอัพ / Pickup

ลำดับที่	ชนิด / รุ่น	เชื้อเพลิง	ทะเบียนรถยนต์	จำนวนชั่วโมง	จำนวนวัน	จำนวนอุปกรณ์	ย้าย	แก้ไข	ลบ
1	เชฟโรเลต / Chevrolet	ดีเซล	กจ 7236	8	5	1			
2	เชฟโรเลต / Chevrolet	ดีเซล	กจ 7398	8	5	1			
3	ฟอร์ด แรนเจอร์ / Ford Ranger	ดีเซล	กง.4082	8	5	1			
4	โตโยต้า / Toyota	ดีเซล	กค 5052	8	5	1			
5	โตโยต้า / Toyota	ดีเซล	กพ 7735	6	5	1			

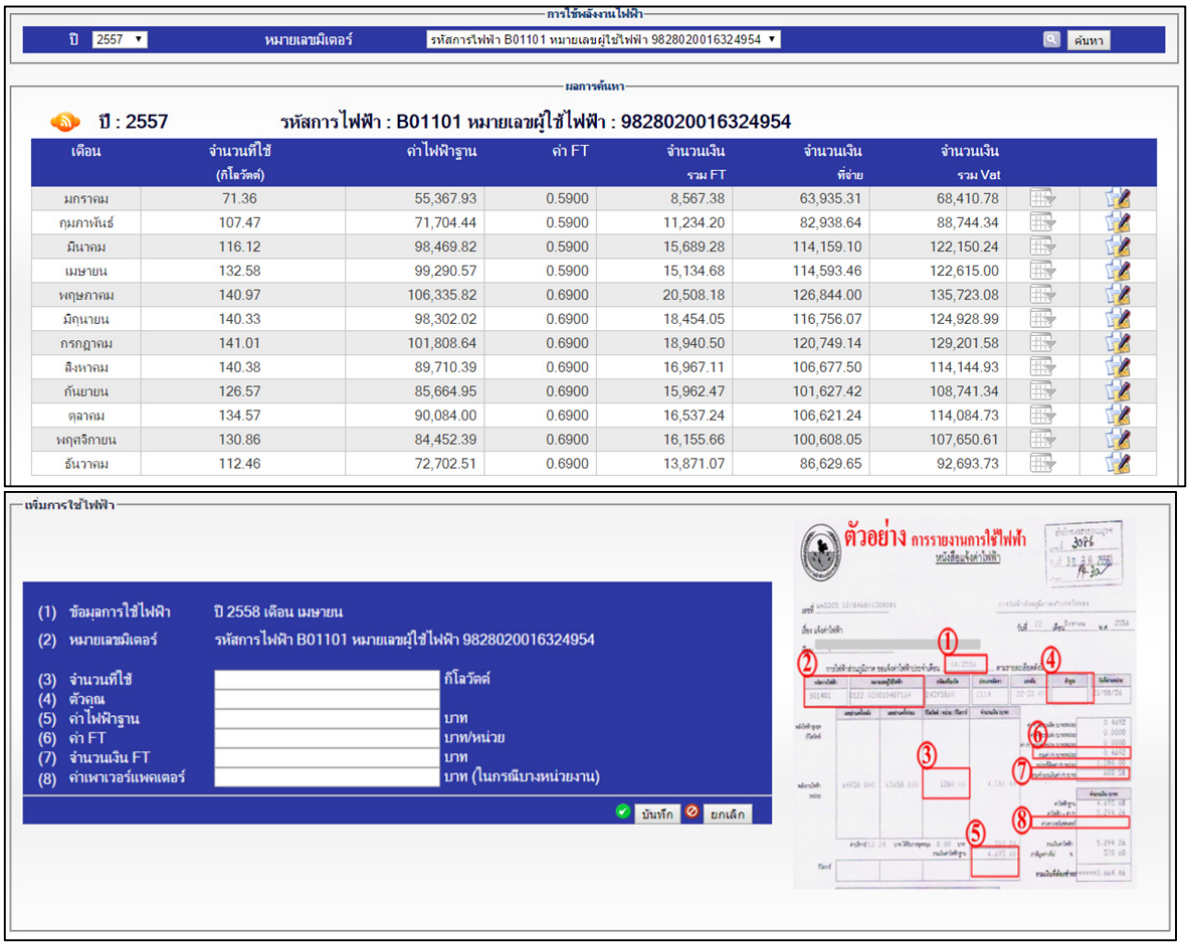
รถตู้ / Van

ลำดับที่	ชนิด / รุ่น	เชื้อเพลิง	ทะเบียนรถยนต์	จำนวนชั่วโมง	จำนวนวัน	จำนวนอุปกรณ์	ย้าย	แก้ไข	ลบ
1	โตโยต้า / Toyota	แก๊สโซฮอลล์	นข1831	6	5	1			
2	โตโยต้า / Toyota	ดีเซล	นข 1191	8	5	1			

รถจักรยานยนต์ / Motorcycle

ลำดับที่	ชนิด / รุ่น	เชื้อเพลิง	ทะเบียนรถยนต์	จำนวนชั่วโมง	จำนวนวัน	จำนวนอุปกรณ์	ย้าย	แก้ไข	ลบ
1	ฮอนด้า / Honda	แก๊สโซฮอลล์	ขขย 784	8	5	1			
2	ฮอนด้า / Honda	แก๊สโซฮอลล์	ขขย 785	8	5	1			
3	ซูซูกิ / Suzuki	แก๊สโซฮอลล์	กลก 870	8	5	1			
4	ซูซูกิ / Suzuki	แก๊สโซฮอลล์	กลก 871	8	5	1			
5	ซูซูกิ / Suzuki	แก๊สโซฮอลล์	ธ 7104	8	5	1			
6	ซูซูกิ / Suzuki	แก๊สโซฮอลล์	ธ 7105	8	5	1			
7	ซูซูกิ / Suzuki	แก๊สโซฮอลล์	ธ 7106	8	5	1			

Picture: Screenshot of page displaying data on motorised vehicles



Picture: Screenshot of page displaying electricity use data

Buildings

The City plans to reduce electricity consumption in buildings by implementing controlled usage of air conditioning. Air conditioners will be switched for shorter periods (i.e. 0900 – 1200 and 1300 – 1630) compared to the previous practice of allowing staff to operate the air conditioners without restrictions.

At the time of data collection, the management is in the process of establishing a new ~~main~~ municipal building with green building features and design, such as:

- Low heat absorbency materials ('eco-bricks')
- Layout which is conducive to natural air flow within the bulding, which will lower ambient temperature
- Double layered walls with sun reflecting materials on the west side of the building (facing the afternoon sun)
- High-efficiency air conditioners and lighting (T5 and LED bulbs)
- Strategic positioning of plants and green materials

This will provide an interesting research case study for comparing the differences of building electricity consumption between the old and new building, with the data collected in this report used as a baseline.

Transport

The City plans to lower vehicle fuel consumption by reducing the frequency of parcel delivery service among municipality offices, from twice to once daily.

To encourage walking and bicycle use, as well as to stimulate the local economy, the City has initiated the 'Walking Street' project since December 2009. The 'Walking Street' is located in the main road next to the market and is closed to motorised traffic one evening per week, allowing citizens to mingle and shop at market stalls. Through this, citizens develop a stronger sense of community, while local businesses are also boosted.

Phitsanulok City is also the second city in Thailand (after Bangkok) to implement bicycle sharing ('Pun Pun Phitsanulok'). The programme has been initiated in cooperation with BSP Joint Venture (3-year contract) since April 2014. There are 15 stations 5 bicycles per station, with operating hours of 0600 – 2000. Besides the 'Pun Pun Phitsanulok' scheme, several communities are also operating informal community-based bicycle sharing systems using old and donated bicycles which are repaired by local technicians.

Users will have to first apply for membership at the Municipality library counter. Membership fee was THB200 (About USD6) until end of promotion on 30th April 2014. After that, the normal membership is set at THB320 (USD10). Registered members receive a card which is used to access bikes at the sharing stations.

Bicycle use is free of charge for the first hour, and rates below are applied for additional hours of use:

- THB20 (2 – 3 hours)
- THB40 (3 – 5 hours)
- THB60 (3 – 5 hours)
- THB80 (6 – 8 hours)
- THB100 (> 8 hours)

Minutes are charged as full hour.

Benefits of the bike sharing programme to Phitsanulok City:

- BSP pays THB150,000 in 3 installments as follows:
    - First payment on the contract signing;
    - Second payment within one year after the signed contract; and
    - Third payment will be done within 2 years after the signed date.)
- BSP pays the municipality THB1,000 per station per month throughout the contract.
- BSP pays signboard taxes for:
    - 15 advertisement boards, size 2.4m x 4.8m
    - 150 signboards, size 1.2 m x 1.8m
    - 15 sign boxes, size 2.4m x 4.8m

As of 30 May 2014, the programme recruited a total of 760 members (311 men and 449 women), with a total of 5,819 uses recorded.

In addition to the bicycle sharing scheme, the City has been conducting the conversion of engines utilising national government subsidy/incentive programmes.

- Public Work Bureau: 4 trucks converted from diesel to NGV engines (3 waste container trucks which transfer waste from the transfer station to sanitary landfill site and one water truck at the transfer station)
- Public Health and Environment Bureau: 10 heavy trucks, 1 diesel pick-up truck and 1 van were converted from diesel to hybrid NGV engines

Although the City intends to expand its engine retrofitting exercises, this has been slowed down by technical issues. Apparently, many incidents of engine malfunction occurred after engine conversion but troubleshooting expertise is not easily accessible, which disrupts the municipality's operations.

Solid Waste

Phitsanulok City is well-known in Thailand and in the region for its innovative and successful approaches to urban environment management, particularly SWM.

The 'Phitsanulok Model' of community-based waste management, which emphasizes the people's participation, was developed from 1999 – 2007 with GIZ's assistance (formerly GTZ). The model has

been adopted by the national government (Department of Environmental Quality Promotion (DEQP)) for national replication under the Local Agenda 21 programme. From 1996 - 2012, waste generation was reduced by around 47% (142t to 74t per day; 1.8kg to 0.96kg daily per capita).

Phitsanulok City has garnered numerous national, regional and international awards (Table 13), and is recognised by ASEAN as a Model Environmentally Sustainable City.

Table 13: Awards Won by Phitsanulok Municipality in Environmental Management (1998 – 2012)

Prizes Won	Period/Year	Details
First Prize, Energy Reduction Campaign Contest	1998	Awarded by the Department of Local Administration (DoLA) and the National Municipality League of Thailand (NMT)
First Prize PCD Award for Solid Waste Management 2000 from Grand exhibition on solid waste management technologies	2000	Awarded by Pollution Control Department (PCD), Ministry of Science and Environment (formerly)
H.M. the King's Golden Pin and Symbolic Plaque	1997-2002	For a reforestation Programme Commemoration of The Royal Golden Jubilee at the city's former landfill, to honor the 50th Anniversary of the King's Ascension to the Throne.
First Prize Cleanliness Contest	2002	Awarded by DoLA and NMLT
PCD Awards 2002 for local Administration Organization with Efficient Solid Waste Management	2002	Awarded by PCD, Ministry of Science and Environment
Dubai International Awards, Best Practice Certificate for Community-Base Solid Waste Management(CBM)	2006	Awarded by the Dubai Municipality, Dubai-United Arab Emirates and the United Nations Human Settlements Programme (UN-HABITAT).
Local Administration Organization with Outstanding Environment Management Award	2007	Awarded by the Institute of Research and Consultation, Thammasat University under the sponsorship from Health Promotion Foundation and Thai National Public Health Foundation
Honorary plaque for supporting outstanding performances by two local communities (Srasonghong, Baromtilokanart 21) which won awards under the national Zero Waste Management Contest	2009 - 2012	Awarded by the Department of Environmental Quality Promotion (DEQP), Ministry of Natural Resources and Environment (MoNRE). Srasonghong Community won First Prize with Trophy given by Crown Princess Sirinthon. Baromtrilokanart 21 Community won a runner-up prize with an honorary plaque.
Honorary plaque for passing all of six categories of efficiency	2009	Awarded by PCD, MoNRE

evaluations for solid waste management		
ASEAN Environmentally Sustainable Cities Awards - Certificate of Recognition, Clean Land (small city category)	2011	Awarded by the ASEAN

Residential communities in Phitsanulok are categorised in three sizes: large (L) (> 300 households), medium (M) (100 – 300 households) and small (S) (< 100 households). Through the Phitsanulok Model of Community-based SWM, eight out of the 64 communities in the city are implementing community-based composting centres and 3R activities (Table 14).

Some of these centres also act as deposit centres for recyclables (plastics, paper, metals etc.) originating from the local community, as well as other communities. The operations are managed by the village committee. The income from the sales of recyclables is used for social welfare activities. For example, in Srasonghong Community, the income is managed as a community fund and used for financial contributions to community members' funerals and families with newborns. Proceeds have also been used to purchase a banana drying equipment to produce dried bananas, which further generates income for the community funds.

Table 14: Communities Active in Composting and 3R Facilities in Phitsanulok City

Community	Size	No. of Composting Centres	Other 3R Activities
Chan Vetchakit Pattana	L	• 12 central points • 6 backyard, household points	• Household-level waste sorting • Reduce plastic bags • Tree pots from plastic bottle • Used plastic bags are cleaned for reuse or sold at THB2/kg • Citrus washing detergent production from fruit and kitchen waste
Dee In Pattana	L	• 1 central point	• Household-level waste sorting • Tables and furniture are made with waste (hard) paper packaging
Ramesuan	L	• 1 central point	• Household-level waste sorting • Used plastic bags are cleaned for reuse or sold • Aluminium drink cans from coffee shops reused as flower pots around community
Sue Tim	L	• 12 central point • 6 backyard, household points	• Household-level waste sorting • Used plastic bags are cleaned for reuse • Reusing waste packaging, for example: used bottles as basket/containers of household waste, used wooden balls (*Ta kraw*) are made into decorative items, aluminimum tabs (from

			drink cans) and waste cloth are made into fashion accessorie, and used PVC pipes are assembled to as frames to hold plastic bags.
Borommatri Lokanard 21	M	• 2 central points	• Community waste bank activities are conducted (recyclables are collected and sold, and proceeds are used for community welfare activities)
Kalayanamitr	M	• 12 central points	• Used plastic bags are cleaned for reuse or sold/donated to Chan Vetchakit Community who sells the plastic to recycling factories. • Hard foam boxes are reused as tree pots • Waste cloths are recycled into handmade handicrafts • Cloth waste for handmade • Brooms are made from soft drink bottles and plastic bottles are reused and re-designed as chairs/furniture.
NongBua	M	• 4 central points	• No 3R activities are conducted. • Household at source separation
Srasonghong	S	• 3 central points	• Recyclables are collected, sold and the income used for community welfare activities • Artistic decorative products (3D Buddha wall paintings) made from recycled paper.

Organic and food waste from markets is informally sold as animal feed. In cooperation with IGES, the municipality has begun implementing a pilot project to expand composting for food wastes from hotels and markets since 2013. In preliminary activities, food and organic waste from municipality-owned markets (approximately 1,890t per year) is sent to composting plant at the sanitary landfill.

Mechanical Biological Treatment (MBT) has been implemented at various stages in the landfill since 2013. MBT is a pre-treatment of waste before final disposal. As landfill GHG emissions mainly originate from the anaerobic digestion of organic matter in waste, an objective of MBT is to maximise the decomposition of organic matter by microorganisms. Through this, MBT helps to prolong the lifespan of the landfill since the overall waste volume and density are reduced.

Mechanical Process: The treatment starts with a mechanical process where and large-sized of materials (e.g. car battery, tire, etc. which may damage a machine in next stage) are sorted and removed. This sorting is done manually or by machine. Next, waste is processed by a Homogenizer (a waste mixing machine). As collected waste is always packed into plastic bags, the Homogenizer has been designed with many teeth to tear off these plastic bags.

Biological process: The biological treatment process typically involves bio-drying, anaerobic digestion, fermentation or a mix of various methods.

In Phitsanulok's MBT facility, the homogenised waste (from the mechanical process) is unloaded and heaped into piles on top of a pallet base layer, like in compost making. The waste piles are controlled

for optimal pile size, moisture content, temperature and air circulation. Perforated corrugated tubes (special punched plastic pipes) are placed throughout the waste pile for air circulation with the passive aerated static method. The finished waste pile is covered with a layer of bio-filter which could be coconut sheets (or any local 'brown' material left from field in the area) to control odours and disturbance by animals.

After about 9 months, microorganisms have consumed all organic substances in the waste piles and the piles are reduced to 20% of its original volume. The result is a compost-like substance which is considered inert and may be safety placed in the landfill without producing excessive emissions of methane gas and leachate. The compost-like substance potentially offers the same quality as compost, but Phitsanulok Municipality prefers not to use it as fertilizer due to risks of from contamination of heavy metal resulting from the imperfect improper waste sorting process.

As an option, the treated waste can be screened by size into several fractions for different purposes. One fraction may be used as biomass fuel for gasification (a process to transform waste to biomass fuel). Another fraction may be used as landfill cover. Plastic bags, which have high calorific value, may be used: (a) as feedstock for a pyrolysis process; or (b) by mixing with coal to produce refuse-derived fuel (RDF) for cement production.

In Phitsanulok City, the plastic fraction of the treated waste is extracted by an air-blowing sieving system, compacted and transported as RDF (to substitute fossil fuel) to SCG cement plants in Saraburi or Lampang Province co-processing for cement plant. The initiative is still in an experimental phase. It has been agreed that SCG will accept and purchase RDF with a thermal calorific value of 5000 kcal/kg and above. As of 2014, this value is still fluctuating due to the inconsistent quality of feedstock and trial phase of processing.

A demonstration-scale biogas (using pig excrement as feedstock) is located at the municipal slaughterhouse, which processes about 240 pigs per day. About 200m^3 of biogas is generated per day to substitute 50kg of LPG (used for the slaughterhouse operations, particularly to produce hot water for scalding pigs), which amounts to a saving of THB300,000 (about USD10,000) per year.

Since May 2012, the municipality has also been implementing a project to recycle waste cooking oil from restaurants and households into biodiesel, in cooperation with the Royal Air Force and PTT (national oil and gas company). As of 2014, the collection rate has expanded to reach the production plant's maximum capacity of 2,000 litres per month.

Wastewater

Since 2010, Phitsanulok City has planned for a new wastewater treatment plant (an activated sludge system) to be located at the municipality-owned slaughterhouse, which would receive wastewater from the City's West Bank area (West of the Nan river). A public hearing was conducted on 18 May 2010.

Appendix A: Detailed Methodology

Institutional Structure, Data Collection Process and Data Sources

At the Project Inception Workshop (30 May 2013), IGES researchers held two sessions to introduce the basic concepts of climate change, low carbon city policies and main MRV frameworks to be applied in this project (i.e. ICLEI's Five Milestone Framework, the GPC and TGO's National Municipality Carbon Footprint Guidelines). The content of each session was tailored to suit the target audience.

- The first session in the morning targeted the high-level staff (Mayors, Deputy Mayors, Municipal Clerk and the head of departments/divisions);
- The second session was targeted at working level officers who would be primarily involved in the actual data collection for the municipal and city-level GHG inventory.

Since the scope of data collection is smaller for a municipality-level GHG inventory (only covering activities of municipal operations), it was agreed that the project would focus first to collect the data for a municipal GHG inventory, at least for the first quarter of the project duration.

The project discussed feasible institutional arrangements for data collection, taking into account the project's goal of establishing a sustainable approach (i.e. the municipality should be able to continue to collect independently (with technical guidance from IGES or other organisations, when required) the necessary data even after the project has closed.

It was assumed that in order for the process and system to be sustained, it had to be harmonised and integrated within existing institutional structures and processes, as far as possible. Since the organisational structure of Thai local governments are required to conform to guidance set by the central government, the institutional arrangements piloted by this project are conjectured to be replicable to other municipalities which are in the equivalent class of Phitsanulok Municipality.

Therefore, IGES researchers first conducted an institutional review of the municipality's organisational structure (Figure 5) and sought to understand the pre-existing procurement processes and rules relevant to key emission categories.

Based on that understanding, IGES researchers requested the Project Working Group to create a complete list of buildings/facilities under municipality control, and to indicate the buildings/facilities according to the jurisdiction of each department/divisions/bureau.

As a result, a total of 51 buildings were identified and listed according to their jurisdiction under each division (The complete list can be seen in Table). An excel form (a standard template) specifying all required data for reporting municipal-level GHG Inventory was issued to each building focal point for data collection.

The data collection process took many months, during which the Project Working Group held regular meetings to share experience and discuss the progress. IGES researchers kept track of the process remotely (via telephone meetings) and through on-site a total of 4 consultative meetings.

Towards the end of the project, the following two potential approaches for sustainable data collection within the municipality were considered:

Option A: Decentralised data collection system (Figure 8)

- This approach was innovated under this project, where focal persons in each of the 8 main departments/divisions were appointed and held responsible appointing supporting staff in each building/facility for data collection.
- Focal persons would use a standardised data collection form (in the initial stage of the project, it was an excel form. After the pilot Energy Reporting System was developed, it became an online form) for each building/facility, which was designed by IGES specifically for this project.
- Although this approach is decentralised, it still requires several overall coordinators from different departments/divisions/bureaus who would guide and persuade department/building focal points to cooperate with the regular and systematic data collection process.
- To address the issue of competing authority (department/division/bureau heads may not necessarily feel motivated to conform to the requests of other department heads of a similar or lower rank), an overall high-level coordinator position has to reside in a higher level above each department i.e. the Municipal Clerk, with the endorsement of the Mayor.
- The high-level coordinator should also be supported by several active and responsible working-level staff who are knowledgeable about MRV and systematic data collection approaches, as well as possessing positive social skills (ability to interact and persuade other working level staff to cooperate with the additional responsibilities of data collection, since there is no real concrete incentives for working level staff to conform to data collection duties, which are additional to existing formal duties.)

Option B: Centralised Approach (Figure 9)

- Most of the paper-based records containing the required data of a municipal GHG inventory (especially for energy (fuel) and electricity use) were recorded, as a matter of standard routine, in both soft (excel file and scanned documents) and hard copies (photocopies) as required the rules of the central government.
- Originals of documents are then submitted by the finance/admin. desk of each department/bureau/division on a monthly basis to the Bureau of Finance. Such records have to be filed and stored for up to 10 years.
- However, the Bureau of Finance is mainly concerned with processing payments and collating financial data (i.e. how much is spent, as opposed to units of consumption which is required for GHG inventory).
- The mandate for compiling and analysing the consumption data actually lies with the Division of Technical Services & Planning (which is akin to a ‘Research and Development’ or Statistical Unit conducting overall research to support policy decisions of the municipality);

- In this approach, the Bureau of Finance would need to coordinate with the Division of Technical Services and Planning, which will extract the relevant consumption-based data from financial documents.
- In addition, Phitsanulok Municipality would need to request data related to non-energy sources (solid waste, wastewater, material use, vehicle/equipment inventory etc.) which are not able to be derived from existing financial documents from the relevant departments, and to establish a procedure to update those data on a periodical basis

After a few months of trial, it was observed that Option A (Decentralised Approach) was more suitable and pragmatic in the case of Phitsanulok Municipality. Furthermore, the IT department, which is located in the Technical Services & Planning Division, created an in-house pilot online energy reporting system, where building/facility focal points could log in online to key in data more easily as compared to collecting data via numerous excel files.

Challenges Encountered

In general, much of the data required for municipality-level GHG inventory can be accessed or are already being collected in existing processes. Table 15 explains the types of data collected, linkages to existing process/Sources and specific challenges.

The broad challenges were encountered as follows:

- Financial data, not consumption data are usually recorded (e.g. for electricity, only the amount paid as billed is recorded.)
- Some data are missing due to lack of routine and proper filing and storage practices.
- A de-centralised approach requires cooperation from staff to collect data, who may perceive such work as an added burden to their existing workload. ‘Silo mentality’ (in the case of high-level staff) and lack of understanding of the purposes and helpfulness for such data collection (in the case of working-level staff) are also barriers.
- Lack of technical knowledge, in certain cases, may lead to incorrect data being collected. This depends on how well the overall coordinator explains the type of data that is required, and the quality control capacity of the coordinator to check and ensure that wrong data is not collected.

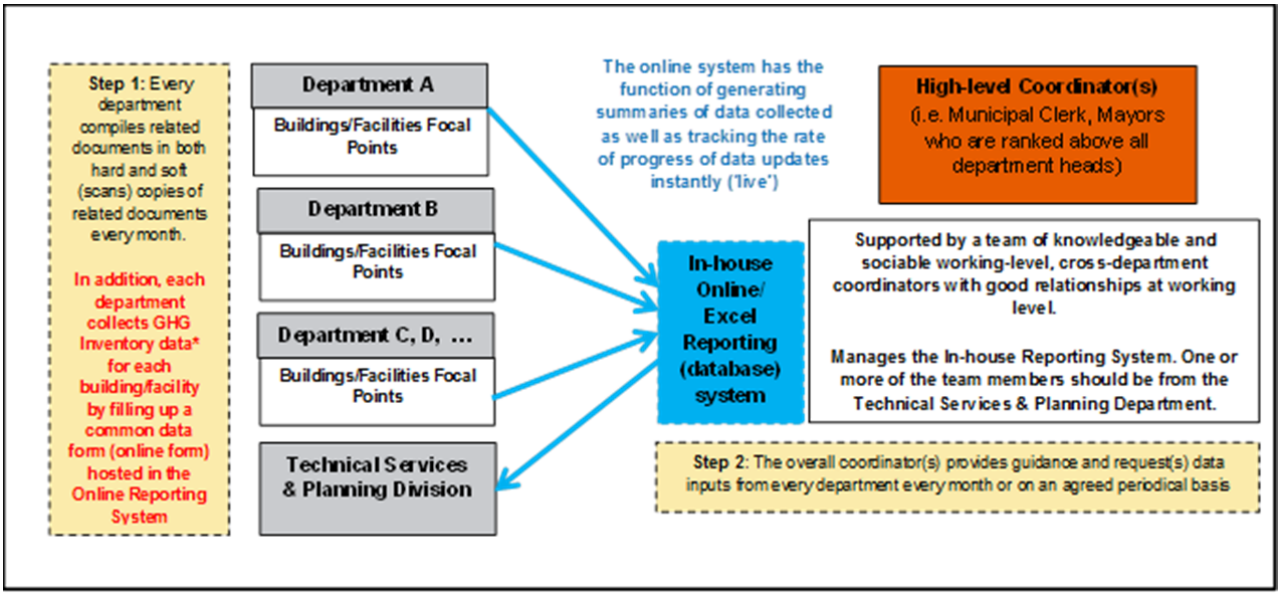


Figure 8: Decentralised approach of GHG data collection (adopted in Phitsanulok Municipality)

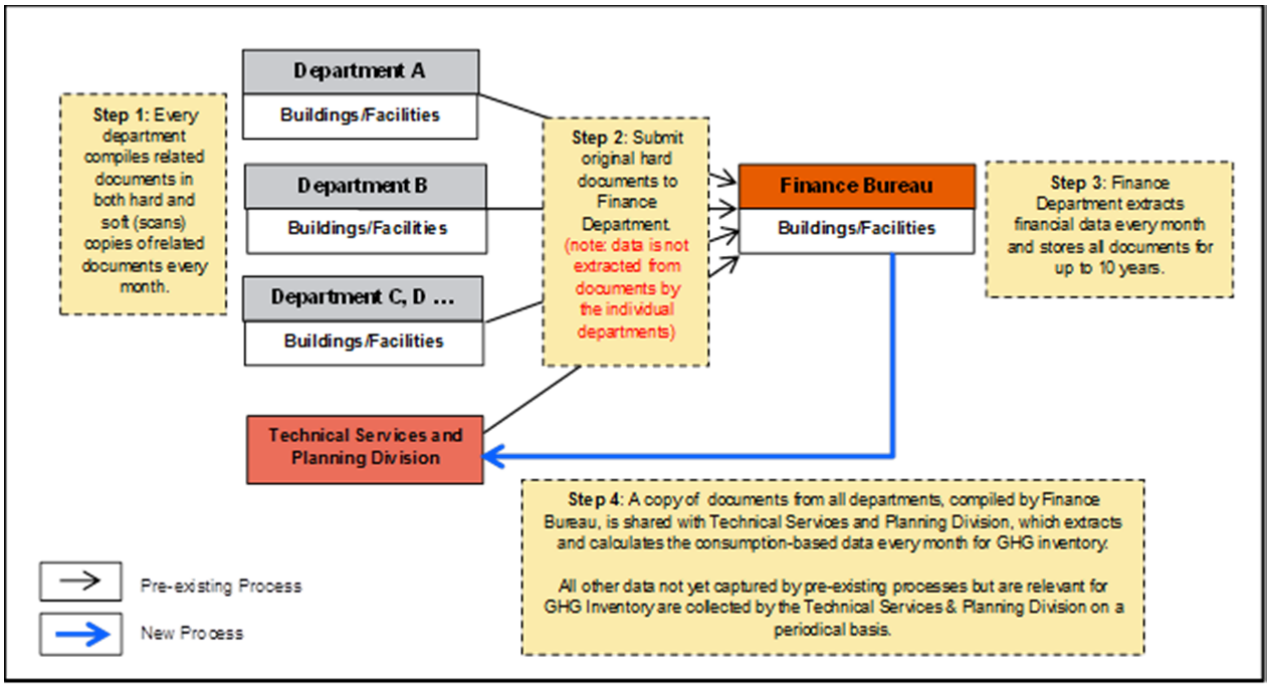


Figure 9: Centralised approach of GHG data collection

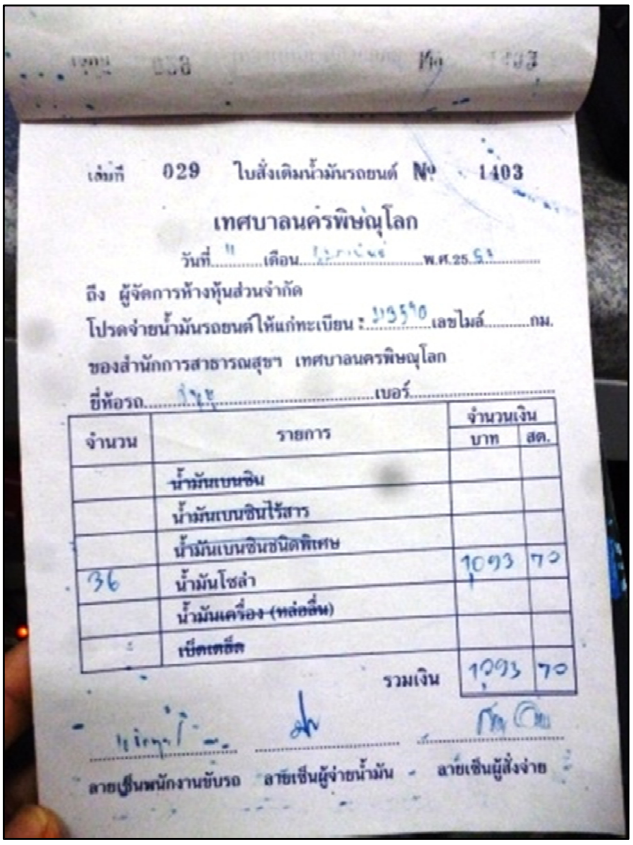
Table 15: Types of Data Collected, Linkages to Existing Process/Sources and Particular Challenges

Type of Data	Linkages with existing process and sources of data	Adjustment to existing data/procedures required for collection for GHG Inventory	Particular Challenges for Collecting Data
Electricity Consumption (Buildings / Stationary Sources)	• Monthly electricity bills (which are linked to electricity meters of buildings) • Only financial data is collected, not number of units consumed	• Record the number of units consumed • Scanning of electricity bill as evidence for verification by 3rd party.	• Electricity meters are not necessarily installed for each building/facility. In some cases, several buildings shared one meter. Some effort is required to clarify this. • It is actually not possible to capture total electricity consumption of municipality operations from electricity bills of buildings, since the municipality is subsidized for a large portion of its electricity expenses (up to 10% of total consumption of electricity by the household sector within the city). This subsidy is applied to buildings offering public services. • Hence, the total electricity consumption needs to be requested from the Provincial Electricity Authority (PEA)[17], by supplying the list of metres in municipality buildings/facilities. PEA's database system does not allow easy and quick scaling down of data limited to only the municipality's buildings/facilities/operations.
Fugitive Emissions (Buildings and Stationary Sources)	• Bills when air-conditioning units, vehicle air-conditioners and fire extinguishers are serviced.	• Same as above	• Municipality staff were not knowledgeable about the type of refrigerants being used. • It is not customary for the amount of refrigerant to be indicated on the service bill. This has to be enquired and requested of the service provider.
Fuel consumption (Buildings and Stationary Sources)	• None	• Please see explanation on the right.	• Fuel purchase records are not available for fuel used in off-road/non-travel vehicles such as fogging machines, grass cutting and water pumping trucks. Fuel is bought in bulk and not tracked by

[17] PEA is a Government Enterprise in the utility sector attached to the Interior Ministry, was established on 28 September 1960 under the Provincial Electricity Authority Act B.E. 1960. The Provincial Electricity Authority's primary responsibilities include generation, procurement, distribution and sale of electricity to the public, business and industrial sectors in 74 provinces, over a nationwide area of 510,000 square kilometers or 99.4% of Thailand, with the exception of Bangkok, Nonthaburi and samut Prakarn provinces

			vehicle/machine. Therefore, the data has to be estimated on a per use basis.
Fuel Consumption – Mobile (Municipality Vehicle Fleet)	• Fuel purchase records (please see photo and translation in the next page) contain the amount and type of fuel purchased.	• None	• The data collected in this project did not include the data of fuel consumed by outsourced waste collection company covering the West side of the city. • The municipality did not conduct a Staff Commuting Survey as recommended by standard protocols of ICLEI and TGO.
List of electric/electronic appliances, equipment and devices (including air-conditioners and fire extinguishers) **List of vehicles**	• Municipalities are already required to maintain a list of municipality assets which should be updated on an annual basis. • The list of assets include electric/electronic appliances, as well as vehicles.	• Operating hours of lights and air-conditions • Brand, capacity and other more technical specifications of appliances/equipment and devices	• The consistency of the type of information recorded for each equipment/device/vehicle was uneven across departments.
Consumption of products with embedded upstream emissions (e.g. paper)	• Purchase records	• See right.	• The purchase and consumption of paper and other products are not routinely monitored in most cases, so measures have to be introduced to collect this data.
Waste generated from municipality operations and city	• Weighbridge at landfill	• None in particular	• None in particular as the municipality has relatively good data collection system (weighbridge) for waste management.
Amount of wastewater generated from municipality operations	• The municipality has no wastewater treatment systems. Hence emission data has to be derived from amount of water supplied to	• None in particular	• The size of septic tanks was estimated. This information is not available for some buildings, as building plans for old buildings were lost. • The accuracy of the data should be properly verified and enhanced over time.

	municipal operations, and also estimated based on the size of septic tanks for each building.		
Fertiliser Use	Purchase records of fertilizers.	None in particular	None in particular
Tree Inventory	The municipality does not conduct a tree inventory as part of its normal operations. However, Phitsanulok Municipality has a very comprehensive tree inventory which was developed in its bid to compete for the ASEAN ESC Awards 2011.	Tree inventory has to be adopted as part of municipal tasks.	Conducting tree inventory is basically extremely time consuming and does not serve any easily understood purposes for working-level staff, hence is not likely to be prioritised. Skills for tree inventory may not be available within the municipality. However, this does nto seem to be a problem for Phitsanulok Municipality staff.



เล่มที่ 029 ใบสั่งเติมน้ำมันรถยนต์ No 1403

เทศบาลนครพิษณุโลก

วันที่ 11 เดือน [illegible] พ.ศ.25[illegible]

ถึง ผู้จัดการห้างหุ้นส่วนจำกัด

โปรดจ่ายน้ำมันรถยนต์ให้แก่ทะเบียน : 3[illegible] เลขไมล์ ..... กม.

ของสำนักการสาธารณสุขฯ เทศบาลนครพิษณุโลก

ยี่ห้อรถ [illegible] เบอร์ .....

จำนวน	รายการ	จำนวนเงิน บาท	สต.
	~~น้ำมันเบนซิน~~		
	น้ำมันเบนซินไร้สาร		
	น้ำมันเบนซินชนิดพิเศษ		
36	น้ำมันโซล่า	1093	70
	~~น้ำมันเครื่อง (หล่อลื่น)~~		
	~~เบ็ดเตล็ด~~		
	รวมเงิน	1093	70

ลายเซ็นพนักงานขับรถ ลายเซ็นผู้จ่ายน้ำมัน ลายเซ็นผู้สั่งจ่าย

Translation to English

Fuel request

PHS Municipality

D/m/y

To Manager of gas station

Please fill in the petrol to vehicle no. _____which belongs to Public Health and Environment Bureau.

Type of vehicle__i.e.Isuzu___

Quantity, type of fuel, amount in baht and signed by the driver, the director and the Gas station's manager.

Picture: An example of the fuel request form used by the City

Case Study of Data Collection Work in one Department

To better understand the actual process of data collection, data sources as well as the practical challenges, the research team conducted a focused interview with the focal point for the Department of Education.

The Department of Education is in charge of the management and operations of 11 buildings/facilities, comprising 5 municipal schools, a public basketball court, a public badminton court, football court, public library, ICT Centre and Child Development Centre.

Ms. Katsanee Praison (left photo) oversees the management of 3 out of 11 buildings. Although her position does not oversee all 11 buildings of the Department of Education, she has been assigned the role of the overall Department Focal Point by her superiors, due to her high capacity and initiative in low carbon city related activities.

She coordinates and seeks the cooperation of each building's focal points to collect the required data covering: (a) electricity consumption; (b) on-site fuel consumption; (c) list of electronic/electric appliances and equipment; and (d) list of vehicles. These data are actually accessible or collected via existing rules/procedures prescribed by the central government.

According to Ms. Praison, it is not difficult to collect the additional data required for GHG Inventory with the cooperation of her staff. The admin clerks of the department or building can usually handle the data collection, with proper explanation.

She cites the following factors for effective data collection within her department:

- She takes a personal interest in sustainable, low-carbon city development and is willing to take the initiative to support this project;
- She works closely with the working-level staff from the IT department, who help to provide support and reminders to motivate staff to collect the data and input into the online reporting system;
- The IT department appears to be a 'natural coordinator' for such data collection, for the following reasons:
- They have a neutral service provision role within the municipality (setting up networks, computer/IT systems for all municipality operations). Through this, they become acquainted and interact with the staff of all 8 departments on a regular basis. This helps to establish trust and good relationships, which is conducive for eliciting cooperation in the data collection process.

- They reside within the Technical Services & Planning Division of the municipality, which has the mandate of conducting research to support development policy of the municipality
- The IT department staff are professionally trained in systematic approaches of collecting and handling data, hence they are able to grasp the concepts and principles of MRV easily, and to design the systems to support the MRV process. This resulted in the in-house energy data reporting system.
- A reflection of the IT department's initiative and skill is demonstrated in how they designed step-by-step instructions to staff for data collection, shown in the Figure 10 below for guiding staff on extracting data from electricity bills.

When asked of the benefits of data collection introduced through this project, Ms. Praison cited the following:

- **Improved technical knowledge** about specifications of electric/electronic equipment and vehicles. For example after this project, she was sensitised to concepts such as the brands, power/capacity of air-conditions and lighting, and she did her own research to learn how such information could be related to energy conservation and efficiency.
- Previously, the **routine collection of data**, including the types and depth of data, was not well enforced. After this project, the regularity and depth of data was improved.
- The data collected (both the consumption data and list of equipment/appliances/lighting/vehicles) and was perceived as useful as **quantitative information to justify the purchase of more costly, yet higher quality** (longer-lasting, more energy-efficient) lights, for example. Previously, without such data there was no objective evidence to justify the one purchasing decision over another. Hence, cost was the sole factor for making purchases (buying the cheapest choice, but those may often break down).

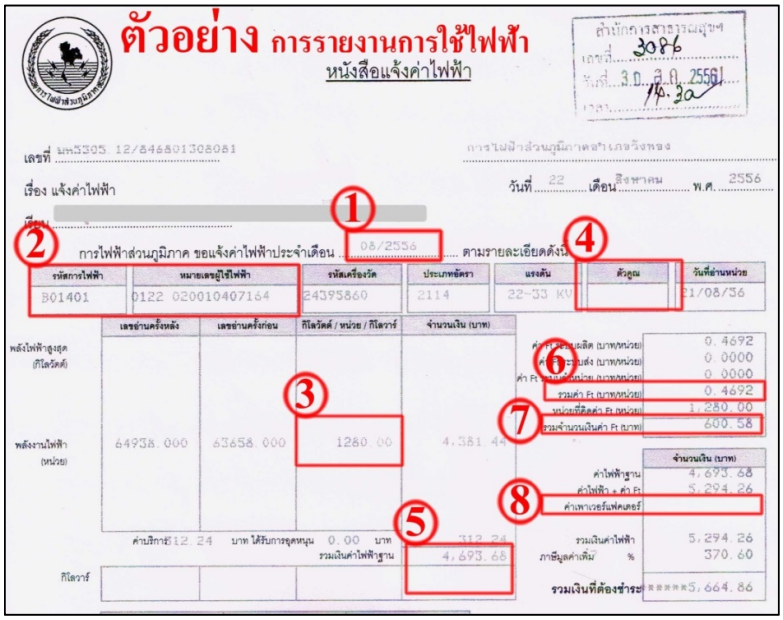
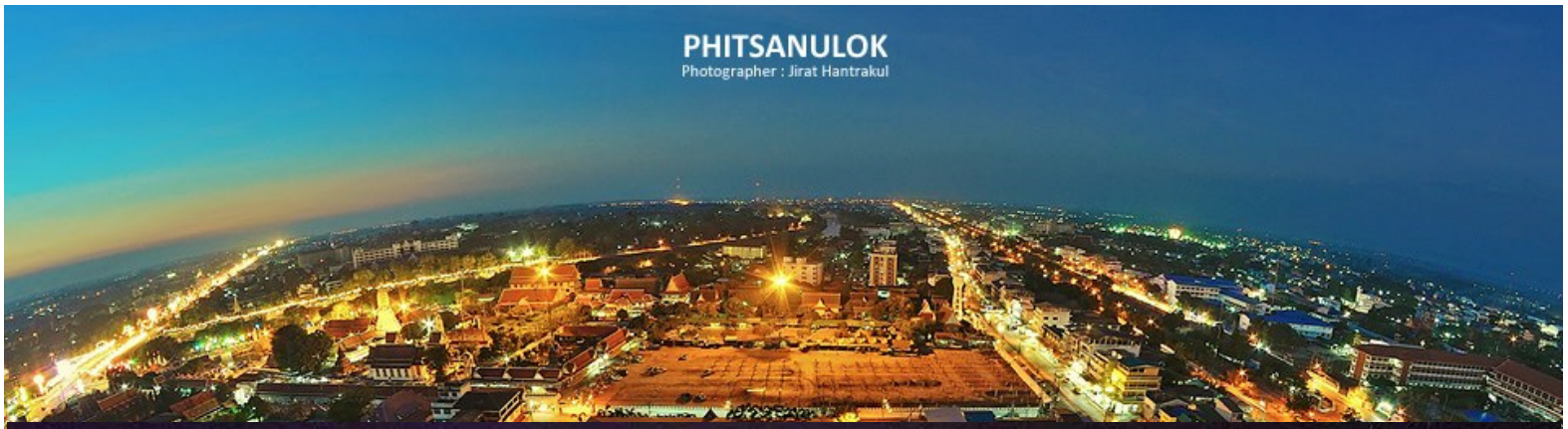


Figure 10:
The step-by-step instructions designed by the IT Department to guide building/department focal points on data entry via the Pilot Online Energy Reporting System

Appendix B: Full Summary Table of Municipal GHG Emissions FY2013


PHITSANULOK
Photographer : Jirat Hantrakul


Passakorn Petcharat
www.facebook.com/passakorn.petcharat
ohmpassakorn@hotmail.com T.089-6405536

Appendix B: Full Summary Table of Municipal GHG Emissions FY2013

Scope	Sector	Activity Data Source	Data Quality	Amount	Units	Emissions (tCO_2e)	% of Total Emissions	Emission Factors								
								CO_2	Unit	Source	CH_4	Unit	Source	N_2O	Unit	Source
Buildings and Other Facilitie																	
1	*Stationary Combustion*																
2	Purchased Electricity for Municipal Buildings (excluding water supply and waste management facilities)	Provincial Electricity Authority (PEA) records	Medium	3,528,319	kWh	1,979	8	0.561	kg CO_2e/kWh	"Guideline on Carbon Footprint Assessment for Organization" (TGO)						
Streetlights and Traffic Signal																	
2	Purchased Electricity	Calculated from lighting inventory	Medium	2,643,371	kWh	1,483	6	0.561	kg CO_2e/kWh	TGO						
Water Supply																	
1	*Stationary Combustion*																
2	Purchased Electricity	Monthly electricity bills	Medium	8,117,072	kWh	4,554	18	0.561	kg CO_2e/kWh	TGO						
1	Tap Water Treatment (City's own consumption)	Municipality water treatment plant records	Medium	9,483,132	m^3	250	1	0.0264	kg CO_2e/m^3	Metropolitan Waterworks Authority (Thailand);TGO						
3	Tap Water Treatment (Other cities' consumption)	Municipality water treatment plant records	Medium	2,719,198	m^3	72	0	0.0264	kg CO_2e/m^3	Metropolitan Waterworks Authority (Thailand);TGO						
Wastewater Facilities																	
1	Septic systems with no treatment, direct discharge[a]	Municipality water treatment plant records		9,483,132	m^3	296	1	0.625	kg CO_2e/kg COD	TGO	0.025	kg CH_4/kg COD	TGO			
Port Facilities																	
Airport Facilities																	
Vehicle Flee																	
1	Mobile Combustion																
	- Diesel	Monthly fuel purchase records	Medium	495,177	L	1,359	5	2.7446	kg CO_2e/L	IPCC 2007						
	- Gasoline		Medium	3,873	L	8	0	2.1896	kg CO_2e/L	IPCC 2007						
	- Gasohol		Medium	31,376	L	69	0	2.1896	kg CO_2e/L	IPCC 2007						
	- CNG		Medium	77,161	Cu. Ft.	4	0	0.054	kg CO_2e/Cu. Ft.	EPA Climate Leaders Mobile Combustion Guidance 2007						
2	*Purchased Electricity*															
3	*Employee Commute*															
Power Generation Facilities																	
Solid Waste Facilitie																	
1	*Stationary Combustion*																
1	Composting (at-source)	Rough estimate by municipality staff	Low	1,890,000	kg	358	1				4	g CH_4/kg waste	TGO	0.3	g N_2O/kg waste	TGO
2	Purchased Electricity	Rough estimate by municipality staff	Low	77,615	kWh	44	0	0.561	kg CO_2e/kWh	TGO						
3	Landfilled Waste[b]	Weighbridge records	Low	26,522,257	kg	14,666	58				0.022	t CH_4/t MSW	Estimated by authors			
Fugitive Emissions & Other																
1	Fertiliser Used	Rough estimate by municipality staff based on purchase records	Low	4,440	kg	4	0									
	N (assume 15% of weight)			666	kg	2	0	3.303643	kg CO2e/kg	TGO				0.01	kg N_2O–N (kg N)-1	IPCC
	P (assume 15% of weight)			666	kg	1	0	1.571609	kg CO2e/kg	TGO						
	K (assume 15% of weight)			666	kg	0	0	0.497353	kg CO2e/kg	TGO						
1	*Refrigerants - Buildings*															
1	*Refrigerants - Vehicles*															
	TOTAL					**25,149**	**100**									

Notes [a] Very rough calculation. Assumes that the value of 0.0005kg/L COD for 12,202,430m^3 (12,202,430,000L) tap water produced, and half of produced water are discharged as wastewater into drains and 10% of organic fraction are degraded into GHG.

[b] For landfilled waste, it was assumed that 4g of CH_4 was released per kg of waste treated. On a wet weight basis. Assumption on the waste treated: 25-50% DOC in dry matter, 2% N in dry matter, moisture content 60%.

[c] Global Warming Potentials are from IPCC 4th Assessment Report

[d] TGO Carbon Footprint: GHG Emissions from Fertilizer (http://thaicarbonlabel.tgo.or.th/carbonfootprint/index.php?page=7)