Customer Information Systems for deregulated ASEAN countries

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***Abstract* — In similar fashion to western countries, ASEAN countries are also gearing up towards deregulation. Despite potentially different motivating drivers, the ultimate objectives are free market competition leading to efficient pricing signals as well as providing customers with the freedom to choose their electricity provider and benefit from competitive prices. This paper provides an ASEAN electricity market analysis and describes the development of electricity deregulation in ASEAN countries. By way of background it also highlights the objectives of deregulation, the potential challenges and also the impact areas focusing on existing Customer Information Systems (CIS) that have been developed by other utilities. In addition, this paper proposes a new framework for improving CIS for ASEAN utilities facing deregulation. The framework outlines a CIS, which has intelligent features enabling the utility to estimate and predict customer behaviour with respect to consumption patterns. It describes how these features can assist the utility companies to retain their existing customers as well as attract more customers.**

***Index Terms* — ASEAN, customer information system, data mining, deregulation**

I. Introduction

ASEAN consists of 10 member countries, namely Thailand, Vietnam, Laos, Indonesia, Philippines, Myanmar, Brunei, Malaysia, Singapore, and Cambodia (see Figure 1). These countries are progressively deregulating their power industries in order to derive advantages from free-market competition and privatisation. These moves will allow customers to choose their electricity provider and benefit from competitive pricing.

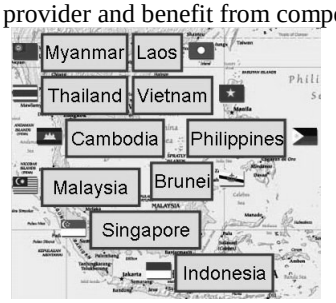

Fig. 1. Location of ASEAN Countries [1]

Some research work on the deregulation of the power industry in ASEAN countries has already been done [2]. However, little attention has been paid so far to investigating the impact of deregulation on the customer information system (CIS) that utilities in the industry require. In this paper, we examine the current and projected power industry growth in ASEAN countries, and we go on to identify the challenges and requirements to be met if a more effective CIS is to be provided in this changing environment. For such an examination, it is necessary first of all to have a comprehensive understanding of the power industry's development in the ASEAN grid.

As shown in table 1 that most of the ASEAN countries are implementing an unbundled structure with the intention of achieving a fully competitive market by 2010. In order to encourage competition within the ASEAN group, those countries that have maintained a vertically integrated structure are now progressing towards introducing an unbundled structure. The countries that have already unbundled their industry are now moving towards the introduction of wholesale competition and, ultimately, to the provision of a system where customers are free to choose their own suppliers [2], [3].

The major developments in the process of deregulation and privatisation in the electricity industry of the ASEAN countries are outlined in Table I. Specifically, most of these countries, including Brunei, Laos, and Myanmar, still operate a vertically-integrated system. As of 2001, Cambodia was still considering the establishment of an independent regulatory body to commercialize the country's power utilities. At the same time, Indonesia, Philippines, Singapore, Vietnam, and Thailand were already progressing towards full customer choice according to the schedule shown in Table I. Malaysia, however, was still reviewing the introduction of full deregulation and further divestment of the Tenaga Nasional Berhad (TNB) was postponed in 2000.

TABLE I. Deregulation Process of ASEAN Countries, [2]

Countries	Vertically integrated	Unbundle structure	Whole sale	Full choice	Year
Thailand		X	→	→	2003
Malaysia		X	- - - - -	- - - - - →	u. r
Indonesia		X	→	→	2007
Myanmar	X				
Philippines		X	→	→	2004
Singapore		X	X	→	2002
Brunei	X				
Vietnam	X	X	→	→	2010
Laos	X				
Cambodia	X	- - - - -	- - - - -	- - - - - →	u. r

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With the deregulation in process, the competition between retailers becomes intense when customers are able to choose their preferred electricity supplier. Therefore, it is crucial for power utilities, and especially the retailers, to ensure and enhance their current CIS with new functionalities and advanced features in order to secure their customer base and expand their business. The new functionalities may come from new customer service modules and advanced computational techniques such as data mining and data warehousing. These also include data mining techniques to build intelligent customer profiles with features that facilitate the estimation and prediction of consumption behaviour. Such information provides a means of ensuring the retention of existing customers. The knowledge gathered from the customer information will also enable new customers to be attracted through appropriately designed marketing strategies.

This paper describes the deregulation process in ASEAN member countries and proposes a CIS framework that uses data mining techniques to develop customers' profiles that help prevent existing customers from migrating to other utilities as well as helping to attract more new customers.

The remainder of the paper is organized into sections as follows. An overview of the ASEAN electricity market, including a consideration of its supply and demand outlook and an analysis of its socio-economic characteristics, is presented in Section I. The objectives, challenges, and impacts of deregulation are discussed in Section II. In Section III, the current practices involved in providing customer and meter databases are outlined alongside a proposed new CIS framework.

II. THE ASEAN ELECTRICITY MARKET OVERVIEW

It is necessary to have an overview of the electricity market of ASEAN countries in order to highlight the needs for new CIS development. The electricity market overview is focused on the fundamental facts including demand-supply outlook and social economical analysis.

A. Demand-Supply Outlook

Before deregulation, ASEAN power utility companies had a vertically-integrated structure and operated with full control over the generation, transmission, and distribution of electricity. With the introduction of deregulation, the structure has been, or will be in the future, unbundled and new players will begin to participate in the market. All ASEAN countries are progressing towards privatisation with the intention of establishing a level playing field where market prices are dictated by the forces of demand and supply. This is in line with the requirements of the ASEAN Power Grid Project that is to be completed by 2020. The project involves the building of 14 interconnections between the countries and requires that all ASEAN members have an almost fully restructured industry by 2010 [2].

In ASEAN countries, electricity consumption is projected to increase on average by about 504.6 TWh over the period 2000 to 2020. This rising demand will stem from revitalized economic expansion and an intensified rural electrification effort [2]. It is evident from Figure 2 that the total demand is projected to increase from 220 TWh in 2000 to 291 TWh in 2005 and then to continue to grow towards 409 TWh in 2010, 577 TWh in 2015, and finally to reach 814 TWh in 2020.

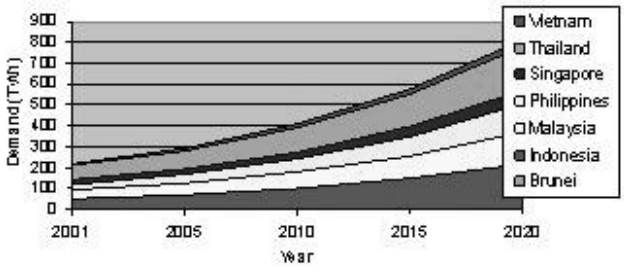

Fig. 2. Demand Outlook of ASEAN Countries [2]

In Figure 2, it is shown that the greatest demand comes from Thailand with 632 TWh, followed by Indonesia with 568 TWh, Malaysia with 444 TWh, and the Philippines with 362 TWh. All of these countries are already adopting an unbundled structure and are preparing themselves to move to a market with full customer choice by 2010. However, countries such as Brunei with a demand of 9 TWh and Vietnam with 101 TWh are still operating with a vertically-integrated structure and only progressing towards restructuring.

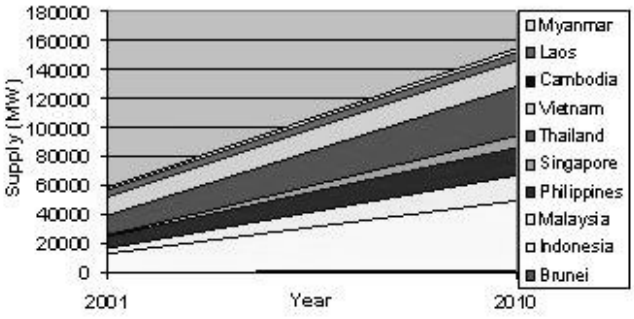

Fig. 3. Supply Outlook for ASEAN Countries [2]

In Figure 3, it is shown that in 2000, the total installed generating capacity was about 95,919 MW. This is projected to increase to 154,592 MW by 2010. The biggest increase will come from Thailand with about 14,019 MW, followed by Indonesia with 12,000 MW, Vietnam with 12,345 MW, and the Philippines with 8,105 MW increases. These planned capacity additions will require large investments, and these are expected to be undertaken by the private sector.

B. Socio-Economic Analysis

The data in Table II indicate that Indonesia has the largest population among the ASEAN countries, followed by Vietnam and then the Philippines. Singapore and Brunei are among the countries that have the smallest populations. However, even though these latter countries have a small population, 100 per cent of the people have access to the electricity supply. This is not the case in the other ASEAN countries. With respect to GDP per capita, Singapore has the highest level, followed by Malaysia and then Thailand. It is Indonesia that has the highest installed electricity production capacity, followed by Malaysia, Thailand, and the Philippines.

The political and economic systems vary considerably among the ASEAN countries. Despite their being developing countries, all of them are heading towards deregulation in the electricity sector as an integral part of the process of

establishing consumer market based economies.

TABLE II SOCIO-ECONOMIC STATISTICS OF THE ASEAN COUNTRIES, [2]

Country	Population (million)	GDP per capita (US$)	Installed capacity (MW)	Population Electrified (%)
Malaysia	20.93	11,000	13,540	99
Brunei	0.305	4,815	770.2	100
Singapore	3.87	20,452	5,600	100
Thailand	61	8,600	18,174	82
Myanmar	n. a.	n. a.	n. a.	n. a.
Philippines	75.15	1,094	12,066	79.89
Vietnam	76.24	1,700	5,559	71
Cambodia	n. a.	n. a.	n. a.	n. a.
Laos	n. a.	n. a.	n. a.	n. a.
Indonesia	212,94	442	21,312	55

It is noted that although the development toward full deregulation in ASEAN countries differs to a certain extent; they are facing similar challenges. Sooner or later development of new CIS systems to suit the needs of deregulation will become a common interest from utilities in ASEAN countries.

III. OPPRTUNITIES AND CHALLENGES IN CUSTOMER CHOICES FROM DEREGULATION

A. Objectives of deregulation

Rothwell [4] identified four reasons for the movement towards deregulation of the power industry around the world. These include, first of all, the availability of new generation technologies capable of achieving high technical efficiencies with low investment cost, together with short periods of construction for combined-cycle gas turbine (CCGT) power plants. Secondly, there has emerged a global pattern of competition that has resulted in pressure to achieve lower electricity prices. Thirdly, former utility owners have proven to be ineffective and slow in responding to problems in the industry when compared to private owners, and this has led to pressure for privatization. Fourthly, the availability of advanced information technologies and communication systems has enabled various commercial packages with attractive prices, high quality, and integrated services to be developed.

Experience in other developing countries, such as in Chile and Argentina, has demonstrated that the implementation of deregulation has overcome problems of inefficient government-owned electricity sectors, including poor investment strategies in the face of high rates of growth in electricity demand and consequent frequent outages. Deregulation in these countries has been in accordance with the respective government's ideology of moving towards general liberalization [5][6]. The deregulation objectives of developed countries, such as Australia and New Zealand, have been to increase efficiency and reduce electricity prices. Norway, Spain, the United Kingdom, and the United States chose deregulation for the same reasons, thus creating a situation where competition in the private sector enabled more efficient decision-making processes in undertaking investment in new technologies and curtailed the previously excessive investment in generation assets [5][6].

The objectives of deregulation in all the ASEAN countries are to promote efficiency, competition, and transparency in the electricity supply industry as a means of benefiting customers, as well as to establish a market in which prices will be dictated by the forces of supply and demand. This is to be achieved through privatization which will see the dismantling of the current, government-dominated and centrally-planned power supply systems with their vertically integrated structures [2] [3]. In all markets, deregulation is seen as a means of generally increasing the efficiency with which already installed generation assets are used.

B. Challenges

The current restructuring of the power industry in ASEAN countries [2] can be classified as being in its infancy. Only half of the members have moved towards an unbundled structure, with the other half still in the process of moving towards deregulation. Consequently, there are many challenges yet to be faced, including stranded costs, social costs, sequencing of reforms, and evolution of regulatory reforms [7]. According to Dehdashti [8], the most critical task for developing countries when preparing for the implementation of deregulation is to establish a balance between the introduction of competition and the existing regime of regulation, command, and control.

Other challenges for the power industry are being discussed in the Head of ASEAN Power Utilities/Authorities (HAPUA) Forum. These include the trend towards establishing tariffs at market-determined rates so as to reflect the costs of providing electricity services, establishing mechanisms to address the issue of subsidies to certain group(s) of customers [9] which effectively present a stranded cost, and the need to develop a regulatory framework that moves towards greater transparency and competition while facilitating continuing foreign investment in the power supply sectors of the ASEAN region.

C. Impacts

Deregulation directly or indirectly affects both the utilities themselves and their customers. The impacts on the utilities involve many areas of their structure and operations, including metering, customer interaction, electronic data exchange, and the billing system [6] [9]. At the same time, residential customers, poor and rural customers, industrial customers, and commercial customers will move to a supply system that allows them to choose their preferred electricity provider based upon which one offers them the most attractive package [10]. The particular concern of this paper is two fold. First, it is to elicit the means of improving the CIS features of a supplier so as to ensure the retention of existing customers by discouraging them from choosing another utility as their electricity provider. Secondly, it is to find the means of attracting new customers by encouraging them to choose a particular utility as their preferred electricity supplier.

IV. A NEW FRAMEWORK FOR CUSTOMER AND METER DATABASE MANAGEMENT

A. Current practice

For the most part, the electricity industry restructuring process in ASEAN countries has been introduced at the generation level. There are some countries, though, those have already introduced retail competition and allow customers to choose

their preferred supplier. Such competition means that where customers apply high standards concerning the level of services they expect to receive, they may penalize retailers that do not meet their expectations by moving to another supplier.

Increasing competition among utilities induces them to ensure that they plan so as to meet the needs of their customers. Most especially, a flexible CIS is required to accommodate customers' demand for informative billing, innovative products, and excellent service in general. Powers [11] described the features of an advanced key CIS with a three-tier architecture that is called the Energy Billing Options Support System (Energy Boss). Its main components include flexible application for billing, a rate calculation engine, and billing data designed to meet increasing customer demands. The system is well adapted to the new requirements of unbundled utility operations.

In addition to these flexible CIS features, the ASEAN utilities need to have an integrated data warehouse with powerful data mining capabilities that can readily distil information. This will enable them to extract patterns of data to support the decision making required to provide better services, increase market share, and boost profit. Werner [8] also stressed that data warehousing plays an important role in the operations of power supply utilities in that it allows them to cater for load studies and for the assessment of quality and customer loyalty. To do so, the data system should be designed for effective performance, have high availability and redundancy, and be flexible and open enough for users to query pertinent data for themselves.

Consequent upon deregulation, a vertically-integrated organization will be unbundled into a number of sectors that will operate of their own accord. These will include such sectors as generation, transmission, distribution, and supply. With this separation, further impacts on operations can be expected, especially with respect to metering, the billing system, data exchange, and customer interaction. McClanahan [6] [9] addressed such issues and recommended that utilities need to adapt to the changes by improving customer services through Customer Relationship Management (CRM). For even though the utilities are already unbundled, in the eyes of their customers the changes that occur should be seen to benefit them in terms of more efficient services as well as bringing more competitive prices.

CRM is one of the necessary applications that are highly desirable for the power industry in assessing profiles of customer profits. It will also enable utilities to build relationships with their customers through marketing strategies that are intended to improve customer satisfaction and differentiate between preferred and regular customers. Appropriately designed sales strategies can attract more new customers as well as ensure the retention of existing customers who have chosen a particular utility as their preferred electricity provider. Kitayama [7][10] also applied data mining techniques in establishing customer load profiles and used a decision tree as one of the methods to provide the classifications and estimations required to design business strategies that give emphasis to customer segmentation.

Another important requirement for a competitive CIS is to incorporate intelligent data mining capabilities into the system. This feature is required because the databases of utilities are characterized not only by their large size, but also by their noisiness, incompleteness, or the absence of some records [12]. In addition to this, there is a need for a reliable modelling capability to derive customer load profiles and load shapes so as to account for half-hourly data or daily data that depend of various demand factors such as the time of day, the time of year, and the weather conditions. One further feature required by utilities in a deregulated electricity market is the personalization of individual customer profiles based on their preferences and behaviour. Adomavicious [13] has developed just such a personalized system featuring personal behaviour rules that can be applied to the profiling of customers.

In summary, the main functionalities of current system developed for power utility companies include:

1. a flexible billing application with three tier architecture
2. an integrated warehouse with effective performance and high availability and redundancy
3. CRM application that link to marketing system
4. intelligent data mining capabilities to establish customer profiles
5. Personalization system based on customers' preferences and behaviour.

The main limitations on the current developed systems are:

- They do not incorporate all the features in a single CIS application
- They only generate customers profile without proceed to implement the next action

The new proposed system should overcome these limitations by having all these existing functionalities added to the new proposed features.

B. Proposed framework

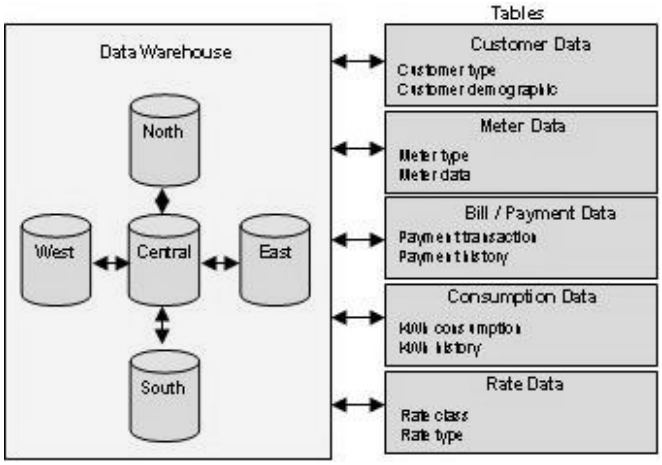

Fig. 4. Relationship among entities in customer information system

Based on the characteristics of the existing CIS systems and considering the challenges from deregulation, we propose a framework for customer and meter database management system. The aim of the proposed framework is to use data mining concepts and techniques to extract data of interest concerning customer behaviour patterns that may be hidden in the large data sets that make up a CIS. This is a useful feature for a CIS to have as it facilitates the retention of existing utility customers and the attraction of new customers by means of

predicting, forecasting, and analysing customer behaviour patterns. Making such data analysis available to the marketing department and the business department will enable them respectively to develop more effective marketing strategies and to improve the quality of their business decision making. The interactive relationships are summarized in Figure 4.

This framework includes 10 stages as shown in Figure 5. The collection of a whole range of customer related data is the first stage of the processes. Currently, under conditions of retail competition, there are many items of data involved in a CIS. Some of these are listed below.

- Customers; e.g. customer demographic, customer type, and customer category
- Meters; e.g. meter type, and meter data
- Payment; e.g. payment pattern, payment history, payment method, bill history, and bill information
- KWh consumptions; e.g. consumption history, and consumption pattern
- Rates; e.g. Rate category, and rate price
- Irregularities; e.g. any irregularities on payment pattern and consumption pattern.

These data will be collected for further processing. The main idea is to integrate all data from various sources, such as those illustrated in Figure 4, through data warehousing. After a cleaning and integration process, the data are selected and tabulated to generate customer and load profiles. The resulting tables will include those carrying such information as customer details, meters, rates, payments, and consumption patterns.

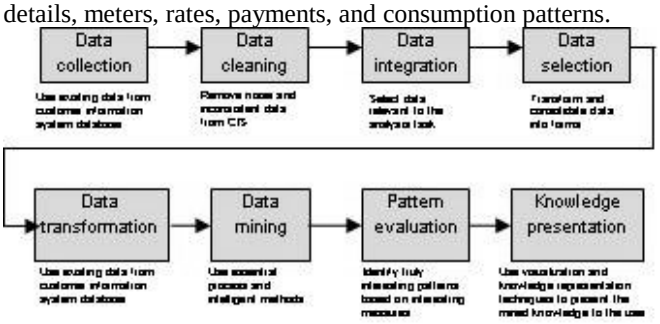

Fig. 5. Process to generate customer profile

Another key area of interest will be the extraction of indicators which are known to correlate strongly with customer patterns of switching utility choices. One such key indicator is price, and another may be the percentage of household income spent on electricity. In the case of commercial customers, a significant indicator of concern is the total annual expenditure on electricity as a percentage of the total expenses of a business. Other key indicators may be derived as complex functions of the quantities captured by the CIS, including those itemised above. The CIS will be initiated by designing a simple but effective questionnaire to be filled out by the customer providing relevant information over the telephone to a customer service operator. Such data gathering will enable the population of the databases with useful information.

The data collected is subjected to a cleaning process that will remove noise and preclude any inconsistent data from entering the customer database. Then the data is integrated with data from other sources and other locations, including from other countries or other states involved. Data selection will be undertaken to choose the particular data set that is relevant to any analysis that is to be carried out. Customer data, meter data, payment transaction data, metered consumption data, and rate data may all be relevant for such purposes. The selected data will be able to be transformed and consolidated into an appropriate form because the database has been designed for such mining. The data mining will extract, for example, patterns of customer payments and electricity consumption. After the patterns are identified and evaluated, they will be presented by means of appropriate visualization and knowledge representation techniques. From the profiles derived, a utility can apply pertinent information to devising marketing strategies or making business decision that provide for added value or attractive packages for its customers.

A further objective of this study is to consider a few techniques of clustering and association rules that have been devised and implemented to generate and segment customer profiles [14-16]. One example of a situation that demonstrates the importance of having data mining facilities in a CIS is set out below. Suppose a marketing manager in power utility company would like to determine the association rules illustrated in Figure 6.

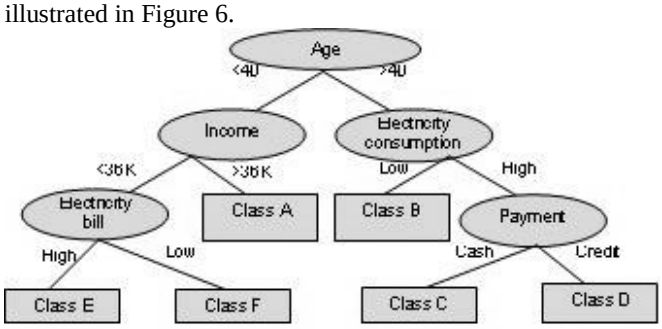

Fig. 6. Decision Tree for Customer Classification

Suppose a customer X is to be classified the decision tree actually represent the following process:

- Age(X, "< 40") ^ income(X, "< 36K") ^ electricity bill(X, "high") → class (X, "E");
- Age(X, "< 40") ^ income(X, "<36K") ^ electricity bill(X, "low") → class (X, "F");
- Age(X, "< 40") ^ income (X, "> 36K") → class (X, "A");
- Age(X, "> 40") ^ electricity consumption(X, "low") → class (X, "B");
- Age(X, "> 40") ^ electricity consumption(X, "high") ^ payment(X, "cash") → class (X, "C");
- Age(X, "> 40") ^ electricity consumption(X, "high") ^ payment(X, "credit") → class (X, "D");

Here a representative power utility customer is under scrutiny. The customer is classified according to different class categories. Given this knowledge, the marketing department will be assisted in directing their marketing strategies towards the respective class groups. The decision tree presented is one that will not only benefit the building up of customer profiles, but will also be of benefit in devising optimal actions to retain existing customers by examining the probability of satisfaction among the customer classes. In order to identify such actions to be taken, a study by Ling [17] included a solution involving mining optimal actions by means of an algorithm to change customers from an undesired status to a desired one.

Much research work has been undertaken concerning data-mining techniques, for example as reported in [14-18]. In the

present study, the intention is to make a comparative analysis of the results presented in such studies. Yen [15] presented a data-mining language that allows users to specify the criteria for discovering the rules, as well as providing a data-mining algorithm to generate the interesting association rules based on the specified criteria. For Chang [16], the use of the fuzzy c-means (FCM) clustering method enabled the identification of natural groupings of data in order to produce a concise representation of system behaviour. Yang [14] applied pattern-based clustering methods and mixture models to establish customer segmentation. In his work, Matsumoto [18] used on-line estimation of the functions in his modelling of a demand-side management system as a means of solving resource allocation, scheduling, and optimization problems. Finally, an outlier analysis reported in [19] can be performed in order to discover irregularities in consumption by detecting abnormalities in payment patterns or irregularities in load profiling. This will help the utility to detect any faulty metering or fraudulent tampering with metering devices. By looking at the relevant consumptions patterns, immediate actions to be taken by utility officers can be specified.

V. CONCLUSIONS

In this paper, we reviewed the current and future status of the ASEAN country power industry toward deregulation and identified the needs for new techniques in retail competition, i.e. a new CIS for utilities in order to attract more customers after the full unbundling of the deregulation sector. The framework presented basically covers existing functionalities of a CIS as well as features to meet the needs of deregulation. The concepts can be used in ASEAN power utility's customer information system that could manage the wholesale operation in ASEAN deregulated utility companies with additional features such as forecasting, estimating features on customer behaviour on load profile management demand side. This feature can benefit power utility in deregulated market to retain their existing customers as well as attract more new customers to choose them as their preferred utility provider.

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VII. BIOGRAPHIES

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Zhao Yang Dong (M'99) obtained his PhD in Electrical and Information Engineering from The University of Sydney, Australia in 1999. He is now a senior lecturer at the School of Information Technology and Electrical Engineering, The University of Queensland, Australia. His research interest includes power system's security assessment and enhancement, electricity market, artificial intelligence and its application in electric power engineering, power system planning and management, and power system stability & control.

Dr. Ariel Liebman trained as a physicist at the University of Queensland. Following that, he has spent over 7 years on the front lines of Energy Risk Management as part of front office and middle office in Major Australian Energy companies. He has also consulted on Energy Risk Management to major international organizations including Duke Energy International and Goldman Sachs. Dr. Liebman is currently leading a team of researchers in his position of Research Fellow at the newly founded Australian Research Council Centre for Complex Systems, headquartered at the University of Queensland in Brisbane.