DYNAMIC CONSUMER CLASSIFICATION FOR DYNAMIC CONSUMER BILLING IN NIGERIA

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ABSTRACT

Electricity consumer classification plays a vital role in power system network planning and electricity service delivery. In Nigeria, consumers are pre-classified based on their type of activity and their envisaged load demand as provided in the consumer data at the point of registration. Unfortunately, many consumers falsify the data they provide and some change activity without notifying electricity service provider. Consumer behavior is dynamic. As such, network planning, billing and service delivery issues occur.

A better approach to consumer classification is the utilization of dynamic consumer load pattern. In this system, consumer consumption data is collected and analyzed by a software. Decisions are made based on result. The approach used in this projects applies data mining clustering algorithm to classify consumers. In this approach, Expectation Maximization (EM) clustering algorithm is applied to 386 validated monthly consumer consumption data. The result is analyzed and then used to propose a suitable dynamic consumer billing model.

The cluster result generated only four (4) cluster as against the seven (7) classes in the pre-classification system. A ranking of cluster of consumers by consumption magnitude from lowest to highest shows that residential consumers fall into the lowest rank while industrial consumers fall into the highest rank. Most commercial consumers fall in the mid ranks. Some consumers moved across ranks over the two month under investigation signifying a net shift in consumption. The billing model evolved uses the consumer rank and activity class.

The four (4) clusters obtained from the result evolves a simplified consumer classification system that eases network planning process. The result also shows the net effect consumers have on the network vis-à-vis the consumer cluster. The result obtained can easily be used to track changes in consumer behavior as to detect irregularities or to make decisions as regard network planning and electricity service delivery. The process can be automated in real-time.

Keywords: Billing, Classification, Consumer, Electricity

Word Count: 317

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DEDICATION

I dedicate this project to the Almighty God, the author and finisher of all things for His protection, provision, guidance and inspiration. All glory be His.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CERTIFICATION

This is to certify that this project was carried out by, **OLUWAPELUMI OLUWASEUN EGUNJOBI** with Matriculation Number **138940**, department of Mechanical Engineering, Faculty of Technology, University of Ibadan.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW AND BACKGROUND

Managing an electricity distribution network is a complex task. It encompasses various functions including planning, maintenance, energy allocation, consumer classification, metering, billing and revenue collection. Each of these functions in itself involve series of complex physical and mental effort which have cost implications. Of importance are the task of consumer classification, billing and revenue collection. All these have direct impact on sustainability and service delivery. In Nigeria, each consumer class has an associated tariff charge which directly affects billing.

Following the unbundling of the power sector in Nigeria, emerging distribution service providers have since been mandated by NERC to ensure all consumers are appropriately linked to consumer tariff class. These service providers are called DISCOs. NERC classification system uses consumer activities and envisaged load demand as supplied by consumer during registration. Every consumer class has an associated tariff charge that is used to bill every consumer in the class. Unfortunately, a number of shortcomings have been identified with the system. One of such shortcomings is that many consumers falsify the data provided at the point of registration. Unfortunately, the Nigerian system also makes verification of consumer data very difficult. As a result, service providers rarely ascertain consumer claims. Therefore, many consumers are classified wrongly from the onset. Asides, many consumers change activity or equipment from time to time without notifying the operating DISCO. Even when the DISCO is informed, they fail to update their record promptly and sometimes they never update it. Unfortunately, because of the large number of consumers, it is difficult to track defaulters.

Asides, another major shortcoming in the classification system at the point of registration, is that it is sometimes difficult to classify some consumers who have peculiar activity type and load

demand. Similarly, actual load demand consumption varies greatly as it depends on many other factors like holiday season, product demand, industrial actions, technological advancements, season, etc. As a result of these short comings, consumers are classified wrongly.

The problem is complicated by shortfall in electricity supply of around 3000MW for an ever growing population of over 120 million people. Asides, many electricity consumers in Nigeria fail to optimize energy usage and still use obsolete equipment with high power ratings. They keep their equipment powered on even not in useful use. As a result, less energy is available for those that actually need it and can afford it.

A better technique to more accurately classify consumers is to track consumer consumption pattern. Fortunately, a consumer variable that reflects the dynamic behavior of consumer is the actual consumer consumption value. The consumer consumption value is influenced by dynamic activity type, electricity supply available, load demand, weather, environmental and socio-economic factors. Consumption figures can be easily obtained from appropriately installed metering infrastructure at consumer's premises. Using actual energy consumption records of consumers is a more precise approach to classifying consumers. This is the basis for dynamic classification and billing.

In many developed countries, dynamic classification has been an effective tool for network planning, improving power system stability, manage demand response, improving energy utilization efficiency, improving billing efficiency and providing better service. In dynamic classification system, a software analyses consumption pattern and uses it to classify consumers.

This projects employs an approach that finds pattern in data set that are difficult to find by manual visible inspection. This approach is called data mining. In this project, data mining clustering algorithm is applied to monthly consumer consumption record. Though several clustering algorithms are available, EM clustering technique is selected to find patterns in

consumption record. The projects uses this data mining techniques approach to classify consumers based on their monthly consumption record. The result is compared across months and a suitable approach for dynamic billing is proposed.

1.2 PROBLEM STATEMENT

Electricity consumers are classified for the purpose of management and billing. Consumer classes have assigned per unit tariff charges. In Nigeria, NERC has established tariff classification groups based on consumer activity type and envisaged load demand. As a result, all consumers are pre-assigned to tariff classes using the details submitted during registration. Unfortunately, many consumers falsify the data they supply in order to cut cost. The Nigerian system also makes it difficult for DISCOs to verify details of her numerous consumer during registration. Asides, consumer activity type and load demand vary from time. These changes are most times not updated in the consumer record with the operating DISCOs. Consequently, this has resulted to poor network planning and management, poor unfair billing system, poor revenue collection, and ultimately poor service delivery.

Proper consumer classification is hence very important for better network planning, system management improved billing. The classification should reflect consumer dynamic consumption pattern as much as possible.

1.3 OBJECTIVES

This projects examines existing consumer fixed classification system and evolves a method for dynamic consumer classification by application of data mining to historic consumer consumption data. The result obtained is then used to propose a method consumer billing. To achieve this, the project:

1. Reviews NERC consumer tariff classification scheme.
2. Identifies limitations of fixed consumer classification.
3. Gathers and organize historic consumer consumption data.
4. Discovers pattern in historic consumer consumption using suitable data mining clustering technique for the purpose of classification.
5. Propose a method for consumer dynamic classification and dynamic billing.

1.4 SIGNIFICANCE OF STUDY

The project aims ultimately to achieve the following:

1. Show that fixed consumers classification has limitations.
2. Find meaningful pattern in consumer electricity consumption data using data mining technique.
3. Evolve consumer dynamic classification and billing method using consumer dynamic consumption behavior.

The project is also intended to induce researches in the application of data mining and machine learning algorithms to solve indigenous problem in Nigerian energy industry.

1.5 SCOPE OF STUDY

The project identify the limitations of fixed consumer classification system and proposes consumers dynamic classification and dynamic billing methods by the application of a suitably selected data mining clustering technique to electricity consumption data.

1.6 LIMITATION OF STUDY

Though a number of problems exist in the power industry for which data mining techniques finds application, this thesis is limited to the following scope:

1. The project utilizes consumer electricity consumption data in Nigeria and hence the result may only be precisely applicable to Nigeria.
2. It does not develop a new data mining technique but rather just uses EM data clustering technique (an existing technique) for consumer classification.
3. The application of data mining technique is limited only to consumer classification.
4. The approach described in this project is only applicable to consumers with electricity meters.
5. Supply pattern varies greatly across areas in Nigeria. Since this has direct effect on consumption, only consumer data with similar supply availability pattern is used.
6. The project does not develop a new tariffs charge or tariff scheme. The process of developing a tariff scheme is itself a complex process requiring knowledge of macroeconomics.

CHAPTER 2

LITERATURE REVIEW

2.1 ELECTRICITY DISTRIBUTION AND UTILIZATION

The system of making available electricity for use is a chain process mainly divided into three (3) sectors with each sector depending on the other. The sector(s) are as explained in the following:

Generation: Electricity begins at the generation level. At this level, electricity is generated at the generating station employing any available technology. Electricity is generated in a 3-phase system at convenient voltage usually between 11kV and 20kV. Different countries have approved generation frequency which may be either 50Hz or 60Hz. In Nigeria, the approved frequency level for electrical system is 50Hz (NSONG, 2016). Technologies used in generation are broadly classified into two based on the energy resources employed. The classes are the renewable and non-renewable energy resources. The renewable energy resources employs energy sources that are abundant and for which they are replenished faster than they are consumed. Many renewable electricity generation station available today employ solar, wind, hydro, bio-mass and tidal resources. On the other hand, non-renewable energy sources use fossil fuels to generate electricity. Amongst these include coal, petroleum products and nuclear. In the world today, non-renewable energy resources still constitute the largest percentage being employed for electricity generation.

Transmission: At the transmission level, electricity generated is evacuated via electrical transmission lines to load centers several distance away. First, the electrical power generated at the generated station is stepped up to convenient high voltage levels and then tied to a grid network. As the transmission network approaches load centers, power is stepped down to a lower voltage at the sub-transmission level. Many countries operate a central grid system at a given

voltage level. In Nigeria, the transmission grid operates at 330kV and at 132kV for sub-transmission level (NSONG, 2016).

Distribution: The distribution network is at the vicinity of the load centers where the electricity generated is finally consumed. Power transmitted from the sub-transmission levels are further stepped down into lower voltage levels as it further approaches utilization centers. In Nigeria, the power received at 132kV is first stepped down to 33kV at the sub-transmission station from where it is evacuated to various injection sub-stations at the distribution level where it is further stepped down to 11kV. Service transformers mostly utilize power at 11kV, stepping it down to 415V phase to phase or 230V phase to neutral. Electrical power is then distributed to various consumers using service lines at this voltage level. In some case, industries like the steel industry utilize electrical power at 11kV, 33kV and even at 132kV voltage levels. At the distribution level, the network becomes very complex with several emanating lines to service numerous widely scattered consumers. At the consumers end, the electricity is utilized for various domestic, commercial and industrial activities.

2.2 ELECTRICITY METERING

The power system itself is a complex system involving numerous activities to ensure efficiency, stability and proper service delivery. Amongst these activities includes preliminary studies, network planning, load forecasting, maintenance, construction, equipment testing, system analysis, energy allocation, energy metering, energy billing and payment, energy accountability. Amongst these activities, energy metering is one the most important operations engaged in by distribution companies. Metering is the point of convergence between consumers and distribution service providers as it often times forms the basis for billing consumers for energy consumed.

An electricity meter is an electrical or electro-mechanical device that measures the quantity of electrical energy consumed by electrical appliances in homes, industries, etc. It measures the electrical energy consumed as a function of electrical power and the duration for which electrical energy is used. The first patented meter was created by Thomas Alva Edison in 1881 (Spintelligent, 2006). His 'electric meter' patented in 1881 (USA patent No. 251,545) used the electrochemical effect of current. Since then electricity meters design have improved from electrolytic meters to smart electronic meters.

2.2.1 TYPES OF ELECTRICITY METERS

Electricity meters from first invention till date have evolved greatly with improved size, capabilities, efficiency, durability and accuracy. Electricity meters are largely of two type:

Electromechanical Meter: It is a more primitive induction meter. In construction, it consist of a rotating metal disc, a permanent magnet, a counter mechanism and two coils housed in a container vessel. In operation, the two coil (for a single phase meter) operate like an induction motor with coil having flux created by the voltage and the other coil having flux induced by the current flowing through it. In actual sense, the metal disc rotates in proportionate speed to the power drawn through the meter (USDIBR, 2000). However, due to the inductive nature of the coils and connected loads, voltage lags current and this establishes eddy current effect that makes the disc rotate disproportionately. The disc rotational speed is counter-acted by a permanent magnetic brake. Hence, by counting the number of revolutions of the disc, the energy usage is determined. In figure 1, the count of disc revolution is transferred to a counter mechanism that registers it for measurement. Three phase electromechanical meters have additional voltage and current coils.

Figure 1: Electromechanical Meter (nPower, 2016)

Electronic Meter: It is a more recent type of electricity meter that works on principle of solid state electronics. It utilizes digital technology to measure electrical energy and uses an LED or LCD for display. More recent types have features that enables them to be read remotely. In construction, it has a solid state power pack, a metering system, a microcontroller and some with additional communication ports. In operation, by sampling technique, voltage and current signals are quantified into equivalent digital signals which are then used to compute energy consumption and other electrical parameters. The meter is equipped with memory to store computed and measured electrical parameters.

Figure 2: Electronic Meter (bijlibachao, 2016)

2.2.2 ADVANCE METERING INFRASTRUCTURE (AMI)

It is the most recent version of the solid-state electronic meter. It is a smart meter that relays remotely at intervals electrical consumption parameters with utility service providers for the purpose of billing, load forecasting, networking planning and maintenance, emergency demand response, dynamic pricing, etc (Chris, 2004). Unlike the AMR meter, AMI meters are equipped with two-way communication between the meter and service provider the central server system. AMI offers utility service providers the advantage of dynamic energy consumption since consumers consumption are sent to communication servers at set intervals.

2.3 ELECTRICITY ENERGY CONSUMPTION COMPUTATION

Electrical energy consumption computation is one of the most important computation in the power industry. The reason for this is not far-fetched. Power from generators are sent to the power grid from where it is travels via the transmission network into the distribution network and then finally to the consumers where it is utilized. At every interface of these stages, energy consumption is computed. Electrical energy is usually computed in kWh.

Whether it is electromechanical or electronic meters, the computation is similar. Both devices are designed such that the energy recorded is a good actual representation of energy consumed. Electrical energy is computed using the equation 1 below.

Electrical Energy = Electrical Power * Time of Usage

Equation 1: Computation for electrical Energy

For example, the electrical energy consumed by a consumer that uses a 6 kW immersion heater, a 4 kW electric stove and three (2) 100 W lamps for all 10 hours will be calculated as:

Total power in kW = 6 + 4 + (100/1000) * 3 = 10.3 kW

Using equation 1,

Energy in kWh = 10.3 x 10 = 103 kWh

Practically, electricity meter use similarly procedures in conjunction with a number of other factors to compute consumption. The readings registered by the meter are consumption in kWh. Sometimes kWh is simply referred to as unit. Therefore, to calculate electrical consumption for a given period of time using this reading, the Present Actual Reading (PAR) and Last Actual Reading (LAR) readings in kWh are obtained and consumption is calculated as:

Energy consumption (kWh) = PAR – LAR

However, in situations where meters do not exist, other means are employed to obtain or estimate current drawn or power consumed and the duration for which it is consumed. The electrical consumption estimated using this method is usually not accurate and forms an object for contention today especially in developing countries where many consumers are unmetered.

2.4 ELECTRICITY CONSUMER CLASSIFICATION

Classification of electricity consumer is the very premise of fair billing of electricity consumers (Y & Y, 2009). In many countries, electricity consumers are usually classified based on the average power demand level and the type of activity for which the power consumed is used for. In this method, consumers are pre-classified at the point of registration using the data provided by the consumer. In recent times, following the opening up of the electricity market, some countries now apply real time consumer consumption data for classification. This method employs various techniques that requires periodic consumption records. It offers numerous advantages. Unfortunately, because of the complexity of this method, many countries still employ the fixed pre-classification method. Generally, for both methods the consumer activity or purpose of usage is considered in consumer classification. The following are the consumer activities considered for classification (O, 2010):

Residential or Domestic: It is the supply of electricity for domestic purposes which is used for domestic water supply, common area lighting, domestic cooling, in residential houses and apartments. Such consumer uses his premises exclusively as a residence.

Commercial: It is the supply of electricity to a premises for purposes other than exclusively as a residence or as a factory for manufacturing goods.

Industrial: It is the supply of electricity to a premises for the purpose of manufacturing or production of goods. Such premises are usually characterized by industrial equipment.

Special: It is a cluster of other consumers for which special considerations are given where electricity supply is to premises like government schools, research centers, religious centers, agro-based centers and government buildings.

Some countries have more specific classifications to cater for more specific category of consumers. Consumers are then further classified amongst the various activity types for the purpose for planning and billing.

2.4.1 FIXED ELECTRICITY CONSUMER CLASSIFICATION

The fixed consumer classification method employs a pre-classification technique. Prospective consumers at the point of registration, before connection to electricity network are mandated to provide some information. As shown in figure 3, the information required for consumer classification includes the connected load detailing major equipment and the type of activity the consumer is engaged in for which electricity is intended to be used for.

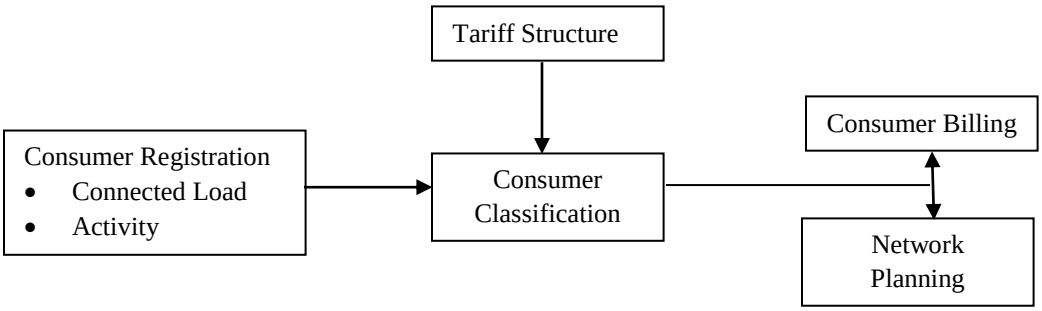

Figure 3: Simplified Block Diagram of Fixed Consumer Classification Process Flow

Fixed consumer classification system offers simplicity in approach. However, the approach has been proved to be grossly inadequate following the increase in the number of electricity consumers and evolution of various consumer activities. Asides, in most cases consumers falsify data supplied during registration to earn a lower tariff charge. In some other cases, consumer use electricity for other purposes other than what was registered without proper documentation with the electricity service provider. Unfortunately, in many countries, because of existing limitation, it is difficult to periodically validate and re-validate consumer records.

Many countries using the fixed consumer classification technique suffer from poor planning and billing inefficiencies. In this case, precise load forecasting for consumers amongst different category and location is difficult. As such, energy allocation is poorly done and the system experiences instability. Also, because consumers are wrongly classified, unfair billing usually exist.

2.4.2 DYNAMIC ELECTRICITY CONSUMER CLASSIFICATION

The dynamic consumer classification approach is a more recent approach that evolved from the need for better network planning and management, fair pricing systems and improved service delivery. Dynamic classification uses actually consumer consumption data on a periodic basis. The interval of gathering of consumption data varies depending on metering infrastructure available, software availability and the purpose of application of dynamic classification. As in figure 4, consumer data are required for classification. In some countries dynamic consumer classification is used for only billing and in some others for only planning. In most countries, it is used for both.

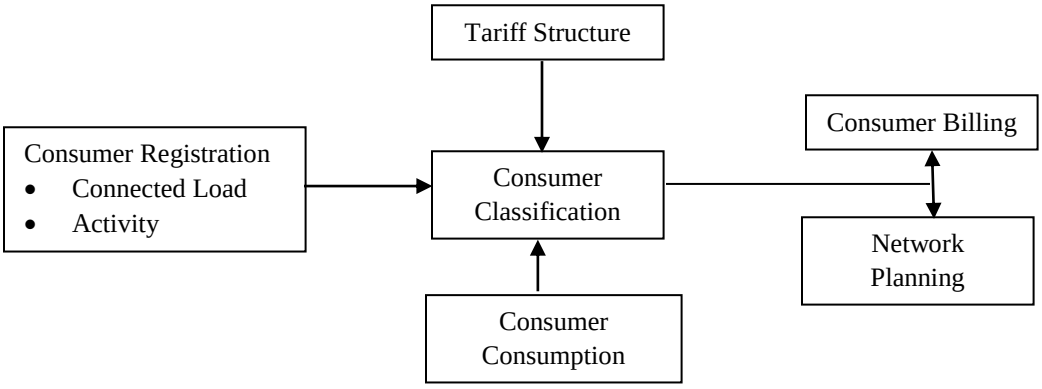

Figure 4: Simplified Block Diagram of Dynamic Consumer Classification Process Flow

Dynamic consumer classification offer numerous advantages. In this approach consumers billing is consumption reflective. To the service provider, the system provides adequate consumption behavioral characteristics that helps to make business decisions especially in energy allocation for profit maximization. The service provider can evolve strategies for efficient service delivery to match the changing consumer behavioral pattern.

In a national and global view, dynamic consumer classification encourages energy conservation and energy utilization optimization. It makes energy available to those that need it, can afford it or both. However, a major setback to dynamic consumer classification is that it requires efficient means of data collection and transfer. In countries where this approach is being used, AMR and AMI meters are deployed.

2.5 ELECTRICITY CONSUMER PRICING AND BILLING

Electricity consumer billing is an important task for billing consumers. It is the process of developing a tariff scheme and the billing of electricity consumer. Every consumer class is assigned a tariff charges. Various factors are considered in assigning tariff charges. A good tariff charge must cover all cost incurred, consider consumer activity type and also be fair enough for the consumer. Generally, tariff scheme are classified as being either fixed or dynamic. Other scheme which are fall offs of either or both also exist. A proper tariff scheme should have the following (S3C, 2016):

- Consumer involvement in scheme design process.
- Tariff scheme should reflect actually energy cost. This makes it easier for consumers to understand basis for charges and ensures that revenue generated can sustain business.
- Tariff scheme should be simple. It should be simple to understand and easy to process.
- Tariffs should stimulate energy utilization maximization and energy conservation provide a proper incentive to customers. Customers will only modify their consumption pattern in case of sufficient financial gain or other perceived benefits.

Many countries adopts the fixed tariff scheme because of its simplicity. Unfortunately, the fixed scheme is not truly consumption reflective as cost of energy varies and it also does not stimulate

efficient use of energy. A contemporary approach is the use of dynamic tariff scheme that may be more complex but offers numerous advantages.

2.5.1 FIXED ELECTRICITY CONSUMER PRICING

In fixed pricing, tariff charges usually remains the same irrespective of energy demand and energy supply cost incurred. Once the scheme is developed, it is always used to bill consumers. Fixed tariff scheme is not consumption reflective. The consumers does not incur any additional tariff charge for sudden load increase and poor energy utilization. There are no incentives to encourage energy savings. As such the network system is usually overburdened and those that can afford the supply and put into efficient use cannot be serviced.

2.5.2 DYNAMIC ELECTRICITY CONSUMER PRICING

Unlike fixed pricing, dynamic pricing tariff charges varies with demand level. Dynamic tariff structures have the potential to flatten demand profiles (Sinha, 2016). It helps in proper system planning and hence helps reduce cost and optimize generation and distribution. To the consumer, it provides incentives in form of reduced bills by controlling consumption level. Different forms of dynamic pricing exist. In some cases, like the block rate scheme, a cap limit beyond which tariff plan changes like the block rate scheme. Some others, offer changing tariff charges as demand changes from off-peak to peak periods like the variable peak pricing. Some other simple apply varying tariff charges with seasonal variation. Effective dynamic pricing uses only closely related consumers with similar electricity supply availability as such it employ consumer segmentation. Some issues with dynamic pricing includes complexity consumption data gathering and processing, requirement for newer meter infrastructure, requirement for process and analyzing software technology, amongst others.

2.6 ELECTRICITY CONSUMER CLASSIFICATION IN NIGERIA

Following the unbundling of the power sector, the Nigerian government established NERC to regulate the activities of the power sector. Some of NERC duties are to ensure properly classification consumers, ensure consumers are metered appropriately and consequently billed reasonably. As a result, the commission has specified rules, regulations, guidelines and methodologies for achieving its aims and objectives. Regulations concerning metering are contained in the Nigeria Metering Code and other related documents. NERC specifies that one of the first criteria for connecting a consumer is that the consumer must first be metered.

The commission also produced a template and guide for classifying consumers. The MYTO and reviewed versions specifies tariff structure and guideline for classifying consumers. The commission generally approved consumer classification is shown in table 1. The consumer and tariff classification method adopted by NERC is fixed. This implies that once a consumer is classified, the consumer remains in that tariff class irrespective of the changes in consumption and activities except a scheduled re-classification is done.

Table 1: NERC Consumer Classification Scheme (Tarrif, 2012)

Consumer Classification	Description	Remarks
Residential		
R1	Life-Line (50kW)	Premises used exclusively as a residence- house or flat
R2	Single and Three Phase	
R3	LV Maximum Demand	
R4	HV Maximum Demand	
Commercial		
C1	Single and Three Phase	Premises used other than as a residence or as a factory for manufacturing goods.
C2	LV Maximum Demand	
C3	HV Maximum Demand	
Industrial		
D1	Single and Three Phase	Premises used for manufacturing goods including welding
D2	LV Maximum Demand	
D3	HV Maximum Demand	
Special		
A1	Single and Three Phase	Agro-allied industries, government buildings and schools, religious houses,
A2	LV Maximum Demand	
A3	HV Maximum Demand	
Street Lighting		
S1	Single and Three Phase	

Every electricity consumer falls in one of the classes and is billed appropriately using the tariff charges of the resulting class. The current tariff charges takes into account all cost incurred in process of delivery energy, maintenance of network and actual unit of energy consumed. In the final billing of consumers, having obtained the units consumed by the consumer in kWh and having classified the consumer class, the computation is done using equation 2.

Billed (NGN) = [Energy units consumed (kWh) * Consumer tariff class charges (NGN/kWh)]

+ Value Added Tax (VAT)

- **Equation 2: Computation for Energy Billing**

2.7 DATA MINING AND APPLICATIONS

With growing volume of data from growing number of electricity consumers, the task of providing quality service becomes more difficult. In many developed countries, the application of data mining techniques have been used to analyze electricity consumer data.

Data mining is a concept that is interested in techniques for finding and describing useful structural patterns in data automatically or semi automatically, as a tool for helping to explain that data and make predictions from it (Witten, Franck, & Hall, 2011). In data mining the interest is in discovering knowledge, such as patterns, associations, changes, anomalies and significant structures, from huge amounts of data that is normally not possible to comprehend or analyze because of the complexity and the immensity of its size (Zhang, MA, Zhan, & Wang, 2009). Data mining integrates concepts from several fields including statistics, machine learning and computing.

Asides the electricity service domain, data mining has wide variety of application in web mining, computer vision, diagnosis, decision making, marketing and sales and many other fields. The process of obtaining knowledge from data is in stages (Data Mining: Wikipedia, 2016) namely selection, pre-processing, transformation, data mining and interpretation/evaluation. Figure 5 is a diagrammatic representation of the stages. In selection, the data and algorithm to be used are determined before pre-processed. Data are pre-processed in order to assemble target data, discover multivariate data set and clean data to remove noise and conform outliers. Data mining techniques are then applied to pre-processed data and the results are investigated and validated.

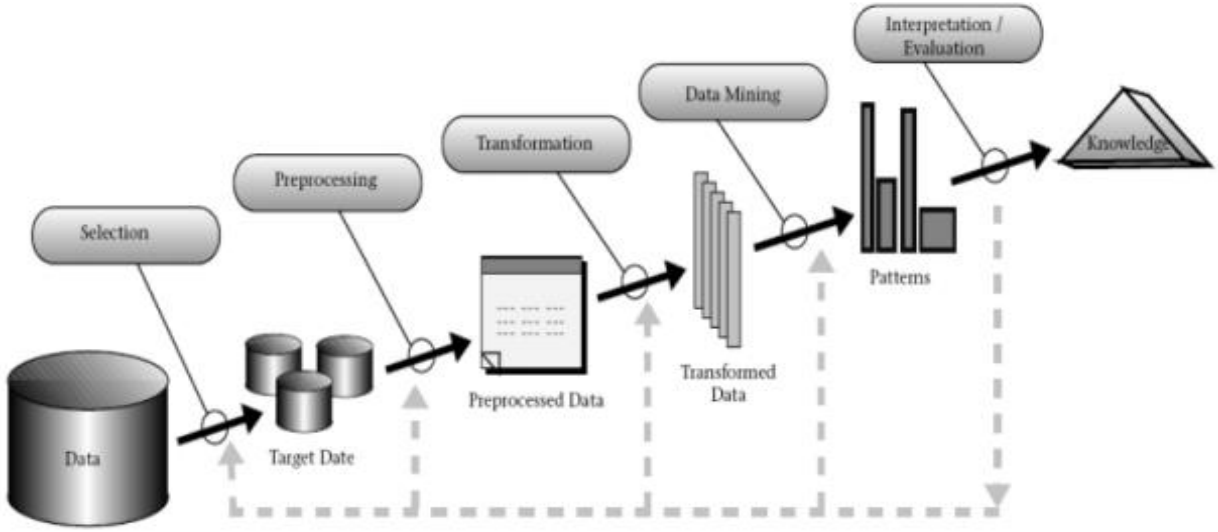

Figure 5: Stages in Data Mining (Ramageri, 2010)

Data mining has found significant application in the power industry. It is used for operations like power system failure detection, fault analysis, plant and network maintenance, consumer behaviour, tariffing and so on. This project focuses on the application of data mining for the classification of electricity consumers.

2.7.1 DATA MINING ALGORITHMS

The actual process of data mining uses data mining algorithms. A data mining algorithm is a set of heuristics and calculations that creates a model from data by first analyzing the data for specific patterns or trends (MSDN: Data Mining Algorithms (Analysis Services - Data Mining), 2016). Data mining algorithms are generally categorized into (Ramageri, 2010):

Classification: It is the most utilized technique which employs a set of pre-classified examples to develop a model. It employs learning and classification technique where a training data set is first analyzed by a classification algorithm and then classified to determine accuracy of the

classification rules. If accuracy is within limits, the model is then used on new data set. Classification learning is sometimes called supervised, because it operates under supervision by being provided with the actual outcome for each of the training examples (Witten, Franck, & Hall, 2011). Some methods of classification models include decision tree induction, Bayesian classification, neural networks, support vector machines (SVM) and association based classification.

Clustering: In clustering, groups of data that belong together are sought by identifying similar classes of objects. The technique allows to further identify dense and sparse regions in object space and can discover overall distribution pattern and correlations among data attributes. Clustering methods include partitioning methods, hierarchical agglomerative (divisive) methods, density based methods, grid-based methods and model-based methods.

Prediction: It uses regression analysis, logistic regression, decision trees and neural networks to model the relationship between independent variables and dependent (target) variables. Prediction methods include linear regression, multivariate linear regression, nonlinear regression and multivariate nonlinear regression.

Association rule: In association learning, correlations between different attributes in a dataset are sought and not just to predict a particular class value. Here, the aim is to discover any interesting structure in the data. Association methods include multilevel association rule, multidimensional association rule and quantitative association rule.

Neural Networks: Neural network is a set of connected input/output units each with a weight. The network learns by adjusting the weights. Neural networks can find pattern in complicated data that are too complex to be noticed by either humans or other computer techniques and hence well suited for prediction or forecasting needs.

Commonly used data mining algorithms are (X, et al., 2007) C4.5, k-means, SVM, Apriori, EM, PageRank, AdaBoost, kNN, Naives Bayes, CART.

2.7.2 EXPECTATION MAXIMIZATION DATA MINING ALGORITHM

Amongst different clustering algorithms, k-means and Expectation Maximization (EM) are the most common. K-means is popular because of its high performance, simplicity in understanding and ease of implementation. It however requires a prior knowledge of the number of dataset cluster required. EM is very similar to k-means but assumes a different approach and does not require prior knowledge of number of clusters.

EM utilizes finite mixture distributions to provide a flexible and mathematical-based approach to the modeling and clustering of data observed on random phenomena (X, et al., 2007). These mixture models are fitted by maximum likelihood. We start with initial guesses and use them to calculate the cluster probabilities for each instance. These probabilities are then used to re-estimate the parameters, and repeat (Witten, Franck, & Hall, 2011). That is, EM involves two steps:

1. Calculation of the cluster probabilities which is expectation and
2. Calculation of the distribution parameters which is the maximization of the likelihood of the distributions given the data available.

These E- and M-steps are alternated until the changes in the estimated parameters or the log likelihood fall within some specified threshold. Numerous literature exist for the mathematical

equations for E- and M-steps. EM is sometimes chosen as better alternative to k-means because (Abbas, 2007):

1. It has a strong statistical bias
2. It is linear in database size and performance
3. It is robust to noisy data
4. It does not require prior knowledge of the number of clusters
5. It converges fast on good initialization

Other sophisticated clustering algorithms exist asides the k-means and EM but with less performance for huge dataset though with their own advantages. However, for the purpose of this project, EM algorithm is adopted because of the advantages highlighted above. For most research operations and implementations, several workbench packed with several algorithms exist. This project uses the WEKA workbench.

2.7.3 WEKA WORKBENCH

Weka workbench was developed at the University of Waikato in New Zealand. The name stands for Waikato Environment for Knowledge Analysis. It is an open source workbench with so many machine learning algorithms and data preprocessing tools providing extensive support for experimental data mining. It has tools for preparing input data, evaluating learning schemes statistically, and visualizing the input data and the result of learning.

Weka contains methods for regression, classification, clustering, association rule mining, and attribute selection. Weka is available from www.cs.waikato.ac.nz/ml/weka.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This project uses EM clustering algorithm on Weka workbench for cluster analysis of electricity consumer records for a period of time. The method evolved uses consumer data of similar supply pattern from different fixed consumer classes. EM algorithm is then applied to the data to obtain dynamic consumer classification. A comparison is done between the fixed consumer classification and the dynamic consumer classification obtained. Furthermore, the result obtained from EM clustering is used to propose a system for dynamic consumer billing. The consumer data used were obtained from a DISCO and some of the records were manually validated by visiting the consumer.

For project the following are required:

1. Consumer data classified according to NERC classification scheme.
2. Validated monthly consumer consumption data for a period of two (2) months.
3. Weka open source workbench

Figure 6 shows the block diagram for the process for dynamic consumer classification and dynamic billing.

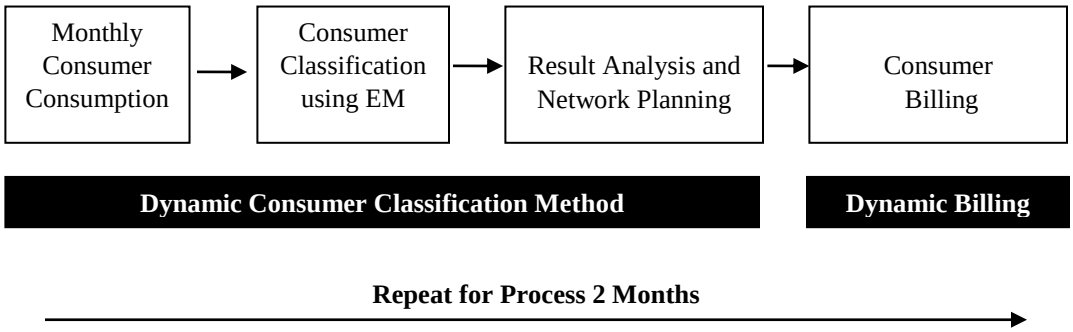

Figure 6: Block Diagram for Proposed Dynamic Classification and Billing

3.2 DYNAMIC CONSUMER CLASSIFICATION

The dynamic consumer classification method evolved here attempts to classify electricity consumers on a monthly basis using actual monthly consumption. The consumer data obtained is first preprocessed before being applied to EM algorithm on the Weka workbench. The following steps were observed in obtaining and preparing the data.

Data Selection: The data selected are those of consumers with similar electricity supply pattern but across different fixed consumer classes. Table 2 shows a summary of the actual consumer data obtained with a breakdown of their consumer classes. Appendix 1, is a more detailed record of the consumer data showing consumption for a period of two (2) consecutive months.

Table 2: Summary of Consumer Consumption Data Investigated

Main Class	Tariff Class	No of Consumers
R (Residential)	R2	211
C (Commercial)	C1	155
	C2	9
D (Industrial)	D1	1
	D2	6
	D3	3
A (Special Commercial)	A1	2
Total		386

From the record shown, a total of 386 consumer consumption records were obtained. The records are spread across four (4) major consumer activity classes and across seven (7) consumer tariff classes according to NERC's classification.

Preprocessing: Consumer personal record in the original record were removed to protect consumer information and each consumer is assigned an arbitrary identification tag in the form "c1, c2, c3…" for the purpose of identification. The data was visibly examined to eliminate errors. Since the data set varies largely, the data was normalized to percentage value using the expression in equation 3.

Normalized value = [Actual Consumption Value / Maximum Value from Record Set] x 100

Equation 3: Normalized Equation for Consumption Value

Transformation: The preprocessed data is converted to Attribute Relation File Format (ARFF) file format before being imported into the Weka workbench. The workbench has a GUI file explorer for importing data file as shown in figure 7.

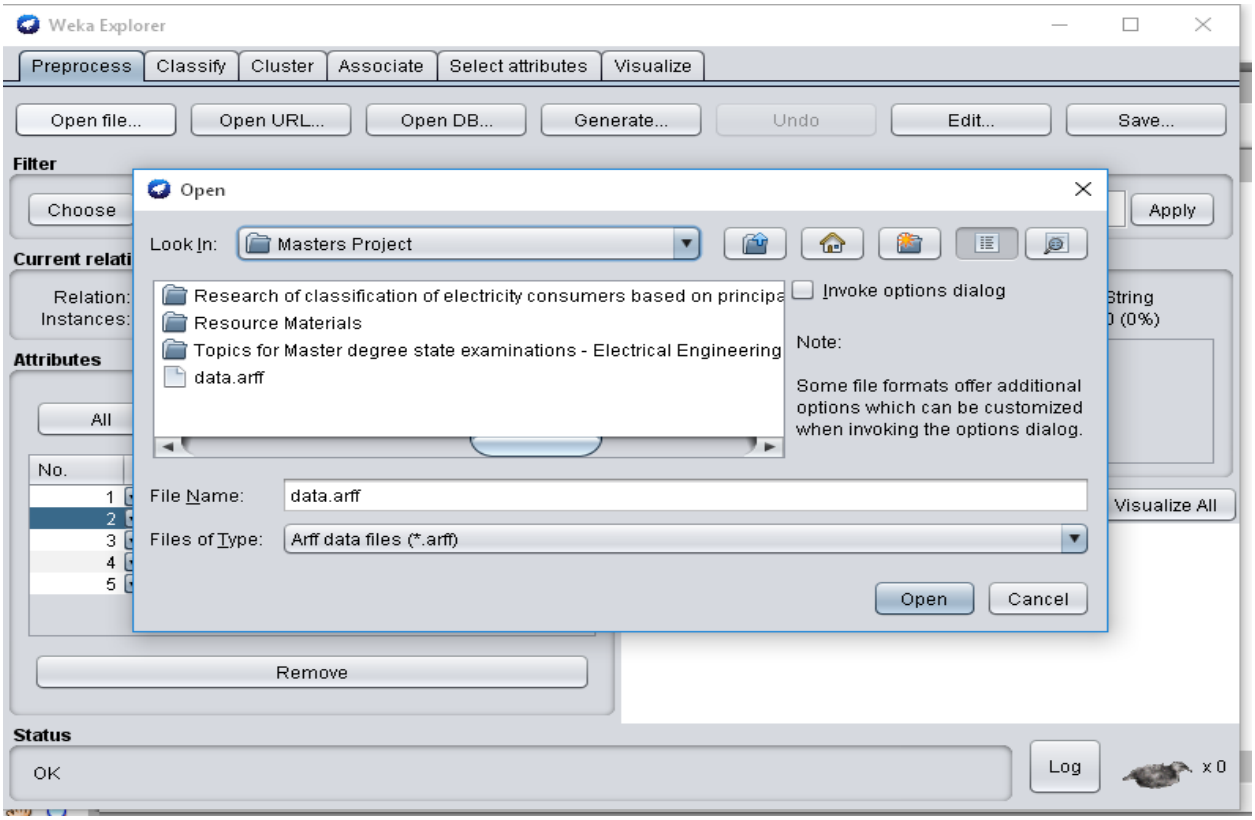

Figure 7: Weka Workbench File Import Explorer

Data Mining: The EM technique was chosen over other clustering techniques because of the advantages mention in chapter 2. The EM clustering technique can be selected from the Cluster tab section of the Weka workbench as shown in figure 8. EM is applied individually to each set of monthly consumer data. Further details on how the EM process was executed is detailed in the following.

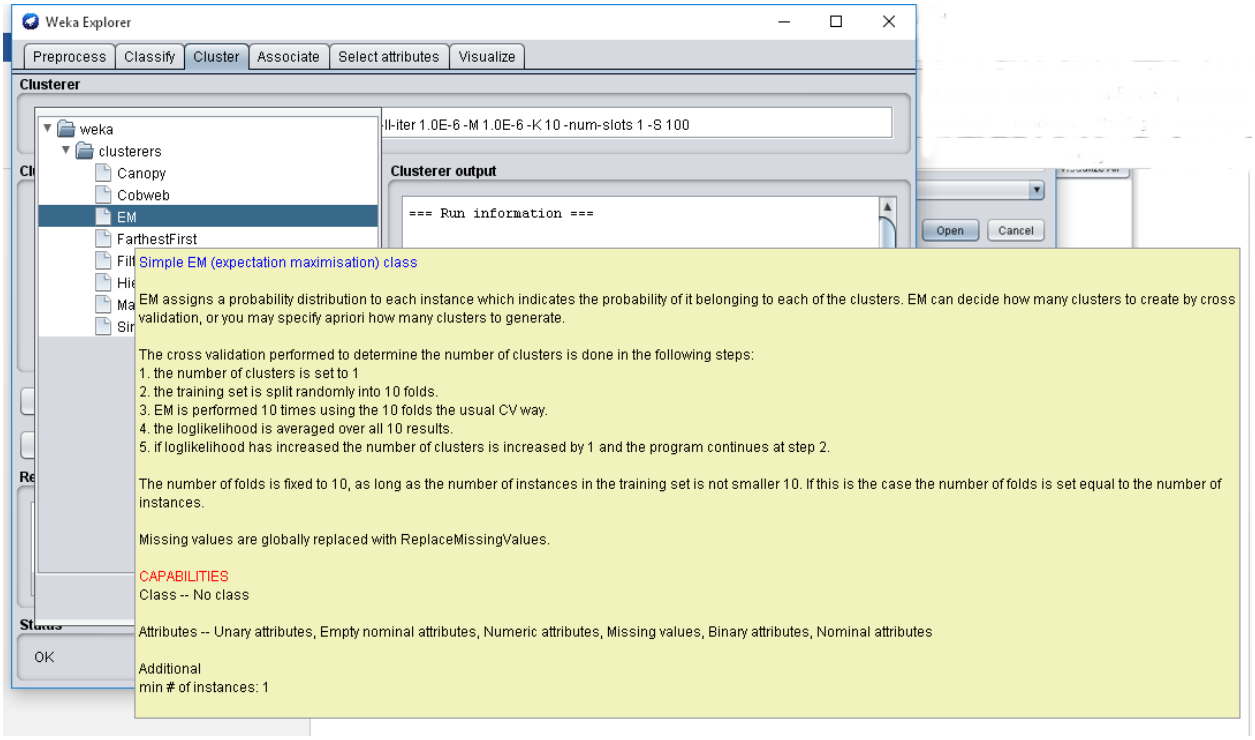

Figure 8: Weka Workbench EM Cluster Selection Interface

3.2.1 EXPECTATION MAXIMIZATION ALGORITHM PROCESS

EM algorithm process does not require initial specification of number of clusters. It clusters data by setting initial cluster to 1 and increments based on the evaluation of a parameter called log likelihood. However, the Weka workbench provides an interface for setting some EM parameters like the minimum cluster. Although, the EM algorithm performs well on several data sets, a better result can be obtained by setting initial minimum number of clusters.

Unlike many other data mining problems, in clustering problems it is usually difficult to evaluate performance of result. Physical examination of data set can help give an idea of the initial number of clusters to set. Also, further evaluation of result of distance between cluster mean values can help make decision on whether further clustering is required or not depending on the

nature of the data. EM algorithm is better at discovering hidden clusters amongst obvious clusters.

For the purpose of this project, EM algorithm is first applied to the data set without setting a minimum number of clusters. The result gave two (2) clusters for each month of the consumer data set under investigation. However, on further analysis and evaluation, the initial number of cluster was set to four (4) based on the following reasons:

1. Consumer data used cuts across consumers engaged in four (4) different activities as shown in figure 8 (Residential R, Commercial C, Industrial D and Special Commercial A).
2. Physical examination of normalized consumer data presented in appendix 1 shows at least four distinct strata of values.
3. Evaluation of initial cluster result showed a large cluster mean distance, necessitating the need for further clustering.

Figure 9 is a simplified flow chart of the EM algorithm process. For the project the initial cluster is set to four (4) for reasons earlier explained.

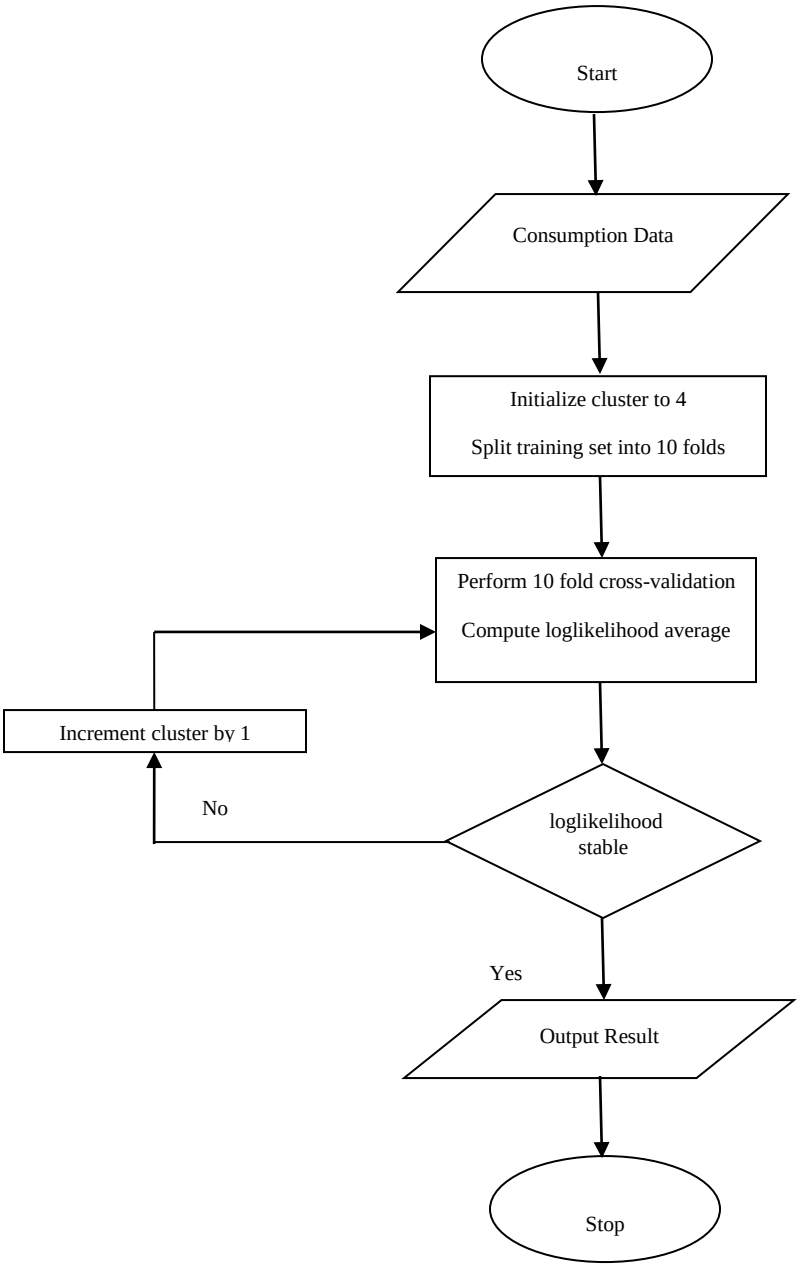

Figure 9: Simplified Expectation Maximization Algorithm Flow Chart

EM algorithm works on iteration and uses log likelihood to test for convergence. Apart from clustering of data, EM gives statistical parameters like mean, standard deviation. The mathematical expressions and derivations for EM algorithm are not explained in this project as it is beyond the scope of the project. Vast academic materials containing EM mathematical derivations are available online. Some of the terms peculiar to EM algorithm process are briefly explained in the following.

Ten-fold Cross Validation

The EM algorithm uses a ten-fold cross validation to arrive at a given number of clusters. The ten-fold cross validation divides the training set (consumption record) into ten (10) portions randomly and then applies the algorithm on each portion. The result is averaged over each and a suitable decision for convergence and number of cluster is made.

Iterations

As shown in EM flow chart in figure 9, the EM algorithm usually repeats a number of steps before convergence. If the averaged result from application of EM to the ten-fold does not indicate convergence, the number of cluster is increased by 1 and the step is performed until convergence. The number of times the step is repeated until convergence is the number of iterations.

Log Likelihood

The log likelihood is used to determine convergence. For each ten-fold cross validation, the average log likelihood is obtained and if it increases then cluster is increased by one until average log likelihood remains stable at convergence.

Confusion Matrix

The confusion matrix generated by Weka EM algorithm shows the data set distribution across the clusters.

Numeric Computations

Weka workbench EM algorithm also computes the mean and standard deviation of each cluster.

3.3 DYNAMIC CONSUMER BILLING

The result obtained from the dynamic consumer classification is used to propose a method for dynamic consumer billing. For the purpose of this project,

1. A suitable single tariff value for per unit of consumption (kWh) is required.
2. Consumer cluster from EM result is ranked according to the number of consumers per cluster.
3. A model is proposed for dynamic consumer billing.

Table 3 shows the tariff structure applicable to the consumer data set used.

Table 3: Tariff Structure

Tariff Class	Tariff Charge (NGN/kWh)
R1	4.00
R2	21.80
R3	36.49
R4	36.92
C1	28.47
C2	37.74
C3	38.14
D1	28.68
D2	38.38
D3	38.85
A1	26.82
A2	30.20
A3	30.36
S1	19.42

Other components considered in evolving the billing model are consumer activity and the cluster mean consumption value of the consumer cluster. These component are considered vital since they have net effect on the stability of the power network and amount of power available for use. Figure 10 shows a block diagram of the proposed billing model components. Each of the component is explained in the following.

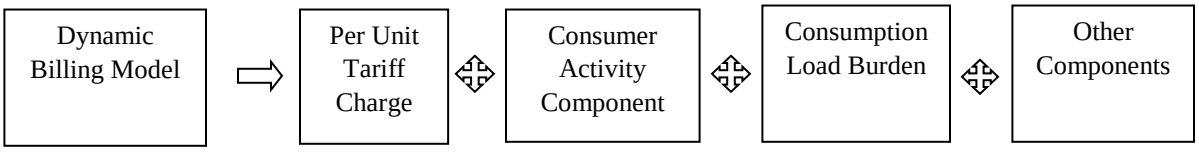

Figure 10: Block Diagram for Dynamic Billing Model

Per Unit Tariff Charge

Per unit tariff charge is the per unit electricity consumption charge rate determined considering several factors. It is set such that business cost are recovered while giving room for some reasonable profit margin. It requires the knowledge of macroeconomics. For the purpose of this project, a suitable single tariff value may be computed from the mean of the tariff structure shown in table 3. However, the determination of per unit tariff charge is beyond the scope of this project.

Consumer Activity Component

Consumer activity is one of the criteria used in classifying consumers. This is because the type of activity a consumer uses electricity supply for will determine the nature of electrical equipment in possession. Electrical equipment exhibit different characteristics and have different effect on the power network. For example, because of the inductive nature and high power demand of industrial motors, industrial consumers will likely add more burden to the network than commercial and commercial than residential. The consumer activity component will often be in terms of burden of inductive loads. Typically, for most planning purpose a power factor of 0.8 is approved. This implies that the consumption values presented in appendix 1, is about 0.8 of the total power delivered on the average. The remaining 0.2 is lost as reactive power especially for industrial consumers. In situations, where reactive power component is part of consumption then activity component can be can assumed neglected. For residential consumers with minimum inductive loads, the consumer activity component can be ignored. In other situations, some installed metering infrastructures at the consumers end can give actual value of power factor. This can be used for obtaining the consumer activity component. Generally, equation 4 is the expression proposed for obtaining consumer activity component from power factor.

Consumer activity component = 1 – Power Factor

Equation 4: Equation for Consumer Activity Component

For the purpose of this project, table 4 shows the consumer activity component and assumed power factor for the various consumer activity type.

Table 4: Consumer Activity Component Table

Consumer Activity	Consumer Activity Component	Assumed Power Factor
Residential	0	1
Commercial	0.15	0.85
Industrial	0.2	0.8
Special Commercial	0.1	0.9

Load Consumption Burden

Load consumption burden also takes care of burden cost of equipment on the network. It is aimed at encouraging electrical energy optimization. Load consumption burden will have higher effect on high energy demand consumers. This components reflects the dynamic behavior of consumers in a particular cluster vis-à-vis their average loading and net effect on the network. Consumption burden of many equipment increases with age as efficiency drops. For the purpose of this project an assumption of a maximum value of 0.5 is assumed as the maximum load consumption burden since most electricity consumers will likely not operate equipment with efficiency less than 50% except in rare situations. In cases where equipment efficiencies are already less than 50% as specified by manufacturer, then the additional burden of consumers operating such can be factored in the other component of the billing model.

The following are the steps carried out in determining load consumption burden:

1. Consumer cluster from EM result are ranked according to mean cluster values from least to highest.
2. The range 0 – 0.5 is divided amongst the number of clusters with the least ranked cluster having a value of zero (0) and highest ranked cluster having a value of 0.5.

Other Components

The other component of the billing model is used to factor in other peculiar factors like rebates, consideration for special consumers, extremely high demand consumers, etc. This component can be in form of increase or decrease effect on the overall consumption value obtained or on any component of the billing model. In this project, this component is not considered.

3.3.1 DYNAMIC BILLING MODEL

The method proposed for dynamic billing eliminates the use of multiple tariff charges for different consumer classes and factors in all other billing components into the consumption value. Combining the billing components explained in the previous sections, a new consumption model is proposed in equation 5.

Total consumption (kWh) = AC + [(CAC*) / (CAC**)] + [AC x LCBC]

Equation 5: Proposed Model Equation for Dynamic Billing

Where,

AC = Actual Consumption as show in appendix 1

CAC = Consumer Activity Component

CAC* = AC x CAC

CAC** = 1 – CAC

LCBC = Load Consumption Burden Component (range 0 – 0.5 as obtained from EM result)

OC = Other Components = 0

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The result of EM clustering on the consumer data described in chapter 3 is presented in this chapter. The result is analyzed and a comparison is made between consumer data for each of the two months. Furthermore, a method for consumer billing method proposed in chapter 3 is applied to the consumer cluster obtained.

4.2 DYNAMIC CONSUMER CLASSIFICATION FROM CONSUMER CLUSTERS

The result of EM algorithm on consumer data is presented in appendix 2. The summary of the result are shown in table 5 and table 6 for each month respectively. In the figures, the values presented are the normalized values of the actual consumption values. Dynamic consumer classification is achieved using the consumer cluster obtained from the result.

Table 5: Result of EM Clustering on Consumption Data for Month 1

Number of clusters created by cross validation				4
Cluster Statistics:				
Attribute	**0**	**1**	**2**	**3**
No. of record	2	3	13	368
% record	1	1	3	95
Mean	30.7759	81.0266	5.5908	0.0184
Standard Dev.	6.6229	15.0257	4.5235	0.0128
Log Likelihood				2.42557

Table 6: Result of EM Clustering on Consumption Data for Month 2

Number of clusters created by cross validation			4	
Cluster Statistics:				
Attribute	**0**	**1**	**2**	**3**
No. of record	2	369	3	12
% record	1	96	1	3
Mean	33.6439	0.016	81.5704	6.5823
Standard Dev.	5.5058	0.0111	15.6678	4.9324
Log Likelihood			2.58952	

Comparison of Cluster Result for Consumption Data

Table 7, shows a ranked table comparison of the result obtained. The ranking is done according to the number of consumers per cluster. Table 8 shows the summary of distribution of consumer activity class over the ranks and table 9 shows the summary of distribution of consumer tariff class over the ranks.

Table 7: Cluster Result Comparison and Ranking for Month 1 and Month 2

		Rank 1	**Rank 2**	**Rank 3**	**Rank 4**
Cluster	**Month 1**	3	2	1	0
	Month 2	1	3	2	0
No. of Record	**Month 1**	368	13	3	2
	Month 2	369	12	3	2
Mean	**Month 1**	0.0184	5.5908	81.0266	30.7759
	Month 2	0.0160	6.5823	81.5704	33.6439
Standard Deviation	**Month 1**	0.0128	4.5235	15.0257	6.6229
	Month 2	0.0111	4.9324	15.6678	5.5058

Table 8: Summary of Consumer Activity Class Distribution over Cluster Ranks

	Residential (R)		Commercial (C)		Industrial (D)		Special Commercial (A)	
Rank	**Month 1**	**Month 2**	**Month 1**	**Month 2**	**Month 1**	**Month 2**	**Month 1**	**Month 2**
1	211	211	154	155	1	1	2	2
2	0	0	8	7	5	5	0	0
3	0	0	2	2	1	1	0	0
4	0	0	0	0	2	2	0	0

Table 9: Summary of Consumer Tariff Class Distribution over Cluster Ranks

	R2		C1		C2		D1		D2		D3		A1	
Rank	**M 1**	**M 2**	**M 1**	**M 2**	**M 1**	**M 2**	**M 1**	**M 2**	**M 1**	**M 2**	**M 1**	**M 2**	**M 1**	**M 2**
1	211	211	154	155	0	0	1	1	0	0	0	0	2	2
2	0	0	1	0	7	7	0	0	3	3	2	2	0	0
3	0	0	0	0	2	2	0	0	1	1	0	0	0	0
4	0	0	0	0	0	0	0	0	2	2	0	0	0	0

Bar chart representations of table 8 are shown in figures 11 and 12 for month 1 and month 2 respectively. Some inference made from the comparison result are stated in the following:

1. From table 7, cluster result on each of the monthly consumption data generated the same number of clusters with very similar log likelihood values. The mean and standard deviation per cluster for the two (2) months are also very close. This indicates a consistency in the consumer consumption pattern over the two months investigated.

2. Table 8 shows an interesting result of consumer data in different consumer classes falling in the same cluster rank. Table 9, is a further investigation showing breakdown into consumer tariff class. It shows how consumers in different tariff classes fall into the same cluster rank.

3. From the tables, the result shows that some consumers in the same tariff class exhibit similar consumption. Unlike the original consumption data with about seven (7) consumer tariff classes (R2, C1, C2, D1, D2, D2, A1) as presented in appendix 1, the EM result generated only four (4) clusters. This indicates that perhaps there may be no further need for sub classification of consumers. The sub classification increases the complexity of the structure and consequently the billing system. Asides, the sub classification creates multiple consumer groups and introduces difficulty in network planning and maintenance process. A simple note of consumer activity type will suffice where it is needed in planning or billing.

4. The tables also show that residential consumers are the lowest consumers while industrial consumers are the highest consumers. Most commercial consumers fall in the mid ranks.

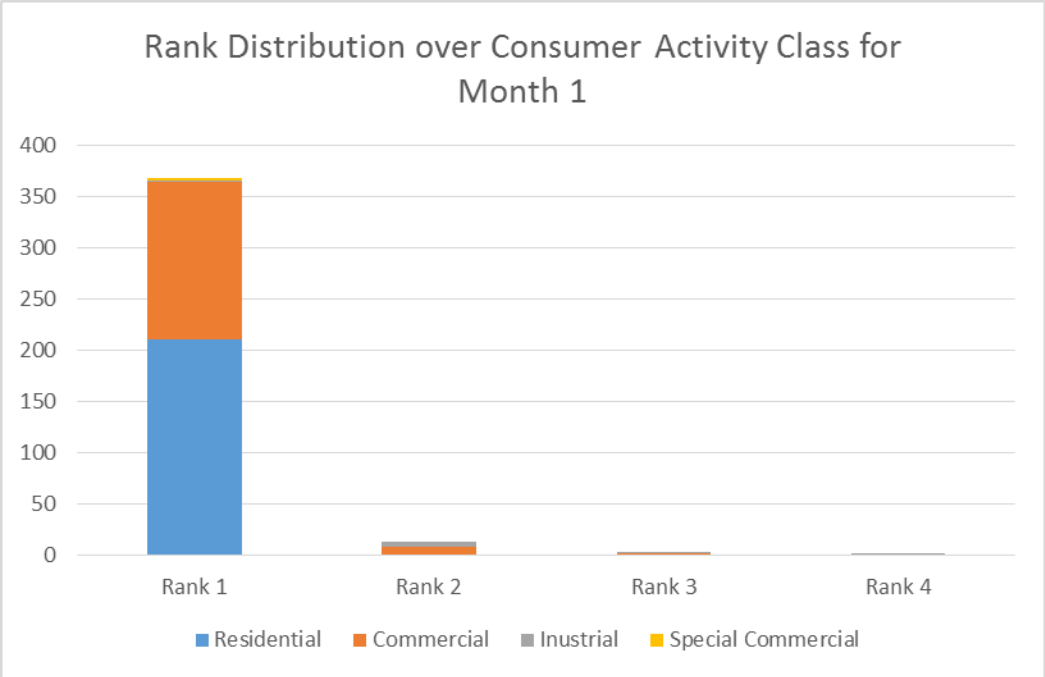

Figure 11: Cluster Rank Distribution over Consumer Activity Class for Month 1

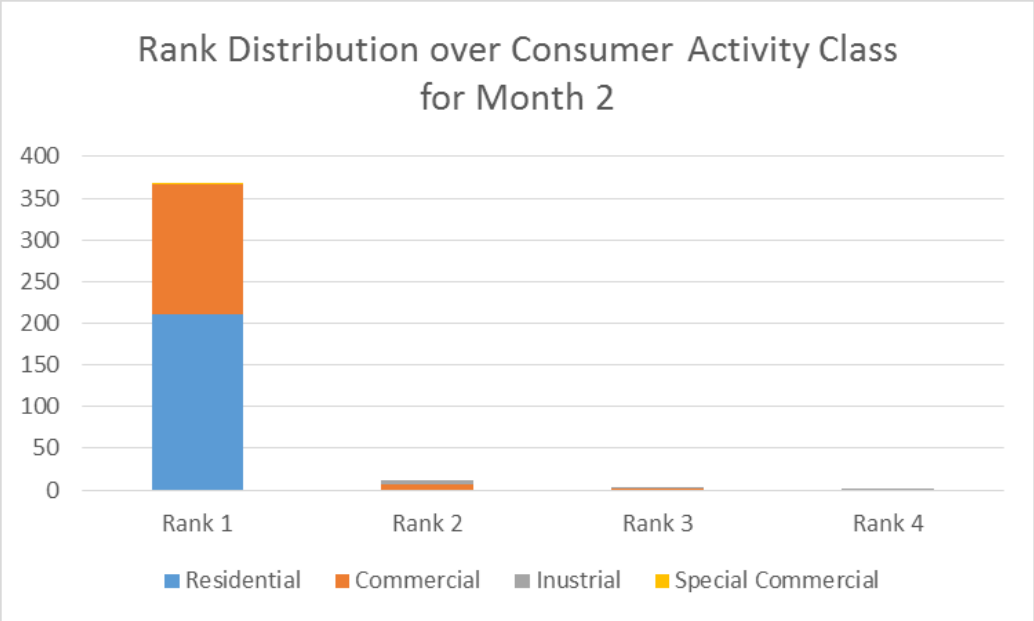

Figure 12: Cluster Rank Distribution over Consumer Activity Class for Month 2

Figure 13, is a line diagram showing individual consumer rank pattern variation presented in appendix 3. From the figure, almost all consumers maintained the same rank over the two (2) months period investigated except for consumer c151.

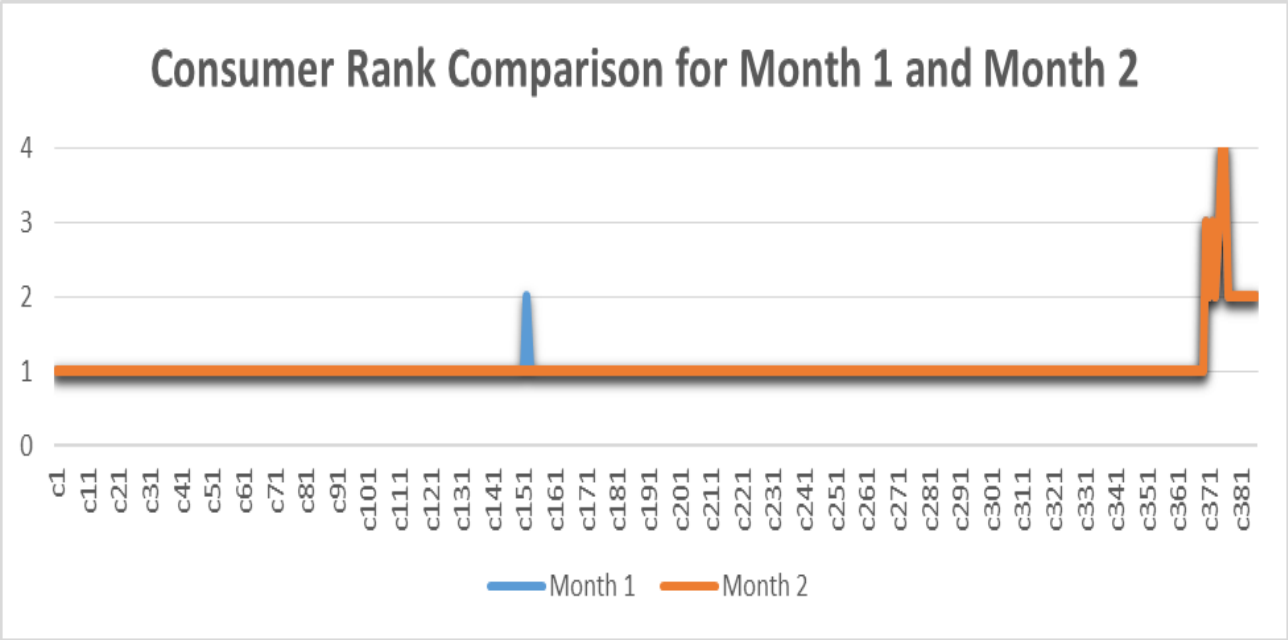

Figure 13: Line Chart of Consumer Rank Distribution

4.3 DYNAMIC BILLING COMPUTATION

The expression model proposed for dynamic billing is described in chapter 3. All components of the model except the Load Consumption Burden Component (LCBC) have been previously determined and assumed as the case may be.

In determining the LCBC value for the consumer data set investigated, the consumer cluster is used. Since there are four (4) clusters generated from the cluster result, following the procedure described in chapter 3, the LCBC computed is shown in table 10.

Table 10: Load Consumption Burden Component (LCBC) Value

Rank	Load Consumption Burden Component (LCBC) Value
1	0.00
2	0.17
3	0.34
4	0.50

The LCBC shown in table 10, is applied to equation 5. The result is presented in appendix 4. In the result presented in appendix 4, consumption value for least ranked consumers remains the same while those of higher ranked consumer increases slightly to cater for burden and activity effect. Consumers in highest ranked cluster had the highest increase. As such, residential consumers did not have any change in consumption value, commercial consumers had slight increase while industrial consumers had the highest increase in consumption value. Figure 14 and figure 15 are line charts representation showing the difference in consumption values for industrial consumers that experienced the highest increase for month 1 and month 2 respectively.

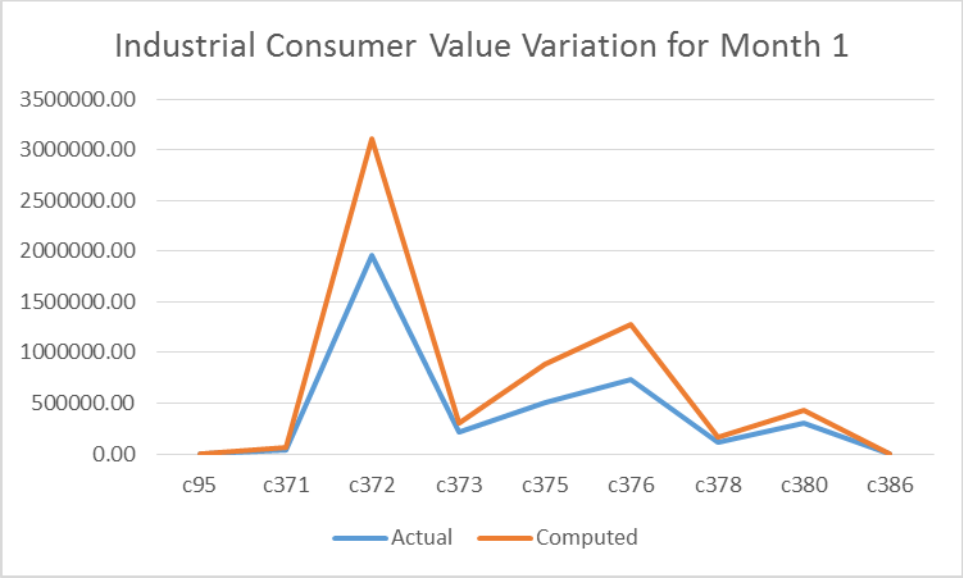

Figure 14: Line Chart Representation of Consumption Variation for Industrial Consumers for Month 1

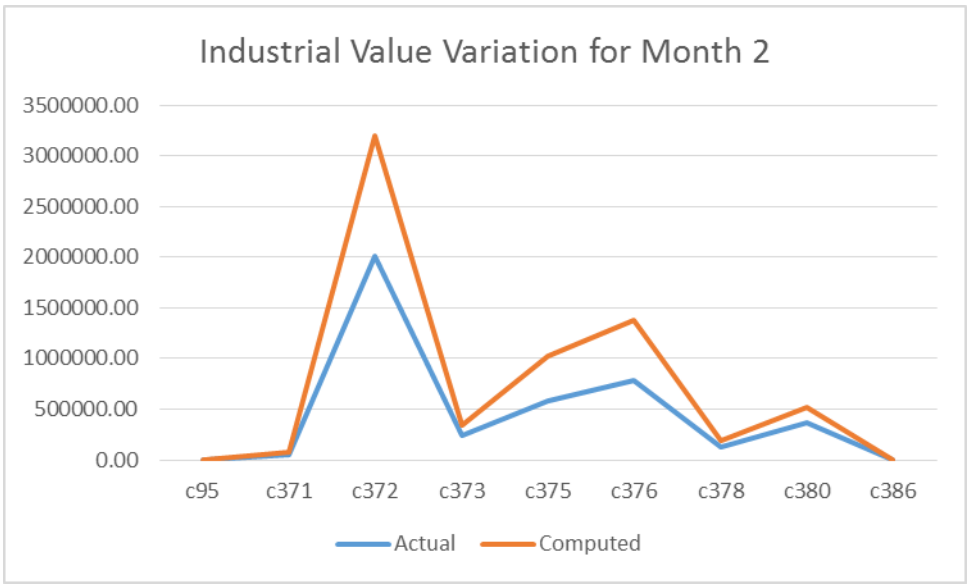

Figure 15: Line Chart Representation of Consumption Variation for Industrial Consumers for Month 2

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In Nigeria, electricity consumers are pre-classified to fixed consumer classes. The pre-classification system uses consumer activity type and envisaged connected loads. However, the fixed pre-classified system has a number of setbacks which includes:

1. Consumers falsify connected loads in order to fall in a lower tariff class.
2. Consumers change activity type without notifying the service companies (DISCO).
3. Many service companies (DISCO) operate a system that makes it difficult to verify and update consumer class.
4. The system has multiple consumer classes with varying tariff charges that introduces complexity into the billing system.
5. Some certain types of consumers cannot be assigned to a suitable tariff class.

As a result of inaccurate and complex consumer classification system, planning and maintenance has been difficult, billing efficiencies has been low and there has been a lot of agitations from consumers as well frustrations from service companies (DISCO). However, the system also offers its own advantages as discussed in previous chapters. On the other hand, dynamic consumer classification offers better result and eliminates most of the problems of fixed pre-classification depending on how it is implemented.

Dynamic consumer classification is an evolving trend in developed countries. No fixed system exist as to how it is achieved. As a result different countries have evolved different methods suitable for its environment. In this project the method employed uses data mining Expectation Maximization (EM) clustering algorithm to cluster consumer data and the result is used to propose a billing method. In the selection of consumer data, only consumers with similar electricity available pattern were selected. This is because of the direct correlation between consumption and availability. The result of the dynamic classification and billing result offers several applications which includes:

1. Since consumer classification is based on consumption value, changes in consumer activity type can be easily suspected. Hence, investigation can be carried out to validate consumer.
2. The changes in consumer consumption pattern with respect to other consumers can be easily detected. It becomes easy to identify possible network problems like meter by-pass and local faults.
3. Dynamic average consumption per consumer class can be accurately determined. This can utilized to meet various forecasting needs.
4. Peculiar consumers with unique connected loads are easily catered for.
5. The billing system places more burden on heavy consumer and hence will tend to encourage optimized utilization and electrical energy savings.
6. Since the billing method uses a single tariff charge, simplicity is introduced into the billing system.

Overall, the result can help improve network planning and billing efficiencies. The dynamic billing model evolved also has its set back. One of such major setbacks is that it introduces all other billing components into the consumption value which may not be easily understood by consumers. However, this can be easily solved by providing in billing report the actual

consumption and the introduced components. Another setback is that since it relies on consumer clusters, advanced computational technique is required.

For this project, EM was applied to 386 consumer data mostly analogue meters and billed electronic meters. Similar procedure can also be applied for any number of consumer record and for further investigation. In the case of pre-paid consumers, the dynamic classification can be utilized for planning purposes and the dynamic billing can also be utilized to compute dynamic billing rate during their next vending.

5.2 LIMITATIONS

At different stages during this project, various limitations were encountered. The following are some of the limitations:

1. The varying electricity supply availability from areas to areas makes it difficult to obtain consumer data. Consumer consumption is affected by supply availability. Selecting consumer data with significantly varying availability pattern will skew the data and affect result.
2. The consumer consumption data required are obtained from installed meters with readable monthly consumption. Therefore, aside similar supply availability, monthly consumption record must be available. Unfortunately, in Nigeria most deployed meters are either analogue or prepaid meter. The service companies (DISCO) do not have exact consumption data of most of their prepaid consumers. This further limits the consumer consumption data available.
3. The issues with bypassed and faulty readable meters also posed a serious concern. Care had to be exercised and validation had to be done in some cases to ensure that only consumption data from working and correctly installed meters are used.

4. Obtaining consumer data was a tedious process itself as the service company (DISCO) was not readily willing to release consumer data.
5. Due to time constraints, consumption data from different areas with different supply availability could gathered and investigated separately.

Asides, the limitations encountered during execution, the project itself has its own set boundaries which have been properly stated in the scope and limitation of study.

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APPENDIX 1

CONSUMER ELECTRICITY CONSUMPTION DATA

Consumer	Tariff	Month1	Month1_Norm	Month2	Month2_Norm
c1	R2	186	0.0095	154	0.0076
c2	R2	298	0.0152	174	0.0086
c3	C1	161	0.0082	194	0.0096
c4	R2	429	0.0219	137	0.0068
c5	C1	355	0.0182	191	0.0095
c6	C1	128	0.0065	133	0.0066
c7	R2	194	0.0099	132	0.0065
c8	C1	158	0.0081	149	0.0074
c9	C1	287	0.0147	113	0.0056
c10	C1	137	0.0070	112	0.0056
c11	C1	197	0.0101	109	0.0054
c12	R2	470	0.0240	355	0.0176
c13	R2	748	0.0383	782	0.0388
c14	R2	325	0.0166	457	0.0227
c15	R2	351	0.0180	404	0.0200
c16	R2	231	0.0118	256	0.0127
c17	C1	632	0.0323	581	0.0288
c18	R2	551	0.0282	507	0.0252
c19	C1	204	0.0104	155	0.0077
c20	R2	154	0.0079	175	0.0087
c21	R2	82	0.0042	51	0.0025
c22	C1	207	0.0106	158	0.0078
c23	R2	799	0.0409	624	0.0310
c24	R2	264	0.0135	313	0.0155
c25	C1	396	0.0203	426	0.0211
c26	R2	585	0.0299	626	0.0311
c27	R2	277	0.0142	286	0.0142
c28	R2	368	0.0188	410	0.0203
c29	R2	370	0.0189	475	0.0236
c30	R2	466	0.0238	670	0.0332
c31	C1	198	0.0101	167	0.0083
c32	C1	357	0.0183	412	0.0204
c33	R2	254	0.0130	452	0.0224
c34	R2	364	0.0186	374	0.0186

c35	C1	452	0.0231	342	0.0170
c36	C1	294	0.0150	515	0.0255
c37	C1	504	0.0258	224	0.0111
c38	R2	313	0.0160	312	0.0155
c39	A1	181	0.0093	254	0.0126
c40	C1	25	0.0013	192	0.0095
c41	R2	324	0.0166	132	0.0065
c42	R2	231	0.0118	61	0.0030
c43	C1	373	0.0191	537	0.0266
c44	R2	211	0.0108	198	0.0098
c45	R2	289	0.0148	324	0.0161
c46	R2	732	0.0374	539	0.0267
c47	C1	266	0.0136	486	0.0241
c48	C1	150	0.0077	163	0.0081
c49	R2	1019	0.0521	721	0.0358
c50	R2	615	0.0315	482	0.0239
c51	R2	738	0.0377	643	0.0319
c52	C1	805	0.0412	653	0.0324
c53	C1	227	0.0116	223	0.0111
c54	C1	1043	0.0533	838	0.0416
c55	C1	113	0.0058	90	0.0045
c56	R2	452	0.0231	302	0.0150
c57	R2	1075	0.0550	945	0.0469
c58	C1	289	0.0148	273	0.0135
c59	C1	411	0.0210	245	0.0122
c60	R2	210	0.0107	129	0.0064
c61	C1	165	0.0084	167	0.0083
c62	R2	79	0.0040	72	0.0036
c63	C1	322	0.0165	288	0.0143
c64	C1	285	0.0146	347	0.0172
c65	C1	414	0.0212	376	0.0187
c66	R2	656	0.0336	653	0.0324
c67	R2	380	0.0194	313	0.0155
c68	R2	276	0.0141	268	0.0133
c69	C1	367	0.0188	114	0.0057
c70	R2	109	0.0056	164	0.0081
c71	R2	228	0.0117	98	0.0049
c72	R2	87	0.0044	81	0.0040
c73	R2	170	0.0087	188	0.0093
c74	C1	467	0.0239	150	0.0074
c75	R2	265	0.0136	205	0.0102

c76	C1	180	0.0092	164	0.0081
c77	C1	135	0.0069	201	0.0100
c78	C1	149	0.0076	249	0.0124
c79	C1	196	0.0100	289	0.0143
c80	R2	90	0.0046	99	0.0049
c81	R2	161	0.0082	143	0.0071
c82	C1	94	0.0048	161	0.0080
c83	R2	50	0.0026	150	0.0074
c84	C1	540	0.0276	409	0.0203
c85	C1	524	0.0268	358	0.0178
c86	C1	1004	0.0514	848	0.0421
c87	C1	361	0.0185	167	0.0083
c88	C1	1061	0.0543	780	0.0387
c89	C1	1330	0.0680	964	0.0478
c90	C1	414	0.0212	287	0.0142
c91	C1	695	0.0355	954	0.0473
c92	A1	411	0.0210	200	0.0099
c93	R2	213	0.0109	140	0.0069
c94	R2	244	0.0125	202	0.0100
c95	D1	1080	0.0552	1202	0.0596
c96	C1	525	0.0269	542	0.0269
c97	C1	245	0.0125	271	0.0134
c98	C1	233	0.0119	407	0.0202
c99	R2	162	0.0083	119	0.0059
c100	R2	489	0.0250	217	0.0108
c101	R2	150	0.0077	150	0.0074
c102	C1	41	0.0021	101	0.0050
c103	R2	92	0.0047	196	0.0097
c104	C1	765	0.0391	184	0.0091
c105	C1	183	0.0094	197	0.0098
c106	C1	669	0.0342	249	0.0124
c107	R2	99	0.0051	94	0.0047
c108	R2	107	0.0055	72	0.0036
c109	R2	504	0.0258	326	0.0162
c110	R2	89	0.0046	60	0.0030
c111	R2	136	0.0070	101	0.0050
c112	R2	115	0.0059	68	0.0034
c113	R2	505	0.0258	313	0.0155
c114	R2	173	0.0088	176	0.0087
c115	C1	181	0.0093	238	0.0118
c116	C1	404	0.0207	325	0.0161

c117	C1	451	0.0231	375	0.0186
c118	R2	504	0.0258	578	0.0287
c119	R2	330	0.0169	343	0.0170
c120	C1	234	0.0120	205	0.0102
c121	R2	36	0.0018	142	0.0070
c122	R2	393	0.0201	259	0.0128
c123	R2	315	0.0161	978	0.0485
c124	R2	109	0.0056	96	0.0048
c125	R2	192	0.0098	146	0.0072
c126	R2	781	0.0399	400	0.0198
c127	R2	471	0.0241	711	0.0353
c128	R2	367	0.0188	289	0.0143
c129	C1	833	0.0426	545	0.0270
c130	R2	588	0.0301	663	0.0329
c131	R2	98	0.0050	93	0.0046
c132	R2	270	0.0138	346	0.0172
c133	R2	994	0.0508	739	0.0367
c134	C1	482	0.0247	368	0.0183
c135	C1	193	0.0099	218	0.0108
c136	C1	317	0.0162	276	0.0137
c137	R2	103	0.0053	183	0.0091
c138	C1	405	0.0207	516	0.0256
c139	C1	470	0.0240	340	0.0169
c140	C1	1058	0.0541	840	0.0417
c141	C1	235	0.0120	187	0.0093
c142	C1	747	0.0382	708	0.0351
c143	C1	422	0.0216	394	0.0195
c144	R2	1180	0.0604	967	0.0480
c145	R2	654	0.0334	564	0.0280
c146	R2	566	0.0289	678	0.0336
c147	C1	668	0.0342	597	0.0296
c148	R2	670	0.0343	567	0.0281
c149	R2	463	0.0237	421	0.0209
c150	C1	286	0.0146	300	0.0149
c151	R2	315	0.0161	102	0.0051
c152	C1	1744	0.0892	626	0.0311
c153	R2	283	0.0145	130	0.0064
c154	R2	196	0.0100	188	0.0093
c155	R2	433	0.0221	92	0.0046
c156	R2	444	0.0227	119	0.0059
c157	R2	239	0.0122	188	0.0093

c158	R2	86	0.0044	89	0.0044
c159	C1	302	0.0154	256	0.0127
c160	R2	294	0.0150	239	0.0119
c161	R2	323	0.0165	298	0.0148
c162	R2	700	0.0358	473	0.0235
c163	R2	496	0.0254	367	0.0182
c164	R2	912	0.0466	646	0.0320
c165	R2	214	0.0109	81	0.0040
c166	C1	369	0.0189	150	0.0074
c167	R2	134	0.0069	115	0.0057
c168	R2	220	0.0113	459	0.0228
c169	R2	147	0.0075	150	0.0074
c170	R2	228	0.0117	108	0.0054
c171	R2	298	0.0152	134	0.0066
c172	R2	381	0.0195	70	0.0035
c173	C1	188	0.0096	145	0.0072
c174	R2	521	0.0266	325	0.0161
c175	C1	216	0.0110	120	0.0060
c176	R2	509	0.0260	320	0.0159
c177	C1	550	0.0281	450	0.0223
c178	R2	602	0.0308	404	0.0200
c179	C1	121	0.0062	209	0.0104
c180	R2	164	0.0084	301	0.0149
c181	C1	582	0.0298	624	0.0310
c182	C1	117	0.0060	232	0.0115
c183	R2	282	0.0144	215	0.0107
c184	C1	383	0.0196	471	0.0234
c185	R2	111	0.0057	37	0.0018
c186	C1	519	0.0265	579	0.0287
c187	R2	174	0.0089	123	0.0061
c188	R2	207	0.0106	195	0.0097
c189	C1	338	0.0173	303	0.0150
c190	C1	224	0.0115	234	0.0116
c191	R2	232	0.0119	272	0.0135
c192	C1	709	0.0363	457	0.0227
c193	C1	127	0.0065	117	0.0058
c194	C1	137	0.0070	152	0.0075
c195	R2	130	0.0066	115	0.0057
c196	R2	468	0.0239	367	0.0182
c197	C1	136	0.0070	119	0.0059
c198	C1	708	0.0362	592	0.0294

c199	R2	162	0.0083	139	0.0069
c200	R2	239	0.0122	240	0.0119
c201	C1	262	0.0134	322	0.0160
c202	R2	254	0.0130	348	0.0173
c203	R2	128	0.0065	109	0.0054
c204	R2	293	0.0150	233	0.0116
c205	R2	110	0.0056	414	0.0205
c206	C1	222	0.0114	226	0.0112
c207	R2	294	0.0150	308	0.0153
c208	R2	500	0.0256	234	0.0116
c209	R2	276	0.0141	255	0.0126
c210	C1	353	0.0181	873	0.0433
c211	C1	62	0.0032	56	0.0028
c212	C1	512	0.0262	255	0.0126
c213	R2	414	0.0212	291	0.0144
c214	C1	856	0.0438	635	0.0315
c215	C1	146	0.0075	245	0.0122
c216	C1	710	0.0363	526	0.0261
c217	C1	680	0.0348	547	0.0271
c218	C1	56	0.0029	76	0.0038
c219	C1	818	0.0418	604	0.0300
c220	C1	145	0.0074	122	0.0061
c221	C1	504	0.0258	409	0.0203
c222	C1	156	0.0080	222	0.0110
c223	R2	298	0.0152	234	0.0116
c224	R2	152	0.0078	826	0.0410
c225	C1	897	0.0459	774	0.0384
c226	R2	162	0.0083	169	0.0084
c227	R2	431	0.0220	439	0.0218
c228	R2	133	0.0068	315	0.0156
c229	C1	1088	0.0556	911	0.0452
c230	R2	95	0.0049	152	0.0075
c231	C1	475	0.0243	526	0.0261
c232	R2	1004	0.0514	789	0.0391
c233	R2	258	0.0132	234	0.0116
c234	R2	148	0.0076	162	0.0080
c235	C1	571	0.0292	365	0.0181
c236	C1	655	0.0335	278	0.0138
c237	R2	233	0.0119	216	0.0107
c238	R2	201	0.0103	154	0.0076
c239	C1	113	0.0058	118	0.0059

c240	C1	722	0.0369	698	0.0346
c241	R2	219	0.0112	385	0.0191
c242	C1	121	0.0062	107	0.0053
c243	R2	53	0.0027	47	0.0023
c244	R2	217	0.0111	132	0.0065
c245	R2	396	0.0203	307	0.0152
c246	R2	30	0.0015	91	0.0045
c247	C1	333	0.0170	203	0.0101
c248	C1	142	0.0073	148	0.0073
c249	C1	187	0.0096	107	0.0053
c250	R2	790	0.0404	565	0.0280
c251	C1	1337	0.0684	1238	0.0614
c252	C1	155	0.0079	206	0.0102
c253	R2	164	0.0084	119	0.0059
c254	C1	262	0.0134	365	0.0181
c255	R2	91	0.0047	85	0.0042
c256	R2	113	0.0058	100	0.0050
c257	C1	952	0.0487	854	0.0424
c258	R2	413	0.0211	350	0.0174
c259	R2	54	0.0028	392	0.0194
c260	R2	742	0.0380	577	0.0286
c261	R2	738	0.0377	353	0.0175
c262	R2	261	0.0133	195	0.0097
c263	R2	211	0.0108	370	0.0184
c264	R2	413	0.0211	329	0.0163
c265	C1	129	0.0066	187	0.0093
c266	R2	301	0.0154	553	0.0274
c267	R2	215	0.0110	518	0.0257
c268	R2	251	0.0128	421	0.0209
c269	R2	310	0.0159	324	0.0161
c270	R2	445	0.0228	275	0.0136
c271	R2	487	0.0249	382	0.0189
c272	R2	100	0.0051	112	0.0056
c273	R2	137	0.0070	99	0.0049
c274	R2	126	0.0064	101	0.0050
c275	C1	92	0.0047	106	0.0053
c276	C1	141	0.0072	146	0.0072
c277	C1	204	0.0104	174	0.0086
c278	R2	872	0.0446	929	0.0461
c279	C1	202	0.0103	233	0.0116
c280	R2	472	0.0241	118	0.0059

c281	C1	180	0.0092	129	0.0064
c282	C1	354	0.0181	297	0.0147
c283	C1	221	0.0113	272	0.0135
c284	R2	202	0.0103	237	0.0118
c285	R2	98	0.0050	73	0.0036
c286	R2	144	0.0074	110	0.0055
c287	R2	914	0.0467	691	0.0343
c288	C1	679	0.0347	638	0.0316
c289	C1	284	0.0145	168	0.0083
c290	C1	293	0.0150	220	0.0109
c291	R2	770	0.0394	107	0.0053
c292	R2	94	0.0048	96	0.0048
c293	R2	277	0.0142	311	0.0154
c294	C1	302	0.0154	332	0.0165
c295	R2	201	0.0103	102	0.0051
c296	R2	566	0.0289	363	0.0180
c297	C1	256	0.0131	225	0.0112
c298	C1	242	0.0124	299	0.0148
c299	R2	386	0.0197	659	0.0327
c300	R2	423	0.0216	144	0.0071
c301	R2	451	0.0231	614	0.0305
c302	R2	430	0.0220	332	0.0165
c303	R2	502	0.0257	544	0.0270
c304	R2	553	0.0283	570	0.0283
c305	R2	393	0.0201	246	0.0122
c306	C1	199	0.0102	177	0.0088
c307	R2	501	0.0256	523	0.0259
c308	R2	1029	0.0526	729	0.0362
c309	R2	225	0.0115	184	0.0091
c310	C1	278	0.0142	192	0.0095
c311	R2	54	0.0028	120	0.0060
c312	C1	357	0.0183	303	0.0150
c313	C1	391	0.0200	599	0.0297
c314	C1	615	0.0315	459	0.0228
c315	R2	443	0.0227	339	0.0168
c316	C1	206	0.0105	244	0.0121
c317	R2	584	0.0299	487	0.0242
c318	R2	201	0.0103	456	0.0226
c319	R2	149	0.0076	89	0.0044
c320	R2	280	0.0143	268	0.0133
c321	R2	222	0.0114	288	0.0143

c322	C1	133	0.0068	465	0.0231
c323	R2	232	0.0119	68	0.0034
c324	C1	542	0.0277	638	0.0316
c325	R2	104	0.0053	181	0.0090
c326	R2	208	0.0106	217	0.0108
c327	C1	283	0.0145	181	0.0090
c328	R2	350	0.0179	385	0.0191
c329	R2	158	0.0081	83	0.0041
c330	C1	234	0.0120	312	0.0155
c331	C1	131	0.0067	156	0.0077
c332	R2	933	0.0477	820	0.0407
c333	R2	530	0.0271	482	0.0239
c334	C1	147	0.0075	139	0.0069
c335	R2	171	0.0087	120	0.0060
c336	R2	710	0.0363	562	0.0279
c337	C1	287	0.0147	237	0.0118
c338	R2	181	0.0093	288	0.0143
c339	C1	134	0.0069	152	0.0075
c340	R2	130	0.0066	167	0.0083
c341	R2	329	0.0168	308	0.0153
c342	R2	215	0.0110	238	0.0118
c343	C1	740	0.0378	903	0.0448
c344	C1	310	0.0159	381	0.0189
c345	C1	554	0.0283	413	0.0205
c346	C1	184	0.0094	160	0.0079
c347	R2	544	0.0278	312	0.0155
c348	R2	156	0.0080	119	0.0059
c349	C1	953	0.0487	836	0.0415
c350	R2	482	0.0247	304	0.0151
c351	R2	484	0.0248	362	0.0180
c352	R2	751	0.0384	603	0.0299
c353	R2	199	0.0102	192	0.0095
c354	R2	132	0.0068	57	0.0028
c355	R2	244	0.0125	198	0.0098
c356	C1	523	0.0267	448	0.0222
c357	C1	279	0.0143	317	0.0157
c358	C1	617	0.0316	651	0.0323
c359	R2	448	0.0229	546	0.0271
c360	C1	202	0.0103	202	0.0100
c361	R2	235	0.0120	101	0.0050
c362	R2	193	0.0099	156	0.0077

c363	C1	184	0.0094	166	0.0082
c364	R2	80	0.0041	64	0.0032
c365	C1	442	0.0226	375	0.0186
c366	C1	351	0.0180	404	0.0200
c367	R2	107	0.0055	137	0.0068
c368	R2	126	0.0064	116	0.0058
c369	R2	267	0.0137	204	0.0101
c370	C2	1253110	64.0915	1265497	62.7769
c371	D2	41670	2.1313	51390	2.5493
c372	D2	1955190	100.0000	2015864	100.0000
c373	D3	209925	10.7368	240210	11.9160
c374	C2	1558601	79.7161	1673366	83.0099
c375	D2	504180	25.7868	581985	28.8703
c376	D2	730683	37.3715	788209	39.1003
c377	C2	135898	6.9506	166035	8.2364
c378	D2	114435	5.8529	130095	6.4536
c379	C2	117128	5.9906	118753	5.8909
c380	D3	306450	15.6737	361350	17.9253
c381	C2	228900	11.7073	234877	11.6514
c382	C2	54151	2.7696	55669	2.7615
c383	C2	18080	0.9247	21057	1.0446
c384	C2	97883	5.0063	98670	4.8947
c385	C2	133788	6.8427	147680	7.3259
c386	D2	3150	0.1611	4320	0.2143

APPENDIX 2:

EM CLUSTERING RESULT ON CONSUMER ELECTRICITY CONSUMPTION DATA

Consumer	Month 1		Month 2	
	Matrix	Cluster	Matrix	Cluster
c1	0 0 0 1	3	0 1 0 0	1
c2	0 0 0 1	3	0 1 0 0	1
c3	0 0 0 1	3	0 1 0 0	1
c4	0 0 0 1	3	0 1 0 0	1
c5	0 0 0 1	3	0 1 0 0	1
c6	0 0 0 1	3	0 1 0 0	1
c7	0 0 0 1	3	0 1 0 0	1
c8	0 0 0 1	3	0 1 0 0	1
c9	0 0 0 1	3	0 1 0 0	1
c10	0 0 0 1	3	0 1 0 0	1
c11	0 0 0 1	3	0 1 0 0	1
c12	0 0 0 1	3	0 1 0 0	1
c13	0 0 0 1	3	0 1 0 0	1
c14	0 0 0 1	3	0 1 0 0	1
c15	0 0 0 1	3	0 1 0 0	1
c16	0 0 0 1	3	0 1 0 0	1
c17	0 0 0 1	3	0 1 0 0	1
c18	0 0 0 1	3	0 1 0 0	1
c19	0 0 0 1	3	0 1 0 0	1
c20	0 0 0 1	3	0 1 0 0	1
c21	0 0 0 1	3	0 1 0 0	1
c22	0 0 0 1	3	0 1 0 0	1
c23	0 0 0 1	3	0 1 0 0	1
c24	0 0 0 1	3	0 1 0 0	1
c25	0 0 0 1	3	0 1 0 0	1
c26	0 0 0 1	3	0 1 0 0	1
c27	0 0 0 1	3	0 1 0 0	1
c28	0 0 0 1	3	0 1 0 0	1
c29	0 0 0 1	3	0 1 0 0	1
c30	0 0 0 1	3	0 1 0 0	1
c31	0 0 0 1	3	0 1 0 0	1
c32	0 0 0 1	3	0 1 0 0	1

c33	0 0 0 1	3	0 1 0 0	1
c34	0 0 0 1	3	0 1 0 0	1
c35	0 0 0 1	3	0 1 0 0	1
c36	0 0 0 1	3	0 1 0 0	1
c37	0 0 0 1	3	0 1 0 0	1
c38	0 0 0 1	3	0 1 0 0	1
c39	0 0 0 1	3	0 1 0 0	1
c40	0 0 0 1	3	0 1 0 0	1
c41	0 0 0 1	3	0 1 0 0	1
c42	0 0 0 1	3	0 1 0 0	1
c43	0 0 0 1	3	0 1 0 0	1
c44	0 0 0 1	3	0 1 0 0	1
c45	0 0 0 1	3	0 1 0 0	1
c46	0 0 0 1	3	0 1 0 0	1
c47	0 0 0 1	3	0 1 0 0	1
c48	0 0 0 1	3	0 1 0 0	1
c49	0 0 0 1	3	0 1 0 0	1
c50	0 0 0 1	3	0 1 0 0	1
c51	0 0 0 1	3	0 1 0 0	1
c52	0 0 0 1	3	0 1 0 0	1
c53	0 0 0 1	3	0 1 0 0	1
c54	0 0 0 1	3	0 1 0 0	1
c55	0 0 0 1	3	0 1 0 0	1
c56	0 0 0 1	3	0 1 0 0	1
c57	0 0 0 1	3	0 1 0 0	1
c58	0 0 0 1	3	0 1 0 0	1
c59	0 0 0 1	3	0 1 0 0	1
c60	0 0 0 1	3	0 1 0 0	1
c61	0 0 0 1	3	0 1 0 0	1
c62	0 0 0 1	3	0 1 0 0	1
c63	0 0 0 1	3	0 1 0 0	1
c64	0 0 0 1	3	0 1 0 0	1
c65	0 0 0 1	3	0 1 0 0	1
c66	0 0 0 1	3	0 1 0 0	1
c67	0 0 0 1	3	0 1 0 0	1
c68	0 0 0 1	3	0 1 0 0	1
c69	0 0 0 1	3	0 1 0 0	1
c70	0 0 0 1	3	0 1 0 0	1
c71	0 0 0 1	3	0 1 0 0	1
c72	0 0 0 1	3	0 1 0 0	1
c73	0 0 0 1	3	0 1 0 0	1

c74	0 0 0 1	3	0 1 0 0	1
c75	0 0 0 1	3	0 1 0 0	1
c76	0 0 0 1	3	0 1 0 0	1
c77	0 0 0 1	3	0 1 0 0	1
c78	0 0 0 1	3	0 1 0 0	1
c79	0 0 0 1	3	0 1 0 0	1
c80	0 0 0 1	3	0 1 0 0	1
c81	0 0 0 1	3	0 1 0 0	1
c82	0 0 0 1	3	0 1 0 0	1
c83	0 0 0 1	3	0 1 0 0	1
c84	0 0 0 1	3	0 1 0 0	1
c85	0 0 0 1	3	0 1 0 0	1
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c87	0 0 0 1	3	0 1 0 0	1
c88	0 0 0 1	3	0 1 0 0	1
c89	0 0 0 1	3	0 1 0 0	1
c90	0 0 0 1	3	0 1 0 0	1
c91	0 0 0 1	3	0 1 0 0	1
c92	0 0 0 1	3	0 1 0 0	1
c93	0 0 0 1	3	0 1 0 0	1
c94	0 0 0 1	3	0 1 0 0	1
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c96	0 0 0 1	3	0 1 0 0	1
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c102	0 0 0 1	3	0 1 0 0	1
c103	0 0 0 1	3	0 1 0 0	1
c104	0 0 0 1	3	0 1 0 0	1
c105	0 0 0 1	3	0 1 0 0	1
c106	0 0 0 1	3	0 1 0 0	1
c107	0 0 0 1	3	0 1 0 0	1
c108	0 0 0 1	3	0 1 0 0	1
c109	0 0 0 1	3	0 1 0 0	1
c110	0 0 0 1	3	0 1 0 0	1
c111	0 0 0 1	3	0 1 0 0	1
c112	0 0 0 1	3	0 1 0 0	1
c113	0 0 0 1	3	0 1 0 0	1
c114	0 0 0 1	3	0 1 0 0	1

c115	0 0 0 1	3	0 1 0 0	1
c116	0 0 0 1	3	0 1 0 0	1
c117	0 0 0 1	3	0 1 0 0	1
c118	0 0 0 1	3	0 1 0 0	1
c119	0 0 0 1	3	0 1 0 0	1
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c121	0 0 0 1	3	0 1 0 0	1
c122	0 0 0 1	3	0 1 0 0	1
c123	0 0 0 1	3	0 1 0 0	1
c124	0 0 0 1	3	0 1 0 0	1
c125	0 0 0 1	3	0 1 0 0	1
c126	0 0 0 1	3	0 1 0 0	1
c127	0 0 0 1	3	0 1 0 0	1
c128	0 0 0 1	3	0 1 0 0	1
c129	0 0 0 1	3	0 1 0 0	1
c130	0 0 0 1	3	0 1 0 0	1
c131	0 0 0 1	3	0 1 0 0	1
c132	0 0 0 1	3	0 1 0 0	1
c133	0 0 0 1	3	0 1 0 0	1
c134	0 0 0 1	3	0 1 0 0	1
c135	0 0 0 1	3	0 1 0 0	1
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c137	0 0 0 1	3	0 1 0 0	1
c138	0 0 0 1	3	0 1 0 0	1
c139	0 0 0 1	3	0 1 0 0	1
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c141	0 0 0 1	3	0 1 0 0	1
c142	0 0 0 1	3	0 1 0 0	1
c143	0 0 0 1	3	0 1 0 0	1
c144	0 0 0 1	3	0 1 0 0	1
c145	0 0 0 1	3	0 1 0 0	1
c146	0 0 0 1	3	0 1 0 0	1
c147	0 0 0 1	3	0 1 0 0	1
c148	0 0 0 1	3	0 1 0 0	1
c149	0 0 0 1	3	0 1 0 0	1
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c151	0 0 0 1	3	0 1 0 0	1
c152	0 0 1 0	2	0 1 0 0	1
c153	0 0 0 1	3	0 1 0 0	1
c154	0 0 0 1	3	0 1 0 0	1
c155	0 0 0 1	3	0 1 0 0	1

c156	0 0 0 1	3	0 1 0 0	1
c157	0 0 0 1	3	0 1 0 0	1
c158	0 0 0 1	3	0 1 0 0	1
c159	0 0 0 1	3	0 1 0 0	1
c160	0 0 0 1	3	0 1 0 0	1
c161	0 0 0 1	3	0 1 0 0	1
c162	0 0 0 1	3	0 1 0 0	1
c163	0 0 0 1	3	0 1 0 0	1
c164	0 0 0 1	3	0 1 0 0	1
c165	0 0 0 1	3	0 1 0 0	1
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c171	0 0 0 1	3	0 1 0 0	1
c172	0 0 0 1	3	0 1 0 0	1
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c174	0 0 0 1	3	0 1 0 0	1
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c178	0 0 0 1	3	0 1 0 0	1
c179	0 0 0 1	3	0 1 0 0	1
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c184	0 0 0 1	3	0 1 0 0	1
c185	0 0 0 1	3	0 1 0 0	1
c186	0 0 0 1	3	0 1 0 0	1
c187	0 0 0 1	3	0 1 0 0	1
c188	0 0 0 1	3	0 1 0 0	1
c189	0 0 0 1	3	0 1 0 0	1
c190	0 0 0 1	3	0 1 0 0	1
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c192	0 0 0 1	3	0 1 0 0	1
c193	0 0 0 1	3	0 1 0 0	1
c194	0 0 0 1	3	0 1 0 0	1
c195	0 0 0 1	3	0 1 0 0	1
c196	0 0 0 1	3	0 1 0 0	1

c197	0 0 0 1	3	0 1 0 0	1
c198	0 0 0 1	3	0 1 0 0	1
c199	0 0 0 1	3	0 1 0 0	1
c200	0 0 0 1	3	0 1 0 0	1
c201	0 0 0 1	3	0 1 0 0	1
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c205	0 0 0 1	3	0 1 0 0	1
c206	0 0 0 1	3	0 1 0 0	1
c207	0 0 0 1	3	0 1 0 0	1
c208	0 0 0 1	3	0 1 0 0	1
c209	0 0 0 1	3	0 1 0 0	1
c210	0 0 0 1	3	0 1 0 0	1
c211	0 0 0 1	3	0 1 0 0	1
c212	0 0 0 1	3	0 1 0 0	1
c213	0 0 0 1	3	0 1 0 0	1
c214	0 0 0 1	3	0 1 0 0	1
c215	0 0 0 1	3	0 1 0 0	1
c216	0 0 0 1	3	0 1 0 0	1
c217	0 0 0 1	3	0 1 0 0	1
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c219	0 0 0 1	3	0 1 0 0	1
c220	0 0 0 1	3	0 1 0 0	1
c221	0 0 0 1	3	0 1 0 0	1
c222	0 0 0 1	3	0 1 0 0	1
c223	0 0 0 1	3	0 1 0 0	1
c224	0 0 0 1	3	0 1 0 0	1
c225	0 0 0 1	3	0 1 0 0	1
c226	0 0 0 1	3	0 1 0 0	1
c227	0 0 0 1	3	0 1 0 0	1
c228	0 0 0 1	3	0 1 0 0	1
c229	0 0 0 1	3	0 1 0 0	1
c230	0 0 0 1	3	0 1 0 0	1
c231	0 0 0 1	3	0 1 0 0	1
c232	0 0 0 1	3	0 1 0 0	1
c233	0 0 0 1	3	0 1 0 0	1
c234	0 0 0 1	3	0 1 0 0	1
c235	0 0 0 1	3	0 1 0 0	1
c236	0 0 0 1	3	0 1 0 0	1
c237	0 0 0 1	3	0 1 0 0	1

c238	0 0 0 1	3	0 1 0 0	1
c239	0 0 0 1	3	0 1 0 0	1
c240	0 0 0 1	3	0 1 0 0	1
c241	0 0 0 1	3	0 1 0 0	1
c242	0 0 0 1	3	0 1 0 0	1
c243	0 0 0 1	3	0 1 0 0	1
c244	0 0 0 1	3	0 1 0 0	1
c245	0 0 0 1	3	0 1 0 0	1
c246	0 0 0 1	3	0 1 0 0	1
c247	0 0 0 1	3	0 1 0 0	1
c248	0 0 0 1	3	0 1 0 0	1
c249	0 0 0 1	3	0 1 0 0	1
c250	0 0 0 1	3	0 1 0 0	1
c251	0 0 0 1	3	0 1 0 0	1
c252	0 0 0 1	3	0 1 0 0	1
c253	0 0 0 1	3	0 1 0 0	1
c254	0 0 0 1	3	0 1 0 0	1
c255	0 0 0 1	3	0 1 0 0	1
c256	0 0 0 1	3	0 1 0 0	1
c257	0 0 0 1	3	0 1 0 0	1
c258	0 0 0 1	3	0 1 0 0	1
c259	0 0 0 1	3	0 1 0 0	1
c260	0 0 0 1	3	0 1 0 0	1
c261	0 0 0 1	3	0 1 0 0	1
c262	0 0 0 1	3	0 1 0 0	1
c263	0 0 0 1	3	0 1 0 0	1
c264	0 0 0 1	3	0 1 0 0	1
c265	0 0 0 1	3	0 1 0 0	1
c266	0 0 0 1	3	0 1 0 0	1
c267	0 0 0 1	3	0 1 0 0	1
c268	0 0 0 1	3	0 1 0 0	1
c269	0 0 0 1	3	0 1 0 0	1
c270	0 0 0 1	3	0 1 0 0	1
c271	0 0 0 1	3	0 1 0 0	1
c272	0 0 0 1	3	0 1 0 0	1
c273	0 0 0 1	3	0 1 0 0	1
c274	0 0 0 1	3	0 1 0 0	1
c275	0 0 0 1	3	0 1 0 0	1
c276	0 0 0 1	3	0 1 0 0	1
c277	0 0 0 1	3	0 1 0 0	1
c278	0 0 0 1	3	0 1 0 0	1

c279	0 0 0 1	3	0 1 0 0	1
c280	0 0 0 1	3	0 1 0 0	1
c281	0 0 0 1	3	0 1 0 0	1
c282	0 0 0 1	3	0 1 0 0	1
c283	0 0 0 1	3	0 1 0 0	1
c284	0 0 0 1	3	0 1 0 0	1
c285	0 0 0 1	3	0 1 0 0	1
c286	0 0 0 1	3	0 1 0 0	1
c287	0 0 0 1	3	0 1 0 0	1
c288	0 0 0 1	3	0 1 0 0	1
c289	0 0 0 1	3	0 1 0 0	1
c290	0 0 0 1	3	0 1 0 0	1
c291	0 0 0 1	3	0 1 0 0	1
c292	0 0 0 1	3	0 1 0 0	1
c293	0 0 0 1	3	0 1 0 0	1
c294	0 0 0 1	3	0 1 0 0	1
c295	0 0 0 1	3	0 1 0 0	1
c296	0 0 0 1	3	0 1 0 0	1
c297	0 0 0 1	3	0 1 0 0	1
c298	0 0 0 1	3	0 1 0 0	1
c299	0 0 0 1	3	0 1 0 0	1
c300	0 0 0 1	3	0 1 0 0	1
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c302	0 0 0 1	3	0 1 0 0	1
c303	0 0 0 1	3	0 1 0 0	1
c304	0 0 0 1	3	0 1 0 0	1
c305	0 0 0 1	3	0 1 0 0	1
c306	0 0 0 1	3	0 1 0 0	1
c307	0 0 0 1	3	0 1 0 0	1
c308	0 0 0 1	3	0 1 0 0	1
c309	0 0 0 1	3	0 1 0 0	1
c310	0 0 0 1	3	0 1 0 0	1
c311	0 0 0 1	3	0 1 0 0	1
c312	0 0 0 1	3	0 1 0 0	1
c313	0 0 0 1	3	0 1 0 0	1
c314	0 0 0 1	3	0 1 0 0	1
c315	0 0 0 1	3	0 1 0 0	1
c316	0 0 0 1	3	0 1 0 0	1
c317	0 0 0 1	3	0 1 0 0	1
c318	0 0 0 1	3	0 1 0 0	1
c319	0 0 0 1	3	0 1 0 0	1

c320	0 0 0 1	3	0 1 0 0	1
c321	0 0 0 1	3	0 1 0 0	1
c322	0 0 0 1	3	0 1 0 0	1
c323	0 0 0 1	3	0 1 0 0	1
c324	0 0 0 1	3	0 1 0 0	1
c325	0 0 0 1	3	0 1 0 0	1
c326	0 0 0 1	3	0 1 0 0	1
c327	0 0 0 1	3	0 1 0 0	1
c328	0 0 0 1	3	0 1 0 0	1
c329	0 0 0 1	3	0 1 0 0	1
c330	0 0 0 1	3	0 1 0 0	1
c331	0 0 0 1	3	0 1 0 0	1
c332	0 0 0 1	3	0 1 0 0	1
c333	0 0 0 1	3	0 1 0 0	1
c334	0 0 0 1	3	0 1 0 0	1
c335	0 0 0 1	3	0 1 0 0	1
c336	0 0 0 1	3	0 1 0 0	1
c337	0 0 0 1	3	0 1 0 0	1
c338	0 0 0 1	3	0 1 0 0	1
c339	0 0 0 1	3	0 1 0 0	1
c340	0 0 0 1	3	0 1 0 0	1
c341	0 0 0 1	3	0 1 0 0	1
c342	0 0 0 1	3	0 1 0 0	1
c343	0 0 0 1	3	0 1 0 0	1
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c348	0 0 0 1	3	0 1 0 0	1
c349	0 0 0 1	3	0 1 0 0	1
c350	0 0 0 1	3	0 1 0 0	1
c351	0 0 0 1	3	0 1 0 0	1
c352	0 0 0 1	3	0 1 0 0	1
c353	0 0 0 1	3	0 1 0 0	1
c354	0 0 0 1	3	0 1 0 0	1
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c356	0 0 0 1	3	0 1 0 0	1
c357	0 0 0 1	3	0 1 0 0	1
c358	0 0 0 1	3	0 1 0 0	1
c359	0 0 0 1	3	0 1 0 0	1
c360	0 0 0 1	3	0 1 0 0	1

c361	0 0 0 1	3	0 1 0 0	1
c362	0 0 0 1	3	0 1 0 0	1
c363	0 0 0 1	3	0 1 0 0	1
c364	0 0 0 1	3	0 1 0 0	1
c365	0 0 0 1	3	0 1 0 0	1
c366	0 0 0 1	3	0 1 0 0	1
c367	0 0 0 1	3	0 1 0 0	1
c368	0 0 0 1	3	0 1 0 0	1
c369	0 0 0 1	3	0 1 0 0	1
c370	0 1 0 0	1	0 0 1 0	2
c371	0 0 1 0	2	0 0 0 1	3
c372	0 1 0 0	1	0 0 1 0	2
c373	0 0 1 0	2	0 0 0 1	3
c374	0 1 0 0	1	0 0 1 0	2
c375	1 0 0 0	0	1 0 0 0	0
c376	1 0 0 0	0	1 0 0 0	0
c377	0 0 1 0	2	0 0 0 1	3
c378	0 0 1 0	2	0 0 0 1	3
c379	0 0 1 0	2	0 0 0 1	3
c380	0 0 1 0	2	0 0 0 1	3
c381	0 0 1 0	2	0 0 0 1	3
c382	0 0 1 0	2	0 0 0 1	3
c383	0 0 1 0	2	0 0 0 1	3
c384	0 0 1 0	2	0 0 0 1	3
c385	0 0 1 0	2	0 0 0 1	3
c386	0 0 1 0	2	0 0 0 1	3

APPENDIX 3

CONSUMER RANK DISTRIBUTION

Consumer	Tariff	Activity	Month 1		Month 2	
			Cluster	Rank	Cluster	Rank
c1	R2	Residential	3	1	1	1
c2	R2	Residential	3	1	1	1
c3	C1	Commercial	3	1	1	1
c4	R2	Residential	3	1	1	1
c5	C1	Commercial	3	1	1	1
c6	C1	Commercial	3	1	1	1
c7	R2	Residential	3	1	1	1
c8	C1	Commercial	3	1	1	1
c9	C1	Commercial	3	1	1	1
c10	C1	Commercial	3	1	1	1
c11	C1	Commercial	3	1	1	1
c12	R2	Residential	3	1	1	1
c13	R2	Residential	3	1	1	1
c14	R2	Residential	3	1	1	1
c15	R2	Residential	3	1	1	1
c16	R2	Residential	3	1	1	1
c17	C1	Commercial	3	1	1	1
c18	R2	Residential	3	1	1	1
c19	C1	Commercial	3	1	1	1
c20	R2	Residential	3	1	1	1
c21	R2	Residential	3	1	1	1
c22	C1	Commercial	3	1	1	1
c23	R2	Residential	3	1	1	1
c24	R2	Residential	3	1	1	1
c25	C1	Commercial	3	1	1	1
c26	R2	Residential	3	1	1	1
c27	R2	Residential	3	1	1	1
c28	R2	Residential	3	1	1	1
c29	R2	Residential	3	1	1	1
c30	R2	Residential	3	1	1	1
c31	C1	Commercial	3	1	1	1

c32	C1	Commercial	3	1	1	1
c33	R2	Residential	3	1	1	1
c34	R2	Residential	3	1	1	1
c35	C1	Commercial	3	1	1	1
c36	C1	Commercial	3	1	1	1
c37	C1	Commercial	3	1	1	1
c38	R2	Residential	3	1	1	1
c39	A1	Special Commercial	3	1	1	1
c40	C1	Commercial	3	1	1	1
c41	R2	Residential	3	1	1	1
c42	R2	Residential	3	1	1	1
c43	C1	Commercial	3	1	1	1
c44	R2	Residential	3	1	1	1
c45	R2	Residential	3	1	1	1
c46	R2	Residential	3	1	1	1
c47	C1	Commercial	3	1	1	1
c48	C1	Commercial	3	1	1	1
c49	R2	Residential	3	1	1	1
c50	R2	Residential	3	1	1	1
c51	R2	Residential	3	1	1	1
c52	C1	Commercial	3	1	1	1
c53	C1	Commercial	3	1	1	1
c54	C1	Commercial	3	1	1	1
c55	C1	Commercial	3	1	1	1
c56	R2	Residential	3	1	1	1
c57	R2	Residential	3	1	1	1
c58	C1	Commercial	3	1	1	1
c59	C1	Commercial	3	1	1	1
c60	R2	Residential	3	1	1	1
c61	C1	Commercial	3	1	1	1
c62	R2	Residential	3	1	1	1
c63	C1	Commercial	3	1	1	1
c64	C1	Commercial	3	1	1	1
c65	C1	Commercial	3	1	1	1
c66	R2	Residential	3	1	1	1
c67	R2	Residential	3	1	1	1
c68	R2	Residential	3	1	1	1
c69	C1	Commercial	3	1	1	1
c70	R2	Residential	3	1	1	1
c71	R2	Residential	3	1	1	1
c72	R2	Residential	3	1	1	1

c73	R2	Residential	3	1	1	1
c74	C1	Commercial	3	1	1	1
c75	R2	Residential	3	1	1	1
c76	C1	Commercial	3	1	1	1
c77	C1	Commercial	3	1	1	1
c78	C1	Commercial	3	1	1	1
c79	C1	Commercial	3	1	1	1
c80	R2	Residential	3	1	1	1
c81	R2	Residential	3	1	1	1
c82	C1	Commercial	3	1	1	1
c83	R2	Residential	3	1	1	1
c84	C1	Commercial	3	1	1	1
c85	C1	Commercial	3	1	1	1
c86	C1	Commercial	3	1	1	1
c87	C1	Commercial	3	1	1	1
c88	C1	Commercial	3	1	1	1
c89	C1	Commercial	3	1	1	1
c90	C1	Commercial	3	1	1	1
c91	C1	Commercial	3	1	1	1
c92	A1	Special Commercial	3	1	1	1
c93	R2	Residential	3	1	1	1
c94	R2	Residential	3	1	1	1
c95	D1	Industrial	3	1	1	1
c96	C1	Commercial	3	1	1	1
c97	C1	Commercial	3	1	1	1
c98	C1	Commercial	3	1	1	1
c99	R2	Residential	3	1	1	1
c100	R2	Residential	3	1	1	1
c101	R2	Residential	3	1	1	1
c102	C1	Commercial	3	1	1	1
c103	R2	Residential	3	1	1	1
c104	C1	Commercial	3	1	1	1
c105	C1	Commercial	3	1	1	1
c106	C1	Commercial	3	1	1	1
c107	R2	Residential	3	1	1	1
c108	R2	Residential	3	1	1	1
c109	R2	Residential	3	1	1	1
c110	R2	Residential	3	1	1	1
c111	R2	Residential	3	1	1	1
c112	R2	Residential	3	1	1	1
c113	R2	Residential	3	1	1	1

c114	R2	Residential	3	1	1	1
c115	C1	Commercial	3	1	1	1
c116	C1	Commercial	3	1	1	1
c117	C1	Commercial	3	1	1	1
c118	R2	Residential	3	1	1	1
c119	R2	Residential	3	1	1	1
c120	C1	Commercial	3	1	1	1
c121	R2	Residential	3	1	1	1
c122	R2	Residential	3	1	1	1
c123	R2	Residential	3	1	1	1
c124	R2	Residential	3	1	1	1
c125	R2	Residential	3	1	1	1
c126	R2	Residential	3	1	1	1
c127	R2	Residential	3	1	1	1
c128	R2	Residential	3	1	1	1
c129	C1	Commercial	3	1	1	1
c130	R2	Residential	3	1	1	1
c131	R2	Residential	3	1	1	1
c132	R2	Residential	3	1	1	1
c133	R2	Residential	3	1	1	1
c134	C1	Commercial	3	1	1	1
c135	C1	Commercial	3	1	1	1
c136	C1	Commercial	3	1	1	1
c137	R2	Residential	3	1	1	1
c138	C1	Commercial	3	1	1	1
c139	C1	Commercial	3	1	1	1
c140	C1	Commercial	3	1	1	1
c141	C1	Commercial	3	1	1	1
c142	C1	Commercial	3	1	1	1
c143	C1	Commercial	3	1	1	1
c144	R2	Residential	3	1	1	1
c145	R2	Residential	3	1	1	1
c146	R2	Residential	3	1	1	1
c147	C1	Commercial	3	1	1	1
c148	R2	Residential	3	1	1	1
c149	R2	Residential	3	1	1	1
c150	C1	Commercial	3	1	1	1
c151	R2	Residential	3	1	1	1
c152	C1	Commercial	2	2	1	1
c153	R2	Residential	3	1	1	1
c154	R2	Residential	3	1	1	1

c155	R2	Residential	3	1	1	1
c156	R2	Residential	3	1	1	1
c157	R2	Residential	3	1	1	1
c158	R2	Residential	3	1	1	1
c159	C1	Commercial	3	1	1	1
c160	R2	Residential	3	1	1	1
c161	R2	Residential	3	1	1	1
c162	R2	Residential	3	1	1	1
c163	R2	Residential	3	1	1	1
c164	R2	Residential	3	1	1	1
c165	R2	Residential	3	1	1	1
c166	C1	Commercial	3	1	1	1
c167	R2	Residential	3	1	1	1
c168	R2	Residential	3	1	1	1
c169	R2	Residential	3	1	1	1
c170	R2	Residential	3	1	1	1
c171	R2	Residential	3	1	1	1
c172	R2	Residential	3	1	1	1
c173	C1	Commercial	3	1	1	1
c174	R2	Residential	3	1	1	1
c175	C1	Commercial	3	1	1	1
c176	R2	Residential	3	1	1	1
c177	C1	Commercial	3	1	1	1
c178	R2	Residential	3	1	1	1
c179	C1	Commercial	3	1	1	1
c180	R2	Residential	3	1	1	1
c181	C1	Commercial	3	1	1	1
c182	C1	Commercial	3	1	1	1
c183	R2	Residential	3	1	1	1
c184	C1	Commercial	3	1	1	1
c185	R2	Residential	3	1	1	1
c186	C1	Commercial	3	1	1	1
c187	R2	Residential	3	1	1	1
c188	R2	Residential	3	1	1	1
c189	C1	Commercial	3	1	1	1
c190	C1	Commercial	3	1	1	1
c191	R2	Residential	3	1	1	1
c192	C1	Commercial	3	1	1	1
c193	C1	Commercial	3	1	1	1
c194	C1	Commercial	3	1	1	1
c195	R2	Residential	3	1	1	1

c196	R2	Residential	3	1	1	1
c197	C1	Commercial	3	1	1	1
c198	C1	Commercial	3	1	1	1
c199	R2	Residential	3	1	1	1
c200	R2	Residential	3	1	1	1
c201	C1	Commercial	3	1	1	1
c202	R2	Residential	3	1	1	1
c203	R2	Residential	3	1	1	1
c204	R2	Residential	3	1	1	1
c205	R2	Residential	3	1	1	1
c206	C1	Commercial	3	1	1	1
c207	R2	Residential	3	1	1	1
c208	R2	Residential	3	1	1	1
c209	R2	Residential	3	1	1	1
c210	C1	Commercial	3	1	1	1
c211	C1	Commercial	3	1	1	1
c212	C1	Commercial	3	1	1	1
c213	R2	Residential	3	1	1	1
c214	C1	Commercial	3	1	1	1
c215	C1	Commercial	3	1	1	1
c216	C1	Commercial	3	1	1	1
c217	C1	Commercial	3	1	1	1
c218	C1	Commercial	3	1	1	1
c219	C1	Commercial	3	1	1	1
c220	C1	Commercial	3	1	1	1
c221	C1	Commercial	3	1	1	1
c222	C1	Commercial	3	1	1	1
c223	R2	Residential	3	1	1	1
c224	R2	Residential	3	1	1	1
c225	C1	Commercial	3	1	1	1
c226	R2	Residential	3	1	1	1
c227	R2	Residential	3	1	1	1
c228	R2	Residential	3	1	1	1
c229	C1	Commercial	3	1	1	1
c230	R2	Residential	3	1	1	1
c231	C1	Commercial	3	1	1	1
c232	R2	Residential	3	1	1	1
c233	R2	Residential	3	1	1	1
c234	R2	Residential	3	1	1	1
c235	C1	Commercial	3	1	1	1
c236	C1	Commercial	3	1	1	1

c237	R2	Residential	3	1	1	1
c238	R2	Residential	3	1	1	1
c239	C1	Commercial	3	1	1	1
c240	C1	Commercial	3	1	1	1
c241	R2	Residential	3	1	1	1
c242	C1	Commercial	3	1	1	1
c243	R2	Residential	3	1	1	1
c244	R2	Residential	3	1	1	1
c245	R2	Residential	3	1	1	1
c246	R2	Residential	3	1	1	1
c247	C1	Commercial	3	1	1	1
c248	C1	Commercial	3	1	1	1
c249	C1	Commercial	3	1	1	1
c250	R2	Residential	3	1	1	1
c251	C1	Commercial	3	1	1	1
c252	C1	Commercial	3	1	1	1
c253	R2	Residential	3	1	1	1
c254	C1	Commercial	3	1	1	1
c255	R2	Residential	3	1	1	1
c256	R2	Residential	3	1	1	1
c257	C1	Commercial	3	1	1	1
c258	R2	Residential	3	1	1	1
c259	R2	Residential	3	1	1	1
c260	R2	Residential	3	1	1	1
c261	R2	Residential	3	1	1	1
c262	R2	Residential	3	1	1	1
c263	R2	Residential	3	1	1	1
c264	R2	Residential	3	1	1	1
c265	C1	Commercial	3	1	1	1
c266	R2	Residential	3	1	1	1
c267	R2	Residential	3	1	1	1
c268	R2	Residential	3	1	1	1
c269	R2	Residential	3	1	1	1
c270	R2	Residential	3	1	1	1
c271	R2	Residential	3	1	1	1
c272	R2	Residential	3	1	1	1
c273	R2	Residential	3	1	1	1
c274	R2	Residential	3	1	1	1
c275	C1	Commercial	3	1	1	1
c276	C1	Commercial	3	1	1	1
c277	C1	Commercial	3	1	1	1

c278	R2	Residential	3	1	1	1
c279	C1	Commercial	3	1	1	1
c280	R2	Residential	3	1	1	1
c281	C1	Commercial	3	1	1	1
c282	C1	Commercial	3	1	1	1
c283	C1	Commercial	3	1	1	1
c284	R2	Residential	3	1	1	1
c285	R2	Residential	3	1	1	1
c286	R2	Residential	3	1	1	1
c287	R2	Residential	3	1	1	1
c288	C1	Commercial	3	1	1	1
c289	C1	Commercial	3	1	1	1
c290	C1	Commercial	3	1	1	1
c291	R2	Residential	3	1	1	1
c292	R2	Residential	3	1	1	1
c293	R2	Residential	3	1	1	1
c294	C1	Commercial	3	1	1	1
c295	R2	Residential	3	1	1	1
c296	R2	Residential	3	1	1	1
c297	C1	Commercial	3	1	1	1
c298	C1	Commercial	3	1	1	1
c299	R2	Residential	3	1	1	1
c300	R2	Residential	3	1	1	1
c301	R2	Residential	3	1	1	1
c302	R2	Residential	3	1	1	1
c303	R2	Residential	3	1	1	1
c304	R2	Residential	3	1	1	1
c305	R2	Residential	3	1	1	1
c306	C1	Commercial	3	1	1	1
c307	R2	Residential	3	1	1	1
c308	R2	Residential	3	1	1	1
c309	R2	Residential	3	1	1	1
c310	C1	Commercial	3	1	1	1
c311	R2	Residential	3	1	1	1
c312	C1	Commercial	3	1	1	1
c313	C1	Commercial	3	1	1	1
c314	C1	Commercial	3	1	1	1
c315	R2	Residential	3	1	1	1
c316	C1	Commercial	3	1	1	1
c317	R2	Residential	3	1	1	1
c318	R2	Residential	3	1	1	1

c319	R2	Residential	3	1	1	1
c320	R2	Residential	3	1	1	1
c321	R2	Residential	3	1	1	1
c322	C1	Commercial	3	1	1	1
c323	R2	Residential	3	1	1	1
c324	C1	Commercial	3	1	1	1
c325	R2	Residential	3	1	1	1
c326	R2	Residential	3	1	1	1
c327	C1	Commercial	3	1	1	1
c328	R2	Residential	3	1	1	1
c329	R2	Residential	3	1	1	1
c330	C1	Commercial	3	1	1	1
c331	C1	Commercial	3	1	1	1
c332	R2	Residential	3	1	1	1
c333	R2	Residential	3	1	1	1
c334	C1	Commercial	3	1	1	1
c335	R2	Residential	3	1	1	1
c336	R2	Residential	3	1	1	1
c337	C1	Commercial	3	1	1	1
c338	R2	Residential	3	1	1	1
c339	C1	Commercial	3	1	1	1
c340	R2	Residential	3	1	1	1
c341	R2	Residential	3	1	1	1
c342	R2	Residential	3	1	1	1
c343	C1	Commercial	3	1	1	1
c344	C1	Commercial	3	1	1	1
c345	C1	Commercial	3	1	1	1
c346	C1	Commercial	3	1	1	1
c347	R2	Residential	3	1	1	1
c348	R2	Residential	3	1	1	1
c349	C1	Commercial	3	1	1	1
c350	R2	Residential	3	1	1	1
c351	R2	Residential	3	1	1	1
c352	R2	Residential	3	1	1	1
c353	R2	Residential	3	1	1	1
c354	R2	Residential	3	1	1	1
c355	R2	Residential	3	1	1	1
c356	C1	Commercial	3	1	1	1
c357	C1	Commercial	3	1	1	1
c358	C1	Commercial	3	1	1	1
c359	R2	Residential	3	1	1	1

c360	C1	Commercial	3	1	1	1
c361	R2	Residential	3	1	1	1
c362	R2	Residential	3	1	1	1
c363	C1	Commercial	3	1	1	1
c364	R2	Residential	3	1	1	1
c365	C1	Commercial	3	1	1	1
c366	C1	Commercial	3	1	1	1
c367	R2	Residential	3	1	1	1
c368	R2	Residential	3	1	1	1
c369	R2	Residential	3	1	1	1
c370	C2	Commercial	1	3	2	3
c371	D2	Industrial	2	2	3	2
c372	D2	Industrial	1	3	2	3
c373	D3	Industrial	2	2	3	2
c374	C2	Commercial	1	3	2	3
c375	D2	Industrial	0	4	0	4
c376	D2	Industrial	0	4	0	4
c377	C2	Commercial	2	2	3	2
c378	D2	Industrial	2	2	3	2
c379	C2	Commercial	2	2	3	2
c380	D3	Industrial	2	2	3	2
c381	C2	Commercial	2	2	3	2
c382	C2	Commercial	2	2	3	2
c383	C2	Commercial	2	2	3	2
c384	C2	Commercial	2	2	3	2
c385	C2	Commercial	2	2	3	2
c386	D2	Industrial	2	2	3	2

APPENDIX 4

CONSUMER CONSUMPTION VALUE COMPUTED USING PROPOSED BILLING MODEL

Consumer	Activity	Tariff	Month 1		Month 2	
			Actual	Computed	Actual	Computed
c1	Residential	R2	186.00	186.00	154.00	154.00
c2	Residential	R2	298.00	298.00	174.00	174.00
c3	Commercial	C1	161.00	189.41	194.00	228.24
c4	Residential	R2	429.00	429.00	137.00	137.00
c5	Commercial	C1	355.00	417.65	191.00	224.71
c6	Commercial	C1	128.00	150.59	133.00	156.47
c7	Residential	R2	194.00	194.00	132.00	132.00
c8	Commercial	C1	158.00	185.88	149.00	175.29
c9	Commercial	C1	287.00	337.65	113.00	132.94
c10	Commercial	C1	137.00	161.18	112.00	131.76
c11	Commercial	C1	197.00	231.76	109.00	128.24
c12	Residential	R2	470.00	470.00	355.00	355.00
c13	Residential	R2	748.00	748.00	782.00	782.00
c14	Residential	R2	325.00	325.00	457.00	457.00
c15	Residential	R2	351.00	351.00	404.00	404.00
c16	Residential	R2	231.00	231.00	256.00	256.00
c17	Commercial	C1	632.00	743.53	581.00	683.53
c18	Residential	R2	551.00	551.00	507.00	507.00
c19	Commercial	C1	204.00	240.00	155.00	182.35
c20	Residential	R2	154.00	154.00	175.00	175.00
c21	Residential	R2	82.00	82.00	51.00	51.00
c22	Commercial	C1	207.00	243.53	158.00	185.88
c23	Residential	R2	799.00	799.00	624.00	624.00
c24	Residential	R2	264.00	264.00	313.00	313.00
c25	Commercial	C1	396.00	465.88	426.00	501.18
c26	Residential	R2	585.00	585.00	626.00	626.00
c27	Residential	R2	277.00	277.00	286.00	286.00
c28	Residential	R2	368.00	368.00	410.00	410.00

c29	Residential	R2	370.00	370.00	475.00	475.00
c30	Residential	R2	466.00	466.00	670.00	670.00
c31	Commercial	C1	198.00	232.94	167.00	196.47
c32	Commercial	C1	357.00	420.00	412.00	484.71
c33	Residential	R2	254.00	254.00	452.00	452.00
c34	Residential	R2	364.00	364.00	374.00	374.00
c35	Commercial	C1	452.00	531.76	342.00	402.35
c36	Commercial	C1	294.00	345.88	515.00	605.88
c37	Commercial	C1	504.00	592.94	224.00	263.53
c38	Residential	R2	313.00	313.00	312.00	312.00
c39	Special Commercial	A1	181.00	201.11	254.00	282.22
c40	Commercial	C1	25.00	29.41	192.00	225.88
c41	Residential	R2	324.00	324.00	132.00	132.00
c42	Residential	R2	231.00	231.00	61.00	61.00
c43	Commercial	C1	373.00	438.82	537.00	631.76
c44	Residential	R2	211.00	211.00	198.00	198.00
c45	Residential	R2	289.00	289.00	324.00	324.00
c46	Residential	R2	732.00	732.00	539.00	539.00
c47	Commercial	C1	266.00	312.94	486.00	571.76
c48	Commercial	C1	150.00	176.47	163.00	191.76
c49	Residential	R2	1019.00	1019.00	721.00	721.00
c50	Residential	R2	615.00	615.00	482.00	482.00
c51	Residential	R2	738.00	738.00	643.00	643.00
c52	Commercial	C1	805.00	947.06	653.00	768.24
c53	Commercial	C1	227.00	267.06	223.00	262.35
c54	Commercial	C1	1043.00	1227.06	838.00	985.88
c55	Commercial	C1	113.00	132.94	90.00	105.88
c56	Residential	R2	452.00	452.00	302.00	302.00
c57	Residential	R2	1075.00	1075.00	945.00	945.00
c58	Commercial	C1	289.00	340.00	273.00	321.18
c59	Commercial	C1	411.00	483.53	245.00	288.24
c60	Residential	R2	210.00	210.00	129.00	129.00
c61	Commercial	C1	165.00	194.12	167.00	196.47
c62	Residential	R2	79.00	79.00	72.00	72.00
c63	Commercial	C1	322.00	378.82	288.00	338.82
c64	Commercial	C1	285.00	335.29	347.00	408.24
c65	Commercial	C1	414.00	487.06	376.00	442.35
c66	Residential	R2	656.00	656.00	653.00	653.00
c67	Residential	R2	380.00	380.00	313.00	313.00
c68	Residential	R2	276.00	276.00	268.00	268.00

c69	Commercial	C1	367.00	431.76	114.00	134.12
c70	Residential	R2	109.00	109.00	164.00	164.00
c71	Residential	R2	228.00	228.00	98.00	98.00
c72	Residential	R2	87.00	87.00	81.00	81.00
c73	Residential	R2	170.00	170.00	188.00	188.00
c74	Commercial	C1	467.00	549.41	150.00	176.47
c75	Residential	R2	265.00	265.00	205.00	205.00
c76	Commercial	C1	180.00	211.76	164.00	192.94
c77	Commercial	C1	135.00	158.82	201.00	236.47
c78	Commercial	C1	149.00	175.29	249.00	292.94
c79	Commercial	C1	196.00	230.59	289.00	340.00
c80	Residential	R2	90.00	90.00	99.00	99.00
c81	Residential	R2	161.00	161.00	143.00	143.00
c82	Commercial	C1	94.00	110.59	161.00	189.41
c83	Residential	R2	50.00	50.00	150.00	150.00
c84	Commercial	C1	540.00	635.29	409.00	481.18
c85	Commercial	C1	524.00	616.47	358.00	421.18
c86	Commercial	C1	1004.00	1181.18	848.00	997.65
c87	Commercial	C1	361.00	424.71	167.00	196.47
c88	Commercial	C1	1061.00	1248.24	780.00	917.65
c89	Commercial	C1	1330.00	1564.71	964.00	1134.12
c90	Commercial	C1	414.00	487.06	287.00	337.65
c91	Commercial	C1	695.00	817.65	954.00	1122.35
c92	Special Commercial	A1	411.00	456.67	200.00	222.22
c93	Residential	R2	213.00	213.00	140.00	140.00
c94	Residential	R2	244.00	244.00	202.00	202.00
c95	Industrial	D1	1080.00	1350.00	1202.00	1502.50
c96	Commercial	C1	525.00	617.65	542.00	637.65
c97	Commercial	C1	245.00	288.24	271.00	318.82
c98	Commercial	C1	233.00	274.12	407.00	478.82
c99	Residential	R2	162.00	162.00	119.00	119.00
c100	Residential	R2	489.00	489.00	217.00	217.00
c101	Residential	R2	150.00	150.00	150.00	150.00
c102	Commercial	C1	41.00	48.24	101.00	118.82
c103	Residential	R2	92.00	92.00	196.00	196.00
c104	Commercial	C1	765.00	900.00	184.00	216.47
c105	Commercial	C1	183.00	215.29	197.00	231.76
c106	Commercial	C1	669.00	787.06	249.00	292.94
c107	Residential	R2	99.00	99.00	94.00	94.00
c108	Residential	R2	107.00	107.00	72.00	72.00

c109	Residential	R2	504.00	504.00	326.00	326.00
c110	Residential	R2	89.00	89.00	60.00	60.00
c111	Residential	R2	136.00	136.00	101.00	101.00
c112	Residential	R2	115.00	115.00	68.00	68.00
c113	Residential	R2	505.00	505.00	313.00	313.00
c114	Residential	R2	173.00	173.00	176.00	176.00
c115	Commercial	C1	181.00	212.94	238.00	280.00
c116	Commercial	C1	404.00	475.29	325.00	382.35
c117	Commercial	C1	451.00	530.59	375.00	441.18
c118	Residential	R2	504.00	504.00	578.00	578.00
c119	Residential	R2	330.00	330.00	343.00	343.00
c120	Commercial	C1	234.00	275.29	205.00	241.18
c121	Residential	R2	36.00	36.00	142.00	142.00
c122	Residential	R2	393.00	393.00	259.00	259.00
c123	Residential	R2	315.00	315.00	978.00	978.00
c124	Residential	R2	109.00	109.00	96.00	96.00
c125	Residential	R2	192.00	192.00	146.00	146.00
c126	Residential	R2	781.00	781.00	400.00	400.00
c127	Residential	R2	471.00	471.00	711.00	711.00
c128	Residential	R2	367.00	367.00	289.00	289.00
c129	Commercial	C1	833.00	980.00	545.00	641.18
c130	Residential	R2	588.00	588.00	663.00	663.00
c131	Residential	R2	98.00	98.00	93.00	93.00
c132	Residential	R2	270.00	270.00	346.00	346.00
c133	Residential	R2	994.00	994.00	739.00	739.00
c134	Commercial	C1	482.00	567.06	368.00	432.94
c135	Commercial	C1	193.00	227.06	218.00	256.47
c136	Commercial	C1	317.00	372.94	276.00	324.71
c137	Residential	R2	103.00	103.00	183.00	183.00
c138	Commercial	C1	405.00	476.47	516.00	607.06
c139	Commercial	C1	470.00	552.94	340.00	400.00
c140	Commercial	C1	1058.00	1244.71	840.00	988.24
c141	Commercial	C1	235.00	276.47	187.00	220.00
c142	Commercial	C1	747.00	878.82	708.00	832.94
c143	Commercial	C1	422.00	496.47	394.00	463.53
c144	Residential	R2	1180.00	1180.00	967.00	967.00
c145	Residential	R2	654.00	654.00	564.00	564.00
c146	Residential	R2	566.00	566.00	678.00	678.00
c147	Commercial	C1	668.00	785.88	597.00	702.35
c148	Residential	R2	670.00	670.00	567.00	567.00
c149	Residential	R2	463.00	463.00	421.00	421.00

c150	Commercial	C1	286.00	336.47	300.00	352.94
c151	Residential	R2	315.00	315.00	102.00	102.00
c152	Commercial	C1	1744.00	2348.24	626.00	736.47
c153	Residential	R2	283.00	283.00	130.00	130.00
c154	Residential	R2	196.00	196.00	188.00	188.00
c155	Residential	R2	433.00	433.00	92.00	92.00
c156	Residential	R2	444.00	444.00	119.00	119.00
c157	Residential	R2	239.00	239.00	188.00	188.00
c158	Residential	R2	86.00	86.00	89.00	89.00
c159	Commercial	C1	302.00	355.29	256.00	301.18
c160	Residential	R2	294.00	294.00	239.00	239.00
c161	Residential	R2	323.00	323.00	298.00	298.00
c162	Residential	R2	700.00	700.00	473.00	473.00
c163	Residential	R2	496.00	496.00	367.00	367.00
c164	Residential	R2	912.00	912.00	646.00	646.00
c165	Residential	R2	214.00	214.00	81.00	81.00
c166	Commercial	C1	369.00	434.12	150.00	176.47
c167	Residential	R2	134.00	134.00	115.00	115.00
c168	Residential	R2	220.00	220.00	459.00	459.00
c169	Residential	R2	147.00	147.00	150.00	150.00
c170	Residential	R2	228.00	228.00	108.00	108.00
c171	Residential	R2	298.00	298.00	134.00	134.00
c172	Residential	R2	381.00	381.00	70.00	70.00
c173	Commercial	C1	188.00	221.18	145.00	170.59
c174	Residential	R2	521.00	521.00	325.00	325.00
c175	Commercial	C1	216.00	254.12	120.00	141.18
c176	Residential	R2	509.00	509.00	320.00	320.00
c177	Commercial	C1	550.00	647.06	450.00	529.41
c178	Residential	R2	602.00	602.00	404.00	404.00
c179	Commercial	C1	121.00	142.35	209.00	245.88
c180	Residential	R2	164.00	164.00	301.00	301.00
c181	Commercial	C1	582.00	684.71	624.00	734.12
c182	Commercial	C1	117.00	137.65	232.00	272.94
c183	Residential	R2	282.00	282.00	215.00	215.00
c184	Commercial	C1	383.00	450.59	471.00	554.12
c185	Residential	R2	111.00	111.00	37.00	37.00
c186	Commercial	C1	519.00	610.59	579.00	681.18
c187	Residential	R2	174.00	174.00	123.00	123.00
c188	Residential	R2	207.00	207.00	195.00	195.00
c189	Commercial	C1	338.00	397.65	303.00	356.47
c190	Commercial	C1	224.00	263.53	234.00	275.29

c191	Residential	R2	232.00	232.00	272.00	272.00
c192	Commercial	C1	709.00	834.12	457.00	537.65
c193	Commercial	C1	127.00	149.41	117.00	137.65
c194	Commercial	C1	137.00	161.18	152.00	178.82
c195	Residential	R2	130.00	130.00	115.00	115.00
c196	Residential	R2	468.00	468.00	367.00	367.00
c197	Commercial	C1	136.00	160.00	119.00	140.00
c198	Commercial	C1	708.00	832.94	592.00	696.47
c199	Residential	R2	162.00	162.00	139.00	139.00
c200	Residential	R2	239.00	239.00	240.00	240.00
c201	Commercial	C1	262.00	308.24	322.00	378.82
c202	Residential	R2	254.00	254.00	348.00	348.00
c203	Residential	R2	128.00	128.00	109.00	109.00
c204	Residential	R2	293.00	293.00	233.00	233.00
c205	Residential	R2	110.00	110.00	414.00	414.00
c206	Commercial	C1	222.00	261.18	226.00	265.88
c207	Residential	R2	294.00	294.00	308.00	308.00
c208	Residential	R2	500.00	500.00	234.00	234.00
c209	Residential	R2	276.00	276.00	255.00	255.00
c210	Commercial	C1	353.00	415.29	873.00	1027.06
c211	Commercial	C1	62.00	72.94	56.00	65.88
c212	Commercial	C1	512.00	602.35	255.00	300.00
c213	Residential	R2	414.00	414.00	291.00	291.00
c214	Commercial	C1	856.00	1007.06	635.00	747.06
c215	Commercial	C1	146.00	171.76	245.00	288.24
c216	Commercial	C1	710.00	835.29	526.00	618.82
c217	Commercial	C1	680.00	800.00	547.00	643.53
c218	Commercial	C1	56.00	65.88	76.00	89.41
c219	Commercial	C1	818.00	962.35	604.00	710.59
c220	Commercial	C1	145.00	170.59	122.00	143.53
c221	Commercial	C1	504.00	592.94	409.00	481.18
c222	Commercial	C1	156.00	183.53	222.00	261.18
c223	Residential	R2	298.00	298.00	234.00	234.00
c224	Residential	R2	152.00	152.00	826.00	826.00
c225	Commercial	C1	897.00	1055.29	774.00	910.59
c226	Residential	R2	162.00	162.00	169.00	169.00
c227	Residential	R2	431.00	431.00	439.00	439.00
c228	Residential	R2	133.00	133.00	315.00	315.00
c229	Commercial	C1	1088.00	1280.00	911.00	1071.76
c230	Residential	R2	95.00	95.00	152.00	152.00
c231	Commercial	C1	475.00	558.82	526.00	618.82

c232	Residential	R2	1004.00	1004.00	789.00	789.00
c233	Residential	R2	258.00	258.00	234.00	234.00
c234	Residential	R2	148.00	148.00	162.00	162.00
c235	Commercial	C1	571.00	671.76	365.00	429.41
c236	Commercial	C1	655.00	770.59	278.00	327.06
c237	Residential	R2	233.00	233.00	216.00	216.00
c238	Residential	R2	201.00	201.00	154.00	154.00
c239	Commercial	C1	113.00	132.94	118.00	138.82
c240	Commercial	C1	722.00	849.41	698.00	821.18
c241	Residential	R2	219.00	219.00	385.00	385.00
c242	Commercial	C1	121.00	142.35	107.00	125.88
c243	Residential	R2	53.00	53.00	47.00	47.00
c244	Residential	R2	217.00	217.00	132.00	132.00
c245	Residential	R2	396.00	396.00	307.00	307.00
c246	Residential	R2	30.00	30.00	91.00	91.00
c247	Commercial	C1	333.00	391.76	203.00	238.82
c248	Commercial	C1	142.00	167.06	148.00	174.12
c249	Commercial	C1	187.00	220.00	107.00	125.88
c250	Residential	R2	790.00	790.00	565.00	565.00
c251	Commercial	C1	1337.00	1572.94	1238.00	1456.47
c252	Commercial	C1	155.00	182.35	206.00	242.35
c253	Residential	R2	164.00	164.00	119.00	119.00
c254	Commercial	C1	262.00	308.24	365.00	429.41
c255	Residential	R2	91.00	91.00	85.00	85.00
c256	Residential	R2	113.00	113.00	100.00	100.00
c257	Commercial	C1	952.00	1120.00	854.00	1004.71
c258	Residential	R2	413.00	413.00	350.00	350.00
c259	Residential	R2	54.00	54.00	392.00	392.00
c260	Residential	R2	742.00	742.00	577.00	577.00
c261	Residential	R2	738.00	738.00	353.00	353.00
c262	Residential	R2	261.00	261.00	195.00	195.00
c263	Residential	R2	211.00	211.00	370.00	370.00
c264	Residential	R2	413.00	413.00	329.00	329.00
c265	Commercial	C1	129.00	151.76	187.00	220.00
c266	Residential	R2	301.00	301.00	553.00	553.00
c267	Residential	R2	215.00	215.00	518.00	518.00
c268	Residential	R2	251.00	251.00	421.00	421.00
c269	Residential	R2	310.00	310.00	324.00	324.00
c270	Residential	R2	445.00	445.00	275.00	275.00
c271	Residential	R2	487.00	487.00	382.00	382.00
c272	Residential	R2	100.00	100.00	112.00	112.00

c273	Residential	R2	137.00	137.00	99.00	99.00
c274	Residential	R2	126.00	126.00	101.00	101.00
c275	Commercial	C1	92.00	108.24	106.00	124.71
c276	Commercial	C1	141.00	165.88	146.00	171.76
c277	Commercial	C1	204.00	240.00	174.00	204.71
c278	Residential	R2	872.00	872.00	929.00	929.00
c279	Commercial	C1	202.00	237.65	233.00	274.12
c280	Residential	R2	472.00	472.00	118.00	118.00
c281	Commercial	C1	180.00	211.76	129.00	151.76
c282	Commercial	C1	354.00	416.47	297.00	349.41
c283	Commercial	C1	221.00	260.00	272.00	320.00
c284	Residential	R2	202.00	202.00	237.00	237.00
c285	Residential	R2	98.00	98.00	73.00	73.00
c286	Residential	R2	144.00	144.00	110.00	110.00
c287	Residential	R2	914.00	914.00	691.00	691.00
c288	Commercial	C1	679.00	798.82	638.00	750.59
c289	Commercial	C1	284.00	334.12	168.00	197.65
c290	Commercial	C1	293.00	344.71	220.00	258.82
c291	Residential	R2	770.00	770.00	107.00	107.00
c292	Residential	R2	94.00	94.00	96.00	96.00
c293	Residential	R2	277.00	277.00	311.00	311.00
c294	Commercial	C1	302.00	355.29	332.00	390.59
c295	Residential	R2	201.00	201.00	102.00	102.00
c296	Residential	R2	566.00	566.00	363.00	363.00
c297	Commercial	C1	256.00	301.18	225.00	264.71
c298	Commercial	C1	242.00	284.71	299.00	351.76
c299	Residential	R2	386.00	386.00	659.00	659.00
c300	Residential	R2	423.00	423.00	144.00	144.00
c301	Residential	R2	451.00	451.00	614.00	614.00
c302	Residential	R2	430.00	430.00	332.00	332.00
c303	Residential	R2	502.00	502.00	544.00	544.00
c304	Residential	R2	553.00	553.00	570.00	570.00
c305	Residential	R2	393.00	393.00	246.00	246.00
c306	Commercial	C1	199.00	234.12	177.00	208.24
c307	Residential	R2	501.00	501.00	523.00	523.00
c308	Residential	R2	1029.00	1029.00	729.00	729.00
c309	Residential	R2	225.00	225.00	184.00	184.00
c310	Commercial	C1	278.00	327.06	192.00	225.88
c311	Residential	R2	54.00	54.00	120.00	120.00
c312	Commercial	C1	357.00	420.00	303.00	356.47
c313	Commercial	C1	391.00	460.00	599.00	704.71

c314	Commercial	C1	615.00	723.53	459.00	540.00
c315	Residential	R2	443.00	443.00	339.00	339.00
c316	Commercial	C1	206.00	242.35	244.00	287.06
c317	Residential	R2	584.00	584.00	487.00	487.00
c318	Residential	R2	201.00	201.00	456.00	456.00
c319	Residential	R2	149.00	149.00	89.00	89.00
c320	Residential	R2	280.00	280.00	268.00	268.00
c321	Residential	R2	222.00	222.00	288.00	288.00
c322	Commercial	C1	133.00	156.47	465.00	547.06
c323	Residential	R2	232.00	232.00	68.00	68.00
c324	Commercial	C1	542.00	637.65	638.00	750.59
c325	Residential	R2	104.00	104.00	181.00	181.00
c326	Residential	R2	208.00	208.00	217.00	217.00
c327	Commercial	C1	283.00	332.94	181.00	212.94
c328	Residential	R2	350.00	350.00	385.00	385.00
c329	Residential	R2	158.00	158.00	83.00	83.00
c330	Commercial	C1	234.00	275.29	312.00	367.06
c331	Commercial	C1	131.00	154.12	156.00	183.53
c332	Residential	R2	933.00	933.00	820.00	820.00
c333	Residential	R2	530.00	530.00	482.00	482.00
c334	Commercial	C1	147.00	172.94	139.00	163.53
c335	Residential	R2	171.00	171.00	120.00	120.00
c336	Residential	R2	710.00	710.00	562.00	562.00
c337	Commercial	C1	287.00	337.65	237.00	278.82
c338	Residential	R2	181.00	181.00	288.00	288.00
c339	Commercial	C1	134.00	157.65	152.00	178.82
c340	Residential	R2	130.00	130.00	167.00	167.00
c341	Residential	R2	329.00	329.00	308.00	308.00
c342	Residential	R2	215.00	215.00	238.00	238.00
c343	Commercial	C1	740.00	870.59	903.00	1062.35
c344	Commercial	C1	310.00	364.71	381.00	448.24
c345	Commercial	C1	554.00	651.76	413.00	485.88
c346	Commercial	C1	184.00	216.47	160.00	188.24
c347	Residential	R2	544.00	544.00	312.00	312.00
c348	Residential	R2	156.00	156.00	119.00	119.00
c349	Commercial	C1	953.00	1121.18	836.00	983.53
c350	Residential	R2	482.00	482.00	304.00	304.00
c351	Residential	R2	484.00	484.00	362.00	362.00
c352	Residential	R2	751.00	751.00	603.00	603.00
c353	Residential	R2	199.00	199.00	192.00	192.00
c354	Residential	R2	132.00	132.00	57.00	57.00

c355	Residential	R2	244.00	244.00	198.00	198.00
c356	Commercial	C1	523.00	615.29	448.00	527.06
c357	Commercial	C1	279.00	328.24	317.00	372.94
c358	Commercial	C1	617.00	725.88	651.00	765.88
c359	Residential	R2	448.00	448.00	546.00	546.00
c360	Commercial	C1	202.00	237.65	202.00	237.65
c361	Residential	R2	235.00	235.00	101.00	101.00
c362	Residential	R2	193.00	193.00	156.00	156.00
c363	Commercial	C1	184.00	216.47	166.00	195.29
c364	Residential	R2	80.00	80.00	64.00	64.00
c365	Commercial	C1	442.00	520.00	375.00	441.18
c366	Commercial	C1	351.00	412.94	404.00	475.29
c367	Residential	R2	107.00	107.00	137.00	137.00
c368	Residential	R2	126.00	126.00	116.00	116.00
c369	Residential	R2	267.00	267.00	204.00	204.00
c370	Commercial	C2	1253110.00	1900304.46	1265497.00	1919088.98
c371	Industrial	D2	41670.00	59171.40	51390.00	72973.80
c372	Industrial	D2	1955190.00	3108752.10	2015864.00	3205223.76
c373	Industrial	D3	209925.00	298093.50	240210.00	341098.20
c374	Commercial	C2	1558601.00	2363572.58	1673366.00	2537610.32
c375	Industrial	D2	504180.00	882315.00	581985.00	1018473.75
c376	Industrial	D2	730683.00	1278695.25	788209.00	1379365.75
c377	Commercial	C2	135898.00	182982.66	166035.00	223561.24
c378	Industrial	D2	114435.00	162497.70	130095.00	184734.90
c379	Commercial	C2	117128.00	157709.41	118753.00	159897.42
c380	Industrial	D3	306450.00	435159.00	361350.00	513117.00
c381	Commercial	C2	228900.00	308207.12	234877.00	316254.97
c382	Commercial	C2	54151.00	72912.73	55669.00	74956.67
c383	Commercial	C2	18080.00	24344.19	21057.00	28352.63
c384	Commercial	C2	97883.00	131796.58	98670.00	132856.25
c385	Commercial	C2	133788.00	180141.61	147680.00	198846.78
c386	Industrial	D2	3150.00	4473.00	4320.00	6134.40