

## GSM Based Smart Distribution System

Muhammad Ilyas Afridi\*, Shah Faisal\*\*, Hikman Ud Din Bangash\*, Engr Qazi Waqar Ali\*,  
Engr Arsalan Arif\*.

\*Department of Electrical Engineering \*

\*\*Sarhad University of Science and Information Technology Peshawar Khyber PakhtunKhwa Pakistan\*

---

### Article Info

#### Article history:

Received Aug 15, 2012

Revised Oct 3, 2012

Accepted Oct 10, 2012

---

#### Keyword:

NTL (Non Technical Losses)  
Utility  
Tariff  
Smart Energy Meter  
GSM (Global System for  
Mobile Communications)  
Central Database Station.

---

### ABSTRACT

Non technical losses (NTL) during transmission of electrical energy are a main problem in developing countries. It is so complicated for the utility companies to detect and fight the people responsible for the theft. Electricity theft forms a main chunk of non technical losses (NTL). These losses affect the quality of supply, increase load on the generating station, and affect tariff forced on actual consumers. This paper shows some common methods used by consumers for electricity theft and also proposes an architectural distribution system for theft detection using GSM based smart energy meter. The Inspiration of this work is to detect illegal consumers, preserve and successfully utilize energy. As well as smart meters are proposed to provide automatic readings/data of dissimilar parameters related to instantaneous power consumption via GSM. It will reduce the laborious task and financial expenditure by adopting the automatic meter reading instead of the manual meter reading process and bill data entry process.

Copyright © 2012 Institute of Advanced Engineering and Science.  
All rights reserved.

---

### Corresponding Author:

Shah Faisal,  
Department of Electrical Engineering (power) 8<sup>th</sup> Semester,  
Sarhad University of Science and Information Technology,  
36-B, Chinar Road, University Town, Peshawar Khyber PakhtunKhwa Pakistan.  
Email: nangyal\_afkar@yahoo.com

---

## 1. INTRODUCTION

Even after taking numbers of measure for closing the doors of theft detection and tampering such as introducing the electronic meter, the cost of electricity is still going up. This is due to the lack of professionalism in the management of distribution, measuring system and generous administrative expenses. The Present system of meter reading is a boring and an expensive one (e.g. In Pakistan), as a number of meter readers have to go and take the reading manually (from the consumer's house) to issue energy bill, which will later be, entered into the software to computerize the billing and payment system. Moreover, the opportunity of tampering, the reading details and not exposure the theft attempts are extremely common. Another key problem with the existing system is that if one electronic energy meter breaks down (damages or stopped due to some technical fault), the office will come to know only after two or even take more months and to repair or replace the damaged meter, depending on the duty of the person who is going to take the meter reading of consumers (in Pakistan). Here now the following section shows that how a consumer can illegally use the electricity.

A consumer can illegally use electricity in the following ways.

- 1) By using mechanical objects: A consumer can use some mechanical objects to stop the disc revolution of an energy meter, so that disk speed goes to slow down, and the recorded energy Figure decreases as well.
- 2) By using a fixed magnet: A consumer can use a fixed magnet to disturb the electromagnetic field of

- the current coils. As we know that the recorded energy is proportional to the electromagnetic field.
- 3) By passing the energy meter: This method gives consumer-free energy without keeping any record.
  - 4) Switching the energy cables at the meter connector box: In this way, the current does not pass through the current coil of the meter, so the meter does not record the energy expenditure.
  - 5) Illegal connection from the distributor: By this method, the consumer takes direct hooks from the distributor.

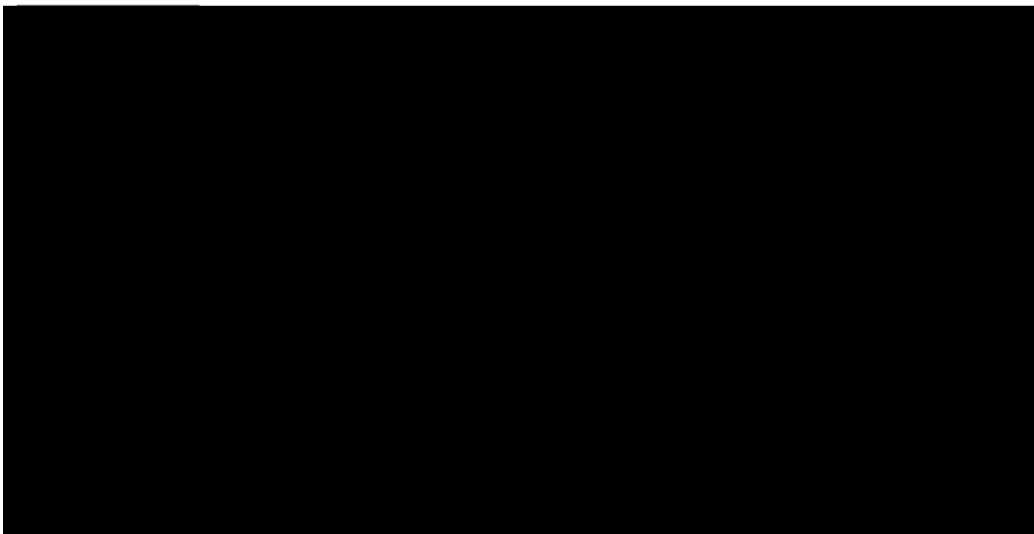
According to ERGEG (2009) Energy, efficiency is one of the most cost-effective ways of reducing greenhouse-gas emissions. Smart metering is such kinds of technologies that can help to achieve this goal. Basically, with smart meters, consumers can be more accurately informed of their consumption mode, hence they will actively adjust their behavior to reduce their energy cost, for example; they can shift from suppliers to suppliers, from peak loads to be off-peak, thereby improving grid operation and future grid planning. Or at a broader picture, the reduction in peak load demand, which is satisfied mostly by fossil-fuel technologies, will possibly result in reduced CO<sub>2</sub> emission. [1]

This paper presents a smart proposed distribution system to detect illegal electricity consumption, by GSM based smart energy meter and a database installed at the central station. This helps in theft detection, billing and management purpose. The energy delivered by the distribution transformer will be measured by GSM based smart energy meter, and it will send this measured value to the Central station via GSM after a specified interval. The energy meter is made so smart that it can detect any kind of tampering. It will compare the phase and neutral current and will send a message via GSM to the central station if any tampering is detected. To detect whether any kind of illegal load is connected to distribution transformer, energy consumed by all consumers in a specified interval will sum up and compared with energy delivered by that transformer in that specified interval. Any difference found between both values will indicate the energy theft in that particular interval and vicinity.

## 2. BUILDING BLOCKS FOR DETECTION

### 2.1. GSM Based Smart Energy Meter

The main components of the GSM based smart energy meter are shown in the Figure below.



A smart meter is an electric meter that records the consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility for monitoring and billing purposes. [2]

Figure 1 shows the architecture illustration of the smart energy meter. These smart energy meters measure the active power consumed by the consumer with the help of Current Transformer (CT) and Potential Transformer (PT).

“The ADE7761 is a high accuracy, fault tolerant, electrical energy measurement IC intended for use with 2-wire distribution systems. The part specifications surpass the accuracy requirements as quoted in the IEC61036 standard. The only analog circuitry used on the ADE7761 is in the ADCs and reference circuit. All other signal processing (such as multiplication and filtering) is carried out in the digital domain. This approach provides superior stability and accuracy over extremes in environmental conditions and over time. The

ADE7761 incorporates a fault detection scheme similar to the ADE7751 by continuously monitoring both the phase and neutral currents. A fault is indicated when these currents differ by more than 6.25%". [3]

The ADE 7761 is an intelligent IC use to measure both the phase current and the neutral current. In case of the illegal act i.e. stopping meter by some illegal means the ADE 7761 detects only the phase current and no neutral current. The micro controller is used for the controlling purpose and also to store the reading of the power consumed by the consumer. The relay and circuit breaker are used to disconnect the supply to the consumer in case of an illegal act when the ADE 7761 messages tremendously detect, and the micro controller sends a signal to it. The LCD unit shows the readings of the energy consumed by the consumer. The GSM transceiver is used for the two-way communication b/w smart meter and central base station. This smart meter will send readings with specified interval of time and also send SMS in case of illegal acts by the consumer. Besides this we have certain more properties of these smart meters.

- These meters are able to send the total reading of the unit at the end of the month either by itself or by sending a message from the central base station.
- When the control unit opens the circuit breaker, the SMS will send to the base station after the action taken against the consumer. The SMS will send from the base station towards the smart meter to close the circuit breaker.

In 2009, the United Kingdom, the Department of Energy and Climate Change announced its intention to have smart meters in every home (approximately 22 million gas and 26 million electricity meters) by 2020. <sup>[4][5]</sup> Similar plans exist in many other European nations.

## 2.2. Communications through GSM:

Global System for Mobile Communications (GSM) is the world's most well accepted standard for mobile telephony systems GSM is used by over 1.5 billion people across more than 212 countries and territories. GSM also pioneered a low-cost (economical) implementation of the short message service (SMS) which allows parties to exchange delayed tolerant short text messages. The popularity and wide coverage of cellular networks have attracted researchers to consider the use of the SMS service.

Though there are certain questionable issues concerning GSM network such as its scalability, reliability and security, especially under high load. SMS messages are generally treated as lower-priority traffic than voice, and various studies have shown that around 1% to 5% of messages are lost entirely, even during normal operating conditions, [6] and others may not be delivered until long after their relevance has passed, [7] Using SMS for AMR service will definitely increase the flow of messages tremendously. This proposed distribution system will communicate the database station, and the specified whole distribution system with GSM technology used in the smart energy meters.

## 2.3. Automatic Meter Reading (AMR):

The proposed system contains GSM based smart energy meters, having the feature of automatic meter reading. A GSM based smart energy meter will be connected to the transformer secondary winding, which will measure the total output power going in the distributor. The measured value shall be sent via GSM to the central database station after a specified interval. Consumer's energy consumption will also be measured by a GSM based smart energy meter connected to service main of the specific consumer. The consumer energy meter will also send the measured value via GSM to the central database station after a specified interval. Both of sending values shall be compared by central database station (software). If any difference calculated (having tolerance of 6% to 10%) between both values, indicates illegal usage of electricity on a specific transformer in a specified interval of time.

## 3. DETECTION AND WORKING SYSTEM

The Proposed distribution system for theft detection shown in following Figure 2 is used for low voltage and limited consumer's distribution system. The system shown in Figure 2 belongs to only one distribution transformer network and should be repeated for every distribution network. In the Proposed distribution system, every consumer has a GSM based smart energy meter assigned to a specified address. These smart energy meters having featured sending to send their reading values to a central base station through GSM. Meters supporting automatic meter reading (AMR) can report demand to utilities automatically via communication Networks [8]. While in case of bypassing or neutral grounding it will detect that the consumer stopped the meter. It will stop the Power supply to the consumer by sending a signal, to operate the circuit breaker and then send SMS to the central station to charge the consumer for doing illegal acts. Similarly, this proposed distribution system also having a GSM based energy meter connected to the secondary winding of a distribution transformer; it will also send total reading value to the central base station. At the central base station, the system has a database software where both the readings from the transformer

(smart energy meter connected to the transformer), and the sum of the consumers' reading is compared. If any difference is calculated in both readings, then clearly there is an illegal connection on the particular distribution transformer. The sending operation of data from the consumer's meter and distribution transformer's meter is done after specified intervals of time. At the central base station, the database software will store the reading sent by each consumer's energy meter. This data will help, to know the behavior of the load of consumers. So it will be easy to distribute the load on the entire transformer equally.

Similarly, the central base station can order to retrieve the data from the consumer's meters and from the distribution meter by sending them, SMS. This will help in the billing process.

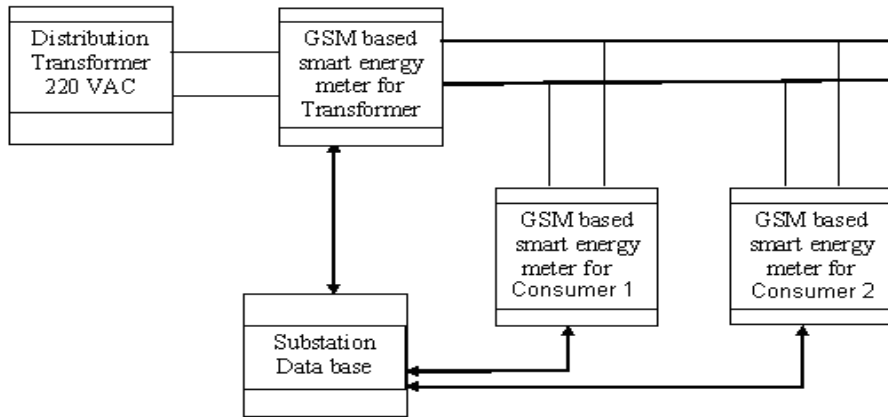


Figure 2. Schematic illustration of GSM Based Smart Distribution System

The above Figure shows the schematic diagram of GSM based smart distribution system. Using GSM based smart energy meter for automatic meter reading. It will send, SMS in case of theft (bypassing the energy meter or neutral grounding). In the meantime, the Database will receive, store and compare both the data received from the consumer's smart energy meter and distribution transformer smart energy meter.

### 3.1. Consumer's Two Energy Meter is neutrally grounded:

In the Figure 3 of the proposed distribution system is shown, which mentions that the consumer two stopped his energy meter by Neutral grounding. In this case, the meter will detect only the phase current and no neutral current. The ADE7761 integrates a novel fault detection that warns and allows the ADE7761 to continue to bill in case a meter is connected to one (phase) wire. However, a message will be sent to the central base station that the neutral is missing and there is an illegal act. So the control unit will send a signal to operate the circuit relay of the energy meter which will operate the circuit breaker and supply to consumer 2 will be disconnected. At the same time, SMS will be sent to the base station that supply has been disconnected. Now the supply companies will charge the same consumer for illegal activity.

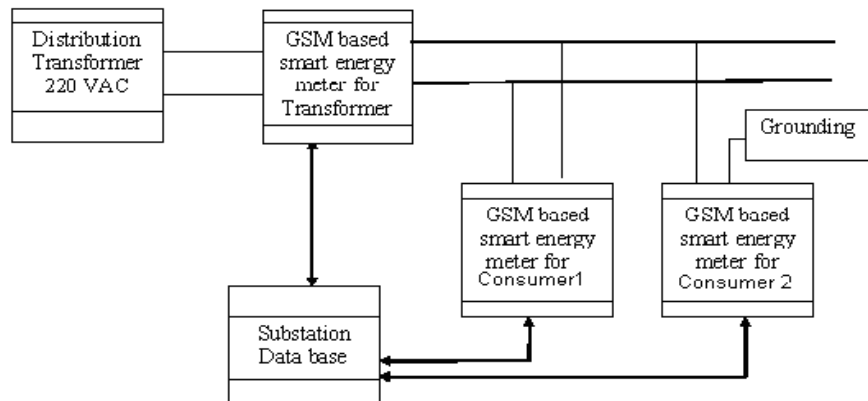


Figure 3. Schematic illustration of GSM Based Smart Distribution System (consumer's 2 energy meter with neutral grounded)

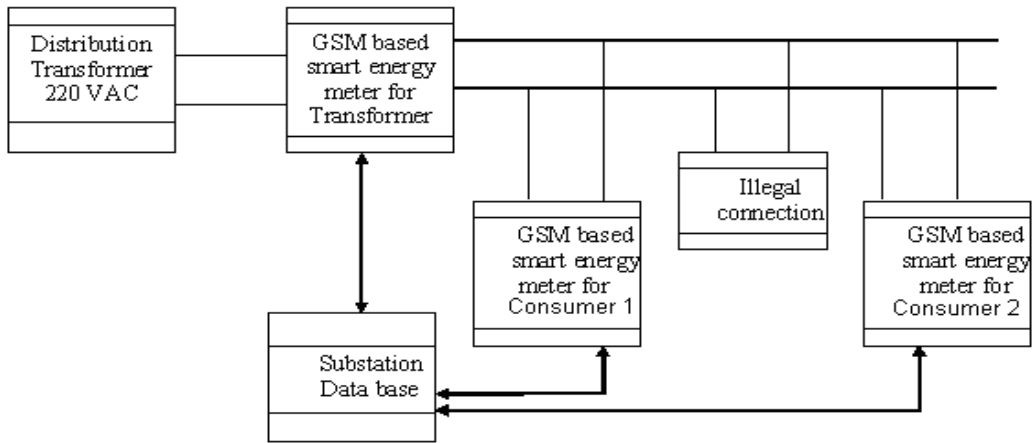


Figure 4. GSM Based Smart Distribution System (illegal connection taken direct from the distributor)

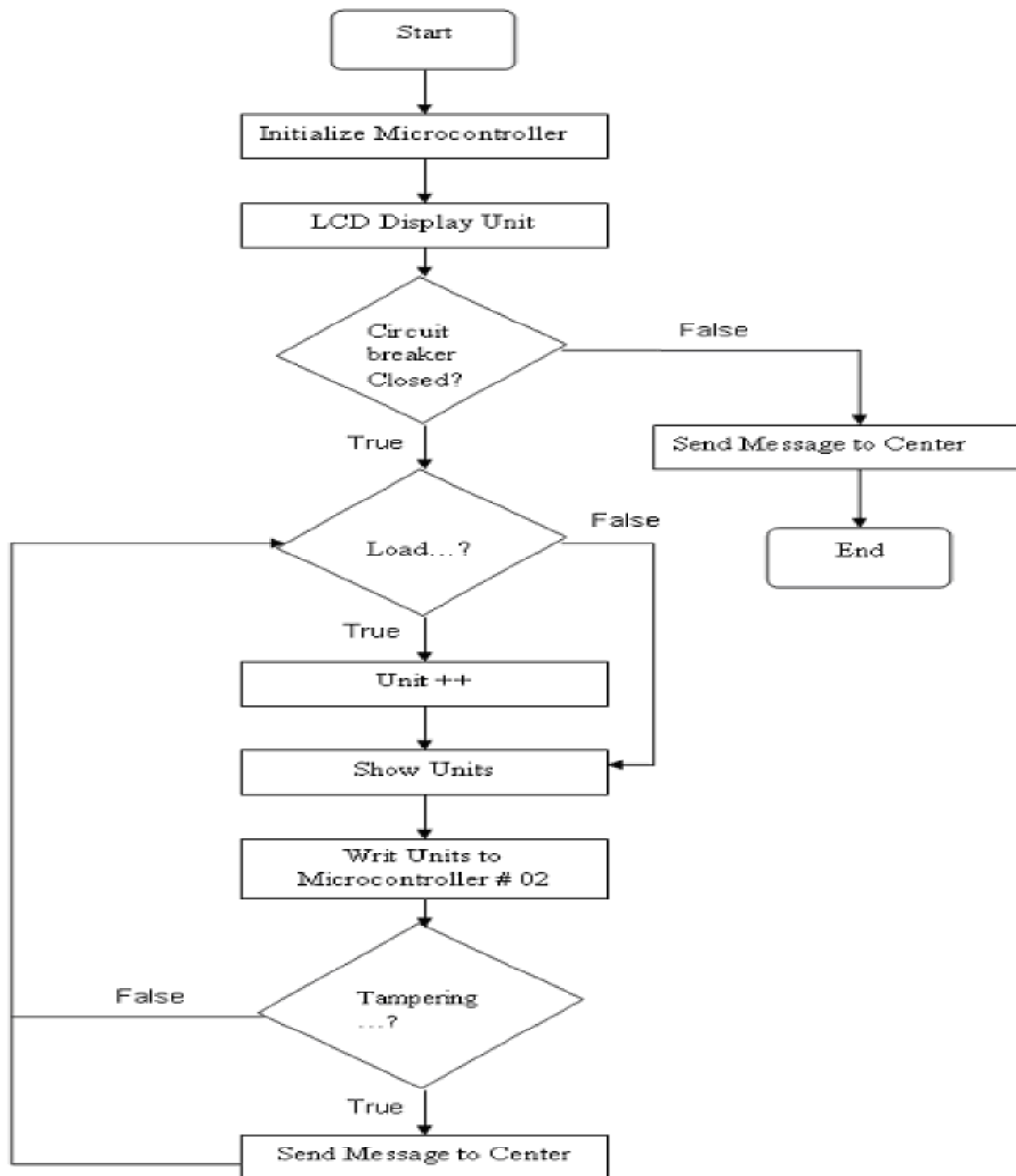


Figure 5. Flow chart for GSM Based Smart Energy Meter

### 3.2. Illegal Connection on The distributor

In Figure 4, the proposed distribution system is shown with an illegal connection mode. To detect this illegal connection of the distribution transformer, the readings will send by the entire consumer's energy meter to the central station (in database software). The smart energy meter connected to the transformer will also send the total reading value to the central base station (database software). Then the sum of the total consumer's reading will compare with the reading sent by the distribution transformer's energy meter. In case of illegal connection, these values will give any intolerable difference (more than 6% to 10% tolerance). If any difference (more than 6% to 10%) is calculated in between these two readings, then there is an illegal connection on that particular transformer. This whole process is done automatically with the help of database software installed at the central station and shows the results on the screen. This process is repeated for the whole time with the specified interval of times.

## 4. FLOW CHART FOR THE GSM BASED SMART ENERGY METER

Figure 5 show flow chart for the GSM based smart energy meter.

## 5. ADVANTAGES

After implementing this proposed distribution system, this system will have some advantages over the present distribution system. Some of them are given below.

- Eliminate Chances of Meter Tampering: This system uses GSM based smart energy meters with built in tamper with detection ability, which removes any chance of mechanical tampering.
- Decrease Meter Reading Costs: Since the load of traveling to read the energy meter reading are removed by using GSM technology, the costs are considerably reduced.
- Quick Determination of Account Queries: As there can be no meter reading record errors, consumer objections will be less. On-line determination of account queries will be available to resolve consumer complaints.
- Enhanced Consumer Care Facilities: The consumer can get full details of his energy consumption as a database for every consumer is being conserved.
- Better Energy Management: Since the load arrangement of a particular area and consumers will be available through the Database, it will accelerate load shedding in the case of the energy shortfall. The system will enable relaxed energy audits.
- Decrease in Power Theft: Because of the actual time theft detection system, power thefts can be extremely decreased or removed.
- In this proposed system all power information can be collected at a centralized single point. Using the same transmitter permits the line voltage, line current and other measurements at various points to be examined by the centralized station. This data can be used in load shedding and fault analysis. The fault position can easily find out using this type of arrangement and fault clearance time can be considerably reduced, thereby increasing system reliability.
- By applying this kind of the remote monitoring system for collecting energy usage Figures through the SM; transmission losses can be acknowledged at the same time so that exactly where the loss is occurring can be identified. The other significant benefit of using this system is that a tampered energy meter can be rapidly sensed, and power pilferage can be decreased.

The country has lost power worth Rs90 billion during the calendar year 2010 on account of leakages and theft in power system derailing the efforts of government to address issues of load shedding across the country that has hit the economic growth. The lost electricity has also been cited as the major reason behind the circular debt that has plagued the entire energy chain. The loss of electricity worth Rs90 billion is in addition to the transmission and distribution losses allowed by National Electric Power Regulatory Authority (Nepra) up to 13-14 per cent during 2010 [9]. This system gives a basic idea for theft detection. Every transformer can be equipped with a meter that sends the meter readings to the authority. By comparing the number of outgoing units and the units consumed by the consumers in that particular area, a report can be generated. If there are any mismatches that is, the sum of the units consumed are less than the outgoing units, there is an energy theft at that location. This way theft can be detected, and preventive measures can be taken to avoid the same.

## 6. DISADVANTAGES

- The present energy billing system provides employment for nearly 8- 10 people in every distribution station

for jobs like billing, processing, etc.

- The presently installed energy meters should be either modified or replaced with the new GSM based smart energy meter, which consumes time, labor and money.

## 7. CONCLUSION

This proposed distribution system for theft detection using GSM based smart energy meter presented in this paper fascinate many advance studies in computer technology and communication technology. The meter reading job can be completed at the management department of residence area by using this system. Meantime, the energy resources Management divisions can monitor the utilization of power in order to advance the utility of power. Once this proposed distribution system is applied in the real life, the distribution losses in Pakistan can be decreased efficiently, and all possibilities of electricity theft will be eliminated. So tampering for electricity theft is impossible. Due to this distribution system, the congestion of the transformer is identified, eliminated, and load management is done easily. By using different tariff rates for peak hours, we can discourage the demand at peak hours.

## REFERENCES:

- [1] Yannick Perez<sup>1</sup> and Guanlan GUO<sup>2</sup>, "GSM Lessons for Smart Meters Standardization."
- [2] Federal Energy Regulatory Commission Assessment of Demand Response & Advanced Metering.
- [3] Energy Metering IC with On-Chip Fault and Missing Neutral Detection.
- [4] DECC Smart electricity and gas meters.
- [5] "New smart meter plan is unveiled." BBC News. 2009-05-11. Retrieved 2010-05-23. [www.datasheetcatalog.org].
- [6] Analysis of the Reliability of a Nationwide Short Message Service [citeseerx.ist.psu.edu].
- [7] Monitoring SMS Delivery Reliability. [www.mobileactive.org].
- [8] Stephen McLaughlin, Dmitry Podkuiko, and Patrick McDaniel, "Energy Theft in the Advanced Metering Infrastructure".
- [9] Zafar Bhutta, "Leakage and theft: Power worth Rs90 billion lost". January 12, 2012.

## BIBLIOGRAPHY



Muhammad Ilyas Afridi  
BE. Electrical (power), 8th Semester.  
Sarhad University of Science and Information Technology Peshawar Khyber PakhtunKhwa  
Pakistan  
Email Address: [enr\\_miafridi@yahoo.com](mailto:enr_miafridi@yahoo.com)



Shah Faisal  
BE. Electrical (power), 8th Semester.  
Sarhad University of Science and Information Technology Peshawar Khyber PakhtunKhwa  
Pakistan  
Email Address: [nangyal\\_afkar@yahoo.com](mailto:nangyal_afkar@yahoo.com)



Hikman Ud Din Bangash  
BE. Electrical (power), 8th Semester.  
Sarhad University of Science and Information Technology Peshawar Khyber PakhtunKhwa  
Pakistan  
Email Address: [enr\\_hikmanuddin@yahoo.com](mailto:enr_hikmanuddin@yahoo.com)



Engr. Qazi Waqar Ali  
Lecturer EED, Sarhad University of Science and Information Technology Peshawar Khyber  
PakhtunKhwa Pakistan  
M.Sc Electrical Power, University of Engineering And Technology Peshawar KPK Pakistan  
Email Address: engr\_qazi@yahoo.com



Engr. Arsalan Arif  
Assistant professor/Coordinator  
EED Sarhad University of Science and Information Technology Peshawar KPK Pakistan  
M.Sc Control System, Hanyang University Korea.  
Email Address: arsalanarif92@gmail.com