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Advance Energy Management through Smart Metering System: An Operational Perspective

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Abstract: *This purpose of this research is to provide some enhancement in the conventional Metering system by smart metering. The term Smart Meter is an advanced energy meter that measures consumption of electrical energy providing additional information compared to a conventional energy meter. Integration of smart meters into electricity grid involves implementation of a variety of techniques and software, depending on the features that the situation demands. Design of a smart meter depends on the requirements of the utility company as well as the customer. In this research report will discuss various features and technologies that can be integrated with a smart meter. In fact, deployment of smart meters needs proper selection and implementation of a communication network satisfying the security standards of smart grid communication. In this Report outlines various issues and challenges involved in design, deployment, utilization, and maintenance of the smart meter infrastructure. In addition, several applications and advantages of smart meter, in the view of future electricity market are discussed in detail. In this Report explains the importance of introducing smart meters in developing countries like UAE to enhance the energy management and validation rules.*
Keywords: *Conventional metering, Smart Meters, Smart Grid, Validation rules.*

I. Introduction

1.1 Background of the Study

In the early phase of domestic industrial technology, delivery of electricity is completely depended on traditional energy meters based on mechanical rotation. These meters play a key role in measuring the consumption of electrical energy in individual households/commercial areas. The usage of these meters has been slowly declining with the advancement in technology as rapid changes has been made to encounter the problems occurred by the traditional meters. The major problem arises when habitants are unaware of their daily consumption of energy. Monthly billing or feedback given to the consumers is not sufficient as the consumers will not have knowledge on how much energy does the individual appliances consume? Traditional meters are only capable of recording consumption and consequently don’t take into account any energy generated by a household.

If you have or are planning to install solar panels or any other renewable energy generating system in your home, a smart meter will enable you to measure how much energy you produce. The smart meter will also calculate whether or not there is a surplus which you could sell back to the grid (Livgard, 2010).

To overcome the problems of traditional electricity meters, Smart Meters have been upgraded and developed. With the use of Smart Meter data, energy alerts will be provided to the consumers based on hour or less or X-time utilization of energy.

The primary key objective of the Smart Meters to reduce or properly manage the energy consumption in the households/ commercial areas.

1.1.2 Cost and Specific benefits:

Electricity is a time critical resource that once generated must be quickly used and cannot be stored in large quantities. As a result, electricity demand in peak usage times is more costly to supply as it requires the growth of network infrastructure and deployment of additional and higher cost generators to meet demand. To the extent that peak-period demand can be curtailed, investment in additional infrastructure to support this demand, namely generators and robust network infrastructure could be avoided (Moss,2010).

The costs of investment in additional infrastructure to support peak period demand are reflected to some extent in the customer bill through increased tariffs and supply charges. The way in which consumers are billed for electricity use using accumulation meters – that is either at a flat or inclining block rate – creates little incentive for customers to avoid electricity use during peak periods. A smart meter, which is able to collect electricity usage data over short increments of time, enables the use of ToU pricing, which allows electricity businesses to use price signals as a mechanism to encourage consumers to shift from peak-period use.

At the time of introduction, based on the outcomes of cost-benefit analysis, presented the benefits of the AMI project to key stakeholders as improving choice, convenience, competition and efficiency:

a. **Benefits to consumers** – consumers will benefit from the capacity to better manage their energy use through an increased level of information and more efficiently managed services and products. Further, consumers will benefit from the improved benefits for the energy market to provide innovative products, tailored pricing solutions, improved customer service and competition.
b. **Benefits to electricity suppliers** – suppliers will benefit through the ability to read meters and turn the electricity supply on and off without visiting the premises. Suppliers will be able to provide improved service quality through better network management, such as detecting and fixing faults remotely. (IBID, 2010)

1.2 Problem Statement:

Due to increase in consumption of Electricity and growth of exponential rise in demand, in the near future, will also effect on energy demand and supply.

This carriestherisk of Grid instability and energy management. Mostly frequently, companies are integrating new Independent power producer into their existing system to avoid this situation of Power Shortage or supply. To manage consumption efficiently, measure losses and generate billing process, companies required advance energy metering and validation system for these principles.

In line, view of the above, the researcher plans to study the existing energy metering system or any current deployed system for measuring energy consumption of Dubai Electricity – UAE. After having analysed the aforementioned system, the researcher plans to recommend the appropriate courses of action to the company for necessary implementation and modification.

1.3 Objectives of the Study:

The basic objectives of this study are:

- To analyse the smart metering system, currently deployed in other electrical utilities as well as existing DEWA technology.
- To suggest improvement in various course of action for further efficiency
- To analyse the raw values of energy meter coming from different zones of metering data points.
  For instance, deals with hourly energy consumption values acquired from the energy provider and consumers.
- Also, the behaviour of the consumers can be studied and results obtained can help the consumers in changing their behaviour, in particular when correlated with a potentially varying price
- A case study is conducted on the standard data obtained from different vendors. The variation in change of the usage has been well understood and determined.
- By using different models, flattening techniques in determining for future saving.

1.4 Significance of the Study:

To be studied on two different parameters.

a. The researcher has gone through variety of literature on the issue in question but hasn't come across the similar study addressing the analysis and areas of improvement in smart metering system in electrical utilities so the study is contribution existing body of knowledge.
b. The finding of this study may be of great use to the decision maker with in smart metering phenomenon. So concerned official may make an effective use of the suggestion targeting the improvement of the relevant phenomenon during their day to day operation handling.

1.5 Limitations of the Study:

There were some problems while I was preparing this report. A wholehearted effort was applied to complete the report and to bring a reliable and fruitful result, however there were some limitations:

1. To access the real time data and currently use Infrastructure and architecture for meter analysis for the improvement of Data quality is difficult within a very short period of time.
2. Portal excess for the required data was not sufficient, for the confidentiality reason of tariff.
3. Data migration techniques are also confidential.

II. Literature Review

2.1 Evolution of Electricity Meters from the Past:

In early years, electricity is available only to a specific section of affluent society. The advancement in technology over time encouraged meeting the demands of common people in all parts of the world. The history of electricity meter is well connected involving researchers from past. The general usage of electricity in the early 1870‘s is only confined to telegraphs and arc lamps. With the invention of the electric bulb by Thomas Elva Edison, the power energy market became widely opened to the public in the year 1879. Shallenberger (1888) introduced his AC ampere hour meter. Eventually, the progressive development in metering technology leads in enlightening the lives of many common people.

According to Aspinall Parr (1903), “It has already been pointed out that the great trouble in the generality of motor meters is the friction of the moving parts, which, if not minimized and compensated for, causes irregularities in the direct proportion between speed and the thing measured.”

2.1.1 Traditional Electricity Meters:

According to Weranga, Kumarawadu & Chandima (2014), the electrical devices that can detect and display energy in the form of readings are termed as electricity meter. Traditional meters are used since the late 19th century. They exchange data between electronic devices in a computerized environment for both electricity production and distribution. In most of the traditional electricity meter aluminium discs are used to find the usage of power. Today‘s electricity meter is digitally operated but still has some limitations.

Some of the limitations faced by the traditional electricity meter are as follows:

- Meters are unreliable in nature as consumer has to anticipate for the monthly electricity bill.
- The process of measurement is supported by a specific mechanical structure and hence they are called as electromechanical meters.
- In order to perform meter readings, a great number of inspectors have to be employed.
- Payment processing is expensive and time consuming.
- New type of tariffs on hourly basis cannot be introduced with the corresponding meters for encouraging the consumer.
- Development of meter software applications and supportive network infrastructure iscomplicated

Besides the above mentioned limitations, there are also several other elements creating a huge gap between the consumer and distributor because of installation of traditional meters. Meters are of distinct types. Even though timely development of electricity meters helps the consumer to gain knowledge with respect to electricity consumption, statistics of the consumption couldn‘t be changed.

2.1.2 Meter Grading / Categories:

Some of the basic types of electricity meters are explained as follows:

1. Standard Meter -usually measure electricity consumption in terms of kWh or kilowatt-hours.These metersusually present a reading in numbers.
2. Variable rate meters –it gives two readings; one reading for daytime and one for the night.
3. Smart meters – Smart meters are the latest in energy meter technology (detail discussed below)

2.2 Grid:

An electrical grid is an interconnected network for delivering electricity from suppliers to consumers. It consists of generating stations that produce electrical power, high-voltage transmission lines that carry power from distant sources to demand centres, and distribution lines that connect individual customers.

2.2.1 Smart Grid:

Smart Grid is the modern development in electricity grid. Recent electrical grids are becoming weak with respect to the electrical load variation of appliances inside the home. The increase in population is also the indication of electrical grids becoming more fragile. The higher the population, the more load on the grid.

Improving the efficiency of grid by remotely controlling and increasing reliability, measuring the consumptions in a communication that is supported by delivering data (real-time) to consumers, supplier and vice versa is termed as Smart Grid . Automated sensors are used in Smart Grids. These sensors are responsible in sending back the measured data to utilities and have the capability to relocate power failures and avoid heating of power lines. It employs the feature of self-healing operation. Literally, the concept of Smart Meter is commenced from the idea of Smart Grid. A carbon emission reduction of 5% is expected by 2030, annually by its installations and it can show a greater impact on environmental changes. For a sustainable development and establishment of new grid infrastructure, Smart Grids are recommended for many countries (Hossain, 2010).

2.2.2 Power Consumption:

The total amount of power consumed in an individual household is referred as power consumption. The consumption of power is an important aspect of electricity supply. People should be aware of preserving energy for future use. With daily usage of electricity, the energy patterns have been slowly varying. This variation of consumption patterns can be caused by weather conditions or unnecessary utilization of power by inhabitants such as increase of appliances in respective households and careless attitude in utilization for example not switching OFF the lights or television when not watching it. These factors may show greater impacts on end user. As the power supplied by energy companies is vast, most of the people are neglecting energy and its savings. The importance of consumption is declining in the mind set of utilities. The energy utilities should play a major role in advancing the Smart Meter technology and should make people participate in reducing energy consequences by creating awareness about the impact of their current level of consumption.

2.2.3 Real-time visibility into the Electrical load Dispatch network:

Deploying a smart metering system gives utilities the chance not only to ensure an effective meter to cash process and to enable new customer-focused applications, but also to get real-time visibility into the distribution grid. This capability is transformative for utilities, providing a real-time view of consumption patterns, distribution system loading, voltage and power quality variations, and power outages.

According to Bose(2003) : "There must be standardization of the monitoring systems including the frequency of data gathering, time stamping, alarming, visualization, etc. So that operators on different control centres on different parts of the grid can communicate intelligently".

2.3 Smart Meter:

Smart Meter is usually an electronic energy meter that is used for measuring the electrical energy in terms of KWh (Kilowatt - hours). It is simply a device that affords a direct benefit to the consumers who want to save money on their electricity bill. They belong to a division of Advanced Meter Infrastructure and are responsible for sending meter readings automatically to the energy supplier (AlAbdulkarim and Lukszo, 2003)
Some other advantages of Smart meters are:

1. More accurate bills — smart meters mean the end of estimated bills, and the end of overpaying (or underpaying) for your energy
2. No one has to come to your home to read your meter; you do not have to submit meter readings yourself
3. Better oversight and management of your energy use with a real-time data display in your home
4. Low operational cost
5. Time saving to the consumers and utility companies for reporting the meter reading back to the energy providers
6. Power consumption can be greatly reduced during the high peaks with an intimation policy.
7. Has a feature of automatically terminating the appliances off when they are not in use

2.3.1 Advance Metering system – Real time approach:

It is an advanced energy meter that measures the energy consumption of a consumer and provides added information to the utility company compared to a regular energy meter. Smart meters can read real-time energy consumption information including the values of voltage, phase angle and the frequency and securely communicates that data.

2.3.2 Load Control:

The ability of smart meters for bidirectional communication of data enables the ability to collect information regarding the electricity fed back to the power grid from customer premises. A smart meter system includes a smart meter, communication infrastructure, and control devices. Smart meters can communicate and execute control commands remotely as well as locally (Jixuan Zheng & Li Lin -2013). Smart meters can be used to monitor and also to control all home appliances and devices at the customer's premises. They can also collect diagnostic information about the distribution grid, home appliances, and can communicate with other meters in their reach. They can measure electricity consumption from the grid, support decentralized generation sources and energy storage devices, and bill the customer accordingly(Ganesh-2011).

2.4 Metering Functions:

Some of the metering functions available through advanced metering techniques are described here. Many of the functions are currently available through add-on equipment and multiple systems. Advanced metering equipment would make it possible to consolidate these functions into one common system, which should reduce equipment and operating costs.

2.4.1 Data Recording:

Advanced meters can duplicate the conventional metering function of recording total consumption, plus offer enhanced functions such as time-of-use, peak demand, load survey, and power outage recording. For electric metering, advanced meters may also include recording of other electric characteristics, such as voltage, current, and power factor.

Using the above method, also requires that there be a reasonable way to estimate the current annual electricity (utility) costs for the building being considered. Except in cases where the buildings already have standard meters, actual usage data to estimate the annual costs will not bearable. In these cases, one of the following accepted methods of estimating building energy use should be applied (FEMP 2007):

- Energy-use intensity
- Calibrated software
- Short-term metering

2.4.2 Total Consumption:

This is the most basic data recording function, which duplicates the standard kilowatt-hour of electricity (kWh), hundred cubic feet volume (CCF) of gas, or gallons (gal) of water consumed between meter readings.

2.4.3 Time-of-Use Metering:

Different rates can be charged for on-peak and off-peak time periods by accumulating the total consumption during operator-defined time windows. The time windows may vary during both time of day and weekday/weekend/holiday.

2.4.4 Peak Demand Metering:

Billing of many larger commercial and industrial customers is based on total consumption and the highest 15-, 30-, or 60-minute demand during the billing period. The peak demand may be reported as a single highest value, highest four values, or highest value during each hour (all peak demand values must be accompanied by an associated time stamp).

2.4.5 Load Survey (Profile or Time-Series Data) :

As per (Sydlowski ,1993): Energy consumption and conservation impact studies, as well as more complex analysis of system loading, require more detailed demand data. A load survey provides periodic consumption or demand data (in time increments of 1, 5, 15, 30, or 60 minutes).

2.4.6 Power Outage Recording:

Recording the time and duration of each power outage can help evaluate the quality of electric power service available to various customer areas.

2.5 Customer Interface:

A two-way communication link between the central station and customer site also provides the opportunity for offering some totally new utility services via the advanced meter. Services include utilities consumption and billing information made available through either a home energy management system or direct displays, and a security systems communication rink.(Sydlowski, 1993)

2.5.1 Energy Management System Home Interface:

The home energy management system (EMS) is an evolving area, with a feature list that is constantly expanding. A vital part of every EMS is measurement and display of utilities consumption. Advanced meters can provide this information directly to the EMS.

2.5.2 Customer Billing Functions:

Customer billing functions can vary between simple displays of instantaneous and cumulative consumption and cost information, and full interaction with the utility company billing system (purchase energy as needed).

2.5.3 Security:

A large distributed communication system that is useful for real-time AMR is also viable for security systems applications. The security system may be a full stand-alone installation that uses the AMR system as a communications rink, or a few alarm functions that are an integral part of the AMR system (EISA 2007).

III. Research Methodology

The researcher adapted below mentioned techniques to conduct this qualitative and specifically available data research. Content Analysis of already published and exiting material regarding smart metering and grid system in energy management.

This qualitative material and data collection helps to develop & proposing an updated perspective of metering solution. Energy management is an old field with new emerging technologies for its different stages. Extensive researches are available and different courses of action has been implemented in this sector to manage and utilize energy efficiently. So collection of data through site survey and grid data will not help in deep rather than some pre-defined terms and speed in the process. In order to introduce a new simple way of data validation and checking in context of energy management require lot of background study which could indicate the work of earlier researchers in different parts of world in metering fields and on different metering protocols for efficient energy management. Gathering all at one place and introducing in a simple form which is useful for all is the task and based for selection of content analysis.

3.1. Reasons for the Selection of above mentioned Methodology:

Below are some to the point reasons for selecting this methodology:

- Smart meters and distributed storages are important components of smart grids. Smart metering is very specialize topic with the involvement of different knowledge areas like billing, cost saving, energy storage, energy management, customers satisfaction, competitors, renewable energy etc. It is difficult to find larger population in one market or in country to conduct empirical research.
- Due to specialize field ample amount of published material available. So, researcher choose to review that material instead of getting expert opinion from field.
- Keeping above reasons, time &resources constraint in mind the researcher content analysis as methodology Researcher developed the list of points and some weaknesses keeping in view the research objective and problem. Points were taken during content analysis in order to have consistent outcomes.

3.2. Data Collection:

Different ways were applied to collect relevant data on subjected matter.

Content Analysis / Literature Review:

Conducted content analysis based on published material, which was mostly library based by study of relevant publish material in the library and on the internet in different journals. Researcher mark & note the relevant data where ever found and then used during research work with appreciation given to earlier researcher for their hard work.

Existing Office materials and reports have been reviewed and analyse available data bank on intranet for meter management on available tools “Regression methods & Kalman filter MATLAB”

All these content Analysis provided the base for this study and given a broader view of the topic to research and able to finalize this research work in time.

Based on content analysis, the researcher summarized point wise in logical sequences and presented in this particular report.

The entire effort of researcher was strictly based on listed points already developed by researcher and was later summarized in to finding and are arranged in logical sequence so that they can help in reaching specific conclusion.

3.3. Compilation of Findings:

Based on content analysis, the researcher summarized point wise in logical sequences and presented in this particular report.

The entire effort of researcher was strictly based on listed points already developed by researcher and was later summarized in to finding and are arranged in logical sequence so that they can help in reaching specific conclusion.

3.4 Reliability and Validity Issues in Qualitative Research:

Validity and reliability issues are the most sensitive issues in qualitative studies as we don’t have numeric data that could be processed on various statistical software to yield reliability result. So establishing validity and reliability was a major challenge, the researcher picked the most relevant paper addressing the pre-requisites of the entrepreneurship. The research also ensured that the journals from where such papers have been selected for study are accredited ones in their countries. For this reason, the researcher accessed the list of accredited journal of many countries and then started exploring the factors or pre-requisites of the entrepreneurial ventures.

IV. Data Analysis & Interpretation

Subsequently doing extensive research on above matter, now we are going to propose a comprehensive and detail solution for advanced AMM (automatic meter reading) and metering management systems. This solution is designed to simplify the way energy companies collect and manage their metering data. As part of the solution, EMVS is an advanced metering management (AMM) system for industrial, commercial and grid applications. With EMVS, you can streamline and make your internal metering-related processes more effective. This EMVS system description describes the application range, system structure, hardware and software requirements, and the functionality of EMVS. In addition, a description of the system interfaces, additional modules, and services is included. The aim of this research is to support decision makers in choosing the optimal solution for their purpose and customers, tailored to a specific customer project.

4.1 Application and Scope:

Converge, is a client/server application for data collection from different metering devices offering a flexible reporting tool. Because of its scalability and modularity, it is the ideal solution for medium-sized and large utilities (DisCo, GridCo) as well as for meter data providers (MetCo) and energy producers (GenCo) that focus on the industrial, commercial, and grid sectors.

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Figure 4.1 Data Converge

This system Converge covers the following typical requirements of industrial, commercial and grid:

- A few hundred to a few hundred thousands of metering points
- A large number of different communication media (GSM, GPRS, serial line, PSTN, X.25, fiber optics, LAN…)
- A variety of meter types of various manufacturers, covering electricity, gas, water and heat metering.
- Large quantities of metering data acquired daily
- Handling of billing and load profile data, as well as device status/event data
- High data security and availability
- Alarm and event processing

4.2 Solution Overview:

Converge is a comprehensive AMM system that meets utility requirements throughout the entire metering value chain. Due to its modular structure, the software can be adapted to meet the unique needs of the utility. Before Converge is deployed, old meter conduct a detailed and thorough analysis of the utility's business processes and its information system environment. The analysis ensures a reliable and cost-effective solution.

Figure 4.2 Loop in Data

4.2.1 Data Acquisition:

The advanced software supports wide range of communication methods which ensures fast, secure and cost-efficient data acquisition. Data acquisition functions include automatic and on demand data collection or eventually data import from different sources as hand held terminals, original data security and archiving.

4.2.2 Automatic Meter Reading:

Remote acquisition of metering data is done using switched or dedicated lines as well as GPRS or Ethernet. Load profile and billing data is stored according to a universal data storage standard. The acquired meter data is initially stored as raw data and then converted into a common format for further processing. The basic license includes the following functions:

- Acquisition of load profile data, meter value status, billing data, and meter status according the List of

Supported meters
- Getting and setting meter time
- Synchronizing control center and meter time
- Handling daylight saving time start and end
- Communication diagnostics and maintenance
- Acquisition of raw data, which is standardized and stored in the database under meter variable sets
- Viewing and configuring meter data

Communication technologies supported:
- PSTN
- GSM/GPRS (static addresses)
- TCP/IP (GPRS, LAN)
- Dedicated/Leased line

In most applications, the metering data for load profiles is acquired at daily intervals. If there is a requirement for acquisition at short intervals, e.g. at the end of each 15-minute integrating period or even in a shorter period System Converge has the possibility to do this. This type of application is often used for power station or interchange metering, where the user wishes to know the usage on a continuous basis.

4.3 Data Validation:
The validation module contains four main functions which are treated below:
- Plausibility and validation checking
- Meter check functionality
- Bypass feeder substitution and calculations

Brief descriptions of these functions are provided here.

4.3.1 Meter Values Operations:
It can be done by the below mentioned methods.

4.3.2 Plausibility and Validation Checking:
The data validation module permits acquired data to be checked for plausibility/validity according to the following criteria:
- Gaps in the acquired data
- Checks on status bits
- Limit Values
- Main/check comparison
- Hierarchical comparison against data acquired in other ways

Based upon these checks, a substitution strategy can be selected from the following possibilities:
- No substitution
- Insert null values
- Insert last plausible value before the plausibility gap
- Insert mean value calculated from values before and after plausibility
- Hierarchical comparison. Insert the first plausible value in the hierarchy

4.3.3 Meter Check Functions:
The meter check functions provide two additional register calculations:

4.3.4Register Comparison:
For devices which are driven by metering pulses, here is no possibility for a direct check between the sum of the load profile values and the actual meter register. Using this function, meter readings taken by the meter reader can be entered into the system periodically (e.g. once per month/year) and the system checks that the difference between the sum of the load profile readings and two manual register readings is within a defined tolerance.

4.3.5Register Construction:

There is sometimes a need to re-construct a meter register value from the sum of the load profile readings, e.g. in order to include the register reading in an invoice for energy supply. This can be required if a meter only provides load profile values without delivering the actual register value. Using this function, an initial register value is entered with its date and time, and from that time register values are calculated periodically.

4.3.6 Bypass Feeder Substitution and Calculations:

The bypass feeder functionality is used in substations where additional switchgear and metering bay is present to take over the feeder metering during switchgear maintenance. Such a substation could have, for example, four feeders equipped with their own meters, plus the coupler bay with its own separate meter.

For bypass feeder operation, first the coupler switchgear is switched to the outgoing feeder, so that both meters are connected in parallel. Then the feeder switchgear is taken off line, leaving only the coupler meter connected. When maintenance has been completed, this process is reversed. Converge therefore needs to carry out the following actions:

- Automatically detect that bypass operation is active and for which feeder
- Merge the load profiles on the feeder and coupler meters, to give the resultant feeder profile
- Automatically detect that bypass operation is finished

Automatic detection is made by means of auxiliary contacts on the switchgear, which are connected to a special auxiliary input of the meter. The switchgear information is stored as a spontaneous event in the DATAGYR FAG or as status information in the meter; this additional information is transmitted to the central station with the load profile data.

4.3.7 Customer Defined Validations:

Specific customer’s requests for validations can be also done via Converge Reports. These Reports are customer specific and are developed separately according to the requirements.

4.4 Data Processing:

Following are the concept for data processing.

Master Accounts enable other master accounts, consumer accounts, and contracts to be grouped according to a common requirement. A master account could be created for a company that has a particular tariff agreement that covers all individual stores. Any number of master accounts can be created containing any number of master accounts, consumer accounts, and/or contracts.

Consumer Accounts represent the individual consumer in the Industrial and Commercial areas of application. Any number of consumer accounts can be created containing any number of contracts.

A **Contract** contains the contractual requirements of an account. A contract must be under a master account or a consumer account. It is possible that more than one contract is assigned to any one account, each reflecting the different contractual requirements.

4.4.3 Data Segment:

Data segments enable the consumer tree to be partitioned either for data protection or convenience by limiting user access. Nodes can be moved to a different data segment, if desired. In this case, the change propagates down through all associated nodes.

The **Data Segments** page enables data segments to be created and managed. There is no limit to the number of data segments defined, and they can be renamed if desired.

The **Top node** is a special case. It does not belong to a data segment. All other nodes can belong to:

- A named data segment
- ”Any” data segment
- ”No Data Segment”

Nodes in a named data segment can only have children of the same data segment. The top node and nodes assigned to "any" can have mixed children. "<No Data Segment>" is treated the same as a named data segment. That means: nodes in "<No Data Segment>" can only have children in "<No Data Segment>".

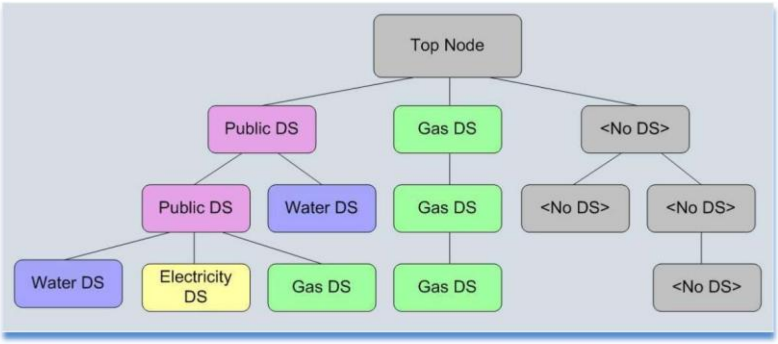

Figure 4.3Node tree

Typical data segmentation could be according to:

Product	e.g. Electricity, Water, Gas, District Heating
Region	e.g. North, South, East, West
Application Area	e.g. Commercial, Industrial, Grid
Sales Region	e.g. Central Belt, Highlands & Islands, Galloway, The Borders

Data segmentation can be applied to any level of the consumer tree. The restrictions are governed by the data segment assigned to the parent container. 4.4.4 Access to Data Segments:
User's access to the data segments can be:

- Restricted to one or any number of named data segments
- Unrestricted.

4.4.5 Active Elements:

Active Elements provide the functionality of their associated container. They hold the information that performs the actions required for processing the load profile data. A Container can be thought of as a directory and active elements as files within a directory. Depending on the type, active elements can be associated with the Top Node, Master Accounts, Consumer Accounts, and Contracts. They may also be schedulable.

Active Element	**Container**	**Schedulable**
Reports	All	Yes
Calculations	All	No
Tariff Agreements	All	No
Daily Courses	All	No
Day Lists	All	No
Persistent Values	All	Yes
Auxiliary Values	All	No
Meter Proxies	Contracts only	Not implemented
Generate Schedules	Top Node only	Yes
Checkpoints	Top Node only	Not implemented

Example:

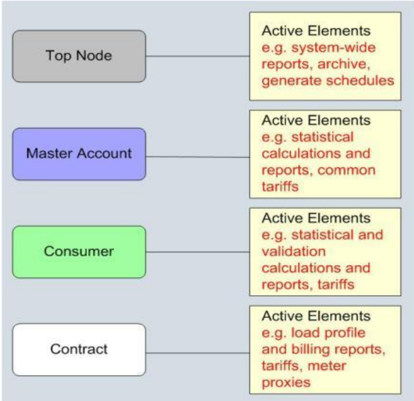

Figure 4.4Active elements

4.4.6 Scheduled Events:

As seen in the above table, some active elements can be scheduled, i.e. executed automatically. Scheduled Events define the execution time and recurrence of an active element. This enables calculation chains to be initiated, on the completion of data acquisition, for example.

A list of all Scheduled Events associated with a particular active element is given within the container. These Scheduled Events are collected and are used by the Schedule Maker as the basis for constructing the daily schedule.

The lists of Scheduled Events are used to construct the daily schedule.

Each Scheduled Event contains:

A Calendar that determines when to execute the associated Active Element. This includes start time and end time (window of opportunity) and periodicity of recurrence. It is also possible make exceptions within the recurrence.

Runtime parameters, e.g. **Automatic data range calculation** that determines which data is used when executing the Scheduled Event. This can be different from when the Scheduled Event is scheduled to run, e.g. a weekly report scheduled to run every Monday at 06:00 could use data acquired the previous week. Another example of a runtime parameter is Output device that determines on which device a Report is to be output, e.g. printer.

The following Active Elements can be scheduled:

- Reports
- Persistent Values
- Archives (during project phase)
- Generate Schedules
- Aggregation for suppliers

4.4.7 Templates:

Templates are an important component of the Converge system. The entire consumer tree, i.e. containers and active elements, is created with the aid of existing templates. A library of standard templates makes it easy to create new Master Accounts, Consumer Accounts, and Contracts with similar contractual obligations. Similarly, Active Elements with similar functionality can be based on the same templates.

All consumer tree elements created using a Template become an Instance of that Template. When a Template is modified, the changes are reflected in all the instances, unless the information contained in the data fields has been overwritten in the instance. Examples of information that is overwritten in the data fields are name, account number, validity range, etc., which are unique to the instance.

Using Templates and Instances simplifies the creation and maintenance of consumer tree elements.

More information to Template management can be found in User Manual

4.4.8 Archive:

The **archive** active element defines the period and scope of meter data archiving. Regular archiving of data reduces the size of the database and thus enhances performance. Meter proxy data, logbook data, and status messages are moved to the archive, and then the archived data is deleted from the database. Restoring archived data is possible at any time (which is a legal requirement), for example if a bill calculation must be redone in case of customer complaints. Restoring archived data is covered in the System Administration chapter.

V. Summary of the Findings, Conclusion And Recommendations

5.1. Summary of key Findings:

Main objective of the research was to propose a comprehensive solution in Smart meter management system by using content based study. Also researcher gone through various latest literature available over internet & books of different authors written over start of the art technology. After reviewing abundant literature researcher take out important points for dynamics, practices and complete solution that are effecting energy management and utilization.

Transformational, comprehensive solutions, many enabled by smart metering technology, are helping utilities and communities around the world advance toward a radically different landscape for meeting their energy needs. So many different factors were identified which offers intelligent operations services combine real-time management with all facets of utility services to enhance power quality, reliability and performance against objectives. Also, it help utilities optimize grid operations, improve reliability, increase customer satisfaction, and enhance process and workforce. By the combination of all, (factors, tools & techniques) researcher propose a simple technique to deploy smart metering technologies to gain greater integration of energy use and digital technologies. During the preparation phase, it modified sometimes with the expert opinion.

During the study of earlier published material it was observed that the material is available for Metering solution in energy management is feel complex & primeval. Researcher tried to come up with a simple comprehensive model which could act as easy to understand in first instance. Smart meters could provide a useful additional means of identifying vulnerable customers and, in particular, patterns of heating use and bill payments suggestive of fuel poverty.

Smart meter data can also help with identifying solutions. But this does require customers to agree to pass on their daily or half-hourly data under current data access rules, and the institutional support to offer effective advice and to follow it up. Reducing the invisibility of the most vulnerable may need to be more prominent in the programme’s benefits case and justification, as a potential public service benefit over and above energy savings, demand response, and ability to switch between tariffs and suppliers. Identifying and protecting vulnerable customers could, in the broader framework of consumer engagement, contribute significantly to acceptance of this technology.

5.2. Conclusion:

Following are the outcomes and conclusion based on our research and analysis:

- Automatic and manual meter reading
- Load profile data, meter value status, billing data and meter status
- Synchronizing control centre and meter time
- Communication diagnostics and maintenance
- Communication back up line for enhanced availability
- Acquisition monitoring & Data validation

There is every reason to believe that Smart Metering will replace most of today’s electromechanical metering approaches within the foreseeable future. At today’s prices, many utilities are constructing conservative business cases that foresee a relatively short five- to six-year payback period for Smart Metering investments. Rapidly falling prices and the multiple advantages to both customers and utilities should make the systems even more compelling. As a result, prudent utilities worldwide are increasingly factoring Smart Metering into long-term IT and customer-program strategies.

5.3. Recommendations:

Following are the recommendations for process improvement in different capacities.

5.3.1 For the Energy Sector of Dubai (DEWA) & outskirt:

Dubai needs to actively engage in looking for means to encourage a more rational use of energy.

For the better management of the energy in both demand side and supply side there is a need of an infrastructure which provides detailed information regarding the usage of electricity to both consumers and suppliers. This will allow the users to actively supervise the energy consumption and adjust their behaviour to their target/ pre-determined consumption of energy. Further it will allow the supply side to better predict the demand of electricity and thus provide a more reliable supply side. Moreover, it will allow the utility to set the prices according to peaks and lows in the demand side.

The whole analysis and research regarding this energy management, also from the wide acceptance of this project around the world shows us that, with no doubt this technology (smart meter, infrastructure, data processing) is mature and can be implemented on a large scale to encourage an efficient use of valued resource such as energy.

Al though there are some challenges to be tackled. The major and foremost challenge is that the success of this project is largely dependent on the consumer who chooses in the first place to make an efficient use of energy and save their money. There is a need for the awareness of this equipment and a know-how is also very important. Also, it is reasonable to say that smart metering should be started in the industrial sector and urban areas first and after the success of the project in those areas it should be deployed intensively in the other states of UAE.

5.3.1 For the Future Researcher:

- In repeated research effort focus group should be enlarge and may include more experts from different industries and regions.
- Different aspect of smart metering in energy management should be studied before commenting new ideas.
- The propose set of hypotheses are recommended for further empirical testing by future researchers.

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