A KNOWLEDGE MANAGEMENT PLATFORM FOR THE PROMOTION OF MODERN RURAL ENERGY SERVICES IN ASEAN COUNTRIES

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ABSTRACT

Modern Rural Energy Service (MRES) has been developed and implemented for years. It offers lots of advantage such as efficient energy and clean environment. However, MRES is used only in a particular group due to the lack of knowledge and promotion. This paper proposes the design and development of a Knowledge Management platform for promotion of MRES in ASEAN countries. The proposed system will employ web service technologies for enhancing and distribution the utilization of MRES.

1. INTRODUCTION

The term Modern Rural Energy Service (MRES) is referred to the provision of energy to rural communities based on technologies that utilize renewable and traditional energy resources with high efficiency. Renewable energy is obtained from sources which include conventional hydroelectric power, wood fuel, biomass, waste residues, geothermal, wind, photovoltaic, and solar thermal energy that are essentially inexhaustible. Renewable energy service is a way to handle the expected shortage of energy that may occur in the not too distant future. In the case of rural areas, there are a lot of renewable energy sources and in particular, biomass and waste residues. These types of renewable energy sources have long been wasted due to the lack of knowledge and technologies in utilizing such resources by the local residents. Traditional energy resources such as wood or oil are also being used inefficiently. Hence, to promote the utilization of renewable energy resources and to maintain efficient use of both types of renewable and traditional energy, rural communities need to improve their ability to build and utilize appropriate appliances that use energy efficiently. As the consumption of all forms of energy will have local, regional and global environment impacts, the use of MRES will bring benefits to all three levels of the environment.

However, it has been described in the previous passage that the lack of knowledge in utilizing the MRES is the main obstacle which prevents the rural communities from using the local energy resources efficiently. This leads to a challenge on how to enhance and utilize the ASEAN rural people's knowledge in order to gain benefits from MRES. Better utilization of MRES will result in a cleaner environment and a sustainable future. 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 MRES. KMS platform is going to be an invaluable tool to assist the rural communities in ASEAN countries in handling the challenges relating to their energy needs. This is the main aim of this research and the following sections outline a proposal on a KMS platform for the promotion and efficient use of the MRES. This will subsequently assist the involved parties to derive solutions in order to meet the energy needs of the rural communities.

2. OVERVIEW OF MRES TECHNOLOGIES

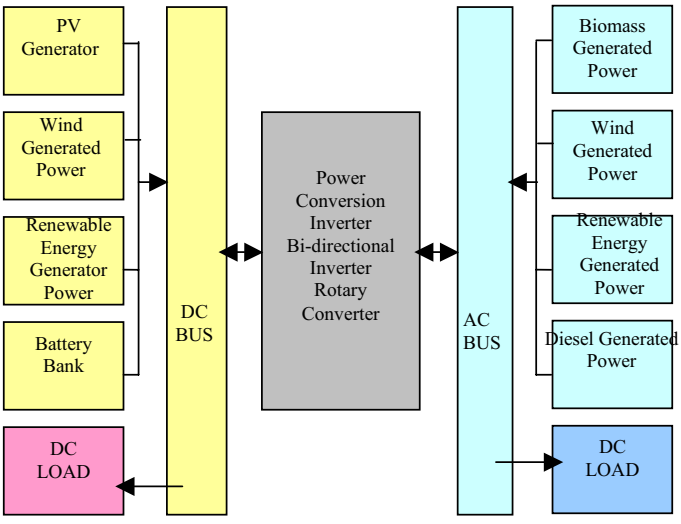

Figure 1: The typical MRES technology [1]

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Figure 1 shows a typical MRES system. The system comprises of a variety of conventional and renewable energy sources. Examples of renewable resources are Photovoltaic (PV) panels, Wind Generator and other sources such as biomass generator or small-scaled hydro. These generators are commonly connected to a Direct-Current (DC) bus or an Alternate Current (AC) bus. A battery bank is also included and connected to the DC bus. On the AC bus, a diesel generator can be connected to meet heavy load demand. Between the two buses, there exists a power converter consists of a bi-directional inverter and a rotary converter rectifier. The purpose of the device is to provide the conversion between the DC and AC power. The battery is mainly used for storing the excess energy when the supply exceeds the demand. Alternatively, the battery can be used to meet the extra load should the supply falls short. Such a MRES system will typically utilizes much less energy as compared to the stand-alone diesel generator units.

At present, researches on MRES have developed and implemented a number of systems at the following rural areas communities:

- A sustainable village power supply in Mexico by renewable energy [2].
- Maintaining supply reliability of small isolated power system using renewable energy in Canada [3].
- A Solar Photovoltaic water pumping system in Nepal [4].
- The FuSolar Home System Project in Thailand [5].
- Deployment of Photovoltaic generators in Phillipines; Biomass in Brazil and Wind in India [6].

Generally, the principles utilizing the above MRES systems are based on technologies which are essentially the same as the typical MRES diagram as shown in Figure 1. In comparing the systems, normally they differ in the types of renewable energy resource being used and the services they provide. For example, the Mexican project manages to sustain the village power supply by using a combination of solar energy, geothermal energy, bio-energy and wind energy [2]. On the other hand, Napel used only solar energy for water pumping system [4]. Figure 2 illustrates the use of solar energy in a typical household in Thailand for small load demands.

3. KNOWLEDGE MANAGEMENT PLATFORM

In order to distribute knowledge on MRES to the public, many approaches have been explored. Knowledge Management (KM) involves in the capturing, defining, storing, categorizing and linking of knowledge; searching for and subscribing relevant content from appropriate sources; and present the contents with sufficient flexibility [7]. In addition, Knowledge Management System (KMS) supports tacit knowledge and meta-information creation. KMS also connects users with the stored knowledge; people with people, and with people who possesses specific tactic knowledge [8]. Hence, a KM platform would be appropriate to promote and to enhance the utilization of MRES by all stakeholders.

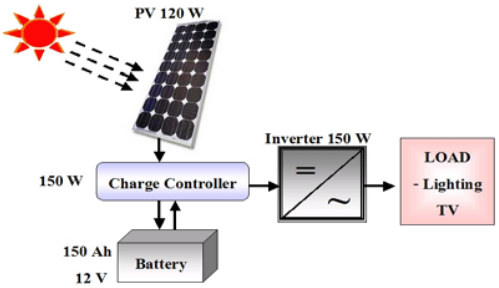

Figure 2: FuSolar Home System Project [1] [5]

As an example, KM platform can be expressed in the form of training lessons to be delivered in education or training institutes. At the end of such a program, the students are expected to understand the process of building energy from renewable energy [9]. Another example is the use of knowledge in the design of Integrated Renewable Energy System (IRES). According to Ramakumar R. at el [10], IRES was developed in order to build energy service to support rural population in developing countries. IRES was a stand alone system that used a relational database and search algorithm. IRES matches the resources, devices and the needs and achieve integration of benefits at the user end by using a relational database only on rural area site. One of the unique features is the use of knowledge management techniques to query the database and the use of a specific search algorithm. The objective was to find a combination of photovoltaic (PV) and/or Wind-Electric Conversion Systems (WECS) ratings and the size of storage that minimizes capital cost and without compromising the loss of power supply probability [10]. The last example of utilization of knowledge management is a computer program in the Rural Electrification Program at Durban, South Africa. The program is used to optimize the allocation of Renewable energy resources and minimizing the losses [11]. The potential of this research offers an ability to determine the most effective energy source to supply the required load at any given time of the day.

It is obvious that these three examples offer inadequate services for the wider community. The renewable energy technology course provides an easy way to understand how to build MRES from rural energy resource but it is only used by the students within the university. In the cases of IRES and the optimization program used in South Africa, the stand-alone databases are inadequate to enable the building of the most efficient energy service system. This is due to the information within the databases are not updated. Therefore, it leads to the present challenge that new technologies are required to offer the ability

to enhance the features and to sustain the relevancy and usefulness of the MRES systems.

In the discipline of Information Communication Technology (ICT), Web Services are emerging as a leading technology to enable the sharing of functionalities across the boundaries of computing platforms, network architecture, operating systems and programming languages [12]. The generation and evolution of web service has brought new opportunities to the development of KMS. Within the context of Web Services Technologies and their potential benefits, it is expected that the features and core knowledge on KMS could be visibly promoted and exchanged [13].

Web services were originally designed as a method of inter-machine communication, which has been typically done implementing a client/server (C/S) model. In the C/S model, requests by a consumer client are made via a broker or project to a web services on a remote service. It is this model which is mostly used for web services development. A typically web services consumer model consists of a number of entities - service providers, service brokers and service requesters. Service providers create web services for the public and register the services with the service brokers. Service brokers maintain a registry of published services. Service requesters find their required services by searching the service brokers' registry. Requesters then bind their applications to the service provider to use the particular services [14].

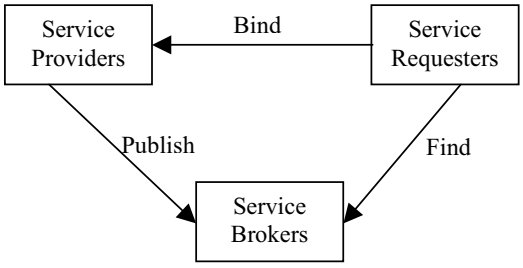

Figure 3: Web Services Consumer Model [14]

Web Services are essentially founded upon three major technologies: Web Services Description Language (WSDL), Universal Description, Discovery and Integration (UDDI), and, the Simple Object Access Protocol (SOAP) [12]. WSDL is a language that programmer can use to describe the programming interface of web services. UDDI allows web services providers register their characteristics or services with a registry so that other applications can find them. SOAP acts as a bridge for communication between web services and the client application. Based on web services technologies, the MRES can identify several desirable attributes of a typical KMS. Such attributes include platform independence and portability, robust access, security, scalability; and ubiquitous, consistent, intuitive client interface. Therefore, Web Services have the appropriate tools facilitating the promotion and sharing of knowledge on MRES over the World Wide Web [13] [8].

4. PROPOSED KNOWLEDGE MANAGEMENT SYSTEM

The proposed KMS is a system that enhances an individual's tacit and explicit knowledge on MRES for all organizations and stakeholders by using web services. Figure 4 illustrates the components of the proposed system. A browser is a stakeholder or anyone who retrieves information from the system in order to undertake the lessons, or, to use collaborative services such as online discussion. A subscriber also receives the similar services as a browser. However, enhanced information and services can be provided to a subscriber such as tools for planning and design.

All stakeholders will provide the knowledge in the forms of entries in database systems, publications and collaborative exchange. The databases may be situated at locations within the entities of the members such as School of Renewable Energy Technology (SERT), ASEAN members and the stakeholders. A knowledge server is a middleware between the users and data of the proposed system. It facilitates integration, organization and aggregation of spatially distributed explicit content and tacit knowledge pointers.

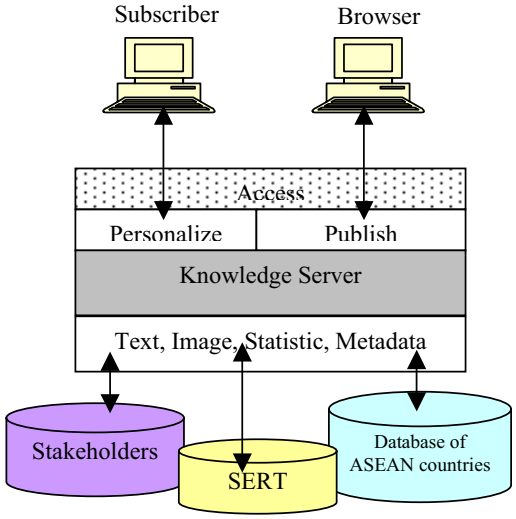

Figure 4: Proposed KMS for MRES

The web programming languages such as XML and Knowledge Query Modeling Language (KQML) are employed for the implementation of the proposed system. The possible features of the proposed system are shown as Table 1. As the proposed system focuses on the use of KM for the promotion of sustainable MRES for ASEAN countries, is it necessary to collaborate with existing ASEAN cooperation schemes, particularly those relating to the energy, rural development sector and environment sector. The ASEAN Energy Centre (AEC) is one of such centers functioning as a regional institution for

the promotion and provision of information on energy and related issues [15]. The School of Renewable Energy Technology (SERT) – Naresuan University in Phitsanulok, Thailand is a local university that has been conducting applied researches in the discipline of renewable and solar energy for over six years. An aim of SERT is to utilize solar energy technologies to meet energy needs in developing countries [1]. These organizations are typical stakeholders in the provision and promotion of information and knowledge on the use of renewable energy and related resources.

Table 1: Features of proposed MRES KMS

Features	Description
Profiles	Data on individuals and organization
Operations	Data on Database of Renewable Energy
Lessons learned	Data on lessons learned from past and ongoing renewable rural energy
Indicators	Statistical data graphs, worksheets and table on rural energy indicator
Correspondence	Serving as central electronic mailbox for correspondence with outside contacts
Archive	Serving as storage of electronic files
Calendar	Information on meeting, seminars, conferences and other events
Forum	Serving as online discussion board
Design & Planing	Convert all the resources to one form (electrical). Then match the resources, needs and technologies to maximize end-use efficiency and benefits at the user end is the ultimate goal.

5. CONCLUSION

This paper has proposed a Knowledge Management System (KMS) for the promotion of the use and design of Modern Rural Energy Services (MRES) in ASEAN countries. MRES has been developed and used for many years. Examples of such installations are village power supply in Mexico, water pumping in Nepal, solar energy in Thailand and so on. However, information and knowledge on MRES are not easily accessible by the public. KMS will provide useful assistance in the promotion of MRES. By using Web Services technologies, the proposed system can operate on any platform and work well under multi programming language of different organization's database. In addition, web services support any web application. Thus, users can access any information on MRES from any location where the Internet is working properly and be able to retrieve accurate information as well as their requirements. The proposed system will be an essential platform for promoting and enhancing MRES in ASEAN countries. The project will bring great benefits to the communities by meeting their energy demands without relying on traditional hydrocarbon-based fuel. This also has the effect of reducing impacts on the environment and maintaining the sustainability of the systems.

6. REFERENCES

[1] The School of Renewable Energy Technology (SERT) – Naresuan University in Phitsanulok Website: http://www.sert.nu.ac.th accessed on 16th March, 2004.

[2] Gutierrez-Vera J., "Renewables For Sustainable Village Power Supply", 2000 IEEE Winter Power Meeting, Singapore.

[3] Billinton R. and Karki R., "Maintaining supply reliability of small isolated power systems using renewable energy", *2001 IEEE Proceeding of Generation, Transmission and Distribution*, Vol.148 No.6. pp. 530-534, November 2001.

[4] Shrestha J. N., "Solar PV water pumping system for rural development in Nepal: problems and prospects", *1996 Energy Conversion Engineering Conference*, Washington, DC USA. 11-16 Aug 1996.

[5] Provincial Electricity Authority, "Solar Home System Project", Available on: www.pea.org.th accessed on 4th April, 2004.

[6] Basheer Ahmed S., Zia UI Haq et al., "Applicability of renewable energy technology technologies in developing countries", *1996 Interconference on Systems, Man and Cybernetics*, Beijing, China, 14-17 October, 1996.

[7] Zack H. M., "Managing Codified Knowledge", *Sloan Management Review*, Vol. 40 No. 4, Summer 1999.

[8] Tiwana A. & Ramesh B., "Integrating knowledge on the web", *IEEE Internet Computing*, pp. 32-39, May-June 2001.

[9] Zahedi A., "Computer-based multi-media system on education of Renewable energy technology; design and use", *1998 International Conference on Systems, Man, and Cybernetics*, San Diego, CA USA, 11-14 October, 1998.

[10] Ramakumar R., "Energizing rural areas of developing countries using IRED", *1996 Energy Conversion Engineering Conference*, Washington, DC USA., 11-16 August, 1996.

[11] Ijumba N.M., raphalalani V. T. and Reddy P., "Optimised of renewable energy sources in rural electrification", *1999 IEEE AFRICON*, Cape town South Africa, 28 September – 1 October, 1999.

[12] Castro-Leon E., "The World Within the Web", IEEE Spectrum, pp. 36-40, February 2004.

[13] IBM Web Services Architecture Team, "Web Services architecture overview: The next stage of evolution for e-business", *2000 IBM*, Available on: www.ibm.com accessed on 1st April, 2004.

[14] Roy J, & Ramanujan A., "Understanding Web Services", *IEEE IT Professional*, Vol. 3 Iss. 6, pp. 69-73, Nov-Dec 2001.

[15] ASEAN Energy Organization (2004) Website: www.aseanenergy.org accessed on 16 Mar, 2004.