

**Knowledge Management Platform for  
Promoting Sustainable Energy  
Technologies in Rural Thai Communities**

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Master of Computer Science, B.Sc. (Computer Science)

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## DECLARATION

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary educational institution.

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## **ABSTRACT**

Sustainable energy services aim to meet the energy demands and to improve the living standards of rural communities with the utilization of sustainable energy technologies. Such services are becoming increasingly important due to the reduction of traditional energy resources and the ongoing increase in the demands. The demands are mainly due to the growth of population, domestic consumptions and industrial uses. In addition, increasing awareness of issues such as global warming, carbon emission, peak oil and the need for a sustainable environment has kindled keen interests in sustainable energy around the world. Many projects on sustainable energy services have been launched and particularly in developing countries. In most areas, at least one type of sustainable energy resources is available. In the case of Thailand, in addition to resources such as solar and wind, there are other sustainable energy resources in the forms of biomass and waste residue from agricultural products. However, there exist practical problems hindering the success of many sustainable energy projects. Two key reasons are the lack of in depth knowledge regarding the sustainable energy systems among the local users, and the limited budgets for planning, research and development. Therefore, the need to promote better understanding of sustainable energy technologies is necessary in order to gain better utilization of the energy services and acceptance by the community. One possible solution is the use of a Knowledge Management System (KMS). Based on advanced Information and Communication Technology (ICT), the integration of knowledge

management and web technologies has enabled KMS to be developed as an effective tool for the sharing, management and dissemination of valuable knowledge on any particular subject. This combination has the potential to promote the knowledge and initiate relevant activities thereby enabling the acquisition and management of diverse types of information and data. Typical functions and services which could be provided are: checking updated information on sustainable energy resources around a particular area; teaching of sustainable energy systems development and maintenance processes; sharing of best practices and lessons learned...etc. With the availability of the internet, a Web-based KMS will be a valuable channel for the gathering, sharing, extracting and dissemination of knowledge about the sustainable energy services for the Thai communities.

This thesis presents the research and development of a knowledge management (KM) platform for sustainable energy technologies. The system is implemented with web GIS server-side application and it is installed at the School of Renewable Energy Technology, Naresuan University, Phitsanulok, Thailand. To assess the effectiveness of the developed system, surveys in the form of pre-questionnaires and post-questionnaires from the users are used. Such information is used to determine the effectiveness of the system and to measure the improvement of the participants' knowledge on the subject. There are three groups of participants involved in this study: local government administrators, researchers and general users. The overall results of the questionnaires reveal that the participants are satisfied with the performance of the KM platform. The results also indicated that the KM

platform provides adequate knowledge on the subject and it has a high level of user friendliness. It was found that the participants' knowledge is also increased and the increase is in proportion to the time they engaged with the KM platform. A linear regression analysis of the researchers and local government administrators has shown that the increment of the participants' knowledge has a linear relationship with the learning period on the KM platform with statistical significance. Findings from this study can be used as a guideline and for further development on improving the local Thai communities' knowledge on sustainable energy technologies.

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I would also like to thank all the participants who spent their time in using and learning from the KM system. Their feedback has been most useful and important for my research and the local community. My research would not have been completed if they have not given their attention and cooperation.

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Finally, I dedicate all my work to my parents and family, for their unconditional love, well wishes and steadfast trust in me.

## SUMMARY OF CONTRIBUTIONS

The contributions of this research are summarised as follows:

1. Research and development of a knowledge management platform to promote and enhance knowledge for local government administrators, researchers and community in Thailand. The problem of lack of knowledge on sustainable energy is common in most parts of the world and particularly in the rural communities. In this study, the utilisation of the state-of-the-art technologies such as Web services, GIS and a knowledge management system provide practical benefits to the community. Although the Information and Communication Technology (ICT) infrastructure in the local community is ready, not all the tools and resources are used efficiently. Thus, the proposed KM platform exploits the potential of these technologies and assists the community to realize the potential of the local resources and the usefulness of the tools. In addition, the integration of Web GIS and KMS offers a new means to promote the development the sustainable energy sector. The benefits include sharing and exchanging information of the KMS across the boundaries of computer hardware, software and communication network.
2. The knowledge on the platform will assist the establishment and more efficient use of sustainable energy services which include both traditional and renewable energy resources. This leads to advantages such as:
  - Maintaining efficient use of energy resources including both renewable and traditional energy sources.



- Local community will be able to gain economic value from the agricultural waste residues. The utilization of biomass in local areas will contribute to the solution of agriculture and household waste disposal.
  - Reducing the environmental degradation due to cut back of the use of firewood.
3. The research has provided an education and training platform for the stakeholders. The participants have gained knowledge after engagement with the system. Empirical studies have carried out and quantitative data collected. Results from the analysis have provided insights on the background of the participants and quantitative information on the minimum time that the participants should spend on the system. This could in turn be used as guidelines for future design and development.

## LIST OF PUBLICATIONS

The following list of papers is the collection of journal or conference papers produced during the course of this study. They have reported the results and findings from this research. These papers have either been published or submitted for consideration at the time of writing this thesis.

1. **Payakpate J.**, Fung, C.C. and Nathakaranakule S. (2008), 'Improving Thailand Life Environment with Knowledge on Sustainable Energy', Accepted for presentation in the International Conference on *ICT, Society and Human Beings (ISHB2008)*, Amsterdam, the Netherlands, 22-24 July, 2008.
2. **Payakpate J.**, Fung, C.C., and Nathakaranakule S. (2008), 'A Knowledge Management Platform to Assist E-business in Sustainable Energy Services', Accepted for presentation in *the 7th Wuhan International Conference on E-Business (WHICEB 2008)*, Wuhan, China, May 31 – June 1, 2008.
3. **Payakpate**, J., Fung, C.C., Nathakaranakule S. and Marinova, D. (2008), "Promoting Knowledge on Sustainable Energy in Digital Ecosystem", *Proceedings of the 2<sup>nd</sup> IEEE International Conference on Digital Ecosystem and Technologies (IEEE-DEST 2008)*, 26-29 February, 2008, Phitsanulok, Thailand, ISBN: 1-4244-1490-3, pp 352-357.

4. **Payakpate J.** and Fung C.C. (2007), 'A Knowledge management System on Sustainable Energy Technologies for Thailand', *Proceedings of the Eighth Postgraduate Electrical Engineering and Computing Symposium (PEECS 2007)*, ISBN 1-74067-5673, Perth, Western Australia, pp. 181-184.
  
5. **Payakpate J.**, Fung, C.C., Nathakaranakule S. and Marinova, D., (2007), 'An Integrated Web-GIS Knowledge Management System to Enhance and Promote Knowledge on Sustainable Energy Technologies', *Proceedings of the International Conference on Energy Planning, Energy Saving, Environmental Education (EPESE' 07)*, Arcachon, France, October 14-16, 2007.
  
6. **Payakpate J.**, Fung, C.C., Nathakaranakule S. and Marinova, D., (2006), 'An Integrated GIS-Web-based Knowledge Management Platform for Sustainable Energy Services in Thailand', *Proceedings of the 3<sup>rd</sup> Asia-Pacific International Conference on Knowledge management (KMAP 2006)*, Hong Kong, China, 11-13 December 2006.
  
7. **Payakpate J.**, Fung, C.C., Nathakaranakule S. and Marinova, D., (2006), 'Integrating GIS and a web-based platform for Effective Knowledge Management', *IIRE International Journal of Renewable Energy 2006* Volume.1 number 2, July 2006, ISSN 1905-7172, pp.63-69.

8. **Payakpate J.** and Fung C.C. (2005), 'Web-based Knowledge Management System for Modern Rural Energy Services (MRES) in Thailand', *Proceedings of the Sixth Postgraduate Electrical Engineering and Computing Symposium (PEECS 2005)*, Perth, Western Australia, ISBN 0-7298-06090-X, pp. 159-162.
  
9. **Payakpate, J.**, Fung, C.C. and Nathakaranakule S., (2005), 'Knowledge Management System for Efficient Use of Modern Rural Energy Services (MRES) in Thailand', *Proceedings of the International Conference on Knowledge Management (ICKM 2005)*, Putra World Trade Center, University Putra Malaysia, 7-9 July 2005, p. 55.
  
10. **Payakpate, J.**, Fung, C.C., Nathakaranakule S. and Marinova, D., (2005), 'Prototype Knowledge Management Platform for Modern Rural Energy Service in Thailand', *Proceedings of The 6<sup>th</sup> European Conference on Knowledge Management (ECKM 2005)*, University of Limerick, Ireland, 8-9 September 2005, ISBN 1-905305-07-9, pp. 398-403.
  
11. **Payakpate J.** and Fung C.C. (2004), 'Using Knowledge Management System to Enhance the Modern Rural Energy Services (MRES) in ASEAN countries', *Proceedings of the Fifth Postgraduate Electrical Engineering and Computing Symposium (PEECS 2004)*, 28<sup>th</sup> September 2004, Perth, Western Australia, pp. 219-222.

12. Khor S.W., **Payakpate J.**, Khan S. and Fung C.C. (2004), 'Fuzzy knowledge representation for decision support', *Proceedings of the Fifth International Conference on Knowledge Based Computer Systems (KBCS)*, 2004, pp. 186-195.
13. Khor S., **Payakpate J.**, Khan S., and Fung C.C. (2004), 'A new approach to fuzzy knowledge representation', *Proceedings of the Fifth Postgraduate Electrical Engineering and Computing Symposium (PEECS 2004)*, 28<sup>th</sup> September 2004, Perth, Western Australia, pp. 169-174.
14. **Payakpate J.**, Fung C.C., Nathakaranakule S., Cole P. and Depickere A. (2004), 'A Knowledge Management Platform for the Promotion of Modern Rural Energy Services in ASEAN countries', *Proceedings of the IEEE Region 10 conference (TenCon 2004)*, 21-24 November 2004, Chiang Mai, Thailand, Vol. C, pp. 535-538.

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## ACRONYMS

ADSL	Asynchronous Digital Subscriber Line
AJAX	Asynchronous Java and XML
APERC	Asia Pacific Energy Research Centre
ArcIMS	ArcInternet Map Servers
C/S	Client/Server architecture
CASE	International Centre for Application of Solar Energy
CAT	Communication Authority of Thailand
CHP	Combine Heat and Power systems
CO <sub>2</sub>	Carbon dioxide gas
COGEN3	Cogeneration - the generation of electricity from energy sources; COGEN 3 was the third phase of the EC-ASEAN co-operation programme
ECP	Energy Conservation Promotion
EGAT	Electricity Generating Authority of Thailand
EIA	Energy Information Administration
EPPO	Energy Policy & Planning Office
ER	Entity Relationship
ESRI	Environment System Research Institute
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information System
GIS DB	Geographic Information System DataBase
GUIs	Graphical User Interfaces



HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
IE	Internet Explorer
IMS	Internet Map Server
IPP	Independent Power Producers
IRES	Integrated Renewable Energy System
ISP	Internet Service Providers
IT	Information technologies
KM	Knowledge Management
KMS	Knowledge Management System
NEPO	National Energy Policy Office of Thailand
PEA	Provincial Electricity Authority of Thailand
PHP	HyperText Preprocessor
PPA	Power Purchase Agreement
PV	Photo-Voltaic
RDBMS	Relational Data Base Management System
RE	Renewable Energy
RPA	Renewable Portfolio Standard
SERT	School of Renewable Energy Technology at Naresuan University, Phitsanulok, Thailand
SGML	Standard Generalized Markup Language
SPP	Small Power Producers
ThaiREN	Thailand Research and Education Network
TOT	Telephone Organization of Thailand
UNINET	Inter University Network

WECS                      Wind-Electric Conversion System  
XML                        eXtensible Markup Language

## CHAPTER 1: INTRODUCTION

Many people in modern societies are taking their daily energy supplies for granted. They expect such utility supplies as electricity and gas to be readily available anytime. They do not have to pay too much attention where such energy comes from. However, for one billion people living in rural communities of sub-Saharan Africa, South Asia and in other developing regions this is not the case. The search for energy for basic daily use can be a laborious grind. The main sources of energy for these people in the rural areas are mainly traditional fuels, such as wood, dung and crop residue. The technologies used are mostly primitive and inefficient. As a consequence, more than two billion people in developing countries have only access to energy supplies that can barely meet their basic needs. Most of these people are living in rural areas and have no access to reliable electricity supply. This inaccessibility to energy is a major cause of their poverty, hardships and environmental problems (World Bank 2004; World Energy Council 1999). In addition, the quantity of available energy resources for such regions is more or less constant while the population is growing rapidly. Future outlooks indicate that there will be a severe shortage of energy, and in particular among the rural areas (World Energy Council 1999; Khatib 1993). The consequences are already appearing and the issues are leading to environmental degradation, social unrests and deepening of the level of poverty in the affected regions. One of the key factors to overcome these problems is the development and provision of "Sustainable Energy

Technologies” in these communities (Hammons, Boyer, Conners, Davies, Ellis, Fraser, Holt, & Markard 2000).

In addition, sustainable energy technologies can also contribute to tackle the global challenge of climate change. Climate change is an effect of too much greenhouse gases (GHG) being released to the Earth’s atmosphere (UNEP & UNFCCC 2003). A report from Renewable Energy policy Network 21<sup>st</sup> Century (REN21) (UNEP 2006) shows that the dominant emitters of GHG are from the energy sector. This phenomenon is expected to rise in the developing countries due to the growing population in these communities. Renewable energy, classified as a type of sustainable energy, is universally recognized as a viable solution for this problem (EREC 2006; WWF 2007).

Sustainable energy technologies are the basis of energy services that utilize sustainable energy resources. Sustainable energy resources may include both traditional and renewable energy resources. Traditional energy sources are wood, oil, coal and natural gas. On the other hand, renewable energy resources are diverse natural resources, which are essentially inexhaustible. This includes solar and wind energy, hydroelectric power as well as geothermal and other bio-based resources. In addition, nuclear power is also considered as a form of sustainable energy. Nuclear power is recognized as a relatively efficient form of energy, and it does not contribute to air pollution, greenhouse effects or acid rain (Hore-Lacy 2000; Virtual Nuclear Tourist 2005). However, nuclear power has not been included as a sustainable energy resource within the context of this study due to the following reasons:

- Large investments are needed to build the nuclear power plant, which is not appropriate for rural areas (Priwan 2007; WWF 2003).
- It requires a large number of manpower and expertise specialized in nuclear power technologies (Sumitra & Chankow 1997) before nuclear power could be deployed. These are not readily available presently.
- There are concerns over safety issues and most developing countries lack affordable resources to meet the demands, so that they have to wait for technological solutions in the future (WWF 2003).

Hence, sustainable energy technology is the way to tackle the problem of energy shortage, which will occur in the not too distant future. Particularly in the rural areas, there are available sustainable energy resources, such as biomass and waste residues. Although these types of resources have long been unutilised, the distribution of such experience and knowledge has been limited to only a limited number of rural and localised communities (Schlapfer 2002; SERT 2004; Ketjoy, Sirisumpunwong, Thanarak, Rakwichian & Chew 2004). In addition, the use of traditional energy resources, such as wood or oil, has been inefficient in many cases. Hence, in order to achieve long term sustainability the promotion of efficient utilisation of sustainable energy and wider use of the relevant technologies is important. The communities also need to improve their ability to build the most appropriate and energy

efficient appliances as well as to improve the way energy is generated and delivered.

However, the utilization of any form of energy will have local, regional and global environmental impacts. Environmental degradation is closely linked to poverty. The efforts and programs that are dedicated towards efficient energy usage and for the achievement of a sustainable environment will establish the indirect benefits of reducing poverty and improving the environment subsequently.

A number of innovative examples, which result in improving energy utilization based on sustainable energy sources, are given below:

- Deployment of Photo-Voltaic (PV) generators at the Philippines and biomass-based fuel production in Brazil (Ahmed, Haq, Schweizer & James 1996).
- Solar PV water pumping systems in Nepal (Shrestha 1996).
- Pico hydropower systems in Kenya (Practical in Action Organization 2006)
- Sustainable village power projects using renewable energy resources in Mexico (Gutierrez-Vera 2000).

In the rural communities of the Visayas, the Philippines (Ahmed, Haq, Schweizer & James 1996), the PV solar systems have been installed for household appliances. This project was granted by the US-Asia

Environmental Partnership. Depending on the seasonal sunlight duration 240 to 290 watts per hour of electricity per day is generated for a household PV solar system. This provides for a number of basic household appliances. Nepal (Shrestha 1996) has been using the innovation of solar PV system for other purposes. The provision of drinking water by using solar PV water pumping systems has been initiated among the rural Nepal communities. This system has led to the improvement of life-style, health and economic conditions. For instance, this solar PV water pumping system is more economical than a diesel pump. The system was set up to about 3 kilowatt per hour for the village community and around 1 Kilo-watt per hour for the irrigation of agricultural fields growing specialty cash crops.

Another example is the biomass-based fuel production in Brazil. The Brazilian biomass experience (Ahmed, Haq, Schweizer & James 1996) revealed that biomass-based fuel production has caused an increase in the economic assets for Brazil. The economic value of ethanol produced was calculated to be equivalent to about 200,000 barrels per day of imported oil in 1975. The amount of ethanol produced has a direct effect on the price of oil in Brazil, and it has reduced the country's reliance on imported oil.

Another example is the pico hydro power system that has provided energy for everyone in the villages of Thima and Kathamba in Kenya (Practical in Action Organization 2006). The quality of life of the local people in these two un-electrified villages is improving. The community gained more income from extended working hours, safety from predators at night due to better public

lighting, and they have saved from spending vital working hours in order to earn enough to buy kerosene and charged batteries from other nearby townships.

The last example of innovation is the sustainable power supplies for villages in rural areas of Mexico (Gutierrez-Vera 2000). This project is generating power from a variety of renewable energy resources including solar, biomass, geothermal, hydro power and wind. It has helped the local communities to improve their quality of life and to meet challenges, such as the prevention of the migration of villagers and the provision of refrigeration for vaccines and medication.

Sustainable energy is now recognized as a viable alternative means to meet energy demands while causing less stress or demands on the environment (Hammons, Boyer, Connors, Davies, Ellis, Fraser, Holt & Markard 2000). Also, sustainable energy systems generate little waste and do not require environmental clean up (Albolino & Mesenzani 2002). Innovations in sustainable energy services also have provided technological solutions to the use of fuel-wood in rural communities. The improvement in the energy conversion has helped to reduce the amount of CO<sub>2</sub> emission (Khatib 1993).

In the case of Thailand, a forecast of population and GDP is shown in Figure 1.1 (APEREC 2006). By the end of 2006, the population had risen to about 65 million and it has been increasing slightly at a rate of 0.5% per year. Along with the GDP, which was growing at a rate of 5% per year, an improvement



of the local living standards is expected by the community. To meet such a demand ensuring a constant and reliable energy supply is the key factor to support the activities for upgrading the quality of life and protecting the well-beings for Thais.

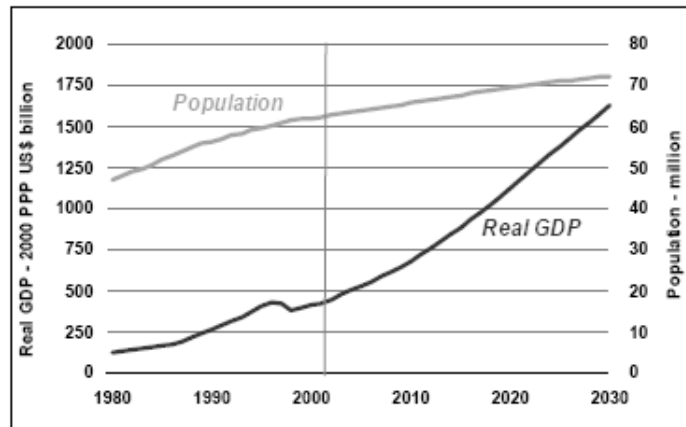


Figure 1.1: GDP and population of Thailand (APERC 2006)

The Asia Pacific Energy Research Centre (APERC) (2006) report shows that the need of energy in Thailand is growing. It is increasing at a rate of 4.5% per year. Thailand's resident energy demand is projected to increase at an annual rate 2% over the fifty-years period of 1980 - 2030. Figure 1.2 shows the forecasted energy demand in Thailand over a period of 1980 - 2030.

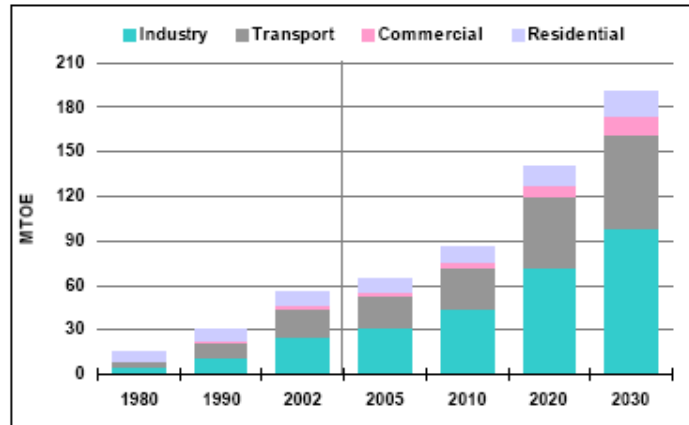


Figure 1.2: Final Energy Demand (APERC 2006)

While energy consumption of Thailand is increasing, the amount of energy production in Thailand is considered as insufficient (EPPO 2006). Figure 1.3 shows the comparison of energy production and energy import in Thailand since 1988.

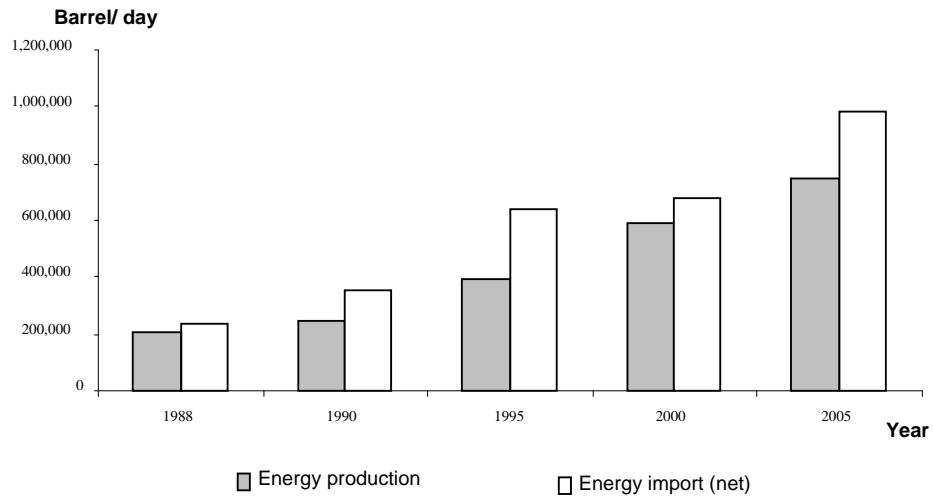


Figure 1.3: GDP and population of Thailand (APERC 2006)

Therefore, steps must be taken to prevent severe shortage of energy in the future. Due to the fact that Thailand is an agriculture-based country, there are a lot of sustainable energy sources in the forms of biomass and agricultural residues. A possible solution to avoid shortage of energy and to improve the quality of life of Thais in rural communities is to promote and distribute sustainable energy technologies. This could lead to an increasing number of sustainable energy services to the communities. The establishment of an Internet based portal to facilitate the promotion and education on sustainable energy is therefore one the key contributions of this study.

### **1.1 Research Problem**

Sustainable energy technologies have evolved and advanced over the years. They have been used by many different communities in diverse forms and arrangements. A wide spectrum of research has also been carried out by many research organizations, utility companies, academic institutes, and related agencies for many years. In Thailand there are a number of existing projects that involve the deployment of sustainable energy technologies in a number of rural Thai communities. These projects are mostly funded by the Thai government and they often explore the applications of modern and efficient technologies. For example, the International Centre for Application of Solar Energy (CASE) has been employed by the Provincial Electricity Authority (PEA) of Thailand to study the feasibility of sustainable energy for island electrification in Thailand (CASE 2001). The study shows that the islands considered for the study are suitable for the development of

sustainable energy services due to their isolation from the main electricity grids and the availability of solar exposure. Another example is a study conducted by the School of Renewable Energy Technology (SERT) at Naresuan University (SERT 2004). A Mini-Grid Concept and project was developed by SERT, and it targeted villages being without any access to the electricity supply. The project employed hybrid systems which are in fact a form of sustainable energy services. The project installed these systems in two non-electrified villages: Ban Pank Praratchatan and Ban Pank Sumnakngan. The result shows that 60% of the villagers were satisfied with the system and that they made good use of it for domestic and light industry electrical applications. It is anticipated that this type of projects will bring many advantages and benefits to the Thai communities and in particular to those located in rural areas. However, there are practical problems (Ketjoy, Sirisumpunwong, Thanarak, Rakwichian, & Chew 2004; Billinton & Karki 2001) that may hinder the success of the projects. Examples of these problems are:

- High turnover of experts and specialists – this is due to the fact that experts are in demand from many parts of the world. These experts will move to other areas where their services are required after the completion of the current projects.
- Lack of in depth knowledge among the local users about the system – sustainable energy service is normally installed in rural areas where the local community may not have in depth technical knowledge about the equipment or how to maintain the system. If any faults occur, the

local people may not have the skills and knowledge to repair the system. The system may end up being ignored and not used any more.

- High cost of systems, tools and equipment – sustainable energy services are expensive to implement and the operation procedure may be complex. Sustainable energy services are therefore not considered in many areas, even though there are potential sustainable energy sources to justify their implementation.
- Limited budget for planning, research and development – due to budgetary limitation, inadequate or insufficient research preparation or data collection may occur. This may subsequently cause errors in the design and/or implementation of the projects through wrong sizing or purchasing inappropriate components.

The main obstacle that prevents the rural Thai communities from using the local sustainable energy sources efficiently is the limited means to distribute the knowledge about sustainable energy technologies. This has led to the challenge on how to enhance and preserve the Thai rural people's knowledge in order to maximise the benefits from sustainable energy services. Knowledge Management Systems (KMS) are an approach that can provide a platform to extract and exchange meaningful knowledge for the stakeholders relating to the design and use of sustainable energy services (Wei, Hu & Chen 2002). In other words, a KMS can be used as a medium for the communities to learn, to share and to exchange knowledge or information about sustainable energy technologies and services. Knowledge

Management (KM) platform (Murray 2002, Lawton 2001) is going to be an invaluable tool to assist the rural communities in Thailand in handling the challenges related to their household energy needs, as well as meeting the demands by the business sector. A KMS may potentially provide an increasing value for an organization and its competitive advantages. This may include the organization's assets, property, intellectual data (or the organization's memory) and the customers' satisfaction (Bayer, Maier, Enparantza & Schmiedinger 2005; Mehta & Mehta 2005). Therefore, the purpose of this thesis is to explore how KMS can be used to assist the adoption and implementation of sustainable energy services in the rural communities of Thailand.

## **1.2 Research Questions and Hypotheses**

This thesis poses the following research questions:

Research question 1: “Does a Knowledge Management platform facilitate the development of sustainable energy services in rural Thai communities?”

In this research, a KMS on sustainable energy technologies is implemented for the distribution of knowledge on sustainable energy technologies to Thai communities. The KM platform provides knowledge and information on sustainable energy technologies via the Internet. The participants involved in this research are classified into three groups:

1. General users – This group covers users who access the KM platform through the Internet. The platform performs as a portal for information dissemination and collection on sustainable energy technologies for users within or outside of the local regions. Users from the local communities are the target visitors of this portal as they could benefit from the KMS. They could be considered as the “knowledge browsers” or “knowledge consumers”. The KMS will play a role in raising their awareness and educating them to use their energy resources more efficiently.
2. Researchers – They are the most significant users who are actively involved in the updating and verification of the knowledge posted on the platform. This group of users comprises the “knowledge workers” who generate and validate the technical information in the KMS.
3. Local government administrators (LGAs) – In Thailand, each district ("Amphoe") is divided into sub-districts known as “Tambon”. LGAs are responsible for the development and improvement of the quality of life in the local communities. With respect to the KMS, they are the knowledge “privileged users” who are responsible for decision making and updating of local information and knowledge to the KMS. In addition to the ability to view the information on sustainable energy technologies, these LGAs are given the access to confidential information (e.g. lessons learned and local energy resources) about the regions where they are located. This will enable and assist them in their decision making concerning use and deployment of sustainable energy services.

With respect to the success in distributing knowledge on sustainable energy technologies to the rural Thai communities, the main contributors will be the general users and LGAs within the communities. These groups of users are essential and they are instrumental in the establishment of the sustainable energy services in real life. Researchers are providers who update and make suggestions to the other two groups of users via the KM platform. Therefore, this question seeks to find out whether the KM platform can improve the knowledge of general users and local government administrators of rural Thai communities.

Research question 2: “What is the role of KMS in the improvement of knowledge on sustainable energy technologies for rural Thai communities?”

Many studies have used KMS as a tool to improve the overall assets of an organization (Bayer, Maier, Enparantza & Schmiedinger 2005; Mehta & Mehta 2005; Wei, Hu & Chen 2002). In the case of sustainable energy technologies, a KM platform based on web applications can be used as a tool to improve knowledge and to facilitate knowledge distribution.

The thesis is based on the following hypotheses:

Hypothesis 1: Knowledge about sustainable energy services of the participants in local Thai communities will be improved through the use of the KM platform developed in this project.



Hypothesis 2: A Knowledge Management (KM) platform will enhance the knowledge of local government administrators in local Thai communities about sustainable energy services and will assist them in the decision making concerning such services.

### **1.3 Research Aims**

The main purpose of this thesis is to implement the KM platform on sustainable energy technologies in order to promote and distribute sustainable energy technologies. The utilization of this platform will benefit the adoption of more sustainable energy services and systems among the rural Thai communities.

### **1.4 Organization of Thesis**

This thesis is structured into seven chapters.

Chapter One describes the research problems and their context, the research questions and hypotheses, and the aim of the study. It also provides an overview of this thesis.

Chapter Two reviews the needs for sustainable energy services among the rural Thai communities. This is followed by descriptions of various applications of sustainable energy technologies. Several application examples of sustainable energy in Thailand are also discussed in this chapter.

Chapter Three reviews the Knowledge Management System (KMS). This chapter describes the operation of the KMS, its benefits and a number of KM tools. Practical examples of research projects on KM are also presented.

Chapter Four outlines the research methodology for the analysis and evaluation of the proposed KM platform adopted in this study. The chapter provides information on both qualitative and quantitative approaches. The research phases are shown and described.

Chapter Five outlines the physical design of the KM platform, including details of the architecture, web technologies, and geographic information system (GIS) used. Communication over the web provides a convenient means of access from any location and the information is presented in easily understandable multimedia formats. With the integration of a GIS server the information on the location and on the types of energy resources in the rural area can be made available. The features and functionalities of the KM platform are described in this chapter.

Chapter Six reports the results and analysis of the survey in assessing the effectiveness of the KM platform. The chapter explains the results of pre- and post-questionnaires. Comparisons and discussions of the results are given. The statistical scales used in this analysis are the Mean, Pearson correlation, pair t-test and linear regression.

Chapter Seven describes the verification of the hypotheses, answers to the research questions, discussions on the analysis of the results, direction for future work and an overall conclusion of this study.

## **CHAPTER 2: SUSTAINABLE ENERGY TECHNOLOGIES IN RURAL AREAS**

The purpose of this chapter is to review the sustainable energy technologies and the significance of sustainable energy services for rural communities in Thailand. This chapter starts with stating the need for sustainable energy services. After that, examples of sustainable energy technologies and their application are shown. Finally, the importance of these services in rural Thai communities is examined.

### **2.1 The Need for Sustainable Energy Services**

The world population in 2002 was about 6.3 billion (Renner, Brown & Christopher 2003). Four billion of them live in developing countries and the world population is increasing on average by 2.4% per year. Forecasts show that the population in developing countries could reach six billion by 2020 (Renner, Brown & Christopher 2003). More than 50% of the population in developing countries lives in rural areas where there is inadequate energy for a minimal standard of living. The vast majority of these people depend on traditional wood fuel, dung and crop residue, or in other words, biomass, as the main source of energy for cooking and heating. In addition, these people often rely on primitive and inefficient technologies. While these traditional energy sources are meeting some of the energy needs, they also present significant problems to the users. For example, the combustion of wood fuels using inefficient technologies and appliances results in wastage of wood resources, and smoke from the traditional burning of the wood can adversely

effect the health of the occupants within the compound (World Energy Council and Food and Agriculture Organization of the United Nations 1999).

Energy is a key factor in improving the quality of life for the population as well as an important factor tightly coupled to economic growth of the community. As the developing countries aspire to increase their standards of living, their energy needs will increase in proportion to their population growth. Currently, there are three types of energy resources: nuclear technologies, fossil fuel and renewable energy (Ahmed, Haq, Schweizer & James 1996). Hydro-power can deliver a large amount of energy. However, the option is limited to geographical constraints, and it is therefore not a source of renewable energy deployable at anywhere. The first one could supply a large amount of energy but there are some serious obstacles in preventing this form of resources to be widely used. Among them are the huge expenses associated with the nuclear plant infrastructure, storage, safety and waste disposal issues. The second, fossil fuel, is the energy resource that has been known to humans for ages. Most of the energy services of today come from fossil fuel, such as coal and oil. They are natural resources and the amount of reserves at the present day indicates that they are not inexhaustible. The production is expected to decline in the not too distant future. This is a serious issue for both the developing and developed countries as most of them do not have adequate natural resources. The majority of these countries have to rely on imported energy resources. The phenomenon known as “peak oil” has suggested that the global pool of fossil-based oil resources is limited and the peak of the world’s oil production will occur

sometime in this century (Duncan & Youngquist 1999). Passing the point of “peak oil”, the total production will only reduce and eventually finish altogether. In addition, the use of oil and coal also releases waste and pollutants including CO<sub>2</sub>. Based on many scientific research results, CO<sub>2</sub> has been recognised as the main culprit that causes global warming and leads to climate change.

On the other hand, sustainable energy is a good choice for the build up of energy services in order to meet the demands in the future. Renewable energy has low or zero environmental impact in terms of air quality, global climate change, and solid waste issues (Boxer 1993; Pereira & Reis, 2002). From an economic viewpoint, the use of sustainable energy also reduces the dependency on imported energy resources. This will help in improving a country's trade balance. In addition, renewable energy has a significant economic growth potential by creating local jobs through manufacturing and maintenance of energy facilities (Ahmed, Haq, Schweizer & James 1996; Khatib 1993).

Therefore, the use of sustainable energy, including more efficient use of traditional wood fuel and renewable energy is important. It is particularly suitable for meeting the energy demands, and in particular in the rural areas. However, development of energy services without planning, inefficient use and failure to learn about the drawbacks can also lead to environmental and economic issues. In other words, there is a need to promote better understanding of the technologies, thereby leading to better utilisation of the

energy resources and acceptance by the community. Sustainable energy technologies, as described here, refer to the technologies that utilize both renewable and traditional resources in an efficient and sustainable manner. Such technologies will be the tools and the key to address the issues of energy utilization as well as to bring benefits to the communities.

## **2.2 Sustainable Energy Services**

The term sustainable energy services refers to the services that deliver energy to meet the needs of communities by using sustainable energy resources and technologies. As stated before, sustainable energy resources could include traditional and renewable energy resources. Traditional energy sources are wood, oil, coal and natural gas. On the other hand, renewable energy resources are diverse natural resources, which are essentially inexhaustible and these include amongst others wind, solar, hydro power, and geothermal energy. Other resources available in farming and agricultural communities are biomass and waste. Sustainable energy technologies have been in use for many years. Examples are wind-mills and hydro-based systems. Innovative uses of such technologies are continually being discovered, developed and implemented. A number of recent examples of the use of such technologies for sustainable energy services are described in the following sub-sections.

### **2.2.1 Solar Energy**

The application of solar technology can be classified into two categories: Solar Thermal systems and Photo-Voltaic (PV) systems.

**Solar Thermal Systems** convert solar radiation into thermal energy. Solar thermal technology can be divided into two categories: direct use of solar (solar dryer) (Cheapok & Pornnareay 2005; Joshi, Pradhan & Pathak 2000) and indirect use of solar energy (Leon, Kumar & Bhattacharya 2002). The former uses the direct heat from the sun is called “low temperature technology”, for example, solar cabinet dryers, and solar tunnel dryers (Figure 2.1). The other approach is to collect the solar energy with panels or troughs. The solar energy is used to raise the temperature of water in a storage tank. The hot water can be used for heating or other domestic applications. Alternatively, the hot water can be boiled and converted to steam. The steam will in turn be used to drive an electrical generator thereby generating electricity for the community. Figure 2.2 shows an example of a solar hot water system using a set of panels as the collector.



Figure 2.1: samples of solar dryer - solar cabinet dryers (Cheapok & Pornnareay 2005) and solar box dryers (Gewali, Joshi & Ramchandra 2005).

**Photo-Voltaic (PV) System** - *Solar PV cells* are semiconductor devices that absorb light energy from the sun and convert the light energy into electrical energy (RISE 2006; PEA 2004). Figure 2.3 illustrates the



operation of a solar PV cell. PV systems have already been used in a broad array of applications in the households, agricultural work, communication and the public sectors, such as government buildings and street lightings.

Rural electrification using PV is an attractive option because of its modularity, applicability in remote areas, ease of use, variety of applications, and its long-term cost effectiveness. Households and small businesses can benefit from energy services, such as in lighting, refrigeration, and entertainment supported by the PV systems (PEA 2004). Solar energy can be applied for stand alone solar cells, grid connected systems, solar home systems, solar pumps, solar public telephones, traffic lights, advertisements, street lights, solar batteries, and solar cars (SERT 2004; PEA 2004).

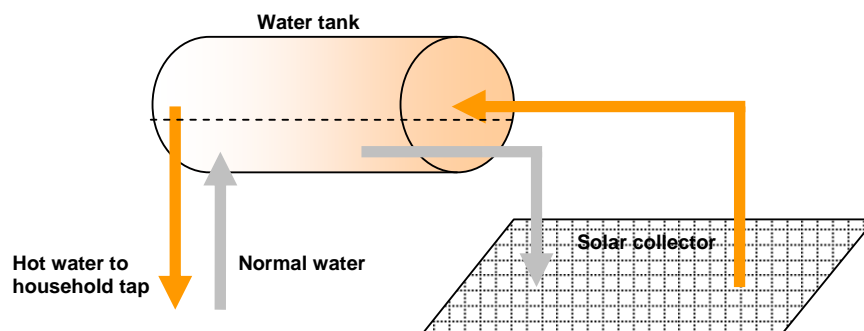


Figure 2.2: The solar hot water system (adapted from Highlands & Islands Enterprise 2004).

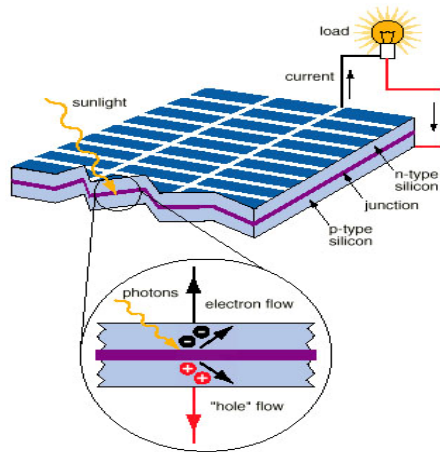


Figure 2.3: The operation of a solar PV cell (RISE 2006).

### 2.2.2 Wind Energy

Wind is a sustainable resource. The kinetic energy of the wind can be converted into other forms of energy, such as mechanical or electrical energy. Wind energy has been used on the farms for ages. The application of wind can be classified into two categories: windmill for water pumping and wind turbine for electrical generators. An example of several wind turbine electric generators is shown in Figure 2.4. Wind is well suited for rural electrification, water pumping, and remote telecommunications applications. Examples of such applications are the wind turbine generators in China and Europe (Chang, Leung, Wu & Yuan 2003; Ackermann & Soder 2002). The configurations can be either small standalone wind systems with energy storage or centralized hybrid systems with a local mini-grid distribution network.



Figure 2.4: Wind Turbine Generators (Photo taken at Mecklenburg, Germany, 2006)

Typically, in these hybrid systems, wind turbines are used in conjunction with photovoltaic and/or diesel generators. When wind energy based generators are integrated into small-scale systems, they are suitable for remote, off grid locations (Ackermann & Soder 2002). Such systems can reduce a community's dependence on high-cost imported diesel fuel to meet its energy needs. The small wind turbines can range in size from 0.85 to 10 kW. These systems can include one or more turbines (depending on the load and the wind resource) a bank of batteries, an inverter/battery charger, a microprocessor controller, and a back up diesel generator. The batteries are typically configured to supply 16-48 hours of load support. Although wind systems have high initial capital costs, the designs have been improved to provide ease of operation and low maintenance costs (Forsyth 1997).

### **2.2.3 Hydro Power**

Hydro power can be classified into 3 categories based on the method that is used for generating power: artificial collectors (dams and human-made lakes) or water fall power, high tide/ebb tide power, and wave power. The first one relies on the principle of the “life cycle of water” and the other two are due to the natural movements of the ocean caused by the moon and the natural rhythm of the sea. High tide/ebb tide power and wave power are mainly related to coastal installations, which are not applicable to inland farming and agricultural communities being the usual way of living in Thailand. Hence they are not considered in this study.

The first category of hydro power relies on the potential energy of a mass of water that can be converted to kinetic energy when the water is released from a high location to a lower location. An example based on the life cycle of water is illustrated in Figure 2.5. Three quarters of the world’s surface is covered by water. The sun is the driver of the life cycle of water, 23% of the solar radiation energy is used to evaporate water, which then condenses to form clouds and precipitation. When the water is turned to rain and falls back to the earth, it will be collected in natural collectors or artificial collectors, such as a human-made reservoir. The water stored in these collectors has a form of potential energy due to its location. When it is released from a high location to a lower location, the water can be used to drive a turbine that turns the potential energy to mechanical and/or electrical energy. Two examples of the utilisation of hydro power technology are dams and pico hydropower stations.

Dams are often used to generate the hydropower into electricity. Depending of the size, the “drop” and the volume of water, one such system can deliver hundreds to several thousands of kilowatts of electrical energy. In terms of amount of energy, pico hydropower is at the other end of the scale. It can be considered as a form of a micro hydropower system with a maximum electrical output not exceeding 5 kilowatt (Yuksel 2007). A hydro power system of this size has benefits over larger systems in terms of cost and simplicity of design. The most important element is called the “drop”, which refers to the difference of the water level.

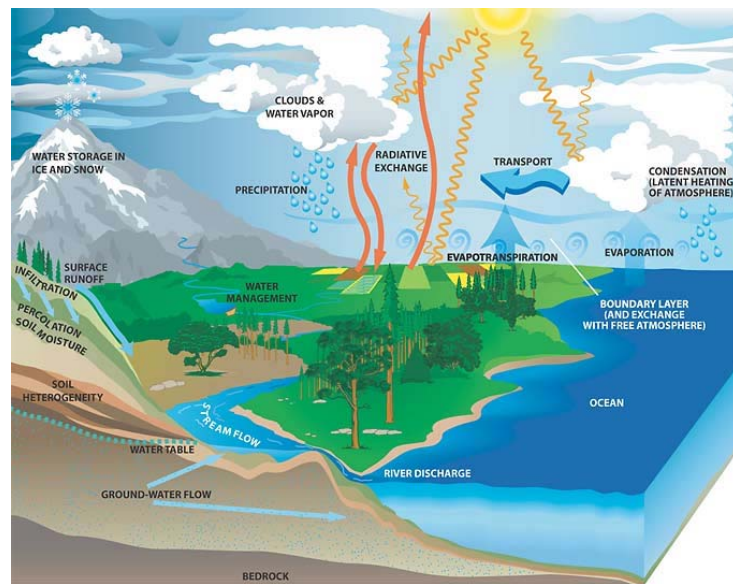


Figure 2.5: Water life cycle (Sanders 2006)

Another parameter to consider is the amount or volume of water flow. A great amount of change in a stream’s elevation is important for producing the electricity. Pico hydropower (Practical in Action Organization 2006; Yuksel 2007) is particularly suitable for use in rural areas due to the fact that the

system only requires a small stream or a small river with a good drop to generate the electricity. The system requires only a small amount of water. The components of a pico hydro power system are shown in Figure 2.6.

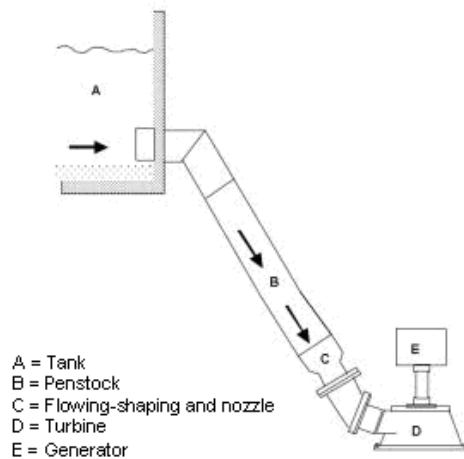


Figure 2.6: The components of a pico hydro power system (Practical in Action Organization 2006)

#### 2.2.4 Biomass

Biomass is a plant-derived material that can be used to generate energy by direct combustion or converting it to either liquid or gas fuel. The most common use of biomass in rural areas is the burning of traditional bio fuels, such as wood charcoal, crop residues, and animal dung. Biomass can be used for power generation by burning the material to produce steam in boilers and the steam is in turn used to drive a steam turbine. Another approach is by the process of biochemical and thermo-chemical degradation of biomass, which then produces biogas and liquid fuels. These fuels can be used directly for fuel or converted to electric power through the use of electrical generators. Figure 2.7 illustrates the process of electricity generation from biomass for household usage (Mckendry 2002). Another

biomass technology is the use of *biomass briquetting*. These are compacted residues which have a higher density and higher energy potential than the original raw materials. This approach facilitates storage, transport and easy management. An example is shown in Figure 2.8.

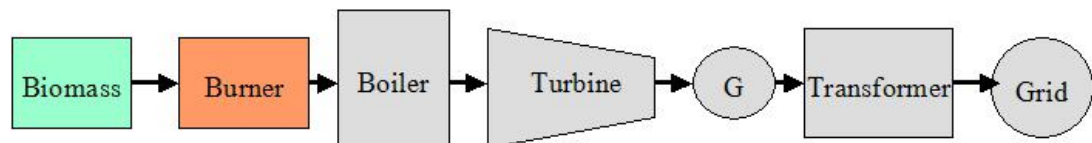


Figure 2.7: Process of conversion of biomass to bio-power (Mckendry 2002)



Figure 2.8: Sawdust briquettes (Photo taken at Mecklenburg, Germany, 2006)

### 2.2.5 Cook Stoves Technologies

Apart from the electrical and mechanical energy, an essential need for energy in rural communities is for cooking, boiling or preparation of food as well as preservation. Traditional wood, charcoal and coal stoves have been used in the households of rural areas for centuries. Most of them however use the energy resources inefficiently. For example, the metal cook stove (Figure 2.9) delivers only 10 to 20% of heat to the cooking pot and the other escapes as carbon monoxide, methane and other flue gases (Kammen

1995). Choking smoke is also released from indoor wood fires, which cause respiratory diseases for the members of the household who are around (News-medical.net 2006). Improved cook stoves technologies have been promoted to rural areas around the world in many projects, such as Nepal, Kenya, China, South Africa and Latin America (Kammen 1995; Reed 1996).

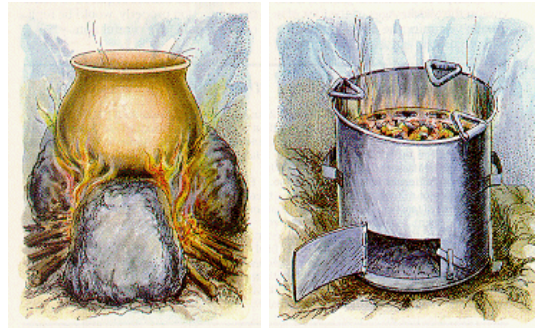


Figure 2.9: Examples of traditional cook stoves (Kammen 1995)

The benefits of cook stove technologies highlight the need to increase the efficient use of energy. An example of these technologies is Jiko (Figure 2.10), a ceramic cook stove of Kenya, which has demonstrated that more than 40% of the heat can be delivered to the cooking pot (Kammen 1995). In addition, the cook stove technologies require a less amount of energy and smokeless combustion after the stove is started as reported by Bhattacharya, Siddique, Leon, Pham and Mahandari (2002). The above discussion illustrates that sustainable energy resources are available everywhere around the world. Any area is expected to have at least one type of these resources. Most rural communities in Asia, which represent many agriculture based countries, should have at least two sustainable energy



resources - biomass and solar resources in addition to wind and hydro power.

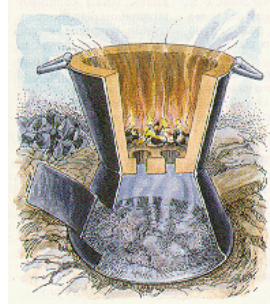


Figure 2.10: Jiko - an example of cook stove technologies (Kammen 1995)

The above examples of sustainable energy technologies indicate that the technologies are ready to serve any community. However, distributions of the information and knowledge about these technologies are limited due to the fact that most knowledge is possessed and managed by academic researchers or government agencies (Ketjoy, Sirisumpunwong, Thanarak, Rakwichian & Chew 2004; Rumakumar 1996; Schlapfer 2002). Hence, there is a need to promote and disseminate such knowledge widely.

### **2.3 The Need for Sustainable Energy Services in Rural Thai**

#### **Communities**

In the case of Thailand the reports by the Energy Information Administration (EIA) and Energy Policy & Planning Office (EPPO) show that the amount of energy production is less than that of energy consumption in every type of energy resources, as is shown in Figure 1.3 of Chapter 1 (Energy Information Administration 2006; EPPO 2007). The trend of the energy

consumption is growing due to the increasing population and the improving standard of living for people in rural communities (PEA 2004; WEC 2001). In addition, the availability of traditional energy resources has not increased, and in fact, is reducing year by year due to inefficiency (EPPO 2007). A possible solution to avoid shortage of energy for rural Thai communities is the development of efficient sustainable energy services.

Thailand is a country based on agriculture, and there are a lot of renewable energy resources, in particular biomass and waste residues. These types of renewable energy resources have long been ignored due to the lack of distributed knowledge and technologies for utilizing such resources by the local residents. Traditional energy resources, such as wood and oil, are also being used inefficiently. Recently, the government has launched the sustainable energy project (CASE 2001; PEA 2004; SERT 2004) in order to improve the quality of life in rural communities. Examples are the feasibility on renewable energy for island electrification in Thailand (CASE 2001), a hybrid system between solar energy and gridline of two villages in the north of Thailand (Ketjoy, Sirisumpunwong, Thanarak, Rakwichian & Chew 2004) and Solar home system (PEA 2004). These sustainable energy projects reveal the potential of Thailand for establishing sustainable energy services and supporting the increasing energy demand of Thais. Some examples of sustainable energy services suitable for rural Thai communities are described in Table 2.1

Table 2.1: Examples of sustainable energy services (SERT 2004; PEA 2004)

Applications	Type of resource	Utilization	Case studies
Solar Dryer System	Solar	Drying fruit and vegetable in rural households with remaining high nutrition	School of Renewable Energy Technology, Naresuan University, Thailand Kho Kor, Phetchabun, Thailand
Solar PV Water Pumping System	Solar	Village water, livestock watering, irrigation	Phitsanulok Thailand, Korat Thailand, Mexico*
Solar Home System	Solar	Electricity in household of rural area	Provincial Electricity Authority, Thailand
PV for Traffic lights	Solar	Traffic light along the road	Phitsanulok, Bangkok
PV for public phone	Solar	Providing the electricity for the public phone	Rural areas in Thailand, such as Doi tung.
Bio-drying system	Biomass	Drying fruit and vegetable	The Philippines*
Bio-electricity	Biomass	Providing the electricity for facilities on campus	Kampangsan campus, Kasetsart University Thailand
Bio-gas system	Biomass	Providing the electricity for facilities in pig farm	Government Slaughter, Phitsanulok Thailand
Bio-diesel	Biomass	Use instead of fuel for vehicle	Bang-Chak Fuel station in Bangkok, Thailand
Gas Sohol	Biomass	Use with car	Fuel station in Thailand
Pico hydropower	Hydro	Providing electricity for house appliances, extending working hours	Thima & Kathamab, Kenya*, Mae Sa Reng, Mae Hong Son, Thailand
Micro Hydropower	Hydro	Providing electricity for house appliances, extending working hours	Tak and Phitsanulok, Thailand
PV wind Hybrid system	Solar, wind	Providing electricity for house appliances, extending working hours	Phrom Tep Cape, Phuket

\*Case studies outside Thailand, however, they can apply to Thailand due to the same situation on sustainable energy resources

The utilization of sustainable energy services has the potential to reduce the problem of lack of energy; such services will also improve the quality of life and reduce CO<sub>2</sub> emission. For example, the building of a dam will not only offer hydro-electricity, it will also create new job opportunities for local people around the dam, such as fisheries, eco-tourism and an irrigation system for farms and orchards around the region. Wind farms generate power, such as electricity, and interestingly, the view of the wind mills has become a local attraction for tourists. Energy from biomass can reduce the amount of waste residue in local areas and help disposing the excess agricultural products from the market, thereby maintaining a reasonable price for the producers. In addition, the utilization of sustainable energy services supports the energy policy of Thailand, which is to distribute the utilization of energy with high efficiency, to increase the capacity building of sustainable energy services and to promote the utilization of sustainable energy services (EPPO 2006, COGEN3 2004).

## **2.4 Summary**

Chapter two reviewed the existing sustainable energy technologies, the potential of sustainable energy resources and the need for sustainable energy services. This review highlighted the existence of sustainable energy services that are suitable for rural Thai communities. It also indicated that the distribution and use of these technologies are limited due to the fact that the study and utilization of these technologies have mainly been confined to research groups. Due to this limitation, this thesis proposes and develops a KMS platform for the promotion of sustainable technologies with the intention

to introduce and to disseminate knowledge and information for the Thai communities. In the next chapter, KMS will be reviewed and introduced as a tool to promote knowledge and to enhance the utilization of these technologies over the Internet.

## **CHAPTER 3: KNOWLEDGE MANAGEMENT SYSTEM (KMS) AND SUSTAINABLE ENERGY TECHNOLOGIES**

The purpose of this chapter is to review the concept of knowledge management (KM) and to explain the roles of knowledge management system (KMS) with respect to sustainable energy technologies. This chapter starts with an introduction of KM and an overview of KMS including its definitions, architectures and functionalities. Then a review of KMS and its applications in sectors, such as business and energy services, is given. Finally, the use of KMS related to sustainable energy technologies is examined. This is followed by reviews on the tools and technologies that may be used to implement effective KMS for sustainable energy services.

### **3.1 Knowledge Management (KM)**

The concept of knowledge management (KM) has been proposed since the mid-1980s. Computer users are required to filter and process large amounts of information from various sources into meaningful knowledge. KM is designed to manage, capture and extract knowledge from documents, such as handbooks, procedures, meeting minutes, people who are knowledgeable in specific areas of work or expertise, and from a variety of other primary and secondary sources of information. Such knowledge can thereby be made available to help or assist the stakeholders of an organization to accomplish its mission and goals (Lawton 2001). Since its introduction, KM has been recognized as an important factor to increase the overall organizational value

in terms of performance and the intellectual assets of the organization (Albolino & Mesenzani 2002).

### **3.1.1 Definitions of KM**

There is no universal definition of KM. It is various depending on the point of views or perspectives from researchers with diverse background in different disciplines. Some of the proposed KM definitions are shown as follows:

*“Knowledge Management (KM) may simply be defined as doing what is needed to get the most out of knowledge resources” (Becerra-Fernandez, Gonzalez & Sabherwal 2004, p. 2).*

*“KM is the process of capturing and making use of a firm's collective expertise anywhere in the business – on paper, in documents, in databases (called explicit knowledge), or in people's heads (called tacit knowledge)” (Awad & Ghaziri 2004, p. 3).*

*“KM can be defined as the application of these knowledge activities on knowledge resources that are constrained facilitated by a wide range of factors. The knowledge activities defined and characterized by KM researchers included; knowledge acquisition, knowledge selection, knowledge generation, knowledge use, knowledge internalization and knowledge transfer” (Joshi & Sarker 2003, p. 26).*

*“Knowledge Management is the debate and systematic coordination of an organization’s people, technology, processes, and organizational structure in order to add value through reuse and innovation. This coordination is achieved through creating, sharing, and applying knowledge as well as through feeding the valuable lessons learned and best practices into corporate memory in order to foster continued organizational learning” (Dalkir 2005, p. 3).*

Despite the apparent differences in these definitions of KM, they have the same major objective, that is, how to facilitate the achievement of the goal of the organization, the project or the research. Thus, within the context of this study, KM is defined as following.

*“KM is an approach that processes the knowledge or information of an organization or a community in order to reach the goals of the organization or the community. This knowledge needs to be formatted by a variety of processes such as sorting, query, coding, etc. in order to be presented in a suitable format for diverse users within the organization and the community.”*

This definition covers all the previous definitions. Similar to Awad & Ghaziri’s definition (2004), KM is defined in the form of the information collection in the firm, so that the information can be reused, shared and transferred between the employees within an organization. The definitions of Dalkir (2005) and Joshi & Sarker (2003) also considers KM as a computer application that allows everyone to access knowledge or lessons learned in similar cases



within an organization. In order to maximize the benefits from KM, the KM activities (refer to 3.1.2) have to be understood by all participants. Also, the implementation or establishment of KMS is necessary to be initiated in the organization. Another addition has been made in the above definition. The deployment of the KM approach is extended to communities instead of just confined within an organization. This is the particular objective of the use of KM in this study targeting the Thai rural communities. The details are explained in the subsequent sections.

### 3.1.2 KM Activities

KM is the name given to the set of systematic and disciplined actions that an organization or individual can take in order to obtain the greatest value from the available knowledge (Marwick 2001). Traditionally, there are two categories of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge is usually represented in documents, books, reports, videos, and in databases. Tacit knowledge is personal knowledge, which is derived from experience, embodied beliefs and values. Based on the notions of tacit and explicit knowledge, the organizational knowledge creation processes can be divided into four categories as shown in Figure 3.1.

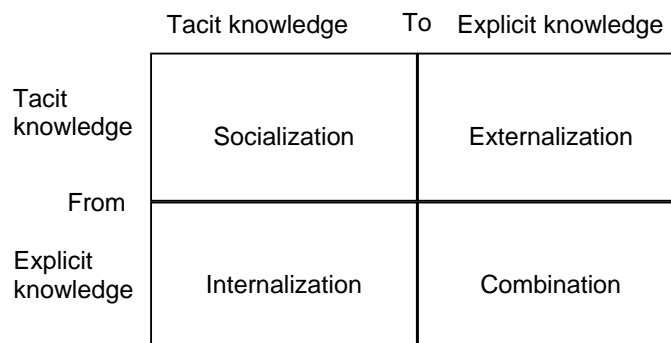


Figure 3.1: Model of knowledge creation (Nonaka, 1994)

**Socialization** is the mode of conversion of tacit knowledge to tacit knowledge via individual communication. This mode depends on the relationship of the communicators on both sides. **Combination** is the mode of conversion of explicit knowledge to explicit knowledge via re-configuring such existing information mechanisms as sorting, adding, re-categorizing, and re-contextualizing of explicit knowledge. This mode leads to new explicit knowledge. **Externalization** is the mode of conversion of tacit knowledge into explicit knowledge. This mode seems to be more difficult due to the involvement of trust in order for the owner to transfer or convert tacit knowledge to explicit knowledge. Also, some tacit knowledge is more complicated or more complex to be converted into a form of explicit knowledge. **Internalization** is the mode of conversion of explicit knowledge into tacit knowledge. It is similar to learning explicit knowledge in order to create new tacit knowledge.

In this research, the focuses of this model are on transferring and sharing both tacit knowledge and explicit knowledge via technologies. This model is widely accepted within the KM circle as a valid means to analyze the transfer and conversion of different types of knowledge. In this study, this model is being applied to handle and manage the knowledge on sustainable energy. This will be discussed further in Chapter 7.

### **3.2 Knowledge Management System (KMS)**

KM is not a single technology but instead, it is a collection of indexing, classification and information-retrieval technologies coupled with methodologies designed to assist the users for the purpose of extracting meaningful knowledge (Lawton 2001). The whole process of KM is often facilitated by KMS. The availability of KMS technologies supports tacit knowledge, meta-information creation and connecting people with knowledge, people with people and knowledge with knowledge (Tiwanna & Ramesh 2001). The flow of tacit knowledge and explicit knowledge in KMS is also in line with Nanaka's mode of knowledge creation, as mentioned in the previous section. In the next section a description of the KMS architecture and its functionalities is given.

#### **3.2.1 KMS Architecture**

Most KMS architectures are designed and categorized based on particular purposes. Some examples are given below:

*Three-layer architecture of Gartner group:* Data layer, Process layer and User Interface layer (Duffy 2000). Gartner identifies architecture as the system components and the interaction between all of them. The three-layer architecture is developed based on how each component of the KMS interacts to each other (Duffy 2000). The data layer is a storage layer in which data is kept in an appropriate format, such as textual data, video, and audio. The process layer describes the logic that is used to link between

Data layer with User interface layer. The user interface layer is the interface of the system where users can access the system.

*Five-layer architecture:* User interface Layer, Knowledge meta-model and knowledge map, Knowledge repository, Knowledge access tools, and Knowledge management enablers (Duffy 2000). This architecture is classified by the impact of integrating the information and communication technology (ICT) to each layer according to the proposal by the Gartner Group.

- User interface: It is a workspace where the user communicates and interacts with the KMS, such as on a web page.
- Knowledge meta-model and knowledge map: Knowledge meta-model is the attribute of each data on knowledge repository. The examples of these attributes are time, owner, format, etc. Knowledge map is the navigational system that enables users to find the answers they seek.
- Knowledge repository: It is a storage system, which can be a file server, a database server or a document management system. The structure of repository depends on the content of data.
- Knowledge access tools and Knowledge management enablers: The combination of these two layers specifies a particular tool for a particular environment.

*Three-layer knowledge management reference model:* Enterprise's cognitive domain, Functional layer and KM resource layer (Abou-Zeid 2002). This

architecture is classified by the distinct features of particular system. The first layer includes the features that are created for communication in the system. The second layer consists of the processes that are needed to manipulate each feature of the first layer. Examples of knowledge manipulating processes are knowledge generation, knowledge identification and knowledge presentation. Finally, the last layer composes of technologies that support knowledge manipulating processes (Abou-Zeid 2002).

*Functional architecture:* Interface layer, intelligent layer and resource layer (Abar, Abe & Kinoshita 2004). This architecture is designed based on the development of scalable, flexible, extensible and interoperable distributed content management that know what to deliver to whom, using what method, when and how quickly.

- Interface Layer: This layer provides the interface between the user and the KMS. It acts as a virtual work environment where the user can interact with the system via this layer.
- Intelligent Layer: This layer acts as the medium or middleware that connects to the information from the resources layer with regard to the user's requirements.
- Resource Layer: A database management layer is used to store data in various forms such as text, images, figure, etc.

Considering the above four architectures, the functional architecture of Abar, Abe & Kinoshita (2004) appears to have an ability to apply tools and to keep

overhead to a minimum. Table 3.1 shows a number of examples of KM technologies that can be matched to the functional architecture as described.

Table 3.1: Examples of existing KM technologies that match with functional architectures (Adapt from Tiwana A. & Ramaesh 2001; IBM 2004; Abar & Kinoshita 2004)

Functional architecture	Existing KM Technologies
1. Interface Layer	Web Conferencing Tools, Voice over IP (VoIP), Interactive map and Visual screen that is created from computer program.
2. Intelligent Layer	Web Server, Groupware, Internet, Intranet, Decision Support System
3. Resources Layer	Database Management System, Data Warehouse

KM technologies provide integrative and complementary mechanisms for creating and managing knowledge in KMS. For example, the transformation between tacit and tacit knowledge can be implemented by web conferencing tools. This technology allows the communication or meeting between two locations or more at the same time (Tiwanna & Ramesh 2001; IBM 2004).

### 3.2.2 Functionalities of KMS

General functions of KMS should include (adapted from Nonaka 1994; Awad & Ghaziri 2004)

- Acquisition and capture: This function supports the creation and capturing of new knowledge both inside and outside the organization. It also offers the capacity in sharing and conversion of tacit knowledge and explicit knowledge.
- Storage: It is the knowledge repository that acts as a bridge between the capture and the retrieval processes. The repository structure should support multiple formats and links, and the cross-referencing facility linking them. It also should provide an effective navigation structure and easy-to-understand visual path for the users. This repository should also offer the ability to update knowledge or add new knowledge easily.
- Retrieval: It is the primary functionality that interacts between the user and the KMS. This function should provide an easy way to search and query; to carry out efficient search and access to the knowledge; and to support multiple search techniques.
- Distribution and presentation: These functionalities act as routing and delivering knowledge to the users. They offer multiple ways of delivery, and they support the ability to send automatic notifications of new contents.

### **3.3 Knowledge Management System (KMS) on Sustainable Energy**

#### **Services**

The success of KMS has been demonstrated in many organizations. From the surveyed literature, it can be seen that KMS have provided an increase

of the organizational value, which includes assets, properties, organizational data (organizational memory), and customer satisfaction among many business organizations (Wei, Hu & Chen 2002; Bayer, Enparantza et al 2005; Mehta & Mehta 2005; Murray 2002). For example, KMS assisted a company in Taiwan in the tape-carrier-package integrated circuit smart-card assembler and testing business to gain a huge profit within two years (Wei, Hu & Chen 2002). The company launched the KMS in 1998, and by the end of 2000 it had reported a profit gain of 700%. Another example is a dice-and-mould company (Bayer, Enparantza & Schmiedinger 2005). The experience and lessons learned from previous projects had been used to enhance the quality of the products and to improve the efficiency of the production. This has led to improved levels of satisfaction among the customers. Experience is important in this dice-and-mould company as well as in many other companies. On the other hand, the lack of experience is a major cause of mistakes and design failures related to the products (Bayer, Enparantza & Schmiedinger 2005). This is another area KMS can assist in. Lessons learned from previous projects are captured in various forms of documentation. The company can reuse them for other employees in each process step. An example of the use KMS is Infosys (Mehta & Mehta 2005). The company has demonstrated that knowledge from previous cases or projects is useful for all employees in every branch across the continents. For example, in the case of an employee in the US who is scheduled to give a presentation to a customer, the KMS of Infosys allows the employee to retrieve previous projects from branches in different countries in order to find out relevant information from these past projects (Mehta & Mehta 2005).



Considering the example above, the functions of KMS are significant factors that assist the company to flourish due to the use of the KMS functions (Section 3.1.2) in order to support the company's goals and mission. By the same token, by deploying KMS in other sectors, such as education, science and energy, and using a similar approach, KMS has the potential to assist organizations to attain success.

In the case of the energy sector, the lack of knowledge is the main obstacle that prevents the rural communities from using the local energy resources efficiently. This leads to community problems including poverty, environmental degradation and poor health (Schlapfer 2002; OECD 1997). Government energy organizations and related agency groups have been employed and worked on pilot studies on sustainable rural energy services projects for many years. However, the inherent problems of these projects are the high turnover of experts and specialists and the lack of in-depth knowledge of the systems among the local users (Ketjoy, Sirisumpunwong et al 2004). The high costs of the systems, tools and equipment, and the limited budget for planning, research and development are other main obstacles (SERT 2004; Albolino & Mesenzani 2002; Rumakumar 1996). The KMS has the potential to solve the above mentioned problems and to support the facilitation and efficient utilisation of sustainable energy technologies. In other words, the implementation of KMS can address the issues of the lack of knowledge in sustainable rural energy technologies and promote the utilization of sustainable energy services.

KMS has been in existence for over two decades. The challenge for research in this area is how to enhance the utilization of KMS in the community by using the facilities offered by the latest information technologies, such as the Internet, intranets, browsers, data warehouses, filters and software agents, to systematize, facilitate, and expedite knowledge management within the communities. Some previous examples on the use of KMS about sustainable energy technologies in the communities are shown in the following:

**Mini grid system for un-electrified villages in the North of Thailand**

(Ketjoy, Sirisumpunwong et al 2004).

In August 2002, the Mini grid system was implemented for two villages: Baan Pank Praratchatan (25 household with 65 inhabitants) and Baan Pank Sumnakngan (4 household with 11 inhabitants). The system consists of a renewable energy hybrid power plant, a low voltage grid line, loads and energy management system. This system generated 170 kWh per month, which could be converted and used. The total plant efficiency was calculated to be 60.5%. The energy management system is a dedicated computer control system, which determines the most effective energy sources to supply the required load and coordinate the various energy sources.

**Integrated Renewable Energy System (IRES) (Rumakumar 1996)**

The Integrated Renewable Energy System (IRES) has been designed as a knowledge-based system that has been used for designing and planning the utilization of available local renewable resources. It was implemented at a rural community in a developing country in 1992. The IRES was a stand

alone system that used a relational database and search algorithm. The objective was to find an optimal combination of PV and/or Wind-Electric Conversion System (WECS) rating and the size of storage that minimizes capital cost, without compromising the loss of power supply probability.

### **Computer-based system on education of renewable energy technology**

(Zahedi 1998)

In 1998, the Internet-based teaching course in Renewable Energy (RE) technology was created in a university in Melbourne. This course is used by undergraduate students in the electrical engineering programs. The course covers the knowledge of basic principles of energy and advanced RE technology, including the environmental impacts. The course materials also include information on the availability of different non-renewable sources of energy, biomass energy system, and barriers to the development of RE sources. The benefits of this course as claimed by the authors are:

- Allowing the learning to take place at locations suitable to the students, making it suitable for both on and off-campus learning.
- Giving students an alternative learning style and makes the learning process an enjoyable experience for students.
- Offering a virtual implementation of RE technology without any investment on physical equipment.

The examples show inadequate services to the wider community. Firstly, all of them are working with stand-alone systems. The ability of these systems

is inadequate to build up the energy services, as data on the databases is not up to date. Next, the user interfaces of the mini grid system and IRES are very complicated. They are not appropriate for local or normal web browsers in rural communities. Also, some results of the above examples have revealed that the lack of communication between the technicians and local people has led to delays for system repairs and maintenance. However, a positive result is illustrated in the teaching courses at a University in Melbourne. Students who took the course were able to understand RE technology better due to the use of web-based and multimedia technologies. Both web-based and multimedia technologies are well suited to illustrate the implementation process for RE. However, these applications of KMS for sustainable energy technologies have not shown all the potential they have. Therefore, it is appropriate to look for a new approach or a suitable solution that can offer a better KMS for sustainable energy technologies. The next section will recommend various tools that can lead to the development of KMS for rural communities in order to achieve the goal of promoting sustainable energy services.

### **3.4 Technologies and Tools for KMS on Sustainable Energy**

#### **Technologies**

Information Technologies (IT) have significant positive effects on the KM process by providing capabilities such as knowledge sharing across the organization boundaries (Khalifa & Liu 2003; Tiwana & Ramesh 2001; IBM 2004; Murray 2002). They also offer many additional benefits. For example, the application of electronic mail, the Internet, collaboration technologies,

bulletin boards, and newsgroups support the distribution of knowledge throughout an organization. They also provide a forum for employees to debate, discuss and interpreted knowledge via multiple perspectives. Most importantly, IT enhances the sharing of knowledge by reducing the restrictions pertaining to time and distance (Bayer, Maier, Enparantza & Schmiedinger 2005; Handzic & Sarajevo 2005). A web-based approach is behind all those applications. The architecture of this approach is shown in Figure 3.2. The web browsers send the HyperText Transfer Protocol (HTTP) requests to the server. The servers process the requests and send the result back to the web browsers via HyperText Markup Language (HTML). Web-based approach is supporting KM activities as shown in the examples in Table 3.1. The approach offers the opportunity for communities to gain benefits from KMS and provides high quality knowledge content and user-friendly interfaces (Onn & Zaman 2005; Zahedi 1998).

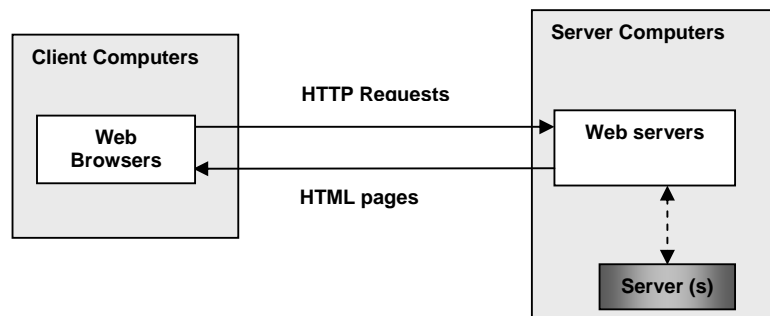


Figure 3.2: The fundamental of Client/Server (C/S) Architecture (Onn & Zaman 2005; Zahedi 1998)

As with most KMSs, information and knowledge on sustainable energy technologies are represented in various forms, such as text, diagram and figure. The location or spatial data of sustainable resources are beginning to

emerge as an important aspect of knowledge. In order to enhance and promote sustainable energy technologies, the most effective KMS has to support these various forms of data. A web-based application is called Web GIS (Geographic Information System). The details of Web GIS are illustrated in the next section. Web-GIS provides the abilities to serve and support KMS functions. In particular, it enables knowledge sharing or distribution of sustainable energy technologies over the Internet including spatial information (Soomro, Zheng & Pan 1999; Li 2003).

#### **3.4.1 Web GIS**

Web GIS is the name describing the integration of web-based application and GIS (Geographic Information System) (Brueckner & Tetiwat 2008). It is able to serve multiple users with both spatial and non-spatial information on a variety of platforms over the Internet (Qing, Ran-Bin, Xun & Yan-Hong 2001). Web GIS also has significant benefits for data managers and developers alike. It provides an environment for rapid system development. In addition, because the information is served from dedicated servers it has the potential to address such issues as security, updating and licensing (Tang & Selwood 2003; Raghavan, Santitamont & Honda 2005; ESRI 2005).

The way of the connection between client computers and server computers of Web GIS is the same as normal C/S architecture (Figure 3.2). Web GIS requires HTML in order to display the information to a user via a web browser. HTML is a data formatting language designed as a means of presenting static information for display purposes (Soomro, Zheng & Pan

1999). However, HTML is inadequate for Web GIS users, as the information cannot be precisely defined within the limited tags set in HTML. The transmission of GIS data over the Internet relies on the capacity of the programming language for the precise data during transfer. It requires the integration of another programming language which is EXtensible Markup Language (XML) (ESRI; Soomro, Zheng & Pan 1999).

XML is a subset of the Standard Generalized Markup Language (SGML) the same as or similar to HTML. However, XML can avoid the common HTML drawbacks due to XML being a specification for designing platform-independent markup language in text format that is unambiguous. In addition, the creation of XML tags can be customised into specific types of information depending on the document storage and logical structure. XML allows the separation of the output of application on the screen and other output devices. The potential benefits for XML on Web GIS applications are shown below:

- Meaningful data definition – The key motivation for developing XML on web based GIS is the user-defined tags. XML allows the creation of specific tags for their own data and to handle and manage large complex data sets.
- Model/view separation – Developers can describe their structured information much more precisely than with HTML. The errors arising from data exchange will be reduced by avoiding formatting tags. On

the other hand, the meaning of the data itself is marked with user-defined tags.

- Database accessibility - With XML extensions such as XML query, XML-based web servers can access data from multiple databases and conventional file systems and return the results in HTML or XML.
- Graphical User Interface (GUI) flexibility – XML provides a better approach to transmit to web browsers across the Internet. The way that the map data is sent in XML and HTML is similar. However, XML will include attributes to generate various interfaces more comprehensive than HTML.

In addition, Web GIS requires a GIS server, also known as Internet Map Server (IMS). IMS is a spatial server which processes the GIS operations based on the request from web servers. IMS connects or collects information from the Database server in order to process the GIS operation as required by the users. The IMS is required to be set up with additional programming languages for the implementation of the GIS features. There are both commercial and open-source IMS available. An example of a commercial Web GIS package that includes IMS is ArcInternet Map Servers (ArcIMS) produced by the Environment System Research Institute (ESRI). This software is classified as a Web GIS server-side application. It offers ease-of-use, GIS web publishing capabilities, metadata services, data integration, multi-services architecture and scalable architecture. In order to implement Web GIS by ArcIMS, the developer needs to meet the licensing requirements. Depending on the functions of the features of the application



program, other Arc softwares may be required. Examples of open-source IMS are MapServer and Google Map.

MapServer specialises at rendering spatial data (maps, images and vector data) for the web. Beyond browsing GIS data, MapServer permits the user to create “geographic image maps”, that is, maps that can direct users to content (Nengcomma 2007; Lime 2007). Some features of MapServer are shown in the following:

- Advanced cartographic output, such as label collision mediation, map element automation (scale bar, reference map, and legend), etc.
- Support for popular scripting and development environments, such as PHP, Python, Perl, Ruby, Java and C#.
- Cross-platform support, such as Linux, Windows, Mac OS X, Solaris.
- A multitude of raster and vector data, such as ESRI shapefiles, PostGIS, Oracle Spatial, MySQL, Open Geospatial Consortium (OGC) web applications, WMS (Client/Server), non-transactional WFS (Client/Server), and others (Lime 2007).
- Map projection support.

Google Map is a free mapping service application and technology provided by Google. Features of Google Map are zoom in, zoom out, search, driving direction and so on. In order to implement the Web GIS, Google Map needs to be integrated with Google API. Google API is used to facilitate developers integrating Google Maps into their web sites, with their own data point. Both

MapServer and Google Map™ are only analogous to the spatial server. Other features can be added by using the other web tools or other programming languages. The major different between them is the programming languages that are used to perform the GIS operation. MapServer uses Common Gateway Interface (CGI) program that can be written in any languages such as C, C++ PERL, etc while Google Map application uses a large amount of JavaScript (Nengcomma 2007; Lime 2007).

There are two types of Web GIS: client-side application and server-side application. The following section gives further details about them.

### 3.4.2 Web GIS Client-Side Application

The Web GIS client-side application (Figure 3.3) is a client-dependent platform configuration, which requires the client machine to process all such GIS operations as spatial query, buffering, overlay and network analysis (Tang & Selwood 2003; Nengcomma, 2007).

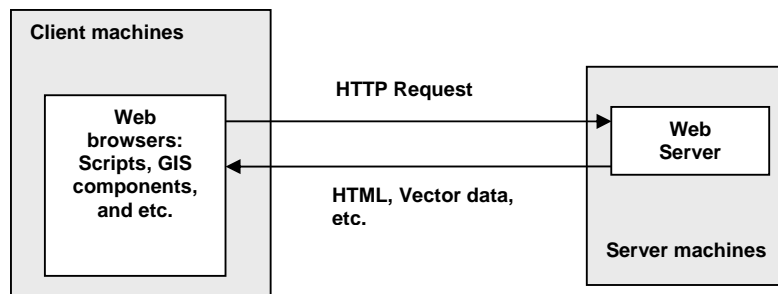


Figure 3.3: Architecture of web GIS client-side application (adapt from Tang & Selwood 2003; Nengcomma, 2007).

The server machine obtains the required data from the database and wraps it with the XML format, then sends it to the client. Once the data is on the client machine, the application is capable of manipulating the data locally. The web browser with the client-side programming language (such as script language, web-enable programming) can assist the client machine to perform the GIS operations. Two clients may receive the same data from the server but different outputs of the GIS operations depending on processing speed and graphical presentation. Data from the server is both vector and raster data, which is proprietary data supported by GIS operations. The developer can create complicated GIS operations on the client machine to manipulate the proprietary vector data that usually offer more efficient and flexible data processing than the generic web-recognized data format (Tang & Selwood 2003; Nengcomma, 2007).

Nevertheless, there are several disadvantages associated with the client-side application stated by Nengcomma (2007) which developers should be aware of. Firstly, the security issues related to the licensing of GIS software and the copyright of the vector data should not be abused. Secondly, in order to ensure transmission of vector data across multiple platforms, the vector data must follow the standard format of the World Wide Web Consortium (W3C). Thirdly, as the vector data is transmitted over the Internet, heavy communication load is unavoidable.

### 3.4.3 Web GIS Server-Side Application

Figure 3.4 illustrates the Web GIS server-side application architecture. A web browser is used on the client machine to generate server requests and to display the results. The host machine usually consists of a Web and a GIS server together with other servers. Users or clients send their requests to a Web server. The web server passes the request to a GIS server, which runs a GIS application and a GIS database. Then the GIS server will wrap the result into the HTML format and sends it back to the web server, which will return the response to the user as a standard web page. All large GIS databases are on the GIS servers thereby allowing a simplified development and maintenance process. Only the result of the GIS operations is converted into the standard HTML format and is transmitted to the web client.

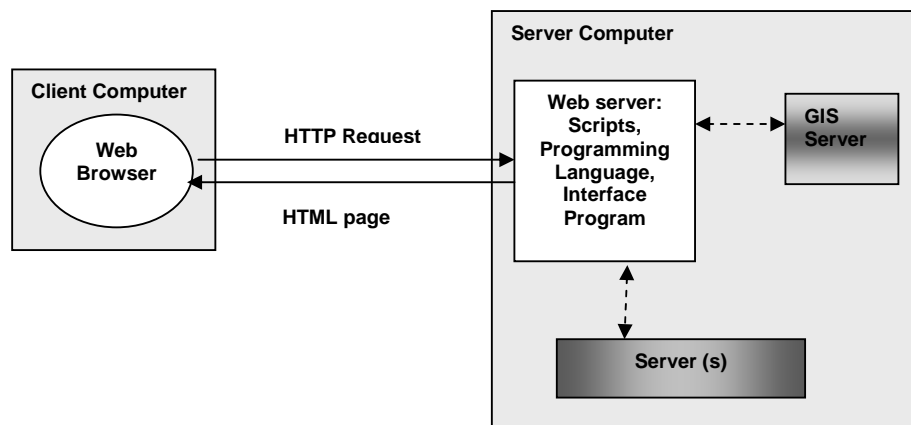


Figure 3.4: Architecture of web GIS server-side application (adapted from Tang & Selwood 2003; Nengcomma, 2007).

In the Web GIS server-side application all clients use the same GUI to perform the same set of GIS functions on the web browsers. All GIS operations are processed by the dedicated server as clients' requests. Thus,

the problems related to data incompatibility, data inconsistency and data unreliability are eliminated.

### **3.5 Summary**

The chapter examined the development and applications of KMS on sustainable energy technologies in rural areas. This review highlighted the problems of the current applications and suggested solutions to improve the potential of these applications. In addition, the web-based application Web GIS is an approach that can increase the potential of KMS. Web GIS and the software developing environment were reviewed. In the sustainable energy sector, KM can be a significant approach for improving the monitoring, investment, and sustain of the use of natural resources.

## **CHAPTER 4: RESEARCH METHODOLOGY**

This chapter outlines the framework for the study. This includes the research design, research phases and the techniques that have been used. These three aspects are clarified in order to explain the purpose of this research, The reasons for selecting particular methods and techniques are quantified, and it is explained how they are used to find the answers for the research questions. This chapter starts with a discussion on the research design. In the following section, a discussion of the quantitative, qualitative and the combined approach is provided. Then, the research phases are illustrated. Finally, the details of each phase are described.

### **4.1 Research Design**

A research question is the articulation of the purpose of a research. In order to obtain the answers for a particular research question or questions, appropriate research methods have to be used. The type of research methods to be selected depends on the particular characteristics of the research, and it also has to correspond with the research question. In general, the research methods to be adopted can be developmental, quantitative, qualitative or a mixture of them together (Creswell 2003; Todd, Nerlich, et al. 2004).

In this study, a combination of developmental, qualitative and quantitative methods has been used to find answers to the research questions. This

study involved the implementation and development of a KM platform, which were considered as development work. With regard to the evaluation of the effectiveness of the KM platform and of the improvement of the users' knowledge, both quantitative and qualitative approaches have been used. According to Creswell (2003) and Todd, Nerlich, et al. (2004), a combination of both methods is necessary for the following reasons:

1. The combination of quantitative and qualitative methods increases the validity of finding the answers. – The qualitative and quantitative methods can be considered as lines that start with different landmarks and at certain bearings. At the end of both lines, they reach the same location. Using a combination of these two methods, the results of the study can be used to counter-check or correlate each other. Also, they could be used as a complementary support to each other and leading to more precise results. By adding qualitative evidence to the research findings, it is possible to provide generalized answers from qualitative methods.
2. The combination of these two approaches is useful for a study that is designed to rely on its own results due to insufficient data from alternate sources. In the case that the results are not overwhelmingly conclusive, a small-scale study from a different angle can be used to provide evidence to support the study or to provide answers to the research question.
3. The combination of both approaches has its strength in the analysis of large scale qualitative data.

4. The combination of these two approaches will lead to better communication across multiple disciplines. The understanding of each of these methods also leads to more productive research programs.
5. This combination also improves the link between academics, practitioners and “consumers” of the research output. Each of the qualitative and quantitative methods will bring researchers into interaction with different sectors of the community, thus increasing the number of contacts and exposure of the research study.

#### 4.1.1 Research Approaches

The relationship of research design of this research is shown in Figure 4.1.



Figure 4.1 Research design

The first stage of this research design is the collection and gathering of data and information on the needs of the community and knowledge about the sustainable energy systems. The information on the needs of the community is required so as to establish the goals of the research and to reinforce the motivation of this study. This provides the insights and formed the hypotheses for the study (Todd, Nerlich et al. 2004; Silverman, 2004; Sharlene 2006). In the other aspect, data and knowledge have been



collected from energy institutes and relevant organizations. They form the basis of the implementation stage. The next stage is the implementation the KM platform. The specifications of the KM platform were finally established, and they were based on information from the parallel work of the investigation and discussions on the requirements with the stakeholders (Reason & Bradbury 2006; Baskerville & Myers 2004).

The last stage for the research design of this study is the evaluation of the KM platform and the research hypotheses. This stage is based on a combination of quantitative pre- and post-questionnaires. A questionnaire provides an objective way of comparing responses over different groups of participants at different times and at different places. It offers an efficient and accurate means of accessing information on representative sample results from the respondents. The results from the questionnaires can be used to determine the relations of variables and constructs (Maxim 1999). The pre-questionnaire survey is conducted prior to the introduction of the KM platform to the users. It is intended to have an assessment of the user's background, experience on the use of information technology, prior exposure to KM and knowledge concerning the sustainable energy systems. The post-questionnaire survey was conducted after the users have been given the access and exposure to the KM platform for at least one week. The objective is to assess the user's knowledge and perception about the subject on sustainable energy services and the effectiveness of the KM platform.

### 4.1.2 Research Phases

This study has been conducted in three phases. Each phase is interrelated with each other and they were designed to answer the research questions as mentioned earlier in Chapter One. Figure 4.2 illustrates the research phases of this study.

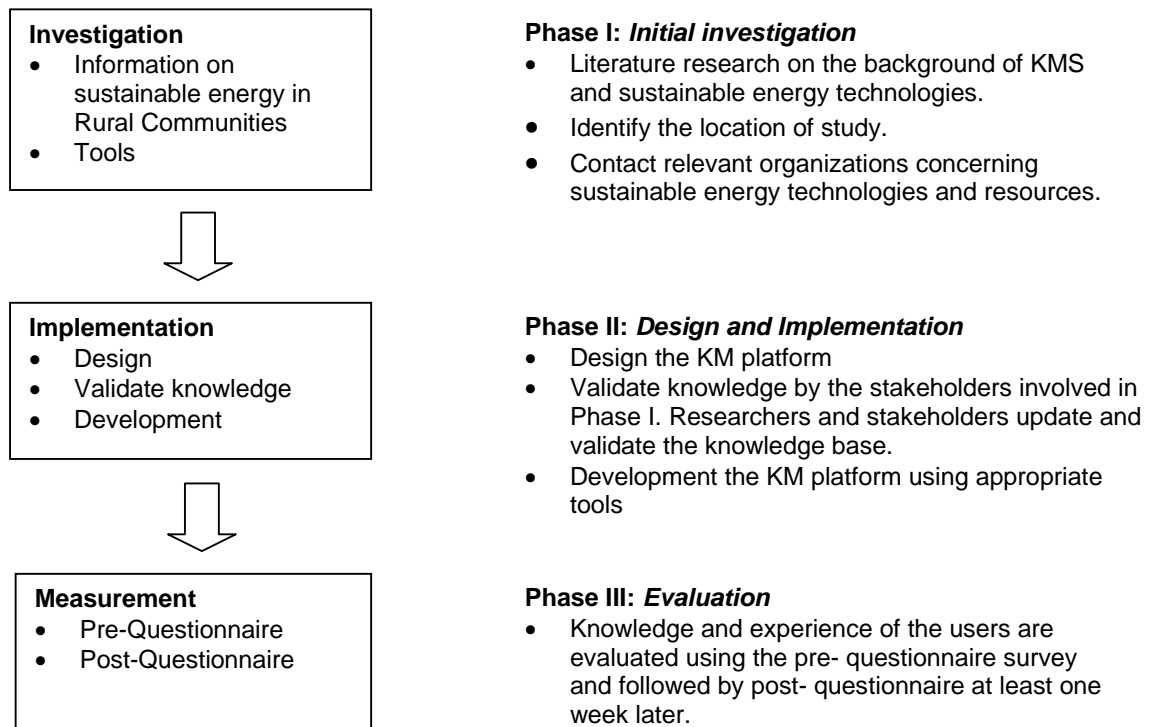


Figure 4.2 Research Phases

Phase One is the Initial phase, which reviews the background research of this study and identifies the location where the case study will be conducted. This involves a study on the relevant literature and gathering of information on sustainable energy technologies. Contacts between organizations which provide information on sustainable energy resources were established. Phase Two involves the design and development of the KM platform.

Research methodologies, tools and approval from the university research ethic committee have also been obtained. The information that was collected for implementing the KM platform has been validated by the stakeholders. The KM platform was implemented by using web GIS server-side application and was installed at the School of Renewable Energy Technology, Naresuan University, Phitsanulok, Thailand. The details of the platform are provided in Chapter Five.

Phase Three, Evaluation, included the assessment of the utilisation of the KM platform, perceived usefulness of the system and the participants' improvement on the level of knowledge about sustainable energy technologies. This phase involved the creation and setting up of the measurement tools. In order to estimate the initial level of knowledge and experience of the participants, a pre-questionnaire survey was conducted. After the KM platform had been launched, the participants were introduced to the system and invited to use it. After a period of at least one week, post-questionnaire was conducted and collected from the participants. This serves to validate the information and knowledge on sustainable energy technologies that the participants have learnt, shared or acquired from the KM platform. The results of the post-questionnaire survey were compared against the pre-questionnaire survey. This will assist in the measurement of the participants' level of knowledge and their perceived usefulness of the KM platform.

## **4.2 Initial Investigation**

In this phase, literature on the background of the KMS and sustainable energy technologies were studied. The selected areas are discussed and their details are described in the following sections.

### **4.2.1 Identification of the Location for Case Study**

One of the primary objectives of this research is to examine the distribution of knowledge on sustainable energy technologies in rural communities. Thailand is one of the developing countries in the world (World Bank 2007), and it has a relatively low standard of living, low income per capita and widespread poverty. This is particularly the case in the rural areas. In addition, the Demographic Yearbook of the United Nations (2003) reveals that only 32.66% of the total population of Thailand reside in the city and the rest are living in rural communities.

Energy is a driving force for rural development. It is required for domestic power appliances and equipment in order to improve the households' quality of living. Energy is also essential to support the industries, which in turns will open up employment opportunities and incomes to the communities. The Thailand Environment report from UN (2003) has shown that energy consumption of Thais has been increasing yearly since 1980. In addition, the amount of energy import is also increasing. As the traditional carbon-based energy resources are limited, it is expected that these resources will be in critical shortage soon. Solutions to these challenges can be the more

efficient use of traditional energy resources and learning how to use alternative resources, such as sustainable energy resources.

In addition, the distribution of knowledge on sustainable energy technologies provides an advantage for Thai people, particularly in rural communities. The local people can learn how to use the appropriate types of sustainable energy resources they have in their communities. They can learn how to use their energy resources with higher efficiency. Besides these advantages, the distribution of knowledge on sustainable energy technologies also helps to decrease the environmental problems and to reduce poverty in the rural community. Hence, the distribution of knowledge is one of the key factors behind successful rural community development.

The province selected for this study is Phitsanulok. Phitsanulok is a province at the northern part of Thailand and further divided into nine Amphoe (districts), namely Chat Trakan, Wat Bot, Phrom Phiram, Mueang, Bang Rakam, Bang Krathum, Wang Thong, Noen Maprang and Nakhon Thai. Each Amphoe consists of 8 to 10 Tambon (sub-districts). The main energy services in these communities are the grid line connections by the Provincial Electricity Authority (PEA). There are also a variety of sustainable energy resources available, such as solar and biomass. However, in most cases these sustainable energy resources are left undeveloped or underutilized, in particular among the rural communities of Phitsanulok.



Figure 4.3 Phitsanulok Province: the selected area of this study

On the other hand, a review undertaken by the Telephone Organization of Thailand (TOT) has shown that the Internet connection infrastructures (both land line and satellite) in these communities are already available (Bhongsatiern 2004; Rattakul 2002; Cusripituck 2002). Phitsanulok has the potential and infrastructure to build the KM platform based on web technologies (Bhongsatiern 2004) and many projects have been launched by respective government organizations. For example, low cost Asynchronous Digital Subscriber Line (ADSL) connections by the Telephone Organization

of Thailand (TOT), Post Office Internet kiosks have already covered 31% of the rural areas (Rattakul 2002), and SchoolNet and Internet Tambon projects (Bhongsatiern 2004) have also been launched by the government. The 2001 report from the Communication Authority of Thailand (CAT) has shown that 90% of rural citizens have already accessed the Internet via the services provided by CAT and TOT (Cusripituck 2002).

Therefore, the study on a KM platform on sustainable energy technologies or services in Phitsanulok is timely and appropriate. The findings from this study can be a prototype for other rural communities of Thailand and other developing countries.

#### **4.2.2 Information Gathering**

A review of previous research on knowledge management and web programming as well as accessibility to the sustainable energy services in rural areas of Thailand has been given in earlier chapters. It suggests that a combination of data collection methods is required to provide a comprehensive overview of the problems of accessibility to the sustainable energy services associated with rural residents. In this thesis, the following types of data are collected in order to implement the KM platform:

- Collection of Information on existing technologies of sustainable energy services and technologies. In this study, the collection of information has been conducted in conjunction with the School of

Renewable Energy Technology, Naresuan University, Phitsanulok, Thailand.

- Collecting information on activities in the sustainable energy sector. The information is collected mainly through the Internet and the literature.
- Collecting the information on the application of sustainable energy technologies that have been implemented in rural communities around the world. This is done through the Internet and together with the School of Renewable Energy Technology, Naresuan University.
- Collecting the information on the regional energy resources in the Phitsanulok area. The information was collected from local organizations and in particular with data from previous projects conducted by the School of Renewable Energy Technology, Naresuan University. An example is a whole year of solar radiation data of Phitsanulok in 2004. In addition, suggestions and recommendations by the researchers within and associated with the school have provided a significant amount of local knowledge and information on the implementation and the energy conversion sections in the KMS. Other key contributors are the District Agricultural Extension Offices of Phitsanulok. The officers have provided valuable information concerning the biomass resources within the province.

All the organizations have been contacted and requested to provide the information that is considered to be useful for the implementation the KM platform. A sample of the contact letters is shown in Appendix F. Assistance



was provided by the School of Renewable Energy Technology, Naresuan University to convert the information to appropriate formats before they were used in the research. Since this project and provision of all the information is Internet-based, all the collected information is therefore converted into such electronic forms as pdf files, tables, and images. During the conversion process, the size of the files has also been carefully considered in order to ensure speedy transfer over the network.

The KM platform was implemented after the initial phase. The details of the implementation process are shown in Chapter Five.

#### **4.3 Evaluation**

After the platform had been launched, the next phase was the evaluation. The techniques used in this phase were pre-questionnaire and post-questionnaire. Both pre-questionnaire and post-questionnaire are self-administered and the instructions were given in the cover-letter. The questionnaires were distributed and collected in a variety of ways as follows:

- Both the pre- and post-questionnaires were sent to the head office of the local government administrators of Phitsanulok. Then they were distributed to the branches in each Amphoe. In this case, the data collection is in the form of a package consisting of the pre-questionnaire, post-questionnaire and a stamped return envelope. Participants answered the questionnaires and posted it back to the researcher.

- The questionnaire could also be processed online as e-mail with the appropriate attachments. This has been sent to the researchers in the energy industry sector.
- The third approach has been conducted in the training classes at Naresuan University. Both the pre- and post-questionnaires were given to the participants in the training courses. The participants were mainly local administrators from the region. The pre-questionnaires were collected after the class and the post-questionnaires were sent back to the researchers after a period of time.

#### **4.3.1 Pre-questionnaire**

The questions for the pre-questionnaire are classified into four sections. The first section is asking for the participants' background information which includes age, nationality, education and job title. The first question regarding the age of the participants is set up in groups such as 20 years old - 29 years old, 30 years old – 39 years old and others. The other answers are using “fill in the blank” approach and the participants are expected to write down the answer in the space provided. This section addresses the background information on how much knowledge the participants have. Also, the answers provide information about the relationship between the community and the participants.

The second section consists of questions concerning the current level of access to the Internet. The questions in this section are set up by using multiple answers and fill in the blank techniques. Participants can choose

more than one answer in a question and if the answer is not provided, then the participant can fill in themselves. The purposes of the questions in this section are checking the infrastructure of Internet connection and the participants' behaviour on using the Internet. In this study, the Internet connection is important because it is the communication channel between the participants and the KMS. This information will also give an indication that whether the participants will be accessing the KMS in the future.

The third section is concerned with the knowledge management (KM) platform. There are many types of KM platform. For example, KM platform on the office documentary is used in the company as a form of content management. The questions are set up by using multiple answers and fill in the blank techniques. The purpose of this section is to estimate that whether the participants have prior knowledge or experience with other types of KM platform. In addition, the participants' behaviour on using KM platform is evaluated. From this, the researcher could assess the level of familiarity of the participants with KM platforms. This is useful for the analysis in this study.

Finally, the last section consists of fifteen multiple choice questions. These questions are set up with the assistance and input from researchers and experts on sustainable energy. The purpose of this section is to evaluate the participants' knowledge and understanding of sustainable energy technologies.

### **4.3.2 Post-questionnaire**

The purpose of the post-questionnaires is to evaluate the usefulness of the KM platform and to estimate the improvement of participants' knowledge on sustainable energy technologies and services. The questions in the post-questionnaire are categorized into four sections. The first section of questions is almost identical to that in the pre-questionnaire. Two additional questions have been included to find out when the participant did answer the pre-questionnaire, and how much time did the participant spend on the KM platform. The second section is set up by using the multiple answers and fill in the blank techniques. The questions of this section are designed to examine the usage of the KM platform and the Internet by the participants. The third section aims at assessing the usefulness of the platform from the perspective of the users. The questions set up are based on the Likert technique. The last section consists of fifteen multiple choice questions similar to section four in the pre-questionnaire. However, the answers of the multi choice questions have been reorganised. The score from this section is used to be compared with the score from the pre-questionnaire.

### **4.3.3 Participants in this Study**

The information on sustainable energy technologies and services is useful for everyone in the region; the participants involved in this study could be anyone who has access to the KM platform from the internet. Evaluation tools such as "counter" have been attached to the KM platform in order to monitor the number of users who have visited the site. In addition, other participants are local stakeholders in Phitsanulok such as academics, local

government officers and researchers. These participants are those who took part in answering the Pre-questionnaires and post-questionnaires. The information on energy resources at Phitsanulok is important for these local stakeholders to design and operate the energy service systems in the area. Therefore, they were specifically asked to participate in this study. Expect number of participants is 150 from the three groups mentioned above. This number is based on the evaluation techniques: descriptive statistic (frequency distribution, percentage, mean), pair t-test and regression. One of the purposes of the platform is to enhance the use of sustainable energy technologies/services in Thailand. The local government officers and researchers are key drivers in order to achieve this objective. The opinion of these people will be very useful for the evaluation and future improvement of the KM platform.

#### **4.4 Summary**

The chapter has examined the research methods that are used in this study. Information gathering and understanding of the problem was the first phase of the research. Based on the requirements and specifications established in the first phase, the KM platform was implemented and launched. Then, qualitative and quantitative approaches using pre-questionnaire and post-questionnaire were used as the research tools to assess the usefulness of the KM platform. The data collected were then analysed using statistical techniques. The following chapter discusses the design and development of the KM platform.

## CHAPTER 5: DESIGN AND DEVELOPMENT OF THE KM PLATFORM

Chapter five presents the design and implementation of the KM platform which is the second phase of this research. The activities consisted of the design of the platform including the use of case diagrams and the formulation of the database structure. Also, the features and sitemap of the platform are described in this chapter.

### 5.1 Overview of the System

The knowledge management system on sustainable energy technologies in this research is a web-based application, which has been implemented since 2006. The design of the system has taken into consideration four aspects: users, the web server, the geographic information system database (GIS DB) and relational database management (RDBMS), as shown in Figure 5.1.

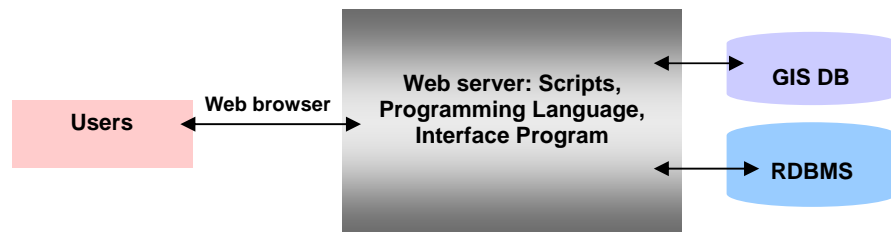


Figure 5.1: An overview of KMS on Sustainable Energy Technologies

The system responds to requests from the users, which were sent to the web server via the web browser. Depending on the requests, the web server retrieves the data from either the RDBMS or the GIS DB. If the request is related to spatial information, the web server will use the appropriate scripts

to gather or collect spatial data from the GIS DB. On the other hand, if the request is related to the RDBMS, the scripts are sent to the RDBMS to retrieve the relevant information. There may also be cases that the requests are referred to both databases. After gathering the information as requested, the web server wraps the result into HTML format and sends it back to the user via the web browser.

In order to support the local communities as well as visitors from other part of the world, the interface of the KM platform was implemented in two languages: Thai and English. Since most of the participants of this study are Thais, the interfaces and displays on the platform were translated into Thai, or the terms were shown with Thai in brackets. An example of the two versions in English and Thai is shown as screen shots in Figure 5.2.



Figure 5.2: An example of English (left) and Thai (right) interfaces

HyperText Markup Language (HTML), HyperText Preprocessor (PHP) and MySQL are the main programming languages used to develop the KM platform. HTML is a standard programming language for information display on any web browsers: Microsoft Internet Explorer (IE) and Mozilla Firefox are

examples of the most commonly used browsers. HTML supports the display of text and images in a variety of heading styles, formats and languages. In addition, Macromedia Flash and scripts were used to provide a more dynamic and flexible way to manage the content and the information on the platform. Another example of the display is shown in Figure 5.3.



Figure 5.3: An example of the main page of the KM platform

In the example, the layout of the main page in the KM platform provides an introduction of sustainable energy services using Flash. This enables an easier way to manage and update the information than the traditional HTML format. The hyperlinks on the page showing Home, Operation, Calendar, Forum, etc. provide the connection to other pages based on the users' requirements.



PHP is a server-side script, which is an open source programming language. It makes the KM platform dynamic and compatible with such server operating systems as IIS, Apache, and UNIX. PHP is used together with MySQL for responding to the queries from the users.



Figure 5.4: An example of a member page of the KM platform

For example, if a user intends to access the Member's Zone of the platform, the user is required to supply username and password. PHP collects the user supplied information and then sends the query to the MYSQL database and checks against the entries in the Member Table in the RDBMS. If the correct username and password have been supplied, the user is permitted to access the Member's Zone as shown in Figure 5.4. Tambon, Ampher and Biomass are selected. Therefore, the map shows the name of Tambon, the

name of Amphoe and the colour corresponding to the amount of biomass energy available. Due to the resolution and size of the screen, zoom may be needed in order to see the name of the Tambon. Member tools on the right hand side also provide more facilities for members, such as changing their passwords and viewing lessons learned. As for the other tools, they are only available to members with Administrator permission. Another tool for the design of the platform is the “Use case Diagrams”. They are described in the following section.

## **5.2 Use Case Diagrams**

The use case diagrams were implemented in order to describe the functions of the system from the users' perspective. In this study, users are classified into three groups:

1. General users – These are users who access the KM platform in order to get information about sustainable energy technologies. They can learn about sustainable energy technologies, operations of sustainable energy services, browsing for information such as events and activities, and, they can also add comments to the forum.
2. Members – These are local government administrators (LGAs) of Phitsanulok and researchers. They can access the same functionalities on the platform as general users, but they also have access to the Member's Zone that allows them to view

information concerning the local energy resources and lessons learnt. They can also supply information and knowledge to the system after moderation by the administrator.

3. Administrators – They are the webmasters or researchers who take on the responsibilities as the administrator of the system. They are responsible for the updating and maintenance of the KM platform by keeping constant communication with the LGAs and other researchers in order to validate and enhance the information online.

There are seven “*actors*” in the use case diagram, such as general user, member, administrator, RDBMS, GIS DB, LGAs and Researchers. These actors enter and receive Information from the system. They interact with the system to perform a variety of tasks, such as start or shutdown of the program, browse/enter/delete or update data, and maintaining the system. The interactions between these actors and/or the system are captured in three use case diagrams as shown in Figure 5.5.

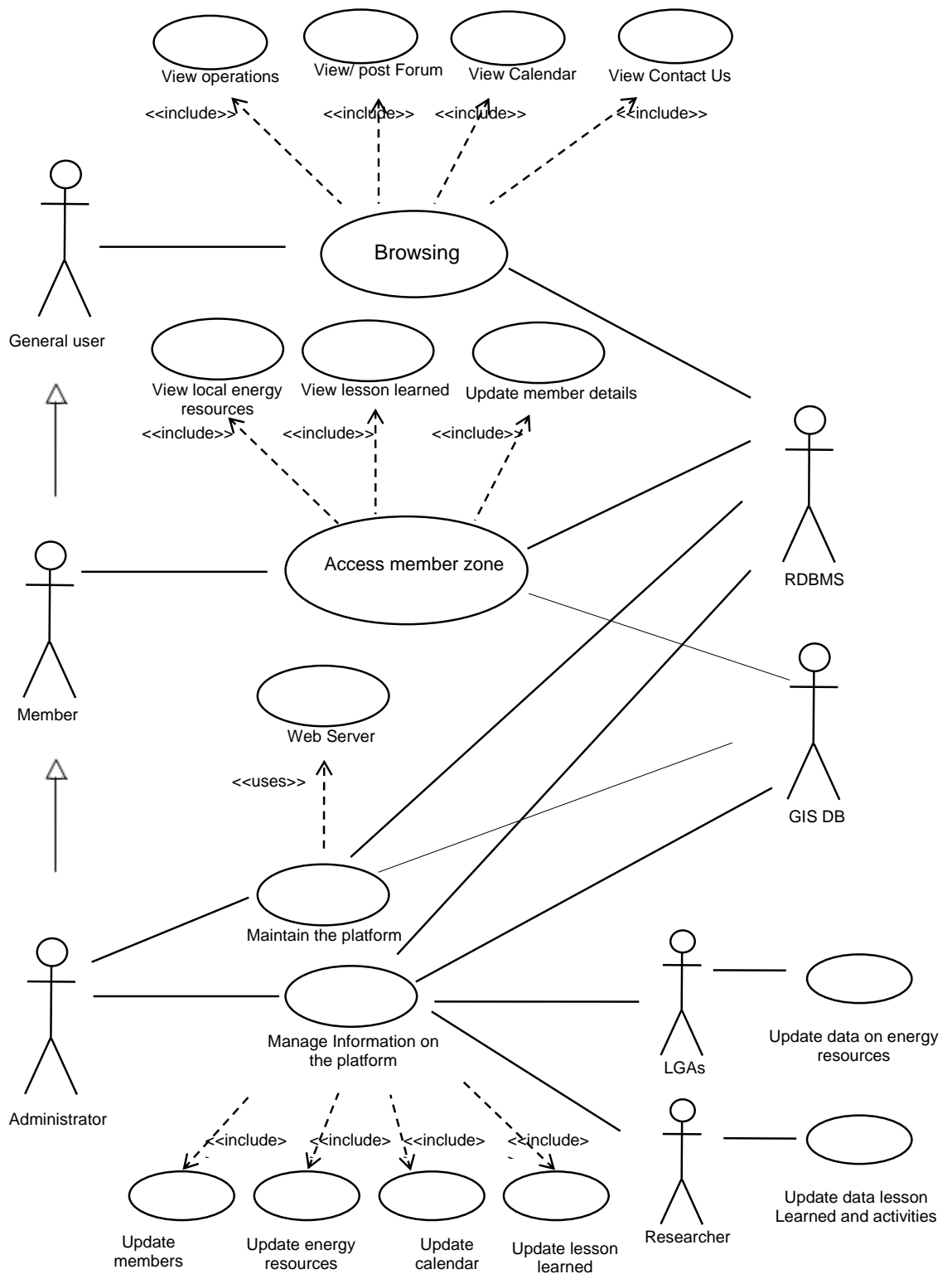


Figure 5.5: The use case diagram

The use cases are: browsing, access member's zone, manage information on the platform and maintain the platform. These use case diagrams are described in the terms of use case name, participating actor, entry condition flow of events and exit condition. They are written in a format similar to "Browsing use case scenario" presented in Table 5.1. In the Browsing use case scenario, the participating actors of this use case are general users, members and administrators. They can choose the features on the platform such as Operations, Calendar, and Forum, etc.

Table 5.1: Browsing use case scenario

<b>Use case name</b>	<b><i>Browsing</i></b>
<i>Participating actor</i>	Initiated by general users, members and administrators
<i>Entry condition</i>	1. User accesses to the KM platform by enter the correct url
<i>Flow events</i>	<p>2. User can click on "Operations" or "Calendar" or "Forum" or "Contact us" or "Member zone".</p> <ul style="list-style-type: none"> <li>- There are four choices in Operations, solar energy, biomass energy, hydro energy and wind energy. The user can click to see the operation of each energy.</li> <li>- The Calendar shows the present date. If the user wanted to see the activities on any date, the user chose on the date then the details of activities will be shown.</li> <li>- There are five choices in the Forum, solar energy, biomass energy, hydro power, wind energy and others. In each forum will allow the user to read through questions and answers, add a new question and reply an answer.</li> <li>- Contact us only show the detail of the administrator that the user can contact if there is any suspecting.</li> <li>- Member zone is only the users who have right permission to access it.</li> </ul>
<i>Exit condition</i>	3. Click on "Home" to go to the main page or click closed page.

All of them can access all the features except the member's zone, which requires username and password. The other use case scenarios are shown in Appendix A. The interaction between actors of each use case is shown in sequence diagram. An example of this is shown in Figure 5.6. The sequence diagram of general user describes the interaction between general users and other actors in the system, such as browser, web server, etc. The rest of the sequence diagrams are outlined in Appendix – A.

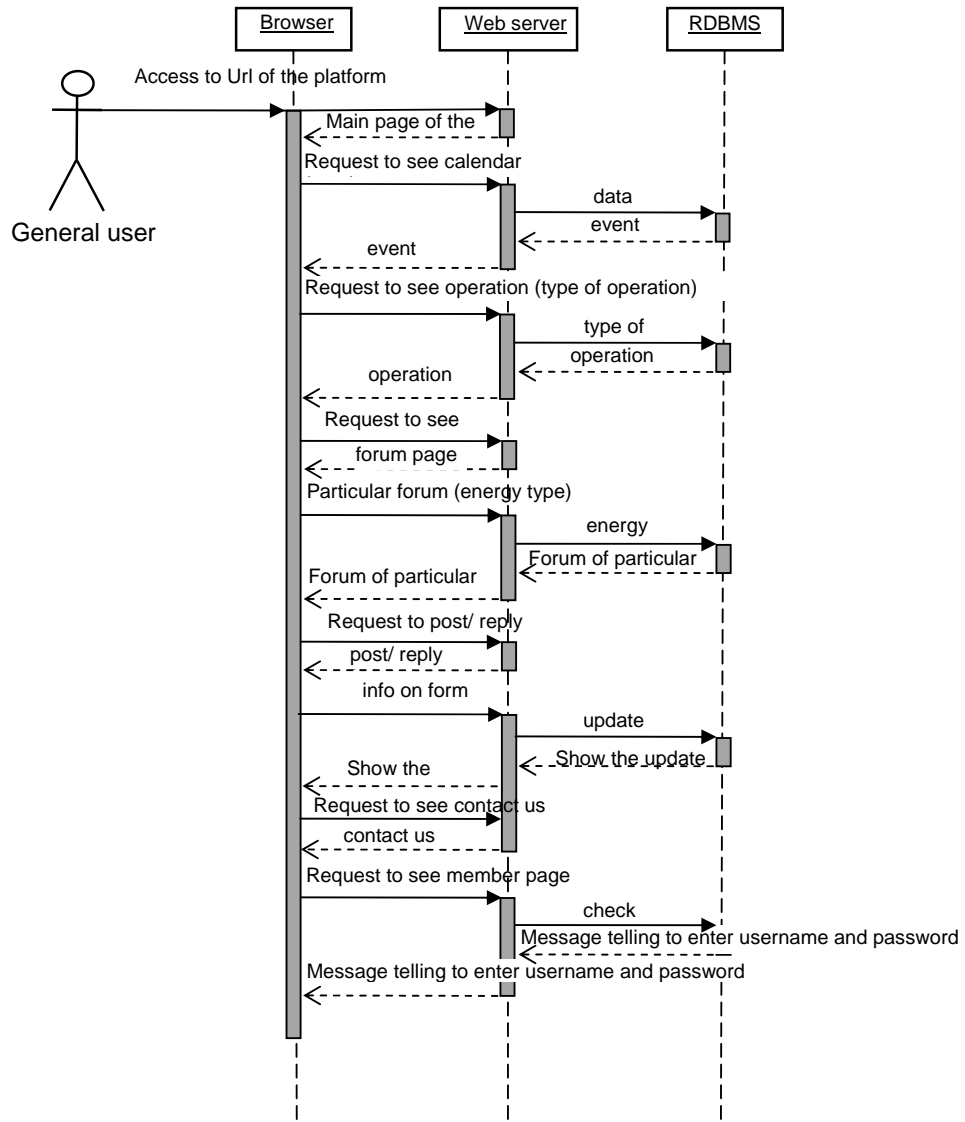


Figure 5.6: Sequence diagram of general user

### 5.3 Database Structures

PHP version 4.4.1 is a web programming language used for accessing data on both the MySQL and GIS DB. Both are the main databases of the platform. MySQL is an open-source relational database system, which is able to store a variety of data table formats. It can be customised by the

developers based on unique requirements of the database server. Also, the incorporation of phpmyadmin and MySQL Query Browser offer the flexibility for the administrator in managing the database over the Internet. MySQL version 5.0.26 is used to store most of the data for the platform except the map and spatial data, which are stored on the GIS DB. The GIS DB is a spatial database implemented by using an open-source software called MapServer. There are three major components of the GIS DB: a shx file, shp files and a dbf file. The shx file is an index file of the shp file and it contains the geometry of local area. The dbf file is the attribute file of each geometry type. The relationship of these three files is shown below:

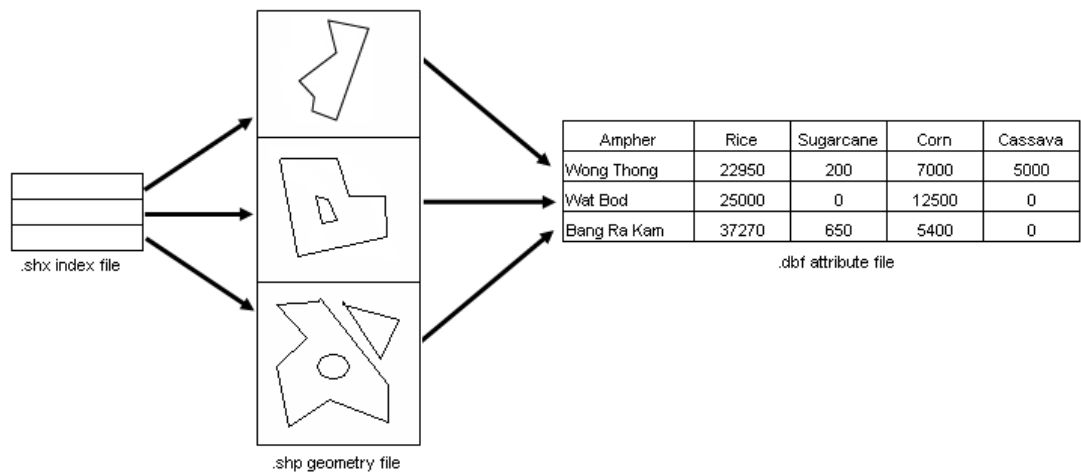


Figure 5.7: The relationship of files on GIS DB

Information access from the RDBMS and the GIS DB depends on the permission rights of the user and the user's requirements. For example, the general user entity (Figure 5. 5) has only access to the RDBMS and it does not have the permission to access the member's zone. On the other hand, the member entity (Figure 5. 5) has both access rights to the RDBMS and

the GIS DB. More entities and relationships among them are shown in following entity relationship (ER) diagrams.

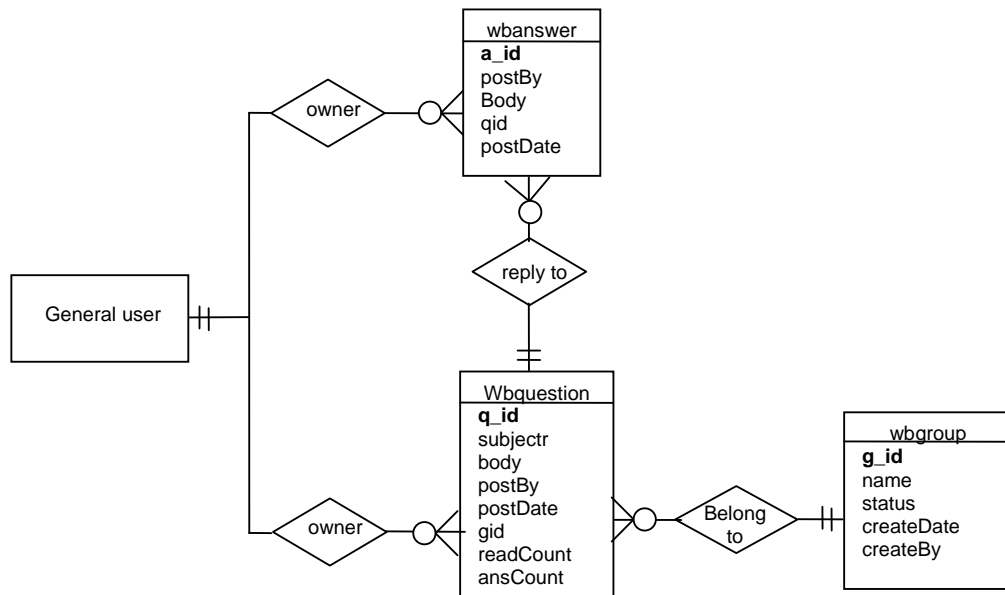


Figure 5.8: ER diagram of general user

The main entities in Figure 5.8 are: general user, wbanswer, wbquestion and wbgroupp. The general user entity is an external user or a visitor. The wbanswer entity is used for storing the details of forum answer. The wbquestion contains such details of forum questions as date and question details. The wbgroupp contains question groups



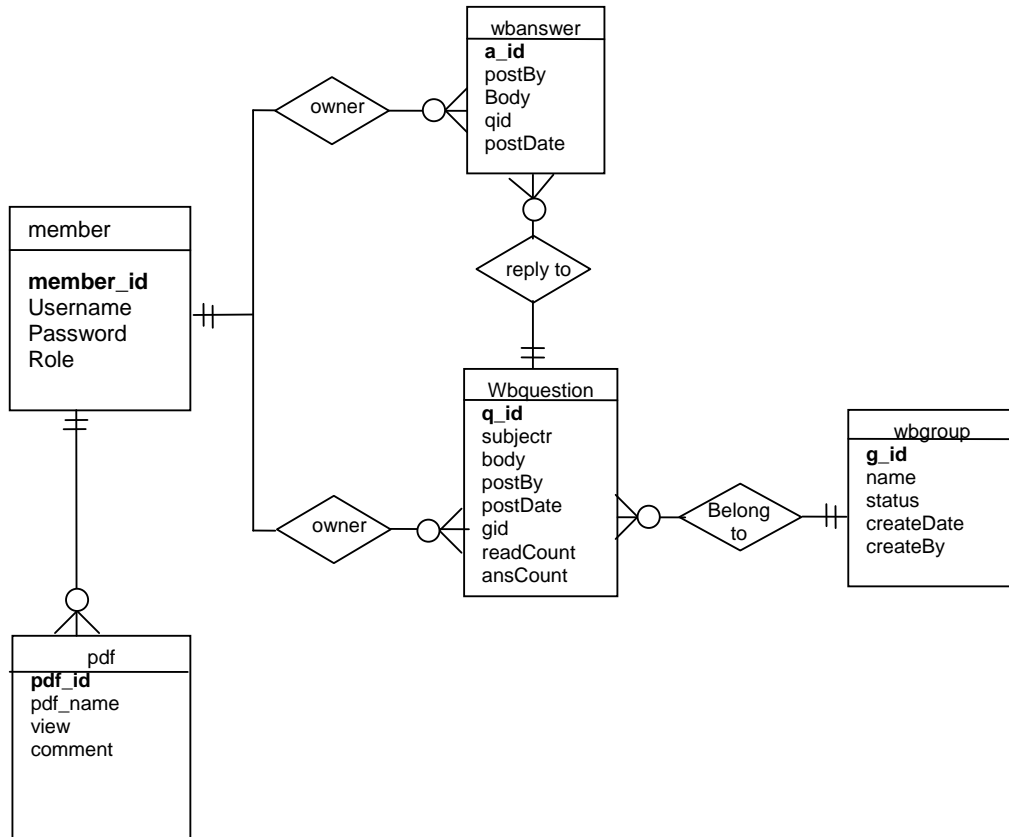


Figure 5.9: ER diagram of member

Figure 5.9 illustrates the ER of members.

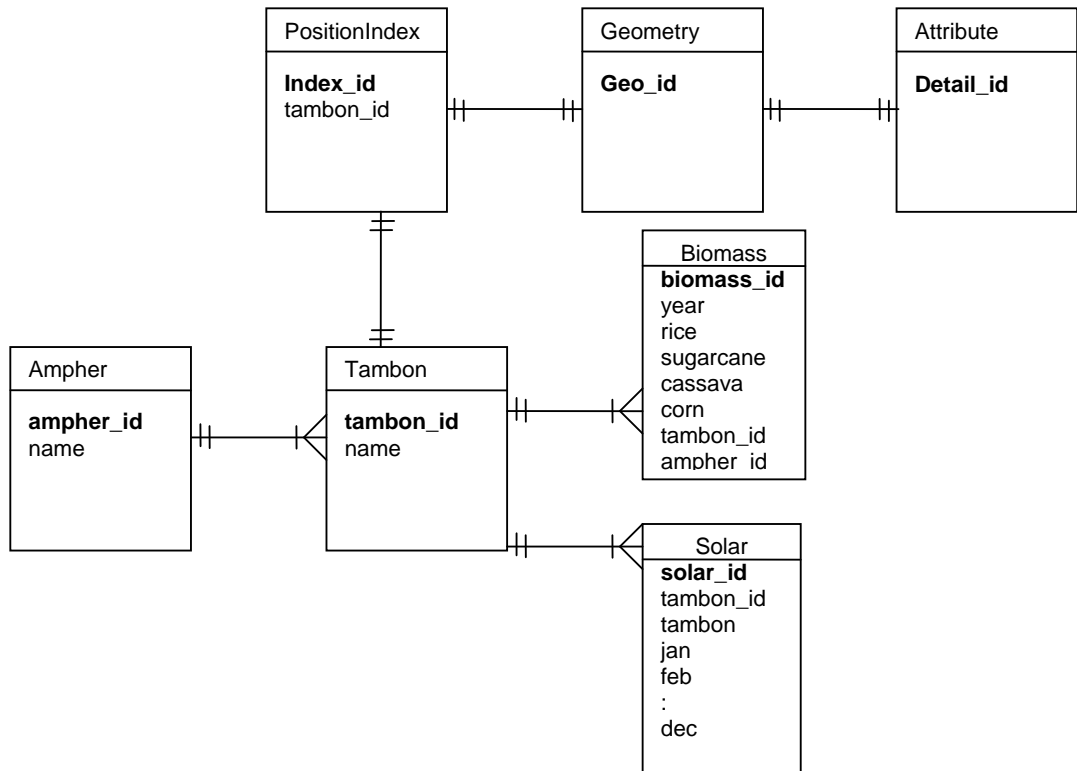


Figure 5.10: ER diagram of administrator

Apart from the entities in Figure 5.8, the member entity contains username, password and member role. The role attribute of the member entity is equal to “member”. It means that a member has more permissions than the general user. More features are allowed to be viewed, such as information on sustainable energy resources and lessons learned. Figure 5.10 is the ER diagram of the administrator. Besides from having the same functions as general users and members, the administrator can update the databases based on information from the researchers, LGAs and the forum.

#### **5.4 Features of the KM Platform**

The features of the KM platform consist of operations, calendars, lesson learned, forum and local energy resources. General users can access the operations and calendars; and to post information in the forum. On the other hand, viewing the lesson learned and local energy resources are only available in the member's zone that requires the security measures of username and password. A summary of the features of the KM Platform is described below:

*1. Operations* - There are information on four main operations of sustainable energy: energy from solar, energy from biomass, energy from wind and energy from hydropower. An example screen shot of the biomass operation is shown in Figure 5.11.

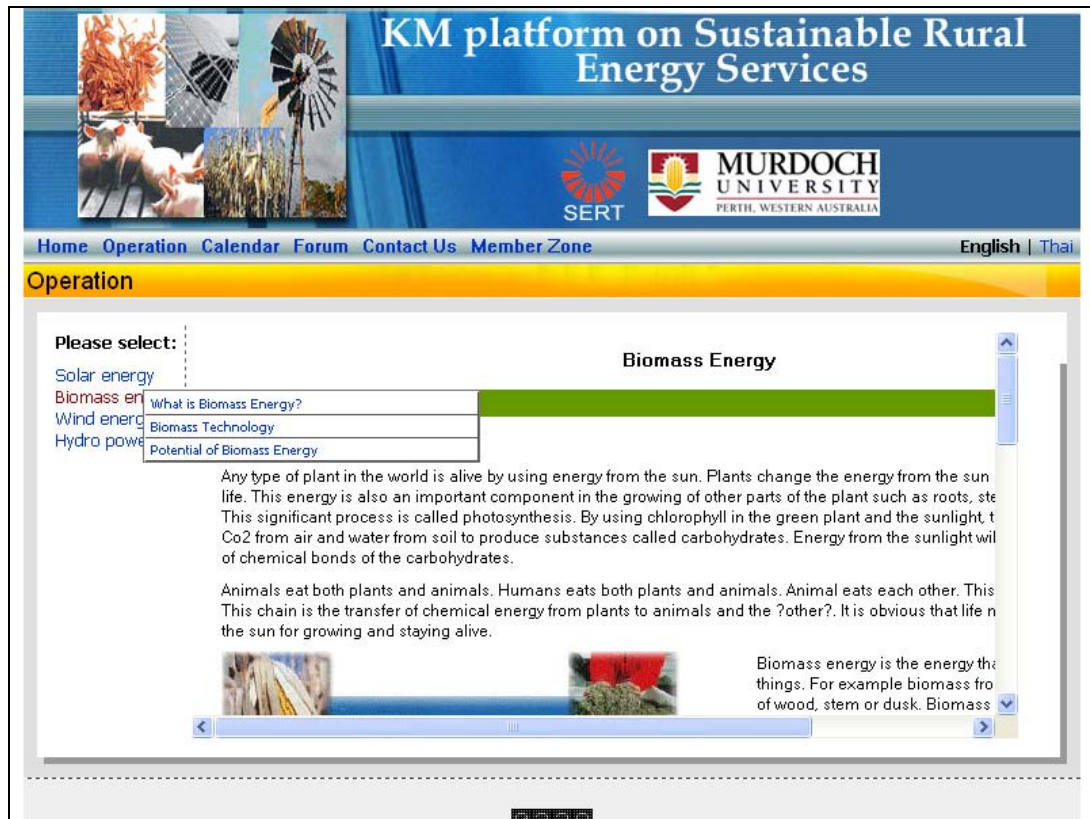


Figure 5.11: An example screen shot of biomass operation on the KM platform

The operation page of biomass consists of three sub-sections: definition of biomass energy, Biomass Technology and Potential of Biomass Energy. The first one introduces biomass to the user. The second explains the biomass energy technology and how to create energy from biomass. The last one describes the potential of biomass energy in Thailand. The format of the information display is similar for the other three operations: solar energy, wind energy and hydro power.

2. *Calendar* – Activities for the stakeholders relating to sustainable energy, such as conferences, training courses, and meetings on both local and global events can be put into the calendar. Users can find out the details about these activities by clicking on the specific date. A screen shot of the calendar is shown in Figure 5.12



Figure 5.12: A screen shot from the Calendar on the KM platform

3. *Forum* – This web board allows all users to post and reply questions that are related to sustainable energy. For security reasons and to ensure the appropriateness of the materials, the submission will be moderated by the administrator prior to putting on the website. The discussions are classified into five groups: solar energy, biomass energy, hydro power, wind energy, and other sources of energy. An example screen shot is shown in Figure 5.13.



Figure 5.13: An example of screen shot of forum on the KM platform

4. *Lessons learned* – This feature is within the member’s zone. Only users with permission right as member can view lessons learned on sustainable energy services or technologies. Figure 5.14 show an example of a screen shot of this feature.

5. *Local energy resources* – The feature is also a part of the member’s zone. It allows a member to see how much energy can be produced by each type of sustainable energy at the local region. At the present moment, the KM platform shows only four types of biomass energy together with solar energy. The four types of biomass are corn, rice, cassava and sugarcane. These are the main products in the province of Phitsanulok. Wind has not been included as the potential of the wind energy in the region is neither high nor

consistent enough to generate sufficient energy. However, it is understood that such information will be essential to other parts of the country. A summary of the amount of energy available is shown as a diagram with selected areas and associated figures shown on the page. An example is shown in Figure 5.15.

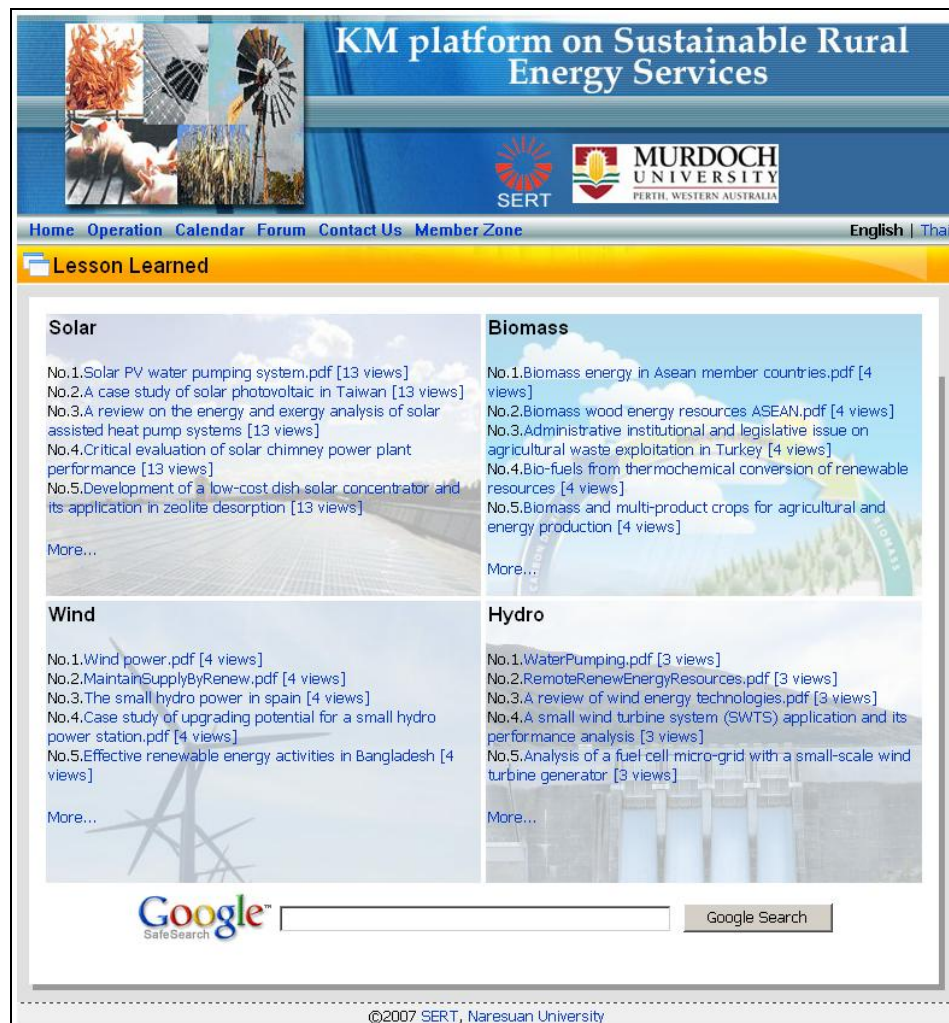


Figure 5.14: An example screen shot of lesson learned shown on the KM platform



The display of the platform is available both in English and Thai language. Some of them have already been shown. The rest of the screen shots can be found in Appendix B. The site map in Figure 5.16 shows the features and structure of the platform. A summary of the access rights to the features of the KM platform by the three groups of participants is shown in Table 5.2.

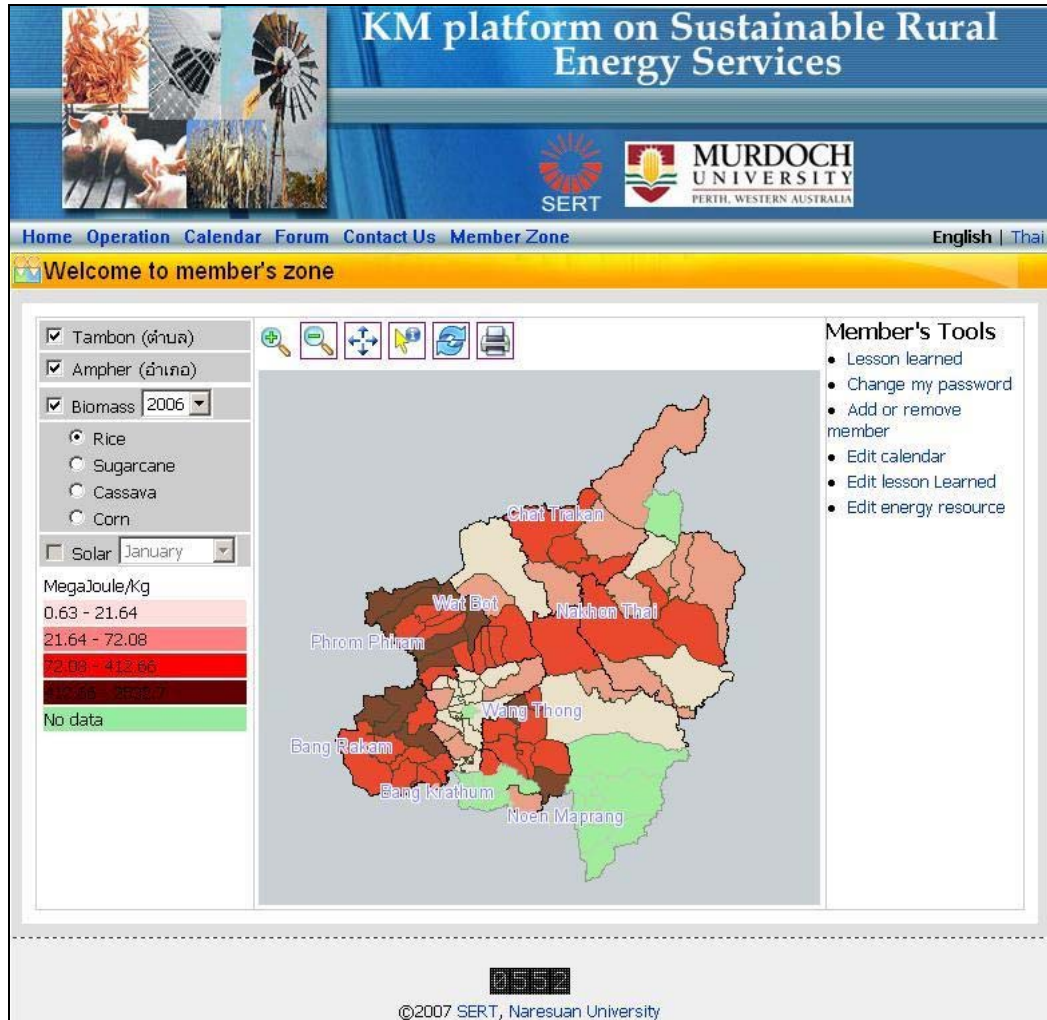


Figure 5.15: An example of a screen shot of local energy resources (rice) on the KM platform



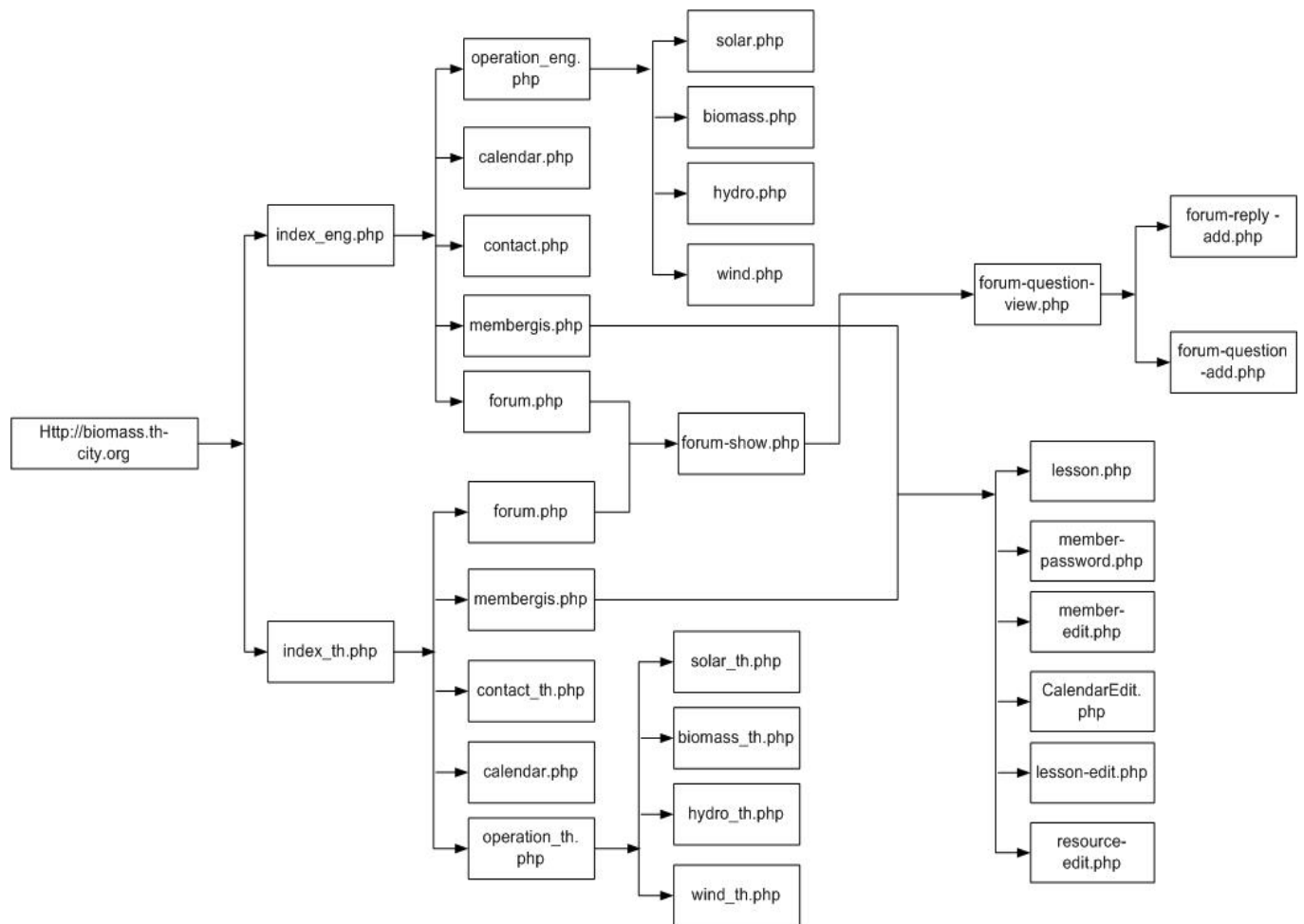


Figure 5.16: Site map

Table 5.2: Access Rights of participants relating to the features of the KM

Platform

Features\Participants	General users	Researchers		LGAs*
		Users	Admin	
1. View Operation	X	X	X	X
2. View Calendar	X	X	X	X
3. Post/ Reply Forum	X	X	X	X
4. View Lesson Learned			X	X
5. View Local Energy Resources			X	X
6. Update data on the system			X	

\*LGA = Local Government Administrator

## **5.5 Summary**

The chapter has examined the design and implementation of the KM platform. In this study, use cases diagrams are used to describe the function of the system based on users' perspective. The database structure shows how the information is stored in the system and what relationships between spatial data and non-spatial data (attribute data) exist. The features of the KM platform are View Operations, View Calendar, Post/ reply Forum, View Lesson Learned, View Local Energy Resources, and Update data on the system. The platform was tested by three groups of participants: general users, researchers and local government administrators (LGA). Each group of participants had different permissions (Table 5.2). The results of the testing process of the KM platform have been gathered in form of a questionnaire and are shown in Chapter 6.

## CHAPTER 6: RESULTS AND ANALYSIS

This chapter presents the research findings from the surveys conducted before and after the three participant groups having used the KM platform: local government administrators (LGAs), researchers and general users. The aims of these findings are:

- To investigate the Internet infrastructure of the participants' locations where the study has taken place. The Internet Infrastructure is important as it is the communication channel for the delivery of knowledge from the Sustainable Energy KM platform.
- To investigate whether the participants are familiar with any type of KMS.
- To find out about the most popular services on the KM platform and the participants' level of satisfaction.
- To find out any improvement of knowledge on sustainable energy technologies among the participants after using the KM platform.

This chapter starts with the results of the pre-questionnaire, followed by the results of the post-questionnaire. Then, results from statistical analysis based on descriptive statistics, Pair T-Test and statistic significance tests using linear regression are provided.

## 6.1 Results from Pre-questionnaire

One hundred and seventy (170) valid pre-questionnaires were received. Out of these, forty-three (43) were from the LGAs, thirty-two (32) were from the group of researchers, and, ninety-five (95) were received from the general users. The results of the pre-questionnaire provide the information on the participants' demography, the Internet infrastructure at the participants' location, the participants' behaviours on the Internet and the participants' familiarity of KMS. The results also include an assessment of the participants' knowledge on sustainable energy technologies based on a set of pre-test questions.

### 6.1.1 Comparative Demography between Each Group of Participants

The demographic data of the participants consist of age and education. The age of participants in each group is shown in Figure 6.1.

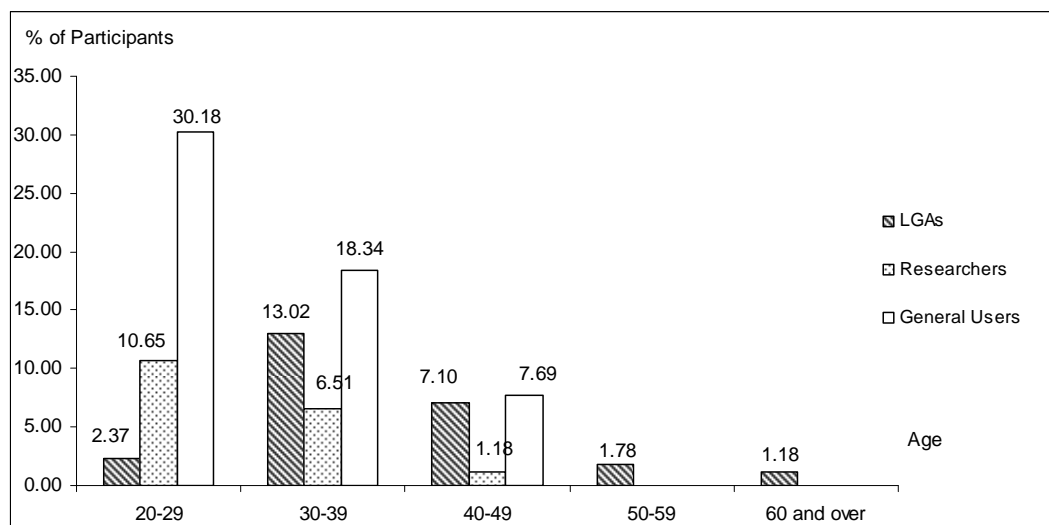


Figure 6.1: Age of participants in each group

Age is classified into five groups in the questionnaire, 20-29, 30-39, 40-49, 50-59, and, 60 years old and over. The participants are mainly between 20 and 49 years old. Only 2.96% of the participants are older than 49 years old. Education was classified into four groups; primary school, high school, undergraduate and postgraduate. 88.02% of the participants graduated from an undergraduate level. 8.98% graduated at a postgraduate level. 2.40% graduated at a high school level and 0.60% graduated at a primary school level.

### **6.1.2 Internet Infrastructure**

The infrastructure of the participants' locations was investigated before the implementation of the KMS. The results of the investigation show that the participants' locations are all internet ready and they are serviced by either government or private Internet Service Providers (ISP). There are approximately more than a hundred Internet cafés in the province and at least one Internet café in each Tambon. In each Tambon, the LGA also provides five to ten Internet stations at the local administrator office for use by the community free of charge. Moreover, there are pre-paid Internet cards available sold at the post offices. Hence, it is not a major problem for the participants to access the Internet.

In the questionnaire, participants were asked the following questions:

1. Do you have access to the Internet?
2. Where do you use the Internet?

3. If you have access, how often do you use the Internet?
4. What do you use the Internet for?
5. How would you rate your level of access to the Internet?

These questions were asked in order to investigate the participants' familiarity with the Internet and the participants' behaviours on using the Internet. In the first question, the objective is to assess the knowledge of the participants on how to access to the internet. The majority of the respondents (97.06%) has the know how to access to the Internet. Only 2.94% of the respondents did not have such knowledge. The results of the second question are shown in Figure 6.2.

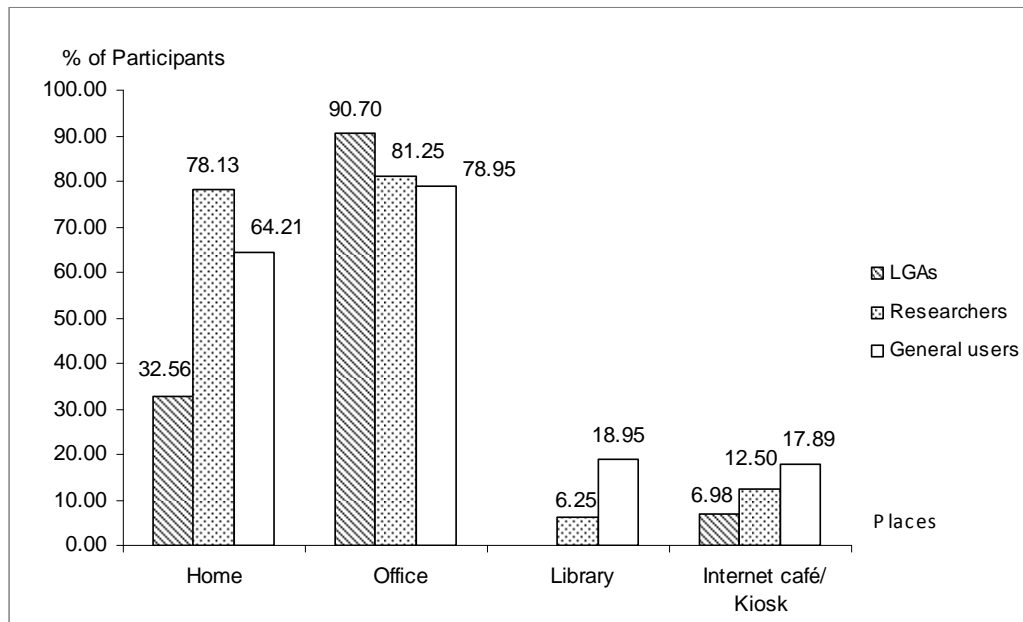


Figure 6.2: Distribution of the locations where the participants access the Internet

The results are based on the returned questionnaires from the three groups of participants. The participants may have multiple accesses at home, in the office, in the library or in Internet cafés. For example, in the case of the LGAs, 32.56% of them indicated that they have access at home and none of them uses an access at the library. The results show that the most popular place for the participants to use the Internet is at the office (90.70% of LGAs, 81.25% of researchers and 78.95% of general users). The least popular place is the library, although the general users have a slightly higher level of utilization than the Internet Café.

Table 6.1: Percentage of how often the participants use the Internet

Level	LGAs (%)	Researchers (%)	General Users (%)
Rarely	0.00	0.00	2.11
Regularly	12.82	0.00	5.26
Often	51.28	15.63	29.47
Use daily	35.90	84.38	63.13

The level of utilizing the Internet in Table 6.1 is classified into four categories: rarely (about once a month), regular (once a week), use often (three times a week) and use daily. The results show that the researchers are the most intense users of the Internet and 84.38% of them “use daily”. Within the same category, 63.13% of the general users and 32.56% of the LGAs also use the Internet daily.

Question number four asked the purpose of using the Internet of all participants. The results are shown in Figure 6.3.

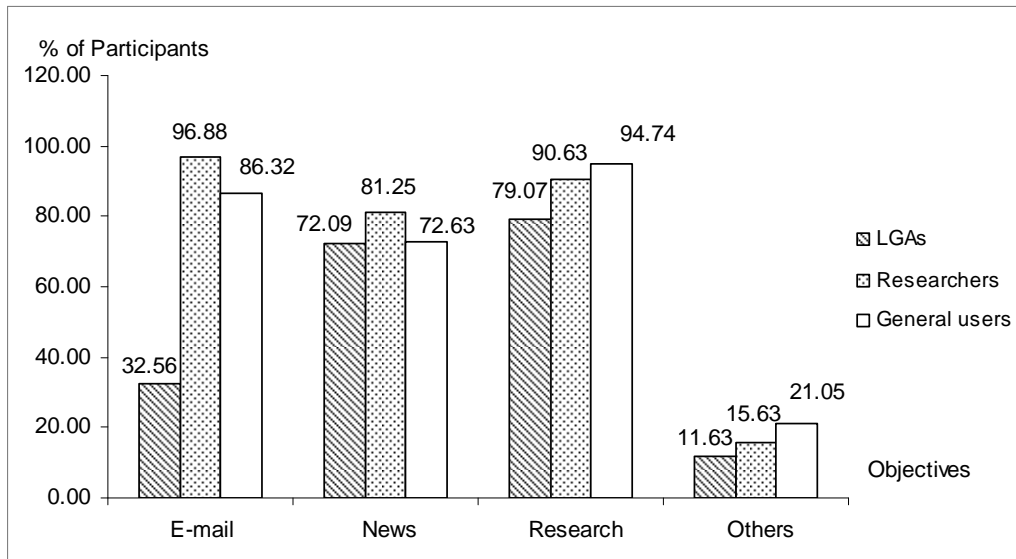


Figure 6.3: Percentage of objective of using the Internet

The percentages in Figure 6.3 were derived in a similar manner as those in Figure 6.2. The participants may choose multiple answers and the percentage is based on the returns from the same group of participants. For example, 32.56% of the LGAs have indicated that they use the Internet for Emails. The most popular purpose of using the internet by all participants is “research” (94.74% of general users, 90.63% of researchers and 79.07% of LGAs). The other popular purposes are “news” and “e-mails”. The remaining purpose, “others”, includes mainly such “entertaining” activities as playing online games and accessing online music, video, and fashion magazines. Finally, the participants’ opinions on the Internet connection of their locations are shown in Table 6.2.



Table 6.2: Participants' opinion on the level of Internet connection

Level	LGAs (%)	Researchers (%)	General Users (%)
Poor	0.00	0.00	1.06
Average	35.90	9.38	27.66
Good	56.41	78.13	57.45
Excellent	7.69	12.50	13.83

The participants' opinions on the Internet connection at their locations are generally "good". Over 50% of the LGAs and general users, and over 70% of the researchers belong this group. It is interesting to note that about one third of the LGAs only rate the level of Internet connection as "Average".

According to the above results, the participants are sufficiently familiar with the Internet. Only a few participants responded that they do not know how to access to the Internet. This may be due to their education or age. Nevertheless, nearly all of the participants know how to access to the Internet and have good level of access. The Internet infrastructure of the participants' locations is ready and convenient to use as most of the access are at the office and from home. The participants also responded with a high level of activities in using the Internet for "research" and most of them use the Internet daily. The Internet connection level is also "good" based on the participants' opinions. Therefore, it can be anticipated that the participants will gain knowledge and learning via the Internet if there are something useful or relevant for them. In this study, the topic of interest is referred to sustainable energy technologies, and it is believed that the knowledge will bring benefits to the participants and their communities.

### 6.1.3 Participants' Background Experience on Knowledge Management

In order to collect the data on the background experience of the participants on KM, the following questions were included in the pre-questionnaire:

1. Have you used any KM platform before?
2. Where did you use the KM platform?
3. If you are using any KM platform, how often do you use the facility?
4. What do you use the KM platform for?

The results of the first question are shown in Figure 6.4.

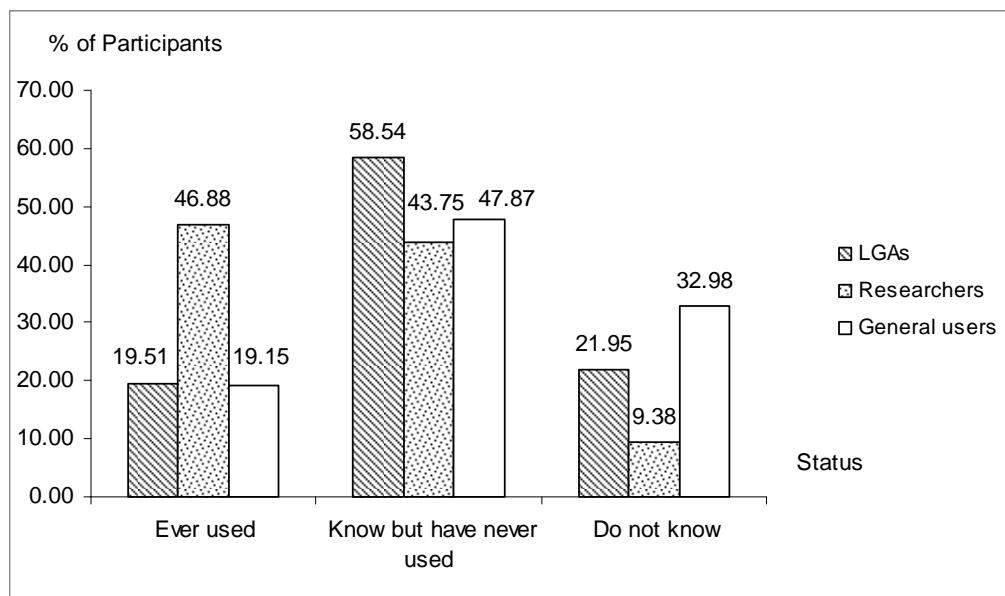


Figure 6.4: Participants' background experience on KM platform

More than 70% of participants are aware of KM platform (67.02% of the general users, 90.62% of the researchers and 78.05% of the LGAs). The most participants who do not know anything about KM platform are the general users (32.98%). This is followed by 21.95% of the LGAs and 9.38% of the researchers.

Responses to the second question have indicated that KM platforms have already been implemented in some of the participants' work places.

Table 6.3: Percentage of places where the participants have used KM

Places	LGAs (%)	Researchers (%)	General Users (%)
Work place	100.00	60.00	66.67
Government site	25.00	13.33	0.00
Education Institute	12.50	26.67	38.89
Others	0.00	0.00	5.56

From Table 6.3, all the LGAs have used KM at their work places and over 60% of both researchers and general users have also used KM at their work places. In addition, the participants have also accessed to KM platforms at government sites and educational institutes. Some general users also accessed to KM platform at "other sites", such as Internet café and libraries.

Table 6.4: Results on how often the participants use KM platforms

Level	LGAs (%)	Researchers (%)	General Users (%)	All participants (%)
Rarely	60.00	0.00	38.89	30.23
Regularly	10.00	26.67	22.22	20.93
Often	20.00	33.33	38.89	32.56
Use daily	10.00	40.00	0.00	16.28

From Table 6.4, the frequency of access to KM platforms by the participants is based on the same definitions as the frequency of access to the Internet as described in the previous section. The average results from all participants are similar between "Rarely" and "Often" at about 30%. However, when compared by groups, the group with the most frequent access to KM platforms is the researchers at 40%. They have indicated that

they use KM daily. On the other hand, the group that indicated the least frequent access to KM platforms is the LGAs. 70% of the LGAs responded that they access to KM platform as “Rarely”.

The purposes for using KM platform are shown in Figure 6.5. Four choices were suggested: job requirements, get information, sharing information and search. Researchers and LGAs are more likely to get information via the KM platform. The figures indicate high values of 60% (researchers) and 75% (LGAs). The general users most likely use the KM platform to share (55.56%) and search (55.56%) information using the KM platform.

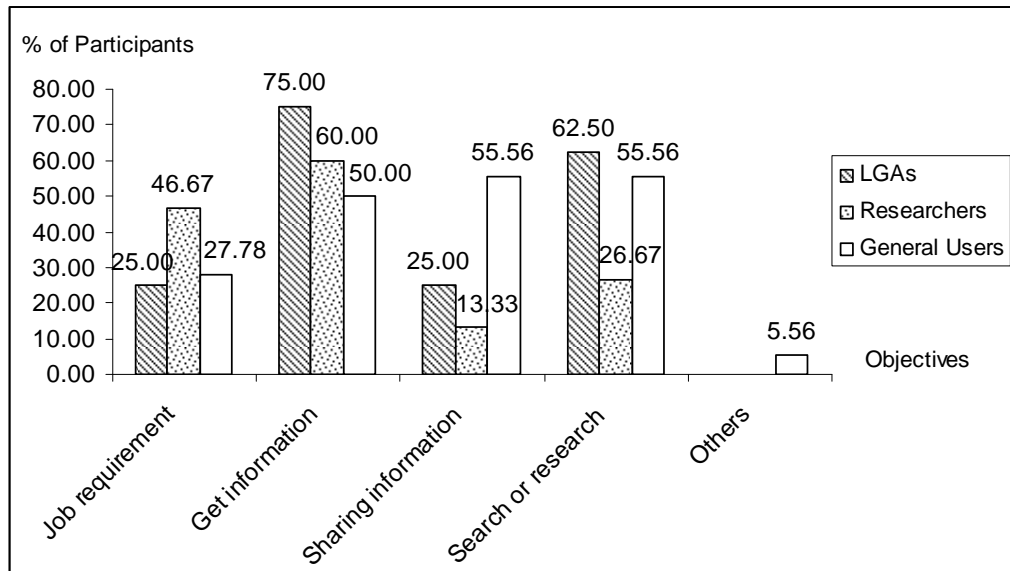


Figure 6.5: Participants’ objectives on access to the KM

In summary, only 25.75% of all the participants do not know anything about KM. The remaining 74.25% of the participants have indicated previous

experience or knowledge about KM platforms. Most of them used KM at their work places for information collection at least once a week. The results also indicate that the LGAs and researchers prefer to get information via the KM platform. In most cases, the “get information” refers to more in depth or detailed information and related to some tasks or work. On the other hand, general users prefer to share and search information for more general purposes.

#### 6.1.4 Means Score of Pre-test

In order to test the knowledge of the participants before they access to the KM platform on sustainable energy technologies developed in this study, pre-test was set up and included in the last section of the pre-questionnaire. It is a set of fifteen multiple choice questions related to sustainable energy technologies. Table 6.5 shows the results of the pre-test.

Table 6.5: Mean and standard deviations of pre-test

Groups	No of participants	Mean value of correct answers	Standard Deviation
LGAs	43	7.72	2.31
Researchers	32	10.28	2.32
General Users	95	8.77	1.84

Out of the 15 questions, the researchers got the highest mean value with 10.28 correct answers. It is not surprising as almost of them are working in the related sector and their educational background has at least completed at undergraduate level. On the other hand, the lowest mean value (7.72)

belongs to the group of LGAs. While the general users seem to have scored a higher mean value; this can be explained that the general users involved in this study are interested in the topic and that they may have some prior knowledge on the subject

## **6.2 Results from Post-questionnaire**

Post questionnaires were returned after the participants having accessed the KM platform for at least one week. One hundred and ten (110) of the valid post-questionnaires were received. This represents about 65% of those taken part in the pre-questionnaire have continued with the post-questionnaire. Fifteen of them are from the group of LGAs, eighteen from the researchers and seventy-seven from the general users. The results from the post-questionnaire show the participants' behaviours on the usage of the KM platform. This includes such information as the engagement period the participants have spent on the KM platform, the frequency of accessing the platform, the services most often used, the participants' satisfaction with the platform, and results of the mean values from the post-test.

### **6.2.1 Participants' Behaviour on Using the KM Platform**

Engagement period is a measure of the time that a participant has spent on the sustainable energy KM platform. It is expected that this duration is a major factor that will help a participant to improve his/her knowledge on sustainable energy technologies. In this section, only 63 of the participants

answered the question and the results of the participants' engagement periods are illustrated in Figure 6.6.

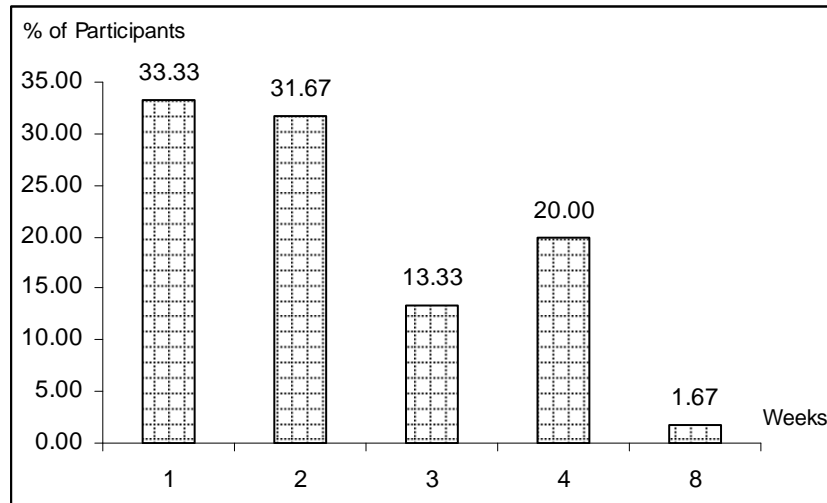


Figure 6.6: Distribution of participants' engagement period with the KM platform and the duration of time

In the above diagram, majority of the respondents spent one to two weeks on the KM platform before they returned the post-questionnaire. Over two-third of the participants belong to this category. The longest period of time spent on the KM platform was eight weeks. This was mainly due to one participant who has chosen to spend more time on the system before returning the questionnaire. The mean value of the duration that the participants spent on the KM platform was 2.35 weeks.

In addition, the frequency of access to the KM platform was asked in order to assess the participants' interest in the KMS. The answers to this question are

classified into four choices: rarely (about once a month), regular (once a week), use often (three times a week) and use daily. The results show that over 43% of the participants have accessed the KM platform regularly. The general users also appear to have accessed to the KM platform more often. However, their duration of engagement is generally shorter while the researchers and LGAs have spent more time even though they have indicated that they only accessed the KM platform rarely. The details are shown in Table 6.6.

Table 6.6: Frequency of access by the participants to the KM platform

Level	LGAs (%)	Researchers (%)	General Users (%)	All participants (%)
Rarely	54.55	64.71	29.85	38.95
Regularly	36.36	17.65	50.75	43.16
Often	9.09	11.76	14.93	13.68
Use daily	0.00	5.88	4.48	4.21

Services on the KM platform are classified into two categories: services for members and services for non-members. The percentage of participants who accessed non-member services of the KM platform is shown in Table 6.7.

Table 6.7: The percentage of participants who accessed non-member services on the KM platform

Services on the Platform	LGAs (%)	Researchers (%)	General Users (%)
Operations	45.45	30.77	38.04
Calendar	45.45	38.46	33.70
Forum	4.55	19.23	15.22
Others (e.g. contact us)	4.55	11.54	13.04



The calendar was the most popular service on the platform used by 45.45% of the LGAs, 38.46% of the researchers and 33.70% of the general users. The information on the calendar include conference dates, seminar and events that are related to sustainable energy. Thus, it indicates that the participants are interested in the updated information on sustainable energy or similar events.

In addition, the counter of each page of the KM platform reveals how often the KM platform has been “hit”. Within a period of four months from July to October 2007, there were 1,592 hits for the main page, 338 hits for the operation page, 300 hits for the calendar page and 288 hits for the forum page. All the above are sections accessible by both members and non-members. In the case of member services, the frequency of access is observed via the hit counter on the member page of the KM platform. It recorded 547 hits indicating the services on the member page were being utilised within this period. The satisfaction level of using both services is described in the next section.

### **6.2.2 Participants’ Level of Satisfaction with the KM Platform**

Likert’s scale 0.00 to 5.00 was used to measure the participants’ level of satisfaction with respect to the KM platform. The five levels of the scale are shown as follows:

0.01 to 1.00 represented “Strongly Disagree”

1.01 to 2.00 represented “Disagree”

2.01 to 3.00 represented “General”

3.01 to 4.00 represented “Agree”

4.01 to 5.00 represented “Strongly agree”

Tables 6.8 to 6.10 show the responses by each group of the participants in the post-questionnaire. The results are illustrated in the forms of the mean value, standard deviation and interpretation based on the five criteria in the questions.

Table 6.8: Mean, standard deviation and interpretation of level of general users’ satisfaction to the KM platform

Criteria	Level of Satisfaction		
	Mean	SD.	Interpretation
1. The graphical user interface of KM platform is user friendly.	3.49	0.58	Agree
2. The information on the KM platform is up to date.	3.47	0.73	Agree
3. The KM platform provides communication between you and others or experts i.e. e-mail, forum and etc.	3.40	0.70	Agree
4. The KM platform provides meaningful information.	3.85	0.59	Agree
5. The KM platform provides adequate information on Sustainable Energy Services for designing and building sustainable energy services.	3.58	0.67	Agree

Table 6.9: Mean, standard deviation and interpretation of level of researchers' satisfaction to the KM platform

Criteria	Level of Satisfaction		
	Mean	SD.	Interpretation
1. The graphical user interface of KM platform is user friendly.	3.29	0.47	Agree
2. The information on the KM platform is up to date.	2.94	0.77	General
3. The KM platform provides communication between you and others or experts i.e. e-mail, forum and etc.	2.82	0.72	General
4. The KM platform provides meaningful information.	3.14	0.53	Agree
5. The KM platform provides adequate information on Sustainable Energy Services for designing and building sustainable energy services.	3.29	0.47	Agree

Table 6.10: Mean, standard deviation and interpretation of level of LGAs' satisfaction to the KM platform

Criteria	Level of Satisfaction		
	Mean	SD.	Interpretation
1. The graphical user interface of KM platform is user friendly.	3.20	0.56	Agree
2. The information on the KM platform is up to date.	3.27	0.59	Agree
3. The KM platform provides communication between you and others or experts i.e. e-mail, forum and etc.	3.27	0.59	Agree
4. The KM platform provides meaningful information.	3.40	0.63	Agree
5. The KM platform provides adequate information on Sustainable Energy Services for designing and building sustainable energy services.	3.13	0.64	Agree

On the whole, the above tables indicate that nearly all the participants have indicated an above average satisfaction level. The groups of general users and LGAs indicated that they have an above average satisfaction in all

criteria. The group of researchers has a similar level of satisfaction with the exception of two criteria: data is up-to-date and communication between users. They only returned a “general” level of satisfaction. This may be due to the fact that the researchers already have a fair level of knowledge about the sustainable energy technologies and that they may feel the information on the KM platform is not up-to-date. In addition, they may expect the portal to provide them a venue for communication with fellow researchers for exchange of information and ideas. Such facilities could include blogs, social networks, podcasts and webcasts, etc. These features will be discussed in Chapter 7 as future direction for this research.

Table 6.11: Mean, standard deviation and interpretation of level satisfaction to the KM platform of the member and non-member group

Criteria	Level of Satisfaction					
	Member			Non-member		
	Mean	SD.	Interpretation	Mean	SD.	Interpretation
1. The graphical user interface of KM platform is user friendly.	3.49	0.58	Agree	3.25	0.51	Agree
2. The information on the KM platform is up to date.	3.47	0.73	Agree	3.10	0.70	Agree
3. The KM platform provides communication between you and others or experts i.e. e-mail, forum and etc.	3.40	0.70	Agree	3.03	0.70	Agree
4. The KM platform provides meaningful information.	3.85	0.60	Agree	3.28	0.58	Agree
5. The KM platform provides adequate information on Sustainable Energy Services for designing and building sustainable energy services.	3.58	0.67	Agree	3.22	0.55	Agree

Table 6.11 shows the mean, standard deviation of criteria as returned by the members and non-members. The results indicate that all participants are satisfied above average in all criteria and the members are having a higher level of satisfaction as indicated in the mean values.

### 6.2.3 Mean Value of Post-test

Post-test was set up and put in the last section of the post-questionnaire. It was a set of fifteen multiple choice questions similar to section four in the pre-questionnaire. However, the answers of the multi choice questions have been reorganised. Table 6.12 shows the results of the post-test.

Table 6.12: Mean and standard deviation of post-test

Groups	No of participants	Mean value of correct answers	Standard deviation
LGAs	15	8.60	1.68
Researchers	18	10.67	1.19
General Users	77	9.83	1.73

The highest mean (10.67) belongs to the researchers, and it is 10.67 out of 15.00. Meanwhile, the lowest mean is 8.60 and belongs to the LGAs.

### 6.3. Pair T-Test

The comparison between the mean of the pre-test and post-test shows that the participants' knowledge of sustainable energy technologies has improved after using the KM platform. Table 6.13 shows the results of the pair T-Test

of the pre-test and the post-test. The mean of the pre-test and post-test is significant different because the significance value is less than 0.05 ( $P = 0.000$ ). The Pearson correlation value (0.391) also shows that the relationship of the mean value between the pre-test and post-test is positive. For example, if a participant got a high score in the pre-test, he/she would get a high score in the post-test too. The factor influencing this difference is described in the next section.

Table 6.13: Pair T-Test of pre-test and post test

Pair	No of participants	Mean	Standard deviation
Post-test	110	9.80	1.72
Pre-test	110	8.74	1.75

Mean differences = 1.06,  $t = 5.80$ , Pearson Correlation = 0.391,  $P = 0.000$

#### 6.4 Linear Regression Analysis

Engagement period on the KM platform was chosen as a factor influencing the different value of the pre-test and post-test. In order to measure the influence level of the learning period towards the different value, linear regression analysis is used.

Table 6.14: Results of linear regression analysis showing the relationship of *all participants'* learning periods on the platform and the different value between pre-test and post-test.

Factors	R	R <sup>2</sup>	Unstandardised Coefficients	Standardised Coefficients	T	P
			B	Beta		
Learning period (weeks)	0.092	0.008	0.132	0.092	0.701	0.486
(constant)			0.912		1.818	0.074

According to Table 6.14, the R square value is 0.008. It implies that the learning period influences the increment value between the pre-test and post-test at only 0.8 percent without statistical significance. The test of the hypothesis about Beta is a two tails test:

H<sub>0</sub>: The engagement period has no linear correlation with the increment value between the pre-test and post-test.

H<sub>1</sub>: The engagement period has a linear correlation with the increment value between the pre-test and post-test.

The hypothesis test found that the significance value is more than 0.05 (P = 0.486). Therefore, H<sub>0</sub> is accepted while H<sub>1</sub> is rejected. This implies that the participants' engagement period has no linear correlation to the influence of the increment between the pre-test and post-test. This is the case for all the participants. However, when each group is considered separately, it will be shown that the hypothesis does not apply to all of the groups.

The test of the correlation between the engagement period and the increment value between the pre-test and post-test by each group of the participants shows the relationship with statistical significance in researchers (P =0.009) and LGAs (P=0.004). Details are given in Table 6.15.

Table 6.15: Correlation value between learning period and the difference value of pre-test and post-test in each group of the participants

Statistic scale	General users	Researchers	LGAs
Pearson correlation	-0.071	-0.891	0.703
P	0.329	0.009	0.004

Linear regression analysis has been performed for the groups of researchers and LGAs. In the case of the researchers, the results of the linear regression analysis are shown in Table 6.16.

Table 6.16: Result of linear regression analysis showing the relationship of *researchers'* engagement period on the KM platform and the increment value between the pre-test and post-test

Factors	R	R <sup>2</sup>	Unstandardised Coefficients	Standardised Coefficients	T	P
			B	Beta		
Learning period (weeks)	0.891	0.793	-1.586	-0.891	-3.916	0.017
(constant)			5.241		6.339	0.003

According to Table 6.16, the R square value is close to 1 (0.793). Thus it implies that the engagement period influences the increment value between



the pre-test and post-test at 79.3% with statistical significance. The test of the hypothesis about Beta is a two tails test:

H<sub>0</sub>: The engagement period has no linear correlation with the increment value between the pre-test and post-test.

H<sub>1</sub>: The engagement period has a linear correlation with the increment value between the pre-test and post-test.

The hypothesis test found that H<sub>0</sub> is rejected because the significance value is less than 0.05 (P = 0.017) meanwhile H<sub>1</sub> is accepted. Therefore, the participants' engagement period influences the increment value between the pre-test and post-test has a linear correlation. This relationship is shown in the equation below:

$$y = 5.241 - (1.586 * z); \text{ y = the increment value between the pre-test and post-test}$$

$$z = \text{the engagement period (weeks)}$$

According to the above equation, it can be shown that if the engagement period was equal to one week, the increment value between the pre-test and post-test were 3.655. This indicates that if the researcher spent one week on the KM platform, the result of the post-test would have been increased by 3.655. In the case of LGAs, the result of the linear regression analysis is shown in Table 6.17.

Table 6.17: Result of linear regression analysis showing the relationship of LGAs' learning period on the KM platform and the different value between pre-test and post-test.

Factors	R	R <sup>2</sup>	Unstandardised Coefficients	Standardised Coefficients	T	P
			B	Beta		
Learning period (weeks)	0.703	0.494	0.667	0.703	3.274	0.007
(constant)			-1.183		-1.684	0.120

According to Table 6.17, it is implied that the learning period influences the difference value between the pre-test and post-test at 49.4 percent with statistical significance. The test of the hypothesis about Beta is a two tails test:

- H<sub>0</sub>: The learning period has no linear correlation with the difference value between the pre-test and post-test.
- H<sub>1</sub>: The learning period has a linear correlation with the difference value between the pre-test and post-test.

The hypothesis test found that H<sub>0</sub> is rejected because its significant value is less than 0.05 (P = 0.007) meanwhile H<sub>1</sub> is accepted. Therefore, the participants' learning period influences the difference value between the pre-test and post-test. Their relationship is a linear correlation. This relationship is shown in the equation below:

$y = -1.183 + (0.667 * z)$ ;  $y$  = the difference value between the pre-test and post-test

$z$  = the learning period (weeks)

According to the above equation, if the engagement period was equal to one week, the increment value between the pre-test and post-test were – 1.484. This indicates that in order to receive the increment value of the post-test at least one, the LGAs have to spend time on the KM platform 3.273 weeks.

## **6.5 Summary**

The chapter has shown the results from the pre and post questionnaires. The analysis of the results has been based on statistical scales: percentage comparison, correlation, compare mean, pair T-Test and linear regression. The participants' demography and in particular, the age and education background seem to affect the participants' scores in the pre-test. However, the engagement period is suspected to be a major factor, which can improve the participants' knowledge on sustainable energy technologies. Results from the pair T-Test have shown that the mean of post-test was higher than pre-test and it has statistical significance. Pearson correlation also showed the relationship between the engagement period and the increment of mean value of the test. The correlation or relationship between the engagement period and the increment value between pre-test and post-test for the general users group has shown to be without statistical significance ( $P = 0.329$ ). On the other hand, there is a linear relationship between the

engagement period and the increment of score of post-test in researchers ( $P = 0.017$ ) and LGAs group ( $P = 0.007$ ). The next chapter will discuss how these results support the research hypothesis, and it is followed by discussion and conclusion of this study.

## CHAPTER 7: DISCUSSION AND CONCLUSION

The results of the pre- and post-questionnaires, and data analysis have been detailed in the previous chapter. In this chapter, these results are used to verify their support of the research hypotheses and to address the research question. In addition, the major aspects of the work carried out in this research are discussed: information collection on sustainable energy, implementation of the KM platform, and quantitative research by the pre- and post- questionnaires. Finally, the chapter concludes the work undertaken in this research and provides the directions for further research.

### 7.1 Verifying the Research Hypotheses

This research study aims to investigate the validity of two hypotheses. They are reiterated and are shown as follows:

*Hypothesis 1: Knowledge about sustainable energy of the participants in rural Thai communities will be improved through the use of the KM platform developed in this project.*

The results from the above section support the hypothesis that the knowledge on sustainable energy of the participants is improved after they used the KM platform. The pair T-Test has shown that the mean value of the post-test was higher than the mean value of pre-test. The results also indicate that the engagement period has a correlation with the increment of

the post-test with statistical significance in two out of the three groups: researchers and LGAs (Table 6.14). The learning period is a factor which influences the increment of the scores in the post-test for researchers (79.3%) and LGAs (49.4%). The linear regression analysis (Section 6.4) shows that the researchers' learning period has a linear relationship with the increment of scores in the post-test with statistical significance ( $P = 0.017$ ). The regression analysis (Section 6.4) shows that researchers spent one week on the KM platform ; the increment value is 3.655 units of score in the post-test. In the case of LGAs, the learning period also has a linear relationship with an increment of scores in the post-test with statistical significance ( $P = 0.007$ ). This shows that LGAs have to spend on average 3.273 weeks on the KM platform in order to increase one unit of score in the post-test. Therefore, the results confirm that the proposed KM platform is an effective tool and can improve the knowledge of sustainable energy for the participants. However, the participants need to spend time on it, and the analysis has indicated quantitative figures to that effect.

*Hypothesis 2: A Knowledge Management (KM) platform will enhance the knowledge of local government administrators in local Thai communities about sustainable energy services and will assist them with the decision making concerning such services.*

It is confirmed that the KM platform improves the knowledge of LGAs due to the result of pair T-Test as discussed in Section 6.3. The linear regression analysis in Section 6.4 also showed that LGAs have to spend time on the KM

platform at least three weeks in order to increase one unit of the score in the post-test. The KM platform can be used as an effective tool to assist the LGAs in their decisions on the implementation of sustainable energy services in their local areas. This is reflected in the feedback of the questionnaires in that the participants have a high level of satisfaction with the KM platform, as has been shown in Section 6.2.2. The LGAs' opinions revealed that the KM platform has provided them with adequate information for the design and setup of sustainable energy services. The average score of the level of satisfaction is 3.13 out of a scale of 5.00. Other criteria such as Graphic User Interface, Up-to-date Information and Meaningfulness of the site also returned average level of satisfaction with values of more than 3.00 (out of a scale of 5.00) from the LGAs.

## **7.2 Answering the Research Questions**

The research has started with two questions:

*Research question 1: "Does a Knowledge Management platform facilitate the development of sustainable energy services in rural Thai communities?"*

*Research question 2: "What is the role of KMS in the improvement of knowledge on sustainable energy technologies for rural Thai communities?"*

Chapter Three on Knowledge Management System and Chapter Six on the Results and Analysis have given the background and the analysis of the results from this study. It can be concluded that from the literature survey and the perspectives of the participants that the KM platform provides meaningful and useful information on sustainable energy technologies for the general users, researchers and LGAs. The KM platform offers a convenient access to its users via the Internet. Participants can enter the KM platform from anywhere as long as they have connection to the Internet. The developed KMS has Graphical User Interfaces (GUIs) that offer the participants a choice of English or Thai version. The more time the participants spend on the KM platform the more knowledge they should gain. The relationship between the period of engagement with the KM platform and the corresponding increment of score in the post-test has been shown in Section 6.3 and Section 6.4. The KM platform also provides the opportunities to share information or any issues concerning sustainable energy technologies via the Forum and e-mail facilities. Researchers in the sustainable energy sector are responsible to answer, give some advices to these queries in the Forum and via e-mails. LGAs are also given access to the services on the KM platform in order to gain more knowledge on sustainable energy technologies. They can estimate the amount of energy available from the sustainable energy resources within their districts. They can also learn from examples and best practices of previous case studies via the member tools. This assists them to design and plan for future development in sustainable energy services for their communities.



### **7.3 Discussion**

#### *1. Quality and Quantity of Knowledge on the KM Platform*

In the opinion of most the participants, the amount of knowledge that exists on the KM platform is adequate and meaningful. The information on sustainable energy on the KM platform is currently available in different digital formats. For example, the lessons learned are in the form of pdf files. The operation of the sustainable energy technologies are in the forms of flash. The number of sustainable energy resources and energy are in the form of tables and figures. These formats provide the convenient access over the KM platform. In the case of quality of the information on sustainable energy, the knowledge on sustainable energy was validated before being released online by the collaborative work with stakeholders, such as the staff and researchers at the School of Renewable Energy Technology, Naresuan University, and their partner organizations.

The results from Section 6.2.2 show that the participants' level of satisfaction is above average on both "meaningful information" (3.68 out of a scale of 5.00) and "information is up to date" (3.36 out of a scale of 5.00). The information of the KM platform also helps the LGAs in the design and development of sustainable energy services for their local areas as given in Table 6.11. The results also show that the participant's knowledge has improved after having spent about two to three weeks on the KM platform, as described in Section 6.2.1 and Section 6.3. Therefore, it can be inferred that

the KM platform has provided meaningful information in appropriate formats for the local Thai communities.

## 2. Features of the KM Platform

In this study, the features of the KM platform are based on the model of knowledge creation (Nonaka 1994). This model classifies the knowledge creation processes into four categories: socialization, externalization, internalization and combination. The mapping between the features of the KM platform and the Nonaka model is shown in Table 7.1 below:

Table 7.1: Mapping the features of the KM platform with Nonaka model

	To Tacit	To Explicit
	Socialization	Externalization
From Tacit	<ol style="list-style-type: none"> <li>1. Forum – new questions and answers are added by the participants.</li> <li>2. E-mail – it is sent to the administrator.</li> </ol>	<ol style="list-style-type: none"> <li>1. Both Forum and E-mail are validated by the administrator with advice from the researchers and LGAs.</li> <li>2. Researchers – translate tacit knowledge into appropriate and comprehensive forms.</li> </ol>
	Internalization	Combination
From Explicit	<ol style="list-style-type: none"> <li>1. Operation – all participants can browse.</li> <li>2. Calendar - all participants can browse.</li> <li>3. Lessons-learned – Only members of the KM platform can access to</li> </ol>	<ol style="list-style-type: none"> <li>1. All of them (Operation, Calendar, Lessons-learned and Sustainable energy resources are updated by the administrator with the advice from the researchers and LGAs.</li> <li>2. The new development of Internet</li> </ol>

	<p>these features.</p> <p>4. Sustainable energy resources -</p> <p>Only member of the KM platform</p> <p>can access to these features.</p>	<p>technologies are developed by the</p> <p>administrator.</p>
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Almost all the features on the KM platform are grouped under “internalization” and “combination”. The explicit knowledge on sustainable energy is distributed to the communities via the KM platform. Internalization is the transferring of the explicit knowledge to the participants. Then, the participants convert (or internalize) the explicit knowledge into tacit knowledge that they only use by themselves. The participants’ knowledge is improved after they have accessed to the KM platform and learned from the information available on the KM Platform. Combination is the transfer of explicit knowledge to explicit knowledge.

In the case of the KM system, this is the updating of the information on the KM platform by the administrator. The administrator updates all information on the KM platform with inputs and advices from the researchers and LGAs. The administrator converts the existing knowledge from such resources as papers, books, and reports. into the appropriate digital formats. The updated files will then be verified by researchers and LGAs before they are uploaded to the KM Platform. There are also a few features for “socialization” and “externalization” available to the users, such as forum and e-mail. Forum and e-mail are tools for transferring tacit knowledge between the participants. The knowledge from this feature is validated and formatted by the researchers and the administrator. However, the researchers’ opinions as

has been discussed in Section 6.2.2 indicate that the KM platform needs more features for socialization. This issue will be incorporated in the future development with the implementation of social network applications, such as podcast, blogs and Wikis.

### *3. Graphic User Interfaces (GUIs)*

The original aim of the KM platform is mainly the distribution of knowledge on sustainable energy technologies and systems for local Thai communities. The GUIs of the KM platform aim to provide user-friendly features for the users. The interfaces of the KM platform are designed in both English and Thai versions. Multimedia techniques, such as flash and streaming maps, are used to describe the information on sustainable energy and related technologies. From the results of the post-questionnaire, the participants are satisfied with the GUIs of the KM platform. The satisfactory level is “Agree” with a value of 3.42 of 5.00 on the Likert scale. In addition, the increment of post-test indicates that the participants have demonstrated better understanding on the sustainable energy topics after learning from the KM platform.

### *4. Internet Infrastructure*

To enhance and promote knowledge on sustainable energy, the Web application over the Internet is an appropriate tool due to its accessibility from anywhere and at anytime. Web programming also supports a variety of formats of information on sustainable energy technologies. Web

programming permits the extraction of information into an easy to understand format and facilitates the delivery of the information over the Internet. With the exception of a few remote areas, the availability and coverage of internet connections in Thailand today is now ready to support the KM platform. In the case of Phitsanulok, the network infrastructure is now provided by both public and private ISPs. Free public Internet kiosks are also available at the local government administrators' offices and libraries. The results from the pre- and post- questionnaires indicate that all the participants' locations are accessible to the Internet as shown in Section 6.1.2. The KM platform is therefore capable of delivering relevant information on sustainable energy technologies to all the participants via their office, library, institute, Internet café, and home connections. In addition, the participants' opinions on their Internet connection have been reported as "good" as indicated in Table 6.2. However, there are still hurdles to overcome. At present, the ADSL service is available only within 10 km around a district. For areas beyond the 10 km radius, the network bandwidth is reduced. In the case of country-sides, they have only 56K dial-up modems. Hence, in the case of members, the constraints on the network bandwidth can affect the usefulness of the KM platform due to the large amount of maps and GIS data required to be streamed over the Internet. This leads to an urgent need for further development of the network services.

##### *5. Community behaviour*

Culture and behaviour of the community are significant factors that can affect the usefulness of the KM Platform. It has been recognized that the LGAs

play a significant factor in contributing to the success of the project. They are responsible for the community development. Traditional Thai culture has people always look up to or follow the leader. Hence, the level of involvement of the LGAs will govern the utilization of the KM platform and subsequent effective development of the sustainable energy services.

In this research, cooperation from the local government officers was sought in order to collect information with regard to the amount of local sustainable energy resources. Their involvement was also essential for the measurement of the usefulness of the KM platform. Future ongoing cooperation is needed to ensure that the KM platform is utilized and to bring forth benefits to the local communities.

#### **7.4 Further Research**

Following the previous discussion, further research and development is needed to maintain the KM platform and to distribute knowledge to the wider communities. Some of the issues and directions for future research are shown below:

##### *1. Utilization and Development of Advanced Technologies*

There are two directions for future research which can contribute further benefits to the communities. Firstly, there is the challenge of how to optimize and fully utilize the available bandwidth of the existing Internet connections while planning for future expansion. While the KM platform distributes knowledge on sustainable energy technologies to the community, the

question is whether the platform can intelligently deliver the “right” information at the “right” time. This requires a compromise between the amount of information to be delivered and the bandwidth constraints. In other words, the system should be “intelligent” enough to react to the network and to the traffic situation. It will then customize the information for the users accordingly. In the case of general users, the knowledge is always in the form of text, figures, photos and other multimedia formats. These formats are supported by the present Internet connection. In the case of the member areas used by the researchers and LGAs, the support of streaming data for the map displays from the GIS application is needed. While the present Internet connection supports such a function, there will be delays if the bandwidth is low. In order to improve the performance new Internet techniques and Web 2.0 applications can be used as they are able to operate on reduced bandwidth. For example, the asynchronous features of the key components of Web 2.0, Java Scripts and XML (AJAX), are able to support better and more efficient streaming of data over the Internet. Web 2.0 also supports social networks and allows the users to have interactions with each other and with the KM platform. Another solution could be using the reserved channel of Thailand Research and Education Network (ThaiREN). ThaiREN provides high bandwidth to all its member institutes. This will bring additional benefits to the LGAs who are the main contributors to the KM platform.

Secondly, a future upgrade of the KM platform can incorporate intelligent techniques, such as data mining, case base reasoning, forecasting,

optimization, classification, simulations, and design automation. Such techniques will harness the KM platform with tools and utilities for better system design and support for future developments in sustainable energy technologies.

*2. Means to achieve a Higher level of cooperation between stakeholders*

In order to provide useful and updated knowledge on sustainable energy technologies, a high level of cooperation between the stakeholders is needed. Firstly, a closer cooperation between the administrator and the researchers will result in a more efficient data validation process and data upload to the KM platform. The close connection between these two groups is essential in order to reduce the time or delay in updating the information. The format of the information on the KM platform is significant as it must be easily understandable by the local people in the community. The administrator has to contact the researchers to validate the format of the information before putting it online.

Secondly, a close cooperation between the administrator and organizations dealing with sustainable energy resources is desired. Such organizations are the providers of up-to-date information concerning the sustainable energy resources. A close link will provide up-to-date information to assist the LGAs to make appropriate decisions with regard to the optimal sustainable energy system design for their communities.



Thirdly, it is useful to have a closer cooperation between researchers and LGAs. LGAs are the local leaders, and responsible for the development of their communities. In order to improve knowledge on the use and development of sustainable energy systems in the community, apart from making the decisions on the choice and utilization of sustainable energy services, they are also a valuable source of information providing feedback and reporting any issues faced by the local communities. This will lead to a better utilization of the KM platform and an ongoing improvement of the services.

Finally, the link between researchers and the communities should be initiated and monitored. The performance and effectiveness of the KM platform need to be measured and assessed. For example, the improvement of the communities' knowledge on sustainable energy could be monitored via the platform. This could be an ongoing exercise of monitoring the utilization of the KM platform and its correlation with local developments. Such information can be used to determine the usefulness of the KM platform and the potential needs for its upgrading.

## **7.5 Summary**

During the course of this research, the world's focus has increasingly been drawn to the issues of rising energy costs; increasing energy demands and especially the rapid development in such countries as China and India. Additional issues are the climate change due to the ongoing increase in carbon emission, the possible reduction and exhaustion of traditional

petroleum-based resources, and the deterioration of the environment due to waste and pollution. The changes over the past few years have highlighted the significance and contribution of this research.

The original research objectives were aimed at promoting knowledge and better utilization of sustainable energy resources among the Thai rural communities with a KM platform. This research has initiated a systematic investigation on the information concerning sustainable energy resources and KMS. This is followed by the development of a proposed KM platform used by three groups of stakeholders – general users, researchers and LGAs. The study also carried out quantitative assessments of the effectiveness of the platform through questionnaires, pre-tests and post-tests. The survey results have been analysed empirically and tested against the proposed hypotheses. To a large extent, the study has fulfilled the original intentions. The research has contributed to knowledge, and it has also provided insights and addressed the issues in this discipline.

In addition to the issues described above, it is also recognized that KM, Internet and Web technologies have advanced rapidly in the past years. Realizing the limitations and constraints of the existing system, such as limited network bandwidth, new internet technologies have been considered and proposed for future development of the existing KM platform. In addition to the Thai version, which is mainly targeting the local communities, the English version can be used to serve the rest of the world. Suggestions for future research have been described in the previous section. If continued,

the research will lead to the development of a new generation KM platform catering for wider communities. This will benefit whoever is interested to address the world's energy problem, and whoever wishes to better utilize the sustainable energy resources. It is believed that this conclusion is not the end of the study, rather, this will lead to the beginning of new research activities and exploration of knowledge in the important area of sustainable energy services.

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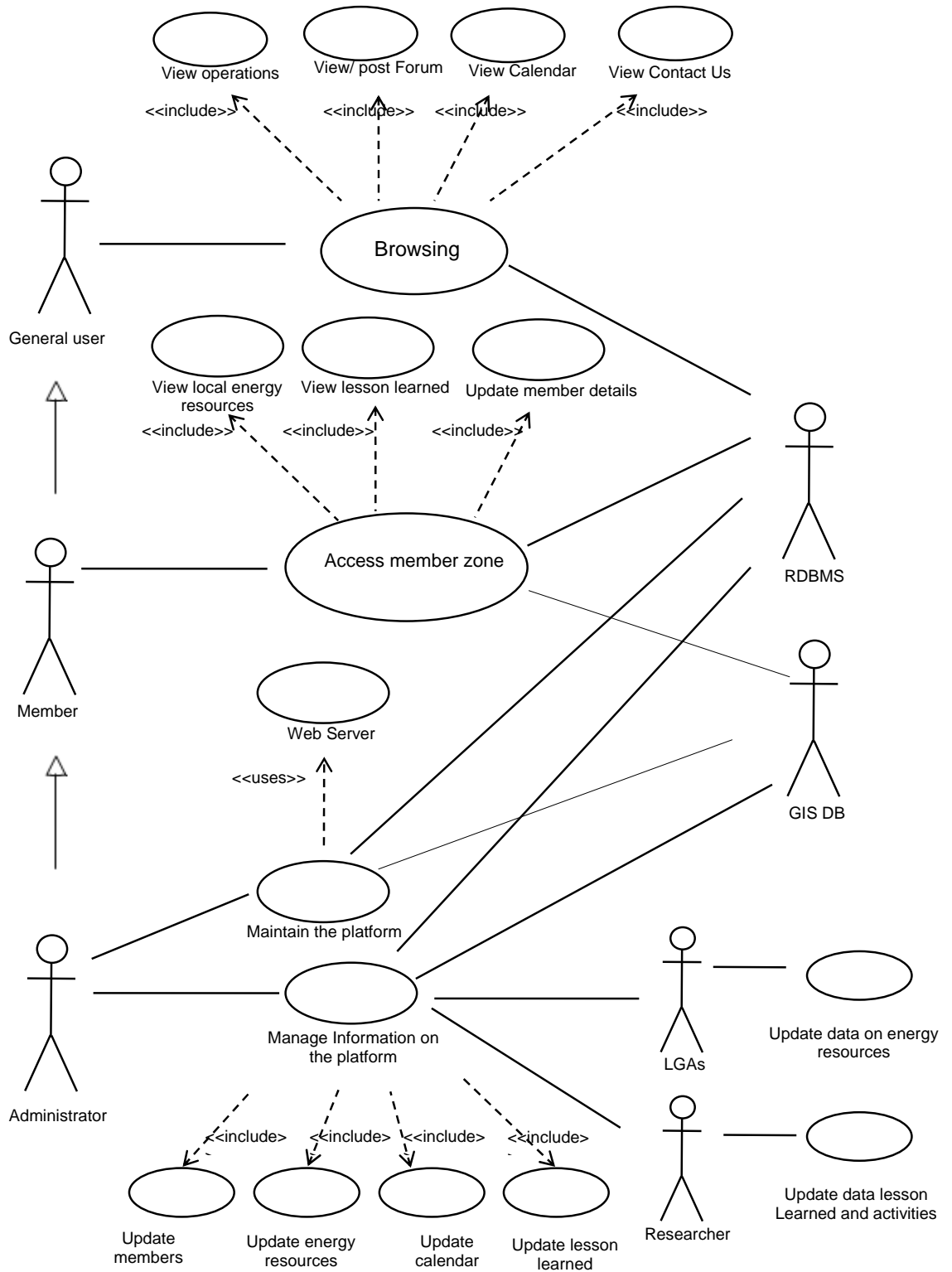
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# Appendix A – The System Design Diagram

## Appendix A.1 – Use Cases





## Appendix A.2 – Use Case Scenarios

Use case name	Browsing
<i>Participating actor</i>	Initiated by General users and
<i>Entry condition</i>	4. User accesses to the KM platform.
<i>Flow events</i>	<p>5. User can click on “Operations” or “Calendar” or “Forum” or “Contact us” or “Member zone”.</p> <ul style="list-style-type: none"> <li>- There are four choices in Operations, solar energy, biomass energy, hydro energy and wind energy. User can click to see the operation of each energy.</li> <li>- Calendar shows the present date. If user wanted to see the activities on any date, user chose the date then the detail of activities would show.</li> </ul>
<i>Exit condition</i>	6. After finish browsing user click on “Home” to go to the main page or

<b>Use case name</b>	<b>Access member zone</b>
<i>Participating actor</i>	Initiated by members
<i>Entry condition</i>	<ol style="list-style-type: none"> <li>1. User accesses the KM platform.</li> <li>2. User is compulsory to enter</li> </ol>
<i>Flow events</i>	<ol style="list-style-type: none"> <li>3. After user enters username and password, member page is shown.</li> <li>4. User can select option-boxes of map options on the left hand side.</li> <li>5. The result of selection is shown on</li> </ol>
<i>Exit condition</i>	<ol style="list-style-type: none"> <li>7. User can exit this member page by close the web page or click</li> </ol>

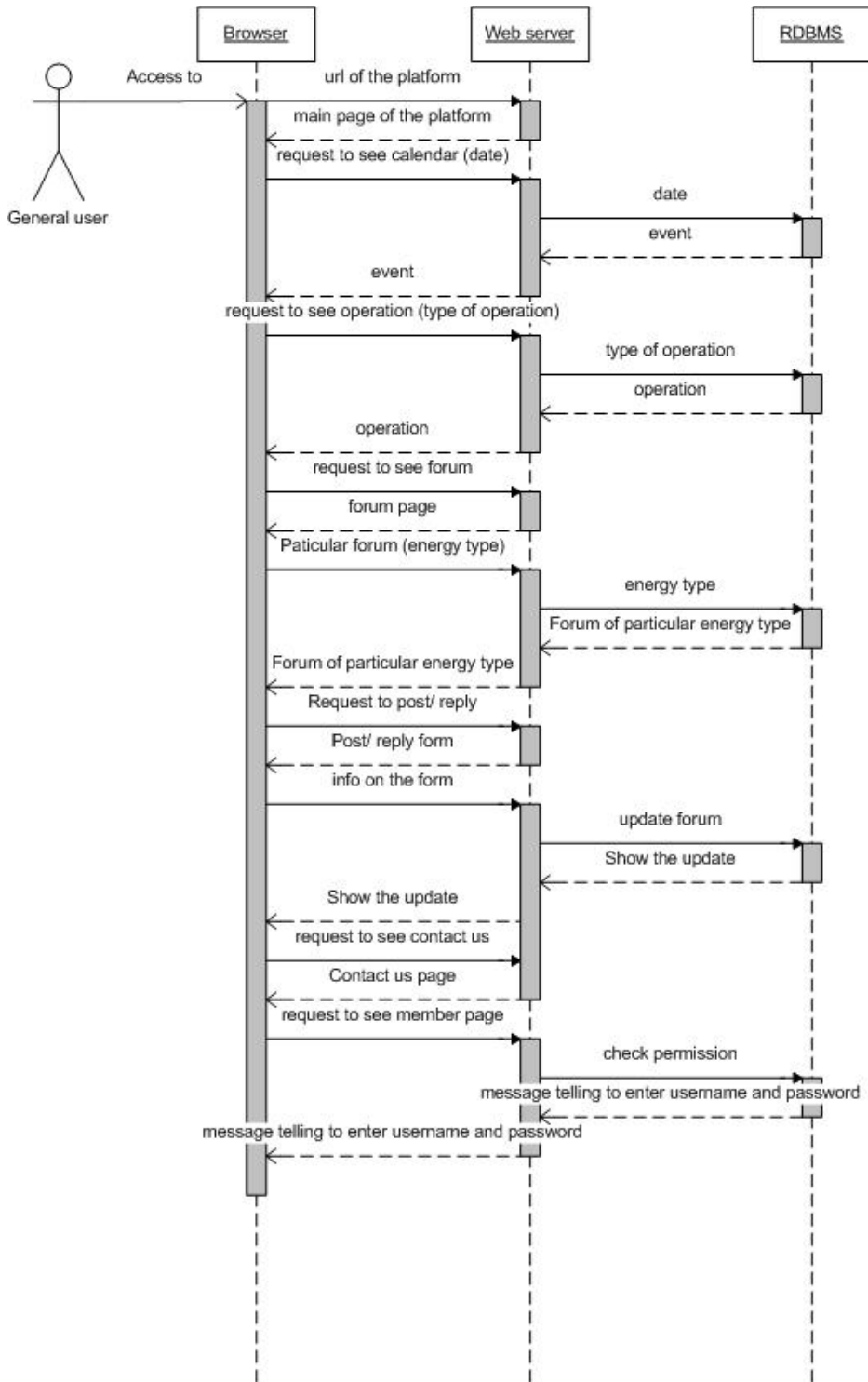
<b>Use case name</b>	<b>Manage information on the platform</b>
<i>Participating actor</i>	Initiated by Administrator
<i>Entry condition</i>	<ol style="list-style-type: none"> <li>1. There are two ways for administrator to access to the server for updating data: access via the KM platform and access via phpMyadmin</li> <li>2. Both of them need permission to enter. The first one needs to enter the username and password with admin permission on the KM platform site. The second one needs to enter the correct URL for phpMyadmin. Then the correct username and password are</li> </ol>

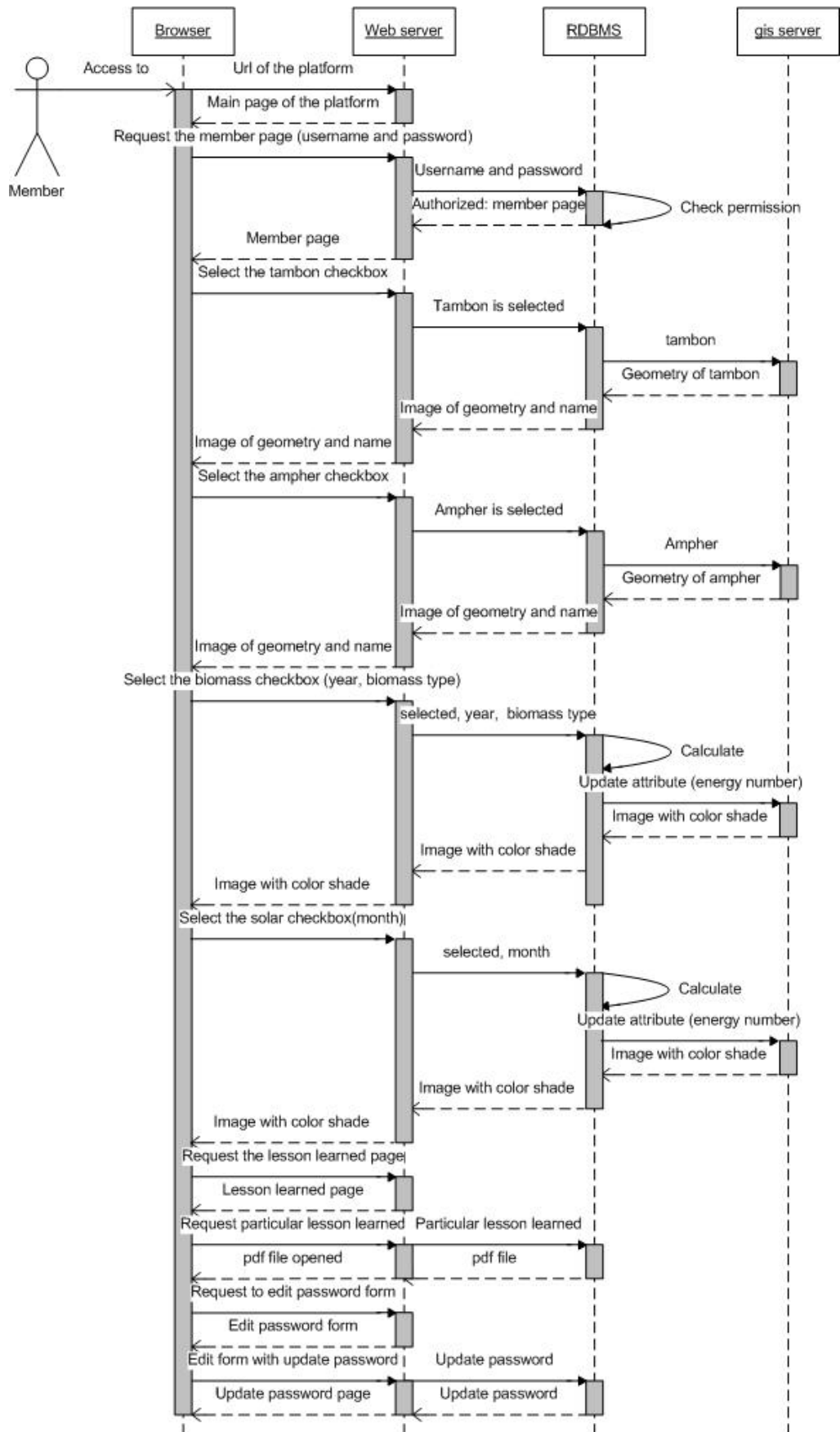
	compulsory after that.
<i>Flow events</i>	<p>3. There are four issues that the administrators can manage: Add or remove user, Calendar, Lesson learned and Energy resources.</p> <p>4. Administrator needs to communicate with researchers and LGAs who are stakeholders for this platform about verification the information before update them to the server.</p>
<i>Exit condition</i>	5. Administrator can exit the page by clicking at close program on the right hand side of the page.

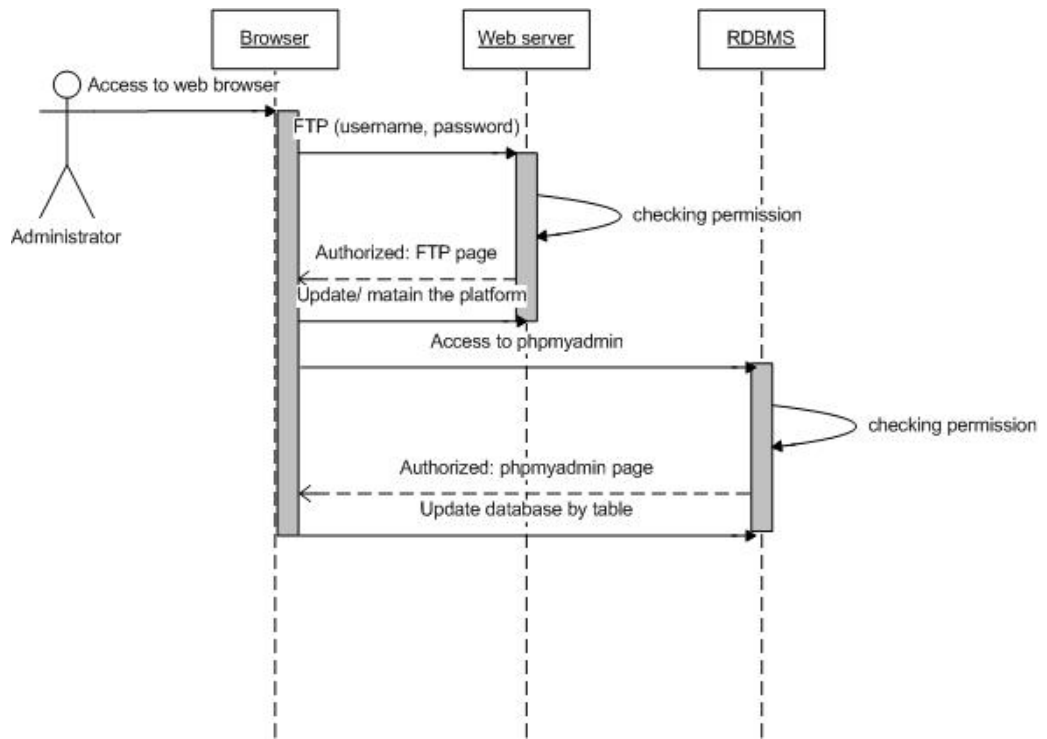
<b>Use case name</b>	<b>Maintain the platform</b>
<i>Participating actor</i>	Initiated by Administrator
<i>Entry condition</i>	1. To access to the web server,
<i>Flow events</i>	<p>2. The files that want to repair are transferred from the server to administrator's computer.</p> <p>3. They are opened by an</p>
<i>Exit condition</i>	5. Administrator exits the ftp by

## Appendix A.3 – Sequence Diagrams

Sequence diagrams depict how each group of the participant access to the KM platform.







## Appendix B – Graphic User Interfaces (GUIs)

### Appendix B.1 – The main page

**KM platform on Sustainable Rural Energy Services**

SERT MURDOCH UNIVERSITY PERTH, WESTERN AUSTRALIA

Home Operation Calendar Forum Contact Us Member Zone English | Thai

### Sustainable Rural Energy Services

The term Sustainable Rural Energy Services is an energy service derived from the implementation of technology that utilizes renewable energy and traditional energy with high efficiency. Renewable energy is energy obtained from sources including conventional hydroelectric power, wood, bio-mass, waste, geothermal, wind, photovoltaic, and solar thermal energy that are essentially inexhaustible. Traditional energy, in this context, means the energy that is derived from coal, oil and natural gas. The use of traditional energy in rural areas is not done efficiently; on the other hand, they lead to some problems such as environmental problems, health care problems and economic problems.

MEMBERS LOGIN HERE  
Username:   
Password:   
Submit

Next

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### Appendix B.2 – Operation: biomass energy

**KM platform on Sustainable Rural Energy Services**

SERT MURDOCH UNIVERSITY PERTH, WESTERN AUSTRALIA

Home Operation Calendar Forum Contact Us Member Zone English | Thai

### Operation

Please select:

- Solar energy
- Biomass energy
- Wind energy
- Hydro power

**Biomass Energy**

What is Biomass Energy?  
Biomass Technology  
Potential of Biomass Energy

Any type of plant in the world is alive by using energy from the sun. Plants change the energy from the sun life. This energy is also an important component in the growing of other parts of the plant such as roots, stem. This significant process is called photosynthesis. By using chlorophyll in the green plant and the sunlight to take up CO<sub>2</sub> from air and water from soil to produce substances called carbohydrates. Energy from the sunlight will be used to form chemical bonds of the carbohydrates.

Animals eat both plants and animals. Humans eat both plants and animals. Animals eat each other. This chain is the transfer of chemical energy from plants to animals and the other way around. It is obvious that life on earth depends on the sun for growing and staying alive.

Biomass energy is the energy that comes from plants and animals. For example biomass from wood, stem or husk. Biomass

Next

## Appendix B.3 – Calendar

**KM platform on Sustainable Rural Energy Services**

SERT MURDOCH UNIVERSITY PERTH, WESTERN AUSTRALIA

Home Operation Calendar Forum Contact Us Member Zone English | Thai

Select year and month:

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	48

2007-11-27

Start	End	Subject (Click for detail)
2007-11-27		CIA2007: ControlsAsia, InstrumentAsia, AnaLabAsia

The page at <http://biomass.th-city.org> says:

More detail on [www.cia-asia.com](http://www.cia-asia.com)

OK

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## Appendix B.4 – Forum

**KM platform on Sustainable Rural Energy Services**

SERT MURDOCH UNIVERSITY PERTH, WESTERN AUSTRALIA

Home Operation Calendar Forum Contact Us Member Zone English | Thai

Forum

- Solar Energy (พลังงานแสงอาทิตย์)
- Biomass Energy (พลังงานชีวมวล)
- Wind Energy (พลังงานลม)
- Hydropower (พลังงานน้ำ)
- Others (อื่นๆ)

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## KM platform on Sustainable Rural Energy Services




English | Thai

[Home](#) [Operation](#) [Calendar](#) [Forum](#) [Contact Us](#) [Member Zone](#)

### Forum > Biomass Energy (พลังงานชีวมวล)

[+ Add new question](#)

- อยากรหาบการผลิตแก๊สไฮโดรเจนและไบโอดีเซล  
Post by นักเรียนศรีป - post date 12-Aug-07 10:08 - 12 read - 3 answers

---

- ขั้นตอนการผลิตถ่านอัดก้อน  
Post by ชะเอม - post date 22-Jul-07 12:10 - 5 read - 2 answers

---

- พลังงานชีวมวลในพืชญโลก  
Post by เวน - post date 25-Jun-07 14:20 - 7 read - 1 answers

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## Appendix B.5 – Contact us



## KM platform on Sustainable Rural Energy Services




English | Thai

[Home](#) [Operation](#) [Calendar](#) [Forum](#) [Contact Us](#) [Member Zone](#)

### Contact Us

**Janjira Payakapate**  
 School of Information Technology, Murdoch University  
 South Street, Murdoch, WA 6150, AUSTRALIA  
 Phone: 618-9360 6974  
 E-mail: [j.payakpate@murdoch.edu.au](mailto:j.payakpate@murdoch.edu.au)

-- Or --

**Janjira Payakapate**  
 Department of Computer Science and  
 Information Technology, Naresuan University  
 Phitsanulok 65000 Thailand  
 Phone: 66 55 261 000 ext. 3201-2

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## Appendix B.6 – An Example of Member Page

**KM platform on Sustainable Rural Energy Services**

SERT MURDOCH UNIVERSITY PERTH, WESTERN AUSTRALIA

Home Operation Calendar Forum Contact Us Member Zone English | Thai

Welcome to member's zone

Tambon (อำเภอ)  
 Amphur (อำเภอ)  
 Biomass 2006  
 Rice  
 Sugarcane  
 Cassava  
 Corn  
 Solar January

MegaJoule/Kg  
0.63 - 21.64  
21.64 - 72.08  
72.08 - 412.66  
No data

Member's Tools

- Lesson learned
- Change my password
- Add or remove member
- Edit calendar
- Edit lesson Learned
- Edit energy resource

Chet Trakan  
Wit Bot  
Nakhon Thai  
Phrom Phiam  
Wang Thong  
Bang Rakam  
Bang Krathum  
Noen Maprang

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## Appendix B.7 – Lessons learned

**KM platform on Sustainable Rural Energy Services**

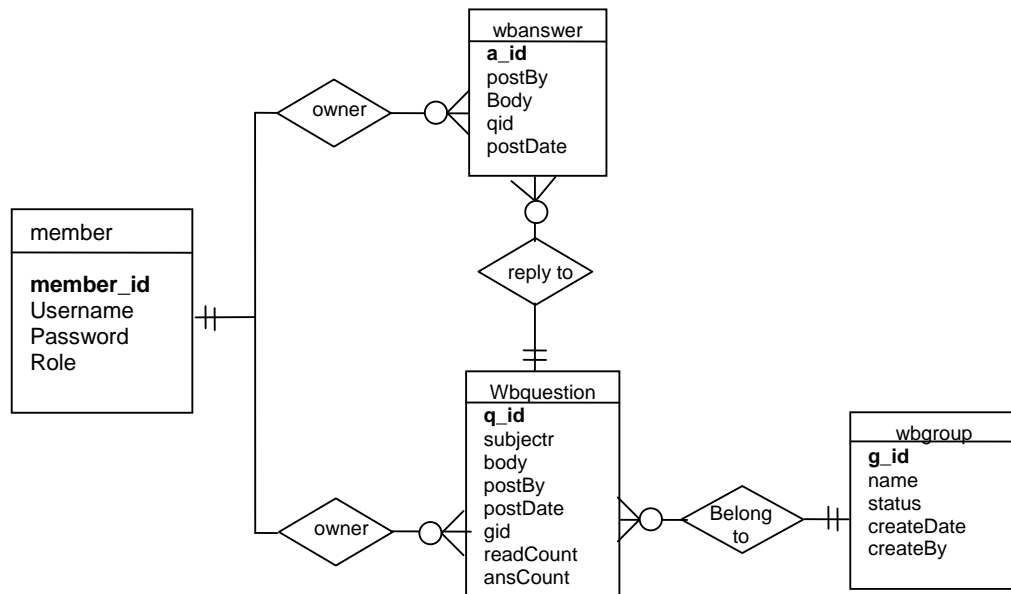
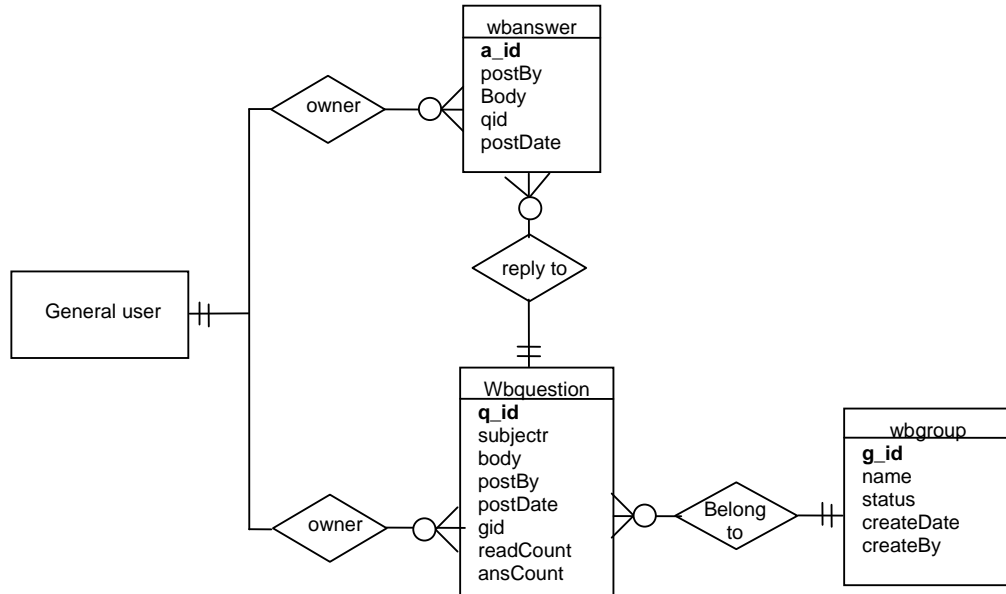
Home Operation Calendar Forum Contact Us Member Zone English | Thai

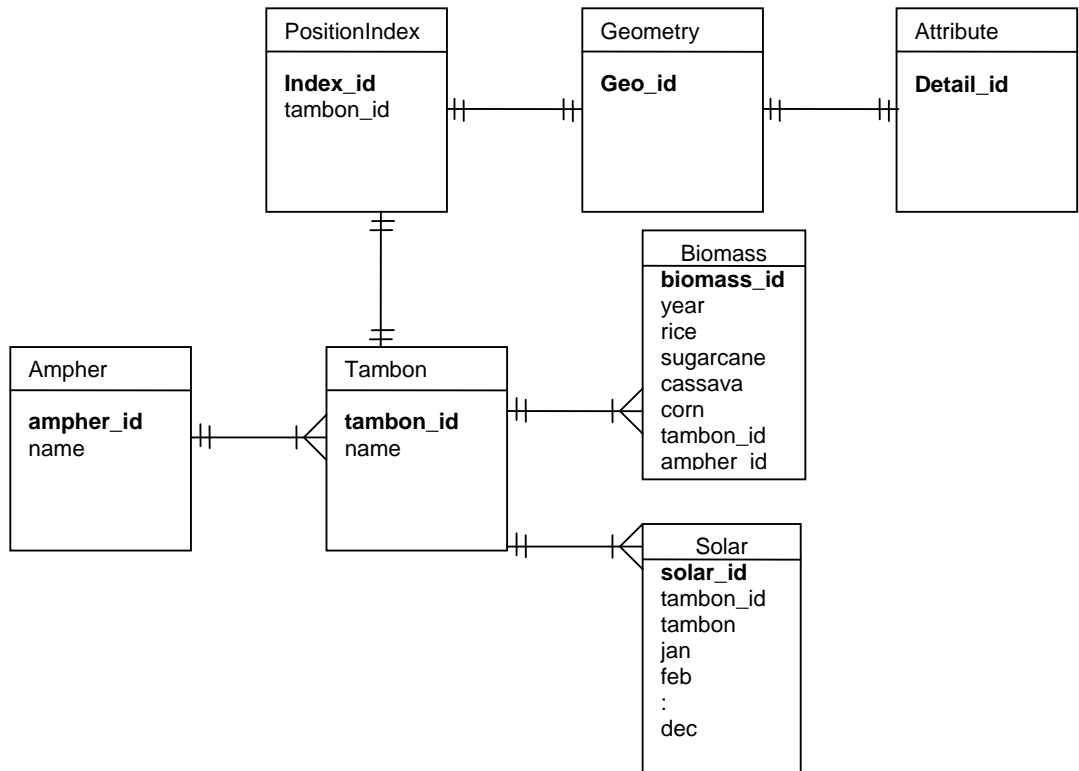
### Lesson Learned

Solar	Biomass
<ul style="list-style-type: none"><li>No.1.Solar PV water pumping system.pdf [13 views]</li><li>No.2.A case study of solar photovoltaic in Taiwan [13 views]</li><li>No.3.A review on the energy and exergy analysis of solar assisted heat pump systems [13 views]</li><li>No.4.Critical evaluation of solar chimney power plant performance [13 views]</li><li>No.5.Development of a low-cost dish solar concentrator and its application in zeolite desorption [13 views]</li></ul> <p>More...</p>	<ul style="list-style-type: none"><li>No.1.Biomass energy in Asean member countries.pdf [4 views]</li><li>No.2.Biomass wood energy resources ASEAN.pdf [4 views]</li><li>No.3.Administrative institutional and legislative issue on agricultural waste exploitation in Turkey [4 views]</li><li>No.4.Bio-fuels from thermochemical conversion of renewable resources [4 views]</li><li>No.5.Biomass and multi-product crops for agricultural and energy production [4 views]</li></ul> <p>More...</p>
Wind	Hydro
<ul style="list-style-type: none"><li>No.1.Wind power.pdf [4 views]</li><li>No.2.MaintainSupplyByRenew.pdf [4 views]</li><li>No.3.The small hydro power in spain [4 views]</li><li>No.4.Case study of upgrading potential for a small hydro power station.pdf [4 views]</li><li>No.5.Effective renewable energy activities in Bangladesh [4 views]</li></ul> <p>More...</p>	<ul style="list-style-type: none"><li>No.1.WaterPumping.pdf [3 views]</li><li>No.2.RemoteRenewEnergyResources.pdf [3 views]</li><li>No.3.A review of wind energy technologies.pdf [3 views]</li><li>No.4.A small wind turbine system (SWTS) application and its performance analysis [3 views]</li><li>No.5.Analysis of a fuel cell micro-grid with a small-scale wind turbine generator [3 views]</li></ul> <p>More...</p>

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## Appendix C – Database Structure





## **Appendix D – Copies of Consent Letter, Pre and Post-questionnaires**

### **Appendix D.1 – English Version of Consent Letter**

**Project Title:** Knowledge Management Platform for Promoting Sustainable Rural Energy Services in Thailand.

I am a PhD student at Murdoch University investigating the utilization of a Knowledge Management (KM) platform to promote the use of sustainable rural energy services in Phitsanulok under the supervision of Associate Professor Lance Fung and Associate Professor Dora Marinova. The purpose of this research is to evaluate the use of KM platform and the provision of facilities to promote sustainable rural energy services in Thailand.

You can help in this study by consenting to learn the KM platform and complete two surveys: a pre-use survey prior to the use of the KM platform and a post-use survey after at least one month of using the system. First, you will be asked to complete the pre-use survey. After that, the KM platform will be demonstrated. It is anticipated that the time to complete the pre-use survey and demonstration of the platform will be no more than 45 minutes. At least one month later, the post-use survey will be sent you again by e-mail or your address as provided. It is anticipated that the time to complete the survey will be no more than 20 minutes. Contained in the survey are questions about your experience and the knowledge you have gained from the KM platform. Other optional questions will include basic demographic information. The post-use survey will either be collected by me or can be

returned by e-mail or by fax: 55 261 000 ext. 3263 or by mail to my Thailand address. Participants can decide to withdraw their consent at any time without disadvantage. All information given in the survey is confidential and no names or other information that might identify you will be used in any publication arising from the research. A summary of the study will be provided by email upon request by participants. If you are willing to participate in this study, could you please complete the details below. If you have any questions about this project please feel free to contact either myself, Janjira Payakpate, or my supervisors, Associate Professor Lance C.C. Fung or Associate Professor Dora Marinova on the detail as following:

Janjira Payakpate  
School of Information Technology,  
Murdoch University  
South Street, Murdoch, WA 6150, AUSTRALIA  
Phone: 618-9360 6974  
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Associate Professor Dora Marinova  
ISTP, Murdoch University  
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Murdoch WA 6150, AUSTRALIA  
Phone: 618-9360 6103  
E-mail: D.marinova@murdoch.edu.au

My supervisors and I are happy to discuss with you any concerns you may have on how this study will be been conducted, or alternatively you can contact Murdoch University's Human Research Ethics Committee on +618-9360 6677 or by email: ethics@central.murdoch.edu.au

\*\*\*\*\*

I \_\_\_\_\_ (the participant) \_\_\_\_\_ have read the information above. Any questions I have asked have been answered to my satisfaction. I agree to take part in this activity, however, I know that I may change my mind and stop at any time. I understand that all information provided is treated as confidential and will not be released by the investigator unless required to do so by law.

Please send the 2<sup>nd</sup> survey to:

my e-mail address: \_\_\_\_\_

my contact detail: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

I would you like a copy of the summary of results.

Yes (Please send to the above contact detail)

No

\_\_\_\_\_

\_\_\_\_\_



Participant

Date

---

Janjira Payakpate

---

Date

## Appendix D.2 – English Version of Pre-questionnaire

### Pre-use Survey questionnaire for Study on “Knowledge Management Platform for Promoting Sustainable Rural Energy Services in Thailand”

This is a survey on the study of the use of knowledge management platform for promoting sustainable rural energy services in Thailand. The purpose of the questionnaire is to access your experience in using KM platforms and your knowledge about sustainable rural energy services. The following questions should be answered before the training session and prior to the introduction of the KM platform. Upon completion of this survey, the form can be submitted to the staff who administers the survey or be mailed to either one of the following addresses:

Janjira Payakpate

School of Information Technology,

Murdoch University

South Street, Murdoch, WA 6150, AUSTRALIA

Janjira Payakpate

Department of Computer Science and

Information Technology, Naresuan University,

Phitsanulok 65000 THAILAND

In order to answer the following questions, there are some definitions that participants should know.

- *Sustainable Rural Energy Services* is the provision of energy to rural communities based on technologies that utilize renewable and traditional energy resources with improved efficiency
- *Knowledge Management System (KMS)* is an approach that can provide a platform to extract and exchange meaningful knowledge for

the stakeholders relating to the design and use of sustainable rural energy services.

- *KM platform* is a web-based application that provides knowledge on sustainable rural energy services over the Internet.

**Please tick the box or answer the short questions**

**Section I:** This section relates to your background and job descriptions

1. Age:  20 – 29       30 – 39       40 – 49  
 50 – 59       60 – Over
2. Highest Education: \_\_\_\_\_
3. Nationality: \_\_\_\_\_
4. Job title and responsibilities: \_\_\_\_\_

**Section II:** This section relates to your current level of access to the Internet.

Please tick the appropriate box(es).

1. Do you have access to the Internet?  
Yes       No
2. Where do you use the Internet? (Tick all that apply.)  
Home       Office       Library   
Internet café       No access
3. If you have access, how often do you use the Internet?  
Use daily       Often (at least three times a week)   
Regularly (about once a week)       Rarely (About once a month)
4. What do you use the Internet for? (Tick all that apply.)  
E-mail       News

Research  Others: \_\_\_\_\_

5. How would you rate your level of access to the Internet?

Excellent  Good  Average  Poor

**Section III:** The following statements are related to your knowledge on KM platform. Please tick the appropriate box (es).

1. Have you used any knowledge management platform before?

Yes  No  Don't know

2. Where did you use the KM platform? (Tick all that apply.)

Work Place  Government Site   
Educational Institute  Other: \_\_\_\_\_

3. If you are using any KM platform, how often do you use the facility?

Use daily  Often (at least three times a week)   
Regularly (about once a week)  Rarely (About once a month)

4. What do you use the KM platform for?

Job requirement  To get information   
To contribute or share knowledge  Research   
Others: \_\_\_\_\_

5. How would you assess your knowledge on KM platform?

Excellent  Good  Average  Poor

**Section IV:** The following questions are related to knowledge about Sustainable Rural Energy Services. Indicate the extent to which you agree by putting an [X] at the appropriate choice below:

1. Which of the following is most energy efficient?
  - a) Incandescent bulb [ ]
  - b) Fluorescent tube light [ ]
  - c) Compact Fluorescent lamp [ ]
2. Which one of the following statements do you agree with?
  - a) The cost of building sustainable rural energy services is higher than traditional energy services [ ]
  - b) Stoves using traditional wood can supply energy services without CO<sub>2</sub> emission. [ ]
  - c) Solar cabinet dryers offer long-term conservative food with nutrition. [ ]
  - d) A kerosene lamp is the best way for enhancing the activities at night of rural people in un-electrified areas. [ ]
3. Which statement is true?
  - a) All appliances have the same energy cost per minute [ ]
  - b) The direction a house faces has no effect on its energy costs [ ]
  - c) Many windows should be constructed on the north side of the house [ ]
  - d) Money can be saved if windows, house placement, and design are planned for solar heating and cooling. [ ]
4. Which of the following is a type of renewable energy resource?
  - a) Wood [ ]
  - b) Coal [ ]
  - c) Biomass [ ]
  - d) Lignite [ ]



- c) Crop residue [ ]
- d) Fuel wood [ ]

11. Of the following burning fossil fuels, which is considered to be the cleanest?

- a) Coal [ ]
- b) Natural gas [ ]
- c) Oil [ ]
- d) Fuel wood [ ]

12. Which one of the following energy resources offers the least harmful effects on the environment?

- a) Biomass [ ]
- b) Nuclear [ ]
- c) Solar [ ]
- d) Wind [ ]

13. The reason that photovoltaic cells are not generally competitive with fossil-fuel-fired power plants is :

- a) The cost of raw silicon is too high [ ]
- b) The expense of growing crystals and fabricating the cells is too high [ ]
- c) The efficiency is only 12% [ ]
- d) They cover too much land area [ ]

14. Industries consuming large amounts of fossil fuels are the largest emitters of this gas which causes acid rain. Which is this harmful gas?

- a) Sulphur dioxide [ ]
- b) Carbon dioxide [ ]
- c) Hydrogen sulphide [ ]
- d) Ozone [ ]

15. What is the most popular energy resource currently?

- a) Fossil [ ]
- b) Nuclear [ ]
- c) Solar [ ]
- d) Wind [ ]

\*\*\*\*\*

Thank you for your cooperation. If you have any question about this survey, please feel free to contact either myself, Janjira Payakpate or my supervisors Associate Professor Lance Fung or Associate Professor Dora Marinova on the details as following:

Associate Professor Lance Chun Che Fung  
School of Information Technology,  
Murdoch University, South Street,  
Murdoch WA 6150, AUSTRALIA  
Phone: 618-9360 7507  
Fax: 618-9360 2941  
Email: L.Fung@murdoch.edu.au

Associate Professor Dora Marinova  
ISTP, Murdoch University  
South Street,  
Murdoch WA 6150, AUSTRALIA  
Phone: 618-9360 6103  
E-mail: D.marinova@murdoch.edu.au

Alternatively, you can contact Murdoch University's Human Research Ethics Committee on +618-9360 6677 or by email: [ethics@central.murdoch.edu.au](mailto:ethics@central.murdoch.edu.au)

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## Appendix D.3 – English Version of Post-questionnaire

### Post-use Survey questionnaire for Study on “Knowledge Management Platform for Promoting Sustainable Rural Energy Services in Thailand”

This is a follow-up survey on the study of the use of knowledge management platform for promoting sustainable rural energy services in Thailand. The purpose of the questionnaire is to access your experience in using KM platforms and your knowledge about sustainable rural energy services. The following questions should be answered after you have used the KM platform for a period of at least one month. Upon completion of this survey, this form can be returned to either one of the following addresses by mail or email to

Janjira Payakpate	OR	Janjira Payakpate
School of Information Technology, Murdoch University South Street, Murdoch, WA 6150, AUSTRALIA Phone: 618-9360 6974 E-mail: j.payakpate@murdoch.edu.au		Department of Computer Science and Information Technology, Naresuan University, Phitsanulok 65000 THAILAND Phone: 66 55 261 000 ext. 3201-2 E-mail: janjirap@nu.ac.th

In order to answer the following questions, there are some definitions that participants should know.

- *Sustainable Rural Energy Services* is the provision of energy to rural communities based on technologies that utilize renewable and traditional energy resources with improved efficiency

- *Knowledge Management System (KMS)* is an approach that can provide a platform to extract and exchange meaningful knowledge for the stakeholders relating to the design and use of sustainable rural energy services.
- *KM platform* is a web-based application that provides knowledge on sustainable rural energy services over the Internet.

**Please tick the box or answer the short questions**

**Section I:** This section relates to your background and job descriptions

- Age:             20 – 29             30 – 39             40 – 49  
                       50 – 59             60 – Over
- Highest Education: \_\_\_\_\_
- Nationality: \_\_\_\_\_
- Job title and responsibilities: \_\_\_\_\_
- When did you fill in the Pre-use Survey? \_\_\_\_\_
- How long have you been using the knowledge management platform?  
 \_\_\_\_\_ (months)

**Section II:** This section relates to your current level of access to the Internet and the KM platform on the sustainable rural energy services for Thailand. Please tick the appropriate box(es).

- Where do you use the Internet? (Tick all that apply.)  
 Home                       Office                       Library   
 Internet café                       No access

2. If you have access to Internet, how often do you use it?
- Use daily  Often (at least three times a week)
- Regularly (about once a week)  Rarely (About once a month)
3. If you have access to the KM platform on sustainable rural energy services for Thailand, how often do you use it?
- Use daily  Often (at least three times a week)
- Regularly (about once a week)  Rarely (About once a month)
4. What do you use the KM platform for? (Tick all that apply.)
- Forum  News
- Operation  Others: \_\_\_\_\_

**Section III:** The following statements are related to presenting knowledge on KM platform. Indicate the extent to which you agree by putting an [X] in the appropriate box below:

	Strongly disagree	Disagree	Natural	Agree	Strongly Agree
1. The graphical user interface of KM platform is user friendly.					
2. The information on the KM platform is up to date.					
3. The KM platform provides communication between you and others or experts i.e. e-mail, forum and etc.					
4. The KM platform provides meaningful information.					
5. The KM platform provides adequate information on Sustainable Rural Energy Services for designing and building					

sustainable rural energy services.					
------------------------------------	--	--	--	--	--

**Section IV:** The following questions are related to knowledge about Sustainable Rural Energy Services. Indicate the extent to which you agree by putting an [X] at the appropriate choice below:

1. Which of the following is most energy efficient?
  - a) Incandescent bulb [ ]
  - b) Compact Fluorescent lamp [ ]
  - c) Fluorescent tube light [ ]
  
2. Which one of the following statements do you agree with?
  - a) The cost of building sustainable rural energy services is higher than traditional energy services. [ ]
  - b) Solar cabinet dryers offer long-term conservative food with nutrition. [ ]
  - c) Stoves using traditional wood can supply energy services without CO2 emission. [ ]
  - d) A kerosene lamp is the best way for enhancing the activities at night of rural people in un-electrified areas. [ ]
  
3. Which statement is true?
  - a) Many windows should be constructed on the north side of the house [ ]
  - b) The direction a house faces has no effect on its energy costs [ ]
  - c) All appliances have the same energy cost per minute [ ]
  - d) Money can be saved if windows, house placement, and design are planned for solar heating and cooling. [ ]
  
4. Which of the following is a type of renewable energy resource?
  - a) Coal [ ]
  - b) Wood [ ]



- a) Coal [ ]
- b) Animal dung [ ]
- c) Crop residue [ ]
- d) Fuelwood [ ]

11. Of the following burning fossil fuels, which is considered to be the cleanest?

- a) Coal [ ]
- b) Fuel wood [ ]
- c) Oil [ ]
- d) Natural gas [ ]

12. Which one of the following energy resources offers the least harmful effects on the environment?

- a) Biomass [ ]
- b) Solar [ ]
- c) Nuclear [ ]
- d) Wind [ ]

13. The reason that photovoltaic cells are not generally competitive with fossil-fuel-fired power plants is :

- a) The efficiency is only 12% [ ]
- b) The expense of growing crystals and fabricating the cells is too high [ ]
- c) The cost of raw silicon is too high [ ]
- d) They cover too much land area [ ]

14. Industries consuming large amounts of fossil fuels are the largest emitters of this gas which causes acid rain. Which is this harmful gas?

- a) Ozone [ ]
- b) Carbon dioxide [ ]
- c) Hydrogen sulphide [ ]
- d) Sulphur dioxide [ ]

15. What is the most popular energy resource currently?

- a) Fossil [ ]
- b) Nuclear [ ]
- c) Solar [ ]
- d) Wind [ ]

\*\*\*\*\*

Thank you for your cooperation. If you have any question about this survey, please feel free to contact either myself, Janjira Payakpate or my supervisors Associate Professor Lance Fung or Associate Professor Dora Marinova on the details as following:

Associate Professor Lance Chun Che Fung  
School of Information Technology,  
Murdoch University, South Street,  
Murdoch WA 6150, AUSTRALIA  
Phone: 618-9360 7507  
Fax: 618-9360 2941  
Email: L.Fung@murdoch.edu.au

Or Associate Professor Dora Marinova  
ISTP, Murdoch University  
South Street,  
Murdoch WA 6150, AUSTRALIA  
Phone: 618-9360 6103  
E-mail: D.marinova@murdoch.edu.au

Alternatively, you can contact Murdoch University's Human Research Ethics Committee on +618-9360 6677 or by email: [ethics@central.murdoch.edu.au](mailto:ethics@central.murdoch.edu.au)

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Appendix D.4 – Thai Version of Consent Letter

งานวิจัยเรื่อง

Knowledge Management Platform for Promoting

Sustainable Rural Energy Services in Thailand

ข้าพเจ้านางสาวจันทร์จิรา พยัคฆ์เพศ  
อาจารย์ประจำภาควิชาวิทยาการคอมพิวเตอร์  
และเทคโนโลยีสารสนเทศ คณะวิทยาศาสตร์  
มหาวิทยาลัยนเรศวร กำลังศึกษาต่อระดับปริญญาเอก  
สาขาเทคโนโลยีสารสนเทศ ที่มหาวิทยาลัย Murdoch  
ประเทศออสเตรเลีย ได้ทำการศึกษาและวิจัยเกี่ยวกับการใช้งาน  
Knowledge Management Platform (KM Platform)  
สำหรับส่งเสริมการใช้พลังงานยั่งยืนภายในท้องถิ่น  
ซึ่งเป็นส่วนหนึ่งของการศึกษาโดยมีอาจารย์ที่ปรึกษาคือ  
รองศาสตราจารย์ Lance Chun Che Fung  
และรองศาสตราจารย์ Dora Marinova



วัตถุประสงค์ของงานวิจัยนี้ คือ ทำการประเมินการใช้งาน KM Platform และส่งเสริมการใช้งานพลังงานยั่งยืนในประเทศไทย ซึ่งท่านสามารถช่วยเหลืองานวิจัยนี้ได้ ด้วยการเรียนรู้การใช้งาน KM Platform และตอบแบบสอบถาม ทั้งก่อนและหลังการทดลองใช้งาน KM Platform ดังนั้น จึงใคร่ขอชี้แจงถึงลำดับขั้นตอนการให้ความช่วยเหลือ ในการทำวิจัยครั้งนี้ โดยสังเขป คือ

1. ตอบแบบสอบถามก่อนการใช้งาน KM Platform เพื่อ

- ทราบข้อมูลพื้นฐานของผู้ตอบแบบสอบถาม
- ทราบความสัมพันธ์ระหว่างผู้ตอบแบบสอบถามกับเทคโนโลยี โดยเฉพาะอย่างยิ่งอินเทอร์เน็ต
- ทราบความรู้พื้นฐานทางด้านพลังงานยั่งยืนของผู้ตอบแบบสอบถาม

2. ขอให้ท่านทดลองใช้งาน KM Platform ได้ที่

### 3. หลังจากทดลองใช้งาน KM Platform แล้ว

ใ ค ร ่ ข อ ค ว า ม ก รุ ณา

ตอบแบบสอบถามหลังการใช้งานซึ่งข้าพเจ้าจะได้จัดส่ง

ไว้ในภายหลัง เพื่อ

-ทดสอบความรู้ทางด้านพลังงานยั่งยืนของผู้ตอบแบบสอ

บถามหลังจากทดลองใช้ KM Platform แล้ว

-ทราบความคิดเห็นเกี่ยวกับ KM Platform

เพื่อนำไปปรับปรุงต่อไป

ถ้าท่านต้องการความช่วยเหลือหรือมีข้อสงสัยเกี่ยวกับงานวิ

จัยนี้กรุณาติดต่อข้าพเจ้าผ่าน ทางอีเมล [janjirap@nu.ac.th](mailto:janjirap@nu.ac.th)

สุดท้ายนี้ ข้าพเจ้าขอขอบคุณทุกท่านที่ให้ความช่วยเหลือใน

การทำวิจัยครั้งนี้มา ณ ที่นี้ด้วย

จันทร์จิรา พยัคฆ์เพศ

## Appendix D.5 – Thai Version of Pre-questionnaire

“Knowledge Management Platform for Promoting  
Sustainable Rural Energy Services in Thailand”

แบบสอบถามก่อนการใช้งาน KM Platform

แบบสอบถามชุดนี้เป็นแบบสอบถามชุดที่ 1 ก่อนการใช้งาน KM

Platform ซึ่งเกี่ยวกับ KM platform

และพลังงานยั่งยืนในท้องถิ่น

โดยมีวัตถุประสงค์หลักที่จะสอบถามข้อมูลเบื้องต้นและ

ประสบการณ์เกี่ยวกับ KM platform

คำจำกัดความที่ควรทราบเบื้องต้น มีดังนี้

- *Sustainable Rural Energy Services*

คือการนำเทคโนโลยีเข้ามาช่วยสนับสนุน

ในการพัฒนาการใช้พลังงานยั่งยืนในชนบทให้มีประสิทธิภาพ

- *Knowledge Management System (KMS)*

คือระบบที่เป็นตัวกลางระหว่างสถาบันพลังงาน

และประชาชนทั่วไปสร้างขึ้นเพื่อกระจายความรู้ทางพลังงาน

และแลกเปลี่ยนความรู้เกี่ยวกับพลังงานยั่งยืนรวมทั้งความ

รู้ทางด้านการออกแบบและการสร้างพลังงานจาก

แหล่งพลังงานเหล่านั้น

- *KM platform* คือ

เว็บแอปพลิเคชันที่ให้ความรู้เกี่ยวกับพลังงานยั่งยืนบนระบบ

เครือข่าย อินเทอร์เน็ต

กรุณาทำเครื่องหมาย X ในกล่องสี่เหลี่ยมหรือตอบอย่างสั้นๆ

ส่วนที่ 1: คำถามต่อไปนี้เกี่ยวข้องกับภูมิหลังและอาชีพ

1. อายุ:

20 – 29

30 – 39

40 – 49

50 – 59

60 –

และมากกว่า

2.

ระดับการศึกษาสูงสุด: \_\_\_\_\_

\_\_\_\_\_

3. เชื้อชาติ: \_\_\_\_\_

4. ประกอบอาชีพ:

\_\_\_\_\_

ส่วนที่ 2:

คำถามต่อไปนี้จะเกี่ยวข้องกับระดับการใช้งานอินเทอร์เน็ต

1. คุณสามารถใช้อินเทอร์เน็ตได้หรือไม่

- ได้                       ไม่ได้

2. คุณใช้อินเทอร์เน็ตที่ไหน (สามารถเลือกได้มากกว่าหนึ่ง)

- ที่บ้าน                       ที่ทำงาน
- ห้องสมุด                       ร้านอินเทอร์เน็ต

3. ถ้าคุณสามารถใช้อินเทอร์เน็ต คุณใช้บ่อยแค่ไหน

- ทุกวัน                       บ่อย (อย่างน้อยอาทิตย์ละสามครั้ง)
- อาทิตย์ละครั้ง                       เดือนละครั้ง

4. วัตถุประสงค์ที่ใช้อินเทอร์เน็ต (สามารถเลือกได้มากกว่าหนึ่ง)

- อีเมลล์                       ข่าว
- ค้นคว้า                       อื่นๆ\_\_\_\_\_

5. บอกระดับการติดต่อของอินเทอร์เน็ตที่คุณใช้งาน

- ดีเยี่ยม                       ดี

- ปานกลาง       ไม่ดี

### ส่วนที่ 3: คำถามต่อไปนี้จะเกี่ยวข้องกับความรู้ของคุณกับ KM

platform

1. คุณเคยใช้ KM platform มาก่อนหรือไม่

- เคย       ไม่เคย       ไม่รู้จัก

2. คุณเคยใช้ KM platform ที่ไหน

(สามารถตอบได้มากกว่าหนึ่ง)

- ที่ทำงาน       สถานที่ราชการ  
 สถานศึกษา       อื่นๆ \_\_\_\_\_

3. ถ้าคุณใช้ KM platform คุณใช้บ่อยแค่ไหน

- ทุกวัน       บ่อย (อย่างน้อยอาทิตย์ละสามครั้ง)  
 อาทิตย์ละครั้ง       เดือนละครั้ง

4. คุณใช้ KM platform เพื่ออะไร

ประกอบการทำงาน     ให้ได้ข้อมูล     แบ่งปันความรู้

อื่นๆ     อื่นๆ: \_\_\_\_\_

5. คุณคิดว่าการติดต่อกับความรู้บน KM platform เป็นอย่างไร

ดีเยี่ยม     ดี

ปานกลาง     ไม่ดี

ส่วนที่ 4:

คำถามต่อไปนี้จะเกี่ยวข้องกับความรู้เกี่ยวกับพลังงานยั่งยืน

1. ข้อใดต่อไปนี้เป็นการใช้พลังงานอย่างมีประสิทธิภาพมากที่สุด

a)     b)     c)

หลอดไฟกลม    หลอดฟลูออเรสเซนต์    ตะเกียงฟลูออเรสเซนต์



## 2. ข้อใดต่อไปนี้เป็นคุณเห็นด้วยมากที่สุด

- ราคาในการสร้างพลังงานจากแหล่งพลังงานยั่งยืนมีราคาสูงกว่าราคาในการผลิต
- เทคโนโลยีโซลาร์เซลล์ให้พลังงานโดยไม่มีการปลดปล่อยก๊าซคาร์บอนไดออกไซด์
- เครื่องอบแห้งแบบ cabinet ช่วยทำการถนอมอาหารโดยไม่สูญเสียคุณค่าอาหาร
- ตะเกียงเจ้าพายุ เป็นวิธีที่ดีที่สุดที่ช่วยให้ชุมชนที่ปราศจากไฟฟ้าสามารถทำกิจกรรม

## 3. ข้อใดต่อไปนี้เป็นจริง

อุปกรณ์ไฟฟ้าทุกชนิดมีการใช้พลังงานไฟฟ้าเท่าเทียมกันต่อวินาที

ทิศทางในการสร้างบ้านไม่มีผลต่อจำนวนพลังงานที่ใช้

หน้าต่างสมควรสร้างทางทิศเหนือของบ้าน

การออกแบบบ้านเช่น หน้าต่าง

โดยคำนึงถึงทิศทางของแสงอาทิตย์เพื่อช่วยลดความร้อน

จะช่วยประหยัดค่าใช้จ่าย

## 4. ข้อใดเป็นแหล่งพลังงานทดแทน

- a) ไม้                       b) ถ่าน
- c) ชีวมวล                 d) ลิกไนต์

5. พลังงานในข้อใดเป็นพลังงานความร้อนที่สร้างขึ้นโดยกระบวนการ

ทางธรรมชาติภายในพื้น

ผิวโลก ตัวอย่างของแหล่งพลังงานนี้เช่นหินร้อน แมกมา

และน้ำพุร้อน

- a)                               b) พลังงานความร้อนภายในโลก

พลังงานแสงอาทิตย์

- c) พลังงานลม               d)

ความร้อนหาสมุทร

6. ชีวมวลสามารถได้มาจากข้อใด

- a) เปลือกถั่ว                 b) กากอ้อย

- c) แกลบ                       d)

ทุกข้อเป็นชีวมวล

7. ก๊าซชีวภาพเป็นก๊าซมีเทนซึ่งเกิดจากการหมักของมูลสัตว์

สิ่งปฏิภูล และเศษวัสดุทางการเกษตร

ประโยชน์ของก๊าซชนิดนี้คือข้อใด

- a) เชื้อเพลิงที่สะอาดและปราศจากควัน
- b) สิ่งเหลือใช้จากการหมักสามารถนำมาเป็นอาหารปลาได้
- c) ศักยภาพของก๊าซชนิดนี้สูงในท้องถิ่นทุรกันดาร
- d) ถูกทุกข้อ

8. พลังงานลมเป็นพลังงานจลน์ที่เกี่ยวข้องกับอากาศในชั้นบรรยากาศ

อากาศ พลังงานจลน์

ถูกใช้มานานแล้วสำหรับกระบวนการในข้อใด

- a) สีข้าว
- b) สร้างกระแสไฟฟ้า
- c) ยานพาหนะ
- d) ถูกทุกข้อ

9. ถ้าคุณเป็นวิศวกรทำงานเกี่ยวกับพลังงานทดแทนคุณจะทำอะไร

าง wind farm ที่ไหน

- a) ตั้ง wind farm ในหุบเขาและที่ราบต่ำ
- b) ตั้ง wind farm ในที่ซึ่งอากาศสงบเงียบ
- c) ตั้ง wind farm ในที่ราบสูง
- d) ตั้ง wind farm ในที่ไหนก็ได้ทุกๆที่

10. ข้อใดเป็นเชื้อเพลิงเชิงชีวภาพที่ไม่ใช่ทางการค้าซึ่งมีปริมาณ

มากในประเทศกำลังพัฒนา

- a) มูลสัตว์
- b) ถ่าน
- c)
- d) ไม้

เศษวัสดุจากพืชไร่

11. พลังงานในข้อใดจัดเป็นเชื้อเพลิงที่สะอาดที่สุด

- a) ถ่าน
- b)

ก๊าซธรรมชาติ

- c) น้ำมัน                       d) ไม้

12. แหล่งพลังงานในข้อใดมีผลกระทบต่อสิ่งแวดล้อมน้อยที่สุด

- a) ชีวมวล                       b) นิวเคลียร์

- c) แสงอาทิตย์                       d) ลม

13. เพราะเหตุใดเซลล์แสงอาทิตย์ไม่ใช่คู่แข่งกับโรงผลิตกระแสไฟฟ้าจากแหล่งพลังงานฟอสซิล

- a) ราคาของซิลิกาที่ใช้ผลิตเซลล์แสงอาทิตย์ราคาสูงเกินไป

- b) ค่าใช้จ่ายในการเลี้ยงคริสตัลเซลล์สูงเกินไป

- c) เซลล์แสงอาทิตย์มีประสิทธิภาพในการทำงาน 12 %

- d) เซลล์แสงอาทิตย์สามารถใช้ครอบคลุมพื้นที่จำนวนมาก

14. โรงงานอุตสาหกรรมที่มีการใช้เชื้อเพลิงฟอสซิลเป็นแหล่งปลดปล่อยก๊าซที่ก่อให้เกิดฝนกรด ก๊าซชนิดนี้มีชื่อว่าอะไร

- a)     b)

ซัลเฟอร์ไดออกไซด์

คาร์บอนไดออกไซด์

c)

d) โอโซน

ไฮโดรเจนไดออกไซด์

15. ข้อใดเป็นแหล่งพลังงานที่นิยมใช้กันในปัจจุบัน

a) ฟอสซิล

b) นิวเคลียร์

c) แสงอาทิตย์

d) ลม

\*\*\*\*\*

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ขอขอบคุณที่ให้ความร่วมมือ กรุณาทดลองใช้งาน KM Platform

เพื่อเตรียมตอบแบบสอบถาม

ชุดต่อไป

หวังว่าคงจะได้รับความอนุเคราะห์เช่นเดิมอีกครั้งหนึ่ง

Appendix D.6 – Thai Version of Post-questionnaire

“Knowledge Management Platform for Promoting  
Sustainable Rural Energy Services in  
Thailand”แบบสอบถามหลังการทดลองใช้งาน KM Platform

แบบสอบถามชุดนี้เป็นแบบสอบถามชุดที่ 2  
ภายหลังจากการทดลองใช้งาน KM platform  
ที่สร้างขึ้นเพื่อส่งเสริมความรู้เกี่ยวกับการใช้พลังงานยั่งยืนในชน  
บท หรือ ทั้ อ ง ถึ น  
โดยมีวัตถุประสงค์หลักเพื่อที่จะถึงประสบการณ์ในการทดลองใช้  
งาน KM platform จึงเป็นคำถามเกี่ยวกับการใช้งาน KM  
platform หลังจากตอบแบบสอบถามแล้ว  
กรุณาส่งแบบสอบถามคืน (ตามที่จำหน่ายไว้แล้ว)

นางสาวจันทร์จิรา พยัคฆ์เพศ อีเมล:

janjirap@nu.ac.th

ภาควิชาวิทยาการคอมพิวเตอร์และเทคโนโลยีสารสนเทศ

เทศ

คณะวิทยาศาสตร์ มหาวิทยาลัยนเรศวร

จังหวัดพิษณุโลก 65000

คำจำกัดความที่ควรทราบเบื้องต้น มีดังนี้

- *Sustainable Rural Energy Services*

คือการนำเทคโนโลยีเข้ามาช่วยสนับสนุน

ในการพัฒนาการใช้พลังงานยั่งยืนในชนบทให้มีประสิทธิภาพ

ภาพ



- *Knowledge Management System (KMS)*

คือระบบที่เป็นตัวกลางระหว่างสถาบันพลังงาน

และประชาชนทั่วไปสร้างขึ้นเพื่อกระจายความรู้ทางพลังงา

นและแลกเปลี่ยนความรู้เกี่ยวกับพลังงานยั่งยืนรวมทั้งความ

รู้ทางด้านการออกแบบและการสร้างพลังงานจากแหล่งพลัง

งานเหล่านั้น

- *KM platform* คือ

เว็บแอปพลิเคชันที่ให้ความรู้เกี่ยวกับพลังงานยั่งยืนบน

ระบบเครือข่ายอินเทอร์เน็ต

## ส่วนที่ 1:

คำถามต่อไปนี้จะเกี่ยวข้องกับภูมิหลังและอาชีพกรุณาทำเครื่

องหมาย X ในกล่องสี่เหลี่ยมหรือตอบอย่างสั้น

1. อายุ:

20 – 29

30 – 39

40 – 49

50 – 59

60 –

และมากกว่า

2.

ระดับการศึกษาสูงสุด: \_\_\_\_\_

\_\_\_\_\_

3. เชื้อชาติ: \_\_\_\_\_

4. ประกอบอาชีพ:

\_\_\_\_\_

5. เมื่อไรที่คุณตอบแบบสอบถามก่อนการใช้งาน

\_\_\_\_\_

6. คุณใช้งาน KM platform มานานเท่าไรแล้ว?

\_\_\_\_\_ (เดือน)

กรุณาทำเครื่องหมาย X

ในกล่องสี่เหลี่ยมในข้อที่คุณเห็นด้วยมากที่สุด

ส่วนที่ 2:

คำถามต่อไปนี้จะเกี่ยวข้องกับระดับการใช้งานอินเทอร์เน็ต และ KM platform

1. คุณใช้อินเทอร์เน็ตที่ไหน (สามารถเลือกได้มากกว่าหนึ่ง)

- ที่บ้าน
- ที่ทำงาน
- ห้องสมุด
- ร้านอินเทอร์เน็ต

2. ถ้าคุณสามารถใช้อินเทอร์เน็ต คุณใช้บ่อยแค่ไหน

- ทุกวัน
- บ่อย (อย่างน้อยอาทิตย์ละสามครั้ง)
- อาทิตย์ละครั้ง
- เดือนละครั้ง

3. ถ้าคุณสามารถเข้าไปใช้ KM platform คุณเข้าบ่อยแค่ไหน

ทุกวัน                       อย่างน้อย 3 ครั้งในหนึ่งอาทิตย์

อาทิตย์ละครั้ง             เดือนละครั้ง

#### 4. คุณมักจะใช้บริการอะไรบน KM platform

(สามารถเลือกได้มากกว่าหนึ่งช่อง)

Forum                       News

Operation                 Others:

#### ส่วนที่3:

ข้อความต่อไปนี้เป็นข้อความที่แสดงถึงลักษณะการนำเสนอข้อมูล

บน KM platform.

กรุณาทำเครื่องหมาย X ในช่องที่คุณเห็นด้วยมากที่สุด

	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ปานกลาง	เห็นด้วย	เห็นด้วยอย่างยิ่ง
1. อินเทอร์เน็ตของแพลตฟอร์มใช้งานง่าย					
2. ข้อมูลบนแพลตฟอร์มมีการ					

อัปเดต ทันต่อเหตุการณ์					
3. การให้บริการติดต่อระหว่างคุณและผู้เชี่ยวชาญ เช่น อีเมลล์, กระจู้ เป็นต้น					
4. แพลตฟอร์ม่ให้บริการควมรู้ หรือ ข้อมูลที่มีประโยชน์					
5. แพลตฟอร์ม่ให้บริการข้อมูลเกี่ยวกับพลังงานยั่งยืนเพียงพอที่จะทำการออกแบบและสร้าง พลังงานยั่งยืน					

#### ส่วนที่ 4 คำถามต่อไปนี้เป็นคำถามเกี่ยวกับการใช้พลังงานยั่งยืน

1. ข้อใดต่อไปนี้เป็นการใช้พลังงานอย่างมีประสิทธิภาพมากที่สุด

- a)  b)  c)

หลอดไฟกลม ตะเกียงฟลูออเรสเซนต์ หลอดฟลูออเรสเซนต์

2. ข้อใดต่อไปนี้คุณคิดว่าถูกต้องมากที่สุด

- a) ราคาในการสร้างพลังงานจากแหล่งพลังงานยั่งยืนมีราคาสูงกว่าราคาในการผลิตพลังงานจากแหล่งพลังงานอื่น
- b) เครื่องอบแห้งแบบตู้หรือกล่องที่มีฝาปิด ช่วยทำการถนอมอาหารโดยไม่สูญเสียคุณค่าทางโภชนาการ
- c) เต้าไฟซึ่งใช้ถ่านไม้ให้พลังงานโดยไม่มีการปลดปล่อยก๊าซคาร์บอนไดออกไซด์

d) ตะเกียงเจ้าพายุ เป็นวิธีที่ดีที่สุดที่ช่วยให้ชุมชนที่ปราศจากไฟฟ้าสามารถทำกิจ

### 3. ข้อใดต่อไปนี้เป็นจริง

a) หน้าต่างสมควรสร้างทางทิศเหนือของบ้าน

b) ทิศทางในการสร้างบ้านไม่มีผลต่อจำนวนพลังงานที่ใช้

c)

อุปกรณ์ไฟฟ้าทุกชนิดมีการใช้พลังงานไฟฟ้าเท่าเทียมกันต่อวินาที

d) การออกแบบบ้านเช่น หน้าต่าง

โดยคำนึงถึงทิศทางของแสงอาทิตย์เพื่อช่วยลดความร้อน

จะช่วยประหยัดค่าใช้จ่าย

### 4. ข้อใดเป็นแหล่งพลังงานทดแทน

a) ถ่าน  b) ไม้

c) ลิกไนต์  d) ชีวมวล

### 5. หินร้อน แมกมา น้ำพุร้อน

จัดเป็นแหล่งพลังงานตามธรรมชาติในข้อใด

- a)  b) พลังงานความร้อนภายในโลก

ความร้อนจากมหาสมุทร

- c) พลังงานแสงอาทิตย์  d) พลังงานลม

6. ชีวมวลสามารถได้มาจากเศษวัสดุในข้อใด

- a) เปลือกถั่ว  b) กากอ้อย

- c) แกลบ  d)

ทุกข้อเป็นชีวมวล

7. ก๊าซชีวภาพเป็นก๊าซมีเทนซึ่งเกิดจากการหมักของมูลสัตว์

สิ่งปฏิกูล และเศษวัสดุทางการเกษตร

ข้อใดกล่าวถูกต้องเกี่ยวกับก๊าซชนิดนี้

- a) ในชนบท

หรือท้องถิ่นทุรกันดารมีศักยภาพในการผลิตก๊าซชนิดนี้สูง

- b)

สิ่งเหลือใช้จากการหมักก๊าซชีวภาพสามารถนำมาใช้เป็นอาหารปลาได้

ก๊าซชีวภาพเป็นเชื้อเพลิงที่สะอาดและปราศจากควัน

ถูกทุกข้อ

8. พลังงานลมเป็นพลังงานจลน์ที่เกิดจากอากาศในชั้นบรรยากาศ

พลังงานเหล่านี้

ถูกใช้มานานแล้วสำหรับกระบวนการในข้อใด

a) สีข้าว

b) ยานพาหนะ

c)

d) ถูกทุกข้อ

สร้างกระแสไฟฟ้า

9. ถ้าคุณเป็นวิศวกรทำงานเกี่ยวกับพลังงานทดแทนคุณจะทำกา

รสร้างวินฟาร์มในสถานที่ใดต่อไปนี

a) ในหุบเขาและที่ราบต่ำ

b) ในที่ราบสูง

c) ในที่ซึ่งไม่มีลมพัดผ่าน อากาศสงบเงียบ

d) ในที่ไหนก็ได้ทุกๆที่



10. ข้อใดเป็นเชื้อเพลิงเชิงชีวภาพที่ไม่ใช่ทางการค้าซึ่งมีปริมาณมากในประเทศกำลังพัฒนา

- a) ถ่าน                       b) มูลสัตว์
- c)                               d) ไม้

เศษวัสดุจากพืชไร่

11. พลังงานในข้อใดจัดเป็นเชื้อเพลิงที่สะอาดที่สุด

- a) ถ่าน                       b) ไม้
- c) น้ำมัน                       d)

ก๊าซธรรมชาติ

12. แหล่งพลังงานในข้อใดมีผลกระทบต่อสิ่งแวดล้อมน้อยที่สุด

- a) ชีวมวล                       b) แสงอาทิตย์
- c) นิวเคลียร์                       d) ลม

13. เพราะเหตุใดเซลล์แสงอาทิตย์ไม่ใช่คู่แข่งกับโรงผลิตกระแสไฟฟ้าจากแหล่งพลังงานฟอสซิล

- a) เซลล์แสงอาทิตย์มีประสิทธิภาพในการทำงาน 12 %
- b) ค่าใช้จ่ายในการเลี้ยงคริสตัลเซลล์สูงเกินไป
- c) ราคาของซิลิกาที่ใช้ผลิตเซลล์แสงอาทิตย์ราคาสูงเกินไป
- d) เซลล์แสงอาทิตย์สามารถใช้ครอบคลุมพื้นที่จำนวนมาก

#### 14. ก๊าซในข้อใดที่ถูกปลดปล่อย

ออกมาจากโรงงานอุตสาหกรรมซึ่งมีการใช้ เชื้อเพลิงฟอสซิล และ ก๊าซชนิดนี้นั่นเองที่เป็นสาเหตุของปรากฏการณ์ที่เรียกว่า ฝนกรด

a) โอโซน

b)

คาร์บอนไดออกไซด์

c)

d)

ไฮโดรเจนไดออกไซด์

ซัลเฟอร์ไดออกไซด์

#### 15. แหล่งพลังงานในข้อใดที่นิยมนำมาผลิตเป็นพลังงานในปัจจุบัน

จจุบัน

a) ฟอสซิล                       b) นิวเคลียร์

c) แสงอาทิตย์                       d) ลม

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ขอบคุณที่ให้ความร่วมมือ.

ถ้าคุณมีคำถามเกี่ยวกับแบบสอบถามนี้

คุณสามารถติดต่อตัวข้าพเจ้าเอง (นางสาวจันทร์จิรา พยัคฆ์เพศ)

หรืออาจารย์ที่ปรึกษา รศ ดร. แลนส์ ฟุง หรือ รศ. ดร. โอรา

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