

**EMISSION FACTOR FOR HOUSEHOLD VOCs IN RAYONG  
PROVINCE, THAILAND**

**JUTAMAS KHAOSANG**

**A THESIS SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTER OF SCIENCE  
(ENVIRONMENTAL TECHNOLOGY)  
FACULTY OF GRADUATE STUDIES  
MAHIDOL UNIVERSITY  
2014**

**COPYRIGHT OF MAHIDOL UNIVERSITY**

Thesis  
entitled  
**EMISSION FACTOR FOR HOUSEHOLD VOCs IN RAYONG  
PROVINCE, THAILAND**

.....  
Miss Jutamas Khaosang  
Candidate

.....  
Asst. Prof. Sarawut Thepanondh,  
Ph.D. (Atmospheric Science)  
Major advisor

.....  
Asst. Prof. Sopa Chinwetkitvanich,  
Ph.D. (Environmental Engineering)  
Co-advisor

.....  
Assoc. Prof. Wanida Jinsart,  
Ph.D. (Chemistry & Biochemistry)  
Co-advisor

.....  
Prof. Banchong Mahaisavariya,  
M.D., Dip Thai Board of Orthopedics  
Dean  
Faculty of Graduate Studies  
Mahidol University

.....  
Assoc Prof. Prayoon Fongsatitkul,  
Ph.D. (Environmental Engineering)  
Program Director  
Master of Science Program in  
Environmental Technology  
Faculty of Graduate Studies  
Mahidol University

Thesis  
entitled  
**EMISSION FACTOR FOR HOUSEHOLD VOCs IN RAYONG  
PROVINCE, THAILAND**

was submitted to the Faculty of Graduate Studies, Mahidol University  
for the degree of Master of Science (Environmental Technology)

on  
March 28, 2014

.....  
Miss Jutamas Khaosang  
Candidate

.....  
Assoc. Prof. Poranee Pataranawat,  
Ph.D. (Env. Toxicol, Tech & Mgt.)  
Chair

.....  
Asst. Prof. Sopa Chinwetkitvanich,  
Ph.D. (Environmental Engineering)  
Member

.....  
Asst. Prof. Sarawut Thepanondh,  
Ph.D. (Atmospheric Science)  
Member

.....  
Assoc. Prof. Wanida Jinsart,  
Ph.D. (Chemistry & Biochemistry)  
Member

.....  
Prof. Banchong Mahaisavariya,  
M.D., Dip Thai Board of Orthopedics  
Dean  
Faculty of Graduate Studies  
Mahidol University

.....  
Assoc Prof. Phitaya Charupoonphol,  
M.D., Dip Thai Board of Epidemiology  
Dean  
Faculty of Public Health  
Mahidol University

## ACKNOWLEDGEMENTS

I would like to express my profound gratitude to my thesis advisor, Assistant Professor Dr. Sarawut Thepanondh, for his valuable guidance, advice and assistance throughout the entire duration of this study. And especially strong encouragement during my thesis study. Special respect and thanks are also extended to Assist.Prof.Sopa Chinwetkitvanich, and Assoc. Prof. Wanida Jinsart for their contribution to the examination of this thesis and providing suggestions for improvement.

I would like to thank all staff of the Department Sanitary Engineering, and laboratory of Faculty of Public Health, Mahidol University for kindly supporting me to finish this thesis.

I wish to thank all my friends who are always nice and friendly, for their consolation and support given to me during my study.

Finally, I would like to express my deep sense of appreciation to my family for their understanding, moral support, financial support, entire care and unconditional love and encouragement throughout. I dedicate to my father and my mother; Mr. Suchart Khaosang and Mrs. Kamonchanok Khaosang who support that have enable me to succeed in my life.

Jutamas Khaosang

**EMISSION FACTOR FOR HOUSEHOLD VOCs IN RAYONG PROVINCE, THAILAND**

JUTAMAS KHAOSANG 5536068 PHET/M

M.Sc. (ENVIRONMENTAL TECHNOLOGY)

THESIS ADVISORY COMMITTEE: SARAWUT THEPANONDH, Ph.D. (ATMOSPHERIC SCIENCE), SOPA CHINWETKITVANICH, Ph.D. (ENV. ENG.),  
WANIDA JINSART, Ph.D. (CHEMISTRY & BIOCHEMISTRY)

**ABSTRACT**

This study aimed to develop the emission factor of household VOCs. The emission factor and emission inventory of household chemical activity are developed taking into consideration local characteristics of the households in Thailand. Activities data in this study are collected in Rayong province. These data will serve and assist in developing the emission database under the Pollutant Release and Transfer Registration (PRTR) program for a non-point source emission estimation. Emission factors of NO<sub>x</sub>, based on amount of LPG usage per household per year are calculated for different size of household. These values are 142.20, 213.30 and 426.60 kg of NO<sub>x</sub> /1000 household/year for small, medium and large sizes of household, respectively. It is estimated that the total amount of NO<sub>x</sub> emissions from household's LPG cooking will be about 60.31 tons per year in Rayong province.

Four VOCs, listed under PRTR target chemical were estimated for their emission rate and amount of release per year. Emission factor of isopropyl alcohol from the use of cleaning product was 0.266 kg/1000 household/year. Emission factor of 1,4-Dichlorobenzene and naphthalene 234.046 kg/1000 household/year and 45.057 kg/1000 household/year, respectively. Emission factor of acetone from the use of nail cleaning product was 16.534 kg/1000 household/year. Emission amounts were estimated as 90.282 kg/year, 79,316.880 kg/year, 15,269.534 kg/year and 5,603.358 year for isopropyl alcohol, 1,4-Dichlorobenzene, naphthalene and acetone, respectively.

**KEY WORDS: OXIDE OF NITROGEN (NO<sub>x</sub>) / HOUSEHOLD / LIQUEFIED PETROLEUM GAS (LPG) / PRTR / HOUSEHOLD CHEMICALS**

110 pages.

EMISSION FACTOR สำหรับสารอินทรีย์ระเหยจากครัวเรือนในจังหวัดระยอง ประเทศไทย

EMISSION FACTOR FOR HOUSEHOLD CHEMICALS IN RAYONG PROVINCE, THAILAND

จุฬามาศ ขาวสังข์ 5536068 PHET/M

วท.ม. (เทคโนโลยีสิ่งแวดล้อม)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์ : สราวุธ เทพานนท์, Ph.D. (ATMOSPHERIC SCIENCE),  
โสภา ชินเวชกิจวานิชย์, Ph.D. (ENV. ENG.), วนิดา จินสาสตร์ (CHEMISTRY & BIOCHEMISTRY)

#### บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อพัฒนาค่า Emission factor จากสารอินทรีย์ระเหยที่ใช้ในครัวเรือน โดยค่า Emission factor และค่าปริมาณการระบายมลพิษของกิจกรรมการใช้สารอินทรีย์ระเหยในครัวเรือน ได้รับการพัฒนาโดยคำนึงถึงลักษณะเฉพาะของท้องถิ่นของครัวเรือนในประเทศไทย ข้อมูลกิจกรรมในการศึกษานี้จะถูกเก็บรวบรวมในจังหวัดระยอง ข้อมูลเหล่านี้สามารถใช้เป็นข้อมูลสนับสนุนในการพัฒนาฐานข้อมูลการปล่อยมลพิษภายใต้การดำเนินงานด้านการประเมินการปลดปล่อยและเคลื่อนย้ายสารมลพิษ (PRTR) สำหรับแหล่งกำเนิดประเภท non-point source ค่า Emission factor ของออกไซด์ของไนโตรเจน ( $\text{NO}_x$ ) อ้างอิงจากปริมาณการใช้แก๊สแอลพีจีต่อครัวเรือนต่อปีของครัวเรือนแต่ละขนาด มีค่าเท่ากับ 142.2, 213.3 และ 426.6 กิโลกรัมของ  $\text{NO}_x$  ต่อ 1000 ครัวเรือนต่อปี สำหรับครัวเรือนขนาดเล็ก ครัวเรือนขนาดกลาง และครัวเรือนขนาดใหญ่ ตามลำดับ โดยปริมาณการระบาย  $\text{NO}_x$  จากการใช้แก๊สแอลพีจีในการประกอบอาหารจากครัวเรือนมีค่าประมาณ 60.31 ตันต่อปีในจังหวัดระยอง

การศึกษานี้ได้พัฒนาค่า Emission factor และปริมาณการระบายต่อปีของสารอินทรีย์ระเหยทั้ง 4 ชนิด ที่ปรากฏในรายการสารเคมีของ PRTR โดยค่า Emission factor ของสาร ไอโซโพรพิลแอลกอฮอล์ จากการใช้ผลิตภัณฑ์ทำความสะอาด มีค่าเท่ากับ 0.266 กิโลกรัมต่อ 1000 ครัวเรือนต่อปี สาร 1-4 ไดคลอโรเบนซีน มีค่าเท่ากับ 234.046 กิโลกรัมต่อ 1000 ครัวเรือนต่อปี สารแนฟทาลีน มีค่าเท่ากับ 45.057 กิโลกรัมต่อ 1000 ครัวเรือนต่อปี และสารอะซีโตน มีค่าเท่ากับ 16.534 กิโลกรัมต่อ 1000 ครัวเรือนต่อปี โดยปริมาณการระบายต่อปีของสาร ไอโซโพรพิลแอลกอฮอล์, 1-4 ไดคลอโรเบนซีน, สารแนฟทาลีน และสารอะซีโตน ที่ระบายจากการใช้สารเคมีในครัวเรือนมีค่าเท่ากับ 90.282 กิโลกรัมต่อปี, 79,316.880 กิโลกรัมต่อปี, 15,269.534 กิโลกรัมต่อปีและ 5,603.358 กิโลกรัมต่อปี ตามลำดับ

## CONTENTS

	<b>Page</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>ABSTRACT (ENGLISH)</b>	<b>iv</b>
<b>ABSTRACT (THAI)</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>LIST OF FIGURES</b>	<b>x</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xi</b>
<b>CHEPTER I INTRODUCTION</b>	<b>1</b>
1.1 Rationales and Justifications	1
1.2 Research objective	2
1.3 Scope of study	2
1.4 Expected outcome	2
1.5 Definition of keywords	2
1.6 Conceptual framework	4
<b>CHEPTER II LITURATURE REVIEW</b>	<b>5</b>
2.1 Pollutant Release and Transfer Registers (PRTR)	5
2.1.1 PRTR chemical	6
2.2 Household chemical	17
2.2.1 Household Chemicals Chart	17
2.3 Related Research	24
<b>CHEPTER III METERIALS AND METHODS</b>	<b>28</b>
3.1 Study area	28
3.2 Sample selection	29
3.3 Selection of selected chemical	30
3.4 Questionnaire survey	32
3.5 Analysis of household chemical	32
3.6 Experimental setup	34

**CONTENTS (cont.)**

	<b>Page</b>
<b>CHAPTER IV RESULTS AND DISCUSSION</b>	<b>35</b>
4.1 Spatial allocation of household sample	35
4.2 Size of household	36
4.3 Emission factor of household	36
4.3.1 Oxide of nitrogen (NO <sub>x</sub> )	36
4.3.2 Summary of emission factor of NO <sub>x</sub> from household	39
4.3.3 Household VOCs	40
4.3.4 Summary of emission factor of household VOCs	46
4.4 Calculation of emission amount	46
4.4.1 Emission amount of NO <sub>x</sub> from household	46
4.4.2 Emission amount of household chemical	50
<b>CHAPTER V CONCLUSIONS AND RECOMMENDATIONS</b>	<b>52</b>
5.1 Conclusions	52
5.2 Recommendations for further study	55
<b>REFERENCES</b>	<b>56</b>
<b>APPENDICES</b>	<b>59</b>
Appendix A Taro Yamane calculation	60
Appendix B Questionnaire survey of household chemicals	61
Appendix C Questionnaire survey of NO <sub>x</sub> from household	67
Appendix D Questionnaire survey of household chemicals	94
<b>BIOGRAPHY</b>	<b>110</b>

## LIST OF TABLES

<b>Table</b>	<b>Page</b>
2.1 List of the Thai's PRTR target chemical	6
2.2 Household chemicals	17
3.1 Spatial allocation of household sample	30
3.2 Selection matrix for household target chemical	31
3.3 Average household size	33
4.1 Spatial allocation of household sample	35
4.2 Size of household from the survey result	36
4.3 Emission factor from combustion of LPG (residential cooking)	38
4.4 Emission factor of NO <sub>x</sub> from LPG	40
4.5 Amount of isopropyl per bottle of cleaning product	41
4.6 Average consumption of product containing isopropyl alcohol	41
4.7 Emission factor of isopropyl alcohol per 1000 household per year	42
4.8 Total consumption of deodorant of household per year	42
4.9 Consumption of mothball in household	44
4.10 Amount of acetone in nail cleaning product	45
4.11 Consumption of acetone per year	45
4.12 Emission factor from the use of household chemicals	46
4.13 Emission inventory of NO <sub>x</sub> from household for each districts in Rayong province	47
4.14 Emission inventory of NO <sub>x</sub> from household in Rayong province	48
4.15 Emission amount of chemicals from household (unit: kg/year)	50
4.16 Emission rate of household chemical per area (kg/km <sup>2</sup> )	51
5.1 Emission factor of NO <sub>x</sub> from household cooking	52
5.2 Emission factor of chemicals from household activity	53
5.3 Summary of emission amount of PRTR chemical from household activity (unit: kg/y)	53

**LIST OF TABLES (cont.)**

<b>Table</b>	<b>Page</b>
5.4 Area-based emission factor of household (unit: kg/km <sup>2</sup> )	54

## LIST OF FIGURES

<b>Figure</b>	<b>Page</b>
1.1 Conceptual Framework	4
3.1 Rayong map	28
3.2 Experimental setup	34
4.1 Comparison of NO <sub>x</sub> emission calculation	48
4.2 Emission amount of NO <sub>x</sub> per area (kg/km <sup>2</sup> /year)	49

## LIST OF ABBREVIATIONS

BC	Black Carbon
DEET	Diethyltoluamide
EF	Emissions Factors
EU	European Union
HPV	High Production Volume
IARC	International Agency for Research on Cancer
PRTR	Pollutant Release and Transfer Registration
LPG	Liquified petroleum gas
NCEs	Nominal combustion efficiencies
NMHC	Non-methane hydrocarbon
NMVOC	Non-methane volatile organic compounds
OC/EC	Organic carbon per elemental carbon
SPE	Solid-Phase Extraction
TSP	Total suspended particulate
ULD	Unit load device
VOCs	volatile organic compounds
WBTs	Water-boiling tests
WHO	World Health Organization

# CHAPTER I

## INTRODUCTION

### 1.1 Rationales and Justifications

Even though household products provide substantial benefits to human life, such as the promotion of hygiene and aesthetics, the emissions composition from such products has been a subject of concern in recent years because many of these compounds are potentially associated with health risks for building occupants (Ki-Dong Kwon *et al.*, 2007). Direct indoor-air monitoring data can be employed to properly estimate the inhalation exposure of building occupants. The characterization of emissions composition for household products can provide valuable information for the semiquantitative estimation of inhalation exposure and for the selection of safer consumer products (Ki-Dong Kwon *et al.*, 2007). Currently, there are many household products, components have been developed continuously. However, there are many products that are harmful for example naphthalene, cleaning products and air fresheners (Salthammer, 1999). The toxic effects of naphthalene have been recognized as a public health concern. Naphthalene is classified as a possible human carcinogen by the International Agency for Research on Cancer (IARC, 2002).

Studies in South Korea on volatile organic compounds (VOCs) in the household found a total of 59 household products currently sold in Korea as potential sources of indoor-air pollution. The chemical composition and concentrations of total VOCs broadly varied with products. Oil paints exhibited an upper range for both the number of chemicals detected and the concentrations of total VOCs. Moreover, the chemical composition and concentrations of total VOCs were substantially different between products even within the same product category (Ki-Dong Kwon *et al.*, 2007). The chemical composition of certain household products was different from that of other studies conducted in other countries. For example, general purpose cleaners analyzed in the present study emitted six compounds (decane, limonene,  $\beta$ -myrcene, octane,  $\alpha$ -pinene, and  $\beta$ -terpinene) (Zhu, 2001).

It can be seen that the use of household products, may not always safe to the fact it bordered on the attunement itself. As part of Pollutant Release and Transfer Registration (PRTR) program, household is expected as one of the emission source of chemical substances. Emission of chemical substances from household is defined as non-point source emission. This study is aimed to determine the chemical use in a household level as well as develop emission factor, used to calculate the emission amount of household chemical. These data will be served and be assisted in developing the emission databases under PRTR program.

## **1.2 Research Objectives**

1. To determine the list of chemicals use in household.
2. To develop the emission factors of chemical substances from household activities.

## **1.3 Scope of the study**

This study was conducted in Rayong Province, Thailand. At least 1000 household in the study area were surveyed for type and consumption of chemical substances. The 107 chemical substances, listed as target compounds under PRTR program were chosen as selection substances in this study.

## **1.4 Expected Outcomes**

1. List of chemical substances used in the household.
2. Emission factor of chemical substances of household activities.

## **1.5 Definition of Keywords**

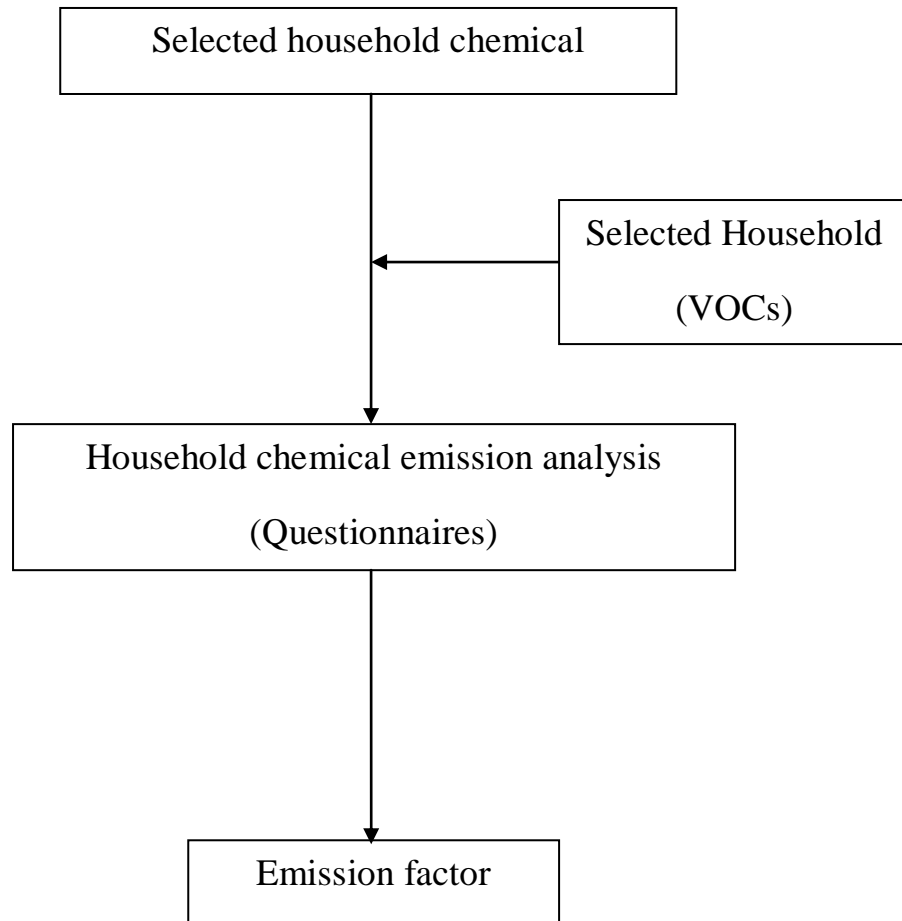
**Pollutant Release and Transfer Register (PRTR)** is a catalogue or database of releases and transfers of potentially harmful chemicals including

information on the nature and quantity of such releases and transfers. The data for PRTRs can be collected from point sources of pollution, such as factories, as well as from diffuse sources, such as agricultural operations or transportation activities. A typical PRTR covers releases to air, water and land as well as wastes transported to treatment and disposal sites (UNITAR, 2013).

**Emissions Factor (EF)** is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average) (USEPA, 2011).

**Volatile organic compounds (VOCs)** are the group of organic compounds that have a boiling temperature of between 50–100 °C and 240–260 °C (WHO,1989).

## 1.6 Conceptual Framework



## **CHAPTER II**

### **LITURATURE REVIEW**

#### **2.1 Pollutant Release and Transfer Registers (PRTR)**

A Pollutant Release and Transfer Register (PRTR) is a catalogue or database of releases and transfers of potentially harmful chemicals including information on the nature and quantity of such releases and transfers. The data for PRTRs can be collected from point sources of pollution, such as factories, as well as from diffuse sources, such as agricultural operations or transportation activities. A typical PRTR covers releases to air, water and land as well as wastes transported to treatment and disposal sites (UNITAR, 2013).

Key features of a PRTR include: periodic collection of information to allow tracking of trends over time; the use of common identifiers for chemicals, facilities and locations to facilitate comparison and aggregation of the data; computerisation of the information for ease of analysis; and dissemination of the information to government policy makers and the general public. Some potential applications of PRTR information include mapping the data to discern the proximity of pollution sources to population centres or to ecologically sensitive areas, as a way of highlighting potential health or environmental impacts and effectively targeting management efforts. Trends in the data can reveal the progress being made by individual facilities or industrial sectors in reducing waste and minimising pollution, or for identifying opportunities for improvement (UNITAR, 2013).

To summaries, a PRTR is a means for obtaining regular, periodic information about releases and/or transfers of chemical substances of interest and for making this information accessible to those who may be interested and/or affected by it. As such, a PRTR is a tool for promoting efficient and effective policies for environmental protection and sustainable development (UNITAR, 2013).

**2.1.1 PRTR chemical:** There are 107 chemical substances, listed under the Thai's PRTR programs as shows in Table 2.1:

**Table 2.1** List of the Thai's PRTR target chemical

No.	Name of Chemical	CAS No.	Note : Reason for selection
1	1-(p-Methoxyphenyl)-2-meyhyl-1,3- propanediol-methylene ether	5689-72-5	HS Act class 3 and over 1000 ton/year.
2	2,4-D-Dimethylammonium	2008-39-1	HS Act class 3 and over 1000 ton/year.
3	2, 4-D-Butotyl	1929-73-3	HS Act class 3 and over 1000 ton/year.
4	2, 4-D-Butyl	94-80-4	HS Act class 3 and over 1000 ton/year.
5	Acetaldehyde	75-07-0	Carcinogen data on US EPA and frequent detection in monitoring.
6	Acetone	67-64-1	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
7	Acrylamide	79-06-1	HS Act class 2, Carcinogen data on US EPA and over 100 ton/year.
8	Acrylic Acid	79-10-7	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
9	Acrylonitrile	107-13-1	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
10	Ametryn	834-12-8	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
11	Antimony and its compounds		Quantitative toxic data on US EPA and over 1000 ton/year.
12	Arsenic and its compounds		HS Act class 3, Carcinogen data on US EPA as Arsenic and approx. 80 ton/year. Expert judgment.
13	Atrazine	1912-24-9	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
14	Benzene	71-43-2	HS Act class 3, Carcinogen data on US EPA and frequent detection in monitoring.
15	Benzyl Chloride	100-44-7	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
16	Bis(2-ethylhexyl)phthalate	117-81-7	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
17	Bisphenol A	80-05-7	Quantitative toxic data on US EPA and over 1000 ton/year.
18	Boron and its compounds		HS Act class 3 and over 1000 ton/year.
19	Bromo-2-chloroethane, 1-	107-04-0	Carcinogen data on US EPA and over 100 ton/year.
20	Butachlor	23184-66-9	HS Act class 3 and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
21	Butadiene, 1,3-	106-99-0	HS Act class 3, Carcinogen data on US EPA and frequent detection in monitoring.
22	Cadmium and its compounds	7440-43-9	HS Act class 3, 4 and over 1000 ton/year.
23	Captan	133-06-2	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
24	Carbon Disulfide	75-15-0	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.
25	Chloroacetaldehyde, 2-	107-20-0	Carcinogen data on US EPA and over 100 ton/year.
26	Chloroacetic Acid	79-11-8	Quantitative toxic data on US EPA and over 1000 ton/year.
27	Chloroform (trichloromethane)	67-66-3	HS Act class 3-4, Carcinogen data on US EPA and approx. 80 ton/year. Expert judgment.
28	Chlorothalonil	1897-45-6	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
29	Chlorpyrifos	2921-88-2	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
30	Copper and soluble salts		HS Act class 3 and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
31	chromium and its compounds		HS Act class 3, Carcinogen data on US EPA as Cr(VI) and over 100 ton/year.
32	Cyclohexanone	108-94-1	Quantitative toxic data on US EPA and over 1000 ton/year.
33	Dialfos (dialifor)	10311-84-9	HS Act class 3 and over 1000 ton/year.
34	Dichlorobenzene, 1,4	106-46-7	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
35	Dichloroethane, 1,2-	107-06-2	HS Act class 3-4, Carcinogen data on US EPA and over 100 ton/year.
36	Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
37	Dichlorvos	62-73-7	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
38	Diethylene Glycol Monobutyl Ether	112-34-5	Quantitative toxic data on US EPA and over 1000 ton/year.
39	Dithiopyr	97886-45-8	HS Act class 3 and over 1000 ton/year.
40	Epichlorohydrin	106-89-8	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
41	Ethyl Acetate	141-78-6	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
42	Ethyl Acrylate	140-88-5	HS Act class 2, Carcinogen data on US EPA and over 100 ton/year.
43	Ethylene Glycol	107-21-1	Quantitative toxic data on US EPA and over 1000 ton/year.
44	Ethylene Glycol Monobutyl Ether	111-76-2	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
45	Ethylene Oxide	75-21-8	HS Act class 4, Carcinogen data on US EPA and over 100 ton/year.
46	Formaldehyde	50-00-0	HS Act class 2, Carcinogen data on US EPA and over 100 ton/year.
47	Formic Acid	64-18-6	Quantitative toxic data on US EPA and over 1000 ton/year.
48	Furfural	98-01-1	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.
49	Glyphosate-Isopropylammonium	38641-94-0	HS Act class 3, and over 1000 ton/year.
50	Hexachlorocyclohexane	319-86-8	Carcinogen data on US EPA and over 100 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
51	Hexane, N-	110-54-3	Quantitative toxic data on US EPA and over 1000 ton/year.
52	Hexanedioic acid	124-04-9	Quantitative toxic data on US EPA and over 1000 ton/year .
53	Hydrogen fluoride	7664-39-3	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
54	Hydroquinone	123-31-9	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
55	Imazaquin-ammonium	81335-47-9	HS Act class 3 and over 1000 ton/year.
56	Isobutyl alcohol	78-83-1	Quantitative toxic data on US EPA and over 1000 ton/year.
57	Isophorone	78-59-1	Carcinogen data on US EPA and over 100 ton/year.
58	Isopropyl alcohol	67-63-0	Quantitative toxic data on US EPA and over 1000 ton/year.
59	Lead and compounds	7439-92-1	Quantitative toxic data on US EPA and over 1000 ton/year.
60	Maleic anhydride	108-31-6	Quantitative toxic data on US EPA and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
61	Manganese and its compounds		HS Act class 1 and over 1000 ton/year.
62	Methanol	67-56-1	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
63	Methyl acetate	79-20-9	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
64	Methyl acrylate	96-33-3	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.
65	Methyl ethyl ketone (2-butanone)	78-93-3	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
66	Methyl isobutyl ketone (4-methyl-2-pentanone)	108-10-1	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
67	Methyl methacrylate	80-62-6	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.
68	Methyl tert-butyl ether (MTBE)	1634-04-4	Carcinogen data on US EPA and over 100 ton/year.
69	Methylene chloride	75-09-2	HS Act class 1, Carcinogen data on US EPA and over 100 ton/year.
70	Methylenediphenyl Diisocyanate	101-68-8	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
71	Molybdenum and its compounds		Quantitative toxic data on US EPA and over 1000 ton/year.
72	Naphthalene	91-20-3	HS Act class 2, Carcinogen data on US EPA and over 100 ton/year.
73	Nickel and its compounds		Carcinogen data as NiCl <sub>2</sub> on US EPA and over 100 ton/year.
74	Paraquat dichloride	1910-42-5	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
75	Pentane, n-	109-66-0	Quantitative toxic data on US EPA and over 1000 ton/year.
76	Phenol	108-95-2	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
77	Phosphoric acid	7664-38-2	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
78	Phosphorus pentoxide and other	1314-56-3	HS Act class 3 and over 1000 ton/year.
79	Phthalic Anhydride	85-44-9	Quantitative toxic data on US EPA and over 1000 ton/year.
80	Polyethylene glycol nonylphenyl ether	9016-45-9	HS Act class 3 and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
81	Potassium chlorate	3811-04-9	HS Act class 3 and over 1000 ton/year.
82	Propanil	709-98-	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
83	Propionicacid	79-09-4	HS Act class 3 and over 1000 ton/year.
84	Propylene	115-07-1	Quantitative toxic data on US EPA and over 1000 ton/year.
85	Propylene glycol	57-55-6	Quantitative toxic data on US EPA and over 1000 ton/year.
86	Propylene Oxide	75-56-9	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
87	Prothiocarb	19622-08-3	HS Act class 3 and over 1000 ton/year.
88	Pyrene	129-00-0	HS Act class 1, Quantitative toxic data on US EPA and over 1000 ton/year.
89	Ryania	15662-33-6	HS Act class 3 and over 1000 ton/year.
90	Sodium chlorate	7775-09-9	HS Act class 3-4 and over 1000 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
91	Sodium cyanide	143-33-9	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
92	Styrene	100-42-5	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.
93	Tebuthiuron	34014-18-1	HS Act class 3, Quantitative toxic data on US EPA and over 1000 ton/year.
94	Tetrachloroethylene	127-18-4	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
95	Tin and its compounds		Quantitative toxic data on US EPA and over 1000 ton/year.
96	Toluene	108-88-3	HS Act class 3, Quantitative toxic data on US EPA and frequent detection in monitoring.
97	Trichloroethylene	79-01-6	HS Act class 1, Carcinogen data on US EPA and over 100 ton/year.
98	Trimethyl benzene, 1,2,4-	95-63-6	Quantitative toxic data on US EPA and over 1000 ton/year.
99	Trimethyl benzene, 1,3,5-	108-67-8	Quantitative toxic data on US EPA and over 1000 ton/year.
100	Trinitrotoluene, 2,4,6-	118-96-7	Carcinogen data on US EPA and over 100 ton/year.

**Table 2.1** List of the Thai's PRTR target chemical (Cont.)

No.	Name of Chemical	CAS No.	Note : Reason for selection
101	Vinyl Acetate	108-05-4	HS Act class 2, Quantitative toxic data on US EPA and over 1000 ton/year.
102	Vinyl Chloride	75-01-4	HS Act class 3, Carcinogen data on US EPA and over 100 ton/year.
103	Xylenes		Quantitative toxic data on US EPA and over 1000 ton/year.
104	Zinc and its compounds		Quantitative toxic data on US EPA and over 1000 ton/year.
105	SO <sub>x</sub>		To be included in data disclosure to public. Not required for industry reporting as regulation already exist for reporting.
106	NO <sub>x</sub>		To be included in data disclosure to public. Not required for industry reporting as regulation already exist for reporting.
107	Dioxin and furan		To be included in the system when the reliable data become available for their emission status and factors. Not included for the pilot project.

Note: HS Act = Hazardous Substance Act

## 2.2 Household chemical

**2.2.1 Household Chemicals Chart:** Potentially dangerous chemicals can be found in every room in the house. If not properly stored or used, these products could end up in causing health problems. It should be noted that most household cleaning products and pesticides are reasonably safe when used as directed, and that the level of toxicity of a product is dependent on the dose of the product used and the length of exposure to the product. The Cleveland clinic foundations identify the list of chemical substance, used in household as follows:

**Table 2.2** Household chemicals

Product	Hazardous Ingredient	Possible Effects
<b>In the garage</b>		
Antifreeze	Ethylene glycol	Poisonous if swallowed -- can cause severe damage to heart, kidneys, brain. Inhalation can cause dizziness.
Motor oil	Heavy metals	Can cause nerve and kidney damage; is thought to cause cancer
	Hydrocarbons	Some forms thought to cause cancer.
Batteries (car, boat, tractor)	Sulfuric acid	Can cause severe skin burns, and blindness
	Lead	Can cause nerve and kidney damage; is thought to cause cancer
Windshield washer fluid	Methanol	Can damage the nervous system, liver, kidneys; inhalation can lead to lung disease; ingestion can cause blindness

**Table 2.2** Household chemicals (Cont.)

Product	Hazardous Ingredient	Possible Effects
	Ethylene glycol	Poisonous if swallowed -- can cause severe damage to heart, kidneys, brain. Inhalation can cause dizziness.
	Isopropanol	Can irritates mucous membranes; ingestion results in drowsiness, unconsciousness and death
<b>In the laundry room/utility room</b>		
Laundry detergent	Cationic, anionic, or non-ionic solutions	If swallowed, cationic detergents can cause nausea, vomiting, shock, convulsions, and coma. Non-ionic detergents can irritate skin and eyes
All-purpose cleaners	Ammonia	Fumes can irritate eyes and lungs; can cause burns or rashes on skin; can produce deadly chloramine gas if mixed with chlorine containing products
	Ethylene glycol monobutyl acetate	Poisonous if swallowed -- can cause severe damage to heart, kidneys, brain. Inhalation can cause dizziness.
	Sodium hypochlorite	Corrosive to skin and lining of nose mouth and throat; fumes irritating to eyes and respiratory tract
Bleach	Sodium hypochlorite solution	Corrosive to skin and lining of nose mouth and throat; fumes irritating to eyes and respiratory tract

**Table 2.2** Household chemicals (Cont.)

Product	Hazardous Ingredient	Possible Effects
Pet flea and tick treatments	Organophosphates and carbamates	Can cause headache, dizziness, twitching, nausea; shown to cause cancer in animals
Insecticides	Organophosphates and carbamates	Can cause headache, dizziness, twitching, nausea; shown to cause cancer in animals
Dishwashing detergents	Cationic, anionic, or non-ionic solutions plus phosphates (automatic dishwasher detergents)	Automatic products can cause skin irritation or burns; hand dishwashing products are milder, though can cause irritation to mouth, throat, and GI tract
Oven cleaners	Lye (consisting of either sodium hydroxide or potassium hydroxide)	Extremely corrosive, burns skin and eyes; can be fatal if swallowed; aerosols disperse chemicals, increasing inhalation dangers
Antibacterial cleaner	Ammonia, Detergents, Lye	see descriptions above
	Cresol	Can be corrosive to tissue; damages liver, kidneys, lungs, pancreas and spleen
	Phenol	Can cause central nervous system depression; severely affect circulatory system; corrosive to skin; suspected of causing cancer
	Pine oil	Can irritate eyes and lining of nose mouth and throat

**Table 2.2** Household chemicals (Cont.)

Product	Hazardous Ingredient	Possible Effects
<b>In the kitchen</b>		
Dishwashing detergents	Cationic, anionic, or non-ionic solutions plus phosphates (automatic dishwasher detergents)	Automatic products can cause skin irritation or burns; hand dishwashing products are milder, though can cause irritation to mouth, throat, and GI tract
Oven cleaners	Lye (consisting of either sodium hydroxide or potassium hydroxide)	Extremely corrosive, burns skin and eyes; can be fatal if swallowed; aerosols disperse chemicals, increasing inhalation dangers
Antibacterial cleaner	Ammonia, Detergents, Lye	see descriptions above
	Cresol	Can be corrosive to tissue; damages liver, kidneys, lungs, pancreas and spleen
	Phenol	Can cause central nervous system depression; severely affect circulatory system; corrosive to skin; suspected of causing cancer
	Pine oil	Can irritate eyes and lining of nose mouth and throat
Window and glass cleaner	Ammonia	Fumes can irritate eyes and lungs; can cause burns or rashes on skin; can produce deadly chloramines gas if mixed with chlorine containing products

**Table 2.2** Household chemicals (Cont.)

Product	Hazardous Ingredient	Possible Effects
	isopropanol	Can irritates mucous membranes; ingestion results in drowsiness, unconsciousness and death
Insect bait traps	Organophosphates and carbamates	Can cause headache, dizziness, twitching, nausea; shown to cause cancer in animals
<b>In the bathroom</b>		
Toilet bowl cleaners	Sodium bisulfate	Forms sulfuric acid, which is corrosive, burns skin
	Oxalic acid	Can damage kidney and liver; irritate eyes and respiratory tract; corrodes mouth and stomach
	5-dimethyldantoin	Forms hypochlorite in water, which is corrosive to skin and mucous membranes
	Hydrochloric acid	Fumes are extremely corrosive; burns skin
	Phenol	Can cause central nervous system depression; severely affect circulatory system; corrosive to skin; suspected of causing cancer
Mold and mildew removers	Chlorine and alkyl ammonium chlorides	Can cause breathing problems; if swallowed, can burn throat
Drain cleaners	Lye and sulfuric acid	Can cause burns to skin and in severe cases, blindness if splashed in eye

**Table 2.2** Household chemicals (Cont.)

Product	Hazardous Ingredient	Possible Effects
<b>In the living room</b>		
Rug, carpet, upholstery cleaners	Perchloroethylene	Fumes cause dizziness, sleepiness, nausea, loss of appetite and disorientation; can cause cancer with long-term exposure
	Naphthalene	Can damage liver; prolonged vapor exposure has led to cataract formation
Furniture polish	Ammonia, naphtha, nitrobenzene, petroleum distillates, and phenol	Can irritate your skin, eyes, throat, lungs and windpipe; if swallowed, furniture polish can cause nausea and vomiting
Air fresheners	Formaldehyde	A strong irritant to the eyes, throat, skin and lungs; thought to cause cancer
	Petroleum distillates	Can irritate skin, eyes, respiratory tract; may cause fatal pulmonary edema; flammable
	P-Dichlorobenzene	Fumes can be irritating to skin, eyes and throat
	Aerosol propellants	Fumes associated with brain damage or highly flammable
Household foggers	Pyrethrins	Can cause severe allergic dermatitis, systemic allergic reactions. Large amounts may cause nausea, vomiting, tinnitus, headache, & other CNS disturbances
	Permethrin	Can cause itching and burning of the skin and eyes; irritate the upper respiratory tract

**Table 2.2** Household chemicals (Cont.)

Product	Hazardous Ingredient	Possible Effects
	Methoprene	Can irritate the skin and eyes
<b>In the bedroom</b>		
Mothballs	Naphthalene, P-Dichlorobenzene	Can cause headaches, dizziness, and irritate the skin, eyes, and throat; cataract formation and liver damage can result from prolonged exposure
<b>In the backyard, pool and garden shed</b>		
Swimming pool chloride tablets	Sodium (or calcium) hypochlorite	Corrosive to skin and lining of nose mouth and throat; fumes irritating to eyes and respiratory tract
Insect repellents	Butopyronoxyl	Can cause mild necrosis in liver and kidney –in animals
	Dimethyl phthalate	Can cause central nervous system depression if swallowed
	Diethyltoluamide (DEET)	Can irritate sensitive skin and respiratory tract tissues as well as loss of coordination, anxiety, behavioral changes, and mental confusion
Weed killers	diquat, 2,4-D, and glyphosate	Can irritate the eyes and skin; can cause abdominal pain, nausea, vomiting, and diarrhea
Rodent control	warfarin	Causes internal bleeding if ingested in large amounts

Source: The Cleveland Clinic Foundation, (2013).

### 2.3 Related Research

Ki-Dong Kwon *et al.*, (2007) estimated emission of 59 household products sold in Korea, using a headspace analysis. The chemical composition and concentrations of total volatile organic compounds (VOCs) broadly varied along with products, even within the same product category. Up to 1–17 organic compounds were detected in the headspace gas phase of any one of the products. The chemical composition of certain household products determined in the current study was different from that of other studies from other countries. Between 4 and 37 compounds were detected in the headspace gas phase of each product class. Several compounds were identified in more than one product class. From the 59 household products analyzed. There were 58 product containing one or more of the 72 compounds at chromatographic peak areas above 104. There were 11 analytes which occurred with a frequency of more than 10%: limonene (44.2%), ethanol (30.5%), acetone (18.6%),  $\alpha$ -pinene (18.6%), *o,m,p*-xylenes (18.6%), decane (17.0%), toluene (17.0%),  $\beta$ -myrcene (11.9%), ammonia (10.2%), ethylbenzene (10.2%), and hexane (10.2%).

Dong Hwa Kang *et al.*, (2011) identified household materials that may contribute to the indoor naphthalene concentration in Canadian homes. Ninety-nine household materials including building materials, furnishings, and consumer products were tested. These materials included well-known naphthalene containing products such as mothballs as well as building and consumer products where naphthalene could have been either added as part of a liquid formulation or used as a chemical intermediate in the manufacture of solid materials and product components. A fast screening method was used to determine the naphthalene concentration in a micro-scale test chamber. The tested materials were ranked based on the naphthalene emission strength combined with the amount of products typically used in homes. As expected, the results showed that mothballs, which had the highest emission factor, are one of the predominant sources. Interestingly, vinyl and wooden furniture with high emission factors and painted walls and ceiling with large surface areas were found to be important sources with the source strength even larger than those of mothballs when maximum emission factors were assumed for these building materials and furnishings. This suggests that some building materials and furnishings could be significant contributors to indoor naphthalene concentrations. This study shows that

selecting materials with lower naphthalene emission factors could be one of many ways to reduce the indoor naphthalene concentration.

Niu *et al.*, (2010) collected 150 household energy use data sets, using questionnaires, from households in Lanzhou, China. Converted to kilograms of coal standardized energy equivalent, urban energy usage is calculated at a yearly rate of 490.37 kgce/a per capita and 1598.61 kgce/a per household. Types of emissions were also specified. Coal was the dominant energy source, and maximum environmental benefit is shown to be gained from substituting natural gas and solar energy for coal, and specific measures for substitution are identified.

Majumdar *et al.*, (2013) prepared emission inventory of greenhouse and non-greenhouse air pollutants from restaurant industry. Emissions were estimated from a primary database on type and amount of cooking fuel combusted in restaurant industry in the selected cities. Liquefied petroleum gas, charcoal, wood, coal, diesel and candy coal were used in this industry, first three being the major ones. Carbon dioxide emission was highest in both cities and liquefied petroleum gas, charcoal and wood were the major contributors to emissions. Total annual emissions of greenhouse gases, viz. carbon dioxide, methane and nitrous oxide were estimated to be 19,251, 27 and 1 Mg/year in Nagpur and 21, 207, 34 and 1 Mg/year in Raipur. Total annual emissions of non-methane hydrocarbon (NMHC), carbon monoxide, total suspended particulate (TSP), sulphur dioxide, nitrogen oxides and black carbon (BC) were 96, 959, 31, 12, 19, 3 Mg/year and 87, 1141, 78, 37, 28, 6 Mg/year in Nagpur and Raipur, respectively. Considering the huge growth of Indian restaurant industry in the last decade and the predicted growth in future, emissions from this industry is assumed to grow and will play a major role in governing regional and national emissions in India.

Zhang *et al.*, (2012) conducted field measurements to determine indoor air particulate pollutant emissions from the burning of coal and wood in rural households in Guizhou, China. Chemical composition, particle mass and particle size distribution as well as number concentration were measured in this study. Chemical composition analysis indicated that the carbonaceous particle was dominant in the PM<sub>2.5</sub> mass, accounting for about 41% for wood and 55% for coal. The OC/EC ratio was 10.8 for wood and 7.6 for coal. Most of the water-soluble ions were found in the 0.4-2.1  $\mu$ m size fractions and were dominated by ammonium and sulfate. Particle mass

concentrations inversely correlated with particle total number concentrations during the sampling period. Obvious differences were observed in the evolution of particle number concentrations and size distributions between coal combustion and wood burning. Particles emitted from coal combustion were characterized by unimodal size distribution, with average peak values ranging from 70.3 to 75.7 nm during the flaming stage of the burning cycle.

Golley and Meng., (2012) investigated variations in carbon dioxide emissions across households with different income levels. Rich households generated more emissions per capita than poor households via both their direct energy consumption and their higher expenditure on goods and services that use energy as an intermediate input. An econometric analysis confirmed a positive relationship between emissions and income and established a slightly increasing marginal propensity to emit (MPE) over the relevant income range. The redistribution of income from rich to poor households was therefore shown to reduce aggregate household emissions, suggesting that the twin pursuits of reducing inequality and emissions can be achieved in tandem.

Johnson *et al.* (2008) estimated the greenhouse gas emissions associated with changes from traditional to improved cookstoves in developing countries come from Water-Boiling Tests (WBTs) conducted in simulated kitchens. The results demonstrate that Nominal Combustion Efficiencies (NCEs) of open fire cookstoves were significantly lower in rural homes during daily cooking activities (90%) compared to WBTs in simulated kitchens (94%).

Fausser and Illerup. (2008) presented the Danish emission inventory for Non-Methane Volatile Organic Compounds (NMVOC) from the use of solvents in industries and households. Solvent used constitutes approximately one third of the total NMVOC emissions in Denmark, i.e. 33,000 tonnes in 2006 and represents 103,000 tonnes CO<sub>2</sub>-equivalents, which constitutes 0.2% of the total Danish CO<sub>2</sub> emissions.

Hassan. (2012) collected stairs and entryway dust samples were collected from 16 houses distributed across Greater Cairo by using vacuum cleaner and sweeping methods during summer season of 2009. Lead (Pb), nickel (Ni), cadmium (Cd), aluminum (Al), iron (Fe), zinc (Zn), cobalt (Co), chromium (Cr) and copper (Cu)

were measured in different dust particle sizes: <38 mm, >38-45 mm and >45-63 mm. The contribution of anthropogenic sources, especially traffic emission, to metal levels in household, entryway and stairs dust was reflected by the high values of enrichment factors for Pb, Cd, Zn and Cu and Ni and Cr in fine dust particle compared to the average crustal composition. Insignificant positive correlation coefficients were found between the concentrations of Pb and other metals in household dust. However, the correlation coefficients between the concentrations of Cd, Ni, Cr, Cu, Zn and Fe were statistically significant.

Trenholm *et al.* (2008) developed a method for determination of 24 household high production volume (HPV) chemicals in municipal wastewater systems using solid-phase extraction (SPE) and analyses using both gas chromatography and liquid chromatography, each with tandem mass spectrometry (GC-MS/MS and LC-MS/MS). Target compounds include pesticides, antioxidants, fragrances, plasticizers, preservatives and personal care products. Method reporting limits ranged from 0.1 to 100 ng/L in water and recoveries for most compounds were between 54 and 112%. Household HPVs were consistently detected in raw sewage entering three full-scale wastewater treatment plants. Compounds such as vanillin, DEET, benzophenone, 3-indolebutyric acid, bisphenol A, triclosan and triclocarban were detected in all wastewater influent and effluent samples, but were significantly lower in the effluent. Many of the remaining compounds were detected in the influent, but below detection in effluent samples. Menthol and phenoxyethanol had the highest observed concentrations in influent samples ranging from 1.5 to 13 ug/L for menthol, and 8.8 to 22 ug/L for phenoxyethanol. MGK-11, methylresorcinol, trifluralin, hexabromododecane, acriflavin and atrazine were not detected in any samples.

## CHEPTER III

### METHODOLOGY

This study was conducted on a personal computer facilitated by the Department of Sanitary Engineering, Faculty of Public Health, Mahidol University.

### 3.1 Study area

#### General information

Rayong province is located in the eastern region of Thailand (about 179 km from Bangkok). The total area of the province is about 3,552 km<sup>2</sup>.

#### Boundary

North direction: connect to Chonburi province

South direction: connect to the Gulf of Thailand

East direction: connect to Chanthaburi province

West direction: connect to Chonburi province



**Figure 3.1** Rayong map (<http://www.rayongthailand.com>, 2013)

### **Administration and population**

The province consists of 8 districts (54 sub-districts, 439 villages, 80 communities). The total population was 583,470 (data as on 31 December 2008). Number of male and female populations were 288,098 (49.38%) and 295,372 (50.62%), respectively. Muang Rayong district had the highest number of population in province (224,850 peoples) while the lowest number of population was at Khao Chamao district (22,915 peoples). The highest population density was at Muang rayong district (437 persons/km<sup>2</sup>) while the lowest population density were at Puak Daeng and Wang Chan districts (63 persons/km<sup>2</sup>). It is predicted that the total number of population will be increased to 638,017 in the year 2017. It should be noted that the number of non-registered population living and working in Rayong was more than 300,000 persons.

### **3.2 Sample selection**

Prior the field survey, number of sample is selected taking into consideration distribution of household in Rayong province by using data of the year 2011. Allocation result is as shown in Table 3.1

Number of sample as calculated by Yamane equation was expected at 400 samples. Calculated results were as shown in Appendix A. However, the total number of household for the survey in this study is targeted as 1000. Expected number of sample for each district is calculated by using percentage of number of household in each district as compared with total number of household in Rayong province.

**Table 3.1** Spatial allocation of household sample

<b>Districts</b>	<b>Household</b>	<b>%</b>	<b>Expected sample</b>
Mueang Rayong	143,753	42.42	424
Bang Chang	32,606	9.62	96
Klaeng	54,509	16.08	161
Wang Chan	10,408	3.07	31
Ban Khai	25,762	7.60	76
Pluak Daeng	39,319	11.60	116
Khao Chamao	9,453	2.79	28
Nikhom Phatthana	23,085	6.81	68
Total	338,895	100	1,000

(Source: Rayong Province office, 2011)

### 3.3 Selection of selected chemical

Selected chemical substances in this study are chosen using a selection matrix by considering a list of 107 substances, designated under the Thai's PRTR program and from reviewed literatures. Substances are selected when they appear in both of the list under PRTR and find in related reference documents. The reference documents, used in the selection matrix are Household Safety (Cleveland Clinic Foundation, 2013) and Characterization of emissions composition for selected household products available in Korea (Kwan et al, 2007). In this study, a market survey is also conducted in order to identify the actual chemical use in household in the country. Market survey is conducted at "Hompro" department store. Details and results of the selection matrix is as shown in Table 3.2

**Table 3.2** Selection matrix for household target chemical

PRTR	Cleveland	Korea	Homepro	Selection	Product class
1. Acetaldehyde		X		/	Deodorizers
2. Acetone		X		/	Cleaning Product, Nail color remove, Paints, Polisher
3. Benzene		X	X	/	Cleaning Product, Deodorizers, Polisher
4. Chloroform (trichloromethane)		X		/	Cleaning Product
5. Chlorpyrifos			X	/	Pesticides
6. Cyclohexanone		X		/	Paints
7. Ethyl Acetate		X		/	Cleaning Product, Glues
8. Ethylene Glycol	X			/	Cleaning Product
9. Isophorone			X	/	Cleaning Product
10. Isopropyl alcohol	X			/	Windshield washer fluid
11. Methanol	X			/	Windshield washer fluid
12. Methyl Acrylate		X		/	Glues
13. Naphthalene	X			/	Rung, Carpet, Upholstery cleaners
14. Phenol	X			/	Antibacterial cleaner
15. Phosphoric Acid			X	/	Cleaning Product
16. Pyrene	X			/	Foggers
17. Sodium chlorate	X			/	Cleaning Product
18. Toluene		X		/	Glues, Paints, Sealants
19. Trichloroethylene			X	/	Cleaning Product

Amount of LPG used for household cooking is obtained from questionnaire survey. These data are use as activity data to compute with emission factor in order to obtain emission amount. The emission factor of NO<sub>x</sub> for LPG used in the residential cooking, obtain from USEPA AP-42 is used in developing emission factor in this study.

### **3.4 Questionnaire survey**

In this study, collection of primary data is conducted by questionnaire survey. Questionnaire is prepared taking into consideration the list of selected substance. Information, obtained from a questionnaire cover type of house, number of resident, type and amount of chemical use, amount of Liquefied Petroleum Gas (LPG) or other type of fuel consumption and geographical position, respectively. Examples of questionnaire, used in this study both in Thai and English are as shown below in Appendix B.

### **3.5 Analysis of household chemical emission**

Analysis of questionnaires, obtained from the field survey is carried out by SPSS version 17.0. Amount of emission to air and water is estimated according to usage pattern of those chemicals in the household. For example mothball, containing, naphthalene is expected to release to air while phenol, used as antibacterial cleaner is expected to release into water. Emission rate of each compound is developed in the unit of kilogram per 1000 household per year (kg/1000 household/year). The emission factors are classified into 3 levels according to the size of household as followed:

- Small household (number of resident less than 3 people)
- Medium household (number of resident 3-6 people)
- Large household (number of resident more than 6 people)

Data of the size of household based on information from the Office for National Statistics indicated that small household has the average number of resident about 3 persons. A medium size of household is designed according to average value of household's resident (3.2-5.7 persons) as shown in table 3.3.

**Table 3.3** Average household size

<b>Year</b>	<b>Average household size</b>
2503	5.6
2513	5.7
2523	5.2
2533	4.4
2543	3.8
2553	3.2

(Source: National statistical office, 2010)

Emission factor of NO<sub>x</sub> from LPG consumption is estimated based on Emissions of greenhouse and non-greenhouse air pollutants from fuel combustion in restaurant industry (USEPA, AP-42).

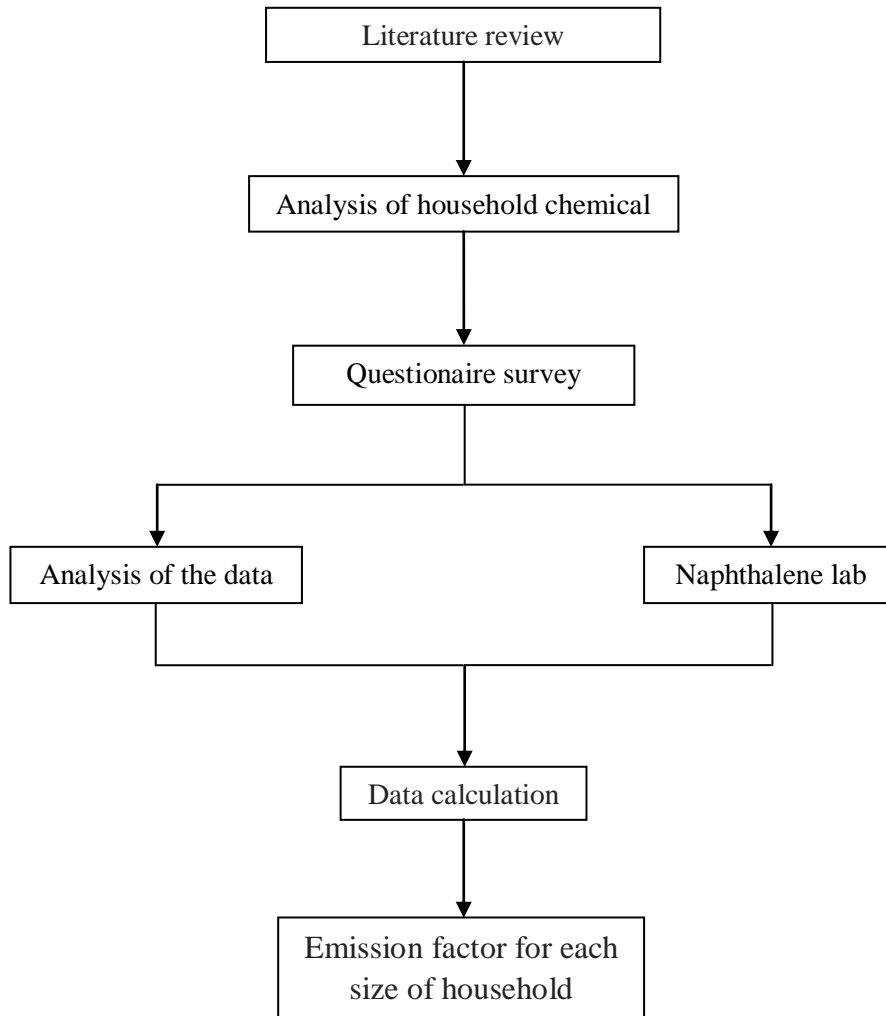
Annual consumption of a given fuel is multiplied by the specific emission factor of a pollutant for the given fuel to obtain total annual emission of the pollutant from the given fuel. The following equation is used for calculating emission of an air pollutant from a source category, i.e. fuel:

**Equation 1:**

$$\mathbf{Emission_{air\ pollutant;fuel} = Consumption_{fuel} \times EF_{air\ pollutant;fuel}}$$

Where Emission<sub>air pollutant, fuel</sub> is the emission of a given air pollutant from a given fuel, Consumption<sub>fuel</sub> is consumption of the given fuel, EF<sub>air pollutant, fuel</sub> is emission factor of a given pollutant for a given fuel.

### 3.6 Experimental setup



## CHAPTER IV

### RESULTS AND DISCUSSION

In this chapter, the measurement data and results of emission factor and emission inventory analysis were presented. Details were as follows:

#### 4.1 Spatial allocation of household sample

The total number of household for the survey in this study is targeted as 1000 household. Spatial allocation of expected and collected number of samples in each district is as shown in Table 4.1. These data are use as activity data to compute with emission factor in order to obtain emission amount.

**Table 4.1** Spatial allocation of household sample

Districts	Number of household	Percent (%)	Expected sample	Collected sample
Mueang Rayong	143,753	42.42	424	<b>428</b>
Bang Chang	32,606	9.62	96	<b>114</b>
Klaeng	54,509	16.08	161	<b>169</b>
Wang Chan	10,408	3.07	31	<b>36</b>
Ban Khai	25,762	7.60	76	<b>76</b>
Pluak Daeng	39,319	11.60	116	<b>118</b>
Khao Chamao	9,453	2.79	28	<b>28</b>
Nikhom Phatthana	23,085	6.81	68	<b>72</b>
<b>Total</b>	<b>338,895</b>	<b>100</b>	<b>1,000</b>	<b>1,041</b>

## 4.2 Size of household

Questionnaire survey was conducted in each district. Collected data included location, geographical coordinate, number of actual resident, cooking behavior and usage of chemical.

In this study, households were classified into 3 groups according to the number of resident as follows:

- Small household (number of resident less than 3 people)
- Medium household (number of resident 3-6 people)
- Large household (number of resident more than 6 people)

Among 1041 household from the questionnaire survey, there were 595, 404 and 42 of small, medium and large size of household as shown in Table 4.2.

**Table 4.2** Size of household from the survey result

Size of household	Collected sample	% Type of household
Small household	595	57
Medium household	404	39
Large household	42	4

## 4.3 Emission factor of household

### 4.3.1 Oxide of nitrogen (NO<sub>x</sub>)

Amount of liquefied petroleum gas (LPG) used for household cooking is obtained from questionnaire survey. Emission rate of oxide of nitrogen from residential cooking is developed in the unit of kilogram per 1000 household per year (kg/1000 household/yr).

The emission factors are classified into 3 levels according to the size of household. The reason of this allocation is due to the fact the consumption amount is relevant to number of resident in the house.

### **1.) Small household**

Data, used to estimated emission of NO<sub>x</sub> from small household was as shown in Appendix C-1. Total number of small household from the survey was 595 households. Annual consumption of LPG was about 47,617.99 kg/yr. The arithmetic mean consumption of LPG per household was 97.58 kg/household/yr. Median value was 60 kg/household/yr.

### **2.) Medium household**

Data, used to estimated emission of NO<sub>x</sub> from medium households was shown in Appendix C-2. Total number of medium household from the survey was 404 households. Annual consumption of LPG about 52,124.48 kg/yr. The arithmetic mean consumption of LPG per household was 134.69 kg/household/yr. Median value was 90 kg/household/yr.

### **3.) Large Household**

Data, used to estimated emission of NO<sub>x</sub> from large households was shown in Appendix C-3. Total number of large household from the survey was 42 households. Annual consumption of LPG in total was about 7,059 kg/yr. The arithmetic mean consumption of LPG per household was 176.48 kg/household/yr. Median value was 180 kg/household/yr.

### **Calculation of NO<sub>x</sub> emission**

The annual consumptions of LPG for each size of household were used to multiply with emission factor of NO<sub>x</sub> from residential cooking (USEPA, AP-42). Emission factors of air pollutants from residential LPG cooking were as shown in Table 4.3

**Table 4.3** Emission factor from combustion of LPG (residential cooking)

Pollutant	Emission Factor (lb/10 <sup>3</sup> gallons)	AP-42 Table	Publication Date
CO	3.2	1.5-1	10/96
NO <sub>x</sub>	13.0	1.4-2	07/98
SO <sub>2</sub>	0.10	1.5-1	10/96
VOC	0.5	1.5-1	10/96
PM10 (Filterable)	0.17	1.4-2	07/98
PM2.5 (Filterable)	0.17	1.4-2	07/98
PM2.5 Condensable	0.51	1.4-2	07/98

Source: <http://www.epa.gov/ttnchie1/conference/ei12/area/haneke.pdf>

*Note:* LPG components of each country differently if the values of LPG emission factor the country would be great.

Emission factor of NO<sub>x</sub> from residential cooking combustion was used in this analysis. Unit of emission factor was converted from lb/10<sup>3</sup> gallons to kg/kgLPG details were as followed:

#### Conversion of emission factor unit

$$\begin{aligned}
 \text{EF NO}_x &= 13 \text{ lb}/10^3 \text{ gallons} \\
 &= (13 \text{ lb}/1000 \text{ gal}) \times (0.4536 \text{ kg}/1 \text{ lb}) \\
 &= 0.0059 \text{ kg}/\text{gallons} \times (1/\text{Density LPG}) \\
 &= (0.0059 \text{ kg}/\text{gallons}) \times (1 \text{ gallon}/4.546 \text{ L}) \times (1.825 \text{ L}/1 \text{ kgLPG}) \\
 &= 2.37 \times 10^{-3} \text{ kg NO}_x/\text{kLPG}
 \end{aligned}$$

This value was used to determine the emission of NO<sub>x</sub> using this equation:

$$\mathbf{Emission_{air\ pollutant;fuel} = Consumption_{fuel} \times EF_{air\ pollutant;fuel}}$$

Arithmetic means of annual LPG consumption of each size of household were used to compute with emission factor. The obtained values were emission factor of NO<sub>x</sub> for each size of household. Details of the calculations were as followed:

#### **Emission factor for small household**

$$\begin{aligned} \text{EF of small household} &= 60 \text{ kg/yr} \times 0.00237 \text{ kgNO}_x / \text{kgLPG} \\ &= 0.1422 \text{ kg NO}_x/\text{yr} \end{aligned}$$

As for 1,000 household, emission of NO<sub>x</sub> = 142.2 kgNO<sub>x</sub>/1000 household/yr

#### **Emission factor for medium household**

$$\begin{aligned} \text{EF of medium household} &= 90 \text{ kg/yr} \times 0.00237 \text{ kgNO}_x / \text{kgLPG} \\ &= 0.2133 \text{ NO}_x/\text{yr} \end{aligned}$$

As for 1,000 household, emission of NO<sub>x</sub> = 213.3 kg NO<sub>x</sub>/1000 household/yr

#### **Emission factor for large household**

$$\begin{aligned} \text{EF of large household} &= 180 \text{ kg/yr} \times 0.00237 \text{ kgNO}_x / \text{kgLPG} \\ &= 0.4266 \text{ NO}_x/\text{yr} \end{aligned}$$

As for 1,000 household, emission of NO<sub>x</sub> = 426.6 kg NO<sub>x</sub>/1000 household/yr

### **4.3.2 Summary of emission factor of NO<sub>x</sub> from household**

Among 1,041 household from the questionnaire survey, there were 595, 404 and 42 of small, medium and large sizes of household. Average emission factor of NO<sub>x</sub> for small household was calculated as  $14.22 \times 10^{-2}$  kg/household/yr or 142.2 kg/1000 household/yr. This value was obtained from average consumption of 60 kgLPG/household/yr. As for medium size of household, an average emission factor of NO<sub>x</sub> was about  $21.33 \times 10^{-2}$  kg/household/yr (213.30 kg/1000 household/yr). This value was obtained from average consumption of 90 kgLPG/household/yr. About  $42.66 \times 10^{-2}$

kg/household /yr (426.60 kg/1000 household/yr) of NO<sub>x</sub> was estimated from large size of household. This value was obtained from average consumption of 180 kgLPG/household/yr. Results were as summarized in Table 4.4.

**Table 4.4** Emission factor of NO<sub>x</sub> from LPG

Household	No. of Household	% of household	EF (kg/1000 household/yr)
Small house	595	57	142.20
Medium house	404	39	213.30
Large house	42	4	426.60

A weighted average of emission factor of NO<sub>x</sub> was estimated as 181.31 kg/1000 household/yr. This value can be applied in a calculation in an inventory domain where only total number of household is available.

#### 4.3.3 Household VOCs

From the survey, the household chemicals were classified into 4 groups. There were cleaning, deodorant, insecticide and nail cleaning groups.

Market survey was carried out in this study to determine the brand and chemicals used in household. It was found that there were at least 17 brands of cleaning group and at least 12 brands 12 of insecticide group. Only some PRTR chemicals were found as compounds in the household product.

Mostly of the cleaning group were not contained PRTR chemical as in their composition. Mostly of them used HCl (hydrochloric acid). However, it was found that a glass cleaning solution had isopropyl alcohol as its composition. Therefore, survey of isopropyl alcohol emission was conducted for this group in this study.

As for deodorant, 1,4-Dichlorobenzene was found as compound used in this group. Naphthalene was a target chemical in an insecticide group. Acetone and ethyl acetate was household chemicals found in the nail cleaning group.

### 1.) Glass cleaning product

From the market survey, there were 2 brands of cleaning solution, having isopropyl alcohol as their composition. They were King Stella (3% isopropyl alcohol w/w) and Happy (1% isopropyl alcohol w/w). Results of the survey of isopropyl alcohol consumption in household were shown in Appendix D-1. The amount of isopropyl in the product was calculated as shown in Table 4.5.

**Table 4.5** Amount of isopropyl per bottle of cleaning products

Product's Name	Isopropyl alcohol (330 ml.)	Total volume
King's Stella	7.77 g.	85.47 g.
Happy	2.59 g.	5.18 g.

The amounts of isopropyl alcohol in a 330 ml container of King's Stella and Happy were calculated as  $7.77 \times 10^{-3}$  kg and  $2.59 \times 10^{-3}$  kg, respectively.

Results from the survey indicated that among 1,041 household, there were 13 households, used these products. The consumption data was as summarized in Table 4.6.

**Table 4.6** Average consumption of product containing isopropyl alcohol

Duration of use per bottle of product (month)	
Arithmetic mean (X)	3.92
SD	2.7
Median	4

The arithmetic mean was used to estimate emission of isopropyl alcohol in this study. Total of 13 households used isopropyl alcohol are  $277.34 \times 10^{-3}$  kg/yr.

These data were used to calculate emission factor of isopropyl alcohol per 1000 household per year as shown in Table 4.7.

**Table 4.7** Emission factor of isopropyl alcohol per 1000 household per year

Number of household/ total household	Monthly emission (g/month)	Annual emission (g/yr)	Annual emission (kg/yr)
13/1041	23.11	277.33	0.28
12.488/1000	22.20	266.41	0.27

Average emission factor of isopropyl alcohol released to air from household activities was 0.27 kg/1000 household/yr.

## 2.) Deodorizer products

In the deodorant group, 1,4-Dichlorobenzene was found as a composition in this group. Therefore, emission factor of 1,4-Dichlorobenzene was evaluated in this study. Results from the survey of 1,4-Dichlorobenzene using in household was shown in Appendix D-2. Among 1,041 of surveyed household, there were 151 households used deodorant containing 1,4-Dichlorobenzene. The sublimation rate of 1,4-Dichlorobenzene was tested in the laboratory. The sublimation rate was about 4.5 days per gram of deodorant. These data were used in calculation of deodorant sublimation rate 4.5 gram per day of deodorant 100 g, annual consumption amount 1,620 g/yr.

Emission factor of 1,4-Dichlorobenzene was calculated in the unit of amount per 1000 household per year. Data used in the calculation was as shown in Table 4.8.

**Table 4.8** Total consumption of deodorant of household per year

Household	g/month	g/yr	kg/yr
151(as for 1041 household)	20,385	244,620	244.62
145.0528(as for 1000 household)	19,582.13	234,985.54	234.99

It was found that the total annual consumption of deodorant was about 234.99kg/1000 household/year. However, the composition of 1,4-Dichlorobenzene in the deodorant was about 99.6% w/w. Therefore, emission of 1,4-Dichlorobenzene to air was estimated as 234.05 kg/1000 household/year.

### 3.) Insecticide product

The PRTR chemical used in this study was naphthalene. This chemical was a common consumption of mothball. Results from the survey were as shown in Appendix D-3.

Among 1,041 of surveyed household, there were 53 households, used mothball-containing naphthalene product. The sublimation rate of naphthalene was tested in the laboratory. Result was as shown in Table 4.9.

Testing of mothball sublimation in laboratory, one pack of mothball was about 90 g by weight. All of them (90 g.) were generally used as the same time in household. The sublimation rate of mothball was tested as 36.46 day for 90 g of mothball. There fore consumption amount of mothball was estimated as 74.04 g/month. Annual consumption of mothball was estimated as 47,092.53 g/yr for 1041 household or about 45,237.78 g/yr for 1000 household. Results were as shown in Table 4.13.

**Note:** Factors that affect the rate of sublimation (Food Network Solution, 2014).

1. Temperature sublimation rate is directly proportional to the temperature at the sublimation temperature rising more and more.
2. The kind of solid Solids are less cohesive force between particles to sublimate easily.
3. Atmospheric pressure, the pressure of the atmosphere increases the rate of sublimation of the solid.
4. Surface area of solids if more space to sublimate easily.
5. The movement of air over a solid, solid air above it must be ventilated to prevent the saturation vapor.

**Table 4.9** Consumption of mothball in household

<b>Number of household</b>	<b>Number of used</b>	<b>Used (g/month)</b>	<b>Used (g/year)</b>
<b>1041</b>	53	3,924.38	47,092.53
<b>1000</b>	50.91	3,769.81	45,237.78

Composition of naphthalene in mothball was about 99.6% w/w. Be said that mothballs 100 g are naphthalene 99.6 g, when mothballs has 45,237.78 g it has naphthalene 45,056.83 g.

Therefore, emission factor of naphthalene of household activity was calculated as about 45.06 kg/1000 household/year.

#### **4.) Cosmetic of nail cleaning solution**

Acetone was a PRTR substance found as composition in nail cleaning solution. Therefore emission factor of acetone was evaluated in this study. Results from the survey were as shown in Appendix D-4. Among 1,041 of surveyed household, there were 273 households used nail cleaning product-containing acetone. The amount of acetone in nail cleaning product was estimated using data from the study in USA as shown in Table 4.10.

**Table 4.10** Amount of acetone in nail cleaning product

Product	Sustance	Content (g/100 cm <sup>3</sup> )
A1	acetone	18.62
A2	acetone	76.75
A3	acetone	58.8
A4	acetone	75.88
A5	acetone	66.8
A6	acetone	70.83
A7	acetone	64.65
A8	acetone	59.17
A9	acetone	71.63
A10	acetone	67.35

Souece: Huzae *et al* (2010). Proceedings of ECOpole

The average content of acetone was 63.05 g/100mL. This value was used in the estimation of acetone emission in this study. Consumption of acetone was calculated as shown in Table 4.11.

**Table 4.11** Consumption of acetone per year

Household	Acetone (g/yr)	Acetone (kg/yr)
273(As for 1041 household )	17,212.10	17.21
262.24784(As for 1000 household)	16,534.20	16.53

The emission factor of acetone released to air from the use of nail cleaning product in household was estimated as 16.53 kg/1000 household/year.

#### 4.3.4 Summary of the emission factor of household VOCs

Total number of household from the survey was 1041 household. Household chemical substances subjected to the substances under the PRTR was isopropyl alcohol found in glass cleaner products, 1,4-Dichlorobenzene, found in deodorant, naphthalene from the mothballs and acetone from nail polish remover. The emission factor of chemicals emitted from household activities from this study was as summarized Table 4.12.

**Table 4.12** Emission factor from the use of household chemicals

Chemical	Emission factor (kg/1000 household/yr)
Isopropyl Alcohol	0.27
1,4 -Dichlorobenzene	234.05
Naphthalene	45.06
Acetone	16.53

## 4.4 Calculation of emission amount

### 4.4.1 Emission amount of NO<sub>x</sub> from household

The ratio of household size and number of households in each district were used to determine the emission amount of NO<sub>x</sub> as shown in Table 4.13.

**Table 4.13** Emission inventory of NO<sub>x</sub> from household for each districts in Rayong province

<i>Districts</i>	<i>Emission Inventory (kg/yr)</i>			<b>Total</b>	<i>Amount of emission per area (kg/km<sup>2</sup>)</i>
	<b>Small household</b>	<b>Medium holdhold</b>	<b>Large household</b>		
Mueang Rayong	11,651.76	11,958.38	2,453.00	26,063.14	50.66
Bang Chang	2,642.85	2,712.40	556.39	5,911.63	24.8
Klaeng	4,418.17	6,627.26	930.14	9,882.75	12.53
Wang Chan	8,43.61	1,265.42	177.60	1,887.02	4.77
Ban Khai	2,088.11	3,132.17	439.60	4,670.78	9.54
Pluak Daeng	3,186.96	4,780.44	670.94	7,128.73	11.53
Khao Chamao	766.20	786.37	161.31	1,713.88	6.35
Nikhom Phatthana	1,871.13	2,806.70	393.92	3,051.42	12.85
Total	27,468.79	27,057.65	5,782.90	60,309.35	...

The total amount of NO<sub>x</sub> emitted from household in Rayong province was calculated as 60.31 tons per year. The largest amounts were emitted from Mueang Rayong district (43% of total provincial emission). Khao Chamao district had the lowest emission amount of NO<sub>x</sub> from residential cooking in Rayong province (3% of total provincial emission). By using an average emission factor of 213.3 kg of NO<sub>x</sub>/1000 household/year, obtained from average consumption of LPG of household in the study area (without considering the size of household) as shown in Table 4.14 or by using an average emission factor of 181.31 kg of NO<sub>x</sub>/1000 household/year, obtained from weight average of emission factor of NO<sub>x</sub> in the study area, the amount of NO<sub>x</sub> emission was estimated as 61.45 ton/year.

**Table 4.14** Emission inventory of NO<sub>x</sub> from household in Rayong province

Districts	Number fo household	Emission amount (kg/yr)
Mueang Rayong	143,753	30,662.52
Bang Chang	32,606	6,954.86
Klaeng	54,509	11,626.77
Wang Chan	10,408	2,220.03
Ban Khai	25,762	5,495.03
Pluak Daeng	39,319	8,386.74
Khao Chamao	9,453	2,016.32
Nikhom Phatthana	23,085	4,924.03
Total	338,895	72,286.30

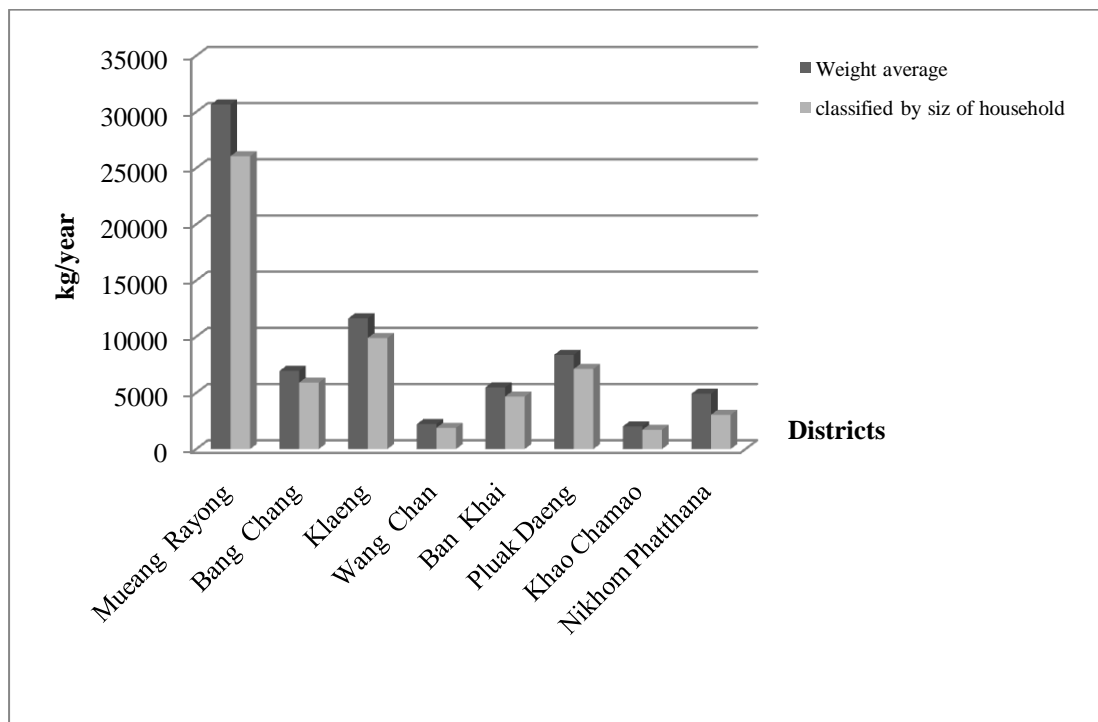
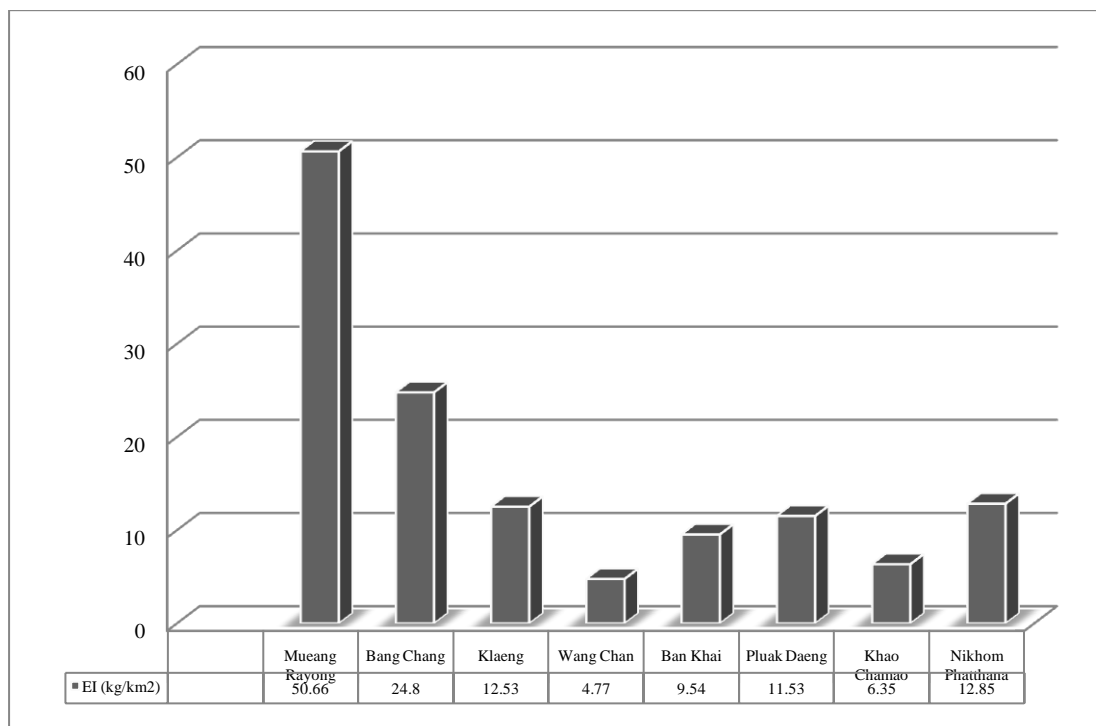
**Figure 4.1** Comparison of NO<sub>x</sub> emission calculation

Figure 4.1 compared calculated results of using a weighted average emission factor and more defined average emission factor as classified by size of household. Even though the total amount of NO<sub>x</sub> emission factor from these two

calculations were not much difference the values for each districts were quite difference. These results indicated that the more defined data, the higher accuracy of the result. However, in an area when these activity data are not aviable, a weighted average emission factor can still be used in calculation of emission amount in such areas.

Calculated result of amount of NO<sub>x</sub> emission per ares of each district in the unit of kg/km<sup>2</sup> was as shown in Table 4.13 and Figure 4.2. The results indicated that the highest value of an area-based emission of NO<sub>x</sub> per year was about 50.66 kg/km<sup>2</sup> at Muang Rayong district. These data can be used as an input data for air pollution dispersion modeling and exposure analysis of air pollutant charactristic particularly for Rayong province in other researches.



**Figure 4.2** Emission amount of NO<sub>x</sub> per area (kg/km<sup>2</sup>/year)

#### 4.4.2 Emission amount of household chemical

Total numbers of household in each district were with emission factor of each chemical.

The annual emission amount of each chemicals release to air from household activity was as summarized in Table 4.20.

**Table 4.15** Emission amount of chemicals from household (unit: kg/year)

Districts	Isopropy Alcohol (kg/yr)	1,4 –Dichlobenzene (kg/yr)	Naphthalene (kg/yr)	Acetone (kg/yr)
Mueang Rayong	38.30	33644.76	6477.06	2376.84
Bang Chang	8.69	7631.29	1469.13	539.11
Klaeng	14.52	12757.59	2456.00	901.26
Wang Chan	2.77	2435.95	468.95	172.09
Ban Khai	6.86	6029.48	1160.75	425.95
Pluak Daeng	10.47	9202.44	1771.59	650.11
Khao Chamao	2.52	2212.43	425.92	156.30
Nikhom Phatthana	6.15	5402.94	1040.14	381.69
Total	90.28	79316.88	15269.54	5603.35

It was found that the high emission amount of chemical release from household was at Mueang Rayong district. Emission rate per area of chemical, released from household activity was calculated by dividing emission amount with total area of each district. Results were as presented in Table 4.21

**Table 4.16** Emission rate of household chemical per area (kg/km<sup>2</sup>)

<b>District</b>	<b>Isopropy Alcohol (kg/km<sup>2</sup>)</b>	<b>1,4 -Dichlobenzene (kg/km<sup>2</sup>)</b>	<b>Naphthalene (kg/km<sup>2</sup>)</b>	<b>Acetone (kg/km<sup>2</sup>)</b>
Mueang Rayong	0.0744	65.3931	12.5890	4.6197
Bang Chang	0.0365	32.0104	6.1624	2.2614
Klaeng	0.0184	16.1803	3.1149	1.1431
Wang Chan	0.0070	6.1631	1.1865	0.4354
Ban Khai	0.0140	12.3151	2.3708	0.8699
Pluak Daeng	0.0169	14.8824	2.8651	1.0514
Khao Chamao	0.0093	8.1957	1.5778	0.5789
Nikhom Phatthana	0.0259	22.7492	4.3795	1.6071

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

The overall results and findings from this study were summarized in this chapter. Conclusions with respect to the objectives of the study were presented.

#### 5.1 Coclusions

The emission factor of  $\text{NO}_x$  and chemical released from household activity were developed in this study.  $\text{NO}_x$  is emitted as by product from combustion of LPG, used in residential cooking. Amount of LPG consumption in different sizes of household in Rayong province were surveyed. These data were used to calculate for emission factor of  $\text{NO}_x$  from different sizes of household and were expressed in the unit of kg of  $\text{NO}_x$  per 1000 household. These data will be much useful database for further implementation of the Pollutant Release and Transfer Registration (PRTR) program for a non-point source emission estimation. Emission factors of  $\text{NO}_x$  emitted from combustion of LPG from household cooking were as summarized in Table 5.1.

**Table 5.1** Emission factor of  $\text{NO}_x$  from household cooking

Size of Household	EF (kg/1000 household/yr)
Small household	142.2
Medium household	213.3
Large household	426.6
Total (without considering the size of household)	213.3

Emission factor of chemical were developed using actual consumption data of chemical use of household product. Four chemical, contained in household product were estimated for their annual emission rate. Results were presented in Table 5.2.

**Table 5.2** Emission factor of chemicals from household activity

<b>Chemical</b>	<b>Emission factor (kg/1000 household/yr)</b>
Isopropyl Alcohol	0.27
1,4 - Dichlorobenzene	234.05
Naphthalene	45.06
Acetone	16.53

Developed emission factors were computed with number of household in each district in order to determine annual emission amount of PRTR target chemical, released from household activity. Results were as summarized in Table 5.3

**Table 5.3** Summary of emission amount of PRTR chemical from household activity (unit: kg/y)

<b>Districts</b>	<b>NO<sub>x</sub> (without considering size of household)</b>	<b>NO<sub>x</sub> (classified by size of household)</b>	<b>Isopropyl Alcohol</b>	<b>1,4- Dichlobenzene</b>	<b>Naphthalene</b>	<b>Acetone</b>
Mueang Rayong	30662.52	26,063.14	38.30	33644.76	6477.06	2376.84
Bang Chang	6954.86	5,911.63	8.69	7631.29	1469.13	539.11
Klaeng	11626.77	9,882.75	14.52	12757.59	2456	901.26
Wang Chan	2220.03	1,887.02	2.77	2435.95	468.95	172.09
Ban Khai	5495.03	4,670.78	6.86	6029.48	1160.75	425.95
Pluak Daeng	8386.74	7,128.73	10.47	9202.44	1771.59	650.11
Khao Chamao	2016.32	1,713.88	2.52	2212.43	425.92	156.3
Nikhom Phatthana	4924.03	3,051.42	6.15	5402.94	1040.14	381.69
Total	72,286.30	60,309.35	90.28	79316.88	15269.54	5603.35

Since household is consideration as non-point source, the area based emission rates were also developed for further calculation in air pollution model in the future. Results were presented in Table 5.4.

**Table 5.4** Area-based emission factor of household (unit: kg/km<sup>2</sup>)

Districts	NO <sub>x</sub> (without considering size of household)	NO <sub>x</sub> (classified by size of household)	Isopropy Alcohol	1,4 - Dichlobenzen e	Naphthalene	Acetone
Mueang Rayong	59.60	50.66	0.0744	65.3931	12.5890	4.6197
Bang Chang	29.17	24.8	0.0365	32.0104	6.1624	2.2614
Klaeng	14.75	12.53	0.0184	16.1803	3.1149	1.1431
Wang Chan	5.62	4.77	0.0070	6.1631	1.1865	0.4354
Ban Khai	11.22	9.54	0.0140	12.3151	2.3708	0.8699
Pluak Daeng	13.56	11.53	0.0169	14.8824	2.8651	1.0514
Khao Chamao	7.47	6.35	0.0093	8.1957	1.5778	0.5789
Nikhom Phatthana	20.73	12.85	0.0259	22.7492	4.3795	1.6071

From table 5.4 emission factor of isopropyl alcohol is minimum and 1,4 – Dichlorobenzene is maximum. Because deodorant containing 1,4 -Dichlorobenzene it's large and are widely used, isopropyl alcohol. Isopropyl alcohol the ingredients in glass cleaning solution will be found to have used product less. Therefore, emission factor of isopropyl alcohol is minimum. It was found that most people prefer to use water instead of glass cleaner product. Naphthalene in mothball sold as a pack it continuous use makes emission factor highly valuable. Nail products available in the market, the survey found that acetone is the main chemical compounds found in nail cleaning solution. The study of the USA found another chemical addition of acetone; another chemical ratio will be different (Huzar *et al.*, 2010).

## **5.2 Recommendations for further study**

It should be noted that the emission factors, developed under this study were objected for use under PRTR system. Therefore, adjustments of the unit of emission rate to the shorter time for using as an input data for air quality modeling are inappropriate. These data were proper to use for estimating emission inventory. Results can be used for spatial and temporal evaluation. However, the emission factors are site-specific values. Therefore, application in other areas must be considered as appropriate. The different areas, cultural and economic conditions will affect the scrap, chemicals and products used in the area. As well as hazardous chemicals found in laundry detergent are tetrachloroethylene often have widespread use in the urban area.

## REFERENCES

- Cara A.M. and Bondi. (2011). Applying the precautionary principle to consumer household cleaning product development. *Journal of Cleaner Production* 19, 429-437.
- Cleveland Clinic. (2013). Household Safety. Retrieved July 17, 2013, From [http://my.clevelandclinic.org/healthy\\_living/safety/hic\\_household\\_chemicals\\_chart\\_whats\\_in\\_my\\_house.aspx](http://my.clevelandclinic.org/healthy_living/safety/hic_household_chemicals_chart_whats_in_my_house.aspx)
- Fausser, P. & Illerup, B.J. (2008). Danish emission inventory for solvents used in industries and households. *Atmospheric Environment* 42, 7947–7953.
- Golley, J. & Meng, X. (2012). Income inequality and carbon dioxide emissions: The case of Chinese urban households. *Energy Economics* 34, 1864–1872
- Huzar, E., Wodnicka, A. & Dzieciol, M. (2010). Quality inspection of nail polish removers and assessments of health hazard associated with the use of the removers. *Proceeding of ECOpole*, vol 4: No. 2.
- IARC, 2002. Some traditional herbal medicins, some mycotoxins, naphthalene and styrene. In: *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, vol. 82 Lyon.
- Johnson, M., Edwards, R., Frenk, A.C., & Masera, O. (2008). In-field greenhouse gas emissions from cookstoves in rural Mexican households. *Atmospheric Environment* 42,1206–1222.
- Kamal, S. and Hassan, M. (2012). Metal concentrations and distribution in the household, stairs and entryway dust of some Egyptian homes. *Atmospheric Environment* 54, 207-215.
- Kang, H.D., Choi, H.D., Won, D., Yang, W., Hans, S. & Jacinthe, D. (2012). Household materials as emission sources of naphthalene in Canadian homes and their contribution to indoor air. *Atmospheric Environment* 50, 79-87.

- Kwon, D.K., Jo, K.W., Lim, J.H., Jeong, S.W., (2007). Characterization of emissions composition for selected household products available in Korea. *Hazardous Materials* 148, 192–198.
- Majumdar, D., Chintada, A., Sahu, J., & Chalapati Rao C. V. (2013). Emissions of greenhouse and non-greenhouse air pollutants from fuel combustion in restaurant industry. *Int. J. Environ. Sci. Technol.* 10, 995–1006.
- Niu, S., Zhang, X., Zhao, C., Ding, Y., Niu, Y., & Christensen, H.T. (2011). Household energy use and emission reduction effects of energy conversion in Lanzhou city, China. *Renewable Energy* 36, 1431-1436.
- Rattanapanoth, N. (2014). Food Network Solution. Retrieved March 8, 2014, From <http://www.foodnetworksolution.com/wiki/word/0562/sublimation>
- Rayong Thailand. (2013). About Rayong Thailand. Retrieved August 22, 2013, From <http://www.rayongthailand.com/>
- Salthammer, T. (1999). Volatile organic ingredients of household and consumer products, in: T. Salthammer (Ed.), *Organic Indoor Air Pollutants*, Wiley-VCH, Weinheim, pp. 219–232.
- Trenholm, A.R., Vanderford, J.B., Drewesb, E.J., & Snyder, A.S. (2008). Determination of household chemicals using gas chromatography and liquid chromatography with tandem mass spectrometry. *Journal of Chromatography A*, 1190, 253–262.
- UNITAR. (2013). Pollutant Release and Transfer Registers. Retrieved July 19, 2013, From <http://www.unitar.org/cwm/prtr/what-is>
- US EPA. (2011). *Compilation of air pollutant emission factors volume I: stationary point and area sources*, AP-42 fifth edition. Retrieved July 17, 2013, from <http://www.epa.gov/ttnchie1/ap42/>
- Wikipedia. (2013). List of house types. Modified on August 5, 2013, From [http://en.wikipedia.org/wiki/List\\_of\\_house\\_types](http://en.wikipedia.org/wiki/List_of_house_types)
- World Health Organization (WHO). (1989). *Indoor air quality: Organic pollutants*. Report on a WHO meeting, Euro-Reports and Studies 111. Copenhagen: WHO Regional Office for Europe.

- Zhang, H., Wang, S., Hao, J., Wan, L., Jiang, J., Zhang, M. Heidi E.S. Mestl., Line W.H. Alnes., Aunan, K., & Mellouki, W.A.(2012). Chemical and size characterization of particles emitted from the burning of coal and wood in rural households in Guizhou, China. *Atmospheric Environment* 51, 94-99.
- Zhu, J., Cao, X.L. & Beauchamp, R. (2001). Determination of 2-butoxy ethanol emissions from selected consumer products and its application in assessment of inhalation exposure associated with cleaning tasks, *Environ. Int.* 26,589–597.

## **APPENDICES**

**APPENDIX A**  
**TARO YAMANE CALCULATION**

**Equation:**

$$n = N / (1 + Ne^2)$$

n = sample size calculations.

N = number of populations

e = allowable error

*Note:* the error level of 5% is used in the formula instead of the 0.05.

Total of household in Rayong province are 338,895 household. Result from the calculation indicates that the number of sample are about 400 households.



ประเภทการใช้งาน	ชื่อผลิตภัณฑ์	ขนาด (ml, L, mg, g)	ระยะเวลาที่ใช้ (ว / ค / ป)	ระบายสู่ (ดิน, น้ำ, อากาศ)
ผลิตภัณฑ์ทำความสะอาด (Cleaning products)	Grandhome <input type="radio"/>			
	HG <input type="radio"/>			
	Magiclean (ห้องน้ำ, พื้น, อื่นๆ) <input type="radio"/>			
	Mr.Muscle (ห้องน้ำ, ห้องน้ำ, พื้น, อื่นๆ) <input type="radio"/>			
	Newsponge <input type="radio"/>			
	Penguin (ห้องน้ำ) <input type="radio"/>			
	Swash <input type="radio"/>			
	Spa clean <input type="radio"/>			
	Vim (ห้องน้ำ) <input type="radio"/>			
	Vixol (ห้องน้ำ) <input type="radio"/>			
	คิงส์สเตลล่า (เช็ดกระจก) <input type="radio"/>			
	โปรแมกซ์ (ห้องน้ำ) <input type="radio"/>			
	แอปเปิ้ล (เช็ดกระจก) <input type="radio"/>			
	ไฮโปร (ห้องน้ำ) <input type="radio"/>			
อื่นๆ _____				
น้ำยาดับกลิ่น (Deodorizers)	Air wick <input type="radio"/>			
	Ambi-pur <input type="radio"/>			
	Biofresh <input type="radio"/>			
	Daily fresh <input type="radio"/>			
	Farcent <input type="radio"/>			
	Glade <input type="radio"/>			
	Renuzit <input type="radio"/>			
	ก๊อন্দับกลิ่น <input type="radio"/>			
	อื่นๆ _____			

ประเภทการใช้งาน	ชื่อผลิตภัณฑ์	ขนาด (ml, L, mg, g)	ระยะเวลาที่ใช้ (ว / ด / ป)	ระบายสู่ (ดิน, น้ำ, อากาศ)
ยาฆ่าแมลง(Pesticides)	Nipponpaint (น้ำยาฆ่าเชื้อรา) <input type="radio"/>			
	Supergreen <input type="radio"/>			
	ก้อนดับกลิ่น <input type="radio"/>			
	เซนไดรี้ท์ <input type="radio"/>			
	ซิลค์ท็อกซ์ <input type="radio"/>			
	จีนเจีย <input type="radio"/>			
	ซอโฟเฟล <input type="radio"/>			
	ไบคอน <input type="radio"/>			
	แบลททานี้กซ์ <input type="radio"/>			
	ลูกเหม็นไล่แมลง(Naphthalene) <input type="radio"/>			
	อาร์ท <input type="radio"/>			
	อัสวิน <input type="radio"/>			
	อื่นๆ _____ <input type="radio"/>			
สีทาเล็บ/น้ำยาล้างเล็บ <input type="radio"/>				

**Table B-2** English Questionnaire

Name\_\_\_\_\_

**Questionnaire using household chemicals**

The survey data and the development and evaluation of the movement of pollutants from Non-Point Source.

1. District. \_\_\_\_\_ Province\_\_\_\_\_

2. Coordinates UTM, X\_\_\_\_\_Y\_\_\_\_\_

3. Household type

- Detached house       Row house  
 Townhouse / house       Temporary housing

4. Actual number of resident \_\_\_\_\_ People

5. Cooking

- Gas volume used \_\_\_\_\_ Tank per month ( \_\_\_\_\_ kg )  
 Wood  
 No cooking

6. The use of household chemicals.

Types of applications	Products Name	Size (ml, L, mg, g)	Duration of usage	Releare (Soil, water, air)
Cleaning products	3M ○			
	Bellinzoni ○			
	Duck ○			
	Grandhome ○			
	HG ○			
	Happy ○			

Types of applications	Products Name	Size (ml, L, mg, g)	Duration of usage	Releare (Soil, water, air)
Cleaning products	Hypro <input type="radio"/>			
	Kingstala <input type="radio"/>			
	Magiclean <input type="radio"/>			
	Mr.Muscle <input type="radio"/>			
	Newsponge <input type="radio"/>			
	Penguin <input type="radio"/>			
	Promax <input type="radio"/>			
	Swash <input type="radio"/>			
	Spa clean <input type="radio"/>			
	Vim <input type="radio"/>			
	Etc _____			
Deodorizers	Air wick <input type="radio"/>			
	Ambi-pur <input type="radio"/>			
	Biofresh <input type="radio"/>			
	Daily fresh <input type="radio"/>			
	Farcent <input type="radio"/>			
	Glade <input type="radio"/>			
	Renuzit <input type="radio"/>			
	Odor Repellent <input type="radio"/>			
	Etc _____			
	Nipponpaint <input type="radio"/>			

Types of applications	Products Name	Size (ml, L, mg, g)	Duration of usage	Releare (Soil, water, air)	
Pesticides	Supergreen <input type="radio"/>				
	Lump <u>Deodorize</u> <input type="radio"/>				
	Chaindrite <input type="radio"/>				
	shieldtox <input type="radio"/>				
	Shanjia <input type="radio"/>				
	soffell <input type="radio"/>				
	Pesticides	Baygon <input type="radio"/>			
		Biattanex <input type="radio"/>			
		Naphthalene <input type="radio"/>			
		Art <input type="radio"/>			
		Etc _____ <input type="radio"/>			
Nail polish / nail remove <input type="radio"/>					

## APPENDIX C

### QUESTIONNAIRE SURVEY OF NO<sub>x</sub> FROM HOUSEHOLD

Table C-1 Small household

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Choeng Noen	Mueang Rayong	749.322	1403.883	Detached house	1	15	48	6.25
Choeng Noen	Mueang Rayong	747.348	1403.886	Row house	3	15	0.5	360
Choeng Noen	Mueang Rayong	747.436	1403.895	Row house	3	15	1	180
Choeng Noen	Mueang Rayong	747.4	1403.944	Row house	2	7	1	84
Choeng Noen	Mueang Rayong	747.391	1403.908	Row house	3	5	0.5	120
Choeng Noen	Mueang Rayong	747.356	1403.908	Townhouse / house	2			ND
Choeng Noen	Mueang Rayong	747.325	1404.015	Townhouse / house	2			ND
Choeng Noen	Mueang Rayong	747.334	1403.923	Row house	2	5	12	5
Choeng Noen	Mueang Rayong	747.307	1403.925	Townhouse / house	2			ND
Choeng Noen	Mueang Rayong	747.369	1403.929	Row house	3			ND
Choeng Noen	Mueang Rayong	747.317	1403.998	Detached house	1	7	12	84
Huai Pong	Mueang Rayong	731.25	1410.418	Detached house	3	7	4	21
Huai Pong	Mueang Rayong	731.28	1410.539	Row house	3	15	3	60
Huai Pong	Mueang Rayong	733.012	1408.335	Row house	2	15	6	30
Huai Pong	Mueang Rayong	733.729	1410.036	Row house	3	5	1	60
Huai Pong	Mueang Rayong	733.779	1409.245	Row house	3	5	2	30
Huai Pong	Mueang Rayong	731.28	1410.539	Row house	2	5	2	30
Map Ta Phut	Mueang Rayong	734.34	1408.405	Townhouse / house	3	5	2	30
Map Ta Phut	Mueang Rayong	735.106	1407.944	Detached house	3			ND
Map Ta Phut	Mueang Rayong	735.132	1408.61	Detached house	2			ND
Map Ta Phut	Mueang Rayong	736.702	1407.626	Row house	3	15	0.5	360
Map Ta Phut	Mueang Rayong	735.132	1408.61	Detached house	3	15	6	30
Map Ta Phut	Mueang Rayong	735.132	1408.61	Townhouse / house	2	15	4	45
Map Ta Phut	Mueang Rayong	735.3	1408.379	Townhouse / house	2	15	3	20
Map Ta Phut	Mueang Rayong	735.647	1406.931	Detached house	3	5	0.25	240
Map Ta Phut	Mueang Rayong	735.647	1406.931	Row house	3			ND
Map Ta Phut	Mueang Rayong	736.467	1402.451	Temporary housing	3	5	15 วัน	120
Map Ta Phut	Mueang Rayong	736.452	1402.464	Temporary housing	2			ND
Map Ta Phut	Mueang Rayong	738.863	1402.698	Detached house	3	15	0.5	60
Map Ta Phut	Mueang Rayong	738.916	1402.667	Detached house	2	15	6	30
Noen Phra	Mueang Rayong	740.587	1403.162	Row house	3	5	3	20
Map Ta Phut	Mueang Rayong	735.149	1403.678	Detached house	3	5	3.5	17.14285714
Map Ta Phut	Mueang Rayong	735.175	1403.434	Detached house	3	15	0.5	360

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	735.216	1403.343	Row house	1	7	1	7*12
Map Ta Phut	Mueang Rayong	735.745	1402.745	Detached house	2			ND
Map Ta Phut	Mueang Rayong	735.088	1405.313	Row house	1			ND
Map Ta Phut	Mueang Rayong	735.102	1405.327	Row house	2	5	1.5	40
Map Ta Phut	Mueang Rayong	735.043	1405.321	Detached house	3	5	3	20
Map Ta Phut	Mueang Rayong	735.225	1403.332	Detached house	2	15	1	180
Choeng Noen	Mueang Rayong	749.916	1401.977	Temporary housing	1			ND
Choeng Noen	Mueang Rayong	749.916	1401.997	Temporary housing	2	15	1	180
Choeng Noen	Mueang Rayong	749.88	1401.983	Temporary housing	2	15	0.5	360
Choeng Noen	Mueang Rayong	749.27	1401.729	Temporary housing	3			ND
Choeng Noen	Mueang Rayong	749.885	1401.944	Temporary housing	3	15	1	180
Choeng Noen	Mueang Rayong	749.784	1401.706	Row house	2	15 kg.	3	60
Choeng Noen	Mueang Rayong	749.796	1401.705	Row house	2	7 kg.	3	28
Choeng Noen	Mueang Rayong	749.77	1401.702	Row house	2			ND
Choeng Noen	Mueang Rayong	749.851	1401.963	Townhouse / house	3	15	6	30
Choeng Noen	Mueang Rayong	749.871	1401.962	Townhouse / house	3			ND
Choeng Noen	Mueang Rayong	749.747	1401.813	Row house	3			ND
Choeng Noen	Mueang Rayong	749.796	1401.903	Townhouse / house	3	15	1	180
Choeng Noen	Mueang Rayong	749.694	1401.721	Townhouse / house	3	15	1	180
Choeng Noen	Mueang Rayong	749.768	1401.812	Row house	2	15	1	180
Choeng Noen	Mueang Rayong	749.813	1401.919	Row house	2	15	1	180
Choeng Noen	Mueang Rayong	749.865	1401.957	Row house	3	15	1	180
Choeng Noen	Mueang Rayong	749.883	1401.631	Row house	2	7	1	180
Choeng Noen	Mueang Rayong	749.849	1401.659	Townhouse / house	3	15	3	60
Choeng Noen	Mueang Rayong	749.795	1401.709	Townhouse / house	3	5	0.5	360
Choeng Noen	Mueang Rayong	749.85	1401.669	Townhouse / house	1	15	5	36
Choeng Noen	Mueang Rayong	749.888	1401.662	Townhouse / house	3	15	1	180
Choeng Noen	Mueang Rayong	749.849	1401.691	Townhouse / house	2	5	0.5	360
Choeng Noen	Mueang Rayong	749.889	1401.721	Townhouse / house	3	15	3	60
Choeng Noen	Mueang Rayong	749.932	1401.738	Townhouse / house	2	15.	6	30
Choeng Noen	Mueang Rayong	749.928	1401.807	Townhouse / house	2	15	3	60
Choeng Noen	Mueang Rayong	749.878	1401.704	Townhouse / house	2	5	1	180
Choeng Noen	Mueang Rayong	749.68	1401.573	Detached house	3	15	1	180
Choeng Noen	Mueang Rayong	749.877	1402.169	Detached house	3	15	1.5	120
Choeng Noen	Mueang Rayong	749.883	1402.175	Detached house	3			ND
Choeng Noen	Mueang Rayong	749.852	1402.221	Detached house	3	15	3	60
Choeng Noen	Mueang Rayong	749.816	1402.234	Townhouse / house	3	15	3	60
Choeng Noen	Mueang Rayong	749.792	1402.193	Townhouse / house	2	4	1	48
Choeng Noen	Mueang Rayong	749.716	1402.179	Townhouse / house	1	15	3	60
Choeng Noen	Mueang Rayong	749.747	1402.143	Townhouse / house	3			ND
Choeng Noen	Mueang Rayong	749.859	1402.109	Townhouse / house	1			ND
Choeng Noen	Mueang Rayong	749.9	1401.975	Row house	2	15	2	90
Choeng Noen	Mueang Rayong	749.766	1402.825	Townhouse / house	1	4	2	24

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Choeng Noen	Mueang Rayong	749.918	1402.008	Detached house	3	15	1	180
Choeng Noen	Mueang Rayong	749.761	1401.939	Townhouse / house	3	15	12	15*1
Choeng Noen	Mueang Rayong	749.755	1401.958	Townhouse / house	3	15	3	60
Choeng Noen	Mueang Rayong	749.768	1401.68	Townhouse / house	3	15	1	180
Choeng Noen	Mueang Rayong	749.722	1401.789	Detached house	3	15	2	90
Choeng Noen	Mueang Rayong	749.722	1401.784	Row house	3			ND
Choeng Noen	Mueang Rayong	749.741	1401.796	Townhouse / house	2			ND
Choeng Noen	Mueang Rayong	749.809	1401.892	Townhouse / house	2	15	1	180
Choeng Noen	Mueang Rayong	749.775	1401.927	Townhouse / house	2	15	3-Feb	120
Huai Pong	Mueang Rayong	733.214	1409.338	Row house	3	7	1	84
Huai Pong	Mueang Rayong	732.415	1409.971	Row house	2	7	2	42
Huai Pong	Mueang Rayong	733.974	1409.01	Row house	3	7	1.5	56
Huai Pong	Mueang Rayong	739.249	1408.438	Detached house	3	15	3	60
Huai Pong	Mueang Rayong	734.66	1408.476	Townhouse / house	3	4	1	48
Huai Pong	Mueang Rayong	735.019	1408.095	Row house	2	4	3	16
Huai Pong	Mueang Rayong	736.317	1407.925	Detached house	3	15	6	30
Huai Pong	Mueang Rayong	735.416	1406.728	Row house	3			ND
Huai Pong	Mueang Rayong	735.376	1406.676	Row house	2	15	2	90
Map Ta Phut	Mueang Rayong	735.533	1406.508	Townhouse / house	3	15	1	180
Map Ta Phut	Mueang Rayong	735.545	1406.525	Row house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.238	1407.75	Row house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.125	1407.925	Townhouse / house	3	4	1	48
Map Ta Phut	Mueang Rayong	734.622	1408.39	Detached house	2	4	1	48
Map Ta Phut	Mueang Rayong	733.352	1409.33	Row house	3	15	1	180
Map Ta Phut	Mueang Rayong	732.297	1412.506	Detached house	3	15	2	90
Map Ta Phut	Mueang Rayong	735.54	1408.305	Townhouse / house	2	15	1	180
Map Ta Phut	Mueang Rayong	735.233	1407.781	Detached house	3	4	1	48
Map Ta Phut	Mueang Rayong	735.548	1408.28	Townhouse / house	3	7	2	42
Huai Pong	Mueang Rayong	732.424	1409.606	Detached house	2	15	3	60
Map Ta Phut	Mueang Rayong	735.44	1408.368	Detached house	3	15	5	3.529411765
Map Ta Phut	Mueang Rayong	735.44	1408.368	Townhouse / house	3			ND
Map Ta Phut	Mueang Rayong	735	1408	Detached house	3	15	2	90
Map Ta Phut	Mueang Rayong	735.421	1406.658	Row house	2			ND
Map Ta Phut	Mueang Rayong	732.235	1412.506	Row house	2	15	4	45
Map Ta Phut	Mueang Rayong	734.625	1408.38	Townhouse / house	3	4	2	24
Map Ta Phut	Mueang Rayong	735.457	1408.384	Detached house	2			ND
Map Ta Phut	Mueang Rayong	736.282	1407.873	Detached house	3	15	0.5	360
Map Ta Phut	Mueang Rayong	735.552	1408.429	Detached house	3	15	3	60
Map Ta Phut	Mueang Rayong	735.581	1408.634	Townhouse / house	3	15	3	60
Map Ta Phut	Mueang Rayong	735.543	1408.578	Row house	2	4	2	24
Map Ta Phut	Mueang Rayong	735.557	1406.549	Townhouse / house	2	15	1	180
Map Ta Phut	Mueang Rayong	735.566	1406.641	Row house	3	15	0.25	360
Map Ta Phut	Mueang Rayong	735.587	1406.665	Townhouse / house	3			ND

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	735.597	1406.748	Detached house	1			ND
Map Ta Phut	Mueang Rayong	734.61	1408.365	Detached house	2	4	3	16
Map Ta Phut	Mueang Rayong	734.528	1408.38	Townhouse / house	3			ND
Map Ta Phut	Mueang Rayong	734.628	1408.345	Row house	3	15	2	90
Map Ta Phut	Mueang Rayong	734.625	1408.38	Detached house	2	4	1.5	32
Map Ta Phut	Mueang Rayong	734.242	1408.446	Detached house	2	4	3	16
Map Ta Phut	Mueang Rayong	731.671	1410.482	Townhouse / house	1	4	5	9.6
Map Ta Phut	Mueang Rayong	732.401	1409.997	Townhouse / house	1	4	4	12
Map Ta Phut	Mueang Rayong	734.846	1407.356	Detached house	2	4	1	48
Map Ta Phut	Mueang Rayong	734.987	1407.59	Townhouse / house	2	4	3	16
Huai Pong	Mueang Rayong	733.172	1409.316	Row house	3	15	1	180
Huai Pong	Mueang Rayong	732.048	1410.832	Row house	2			ND
Huai Pong	Mueang Rayong	732.402	1409.983	Row house	1			ND
Huai Pong	Mueang Rayong	732.408	1409.991	Row house	2	15	1	180
Huai Pong	Mueang Rayong	733.191	1409.325	Row house	2	15	0.5	360
Huai Pong	Mueang Rayong	733.169	1409.317	Row house	3	15	0.5	360
Huai Pong	Mueang Rayong	732.865	1409.659	Row house	1	4	0.33	48
Map Ta Phut	Mueang Rayong	735.524	1406.539	Row house	2	15	0.33	540
Map Ta Phut	Mueang Rayong	735.504	1406.552	Row house	1	15	12	15
Map Ta Phut	Mueang Rayong	735.192	1403.448	Row house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.265	1403.286	Row house	2	15	4	45
Map Ta Phut	Mueang Rayong	735.068	1406.534	Detached house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.236	1405.75	Row house	2	4	1.5	32
Map Ta Phut	Mueang Rayong	735.093	1405.253	Row house	3	15	3	60
Noen Phra	Mueang Rayong	736.656	1402.568	Row house	2	15	6	30
Noen Phra	Mueang Rayong	736.102	1402.435	Row house	1	ไม้/หิน		ND
Noen Phra	Mueang Rayong	737.72	1402.715	Row house	2	15	3	60
Noen Phra	Mueang Rayong	738.253	1402.711	Row house	3	15	3	60
Noen Phra	Mueang Rayong	740.588	1403.158	Detached house	2	15	2	90
Noen Phra	Mueang Rayong	736.451	1401.781	Detached house	2	15	1	180
Noen Phra	Mueang Rayong	737.843	1402.65	Detached house	3	15	1	180
Noen Phra	Mueang Rayong	735.81	1403.986	Detached house	3	4	1.5	32
Noen Phra	Mueang Rayong	735.81	1402.485	Detached house	1			ND
Noen Phra	Mueang Rayong	735.84	1402.605	Detached house	2	15	2	90
Noen Phra	Mueang Rayong	735.833	1402.604	Detached house	2	4	1	48
Noen Phra	Mueang Rayong	735.766	1402.52	Row house	3	4	1	48
Noen Phra	Mueang Rayong	740.808	1403.19	Row house	2	4	1	48
Noen Phra	Mueang Rayong	739.564	1403.159	Row house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.316	1403.228	Row house	2	15	12	15
Map Ta Phut	Mueang Rayong	735.448	1402.884	Row house	3	4	0.75	72
Map Ta Phut	Mueang Rayong	735.122	1405.166	Row house	2	15	2	90
Map Ta Phut	Mueang Rayong	735.244	1405.794	Row house	2	15	2	90
Map Ta Phut	Mueang Rayong	735.621	1401.986	Row house	3	15	3	60

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	735.327	1403.109	Row house	2	15	2	90
Map Ta Phut	Mueang Rayong	735.623	1401.977	Row house	2	15	1	180
Map Ta Phut	Mueang Rayong	735.275	1403.273	Row house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.194	1403.45	Row house	2	4	0.5	96
Tha Pradu	Mueang Rayong	735.241	1403.295	Townhouse / house	2	4	1	48
Noen Phra	Mueang Rayong	737.844	1402.852	Detached house	3	15	1	180
Tha Pradu	Mueang Rayong	735.149	1403.513	Row house	3	4	1	48
Noen Phra	Mueang Rayong	740.896	1403.187	Row house	2	15	2	90
Tha Pradu	Mueang Rayong	735.193	1403.401	Detached house	3	15	1	180
Map Ta Phut	Mueang Rayong	735.28	1403.286	Townhouse / house	3	4	0.5	96
Noen Phra	Mueang Rayong	740.588	1403.165	Row house	2	4	1	48
Noen Phra	Mueang Rayong	740.633	1403.204	Row house	2	4	1	48
Noen Phra	Mueang Rayong	735.727	1402.241		2	15	1	180
Noen Phra	Mueang Rayong	737.019	1402.573	Row house	3	15	1	180
Map Ta Phut	Mueang Rayong	735.754	1402.222	Detached house	2	15	1	180
Map Ta Phut	Mueang Rayong	735.754	1402.244	Row house	3	4	1	48
Map Ta Phut	Mueang Rayong	735.236	1403.292	Row house	2	4	1	48
Map Ta Phut	Mueang Rayong	735.221	1403.355	Temporary housing	2	4	1	48
Map Ta Phut	Mueang Rayong	735.236	1403.293	Temporary housing	1	4	1	48
Map Ta Phut	Mueang Rayong	735.302	1406.034	Detached house	2	15	0.16	360
Map Ta Phut	Mueang Rayong	735.098	1405.325	Row house	2	ไม้/หิน		ND
Map Ta Phut	Mueang Rayong	735.308	1405.991	Detached house	3	15	1	180
Map Ta Phut	Mueang Rayong	735.218	1403.255	Row house	2	15	2.5	72
Map Ta Phut	Mueang Rayong	735.145	1403.512	Row house	2	4	2	24
Map Ta Phut	Mueang Rayong	737.538	1402.744	Detached house	3	15	5	40
Map Ta Phut	Mueang Rayong	735.408	1402.919	Row house	2	7	1	84
Map Ta Phut	Mueang Rayong	735.631	1402.045	Detached house	2	7	2	42
Map Ta Phut	Mueang Rayong	735.267	1405.976	Row house	3	15	0.5	360
Map Ta Phut	Mueang Rayong	735.292	1405.991	Detached house	2	15	12	15
Map Ta Phut	Mueang Rayong	735.251	1403.239	Temporary housing	1			ND
Map Ta Phut	Mueang Rayong	735.668	1402.068	Temporary housing	3	ไม้/หิน		ND
Map Ta Phut	Mueang Rayong	735.069	1405.223	Row house	3	15	6	36
Map Ta Phut	Mueang Rayong	735.791	1402.285	Row house	2	15	2	90
Map Ta Phut	Mueang Rayong	735.383	1402.207	Row house	2			ND
Map Ta Phut	Mueang Rayong	735.422	1402.918	Row house	3	7	1	84
Map Ta Phut	Mueang Rayong	735.429	1402.907	Row house	3	4	1	48
Map Ta Phut	Mueang Rayong	735.444	1402.891	Temporary housing	3			ND
Map Ta Phut	Mueang Rayong	735.435	1402.903	Row house	1	7	1.5	11.2
Map Ta Phut	Mueang Rayong	735.122	1403.658	Row house	1	7	12	84
Map Ta Phut	Mueang Rayong	735.259	1403.175	Row house	2			ND
Map Ta Phut	Mueang Rayong	735.311	1406.013	Detached house	3	4	3.5	13.71428571
Map Ta Phut	Mueang Rayong	735.206	1406.073	Detached house	3	15	3	60
Map Ta Phut	Mueang Rayong	735.189	1406.057	Row house	3	ไม้/หิน		ND

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	735.268	1405.981	Row house	2			ND
Map Ta Phut	Mueang Rayong	735.65	1402.43	Row house	3			ND
Map Ta Phut	Mueang Rayong	735.758	1402.365	Row house	2	7	1	84
Map Ta Phut	Mueang Rayong	735.818	1402.57	Row house	1	4	1	48
Map Ta Phut	Mueang Rayong	738.289	1402.921	Detached house	3	15	3.5	51.42857143
Map Ta Phut	Mueang Rayong	738.28	1402.879	Row house	2			ND
Map Ta Phut	Mueang Rayong	740.782	1403.165	Row house	1	15	1	180
Map Ta Phut	Mueang Rayong	735.114	1403.668	Temporary housing	2	7	1	42
Map Ta Phut	Mueang Rayong	737.554	1402.722	Detached house	2	7	1	84
Map Ta Phut	Mueang Rayong	735.151	1403.516	Detached house	1			ND
Choeng Noen	Mueang Rayong	735.34	1373.158	Row house	2	15	3	60
Choeng Noen	Mueang Rayong	735.326	1373.154	Row house	1			ND
Choeng Noen	Mueang Rayong	735.32	1373.141	Row house	3	4	1	48
Choeng Noen	Mueang Rayong	735.318	1373.125	Row house	1	15	3	60
Choeng Noen	Mueang Rayong	735.371	1373.157	Townhouse / house	2	7	3	84
Choeng Noen	Mueang Rayong	735.364	1373.146	Row house	3	15	2	90
Choeng Noen	Mueang Rayong	735.32	1373.095	Detached house	2	15	4	45
Choeng Noen	Mueang Rayong	735.302	1373.101	Detached house	3	15	4	90
Choeng Noen	Mueang Rayong	735.368	1373.065	Temporary housing	3			ND
Choeng Noen	Mueang Rayong	735.299	1373.101	Detached house	3	4	1	48
Choeng Noen	Mueang Rayong	735.231	1373.128	Row house	2			ND
Choeng Noen	Mueang Rayong	735.341	1373.158	Row house	3			ND
Choeng Noen	Mueang Rayong	735.339	1373.16	Row house	2			ND
Choeng Noen	Mueang Rayong	735.344	1373.156	Row house	3	15	3	60
Choeng Noen	Mueang Rayong	735.309	1373.099	Row house	4	15	1	180
Choeng Noen	Mueang Rayong	735.304	1373.099	Row house	4	4	1	48
Choeng Noen	Mueang Rayong	735.32	1373.097	Row house	2	4	1	48
Choeng Noen	Mueang Rayong	735.339	1373.158	Row house	3			ND
Thung Khwai Kin	Klaeng	795.977	1420.503	Detached house	3	15	1	180
Kram	Klaeng	747.329	1401.024	Townhouse / house	3	15	1	180
Kram	Klaeng	12.66032	101.64522	Detached house	1	5	6	10
Kram	Klaeng	12.65904	102.64262	Detached house	3	15	1	180
Kram	Klaeng	12.65468	101.63952	Detached house	3	15	2	90
Kram	Klaeng	786.086	1402.536	Townhouse / house	3	15	3	60
Kram	Klaeng	786.123	1402.477	Detached house	2	15	3	60
Thang Kwian	Klaeng	788.22	1413.908	Detached house	3	15	2	90
Thang Kwian	Klaeng	788.206	1413.979	Row house	3	5	1	180
Pak Nam Krasae	Klaeng	793.624	1406.845	Townhouse / house	3	15	4	45
Pak Nam Krasae	Klaeng	739.606	1406.486	Townhouse / house	2	15	2.5	90
Thang Kwian	Klaeng	787.109	1414.305	Row house	3			ND
Thang Kwian	Klaeng	787.157	1414.314	Row house	3	7	0.6	126
Thang Kwian	Klaeng	787.104	1414.264	Row house	3			ND
Thang Kwian	Klaeng	787.575	1414.469	Townhouse / house	3	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Thang Kwian	Klaeng	787.51	1414.348	Townhouse / house	3	15	1	180
Thang Kwian	Klaeng	787.587	1414.298	Townhouse / house	2	15	2	90
Thang Kwian	Klaeng	787.61	1414.287	Townhouse / house	2	7	1	84
Kram	Klaeng	786.585	1400.35	Townhouse / house	3	15	3	60
Kram	Klaeng	786.633	1400.566	Detached house	3	15	1	180
Kram	Klaeng	786.651	1400.454	Detached house	3	15	2	90
Kram	Klaeng	786.661	1400.62	Detached house	2	15	3	60
Kram	Klaeng	786.27	1400.245	Detached house	3	15	1.5	120
Thang Kwian	Klaeng	788.204	1413.933	Townhouse / house	2	15	3	60
Thang Kwian	Klaeng	788.203	1413.934	Townhouse / house	3	15	4	45
Thang Kwian	Klaeng	788.207	1413.972	Townhouse / house	3	15	1.5	120
Thang Kwian	Klaeng	787.473	1415.117	Townhouse / house	2	15	5	36
Thang Kwian	Klaeng	787.11	1414.298	Row house	2	15	5	36
Thang Kwian	Klaeng	787.118	1414.276	Row house	3	15	4	45
Thang Kwian	Klaeng	787.093	1414.247	Row house	3	15	3	60
Thang Kwian	Klaeng	787.537	1414.409	Townhouse / house	3	4	3	60
Thang Kwian	Klaeng	787.555	1414.436	Townhouse / house	3	15	3	60
Thang Kwian	Klaeng	787.749	1414.333	Townhouse / house	2	15	3	60
Kram	Klaeng	787.05	1400.66	Detached house	2	4	1	48
Kram	Klaeng	786.7745	1400.231	Detached house	3	15	1	180
Thang Kwian	Klaeng	788.204	1413.978	Row house	2	4	1	48
Thang Kwian	Klaeng	788.21	1413.946	Row house	3	15	2	90
Thang Kwian	Klaeng	788.201	1413.974	Row house	3	15	1	180
Pak Nam Krasae	Klaeng	793.612	1406.808	Townhouse / house	3	15	2	90
Thang Kwian	Klaeng	787.058	1414.366	Row house	3	15	1.5	120
Thang Kwian	Klaeng	787.162	1414.327	Row house	2	15	1	180
Thang Kwian	Klaeng	787.091	1414.238	Row house	2	4	0.5	32
Thang Kwian	Klaeng	787.589	1414.537	Townhouse / house	2	15	2	90
Thang Kwian	Klaeng	787.548	1414.436	Townhouse / house	3	15	1	180
Thang Kwian	Klaeng	787.106	1414.337	Row house	2	4	1	48
Thang Kwian	Klaeng	787.565	1414.31	Townhouse / house	2	4	1	48
Thang Kwian	Klaeng	787.666	1414.344	Townhouse / house	3	4	0.5	96
Kram	Klaeng	785.956	1402.86	Townhouse / house	3	15	3	60
Thang Kwian	Klaeng	786.955	1414.393	Row house	3			ND
Kram	Klaeng	786.402	1400.825	Detached house	3	4	0.6	78
Kram	Klaeng	786.343	1400.844	Detached house	3	15	1	180
Kram	Klaeng	786.545	1400.85	Detached house	3	15	0.5	360
Kram	Klaeng	786.005	1402.598	Townhouse / house	1			ND
Kram	Klaeng	785.958	1402.843	Townhouse / house	1			ND
Kram	Klaeng	785.957	1402.843	Townhouse / house	3	15	0.5	360
Thang Kwian	Klaeng	788.178	1413.818	Row house	2	15	3	60
Klaeng	Klaeng	788.167	1413.811	Townhouse / house	3	15	1	180
Thang Kwian	Klaeng	788.178	1413.838	Row house	3	11.5	1	138

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pak Nam Krasae	Klaeng	793.634	1406.774	Row house	3	15	1	180
Pak Nam Krasae	Klaeng	793.601	1406.685	Row house	1	15	2	90
Pak Nam Krasae	Klaeng	739.605	1406.618	Row house	2	15	1	180
Pak Nam Krasae	Klaeng	739.596	1406.562	Row house	3	15	1	180
Pak Nam Krasae	Klaeng	739.602	1406.564	Row house	2	15	3	60
Pak Nam Krasae	Klaeng	793.598	1406.546	Row house	3	15	2	90
Thang Kwian	Klaeng	786.971	1415.228	Row house	2			ND
Thang Kwian	Klaeng	786.933	1414.432	Row house	3	15	3	60
Thang Kwian	Klaeng	786.725	1414.429	Townhouse / house	2			ND
Thang Kwian	Klaeng	787.052	1414.449	Row house	2			ND
Thang Kwian	Klaeng	787.029	1414.42	Row house	1			ND
Thang Kwian	Klaeng	787.011	1414.425	Row house	3	15	3	60
Thang Kwian	Klaeng	787.014	1414.429	Row house	3	15	1	180
Thang Kwian	Klaeng	787.015	1414.423	Row house	1	15	3	60
Thang Kwian	Klaeng	787.494	1414.504	Row house	3	15	0.67	270
Thang Kwian	Klaeng	787.028	1414.422	Row house	1	15	2	90
Thang Kwian	Klaeng	787.027	1414.439	Row house	2	15	6	30
Thang Kwian	Klaeng	788.515	1414.526	Temporary housing	1			ND
Thang Kwian	Klaeng	787.557	1414.61	Row house	1			ND
Thang Kwian	Klaeng	786.955	1414.406	บ้านเดี่ยว	3	15	0.67	270
Klaeng	Klaeng	787.473	1415.117	Row house	3	15	3	60
Klaeng	Klaeng	787.422	1414.988	Row house	2	7	3	60
Klaeng	Klaeng	787.422	1414.988	Row house	2	15	5	36
Thang Kwian	Klaeng	787.423	1414.988	Detached house	3	15	1	180
Thang Kwian	Klaeng	787.421	1414.988	Row house	3	15	3	60
Thang Kwian	Klaeng	787.473	1415.117	Row house	1			ND
Pak Nam Krasae	Klaeng	739.614	1406.771	Row house	3	15	1	180
Kram	Klaeng	786.086	1402.7	Detached house	3	7	0.5	168
Kram	Klaeng	786.029	1402.615	Row house	3	7	2	42
Kram	Klaeng	786.673	1400.574	Detached house	2	15	2	90
Kram	Klaeng	786.603	1402.6	Detached house	3	15	5	36
Kram	Klaeng	786.656	1400.721	Detached house	3	15	1	180
Kram	Klaeng	786.691	1400.214	Row house	3	15	4	45
Kram	Klaeng	786.245	1402.306	Detached house	3	15	3	60
Thang Kwian	Klaeng	784.218	1413.481	Townhouse / house	2	15	1	180
Thang Kwian	Klaeng	788.213	1413.931	Townhouse / house	2	5	1	180
Thang Kwian	Klaeng	788.204	1413.96	Row house	2	15	2	60
Thang Kwian	Klaeng	788.21	1413.943	Townhouse / house	3			ND
Thang Kwian	Klaeng	787.092	1414.346	Row house	2			ND
Thang Kwian	Klaeng	787.11	1414.328	Row house	3	15	3	60
Thang Kwian	Klaeng	787.134	1414.311	Row house	1	4	2	24
Thang Kwian	Klaeng	787.081	1414.276	Row house	2	15	4	45
Thang Kwian	Klaeng	787.564	1414.449	Townhouse / house	3	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Thang Kwian	Klaeng	787.541	1414.431	Townhouse / house	3	15	2	90
Thang Kwian	Klaeng	787.497	1414.375	Townhouse / house	2	15	2	90
Pluak Daeng	Pluak Daeng	739.752	1436.49	Detached house	2	4	1	48
Pluak Daeng	Pluak Daeng	739.759	1436.523	Row house	3			ND
Pluak Daeng	Pluak Daeng	739.807	1436.504	Row house	3	4	1	48
Pluak Daeng	Pluak Daeng	739.842	1436.609	Row house	3	4	1	48
Pluak Daeng	Pluak Daeng	739.829	1436.58	Row house	3	4	1	48
Pluak Daeng	Pluak Daeng	740.081	1436.112	Row house	3	4	1	48
Pluak Daeng	Pluak Daeng	740.156	1436.081	Row house	2	4	1	48
Pluak Daeng	Pluak Daeng	740.2	1436.04	Row house	2	4	1	48
Pluak Daeng	Pluak Daeng	740.224	1436.067	Row house	2	4	1	48
Pluak Daeng	Pluak Daeng	740.211	1436.132	Row house	2	4	1	48
Pluak Daeng	Pluak Daeng	740.072	1436.066	Row house	3	4	1	48
Pluak Daeng	Pluak Daeng	739.645	1436.207	Row house	2	4	4	12
Pluak Daeng	Pluak Daeng	739.739	1436.453	Detached house	3	4	2	24
Pluak Daeng	Pluak Daeng	739.128	1435.66	Row house	2	15	2	
Pluak Daeng	Pluak Daeng	739.125	1435.668	Row house	3	15	1	180
Pluak Daeng	Pluak Daeng	739.125	1435.673	Row house	3	15	1	180
Pluak Daeng	Pluak Daeng	739.127	1435.689	Row house	2	15	1	180
Pluak Daeng	Pluak Daeng	740.193	1436.051	Row house	2	15	1	180
Pluak Daeng	Pluak Daeng	738.973	1435.669	Townhouse / house	3	15	1	180
Pluak Daeng	Pluak Daeng	738.973	1435.676	Townhouse / house	3	15	2	90
Pluak Daeng	Pluak Daeng	738.966	1435.655	Townhouse / house	2	15	2	90
Pluak Daeng	Pluak Daeng	739.652	1436.349	Row house	2	15	3	60
Pluak Daeng	Pluak Daeng	739.652	1436.104	Townhouse / house	1			ND
Pluak Daeng	Pluak Daeng	738.976	1435.969	Detached house	3	15	2	90
Pluak Daeng	Pluak Daeng	739.11	1435.778	Temporary housing	2	15	2	90
Pluak Daeng	Pluak Daeng	740.192	1436.044	Row house	1	4	2	24
Pluak Daeng	Pluak Daeng	740.232	1436.1	Townhouse / house	2			ND
Pluak Daeng	Pluak Daeng	740.205	1436.073	Townhouse / house	3	15	1	180
Pluak Daeng	Pluak Daeng	740.139	1436.105	Row house	2	4	1	48
Pluak Daeng	Pluak Daeng	739.806	1436.507	Detached house	1			ND
Pluak Daeng	Pluak Daeng	739.777	1436.55	Detached house	3	15	1	180
Pluak Daeng	Pluak Daeng	739.733	1436.473	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.724	1436.403	Row house	3			ND
Pluak Daeng	Pluak Daeng	739.652	1436.62	Row house	2			ND
Pluak Daeng	Pluak Daeng	739.638	1436.203	Row house	3			ND
Pluak Daeng	Pluak Daeng	740.039	1430.135	Row house	2			ND
Pluak Daeng	Pluak Daeng	740.067	1436.119	Row house	3	4	1 เดือน	48
Pluak Daeng	Pluak Daeng	739.937	135.246	Townhouse / house	2			ND
Pluak Daeng	Pluak Daeng	739.943	1435.298	Row house	3	15	4	45
Pluak Daeng	Pluak Daeng	739.95	1435.301	Row house	3	15	3	60
Pluak Daeng	Pluak Daeng	739.991	1435.667	Row house	1			ND

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pluak Daeng	Pluak Daeng	740.024	1435.663	Row house	2	4	2	24
Pluak Daeng	Pluak Daeng	740.013	1435.665	Row house	1	4	2	24
Pluak Daeng	Pluak Daeng	740.018	1435.729	Row house	2	4	2	24
Pluak Daeng	Pluak Daeng	740.019	1435.724	Row house	2			ND
Pluak Daeng	Pluak Daeng	739.196	1435.77	Row house	3	4	0.5	55.2
Pluak Daeng	Pluak Daeng	739.592	1436.116	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.575	1436.097	Townhouse / house	2			ND
Pluak Daeng	Pluak Daeng	739.123	1435.722	Temporary housing	1			ND
Pluak Daeng	Pluak Daeng	739.123	1435.746	Row house	3	4	3	16
Pluak Daeng	Pluak Daeng	739.122	1435.74	Row house	2			ND
Pluak Daeng	Pluak Daeng	739.133	1435.732	Temporary housing	3	15	2	90
Pluak Daeng	Pluak Daeng	739.041	1435.742	Row house	1			ND
Pluak Daeng	Pluak Daeng	739.043	1435.744	Row house	2	4	3	16
Pluak Daeng	Pluak Daeng	739.083	1435.764	Row house	2			ND
Pluak Daeng	Pluak Daeng	739.013	1435.598	Temporary housing	2	15	1	180
Pluak Daeng	Pluak Daeng	739.951	1435.620	Townhouse / house	2	15	6	30
Pluak Daeng	Pluak Daeng	739.146	1435.822	Townhouse / house	3	15	6	30
Pluak Daeng	Pluak Daeng	738.928	1435.598	Townhouse / house	3	15	1	180
Pluak Daeng	Pluak Daeng	738.966	1435.692	Townhouse / house	2	15	6	30
Pluak Daeng	Pluak Daeng	738.966	1435.646	Townhouse / house	3	15	3	60
Pluak Daeng	Pluak Daeng	738.994	1435.681	Temporary housing	2	15	6	30
Pluak Daeng	Pluak Daeng	739.872	1436.094	Townhouse / house	3	15	2	90
Pluak Daeng	Pluak Daeng	739.889	1436.083	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.882	1436.081	Townhouse / house	2	15	5	36
Pluak Daeng	Pluak Daeng	739.659	1436.142	Temporary housing	1			ND
Pluak Daeng	Pluak Daeng	739.585	1436.011	Townhouse / house	3	4	1	48
Pluak Daeng	Pluak Daeng	739.588	1436.008	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.568	1436.012	Townhouse / house	3	4	0.5	96
Pluak Daeng	Pluak Daeng	739.181	1435.728	Townhouse / house	2			ND
Pluak Daeng	Pluak Daeng	739.204	1453.751	Row house	2			ND
Pluak Daeng	Pluak Daeng	739.599	1435.993	Townhouse / house	3	4	3	16
Pluak Daeng	Pluak Daeng	739.608	1436.007	Townhouse / house	2	15	3	60
Pluak Daeng	Pluak Daeng	739.583	1436.068	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.588	1436.074	Townhouse / house	4	4	1	48
Pluak Daeng	Pluak Daeng	739.197	1435.766	Row house	3	4	2	24
Pluak Daeng	Pluak Daeng	739.244	1435.75	Row house	2	4	1	48
Pluak Daeng	Pluak Daeng	739.188	1435.755	Townhouse / house	2	4	0.67	66
Pluak Daeng	Pluak Daeng	740.027	1436.233	Row house	2	15	1	180
Pluak Daeng	Pluak Daeng	730.99	1436.252	Row house	2			ND
Pluak Daeng	Pluak Daeng	700.297	1436.733	Row house	3	4	2	96
Pluak Daeng	Pluak Daeng	739.977	1436.238	Row house	2			ND
Pluak Daeng	Pluak Daeng	739.251	1435.838	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.941	1435.944	Townhouse / house	3	15	1	90

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pluak Daeng	Pluak Daeng	739.917	1435.956	Townhouse / house	3			ND
Pluak Daeng	Pluak Daeng	739.923	1435.983	Townhouse / house	2	15	1	180
Pluak Daeng	Pluak Daeng	739.927	1435.962	Townhouse / house	1	15	5	36
Ban Khai	Ban Khai	749.51	1415.176	Row house	3	15	3	60
Ban Khai	Ban Khai	749.487	1415.188	Row house	2			ND
Nong Bua	Ban Khai	750.472	1423.717	Detached house	2	15	5	36
Ban Khai	Ban Khai	749.33	1414.349	Townhouse / house	1	15	3	60
Ban Khai	Ban Khai	749.338	1414.42	Townhouse / house	3	15	1.5	120
Ban Khai	Ban Khai	750.49	1423.748	Townhouse / house	3	15	2	90
Ban Khai	Ban Khai	749.887	1401.783	Townhouse / house	3	15	3	60
Chak Bok	Ban Khai	754.613	1415.57	Townhouse / house	1	15	6	30
Nong Bua	Ban Khai	750.489	1423.779	Detached house	1	15	3	60
Nong Bua	Ban Khai	750.46	1423.768	Detached house	2	15	3	60
Nong Bua	Ban Khai	750.427	1423.781	Detached house	3	15	2	90
Ban Khai	Ban Khai	749.521	1414.816	Townhouse / house	2	15	1	180
Ban Khai	Ban Khai	749.524	1414.819	Townhouse / house	3	15	2	90
Ban Khai	Ban Khai	749.484	1414.673	Townhouse / house	3	15	4	45
Chak Bok	Ban Khai	754.697	1415.6	Townhouse / house	1	4	2	24
Chak Bok	Ban Khai	754.696	1415.584	Detached house	2	4	1	48
Nong Bua	Ban Khai	750.458	1423.762	Detached house	3	15	1	180
Nong Bua	Ban Khai	750.493	1423.768	Detached house	2	15	6	30
Nong Bua	Ban Khai	750.48	1423.743	Detached house	1	15	8	22.5
Ban Khai	Ban Khai	749.345	1414.422	Detached house	1	15	7	25,71428571
Ban Khai	Ban Khai	749.47	1414.642	Townhouse / house	3	15	1	180
Nong Bua	Ban Khai	750.409	1423.74	Townhouse / house	1	15	2	90
Nong Bua	Ban Khai	750.38	1423.767	Detached house	3	15	2	90
Ban Khai	Ban Khai	749.424	1413.892	Townhouse / house	2	15	1	180
Ban Khai	Ban Khai	749.428	1413.917	Townhouse / house	3	15	2	90
Ban Khai	Ban Khai	749.501	1415.16	Row house	1	4	4	45
Nong Lalok	Ban Khai	748.667	1417.735	Detached house	2	15	1	180
Nong Lalok	Ban Khai	748.919	1417.911	Detached house	3	15	1	180
Nong Lalok	Ban Khai	748.715	1417.651	Detached house	2	15	3	60
Nong Lalok	Ban Khai	748.996	1417.964	Detached house	2	15	2	90
Nong Lalok	Ban Khai	748.912	1417.828	Detached house	3	15	3	60
Nong Lalok	Ban Khai	748.868	1417.787	Detached house	3	15	3	60
Nong Bua	Ban Khai	751.011	1424.329	Detached house	3	15	0.5	360
Chak Bok	Ban Khai	754.89	1415.699	Detached house	1	15	3	60
Chak Bok	Ban Khai	754.836	1415.626	Detached house	3	15	3	60
Ban Khai	Ban Khai	749.457	1414.519	Townhouse / house	2	15	1.5	120
Ban Khai	Ban Khai	749.463	1414.548	Row house	2	15	1	180
Ban Khai	Ban Khai	749.568	1414.628	Detached house	2	15	3	60
Ban Khai	Ban Khai	749.532	1414.927	Townhouse / house	2	15	3	60
Ban Khai	Ban Khai	749.585	1414.184	Detached house	2	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Ban Khai	Ban Khai	749.572	1414.214	Detached house	3	15	0.5	360
Samnak Thon	Bang Chang	717.998	1412.216	Row house	3	15	3	60
Samnak Thon	Bang Chang	718.817	1411.224	Row house	3	15	1	180
Bang Chang	Bang Chang	723.033	1407.707	Detached house	2	4	1	48
Bang Chang	Bang Chang	722.986	1407.796	Detached house	2	15	1	180
Pla	Bang Chang	724.925	1402.453	Townhouse / house	3	15	2	90
Pla	Bang Chang	722.202	1401.563	Detached house	3	15	3	60
Pla	Bang Chang	722.212	1401.415	Row house	1	4	12	4
Samnak Thon	Bang Chang	719.782	1412.675	Row house	2	4	1	48
Samnak Thon	Bang Chang	719.506	1411.605	Townhouse / house	3	15	1	180
Samnak Thon	Bang Chang	721.175	1410.618	Detached house	1	15	2	90
Samnak Thon	Bang Chang	721.17	1410.612	Detached house	2	15	1.5	120
Bang Chang	Bang Chang	723.092	1407.576	Detached house	2	4	12	4
Bang Chang	Bang Chang	723.067	1407.59	Detached house	2	15	1	180
Samnak Thon	Bang Chang	719.487	1411.604	Detached house	2	4	3	16
Samnak Thon	Bang Chang	712.115	1410.714	Detached house	2	15	2	90
Samnak Thon	Bang Chang	721.117	1410.712	Detached house	3	15	1	180
Bang Chang	Bang Chang	724.912	1402.455	Row house	2	4	1	48
Samnak Thon	Bang Chang	719.442	1412.664	Detached house	2	15	3	60
Bang Chang	Bang Chang	724.884	1402.472	Row house	2			ND
Pla	Bang Chang	722.01	1401.236	Row house	2	4	2	24
Bang Chang	Bang Chang	722.883	1407.891	Townhouse / house	3	15	2	90
Bang Chang	Bang Chang	722.872	1407.882	Row house	3	4	2	24
Samnak Thon	Bang Chang	723.009	1407.682	Townhouse / house	2	15	1	180
Bang Chang	Bang Chang	729.614	1403.382	Temporary housing	3			ND
Bang Chang	Bang Chang	724.894	1402.438	Row house	2	15	4	45
Bang Chang	Bang Chang	724.873	1402.549	Detached house	3	15	3	60
Pla	Bang Chang	721.777	1401.363	Townhouse / house	3	7	1	84
Pla	Bang Chang	722.23	1401.382	Row house	2	15	0.5	360
Pla	Bang Chang	722.041	1401.129	Detached house	2	15	1	180
Pla	Bang Chang	721.449	1401.058	Detached house	2			ND
Bang Chang	Bang Chang	722.048	1401.17	Detached house	3	15	1	180
Samnak Thon	Bang Chang	720.662	1411.57	Townhouse / house	3	15	3	60
Bang Chang	Bang Chang	721.453	1401.125	Townhouse / house	3			ND
Samnak Thon	Bang Chang	791.339	1413.494	Detached house	3	15	3	60
Samnak Thon	Bang Chang	719.797	1412.671	Detached house	3	15	1	180
Samnak Thon	Bang Chang	719.538	1411.572	Detached house	2	15	3	60
Bang Chang	Bang Chang	722.883	1407.851	Townhouse / house	3	15	2	90
Bang Chang	Bang Chang	722.741	1407.783	Townhouse / house	3	15	2	90
Bang Chang	Bang Chang	723.952	1407.802	Townhouse / house	3	7	2	90
Bang Chang	Bang Chang	722.807	1407.967	Detached house	3	15	2	90
Bang Chang	Bang Chang	722.807	1407.975	Temporary housing	1			ND
Pla	Bang Chang	723.29	1402.113	Townhouse / house	3	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pla	Bang Chang	722.227	1401.653	Townhouse / house	3	15	1	180
Pla	Bang Chang	722.251	1401.407	Row house	2	15	3	60
Samnak Thon	Bang Chang	719.558	1412.631	Row house	2			ND
Pla	Bang Chang	722.027	1401.087	Townhouse / house	2	15	2	90
Bang Chang	Bang Chang	722.886	1407.672	Townhouse / house	2	15	4	180
Bang Chang	Bang Chang	724.799	1402.693	Detached house	3	15	1	180
Bang Chang	Bang Chang	722.998	1407.222	Townhouse / house	3	15	1	180
Bang Chang	Bang Chang	723.027	1407.65	Townhouse / house	2	15 kg.	1	180
Samnak Thon	Bang Chang	721.118	1410.702	Row house	3	15	0.5	360
Samnak Thon	Bang Chang	721.116	1410.708	Row house	3	4	1	48
Samnak Thon	Bang Chang	721.112	1410.713	Row house	2	15	3	60
Samnak Thon	Bang Chang	719.558	1412.631	Row house	3	15	3	60
Samnak Thon	Bang Chang	719.488	1411.612	Townhouse / house	3	15	8	22.5
Pla	Bang Chang	721.903	1401.166	Detached house	3	15	2	90
Bang Chang	Bang Chang	724.895	1402.475	Row house	1	4	1	48
Pla	Bang Chang	722.108	1401.282	Detached house	2	15	1.5	120
Bang Chang	Bang Chang	724.872	1402.47	Row house	1	15	1.5	120
Bang Chang	Bang Chang	724.916	1402.455	Row house	2	4	1	48
Bang Chang	Bang Chang	735.922	1402.406	Detached house	3	15	3	60
Khao Noi	Khao Chamao	783.142	1450.3	Detached house	3	15	1	180
Khao Noi	Khao Chamao	783.136	1450.284	Detached house	3	15	3	60
Khao Noi	Khao Chamao	783.133	1450.284	Detached house	2	15	3	60
Khao Noi	Khao Chamao	784.272	1449.507	Detached house	1	15	3	60
Huai Thap Mon	Khao Chamao	791.069	1436.371	Detached house	3	15	1	180
Huai Thap Mon	Khao Chamao	791.127	1436.099	Townhouse / house	3	15	1	180
Num Pen	Khao Chamao	797.357	1422.568	Detached house	3	15	4	45
Num Pen	Khao Chamao	797.345	1422.525	Detached house	2	15	1.5	120
Huai Thap Mon	Khao Chamao	790.938	1436.51	Townhouse / house	2	15	3	60
Huai Thap Mon	Khao Chamao	791.104	1436.082	Townhouse / house	2	15	2	90
Num Pen	Khao Chamao	797.356	1422.557	Townhouse / house	3	15.	3	60
Khao Noi	Khao Chamao	783.126	1450.315	Detached house	3	15	1	180
Khao Noi	Khao Chamao	783.132	1450.305	Detached house	2	15	3	60
Khao Noi	Khao Chamao	783.125	1450.277	Detached house	3	15	2	90
Chum Saeng	Wang Chan	744.113	1430.631	Detached house	1	15	1	180
Chum Saeng	Wang Chan	773.887	1431.968	Townhouse / house	2	15	1	180
Chum Saeng	Wang Chan	774.15	1431.693	Townhouse / house	3	15	12	15
Chum Saeng	Wang Chan	773.791	1413.594	Detached house	3	4	1	48
Chum Saeng	Wang Chan	773.789	1413.606	ทาวน์โฮม/บ้านแฝด	2	15	6	30
Chum Saeng	Wang Chan	773.804	1413.595	Detached house	2	15	12	15
Chum Saeng	Wang Chan	774.143	1431.698	Detached house	2	15	3	60
Chum Saeng	Wang Chan	773.856	1431.617	Townhouse / house	3	15	1	180
Chum Saeng	Wang Chan	774.088	1431.655	Detached house	3	15 kg.	1	180
Chum Saeng	Wang Chan	774.181	1431.717	Townhouse / house	3	15 kg.	2	90

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Chum Saeng	Wang Chan	774.156	1431.698	Row house	2	15 kg.	1	180
Chum Saeng	Wang Chan	774.084	1431.669	Row house	1			ND
Chum Saeng	Wang Chan	774.095	1431.572	Row house	3	15	1	180
Chum Saeng	Wang Chan	774.122	1431.66	Townhouse / house	2	15	3	60
Chum Saeng	Wang Chan	774.049	1431.646	Row house	1			ND
Chum Saeng	Wang Chan	773.951	1431.611	Townhouse / house	3	15	1	60
Chum Saeng	Wang Chan	773.917	1431.581	Townhouse / house	2	15	3	60
Chum Saeng	Wang Chan	773.898	1431.568	Row house	1	15	7	25.71428571
Chum Saeng	Wang Chan	773.807	1431.55	Townhouse / house	3	15	3	60
Nikhom Phatthana	Nikhom Phatthana	737.747	1418.602	Row house	3	15 kg.	1	180
Nikhom Phatthana	Nikhom Phatthana	739.818	1419.824	Row house	2	15	4	45
Nikhom Phatthana	Nikhom Phatthana	738.833	1419.764	Detached house	2	15 kg.	1.5	120
Nikhom Phatthana	Nikhom Phatthana	738.951	1419.838	Townhouse / house	2	15 kg.	2	90
Nikhom Phatthana	Nikhom Phatthana	738.959	1419.211	Row house	2	4 kg.	6	8
Nikhom Phatthana	Nikhom Phatthana	738.984	1419.262	Row house	2			ND
Nikhom Phatthana	Nikhom Phatthana	739.022	1419.331	Townhouse / house	2			ND
Nikhom Phatthana	Nikhom Phatthana	739.081	1419.366	Townhouse / house	3	4	2	24
Nikhom Phatthana	Nikhom Phatthana	738.825	1419.854	Row house	3	4	1.5	32
Nikhom Phatthana	Nikhom Phatthana	738.945	1419.872	Townhouse / house	2	4	1.5	32
Nikhom Phatthana	Nikhom Phatthana	738.954	1419.855	Row house	3	4	2	24
Nikhom Phatthana	Nikhom Phatthana	738.621	1419.865	Row house	3	4	0.33	144
Nikhom Phatthana	Nikhom Phatthana	738.751	1419.832	Row house	1	4	4	12
Nikhom Phatthana	Nikhom Phatthana	738.652	1419.625	Row house	2	15	0.33	540
Nikhom Phatthana	Nikhom Phatthana	738.626	1419.332	Row house	2	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.612	1418.662	Row house	1	7	12	7
Nikhom Phatthana	Nikhom Phatthana	739.621	1418.539	Row house	3	15	3	60
Nikhom Phatthana	Nikhom Phatthana	739.343	1418.261	Row house	2	15	1	180
Nikhom Phatthana	Nikhom Phatthana	738.302	1419.112	Row house	3	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.073	1418.542	Row house	3			ND
Nikhom Phatthana	Nikhom Phatthana	738.041	1418.515	Detached house	3	15	2	90
Nikhom Phatthana	Nikhom Phatthana	738.068	1418.516	Row house	3	4	2	24
Nikhom Phatthana	Nikhom Phatthana	738.082	1418.399	Row house	2	15	1	180
Nikhom Phatthana	Nikhom Phatthana	739.551	1419.832	Row house	3	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.941	1419.834	Row house	2	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.92	1419.828	Row house	1	15	24	7.5
Nikhom Phatthana	Nikhom Phatthana	738.924	1419.848	Row house	2			ND
Nikhom Phatthana	Nikhom Phatthana	738.852	1419.8	Detached house	2	15.	4	45
Nikhom Phatthana	Nikhom Phatthana	738.806	1419.788	Row house	3	4	3	60
Nikhom Phatthana	Nikhom Phatthana	738.121	1419.267	Townhouse / house	2	15	3	60
Nikhom Phatthana	Nikhom Phatthana	739.104	1419.282	Row house	2	15	4	45
Nikhom Phatthana	Nikhom Phatthana	739.083	1419.286	Townhouse / house	2	15	2	90
Nikhom Phatthana	Nikhom Phatthana	739.082	1419.315	Row house	3	15	2	90
Nikhom Phatthana	Nikhom Phatthana	739.014	1419.226	Row house	3	15	4	45

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container(kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Nikhom Phatthana	Nikhom Phatthana	739.013	1419.212	Townhouse / house	2			ND
Nikhom Phatthana	Nikhom Phatthana	738.997	1419.191	Row house	3	15	4	42
Nikhom Phatthana	Nikhom Phatthana	738.992	1419.182	Row house	2	15	6	30
Total								47617.9937

**Table C-2 Medium household**

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Choeng Noen	Mueang Rayong	747.269	1404.014	Row house	5	7	4	21
Choeng Noen	Mueang Rayong	747.297	1404	Detached house	4			ND
Choeng Noen	Mueang Rayong	747.337	1404	Townhouse / house	4	7	3	28
Choeng Noen	Mueang Rayong	747.358	1404.065	Townhouse / house	5	15	2	90
Choeng Noen	Mueang Rayong	747.361	1404.066	Townhouse / house	5	15	1.5	120
Choeng Noen	Mueang Rayong	747.382	1404.131	Townhouse / house	4	15	3	60
Choeng Noen	Mueang Rayong	747.322	1403.87	Townhouse / house	5	5	1.5	40
Choeng Noen	Mueang Rayong	747.377	1403.997	Detached house	5	15	2	90
Map Ta Phut	Mueang Rayong	735.132	1408.61	Row house	4	4	2	24
Map Ta Phut	Mueang Rayong	732.905	1406.895	Detached house	6	15	1.5	120
Map Ta Phut	Mueang Rayong	735.387	1408.38	Detached house	5	15	3.5	51.42857143
Map Ta Phut	Mueang Rayong	735.368	1410.593	Townhouse / house	4	15	1	180
Map Ta Phut	Mueang Rayong	735.132	1408.61	Townhouse / house	5	15	1	180
Map Ta Phut	Mueang Rayong	735.387	1408.38	Townhouse / house	4	15	1	180
Map Ta Phut	Mueang Rayong	737.359	1402.577	Detached house	5	4	0.67	78
Noen Phra	Mueang Rayong	740.643	1403.209	Row house	4	4	2	24
Map Ta Phut	Mueang Rayong	735.219	1403.335	Row house	4	4	3	16
Map Ta Phut	Mueang Rayong	735.247	1403.281	Row house	5	4	0.67	78
Map Ta Phut	Mueang Rayong	735.738	1402.231	Detached house	4	15	0.5	360
Map Ta Phut	Mueang Rayong	735.776	1402.231	Detached house	6			ND
Map Ta Phut	Mueang Rayong	735.76	1402.281	Detached house	6	15	0.5	360
Map Ta Phut	Mueang Rayong	735.295	1405.979	Detached house	6	15	3	60
Choeng Noen	Mueang Rayong	749.88	1401.983	Townhouse / house	5	15	2.5	72
Choeng Noen	Mueang	749.803	1401.703	Row house	4	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
	Rayong							
Choeng Noen	Mueang Rayong	749.88	1401.936	Row house	4	15	1	180
Choeng Noen	Mueang Rayong	749.862	1401.927	Row house	4	15	1	180
Choeng Noen	Mueang Rayong	749.895	1401.933	Townhouse / house	4	15	1	180
Choeng Noen	Mueang Rayong	749.871	1401.946	Townhouse / house	4	15	6	30
Choeng Noen	Mueang Rayong	749.686	1401.72	Townhouse / house	4	15	1	180
Choeng Noen	Mueang Rayong	749.679	1401.519	Townhouse / house	4	15	3	60
Choeng Noen	Mueang Rayong	749.834	1401.635	Townhouse / house	4	15	3	60
Choeng Noen	Mueang Rayong	749.85	1401.642	Townhouse / house	4	15 kg.	1	180
Choeng Noen	Mueang Rayong	749.843	1401.683	Townhouse / house	4	15	1	180
Choeng Noen	Mueang Rayong	749.893	1401.644	Townhouse / house	4	15	3	60
Choeng Noen	Mueang Rayong	749.838	1401.852	Detached house	5	15	2	90
Choeng Noen	Mueang Rayong	749.897	1401.807	Detached house	4	15	3	60
Choeng Noen	Mueang Rayong	749.952	1401.738	Townhouse / house	5	15	3	60
Choeng Noen	Mueang Rayong	749.855	1401.642	Townhouse / house	4	15	6	30
Choeng Noen	Mueang Rayong	749.96	1402.126	Detached house	6	15	1	180
Choeng Noen	Mueang Rayong	749.798	1402.182	Townhouse / house	4	15	1	180
Choeng Noen	Mueang Rayong	749.733	1402.161	Townhouse / house	4	15	1	180
Choeng Noen	Mueang Rayong	749.797	1402.139	Townhouse / house	4	15	1	180
Choeng Noen	Mueang Rayong	749.801	1402.128	Townhouse / house	4	15	3	60
Choeng Noen	Mueang Rayong	749.818	1402.127	Townhouse / house	5	15	2	90
Choeng Noen	Mueang Rayong	749.858	1402.109	Townhouse / house	5	15	1	180
Choeng Noen	Mueang Rayong	749.915	1401.966	Townhouse / house	5	15	2.5	78.26086957
Choeng Noen	Mueang Rayong	749.841	1401.974	Row house	4	15/15		ND
Choeng Noen	Mueang Rayong	749.915	1401.996	Townhouse / house	5	15	3	60
Choeng Noen	Mueang Rayong	749.792	1401.886	Townhouse / house	5	15	2.5	78.26086957
Choeng Noen	Mueang Rayong	749.766	1401.968	Detached house	5	15	1	180
Choeng Noen	Mueang Rayong	749.775	1401.656	Row house	5	15	1	180
Choeng Noen	Mueang Rayong	749.811	1401.688	Townhouse / house	4	15	3	60
Choeng Noen	Mueang Rayong	749.81	1401.672	Townhouse / house	5	15	1	180
Choeng Noen	Mueang Rayong	749.757	1401.832	Townhouse / house	4	15	0.5	360
Huai Pong	Mueang Rayong	732.895	1409.7	Row house	5	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Huai Pong	Mueang Rayong	732.309	1410.054	Detached house	4	15	2	90
Huai Pong	Mueang Rayong	732.337	1410.046	Detached house	4			ND
Huai Pong	Mueang Rayong	731.954	1411.438	Detached house	4	4	5	36
Huai Pong	Mueang Rayong	734.697	1408.453	Townhouse / house	4	15	1	180
Huai Pong	Mueang Rayong	734.677	1408.448	Detached house	5	15	1.5	120
Huai Pong	Mueang Rayong	734.701	1408.458	Townhouse / house	4	4	0.67	78
Huai Pong	Mueang Rayong	735.576	1407.956	Detached house	4	15	4	45
Huai Pong	Mueang Rayong	735.453	1408.458	Townhouse / house	4	15	4	45
Huai Pong	Mueang Rayong	735.424	1408.466	Townhouse / house	5	15	3	60
Huai Pong	Mueang Rayong	735.449	1408.409	Townhouse / house	6	15	3	60
Huai Pong	Mueang Rayong	735.167	1408.363	Townhouse / house	4	4	3	60
Huai Pong	Mueang Rayong	735.624	1406.665	Townhouse / house	4	15	1	180
Huai Pong	Mueang Rayong	735.421	1406.743	Row house	6	15	3	60
Map Ta Phut	Mueang Rayong	734.655	1408.381	Townhouse / house	4	4	1	180
Map Ta Phut	Mueang Rayong	734.635	1408.365	Townhouse / house	4	15	2	90
Map Ta Phut	Mueang Rayong	736.294	1407.87	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	734.233	1408.465	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	732.38	1409.72	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	734.269	1408.38	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	734.24	1408.46	Row house	5	15	0.5	360
Map Ta Phut	Mueang Rayong	735.442	1408.389	Townhouse / house	4			ND
Map Ta Phut	Mueang Rayong	735.446	1408.374	Row house	4	15	2	90
Map Ta Phut	Mueang Rayong	734.625	1408.38	Townhouse / house	4	15	3	60
Map Ta Phut	Mueang Rayong	735.421	1406.658	Townhouse / house	4	15	2	90
Huai Pong	Mueang Rayong	732.235	1412.506	Detached house	4	15	3	60
Huai Pong	Mueang Rayong	732.432	1409.602	Row house	5	4	4	12
Map Ta Phut	Mueang Rayong	734.625	1408.38	Row house	7	15	1	180
Map Ta Phut	Mueang Rayong	734.625	1408.38	Detached house	4	15	2	90
Map Ta Phut	Mueang Rayong	735.598	1408.652	Townhouse / house	4	4	2	24
Map Ta Phut	Mueang Rayong	735.562	1407.636	Townhouse / house	4	15	2	90
Map Ta Phut	Mueang Rayong	735.552	1407.625	Townhouse / house	5	4	3	60
Map Ta Phut	Mueang Rayong	735.421	1406.658	Townhouse / house	5	15	4	12

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	734.616	1408.381	Detached house	5	4	2	24
Map Ta Phut	Mueang Rayong	734.619	1408.369	Detached house	4	15	2	90
Map Ta Phut	Mueang Rayong	735.446	1408.416		5	15, 4.	1	228
Map Ta Phut	Mueang Rayong	734.24	1408.434	Row house	6	15	3	60
Map Ta Phut	Mueang Rayong	732.804	1409.593	Townhouse / house	4	4	3	16
Map Ta Phut	Mueang Rayong	733.238	1409.324	Row house	4	4	5	9.6
Map Ta Phut	Mueang Rayong	732.224	1410.116	Detached house	4	4	6	8
Huai Pong	Mueang Rayong	732.257	1410.119	Row house	4	15	0.25	720
Huai Pong	Mueang Rayong	732.851	1409.642	Row house	4	15	1	180
Map Ta Phut	Mueang Rayong	735.011	1408.502	Detached house	6	15	1	180
Map Ta Phut	Mueang Rayong	735.446	1408.416		5	15, 4	1	228
Map Ta Phut	Mueang Rayong	735.449	1408.403	Row house	5	15	0.5	360
Map Ta Phut	Mueang Rayong	735.573	1407.995	Detached house	4	15	0.5	360
Map Ta Phut	Mueang Rayong	735.589	1407.992	Detached house	5	15	0.5	360
Map Ta Phut	Mueang Rayong	735.143	1407.925	Row house	4	15	0.5	360
Map Ta Phut	Mueang Rayong	735.052	1408.047	Row house	4	4	1	48
Map Ta Phut	Mueang Rayong	734.656	1408.309	Row house	5	15	0.5	360
Map Ta Phut	Mueang Rayong	734.647	1408.371	Detached house	5	15	0.5	360
Map Ta Phut	Mueang Rayong	734.001	1409.009	Row house	5	4	1	48
Map Ta Phut	Mueang Rayong	733.996	1408.995	Row house	4	7	0.33	252
Map Ta Phut	Mueang Rayong	737.355	1402.658	Detached house	5	15	1	180
Map Ta Phut	Mueang Rayong	735.359	1403.053	Detached house	5	15	0.5	360
Map Ta Phut	Mueang Rayong	735.77	1402.316	Detached house	4	15	3.5	51.42857143
Noen Phra	Mueang Rayong	736.449	1402.505	Row house	4	4	1	48
Noen Phra	Mueang Rayong	737.734	1402.665	Detached house	4	15	1	180
Noen Phra	Mueang Rayong	738.9	1402.648	Row house	4	15	2.5	72
Noen Phra	Mueang Rayong	738.716	1402.749	Detached house	9	15	2	90
Map Ta Phut	Mueang Rayong	735.254	1405.898	Detached house	4	4	1	48
Map Ta Phut	Mueang Rayong	735.26	1405.895	Detached house	6	7	1	84
Noen Phra	Mueang Rayong	735.739	1402.578	Townhouse / house	5	4	0.25	192
Map Ta Phut	Mueang Rayong	735.222	1403.343		5	15	3	60
Map Ta Phut	Mueang Rayong	735.243	1403.224	Row house	5	15	6	30

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	735.297	1403.162		4	4	3	16
Map Ta Phut	Mueang Rayong	735.267	1403.157	Detached house	4	4	2	24
Map Ta Phut	Mueang Rayong	735.724	1402.252	Detached house	4	4	2	24
Map Ta Phut	Mueang Rayong	735.781	1402.235	Detached house	4	4	0.25	192
Map Ta Phut	Mueang Rayong	735.776	1402.239	Detached house	4	4	1	48
Map Ta Phut	Mueang Rayong	735.634	1402.006	Detached house	4	4	1	48
Map Ta Phut	Mueang Rayong	735.361	1402.03	Detached house	6	15	1	180
Map Ta Phut	Mueang Rayong	735.798	1402.308	Row house	4	15	1	180
Noen Phra	Mueang Rayong	738.197	1402.821	Row house	4	4	1	180
Noen Phra	Mueang Rayong	737.793	1402.776	Detached house	4	4	0.67	72
Noen Phra	Mueang Rayong	737.391	1402.678		6	15	1	180
Noen Phra	Mueang Rayong	737.864	1402.812		4	ไม่/อื่น		ND
Noen Phra	Mueang Rayong	736.452	1402.457	Temporary housing	4	15	1	180
Noen Phra	Mueang Rayong	740.584	1403.986	Row house	4	15	1	180
Noen Phra	Mueang Rayong	737.037	1402.561	Temporary housing	4	15	1	180
Noen Phra	Mueang Rayong	739.226	1402.773	Detached house	2	7	1	84
Noen Phra	Mueang Rayong	739.199	1402.797	Row house	6	7	1	84
Map Ta Phut	Mueang Rayong	735.739	1402.28	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	735.227	1403.311	Row house	4	15	1	180
Map Ta Phut	Mueang Rayong	735.171	1403.438	Detached house	4	15	2	90
Map Ta Phut	Mueang Rayong	735.294	1405.926	Detached house	4	15	2	90
Map Ta Phut	Mueang Rayong	735.056	1405.283	Detached house	5	15	1	180
Map Ta Phut	Mueang Rayong	735.751	1402.322	Detached house	6	15	1	180
Map Ta Phut	Mueang Rayong	735.215	1406.011	Temporary housing	5	15	1	180
Noen Phra	Mueang Rayong	737.389	1402.675	Detached house	4	15	1.5	120
Map Ta Phut	Mueang Rayong	735.666	1402.495	Temporary housing	4	15	1	180
Map Ta Phut	Mueang Rayong	735.125	1403.636	Row house	4	15	1.5	120
Map Ta Phut	Mueang Rayong	737.584	1402.701	Detached house	7	7	4	21
Map Ta Phut	Mueang Rayong	738.315	1402.919	Row house	5	7	1	84
Map Ta Phut	Mueang Rayong	738.319	1402.94	Detached house	5	7	1	84
Map Ta Phut	Mueang Rayong	735.255	1403.183	Row house	6			ND
Map Ta Phut	Mueang Rayong	735.331	1403.079	Row house	5	7	1	84

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	735.765	1402.361	Detached house	6	15	1	180
Map Ta Phut	Mueang Rayong	735.367	1403.768	Detached house	7	15	1.5	120
Map Ta Phut	Mueang Rayong	735.814	1402.259	Temporary housing	5	7	1	84
Map Ta Phut	Mueang Rayong	735.79	1402.513	Row house	4	7	1	84
Map Ta Phut	Mueang Rayong	735.138	1403.501	Detached house	6	4	1.5	32
Map Ta Phut	Mueang Rayong	735.243	1406.146	Row house	4	15	1.5	120
Map Ta Phut	Mueang Rayong	735.235	1405.988	Detached house	4	4	3	16
Map Ta Phut	Mueang Rayong	735.791	1402.564	Detached house	5	7	1	84
Map Ta Phut	Mueang Rayong	735.786	1402.519	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	735.791	1402.555	Detached house	6	15	1	180
Map Ta Phut	Mueang Rayong	735.814	1402.517	Temporary housing	5	4	1	48
Map Ta Phut	Mueang Rayong	735.795	1402.5	Detached house	6	4	1	48
Map Ta Phut	Mueang Rayong	735.11	1403.704	Row house	5	15	1.5	120
Map Ta Phut	Mueang Rayong	737.432	1402.717	Detached house	4	15	1	180
Map Ta Phut	Mueang Rayong	737.54	1402.769	Detached house	5	7	1	84
Choeng Noen	Mueang Rayong	735.216	1373.126	Row house	4	7	3	28
Choeng Noen	Mueang Rayong	735.361	1373.066	Row house	5	15	1	180
Choeng Noen	Mueang Rayong	735.327	1373.092	Temporary housing	5	7	2	42
Choeng Noen	Mueang Rayong	735.317	1373.095	Detached house	5			ND
Choeng Noen	Mueang Rayong	735.304	1373.101	Detached house	5	15	1	180
Choeng Noen	Mueang Rayong	735.291	1373.126	Detached house	6	15	2	90
Choeng Noen	Mueang Rayong	735.358	1373.086	Detached house	5			ND
Choeng Noen	Mueang Rayong	735.313	1373.098	Detached house	6	15	1	180
Choeng Noen	Mueang Rayong	735.337	1373.094	Row house	5	15.	0.5	360
Choeng Noen	Mueang Rayong	735.347	1373.093	Detached house	4	15	1	180
Choeng Noen	Mueang Rayong	735.362	1373.131	Row house	5	15	1	180
Choeng Noen	Mueang Rayong	735.291	1373.126	Row house	4	15	1	180
Choeng Noen	Mueang Rayong	735.302	1373.099	Row house	5	15	1	180
Choeng Noen	Mueang Rayong	735.281	1373.127	Detached house	4	15	0.25	720
Choeng Noen	Mueang Rayong	735.321	1373.094	Row house	4	15	0.33	540
Kram	Klaeng	786.743	1400.331	Detached house	5	15.	1	180
Kram	Klaeng	786.232	1402.325	Detached house	5	15	2	90
Thang Kwian	Klaeng	788.203	1413.934	Row house	4	15	2	90

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pak Nam Krasae	Klaeng	793.619	1406.81	Townhouse / house	7	15	1	180
Thang Kwian	Klaeng	787.067	1414.362	Townhouse / house	4	15	1	180
Thang Kwian	Klaeng	787.132	1414.3	Row house	5	4	2	24
Thang Kwian	Klaeng	787.096	1414.052	Row house	4	15	2.5	72
Thang Kwian	Klaeng	787.524	1414.34	Townhouse / house	6	15	1	180
Thang Kwian	Klaeng	787.618	1414.276	Townhouse / house	5	15	2	90
Kram	Klaeng	786.7	1400.335	Detached house	4	15	2	90
Kram	Klaeng	786.21	1400.356	Detached house	4	15	2	90
Thang Kwian	Klaeng	787.422	1414.992	Townhouse / house	6	15	1	180
Thang Kwian	Klaeng	787.123	1414.296	Row house	4	4	2	24
Thang Kwian	Klaeng	787.567	1414.444	Townhouse / house	4	15	2	90
Thang Kwian	Klaeng	787.504	1414.386	Townhouse / house	4	15	2	90
Thang Kwian	Klaeng	787.492	1414.365	Townhouse / house	5	15	1.5	120
Thang Kwian	Klaeng	787.733	1414.36	Townhouse / house	4	15	2	90
Kram	Klaeng	787.34	1401.026	Townhouse / house	5	15	1	180
Kram	Klaeng	787.05	1400.66	Townhouse / house	5	15	1	180
Kram	Klaeng	786.745	1400.362	Detached house	4	15	2	90
Kram	Klaeng	786.096	1402.515	Detached house	4	15	1	180
Kram	Klaeng	786.236	1402.236	Detached house	5	15	1.5	120
Kram	Klaeng	786.195	1402.403	Detached house	4	15	2	90
Pak Nam Krasae	Klaeng	793.578	1406.819		4	15	1	180
Pak Nam Krasae	Klaeng	793.618	1406.828	Townhouse / house	4	15	5	36
Thang Kwian	Klaeng	787.503	1414.374	Townhouse / house	4	15	0.75	270
Thang Kwian	Klaeng	787.645	1414.316	Townhouse / house	5	15	1	180
Thang Kwian	Klaeng	787.673	1414.346	Townhouse / house	4	15	1	180
Kram	Klaeng	785.978	1502.716	Townhouse / house	5	15	1	180
Kram	Klaeng	785.962	1402.781	Detached house	5	15	0.5	360
Kram	Klaeng	786.116	1402.506		4	15	2	90
Klaeng	Klaeng	717.524	1414.557	Townhouse / house	4	15	2	90
Klaeng	Klaeng	787.599	1414.57	Townhouse / house	4	15	1	180
Klaeng	Klaeng	787.526	1414.591	Townhouse / house	4	15	1	180
Klaeng	Klaeng	787.535	1414.617	Townhouse / house	6	15	0.5	360
Klaeng	Klaeng	787.503	1414.628	Townhouse / house	6	15	1	180
Kram	Klaeng	786.456	1400.783	Detached house	4	15	6	30
Kram	Klaeng	786.426	1400.819	Detached house	5	15	2	90
Kram	Klaeng	786.522	1400.86	Townhouse / house	4	15	1	180
Kram	Klaeng	786.498	1400.909	Detached house	4	15	2	90
Kram	Klaeng	786.551	1400.947	Detached house	4	15	1	180
Kram	Klaeng	785.957	1402.808	Townhouse / house	4	15	0.25	720
Pak Nam Krasae	Klaeng	793.655	1406.72	Row house	5	15	2	90
Pak Nam Krasae	Klaeng	739.595	1406.618	Row house	4	15	0.5	360
Thang Kwian	Klaeng	785.954	1415.186	Row house	4	15	2	90
Thang Kwian	Klaeng	787.004	1414.397	Townhouse / house	6	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Thang Kwian	Klaeng	787.539	1414.571	Row house	6	15	1	180
Klaeng	Klaeng	787.546	1414.572	Townhouse / house	5	15	1	180
Kram	Klaeng	786.512	1400.983	Detached house	4	7	3	28
Thang Kwian	Klaeng	787.421	1414.988	Detached house	4	7	0.67	126
Thang Kwian	Klaeng	787.421	1414.988	Detached house	4	15	3	60
Thang Kwian	Klaeng	787.474	1415.118	Detached house	4	7	6	14
Pak Nam Krasae	Klaeng	739.601	1406.511	Row house	7	15	1	180
Pak Nam Krasae	Klaeng	739.606	1406.585	Row house	4	7	3	28
Pak Nam Krasae	Klaeng	739.592	1406.664	Row house	5	4	0.67	72
Thang Kwian	Klaeng	788.142	1413.786	Townhouse / house	4	7	2	42
Kram	Klaeng	786.465	1400.801	Detached house	4	15	2	90
Kram	Klaeng	786.107	1402.699	Detached house	6	7	1.5	56
Kram	Klaeng	786.045	1402.728	Detached house	4	7	4	21
Kram	Klaeng	786.039	1402.711	Detached house	5	7	1.5	56
Kram	Klaeng	786.745	1400.358	Detached house	5	15	1	180
Thang Kwian	Klaeng	788.211	1413.919	Townhouse / house	4	15	2	90
Thang Kwian	Klaeng	788.205	1413.98	Row house	6	15	1	180
Thang Kwian	Klaeng	787.134	1414.335	Detached house	4	15	1	180
Thang Kwian	Klaeng	787.514	1414.391	Townhouse / house	6	15	1	180
Thang Kwian	Klaeng	787.696	1414.376	Townhouse / house	4	15	3	60
Thang Kwian	Klaeng	787.675	1414.354	Townhouse / house	4	15	1	180
Pluak Daeng	Pluak Daeng	739.747	1436.418	Townhouse / house	4	15	1	180
Pluak Daeng	Pluak Daeng	739.822	1436.537	Detached house	4	15	2	90
Pluak Daeng	Pluak Daeng	740.12	1436.107	Detached house	5	15	2	90
Pluak Daeng	Pluak Daeng	740.179	1436.058	Row house	4	15	2	90
Pluak Daeng	Pluak Daeng	740.158	1436.057	Row house	5	15	1	180
Pluak Daeng	Pluak Daeng	740.177	1436.066	Row house	4	15	1	180
Pluak Daeng	Pluak Daeng	739.084	1435.767	Townhouse / house	5	15	1	180
Pluak Daeng	Pluak Daeng	738.968	1435.663	Townhouse / house	4	15	1	180
Pluak Daeng	Pluak Daeng	739.721	1436.298	Row house	6	15	2	90
Pluak Daeng	Pluak Daeng	740.291	1436.066	Townhouse / house	4	15	0.5	360
Pluak Daeng	Pluak Daeng	739.828	1436.563	Temporary housing	4	4	2	24
Pluak Daeng	Pluak Daeng	739.82	1436.564	Row house	4			ND
Pluak Daeng	Pluak Daeng	739.749	1436.412	Townhouse / house	5	15	1	180
Pluak Daeng	Pluak Daeng	739.716	1436.287	Row house	4			ND
Pluak Daeng	Pluak Daeng	739.98	1435.661	Row house	5			ND
Pluak Daeng	Pluak Daeng	740.044	1436.296	Row house	5	15	1	180
Pluak Daeng	Pluak Daeng	739.553	1435.942	Townhouse / house	6	15	0.1	1800
Pluak Daeng	Pluak Daeng	739.584	1436.022	Townhouse / house	6	4	1	48
Pluak Daeng	Pluak Daeng	739.697	1436.406	Detached house	4	15	3	60
Pluak Daeng	Pluak Daeng	738.964	1435.616	Townhouse / house	4	15	6	30
Pluak Daeng	Pluak Daeng	738.987	1435.68	Detached house	4	15	3	60
Pluak Daeng	Pluak Daeng	739.62	1436.143	Townhouse / house	5			ND

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pluak Daeng	Pluak Daeng	739.555	1436.012	Townhouse / house	4	4	1	48
Pluak Daeng	Pluak Daeng	739.696	1436.183	Townhouse / house	5	15	0.5	360
Pluak Daeng	Pluak Daeng	739.697	1436.134	Townhouse / house	5	15	1	180
Pluak Daeng	Pluak Daeng	739.599	1436.069	Townhouse / house	6	15	2	90
Pluak Daeng	Pluak Daeng	739.944	1435.846	Townhouse / house	4	4	4	12
Pluak Daeng	Pluak Daeng	740.291	1436.723	Row house	4	4	1	48
Pluak Daeng	Pluak Daeng	739.887	1436.045	Townhouse / house	5	15	3	60
Pluak Daeng	Pluak Daeng	739.906	1436.014	Townhouse / house	4	15	1	180
Ban Khai	Ban Khai	749.499	1415.172	Row house	5	15	2	90
Chak Bok	Ban Khai	754.79	1415.5	Detached house	5	15	3	60
Nong Bua	Ban Khai	750.41	1423.709	Detached house	4	15	2	90
Nong Bua	Ban Khai	750.422	1423.732	Detached house	4	15	1	180
Nong Bua	Ban Khai	750.465	1423.706	Detached house	4	15	2	90
Ban Khai	Ban Khai	749.462	1415.059	Townhouse / house	4	15	2	90
Chak Bok	Ban Khai	754.788	1415.569	Detached house	5	15	3	60
Ban Khai	Ban Khai	749.485	1414.681	Townhouse / house	5	15	1	180
Chak Bok	Ban Khai	754.815	1415.539	Detached house	6	15	3	60
Ban Khai	Ban Khai	749.43	1414.567	Townhouse / house	6	15	1	180
Nong Lalok	Ban Khai	748.53	1417.885	Detached house	4	15	3	60
Ban Khai	Ban Khai	749.409	114.517	Townhouse / house	4	15	1	180
Chak Bok	Ban Khai	754.588	1415.574	Detached house	4	15	2	90
Nong Bua	Ban Khai	750.482	1423.795	Detached house	5	15	1	180
Ban Khai	Ban Khai	749.478	1414.656	Townhouse / house	5	15	1	180
Ban Khai	Ban Khai	749.525	1414.838	Townhouse / house	5	15	3	60
Nong Bua	Ban Khai	749.588	1421.705	Detached house	4	15	5	36
Nong Bua	Ban Khai	750.394	1423.754	Detached house	4	15	2	90
Ban Khai	Ban Khai	749.434	1413.941	Townhouse / house	4	15	2	90
Ban Khai	Ban Khai	749.511	1415.181	Row house	5	4	0.67	72
Nong Lalok	Ban Khai	749.035	1417.193	Detached house	5	15	1	180
Nong Lalok	Ban Khai	748.996	1417.902	Detached house	4	15	1	180
Nong Lalok	Ban Khai	748.884	1417.822	Detached house	4	15	3	60
Nong Lalok	Ban Khai	747.565	1413.724	Detached house	5	15	2	90
Nong Bua	Ban Khai	751.013	1424.296	Detached house	5	15	1	180
Ban Khai	Ban Khai	749.141	1414.334	Detached house	5	15	2	90
Nong Lalok	Ban Khai	748.495	1417.801	Detached house	4	15	3	60
Ban Khai	Ban Khai	749.542	1414.942	Detached house	5	15	1	180
Sammak Thon	Bang Chang	720.754	1410.609	Detached house	6	15	1	180
Sammak Thon	Bang Chang	720.728	1410.441	Detached house	6	15	1	180
Sammak Thon	Bang Chang	721.008	1407.421	Row house	4			ND
Bang Chang	Bang Chang	725.025	1402.747	Detached house	5	15	1.5	120
Bang Chang	Bang Chang	725.025	1402.741	Row house	6	4	1	48
Pla	Bang Chang	722.248	1401.423	Detached house	4	15	1	180
Pla	Bang Chang	723.291	1402.11	Detached house	5	15	3	60

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Pla	Bang Chang	723.208	1401.825	Detached house	4	15	4	45
Bang Chang	Bang Chang	722.987	1407.686	Detached house	4	15	2	90
Bang Chang	Bang Chang	722.986	1407.796	Townhouse / house	4	11.5	1	180
Pla	Bang Chang	724.947	1402.511	Row house	4	4	1	48
Pla	Bang Chang	722.259	1401.407	Detached house	4	15	1	180
Pla	Bang Chang	722.202	1401.563	Detached house	4	15	2	90
Sannak Thon	Bang Chang	721.171	1410.618	Detached house	5	15	1	180
Bang Chang	Bang Chang	723	1407.696	Townhouse / house	5	15	1	180
Bang Chang	Bang Chang	723.056	1407.626	Detached house	4	15	1.5	120
Bang Chang	Bang Chang	724.854	1402.503	Detached house	5	15	1	180
Pla	Bang Chang	722.193	1401.4	Detached house	4	15	1	180
Pla	Bang Chang	721.971	1401.155	Detached house	5	15	1	180
Sannak Thon	Bang Chang	791.39	1412.623	Detached house	4	15	1	180
Bang Chang	Bang Chang	724.929	1402.379	Detached house	5	15	1	180
Bang Chang	Bang Chang	723.972	1402.454	Row house	4	7	2	42
Bang Chang	Bang Chang	722.467	1405.66	Detached house	5	15	1	180
Bang Chang	Bang Chang	722.281	1408	Townhouse / house	5	15	1	180
Bang Chang	Bang Chang	724.9	1402.45	Row house	5			ND
Pla	Bang Chang	722.05	1401.18	Detached house	5	15	1	180
Bang Chang	Bang Chang	722.227	1401.258	Townhouse / house	5	15	2	90
Bang Chang	Bang Chang	722.49	1405.769	Row house	5	15	2	90
Bang Chang	Bang Chang	722.044	1401.179	Detached house	4	15	2	90
Sannak Thon	Bang Chang	719.921	1413.48	Detached house	6	15	2	90
Bang Chang	Bang Chang	722.44	1404.899	Row house	4	15	3	60
Sannak Thon	Bang Chang	719.942	1413.539	Detached house	4	15	1	180
Sannak Thon	Bang Chang	721.19	1410.594	Row house	4	15	2	90
Bang Chang	Bang Chang	722.933	1407.8	Townhouse / house	4	15	2	90
Bang Chang	Bang Chang	722.78	1406.011	Row house	5	15	1	180
Bang Chang	Bang Chang	722.929	1407.829	Townhouse / house	5	7	1	180
Bang Chang	Bang Chang	723.852	1407.809	Townhouse / house	5	15	1	180
Bang Chang	Bang Chang	724.959	1402.4	Detached house	6	15	2	360
Pla	Bang Chang	722.21	1401.553	Detached house	5	15	1	180
Bang Chang	Bang Chang	725.025	1402.748	Row house	5	4	1	48
Bang Chang	Bang Chang	724.94	1402.511	Row house	4	4	0.5	96
Sannak Thon	Bang Chang	719.464	1411.548	Townhouse / house	5	15	0.75	240
Num Pen	Khao Chamao	794.597	1428.294	Detached house	6	15	2	90
Num Pen	Khao Chamao	797.464	1428.051	Detached house	5	15	3	60
Huai Thap Mon	Khao Chamao	794.435	1428.032	Detached house	5	15	2	90
Huai Thap Mon	Khao Chamao	794.427	1428.048	Detached house	6	15	1	180
Num Pen	Khao Chamao	794.473	1428.169	Detached house	4	15	2	90
Khao Noi	Khao Chamao	781.914	1449.796	Detached house	5	15	1	180
Khao Noi	Khao Chamao	794.591	1428.295	Detached house	4	15	6	30
Num Pen	Khao Chamao	794.591	1428.296	Detached house	5	15	1	180

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Num Pen	Khao Chamao	794.518	1428.23	Detached house	5	15	2	90
Khao Noi	Khao Chamao	783.163	1450.283	Row house	4	15	1	180
Chum Saeng	Wang Chan	773.778	1432.089	Townhouse / house	5	15	1	180
Chum Saeng	Wang Chan	773.887	1431.971	Detached house	5	15	6	30
Chum Saeng	Wang Chan	796.023	1420.534	Detached house	4	15	12	15
Chum Saeng	Wang Chan	773.889	1431.594	Townhouse / house	4	15	6	30
Chum Saeng	Wang Chan	773.905	1431.594	Detached house	4	15	2	90
Chum Saeng	Wang Chan	773.871	1431.628	Detached house	5	15	2	90
Chum Saeng	Wang Chan	773.7847	1413.611	Detached house	4	15	1	180
Chum Saeng	Wang Chan	773.813	1431.612	Townhouse / house	5	15	1	180
Chum Saeng	Wang Chan	773.831	1431.617	Townhouse / house	4	15	1	180
Chum Saeng	Wang Chan	775.284	1433.299	Detached house	5	15	3	60
Chum Saeng	Wang Chan	775.316	1433.314	Detached house	5	15	1	180
Chum Saeng	Wang Chan	773.81	1431.573	Townhouse / house	5	15	1	180
Chum Saeng	Wang Chan	775.25	1433.286	Row house	6	15	0.5	360
Chum Saeng	Wang Chan	774.21	1431.71	Townhouse / house	4	15	1	180
Chum Saeng	Wang Chan	774.051	1431.655	Row house	5	15	0.83	225
Nikhom Phatthana	Nikhom Phatthana	815.459	1420.726	Row house	4	7	1	84
Nikhom Phatthana	Nikhom Phatthana	739.136	1419.204	Row house	5	15	0.67	240
Nikhom Phatthana	Nikhom Phatthana	739.017	1419.225	Row house	5	15	5	36
Nikhom Phatthana	Nikhom Phatthana	739.016	1419.346	Row house	5	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.805	1419.793	Row house	5	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.766	1419.762	Townhouse / house	4	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.006	1419.343	Row house	4	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.826	1419.848	Row house	4	15	8	22.5
Nikhom Phatthana	Nikhom Phatthana	738.867	1419.812	Detached house	6	15	0.75	270
Nikhom Phatthana	Nikhom Phatthana	738.94	1419.858	Townhouse / house	4	4	1 เดือน	48
Nikhom Phatthana	Nikhom Phatthana	738.078	1418.59	Townhouse / house	4	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.149	1418.39	Row house	4	4	1	48
Nikhom Phatthana	Nikhom Phatthana	739.542	1419.383	Row house	4	15	2	90
Nikhom Phatthana	Nikhom Phatthana	738.4	1419.32	Row house	5	15	1	180
Nikhom Phatthana	Nikhom Phatthana	738.952	1419.666	Detached house	4	15	1	180
Nikhom Phatthana	Nikhom Phatthana	738.124	1419.131	Row house	6	15	1	180
Nikhom Phatthana	Nikhom Phatthana	739.393	1419.493	Row house	5	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.025	1418.226	Detached house	4	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.335	1418.552	Row house	4	15	3	60

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Nikhom Phatthana	Nikhom Phatthana	738.112	1418.111	Row house	4	15	3	60
Nikhom Phatthana	Nikhom Phatthana	738.077	1418.546	Row house	5			ND
Nikhom Phatthana	Nikhom Phatthana	738.074	1418.551	Row house	4	15	4	45
Nikhom Phatthana	Nikhom Phatthana	738.819	1419.792	Row house	4			ND
Nikhom Phatthana	Nikhom Phatthana	738.811	1419.79	Row house	5	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.792	1419.787	Row house	5	15	4	45
Nikhom Phatthana	Nikhom Phatthana	738.83	1419.815	Row house	4	15	5	36
Nikhom Phatthana	Nikhom Phatthana	738.827	1419.826	Row house	5	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.12	1419.276	Townhouse / house	4	15	2	90
Nikhom Phatthana	Nikhom Phatthana	739.122	1419.251	Row house	6	15	2	90
Nikhom Phatthana	Nikhom Phatthana	739.07	1419.29	Row house	4	4	3	16
Nikhom Phatthana	Nikhom Phatthana	738.982	1419.176	Row house	4	15	4	45
Total								52124.47888

Table C-3 Large household

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Map Ta Phut	Mueang Rayong	734.34	1408.405	Detached house	7	15	1	180
Map Ta Phut	Mueang Rayong	737.745	1402.698	Row house	7	15	0.67	240
Choeng Noen	Mueang Rayong	749.674	1401.473	Townhouse / house	7	15	1	180
Choeng Noen	Mueang Rayong	749.856	1401.624	Detached house	10	15	0.5	360
Choeng Noen	Mueang Rayong	749.708	1401.955	Townhouse / house	7	15	0.67	240
Huai Pong	Mueang Rayong	735.02	1408.535	Detached house	8	15	2	90
Huai Pong	Mueang Rayong	735.715	1406.95	Townhouse / house	12	15	2	90
Huai Pong	Mueang Rayong	732.352	1409.95	Detached house	7	4	0.33	144
Map Ta Phut	Mueang Rayong	735.121	1407.92	Detached house	10	15	0.5	360
Map Ta Phut	Mueang Rayong	735.189	1408.373	Row house	8	4 kg.	1	48
Map Ta Phut	Mueang Rayong	734.63	1408.333	Row house	11	15	0.5	360
Map Ta Phut	Mueang Rayong	736.477	1402.516	Row house	8	4	1	48
Choeng Noen	Mueang Rayong	735.3	1373.102	Detached house	8	15	1	180
Pluak Daeng	Pluak Daeng	739.575	1436.096	Townhouse / house	10			ND
Nong Bua	Ban Khai	750.397	1423.745	Detached house	8	15	1	180
Ban Khai	Ban Khai	749.368	1414.45	Detached house	8	15	5	36

Sub-district	Districts	UTM (X,Y)		Type of household	Number of actual resident	Size of LPG container (kg)	Duration of usage/ container (month)	Consumption of LPG (kg/y)
		X	Y					
Ban Khai	Ban Khai	749.441	1415.015	Townhouse / house	10	15	1	180
Ban Khai	Ban Khai	749.459	1415.047	Townhouse / house	7	15	2	90
Chak Bok	Ban Khai	754.125	1415.383	Detached house	8	15	1	180
Nong Lalok	Ban Khai	748.886	1417.797	Townhouse / house	8	15	0.5	360
Nong Lalok	Ban Khai	748.863	1417.8	Townhouse / house	7	15	1	180
Ban Khai	Ban Khai	749.436	1414.579	Townhouse / house	8	15	4	45
Bang Chang	Bang Chang	724.799	1402.699	Townhouse / house	7	4	0.67	72
Pla	Bang Chang	722.615	1401.919	Detached house	7	15	1	180
Pla	Bang Chang	721.457	1404.425	Detached house	8	15	3	60
Pla	Bang Chang	724.928	1402.63	Detached house	7	15	1	180
Pla	Bang Chang	722.091	1401.49	Detached house	8	15	1	180
Samnak Thon	Bang Chang	719.939	1413.525	Detached house	7	15	1	180
Samnak Thon	Bang Chang	719.553	1411.589	Townhouse / house	7	15	1	180
Pla	Bang Chang	722.615	1401.911	Detached house	7	15	1	180
Pla	Bang Chang	722.027	1401.087	Detached house	10	15.	1	180
Samnak Thon	Bang Chang	719.518	1410.614	Townhouse / house	8	15	1	180
Num Pen	Khao Chamao	797.362	1422.628	Detached house	7	15	1	180
Num Pen	Khao Chamao	799.379	1422.528	Townhouse / house	8	48	4	144
Khao Noi	Khao Chamao	782.883	1450.251	Detached house	7	15	1	180
Num Pen	Khao Chamao	794.622	1428.338	Detached house	10	15	1	180
Chum Saeng	Wang Chan	773.887	1431.967	Detached house	7	15	0.5	360
Chum Saeng	Wang Chan	773.862	1431.556	Row house	7	15	0.5	360
Nikhom Phatthana	Nikhom Phatthana	739.121	1418.224	Townhouse / house	7	15.	1	180
Nikhom Phatthana	Nikhom Phatthana	738.077	1418.951	Row house	8	7	1	84
Nikhom Phatthana	Nikhom Phatthana	738.026	1418.439	Row house	7	4	1	48
Nikhom Phatthana	Nikhom Phatthana	738.087	1418.555	Townhouse / house	8			ND
Total								7059

## APPENDIX D

### QUESTIONNAIRE SURVEY OF HOUSEHOLD CHEMICALS

**Table D-1** Cleaning product

Sub-district	Districts	Coordinates		Type of household	Number of resident	Brand	Amount per bottle (mL)	Duration of use per bottle (month)	Chemical constituents	% (w/w)
		X	Y							
Choeng Noen	Mueang Rayong	749.27	1401.729	Townhouse / house	3	King's Stella	330	4	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.674	1401.473	Townhouse / house	7	King's Stella	330	12	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.679	1401.519	Townhouse / house	4	King's Stella	330	5	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.834	1401.635	Townhouse / house	4	King's Stella	330	4	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.856	1401.624	Detached house	10	King's Stella	330	3	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.798	1402.182	Townhouse / house	4	King's Stella	330	5	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.766	1401.968	Detached house	5	Happy	330	4	Isopropyl alcohol	1
Choeng Noen	Mueang Rayong	749.775	1401.656	Row house	5	King's Stella	330	2	Isopropyl alcohol	3
Choeng Noen	Mueang Rayong	749.775	1401.927	Detached house	2	King's Stella	330	4	Isopropyl alcohol	3
Thang Kwian	Klaeng	787.106	1414.337	Row house	2	King's Stella	330	1	Isopropyl alcohol	3
Pluak Daeng	Pluak Daeng	739.013	1435.598	Temporary housing	2	Happy	330	2	Isopropyl alcohol	1
Nong Bua	Ban Khai	750.394	1423.754	Detached house	4	King's Stella	330	3	Isopropyl alcohol	3
Num Pen	Khao Chamao	797.345	1422.525	Detached house	2	King's Stella	330	2	Isopropyl alcohol	3

**Table D-2** Deodorant product

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Size (g)	Consumption amount (g/month)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	747.358	1404.065	Townhouse / house	5	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.106	1407.944	Detached house	3	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.387	1408.38	Detached house	4	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.647	1406.931	Detached house	3	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.216	1403.343	Row house	1	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.219	1403.335	Row house	4	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.247	1403.281	Row house	5	100	135	1,4 - Dichlobenzene

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Size (g)	Consumption amount (g/month)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	749.871	1401.946	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.796	1401.705	Row house	2	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.77	1401.702	Row house	2	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.796	1401.903	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.694	1401.721	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.768	1401.812	Row house	2	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.813	1401.919	Row house	2	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.865	1401.957	Detached house	3	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.797	1402.139	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	749.757	1401.832	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	733.214	1409.338	Row house	3	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	732.337	1410.046	Detached house	4	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	735.576	1407.956	Detached house	4	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	735.715	1406.95	Townhouse / house	12	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	735.421	1406.743	Row house	6	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	736.294	1407.87	Detached house	4	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	734.269	1408.38	Detached house	4	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.54	1408.305	Townhouse / house	2	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	732.424	1409.606	Detached house	2	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	732.257	1410.119	Row house	4	100	135	1,4 - Dichlobenzene
Huai Pong	Mueang Rayong	732.408	1409.991	Row house	2	100	135	1,4 - Dichlobenzene
Noen Phra	Mueang Rayong	738.9	1402.648	Row house	4	100	135	1,4 - Dichlobenzene
Noen Phra	Mueang Rayong	735.81	1402485	Detached house	1	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.275	1403.273	Row house	2	100	135	1,4 - Dichlobenzene
Noen Phra	Mueang Rayong	740.896	1403.187	Row house	2	100	135	1,4 - Dichlobenzene
Noen Phra	Mueang Rayong	737.864	1402.812	0	4	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.236	1403.292	Row house	2	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.666	1402.495	Temporary housing	4	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.206	1406.073	Detached house	3	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.791	1402.564	Detached house	5	100	135	1,4 - Dichlobenzene
Map Ta Phut	Mueang Rayong	735.795	1402.5	Detached house	6	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.34	1373.158	Row house	2	100	135	1,4 - Dichlobenzene

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Size (g)	Consumption amount (g/month)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	735.326	1373.154	Row house	1	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.364	1373.146	Row house	3	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.302	1373.101	Detached house	3	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.3	1373.102	Detached house	8	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.344	1373.156	Detached house	3	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.309	1373.099	Row house	4	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.313	1373.098	Detached house	6	100	135	1,4 - Dichlobenzene
Choeng Noen	Mueang Rayong	735.339	1373.158	Row house	3	100	135	1,4 - Dichlobenzene
Kram	Klaeng	12.65904	102.64262	Detached house	3	100	135	1,4 - Dichlobenzene
Kram	Klaeng	786.123	1402.477	Detached house	2	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	788.203	1413.934	Row house	4	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.067	1414.362	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.132	1414.3	Row house	5	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.524	1414.34	Townhouse / house	6	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.61	1414.287	Townhouse / house	2	100	135	1,4 - Dichlobenzene
Kram	Klaeng	786.661	1400.62	Detached house	2	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.093	1414.247	Row house	3	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.537	1414.409	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.749	1414.333	Townhouse / house	2	100	135	1,4 - Dichlobenzene
Kram	Klaeng	785.956	1402.86	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Pak Nam Krasae	Klaeng	793.655	1406.72	Row house	5	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	786.971	1415.228	Row house	2	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.539	1414.571	Row house	6	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.027	1414.439	Row house	2	100	135	1,4 - Dichlobenzene
Klaeng	Klaeng	787.546	1414.572	Townhouse / house	5	100	135	1,4 - Dichlobenzene
Kram	Klaeng	786.512	1400.983	Detached house	4	100	135	1,4 - Dichlobenzene
Thang Kwian	Klaeng	787.421	1414.988	Detached house	4	100	135	1,4 - Dichlobenzene
Pak Nam Krasae	Klaeng	739.606	1406.585	Row house	4	100	135	1,4 - Dichlobenzene
Kram	Klaeng	786.086	1402.7	Detached house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.128	1435.66	Row house	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.125	1435.673	Row house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	740.177	1436.066	Row house	4	100	135	1,4 - Dichlobenzene

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Size (g)	Consumption amount (g/month)	Chemical constituents
		X	Y					
Pluak Daeng	Pluak Daeng	738.968	1435.663	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	738.973	1435.669	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.652	1436.104	Townhouse / house	1	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.11	1435.778	Temporary housing	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.828	1436.563	Temporary housing	4	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.777	1436.55	Detached house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.638	1436.203	Row house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	740.024	1435.663	Row house	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	740.013	1435.665	Row house	1	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.98	1435.661	Row house	5	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.196	1435.77	Row house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.123	1435.722	Temporary housing	1	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.122	1435.74	Row house	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.041	1435.742	Row house	1	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.043	1435.744	Row house	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.083	1435.764	Row house	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.013	1435.598	Temporary housing	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.951	1435.620	Townhouse / house	2	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	738.928	1435.598	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Pluak Daeng	Pluak Daeng	739.588	1436.074	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.51	1415.176	Row house	3	100	135	1,4 - Dichlobenzene
Nong Bua	Ban Khai	750.41	1423.709	Detached house	4	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.338	1414.42	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.462	1415.059	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.459	1415.047	Townhouse / house	7	100	135	1,4 - Dichlobenzene
Chak Bok	Ban Khai	754.815	1415.539	Detached house	6	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.521	1414.816	Townhouse / house	2	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.409	114.517	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.345	1414.422	Detached house	1	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.478	1414.656	Townhouse / house	5	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.525	1414.838	Townhouse / house	5	100	135	1,4 - Dichlobenzene
Nong Lalok	Ban Khai	748.715	1417.651	Row house	2	100	135	1,4 - Dichlobenzene

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Size (g)	Consumption amount (g/month)	Chemical constituents
		X	Y					
Nong Lalok	Ban Khai	748.996	1417.902	Detached house	4	100	135	1,4 - Dichlobenzene
Nong Lalok	Ban Khai	748.912	1417.828	Detached house	3	100	135	1,4 - Dichlobenzene
Nong Lalok	Ban Khai	748.886	1417.797	Townhouse / house	8	100	135	1,4 - Dichlobenzene
Nong Lalok	Ban Khai	748.863	1417.8	Townhouse / house	7	100	135	1,4 - Dichlobenzene
Nong Bua	Ban Khai	751.011	1424.329	Detached house	3	100	135	1,4 - Dichlobenzene
Nong Lalok	Ban Khai	748.495	1417.801	Detached house	4	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.568	1414.628	Detached house	2	100	135	1,4 - Dichlobenzene
Ban Khai	Ban Khai	749.532	1414.927	Townhouse / house	2	100	135	1,4 - Dichlobenzene
Bang Chang	Bang Chang	725.025	1402.741	Row house	6	100	135	1,4 - Dichlobenzene
Pla	Bang Chang	721.457	1404.425	Detached house	8	100	135	1,4 - Dichlobenzene
Bang Chang	Bang Chang	724.9	1402.45	Row house	5	100	135	1,4 - Dichlobenzene
Pla	Bang Chang	722.05	1401.18	Detached house	5	100	135	1,4 - Dichlobenzene
Samnak Thon	Bang Chang	719.797	1412.671	Detached house	3	100	135	1,4 - Dichlobenzene
Samnak Thon	Bang Chang	719.538	1411.572	Detached house	2	100	135	1,4 - Dichlobenzene
Bang Chang	Bang Chang	722.78	1406.011	Row house	5	100	135	1,4 - Dichlobenzene
Bang Chang	Bang Chang	724.799	1402.693	Detached house	3	100	135	1,4 - Dichlobenzene
Samnak Thon	Bang Chang	721.112	1410.713	Row house	2	100	135	1,4 - Dichlobenzene
Samnak Thon	Bang Chang	719.464	1411.548	Townhouse / house	5	100	135	1,4 - Dichlobenzene
Samnak Thon	Bang Chang	719.558	1412.631	Row house	3	100	135	1,4 - Dichlobenzene
Bang Chang	Bang Chang	724.872	1402.47	Row house	1	100	135	1,4 - Dichlobenzene
Bang Chang	Bang Chang	724.916	1402.455	Row house	2	100	135	1,4 - Dichlobenzene
Khao Noi	Khao Chamao	783.142	1450.3	Detached house	3	100	135	1,4 - Dichlobenzene
Num Pen	Khao Chamao	794.597	1428.294	Detached house	6	100	135	1,4 - Dichlobenzene
Khao Noi	Khao Chamao	783.136	1450.284	Detached house	3	100	135	1,4 - Dichlobenzene
Khao Noi	Khao Chamao	783.133	1450.284	Detached house	2	100	135	1,4 - Dichlobenzene
Huai Thap Mon	Khao Chamao	791.069	1436.371	Detached house	3	100	135	1,4 - Dichlobenzene
Num Pen	Khao Chamao	797.362	1422.628	Detached house	7	100	135	1,4 - Dichlobenzene
Khao Noi	Khao Chamao	783.125	1450.277	Detached house	3	100	135	1,4 - Dichlobenzene
Khao Noi	Khao Chamao	794.591	1428.295	Detached house	4	100	135	1,4 - Dichlobenzene
Num Pen	Khao Chamao	794.622	1428.338	Detached house	10	100	135	1,4 - Dichlobenzene
Num Pen	Khao Chamao	794.591	1428.296	Detached house	5	100	135	1,4 - Dichlobenzene
Num Pen	Khao Chamao	794.518	1428.23	Detached house	5	100	135	1,4 - Dichlobenzene

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Size (g)	Consumption amount (g/month)	Chemical constituents
		X	Y					
Khao Noi	Khao Chamao	783.163	1450.283	Row house	4	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	774.15	1431.693	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	773.889	1431.594	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	773.791	1413.594	Detached house	3	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	773.804	1413.595	Detached house	2	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	773.856	1431.617	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	773.831	1431.617	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	774.088	1431.655	Detached house	3	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	774.051	1431.655	Row house	5	100	135	1,4 - Dichlobenzene
Chum Saeng	Wang Chan	773.862	1431.556	Row house	7	100	135	1,4 - Dichlobenzene
Nikhom Phatthana	Nikhom Phatthana	739.081	1419.366	Townhouse / house	3	100	135	1,4 - Dichlobenzene
Nikhom Phatthana	Nikhom Phatthana	738.078	1418.59	Townhouse / house	4	100	135	1,4 - Dichlobenzene
Nikhom Phatthana	Nikhom Phatthana	738.112	1418.111	Row house	4	100	135	1,4 - Dichlobenzene
Nikhom Phatthana	Nikhom Phatthana	738.041	1418.515	Detached house	3	100	135	1,4 - Dichlobenzene
Nikhom Phatthana	Nikhom Phatthana	738.068	1418.516	Row house	3	100	135	1,4 - Dichlobenzene
Nikhom Phatthana	Nikhom Phatthana	738.941	1419.834	Row house	2	100	135	1,4 - Dichlobenzene

**Table D-3** Insecticide product

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Products name	Size (g)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	747.358	1404.065	Townhouse / house	5	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	732.905	1406.895	Detached house	6	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	735.3	1408.379	Townhouse / house	2	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	735.295	1405.979	Detached house	6	Mothballs	90	Naphthalenes
Huai Pong	Mueang Rayong	732.895	1409.7	Row house	5	Mothballs	90	Naphthalenes
Huai Pong	Mueang Rayong	735.624	1406.665	Townhouse / house	4	Mothballs	90	Naphthalenes
Huai Pong	Mueang Rayong	735.715	1406.95	Townhouse / house	12	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	735.275	1403.273	Row house	2	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	735.295	1405.979	Row house	3	Mothballs	90	Naphthalenes

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Products name	Size (g)	Chemical constituents
		X	Y					
Map Ta Phut	Mueang Rayong	735.236	1403.293	Row house	1	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	735.206	1406.073	Detached house	3	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	735.791	1402.564	Detached house	5	Mothballs	90	Naphthalenes
Map Ta Phut	Mueang Rayong	737.54	1402.769	Detached house	5	Mothballs	90	Naphthalenes
Choeng Noen	Mueang Rayong	735.344	1373.156	Detached house	3	Mothballs	90	Naphthalenes
Choeng Noen	Mueang Rayong	735.302	1373.099	Row house	5	Mothballs	90	Naphthalenes
Kram	Klaeng	12.65904	102.64262	Detached house	3	Mothballs	90	Naphthalenes
Kram	Klaeng	786.086	1402.536	Townhouse / house	3	Mothballs	90	Naphthalenes
Kram	Klaeng	785.956	1402.86	Townhouse / house	3	Mothballs	90	Naphthalenes
Klaeng	Klaeng	787.535	1414.614	Townhouse / house	6	Mothballs	90	Naphthalenes
Pak Nam Krasae	Klaeng	793.655	1406.72	Row house	5	Mothballs	90	Naphthalenes
Pak Nam Krasae	Klaeng	793.598	1406.546	Row house	3	Mothballs	90	Naphthalenes
Thang Kwian	Klaeng	786.971	1415.228	Row house	2	Mothballs	90	Naphthalenes
Kram	Klaeng	786.512	1400.983	Detached house	4	Mothballs	90	Naphthalenes
Pak Nam Krasae	Klaeng	739.601	1406.511	Row house	7	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	739.943	1435.298	Row house	3	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	739.196	1435.77	Row house	3	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	739.083	1435.764	Row house	2	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	739.146	1435.822	Townhouse / house	3	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	738.966	1435.692	Townhouse / house	2	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	738.987	1435.68	Detached house	4	Mothballs	90	Naphthalenes
Pluak Daeng	Pluak Daeng	739.608	1436.007	Townhouse / house	2	Mothballs	90	Naphthalenes
Nong Bua	Ban Khai	750.41	1423.709	Detached house	4	Mothballs	90	Naphthalenes
Nong Bua	Ban Khai	750.397	1423.745	Detached house	8	Mothballs	90	Naphthalenes
Ban Khai	Ban Khai	749.462	1415.059	Townhouse / house	4	Mothballs	90	Naphthalenes
Ban Khai	Ban Khai	749.459	1415.047	Townhouse / house	7	Mothballs	90	Naphthalenes
Nong Bua	Ban Khai	750.489	1423.779	Detached house	1	Mothballs	90	Naphthalenes
Chak Bok	Ban Khai	754.588	1415.574	Detached house	4	Mothballs	90	Naphthalenes
Nong Bua	Ban Khai	750.394	1423.754	Detached house	4	Mothballs	90	Naphthalenes
Sammak Thon	Bang Chang	720.754	1410.609	Detached house	6	Mothballs	90	Naphthalenes
Sammak Thon	Bang Chang	718.817	1411.224	Row house	3	Mothballs	90	Naphthalenes
Bang Chang	Bang Chang	723.033	1407.707	Row house	4	Mothballs	90	Naphthalenes
Bang Chang	Bang Chang	722.986	1407.796	Detached house	2	Mothballs	90	Naphthalenes
Bang Chang	Bang Chang	723.092	1407.576	Row house	2	Mothballs	90	Naphthalenes
Pla	Bang Chang	722.041	1401.129	Detached house	2	Mothballs	90	Naphthalenes
Sammak Thon	Bang Chang	719.921	1413.48	Detached house	6	Mothballs	90	Naphthalenes
Bang Chang	Bang Chang	722.933	1407.8	Row house	4	Mothballs	90	Naphthalenes
Khao Noi	Khao Chamao	784.272	1449.507	Detached house	1	Mothballs	90	Naphthalenes

Locality	Districts	UTM (x,Y)		Type of household	Actual resident	Products name	Size (g)	Chemical constituents
		X	Y					
Num Pen	Khao Chamao	797.362	1422.628	Detached house	7	Mothballs	90	Naphthalenes
Khao Noi	Khao Chamao	783.125	1450.277	Detached house	3	Mothballs	90	Naphthalenes
Nikhom Phatthana	Nikhom Phatthana	738.959	1419.211	Row house	2	Mothballs	90	Naphthalenes
Nikhom Phatthana	Nikhom Phatthana	738.984	1419.262	Row house	2	Mothballs	90	Naphthalenes
Nikhom Phatthana	Nikhom Phatthana	739.081	1419.366	Townhouse / house	3	Mothballs	90	Naphthalenes
Nikhom Phatthana	Nikhom Phatthana	738.867	1419.812	Detached house	6	Mothballs	90	Naphthalenes

**Table D-4** Cosmetic of cleaning solution

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml)	Consumption time (month)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	747.348	1403.886	Row house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	747.436	1403.895	Row house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	747.4	1403.944	Row house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	747.391	1403.908	Row house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	747.325	1404.015	Townhouse / house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	747.297	1404	Detached house	4	100	12	Acetone
Huai Pong	Mueang Rayong	733.779	1409.245	Row house	3	100	12	Acetone
Huai Pong	Mueang Rayong	731.28	1410.539	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.387	1408.38	Detached house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	737.745	1402.698	Row house	7	100	12	Acetone
Map Ta Phut	Mueang Rayong	738.863	1402.698	Detached house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	740.587	1403.162	Row house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.219	1403.335	Row house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.247	1403.281	Row house	5	100	12	Acetone
Choeng Noen	Mueang Rayong	749.27	1401.729	Townhouse / house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.803	1401.703	Row house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	749.851	1401.963	Townhouse / house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.871	1401.962	Townhouse / house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.694	1401.721	Townhouse / house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.768	1401.812	Row house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	749.813	1401.919	Row house	2	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	749.834	1401.635	Townhouse / house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	749.883	1401.631	Detached house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	749.85	1401.669	Townhouse / house	1	100	12	Acetone
Choeng Noen	Mueang Rayong	749.888	1401.662	Townhouse / house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.893	1401.644	Townhouse / house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	749.897	1401.807	Detached house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	749.878	1401.704	Townhouse / house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	749.883	1402.175	Detached house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.816	1402.234	Townhouse / house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.818	1402.127	Townhouse / house	5	100	12	Acetone
Choeng Noen	Mueang Rayong	749.841	1401.974	Row house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	749.915	1401.996	Townhouse / house	5	100	12	Acetone
Choeng Noen	Mueang Rayong	749.708	1401.955	Townhouse / house	7	100	12	Acetone
Choeng Noen	Mueang Rayong	749.811	1401.688	Townhouse / house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	749.81	1401.672	Townhouse / house	5	100	12	Acetone
Choeng Noen	Mueang Rayong	749.722	1401.789	Detached house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	749.809	1401.892	Detached house	2	100	12	Acetone
Huai Pong	Mueang Rayong	734.66	1408.476	Townhouse / house	3	100	12	Acetone
Huai Pong	Mueang Rayong	735.019	1408.095	Row house	2	100	12	Acetone
Huai Pong	Mueang Rayong	735.424	1408.466	Townhouse / house	5	100	12	Acetone
Huai Pong	Mueang Rayong	735.624	1406.665	Townhouse / house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.655	1408.381	Townhouse / house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.635	1408.365	Townhouse / house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.125	1407.925	Townhouse / house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	736.294	1407.87	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.233	1408.465	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	733.352	1409.33	Row house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.233	1407.781	Detached house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.44	1408.368	Detached house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	732.235	1412.506	Row house	0	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.625	1408.38	Row house	7	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.543	1408.578	Row house	2	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
Map Ta Phut	Mueang Rayong	735.595	1408.546	Detached house	0	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.552	1407.625	Townhouse / house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.587	1406.665	Townhouse / house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.61	1408.365	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.619	1408.369	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.242	1408.446	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	731.671	1410.482	Townhouse / house	1	100	12	Acetone
Map Ta Phut	Mueang Rayong	732.401	1409.997	Townhouse / house	1	100	12	Acetone
Huai Pong	Mueang Rayong	733.172	1409.316	Row house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.189	1408.373	Row house	8	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.446	1408.416	Row house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.647	1408.371	Detached house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	734.001	1409.009	Row house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.359	1403.053	Detached house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.068	1406.534	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.236	1405.75	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.093	1405.253	Row house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	736.477	1402.516	Row house	8	100	12	Acetone
Noen Phra	Mueang Rayong	736.656	1402.568	Row house	2	100	12	Acetone
Noen Phra	Mueang Rayong	737.734	1402.665	Detached house	4	100	12	Acetone
Noen Phra	Mueang Rayong	737.72	1402.715	Row house	2	100	12	Acetone
Noen Phra	Mueang Rayong	738.253	1402.711	Row house	3	100	12	Acetone
Noen Phra	Mueang Rayong	735.768	1402.506	Row house	6	100	12	Acetone
Noen Phra	Mueang Rayong	740.808	1403.19	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.222	1403.343	Detached house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.316	1403.228	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.33	1403.082	Detached house	0	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.724	1402.252	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.621	1401.986	Detached house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.634	1402.006	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.361	1402.03	Detached house	6	100	12	Acetone
Noen Phra	Mueang Rayong	737.844	1402.852	Detached house	3	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
Noen Phra	Mueang Rayong	737.391	1402.678	Detached house	6	100	12	Acetone
Noen Phra	Mueang Rayong	736.452	1402.457	Temporary housing	4	100	12	Acetone
Noen Phra	Mueang Rayong	740.584	1403.986	Row house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.754	1402.222	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.236	1403.292	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.302	1406.034	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.294	1405.926	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.098	1405.325	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.218	1403.255	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.145	1403.512	Row house	2	100	12	Acetone
Noen Phra	Mueang Rayong	737.389	1402.675	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.666	1402.495	Temporary housing	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	738.315	1402.919	Row house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.383	1402.207	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.422	1402.918	Row house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.444	1402.891	Temporary housing	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.765	1402.361	Detached house	6	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.206	1406.073	Detached house	3	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.268	1405.981	Row house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.791	1402.564	Detached house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.786	1402.519	Detached house	4	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.814	1402.517	Row house	5	100	12	Acetone
Map Ta Phut	Mueang Rayong	735.795	1402.5	Detached house	6	100	12	Acetone
Map Ta Phut	Mueang Rayong	737.554	1402.722	Detached house	2	100	12	Acetone
Map Ta Phut	Mueang Rayong	737.54	1402.769	Detached house	5	100	12	Acetone
Choeng Noen	Mueang Rayong	735.326	1373.154	Row house	1	100	12	Acetone
Choeng Noen	Mueang Rayong	735.32	1373.141	Row house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	735.216	1373.126	Row house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	735.371	1373.157	Townhouse / house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	735.302	1373.101	Detached house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	735.299	1373.101	Detached house	3	100	12	Acetone
Choeng Noen	Mueang Rayong	735.304	1373.099	Row house	4	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
Choeng Noen	Mueang Rayong	735.32	1373.097	Row house	2	100	12	Acetone
Choeng Noen	Mueang Rayong	735.347	1373.093	Detached house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	735.291	1373.126	Row house	4	100	12	Acetone
Choeng Noen	Mueang Rayong	735.302	1373.099	Row house	5	100	12	Acetone
Choeng Noen	Mueang Rayong	735.321	1373.094	Row house	4	100	12	Acetone
Kram	Klaeng	12.65904	102.64262	Detached house	3	100	12	Acetone
Kram	Klaeng	12.65468	101.63952	Detached house	3	100	12	Acetone
Kram	Klaeng	786.743	1400.331	Detached house	5	100	12	Acetone
Kram	Klaeng	786.086	1402.536	Townhouse / house	3	100	12	Acetone
Kram	Klaeng	786.232	1402.325	Detached house	5	100	12	Acetone
Pak Nam Krasae	Klaeng	793.619	1406.81	Townhouse / house	7	100	12	Acetone
Thang Kwian	Klaeng	787.132	1414.3	Row house	5	100	12	Acetone
Thang Kwian	Klaeng	787.104	1414.264	Row house	3	100	12	Acetone
Thang Kwian	Klaeng	787.524	1414.34	Townhouse / house	6	100	12	Acetone
Thang Kwian	Klaeng	788.203	1413.934	Townhouse / house	3	100	12	Acetone
Thang Kwian	Klaeng	787.123	1414.296	Row house	4	100	12	Acetone
Thang Kwian	Klaeng	787.118	1414.276	Row house	3	100	12	Acetone
Thang Kwian	Klaeng	787.537	1414.409	Townhouse / house	3	100	12	Acetone
Thang Kwian	Klaeng	787.492	1414.365	Townhouse / house	5	100	12	Acetone
Thang Kwian	Klaeng	787.749	1414.333	Townhouse / house	2	100	12	Acetone
Thang Kwian	Klaeng	787.733	1414.36	Townhouse / house	4	100	12	Acetone
Kram	Klaeng	786.236	1402.236	Detached house	5	100	12	Acetone
Thang Kwian	Klaeng	787.162	1414.327	Row house	2	100	12	Acetone
Thang Kwian	Klaeng	787.503	1414.374	Townhouse / house	4	100	12	Acetone
Kram	Klaeng	785.962	1402.781	Detached house	5	100	12	Acetone
Klaeng	Klaeng	787.535	1414.617	Townhouse / house	6	100	12	Acetone
Kram	Klaeng	786.456	1400.783	Detached house	4	100	12	Acetone
Kram	Klaeng	786.522	1400.86	Townhouse / house	4	100	12	Acetone
Pak Nam Krasae	Klaeng	739.605	1406.618	Row house	2	100	12	Acetone
Pak Nam Krasae	Klaeng	739.602	1406.564	Row house	2	100	12	Acetone
Pak Nam Krasae	Klaeng	793.598	1406.546	Row house	3	100	12	Acetone
Thang Kwian	Klaeng	787.029	1414.42	Row house	1	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
Thang Kwian	Klaeng	787.015	1414.423	Row house	1	100	12	Acetone
Thang Kwian	Klaeng	787.028	1414.422	Row house	1	100	12	Acetone
Thang Kwian	Klaeng	787.027	1414.439	Row house	2	100	12	Acetone
Kram	Klaeng	786.465	1400.801	Detached house	4	100	12	Acetone
Kram	Klaeng	786.039	1402.711	Detached house	5	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.128	1435.66	Row house	2	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.125	1435.673	Row house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	740.158	1436.057	Row house	5	100	12	Acetone
Pluak Daeng	Pluak Daeng	740.177	1436.066	Row house	4	100	12	Acetone
Pluak Daeng	Pluak Daeng	740.193	1436.051	Row house	2	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.084	1435.767	Townhouse / house	5	100	12	Acetone
Pluak Daeng	Pluak Daeng	738.968	1435.663	Townhouse / house	4	100	12	Acetone
Pluak Daeng	Pluak Daeng	738.973	1435.669	Townhouse / house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.652	1436.349	Row house	2	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.11	1435.778	Temporary housing	2	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.724	1436.403	Row house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.95	1435.301	Row house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	740.013	1435.665	Row house	1	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.123	1435.746	Row house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.122	1435.74	Row house	2	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.043	1435.744	Row house	2	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.146	1435.822	Townhouse / house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.575	1436.096	Townhouse / house	10	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.697	1436.134	Townhouse / house	5	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.588	1436.074	Townhouse / house	4	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.917	1435.956	Townhouse / house	3	100	12	Acetone
Pluak Daeng	Pluak Daeng	739.906	1436.014	Townhouse / house	4	100	12	Acetone
Ban Khai	Ban Khai	749.499	1415.172	Row house	5	100	12	Acetone
Ban Khai	Ban Khai	749.441	1415.015	Townhouse / house	10	100	12	Acetone
Ban Khai	Ban Khai	749.462	1415.059	Townhouse / house	4	100	12	Acetone
Ban Khai	Ban Khai	749.459	1415.047	Townhouse / house	7	100	12	Acetone
Chak Bok	Ban Khai	754.788	1415.569	Detached house	5	100	12	Acetone
Ban Khai	Ban Khai	749.485	1414.681	Townhouse / house	5	100	12	Acetone
Ban Khai	Ban Khai	750.49	1423.748	Detached house	3	100	12	Acetone
Chak Bok	Ban Khai	754.815	1415.539	Detached house	6	100	12	Acetone
Nong Bua	Ban Khai	750.489	1423.779	Detached	1	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
				house				
Nong Bua	Ban Khai	750.46	1423.768	Detached house	2	100	12	Acetone
Nong Bua	Ban Khai	750.427	1423.781	Detached house	3	100	12	Acetone
Ban Khai	Ban Khai	749.43	1414.567	Townhouse / house	6	100	12	Acetone
Chak Bok	Ban Khai	754.588	1415.574	Detached house	4	100	12	Acetone
Chak Bok	Ban Khai	754.125	1415.383	Detached house	8	100	12	Acetone
Nong Bua	Ban Khai	750.394	1423.754	Detached house	4	100	12	Acetone
Ban Khai	Ban Khai	749.428	1413.917	Townhouse / house	3	100	12	Acetone
Nong Lalok	Ban Khai	748.919	1417.911	Detached house	3	100	12	Acetone
Nong Lalok	Ban Khai	749.035	1417.193	Detached house	5	100	12	Acetone
Nong Lalok	Ban Khai	748.996	1417.964	Detached house	2	100	12	Acetone
Nong Lalok	Ban Khai	748.912	1417.828	Detached house	3	100	12	Acetone
Nong Lalok	Ban Khai	748.886	1417.797	Townhouse / house	8	100	12	Acetone
Nong Lalok	Ban Khai	748.863	1417.8	Townhouse / house	7	100	12	Acetone
Nong Lalok	Ban Khai	748.884	1417.822	Detached house	4	100	12	Acetone
Nong Bua	Ban Khai	751.011	1424.329	Detached house	3	100	12	Acetone
Ban Khai	Ban Khai	749.141	1414.334	Detached house	5	100	12	Acetone
Ban Khai	Ban Khai	749.457	1414.519	Townhouse / house	2	100	12	Acetone
Ban Khai	Ban Khai	749.463	1414.548	Row house	2	100	12	Acetone
Ban Khai	Ban Khai	749.542	1414.942	Detached house	5	100	12	Acetone
Bang Chang	Bang Chang	724.799	1402.699	Townhouse / house	7	100	12	Acetone
Bang Chang	Bang Chang	725.025	1402.747	Detached house	5	100	12	Acetone
Bang Chang	Bang Chang	725.025	1402.741	Row house	6	100	12	Acetone
Pla	Bang Chang	722.248	1401.423	Detached house	4	100	12	Acetone
Pla	Bang Chang	723.291	1402.11	Detached house	5	100	12	Acetone
Pla	Bang Chang	724.925	1402.453	Townhouse / house	3	100	12	Acetone
Pla	Bang Chang	722.212	1401.415	Row house	1	100	12	Acetone
Samnak Thon	Bang Chang	721.17	1410.612	Townhouse / house	2	100	12	Acetone
Bang Chang	Bang Chang	723.056	1407.626	Detached house	4	100	12	Acetone
Pla	Bang Chang	721.971	1401.155	Detached house	5	100	12	Acetone
Bang Chang	Bang Chang	722.467	1405.66	Detached house	5	100	12	Acetone
Bang Chang	Bang Chang	722.281	1408	Townhouse / house	5	100	12	Acetone
Bang Chang	Bang Chang	724.894	1402.438	Row house	2	100	12	Acetone
Pla	Bang Chang	721.777	1401.363	Townhouse /	3	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
				house				
Pla	Bang Chang	722.23	1401.382	Row house	2	100	12	Acetone
Pla	Bang Chang	722.041	1401.129	Detached house	2	100	12	Acetone
Bang Chang	Bang Chang	722.227	1401.258	Townhouse / house	5	100	12	Acetone
Sammak Thon	Bang Chang	749.428	1413.917	Townhouse / house	3	100	12	Acetone
Sammak Thon	Bang Chang	719.939	1413.525	Detached house	7	100	12	Acetone
Bang Chang	Bang Chang	722.883	1407.851	Townhouse / house	3	100	12	Acetone
Bang Chang	Bang Chang	722.78	1406.011	Row house	5	100	12	Acetone
Bang Chang	Bang Chang	722.741	1407.783	Townhouse / house	3	100	12	Acetone
Bang Chang	Bang Chang	723.952	1407.802	Townhouse / house	3	100	12	Acetone
Bang Chang	Bang Chang	722.929	1407.829	Townhouse / house	5	100	12	Acetone
Bang Chang	Bang Chang	724.959	1402.4	Detached house	6	100	12	Acetone
Sammak Thon	Bang Chang	721.118	1410.702	Row house	3	100	12	Acetone
Sammak Thon	Bang Chang	719.464	1411.548	Townhouse / house	5	100	12	Acetone
Sammak Thon	Bang Chang	719.558	1412.631	Row house	3	100	12	Acetone
Sammak Thon	Bang Chang	719.488	1411.612	Townhouse / house	3	100	12	Acetone
Bang Chang	Bang Chang	724.872	1402.47	Row house	1	100	12	Acetone
Khao Noi	Khao Chamao	783.142	1450.3	Detached house	3	100	12	Acetone
Khao Noi	Khao Chamao	783.133	1450.284	Detached house	2	100	12	Acetone
Huai Thap Mon	Khao Chamao	791.069	1436.371	Detached house	3	100	12	Acetone
Num Pen	Khao Chamao	797.357	1422.568	Detached house	3	100	12	Acetone
Num Pen	Khao Chamao	797.464	1428.051	Detached house	5	100	12	Acetone
Huai Thap Mon	Khao Chamao	794.435	1428.032	Detached house	5	100	12	Acetone
Num Pen	Khao Chamao	797.356	1422.557	Townhouse / house	3	100	12	Acetone
Khao Noi	Khao Chamao	782.883	1450.251	Detached house	7	100	12	Acetone
Khao Noi	Khao Chamao	794.591	1428.295	Detached house	4	100	12	Acetone
Num Pen	Khao Chamao	794.622	1428.338	Detached house	10	100	12	Acetone
Num Pen	Khao Chamao	794.591	1428.296	Detached house	5	100	12	Acetone
Chum Saeng	Wang Chan	744.113	1430.631	Detached house	1	100	12	Acetone
Chum Saeng	Wang Chan	796.023	1420.534	Detached house	4	100	12	Acetone
Chum Saeng	Wang Chan	774.15	1431.693	Townhouse / house	3	100	12	Acetone
Chum Saeng	Wang Chan	773.789	1413.606	Townhouse / house	2	100	12	Acetone
Chum Saeng	Wang Chan	773.871	1431.628	Detached house	5	100	12	Acetone

Locality	Districts	UTM (X,Y)		Type of household	Actual resident	Size (ml.)	Consumption time (month)	Chemical constituents
		X	Y					
Chum Saeng	Wang Chan	773.856	1431.617	Townhouse / house	3	100	12	Acetone
Chum Saeng	Wang Chan	775.316	1433.314	Detached house	5	100	12	Acetone
Chum Saeng	Wang Chan	774.084	1431.669	Row house	1	100	12	Acetone
Chum Saeng	Wang Chan	773.81	1431.573	Townhouse / house	5	100	12	Acetone
Chum Saeng	Wang Chan	774.21	1431.71	Townhouse / house	4	100	12	Acetone
Chum Saeng	Wang Chan	773.862	1431.556	Row house	7	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.136	1419.204	Row house	5	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.078	1418.59	Townhouse / house	4	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.4	1419.32	Row house	5	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.621	1418.539	Row house	3	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.343	1418.261	Row house	2	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.025	1418.226	Detached house	4	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.335	1418.552	Row house	4	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.074	1418.551	Row house	4	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.551	1419.832	Row house	3	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.819	1419.792	Row house	4	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.811	1419.79	Row house	5	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.104	1419.282	Row house	2	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.083	1419.286	Townhouse / house	2	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.014	1419.226	Row house	3	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	739.013	1419.212	Townhouse / house	2	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.997	1419.191	Row house	3	100	12	Acetone
Nikhom Phatthana	Nikhom Phatthana	738.982	1419.176	Row house	4	100	12	Acetone

**BIOGRAPHY**

<b>NAME</b>	Miss Jutamas Khaosang
<b>DATE OF BIRTH</b>	September 1, 1989
<b>PLACE OF BIRTH</b>	Songkhla, Thailand
<b>INSTITUTIONS ATTENDED</b>	Prince of Songkhla University, 2008-2011 Biology Science Mahidol University, 2012-2013 Master of Science (Environmental Technology)
<b>HOME ADDRESS</b>	11/5 Moo 3 Tumbon Chumpol Amphur Sathingpra, Songkhla, Thailand 90190. Tel. 086-2975297 E-mail: jk_sine@hotmail.com
<b>PUBLICATION / PRESENTATION</b>	Proceedings of the 5 <sup>th</sup> KKU International Conference Engineering and Technological Responses to Global Challenges, Pullman Khon Kaen Raja Orchid, Khon Kaen, Thailand, March 27-29, 2014