# Assessing introduction of prepaid gas meters for domestic users and its viability in Bangladesh:

## *A case of Titas Gas Transmission and Distribution Company Limited*


Submitted by:

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**MPSM, Batch No. 15**

**ID No.: 17382017**


*Summer 2018*


**BRAC Institute of Governance and Development (BIGD)**

**BRAC University**


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# Declaration

I hereby declare that the dissertation entitled "Assessing introduction of prepaid gas meters for domestic users and its viability in Bangladesh: *A case of Titas Gas Transmission and Distribution Company Limited*", submitted to BRAC Institute of Governance and Development, BRAC University for the degree of Masters in Procurement and Supply Management (MPSM) is exclusively my own and original work. No part of it in any form, has been submitted to any other university or institute for any degree, diploma or for other similar purposes.

Dhaka, 8 April 2018

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# Abstract

Bangladesh has limited resources of Natural Gas and it will not last if not used cautiously.
In Bangladesh, Gas consumption of domestic customers is not metered and they are not cautious about the gas usage. Prepaid meter will ensure that customers will not waste gas as they have to pay for the exact amount of gas they use.

Natural Gas is distributed to the customer through quite a few distribution companies in Bangladesh, among them Titas Gas Transmission and Distribution Company Limited (TGTDCL) is the largest. Prepaid Gas meter was first introduced in Bangladesh in 2004 at Banani Residential Area which is under TGTDCL franchise area.

This study examines how and up to what extent natural gas wastage in domestic customer premises of TGTDCL can be reduced by the implementation of pre-paid gas metering system. Pre-paid gas metering system is a new concept in Bangladesh. This study also examines whether this system is acceptable to TGTDCL domestic customers or not. This study also examines the financial and economic viability of implementing pre-paid gas metering system in TGTDCL.

In the study it was found that significant amount of gas is saved by the implementation of pre-paid metering system in domestic customer premises and this saved gas can be used by industrial or commercial customers, which results increase in TGTDCL revenue. Domestic Customers also welcomed this new concept as it reduced their utility costs if they use it cautiously. Some customers are not willing to use this system as recharging points of prepaid gas meter cards are far away from their home, some customers are not happy with TGTDCL service. TGTDCL also benefited by the system as there is no outstanding bills. It was also found in the study that though it is not financially viable for TGTDCL to implement this system, it is economically viable for the organization.

As, there is a huge gap in demand and supply of natural gas in Bangladesh, Prepaid gas meter should be introduced to reduce wastage in the domestic customer premises. TGTDCL should give more emphasis on prepaid customer service and also they need to increase more recharging points in order to buy in customers into prepayment system.

**Key words:** Natural gas, Pre-paid gas metering system, TGTDCL

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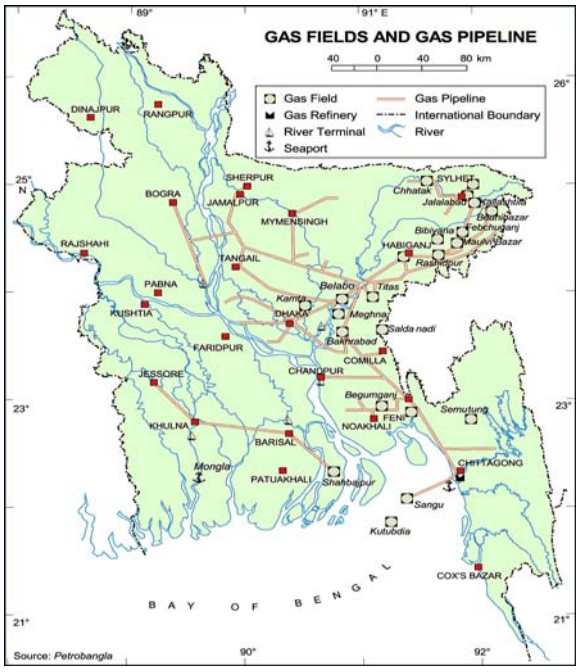
# *Chapter 1*

# Introduction

## 1.1 The Context for the Study

Bangladesh is a natural gas producing country. Natural gas is a non-renewable source of energy. Presently, the natural gas producing fields of this country are located in the northeastern and eastern part of the country and the gas is piped through the transmission and distribution pipelines. Map 1.1 demonstrates gas fields and gas transmission pipelines across the various parts of the country.

Map 1.1: Gas Fields and Gas Pipeline in Bangladesh




Source: http://www.thebangladesh.net/gas-fields-gas-pipeline-of-bangladesh.html#map-1

### 1.1.1 Genesis of Titas Gas Transmission and Distribution Company Limited (TGTDCL)

The discovery of a large gas field on the bank of the Titas River in Bhramanbaria in 1962 provided new opportunities for the utilization of natural gas. With an aim to ensure the proper utilization of the extracted gas, the Titas Gas Transmission and Distribution Company Limited (TGTDCL), popularly known as 'Titas Gas' was established on November 20, 1964 (Titas Gas Transmission and Distribution Company Limited [TGTDCL], 2016). The Company began its commercial operation with the commissioning of gas supply to Siddhirganj Thermal Power Station on April 28, 1968 after construction of 14 inch dia 58 mile long Titas-Demra gas pipeline by the then East Pakistan Industrial Development Corporation. In October 1968, domestic natural gas connection was inaugurated with providing the connection to the residence of renowned litterateur Shawkat Osman (ibid). As a national organization, the TGTDCL has earned the glory of being a trustworthy organization for the people by the quality of service delivery. This has been possible because of the relentless and cordial endeavours of its officials and employees.

### 1.1.2 Role of Titas Gas in national economy

Titas Gas is playing a significant role in strengthening the socio-economic condition of Bangladesh, even pioneering in saving foreign currency by ensuring expected use of natural gas. As a leader among gas distribution companies, contribution of Titas Gas to the Bangladesh Economy is as evident as its eternal flame to the total economy of the country. In the beginning, 90 per cent of its shares belonged to the then Pakistan Government and the rest was owned by the Pakistan Shell Oil Company (TGTDCL, 2016). Under the Nationalization Order of 1972, all the Government owned shares of the Company were vested in the Government of Bangladesh (GOB). In accordance with an agreement signed between Shell Oil Company and GOB on August 9, 1975, the rest of the ownership 10 per cent shares was transferred to the GOB through Petrobangla in exchange for a lump-sum payment of £ 1,00,000 (ibid). After the independence of Bangladesh in 1971, the Company started its journey as a Company of Petrobangla with the authorized and paid up capital of Tk.17.8 million. At present, the authorized and the paid up capital of the Company are Tk. 20 billion and Tk. 9.89 billion respectively (ibid). Main objective

of the Company is to supply natural gas to customers of different categories under Titas Franchise Area (Map 1.2), thereby reducing dependency on imported liquid fuel. Towards this end, the Company has to construct, operate and maintain pipelines, stations and associated facilities. Currently, the Company provides gas supply in the districts of Dhaka, Narayanganj, Narsingdi, Munshiganj, Manikganj, Gazipur, Tangail, Mymensingh, Jamalpur, Sherpur, Netrokona, and Kishoreganj.

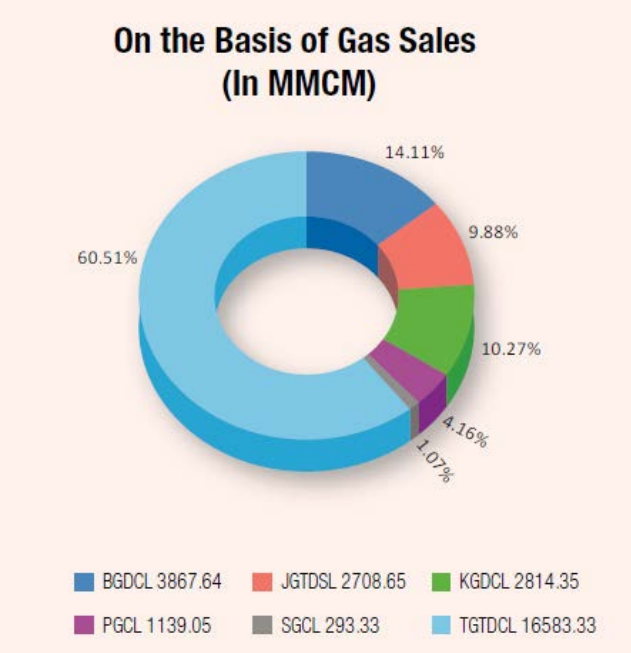
Map 1.2: Titas Franchise Area


Source: TGTDCL, 2015: Page 4.

Titas Gas Transmission and Distribution Company Ltd. (TGTDCL) is the biggest gas marketing company in Bangladesh and only marketing company who also owns substantial length of transmission line with the largest distribution network. It has almost 60.51 per cent market share in the country (Figure 1.1). Other gas marketing companies in the country include Jalalabad Gas Transmission & Distribution System Ltd (JGTDSL), Bakhrabad Gas Distribution Company Ltd

(BGDCL), Paschimanchal Gas Company Ltd (PGCL), Karnaphuli Gas Distribution Company Ltd (KGDCL) & Sundarban Gas Distribution Company Ltd (SGCL).

**Figure 1.1: Market share of different gas distribution companies in Bangladesh**

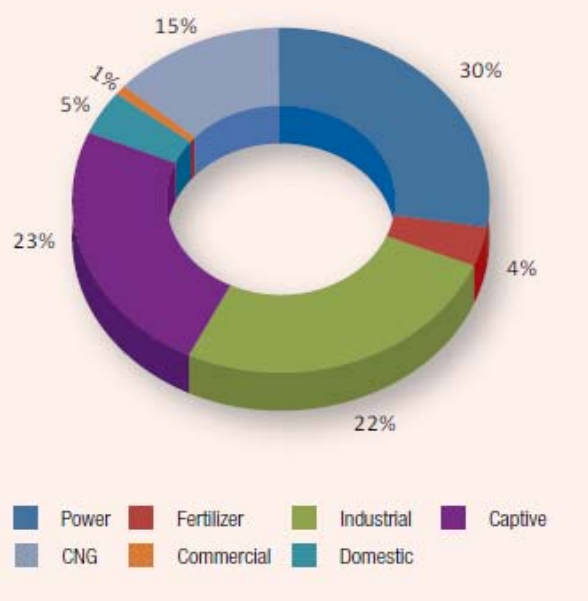



Source:TGTDCL, 2016:Page 56

TGTDCL is getting gas mainly from Titas gas field, Bakhrabad gas field, and also from GTCL Transmission line which is fed from other gas fields like Habiganj, Beanibazar, Rashidpur etc. and IOC gas fields in Bangladesh(Final report on Supply Efficiency Improvement of TGTDCL by Pegasus International (UK) Limited, September 2013: page 5: para 3).

Titas operates its own 12 to 16-inches main transmission pipe lines. They distribute the gas to the various types of consumers like the power, fertilizer, industrial, CNG, captive power, commercial and domestic (Final report on Supply Efficiency Improvement of TGTDCL by Pegasus International (UK) Limited, September 2013: page 5: para 3). Figure 2 shows the shares of Titas gas consumed by various sectors.

**Figure 1.2: Customers of TGTDCL on the basis of gas consumption**




Source: TGTDCL, 2016: page 56

TGTDCL is trying its best to serve the nation to ensure efficient utilization of gas supplied to households, commercial establishments, industrial concerns, CNG stations, power, fertilizer and captive power consumers. The company is playing an important role in the national economy by giving large amounts of revenue to the government of Bangladesh.

### 1.1.3 Introduction of prepaid meters to measure gas usage

All the gas usage were metered by TGTDCL except for the domestic use (Pegasus International (UK) Limited, 2013). Domestic users pay their bills on a flat rate basis, irrespective of the volume of the gas consumed. Up to June 2016, it has 2.06 million domestic connections which consume 15 per cent of the total gas sales (TGTDCL, 2016). It has been observed from several studies that domestic customers within Titas Franchise Area use gas inefficiently which causes wastage ( Pegasus International (UK) Limited, 2013). As the domestic connections are not metered, there is scope for dishonest customers to use unauthorized extra appliances and thus steal precious natural gas. This is one of the major factors which contribute to the system loss of this non-renewable energy resource. Therefore, introduction of gas metering is a tool to address

such wastage and pilferage of gas at domestic level. In prepaid metering arrangement, customers will have to pay in advance to get gas; accordingly, they will be aware about the wastage of gas and pilferage of gas could be checked. Considering these factors the Government of Bangladesh, with the help of Asian Development Bank (ADB) and Japan International Cooperation Agency (JICA), has implemented prepaid metering projects in TGTDTCL. It is assumed that this prepaid metering system will create awareness among the customers and also place a check on dishonest motives. In this way, the prepaid metering system is assumed to enhance supply efficiency, reduce system loss and wastage of gas in order to contribute to the conservation of energy vis-a–vis national energy security. TGTDCL has already installed 4,500 prototype pre-paid meters at Lalmatia and Mohammadpur, developed and supplied by the Institute of Information and Communication Technology (IICT) and the Bangladesh University of Engineering and Technology (BUET), and also installed 8,600 pre-paid gas meters in Mohamadpur and Lamatia area under another pilot project funded by ADB. Furthermore, JICA is also funding a project of installing 200,000 prepaid gas meters in Dhaka North City Corporation (ibid). It is expected that the pre-paid metering will enable to reduce wastage of precious natural gas and also revenue collection will be enhanced as customer will pay first before usage.

## 1.2 Research Objectives

The main objective of this study is to assess the effectiveness of the introduction of prepaid meters in addressing the wastage, its acceptability to domestic customers and economic and financial viability to implement the initiative Built on this broad objective, the study plans to answer the following questions:

1. To what extent the wastage of gas usage in customer premises can be reduced through the implementation of pre-paid metering system in the domestic level?
2. To what extent the pre-paid metering system is acceptable to the domestic customers
3. Is the implementation of prepaid gas metering system in TGTDCL is economically and financially viable?

# *Chapter 2*

# Literature review

## 2.1 What is Natural Gas?

As per American Gas Association (AGA), natural gas is a combustible, gaseous mixture of simple hydrocarbon compounds, usually found in deep underground reservoirs formed by porous rock. Natural gas is a fossil fuel composed almost entirely of methane, but does contain small amounts of other gases such as ethane, propane, butane and pentane. The prevailing scientific theory is that, natural gas was formed millions of years ago when plants and tiny sea animals were buried by sand and rock. Layers of mud, sand, rock and plant and animal matter continued to build up until the pressure and heat from the earth turned them into petroleum and natural gas. Like other forms of heat energy, natural gas is measured in British thermal units or Btu. One Btu is equivalent to the heat needed to raise the temperature of one pound of water by one degree Fahrenheit at atmospheric pressure (citation). Three segments of the industry are involved in delivering natural gas from the wellhead to the consumer. Production and Exploration companies explore, drill and extract natural gas from the ground. Transmission companies operate the pipelines that link the gas fields to several cities and industrial areas where natural gas will be used. Distribution companies are the local utilities that deliver natural gas to the end customer. Natural gas is used in residential, commercial and industrial applications. The use of natural gas is also rapidly increasing in power generation. Natural gas is the cleanest burning fossil fuel, producing primarily carbon dioxide, water vapor and small amounts of nitrogen oxides.

## 2.2 History of Natural Gas in Bangladesh

The British Raj-era province of Eastern Bengal and Assam was one of the world's earliest petroleum producers due to the discovery of oil and gas deposits in Assam, which

included Sylhet region. The Indo-Burma Petroleum Company drilled the first oil wells in Eastern Bengal between 1908 and 1914 in Chittagong (Wikipedia, 2018). The Burmah Oil Company discovered the first gas field in East Bengal in the year 1955 and industrial use of natural gas began in 1959. The Shell Oil Company and Pakistan Petroleum discovered seven gas fields in the 1960s (ibid).

After the Independence War , the first government of Bangladesh led by Sheikh Mujibur Rahman, with Dr. Kamal Hossain as Minister of Energy, enacted the Bangladesh Petroleum Act in 1974. The government welcomed many international oil companies to explore energy sources in the country. It established Petrobangla as the national mineral resources corporation. Petrobangla accelerated exploration activities in 1980s and discovered nine gas fields. The Jalalabad, Maulvi Bazar, Bibiyana and Bangura-Lalmai gas fields were tapped in the 1990s by numerous multinational oil and gas companies which includes Shell and Unocal. In 2005 the assets of Unocal in Bangladesh were acquired by energy giant Chevron (ibid).

## 2.3 Prepaid Metering System

The term prepaid has been very much in news since the mobile revolution began in Bangladesh. Various factors have led to the genesis of prepayment metering concept in Bangladesh keeping in view the benefits that are going to accrue to all involved in the concept and its acceptance. Prepayment or pay as you go system is receiving more and more attention worldwide as utilities are looking at ways to improve customer service, improve their cash flow and minimize their risks. Figure 2.1 and 2.2 illustrates the typical pre-paid gas meter.

**Figure 2.1: Prepaid Gas Meter**


**Figure 2.2: Prepaid gas meter at customer premises**

The concept of prepaid remains the same but there is going to be a paradigm shift in the application. This will in the days to come, open up new vistas for investment and deployment of infrastructure for better customer services. There will be immense benefits, which will be reaped by the utility companies and customers. Prepayment metering system is very simple. The consumer has a new kind of meter installed in his house which has an inbuilt disconnecting device. The customer buys natural gas in advance by paying at any of the vending office. Once the amount is exhausted the meter automatically disconnects the supply after providing an alarm. The consumer can reconnect himself by buying more natural gas and recharging the meter.

Historically, prepayment metering system dates back to over 100 years. The first prepayment meters were manufactured by General Electric (GE) in the year 1899 which were coin operated similar to the coin operated telephone booths. Technological advancement saw new generation of prepayment meters using magnetic cards and then smart cards. The latest generation of prepayment meters uses keypad technology, wherein there is a telephone like keypad on the meter for recharging.

## 2.4 Pre-payment system in different countries

Geographically, prepayment meters have been deployed across the globe. Prepaid meters for utilities have a long history of use in England dated back to the coin-in-the slot meters that were used until the 1980s, then replaced by meters using tokens, keys or cards which overcame many problems with coin-in-the slot meters. Following the advent of the newer technology the numbers of prepayment meters in United Kingdom (UK) began to rise- for example, from around 2 million electricity prepayment meters to 3.6 million in 1997(Owen and Ward, 2010). Gas prepayment meter numbers are raising substantially in the UK. In Australia prepayment meters are widely used in Tasmania, Northern Territory (mainly in Aboriginal communities) and South Australia. In Tasmania around 20 per cent of electricity customers prepay for electricity this way (The Allen Consulting Group, 2009).

## 2.5 Introduction of prepayment system in Bangladesh

Prepayment system was first introduced in the power sector in Bangladesh. In June of 2001, a Bangladesh University of Engineering and Technology (BUET) project on prepayment scheme was awarded first prize in a world wide design competition organized by International Application Society (IAS) of Institute of Electrical & Electronic engineers (IEEE) held in Chicago, USA (https://www.desco.org.bd/index.php?page=pre-paid-meter). Dhaka Electricity Supply Company (DESCO) quickly extended its financial help to lead this venture of achievement in the form of commercial meter. On this regard BUET has developed the design and the prototype of the commercial form of the running 'Pre-Paid Meter' to the consumer end. In order to facilitate continuous supply of pre-paid meter in future, DESCO had set up a "Pre-paid meters Production Unit" with the technical assistance of IICT, BUET at Mirpur. In First phase 5000 single phase meters were supplied by BUET. In the following two phases, 5000 meters and 1000 meters were produced in DESCO's own production house. All the meters were installed in Uttara residential area. Presently, production of 12000 meters is going on which will be installed in Uttara residential area. Planning for production of another 100,000 pre-paid meter is almost complete which will be installed in other residential area like Gulshan, Banani, Mirpur and Baridhara (https://www.desco.org.bd/?page=pre-paid-meter). Government

of Bangladesh is giving high priority to this prepayment system and is planning to have nationwide prepaid electric metering system by 2021 (News Today, 2017).

### 2.5.1 Prepayment System in gas sector in Bangladesh

Prepayment system in gas sector is first introduced in Bangladesh in 2004 in Banani residential area. One thousand domestic customers of Titas Gas Transmission and Distribution Co. Ltd. (TGTDCL) were given prepaid gas meters on pilot basis. The project was not successful as most of the meters went out of order within two years and eventually the all meters were withdrawn from customer premises. Influenced by the success of DESCO prepaid meter project, TGTDCL in collaboration with IICT, BUET implemented a project of installing 4500 prepaid gas meter in Lalmatia and Mohammadpur residential areas in 2012 (TGTDCL, 2012). Another project was taken by TGTDCL with the financial aid from Government of Bangladesh (GOB) and Asian Development Bank to install 8600 prepaid gas meters in Mohammadpur and Dhanmondi residential areas. Currently, JICA is funding two projects of prepaid gas metering system one in Dhaka and another in Chittagong. In Dhaka, TGTDCL is going to install 200,000 prepaid gas meters in its service areas and in Chittagong, Karnafully Gas Transmission and Distribution Co. Ltd. (KGTDCL) is going to install 60,000 prepaid gas meters (https://kgdcl.gov.bd/project-summary/).

## 2.6 Benefits of using prepayment systems

In the various reports and discussions the following benefits for utility companies from prepaid metering are cited:

- Upfront payment for natural gas: Energy is paid for before it is consumed. This is in contrast to the current arrangement of flat rate billing. The benefits will lie in earlier cash flow for utility companies.
- No unpaid bill: Since energy bills are prepaid, there will be no burden for collection of arrears and hence unpaid bills will be no more.

- Lower overheads: As there is no meter reading, no billing, no bill generation, there is a gradual decrease in the overheads. This manpower of utility companies can be put for some further value added jobs like vigilance etc.
- Bad debt will be eliminated: As connection will be disconnected when a customer fails to recharge, there will be no chance of bad debt.

As like as the benefits of utility companies, there might be some benefits for the users as follows:

- Customers will control their gas usage and as a result there will be efficient budget management.
- Convenience of purchase credit through distributed points of sale and customers do not have to stand in long ques.
- There will be no cost for disconnection and reconnection,
- There will be display of remaining credit in the meter which helps customers to decide when he/she should go for recharge.

# *Chapter 3*

# Methodology

In order to respond the first research question (RQ1), the pre and post situation of prepaid metering situation in Dhanmondi and Mohammadpur were examined. Data was collected from Titas Gas Prepaid Meter Cell office for this comparison. Then, historical gas usage of 42 domestic prepaid meter users for about one year were analyzed thoroughly to determine the savings potential by using of prepaid gas meter. In addition, tariffs paid by customers before and after introduction of prepaid meters were analyzed to assess financial benefits for both users and supplier. The time duration was chosen from March 2016 to February 2017 as during that time flat rate gas tariff was fixed at 650 BDT. Details of 42 customers are provided in Appendix 1.

For RQ2, a questionnaire survey was administered among 42 customers regarding impact of prepaid meters on their gas usage, gas conservation, awareness customer service of Titas, vending stations etc. Questionnaire is given in Appendix 2.

RQ has been addressed through collecting data from the Planning Department of TGTDCL and also from the “Installation of Pre-paid Gas Meter for TGTDCL” project office. Based on data collected financial and economic analyses were carried out to determine the financial and economic viability of the installing pre-paid gas meter.

# *Chapter 4*

# Findings

This chapter presents findings, which are organized under three themes such as addressing wastage, acceptability of prepaid meters by customers and financial and economic viability of prepaid meter.

## 4.1 Prepaid meter and addressing wastage of gas use at domestic level

### 4.1.1 Expenditures for gas usage in and after introduction of pre-paid metering system in the domestic level

In order to understand the extent of reduction of wastage, 42 customers' expenditures for gas usage before and after introduction of pre-paid meters have been analyzed. It is observed that there had been no change in case of one customer before and after introduction of pre-paid meters in households.

Out of 42 consumers, five had spent an average of Tk. 980 yearly more in pre-paid metering system than flat rate billing system. While a customer was required to pay an average of Tk. 7800 annually as gas bill, the same consumer paid Tk. 8780 in a year after the introduction of pre-paid meter. These are detailed in Table 4.1. However, due to introduction of pre-paid meter in households, the government could earn more revenues i.e. Tk. 4900 in total during March 2016 – February 2017.

**Table 4.1: Customers who spent more in pre-paid metering system than flat rate billing**

| Customer no. | Customer ID | Total recharge in Mar. 2016 - Feb. 2017 (Tk.) | Total flat rate bills in Mar. 2016 - Feb. 2017 (Tk.) | Difference (Tk) |
|---|---|---|---|---|
| 1 | 0112300294814 | 9500 | 7800 | -1700 |
| 2 | 0112300504817 | 9000 | 7800 | -1200 |
| 3 | 0112300506718 | 8800 | 7800 | -1000 |
| 4 | 0112300731415 | 8500 | 7800 | -700 |
| 5 | 0112300672318 | 8100 | 7800 | -300 |
| **Total** | | **43900** | **39000** | **-4900** |
| **Average** | | **8780** | **7800** | **-980** |

Conversely, majority of the consumers had spent less in prepaid metering system compared to flat rate billing. Table 4.2 demonstrates that 36 consumers recharged an average of Tk. 5154.2 annually for using gas in respective households whereas the flat rate billing system required them to pay Tk. 7800 in the same year. This means that the consumers could save an average of Tk. 2645.8 annually.

**Table 4.2: Customers who spent less in pre-paid metering system than flat rate billing**

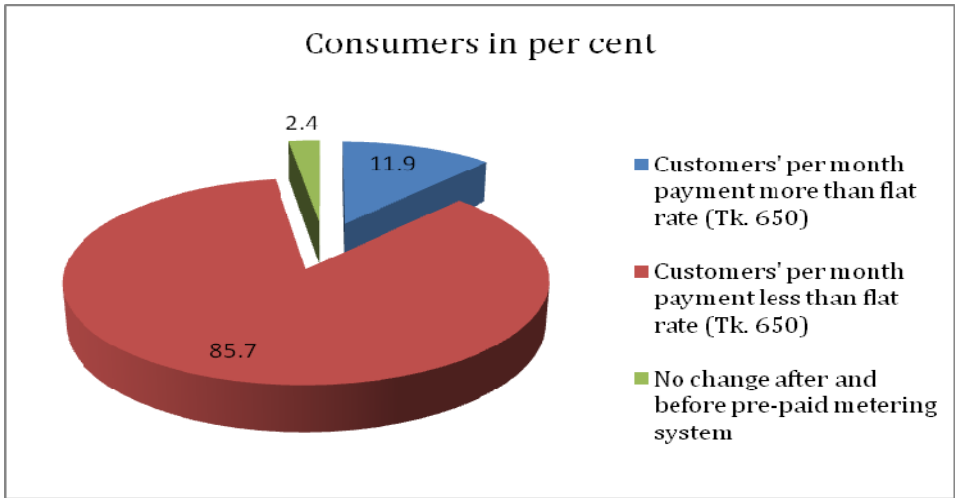
| Customer no. | Customer ID | Total recharge in Mar. 2016 - Feb. 2017 | Total flat rate bills in Mar. 2016 - Feb. 2017 | Difference (E-D) |
|---|---|---|---|---|
| 1 | 0112300882312 | 7600 | 7800 | 200 |
| 2 | 0112300591511 | 7500 | 7800 | 300 |
| 3 | 0112300639615 | 7500 | 7800 | 300 |
| 4 | 0112300750517 | 7100 | 7800 | 700 |
| 5 | 0112300972018 | 7000 | 7800 | 800 |
| 6 | 0112301196118 | 7000 | 7800 | 800 |
| 7 | 0112301212410 | 6600 | 7800 | 1200 |
| 8 | 0112300750811 | 6500 | 7800 | 1300 |
| 9 | 0112300809614 | 6500 | 7800 | 1300 |
| 10 | 0112401236711 | 6350 | 7800 | 1450 |
| 11 | 0112300294015 | 6000 | 7800 | 1800 |

| | | | | |
|---|---|---|---|---|
| 12 | 0112300991212 | 6000 | 7800 | 1800 |
| 13 | 0112300277117 | 5950 | 7800 | 1850 |
| 14 | 0112401237611 | 5950 | 7800 | 1850 |
| 15 | 0112300707014 | 5900 | 7800 | 1900 |
| 16 | 0112300844916 | 5500 | 7800 | 2300 |
| 17 | 0112301180414 | 5500 | 7800 | 2300 |
| 18 | 0112301051016 | 5000 | 7800 | 2800 |
| 19 | 0111401032915 | 5000 | 7800 | 2800 |
| 20 | 0112300690318 | 5000 | 7800 | 2800 |
| 21 | 0112300549514 | 4500 | 7800 | 3300 |
| 22 | 0112300543618 | 4500 | 7800 | 3300 |
| 23 | 0112300592411 | 4500 | 7800 | 3300 |
| 24 | 0112300503614 | 4500 | 7800 | 3300 |
| 25 | 0112300671115 | 4000 | 7800 | 3800 |
| 26 | 0112300512118 | 4000 | 7800 | 3800 |
| 27 | 0112300867517 | 4000 | 7800 | 3800 |
| 28 | 0112301080413 | 4000 | 7800 | 3800 |
| 29 | 0112300556016 | 4000 | 7800 | 3800 |
| 30 | 0112301211813 | 3800 | 7800 | 4000 |
| 31 | 0112300509418 | 3500 | 7800 | 4300 |
| 32 | 0112300905712 | 3500 | 7800 | 4300 |
| 33 | 0112300543012 | 3300 | 7800 | 4500 |
| 34 | 0112300868913 | 3000 | 7800 | 4800 |
| 35 | 0112301124311 | 2500 | 7800 | 5300 |
| 36 | 0112300849012 | 2500 | 7800 | 5300 |
| **Total** | | **185550** | **280800** | **95250** |
| **Average** | | **5154.2** | **7800** | **2645.8** |

While the introduction of pre-paid meters had brought financial benefits for the consumers, the government got deprived of mobilizing resources. In flat rate billing system the government could earn Tk. 95250 more during March 2016 – February 2017.

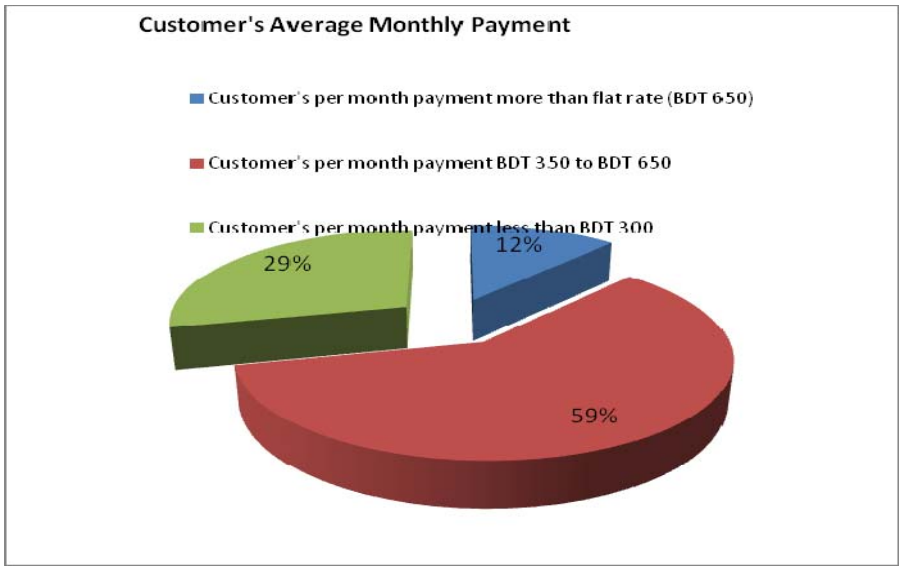
In sum, the expenditure profile of 42 consumers shows that 85.7 per cent paid less in pre-paid metering system than what they used to pay in flat rate. Only approximately 12 per cent users paid more than flat rate. Details are shown in Figure 4.1.

**Figure 4.1: Consumers payment status before and after prepaid meter**




It was also further revealed that 59 per cent customers spent Tk. 300 – Tk. 650 monthly and only 12 per cent spent more than flat rate Tk. 650 monthly after introduction of pre-paid metering system.

**Figure 4.2: Customers' monthly expenditure after pre-paid metering system**



Therefore, it has been demonstrated that installation of pre-paid gas meters at customers' premises is financially beneficial for them. .

### 4.1.2 Energy consumption by customers

Data from the Pre-paid Gas Meter Cell shows that average monthly consumption of a pre-paid customer of Dhanmondi and Mohammadpur residential area has been 61 cubic meters after installation of pre-paid meters. In contrast, prior to pre-paid meters, average monthly consumption of all domestic customers was 105 cubic meters (Annual Report of TGTDCL for the year 2015-16). This has two implications.

Firstly, pre-paid meters stopped revenue loss of Titas. On a flat rate basis, Titas was charging domestic customers considering that the said household will use maximum 87 cubic meters monthly for a double burner (Bangladesh Energy Regularity Commission, 2017 ). In reality, the household used 105 cubic meters monthly. Accordingly, the Company was losing almost Tk. 31 billion Taka annually (considering gas price for domestic metered customer as of 1 September 2015, which is 7 taka per cubic meter) by using flat rate mode in domestic customer billing.

Secondly, if we go for pre-paid metering, there will be a saving of 44 cubic meter natural gas per customer per month. If all the domestic customers of TGTDCL are brought under the coverage of pre-paid metering system, there will be a saving of 90.64 million cubic meter of natural gas, which can be used in other sectors like power, industrial, commercial, etc. worth Tk. 6.59 billion per month (considering weighted average gas price for all customers except domestic customers as of 1 September 2015, which is 7.27 taka per cubic meter).

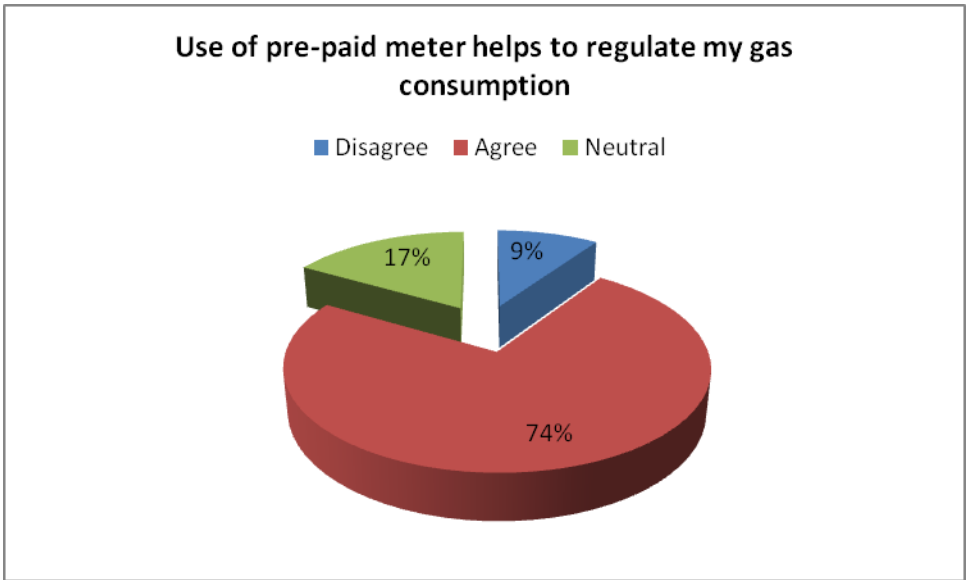
## 4.2 Customers' opinion regarding various aspects of pre-paid meters

In this study 42 customers' opinion regarding various aspects of pre-paid meters was collected and their feedback are summarized below.

### 4.2.1 Impact of pre-paid meter on reducing gas consumption by customers

About two-third customers said that pre-paid meters helped them regulate their gas consumption. At present, the prepaid customers don't use gas unnecessary and switch off their burners after use. Details are given in Figure 4.3.

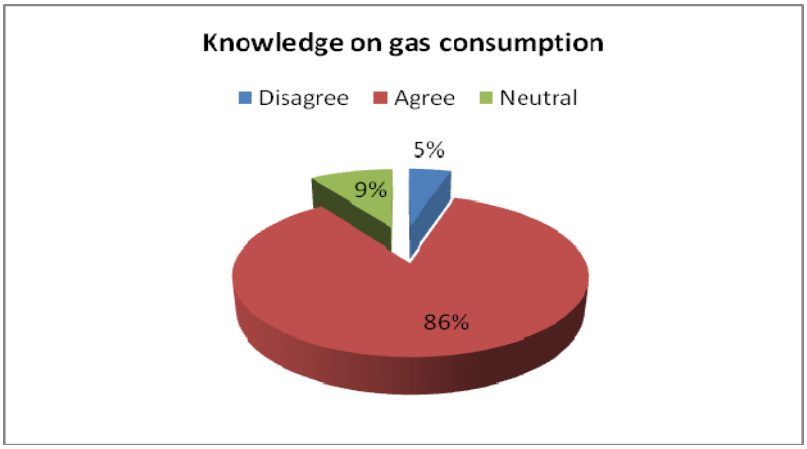
**Figure 4.3: Regulation of gas consumption due to prepaid meter**




### 4.2.2 Customers' better knowledge on gas consumption

Prepaid meter system improved customers' understanding regarding gas consumption. Figure 4.4 illustrates that 86 per cent customers agree with the statement that they have better knowledge of gas consumption after billing was converted to prepayment system.

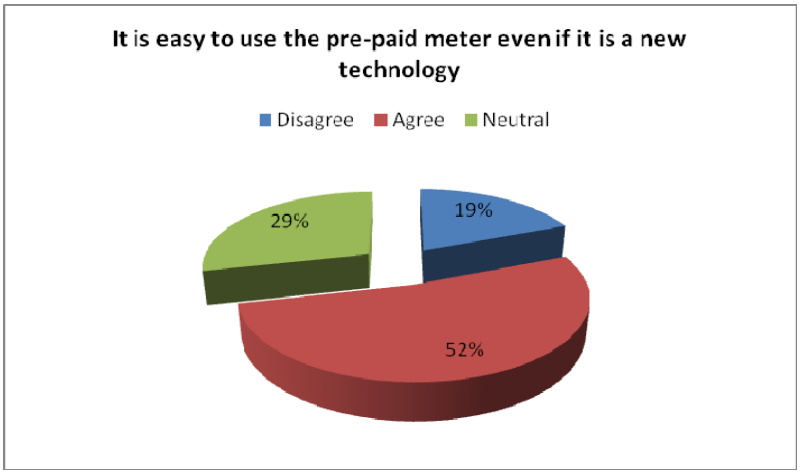
**Figure 4.4: Better knowledge on gas consumption due to prepaid meters**




### 4.2.3 Easy to use the pre-paid meter by customers

Despite the customers overwhelmingly acknowledged benefits of prepaid meter in terms of gas consumption and better energy use, 19 per cent respondents found this technology quite difficult to handle. In contrast, approximately half the respondents (52 per cent) found this system easy to manage. Figure 4.5 illustrates details.

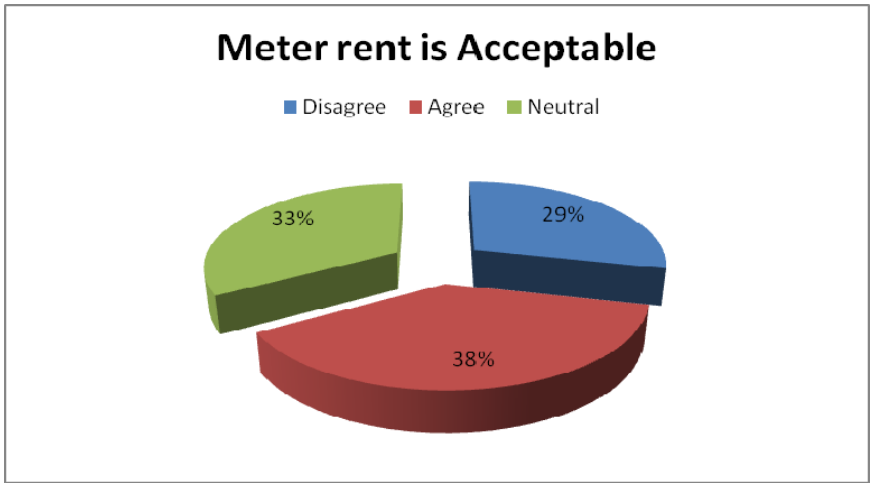
**Figure 4.5: Easiness in using prepaid meter**



### 4.2.4 Acceptability of prepaid monthly meter rents

Despite financial benefits of customers due to installation of prepaid meters, this prepaid meter monthly rent appear to be acceptable to only 38 per cent of prepaid consumers, that means 38 percent customer things meter rent TGTDCL in taking from the customers in justifiable with the customer service and facilities they give to the customer. Approximately one-third do not like prepaid meter monthly rent. Details are given in Figure 4.6.

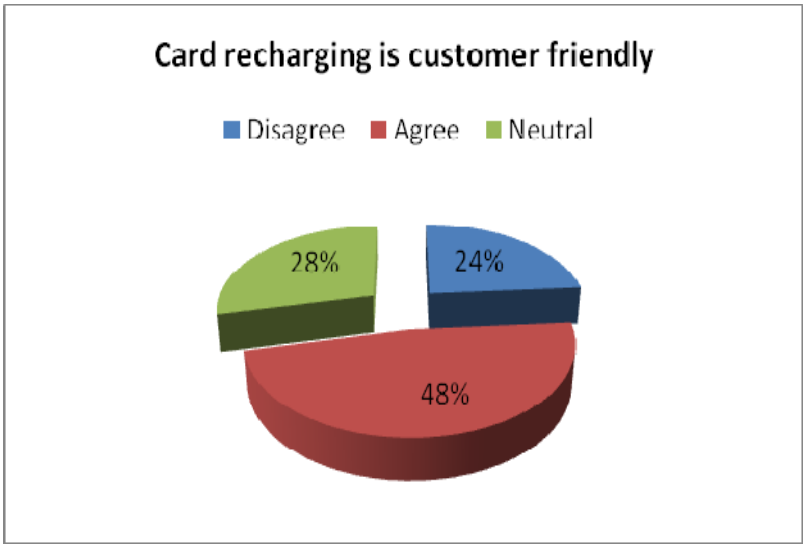
**Figure 4.6: Acceptability of prepaid monthly meter rents**




### 4.2.5 Customer friendliness of card recharging method

Around 48 per cent customers appreciated the card recharging method as customer friendly while 24 per cent customers think it was a quite difficult process to recharge the card (Figure 4.7).

**Figure 4.7: Customer friendliness of card recharging method**




### 4.2.6 Respondents' satisfaction regarding customer service from pre-paid meter cell

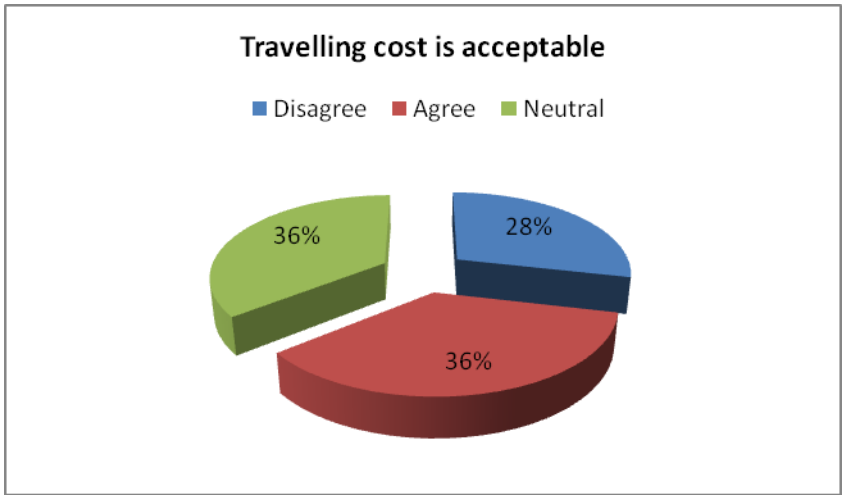
42 prepaid customers were asked to rate their satisfaction level towards customer service of prepaid meter cell of TGTDCL. It was revealed that most of the respondents remained neutral in this regard (Figure 4.8). 36 per cent consumers marked their service as unsatisfactory in opposed to 24 per cent respondents who rated this service satisfactory.

**Figure 4.8: Satisfaction towards customer service of pre-paid meter cell**

### 4.2.7 Travelling cost to vending station

It was found that travelling cost to vending station, which was in Dhanmondi Road no 27 (old) for the surveyed Dhanmondi customers and in Shamoly Square for surveyed Mohammadpur customers, was acceptable to 36 per cent customers. Around 36 per cent customers consider travelling cost high. Figure 4.9 shows the details.

**Figure 4.9: Acceptability of cost for travelling to vending station**




From the aforesaid description it can be said that although customers find out benefits from prepaid meter system, there is room for popularizing this system to the consumers. For instance, vending stations need to be decentralized within the easy reach of customers and customer services from Titas should be more customers-friendly.

## 4.3 Economic and financial viability of introduction of prepaid meter

To address research question “Is the implementation of prepaid gas metering system in TGTDCL is economically and financially viable?”, financial and economic analyses have been done.

### 4.3.1 Financial Analysis

Installation of prepaid meters involves two types of costs namely, capital or investment costs and operation and maintenance costs.

(a) According to the Development Project Proforma for Installation of Pre-paid Gas Meter Project by TGTDCL, investment costs for installing 200,000 pre-paid gas meters were estimated at Tk. 7121.2 billion; it means per meter installation capital cost is Tk. 35606.

(b) Operation and maintenance (O&M) costs: The estimated amount necessary for O&M works of the prepaid meter installation project excluding price escalation was estimated at approximately Tk. 35 million per year (Jica Survey Team, Year). Operating expenditures include personnel positioning and staff assignment, administration costs and spare parts. The breakdown of O&M costs is given in Table 4.3.

**Table 4.3: Breakdown of O&M costs for pre-paid gas meters for TGTDCL**

| Work Item | Annual cost/year (Tk) |
|---|---|
| Personnel positioning and staff assignment | 10,800000 |
| Administration costs | 20,500000 |
| Spare parts | 3,400000 |
| Total | 34,700000 |

Source: Japan International Cooperation Agency, 2014

Weighted Average Cost of Capital (WACC): The WACC represents the minimum rate of return at which a company produces value for its investors. Let's say a company produces a return of 20% and has a WACC of 11%. That means that for every 100 Taka the company invests into capital, the company is creating 9 Taka of value. To calculate the WACC, we consider the following assumptions

- Cost of Equity = 17 per cent p.a. (before tax)
- Equity／(Equity + Debt) = 14 per cent
- Debt Cost = 1 per cent p.a.

- Debt／(Equity + Debt) = 86 per cent
- Corporate Tax Rate = 27.5 per cent

Source: Japan International Cooperation Agency, 2014

Those assumed figures are inserted into the formulae to draw the output rates for WACC. is As a result of the above exercise, the weighted average of capital costs is 4.17 per cent before tax. The project will be deemed viable when the project financial internal rate of return (FIRR) is found above WACC rate (i.e. 4.17 per cent).

**FIRR on total investment cost:** To confirm the underlying financial viability or the true soundness of the project, the financial internal rate of return (FIRR) of the project was calculated. Prospective sources of revenues and expenditures heads for pre-paid gas meters are the followings.

**Revenue sources**: Gas sales revenue from domestic customers and other sectors by reducing the waste in gas usage and interest from tariff collection in advance due to installation of pre-paid gas meters.

**Expenditure heads:** Construction cost of pre-paid meter, project management cost, dispute board fee, executing agency's administration cost, taxes, IDC and operation and maintenance.

FIRR was calculated assuming 20 years of project life and for this period year-wise total costs and benefits with discount factors had been calculated which is given in Table 4.4.

**Table 4.4: Financial calculation for 20 years**

**(Tk.in Lac)**

| Project Life | Investment Cost (PV) | O&M Cost (PV) | Operating Cost (PV) | Total Cost (PV) | Total Benefit (PV) | Net Benefit (PV) | Discount Factor (12%) | Discounted Total Cost (PV) | Discounted Total Benefit (PV) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1956.64 | | | 1956.64 | 0.00 | -1956.64 | 1.0000 | 1956.64 | 0.00 |
| 2 | 7269.33 | | | 7269.33 | 0.00 | -7269.33 | 0.8929 | 6490.47 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 25579.99 | | | 25579.99 | 62.11 | -25517.89 | 0.7972 | 20392.21 | 49.51 |
| 4 | 36403.92 | 623.40 | 485.63 | 36889.55 | 901.43 | -35988.12 | 0.7118 | 26257.25 | 641.62 |
| 5 | | 659.02 | 513.38 | 513.38 | 2572.50 | 2059.12 | 0.6355 | 326.26 | 1634.87 |
| 6 | | 694.64 | 541.13 | 541.13 | 4412.89 | 3871.76 | 0.5674 | 307.05 | 2503.99 |
| 7 | | 765.89 | 596.63 | 596.63 | 5083.49 | 4486.86 | 0.5066 | 302.27 | 2575.45 |
| 8 | | 765.89 | 596.63 | 596.63 | 5332.71 | 4736.09 | 0.4523 | 269.88 | 2412.25 |
| 9 | | 801.51 | 624.38 | 624.38 | 5587.34 | 4962.96 | 0.4039 | 252.17 | 2256.63 |
| 10 | | 837.13 | 652.13 | 652.13 | 5847.37 | 5195.25 | 0.3606 | 235.16 | 2108.62 |
| 11 | | 872.75 | 679.88 | 679.88 | 6112.82 | 5432.94 | 0.3220 | 218.90 | 1968.16 |
| 12 | | 908.38 | 707.63 | 707.63 | 6383.69 | 5676.06 | 0.2875 | 203.43 | 1835.16 |
| 13 | | 944.00 | 735.38 | 735.38 | 6659.98 | 5924.61 | 0.2567 | 188.75 | 1709.45 |
| 14 | | 980.00 | 763.42 | 763.42 | 6941.71 | 6178.29 | 0.2292 | 174.96 | 1590.86 |
| 15 | | 1015.00 | 790.69 | 790.69 | 7228.88 | 6438.20 | 0.2046 | 161.79 | 1479.17 |
| 16 | | 1051.00 | 818.73 | 818.73 | 7521.50 | 6702.77 | 0.1827 | 149.58 | 1374.15 |
| 17 | | 1086.00 | 845.99 | 845.99 | 7819.57 | 6973.58 | 0.1631 | 138.00 | 1275.54 |
| 18 | | 1122.00 | 874.04 | 874.04 | 8123.11 | 7249.07 | 0.1456 | 127.30 | 1183.09 |
| 19 | | 1158.00 | 902.08 | 902.08 | 8432.12 | 7530.04 | 0.1300 | 117.31 | 1096.51 |
| 20 | | 1193.00 | 929.35 | 929.35 | 8746.61 | 7817.26 | 0.1161 | 107.90 | 1015.54 |
| | 71211.88 | **15478** | **12057** | **83267** | **103770** | **20503** | | **58377** | **28710** |

Here, Net Present Value @ 12 per cent DF is Tk. 29,66671000 (negative) and FIRR stands at 2.57 per cent, which is below WACC (4.17 per cent).. Therefore the Project is not regarded as financially viable. Again Net Present Value is negative after 20 years, so we cannot consider the Project viable.

**Sensitivity to FIRRs:** Separate analyses were carried out to examine the sensitivity of projected financial returns to adverse changes in key variables. The risks involved in the project in terms of financial viability are the future uncertainty of the initial investment costs and the exchange

rate between the local currency and the US dollar. Hence, the variables considered for the sensitivity analyses were as follows;

a) 10 per cent higher cost of eligible portion in initial investment cost
b) 20 per cent higher cost of eligible portion in initial investment cost
c) 10 per cent lower cost of eligible portion in initial investment cost
d) 20 per cent lower cost of eligible portion in initial investment cost

The results of the above sensitivity test are summarized in Table 4.5.

**Table 4.5 Results of sensitivity analysis on FIRR for prepaid meters**

| | **Scenario** | **Project FIRR (per cent)** |
|---|---|---|
| 1 | 10 per cent higher cost of eligible portion in initial investment cost | 1.52 |
| 2 | 20 per cent higher cost of eligible portion in initial investment cost | 0.64 |
| 3 | 10 per cent lower cost of eligible portion in initial investment cost | 3.70 |
| 4 | 20 per cent lower cost of eligible portion in initial investment cost | 5.01 |

The above sensitivity analysis reveals that the FIRRs, for 10 per cent and 20 per cent higher costs of the eligible portion and 10 per cent lower costs of the eligible portion are lower than WACC (4.17 per cent). Only 20 per cent lower costs of the eligible portion gives higher FIRR than WACC and in that case the project will be financially viable.

Detailed calculation of sensitivity test is given in Appendix 3a – 3d.

### 4.3.2 Economic Analysis

Further to the financial analysis of the project, an economic analysis was done to assess economic viability of the prepaid meter installation.

(a) Economic benefit: Reduction of gas usage, consequently the saving of gas, among domestic customers due to the introduction of a pre-paid metering system will increase the gas supply to other sectors, whereas the whole volume of gas supply to society will be constant from a national point of view. Hence, it will replace expensive imported energy such as crude oil and LNG.

The calculation for the economic benefit of the Project is as follows;

Economic benefit = (the saved gas volume) x {(imported LNG price) – (average gas price in Bangladesh)}

(b) Assumptions in the analysis are as follows

- Total 200000 meters will be installed
- Gas price in domestic Tk. 7 per cubic meter.
- Gas price in other sectors Tk. 7.27 per cubic meter.
- Weighted average gas price US$ 3.31 per mmbtu
- LNG price US$ 14.49 per mmbtu
- LNG price increase per annum .84 per cent
- Natural gas price increase per annum 8 per cent

**Economic Internal Rate of Return (EIRR):** Costs and benefits of pre-paid gas meters for economic analysis summarized as follows:

**Costs:** Construction cost of pre-paid meter, project management cost, dispute board fee, executing agency's administration cost and operation & maintenance (excluding taxes and IDC)

**Benefits:** Cost saving in replacing import energy. Reduction of gas usage, consequently the saving of gas among domestic customers due to the introduction of pre-paid metering system will increase the gas supply to other sectors, and it will substitute expensive import energy.

As like as FIRR, EIRR was calculated assuming 20 years of project life. Table 4.6 demonstrates values for economic analysis.

**Table 4.6: Economic calculation for 20 years**

(In Lac Taka)

| Yr | Cumm Installed Meter | Savings of gas in MMBTU | Cost inc. by LNG import | Cost incurred by natural gas | Eco. Ben. | Initial Investment Cost | Op. Cost/ annum | Total Cost | Net Benefit | DF (12%) | Dis Ecobenefit | Dis Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 1700 | | 1700 | -1700 | 1 | 0 | 1700 |
| 2 | | 0 | 0 | 0 | 0 | 5120 | | 5120 | -5120 | 0.8929 | 0 | 4572 |
| 3 | 4000 | 23613 | 281 | 78 | 203 | 17337 | | 17683 | -17480 | 0.7972 | 162 | 14097 |
| 4 | 49111 | 313530 | 3757 | 1096 | 2661 | 24657 | 346 | 25142 | -22481 | 0.7118 | 1894 | 17895 |
| 5 | 113778 | 961579 | 11615 | 3565 | 8050 | | 485 | 485 | 7565 | 0.6355 | 5116 | 308 |
| 6 | 178444 | 1725070 | 21005 | 6761 | 14244 | | 457 | 457 | 13787 | 0.5674 | 8083 | 259 |
| 7 | 200000 | 2234064 | 27420 | 9229 | 18191 | | 485 | 485 | 17706 | 0.5066 | 9216 | 246 |
| 8 | 200000 | 2361312 | 29212 | 10255 | 18957 | | 513 | 513 | 18445 | 0.4523 | 8575 | 232 |
| 9 | 200000 | 2361312 | 29442 | 10755 | 18687 | | 540 | 540 | 18147 | 0.4039 | 7547 | 218 |
| 10 | 200000 | 2361312 | 29672 | 11255 | 18417 | | 568 | 568 | 17849 | 0.3606 | 6641 | 205 |
| 11 | 200000 | 2361312 | 29902 | 11755 | 18146 | | 596 | 596 | 17550 | 0.3220 | 5843 | 192 |
| 12 | 200000 | 2361312 | 30131 | 12255 | 17876 | | 624 | 624 | 17252 | 0.2875 | 5139 | 179 |
| 13 | 200000 | 2361312 | 30361 | 12756 | 17606 | | 651 | 651 | 16954 | 0.2567 | 4519 | 167 |
| 14 | 200000 | 2361312 | 30591 | 13256 | 17335 | | 679 | 679 | 16656 | 0.2292 | 3973 | 156 |
| 15 | 200000 | 2361312 | 30821 | 13756 | 17065 | | 707 | 707 | 16358 | 0.2046 | 3492 | 145 |
| 16 | 200000 | 2361312 | 31051 | 14256 | 16795 | | 734 | 734 | 16060 | 0.1827 | 3068 | 134 |
| 17 | 200000 | 2361312 | 31281 | 14756 | 16525 | | 762 | 762 | 15762 | 0.1631 | 2696 | 124 |
| 18 | 200000 | 2361312 | 31511 | 15257 | 16254 | | 790 | 790 | 15464 | 0.1456 | 2367 | 115 |
| 1 | 20000 | 2361312 | 31741 | 15757 | 15984 | | 818 | 818 | 15166 | 0.1300 | 2079 | 106 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 0 | | | | | | | | | | | |
| 20 | 200000 | 2361312 | 31971 | 16257 | 15714 | | 845 | 845 | 14868 | 0.1161 | 1824 | 98 |
| | | | | | | | | | **Total** | | **82234** | **41149** |

Here, PV at 12 % D.F is Tk. 41,085.17, and accordingly, EIRR is 25.80 per cent. This value demonstrates the economic viability of the project, because the 25.80 EIRR is above the 12 per cent, cut off rate of the evaluation criteria for economic analysis.

**Sensitivity Analysis of the EIRRs**

A sensitivity test was performed on the EIRR for the initial investment cost only, which is the largest foreign cost component. The results of the test are given Table 4.7.

**Table 4.7: Sensitivity Analysis of EIRRS**

| | **Scenario** | **Project EIRR (per cent)** |
|---|---|---|
| 1 | 10 per cent higher cost of eligible portion in initial investment cost | 23.67 |
| 2 | 20 per cent higher cost of eligible portion in initial investment cost | 21.85 |

A substantial cost overrun of the initial investment cost could not undermine the project's viability. As a result of this sensitivity analysis, the EIRRs are over 12% in the cases of a 10 per cent and 20 per cent higher initial investment. Thus, it can be said that the Project is economically viable in opposed to financial non-viability.

Detailed calculation of sensitivity test is given in Appendix 4a – 4b.

# *Chapter 5*

# Conclusion and recommendations

## 5.1 Reduction of the pilferage and wastage of natural gas

By analyzing customer gas usage trend for a year after they have been converted to pre-payment customer, we found that 88 per cent customers are paying less than what they used to pay when they were in flat rate system and among them, 29 per cent, customers are saving more than Tk. 300. This shows there is a huge savings of natural gas. These findings demonstrate financial benefits of customers from pre-paid meter system.

From the calculation of quantity of gas used by domestic users we have found that there is a savings of 44 cubic meter per customer per month. This amount of gas can be used in other sectors like industry, power and CNG. If we can convert all our domestic customers into Pre-paid, there will be a savings of 90.64 million cubic meter of natural gas, worth Tk. 6.62 billion per month, which highlights financial benefits for gas providing agency and the country

From the customer survey we have found that around 86 per cent customers now have better knowledge on gas consumption and it helps 74 per cent customers to regulate the gas consumption. Customer awareness will help to reduce the wastage to a significant level.

52 per cent customers think that pre-paid meter operation is easy and 48 per cent customers think that card recharging process is customer friendly, which shows a mixed review from the customers on customer friendliness pre-paid gas meter. TGTDCL can take more initiatives to make this system more customer-friendly.

Customers are not satisfied with the service they are getting from the TGTDCL staffs. 36 per cent customers are not happy with the customer service. TGTDCL should give more emphasis on customer service by giving appropriate training to their technicians and Sale Point operators.

There is a mixed review with the travelling cost to the vending stations. Customers who are living far from the vending stations are not happy as they have to travel more and costing is high. This calls for decentralizing vending stations to door of customers.

Therefore, pre-paid metering system will help to reduce the natural gas wastage to a great deal but TGTDCL has to give more emphasis on customer service. If prepaid meter users are not happy with the service, there will be a negative impression and other customers will be less interested to install pre-paid meter which will result in less reduction of wastage.

## 5.2 Financial and economic viability of the project

The project FIRR of the base case is 2.57 per cent, which does not exceed WACC (4.17 per cent). Therefore, the project is not regarded as financially viable or a sound investment. The main reason for this is that the current gas sales price is set quite low. It is recommended that TGTDCL carries out a further study to revise and possibly raise the current gas sales price for domestic customers. It is expected that the Project FIRR will be higher, provided that the revision and increase of gas sales price are carried out in the near future, which would contribute to higher financial viability of the Project. On the contrary, when we consider EIRR, we found it 25.80 which is way above the cut off rate 12 per cent. This indicates economic viability of the project.

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# Appendices

## Appendix 1: Surveyed prepaid gas meter customer list

| Sl No. | Customer Id | Name | Address |
|---|---|---|---|
| 1 | 0112300294814 | Mrs. Asayad Amina Khanam. | House-45/B, Road-16. Dhanmondi Dhaka. |
| 2 | 0112300504817 | M. Mosiur Rahman | House-35/A, Road-16, Dhanmondi, Dhaka |
| 3 | 0112300506718 | Khandaker Nuruzzaman | House-53, Road-9/A, Dhanmondi, Dhaka |
| 4 | 0112300731415 | Mustafizur Rahman | Plot No -38 Road-13/A Dhanmondi Dhaka,Flat-5/B |
| 5 | 0112300672318 | Shahazan Choudhry | House-40 Road - 13/A Dhanmondi Dhaka |
| 6 | 0112300750012 | Mrs.Selinabegum | House-46,Road-11/A,Flat-A/2,Dhanmondi,Dhaka. |
| 7 | 0112300882312 | M.D.Adcl | House-42/A, Road-15, Dhanmondi, Dhaka A/3 |
| 8 | 0112300591511 | Khaledah Habib | Plot # 73, Road # 8/A, Dhanmondi, Dhaka |
| 9 | 0112300639615 | Dil Ruba Haq (Md. Manjurul Haq) | House-28, Road-9/A, Dhanmondi Dhaka |
| 10 | 0112300750517 | Mahmud Hasan Chowdhury | Plot No-46,Road No-11/A Dhanmondi Dhaka |
| 11 | 0112300972018 | Khwaja Asif Ahmed | House-57, Road--8/A, Flat-B/1, Dhanmondi, R/A, Dhaka. |
| 12 | 0112301196118 | Md. Earsadul Haque | Plot-6,Road-9,Dhanadmondi |
| 13 | 0112301212410 | Mainuddin Hasan Roshed | Plot-27,Road-7,Dhandmondi,Dhaka |
| 14 | 0112300750811 | Dewer Hossain Chowdhury | Plot-46, Road-11/A, Dhanmondi, Dhaka. |
| 15 | 0112300809614 | Kabir Hossain | House # 69, Road # 15/A, Dhanmondi, Dhaka |
| 16 | 0112401236711 | Md. Azaz Hossan | 3/19 Iqbl Road Mohammad Pur Flat-A/4, Dhaka |

| | | | |
|---|---|---|---|
| 17 | 0112300294015 | Mrs. Saiyad Amina Khanam. | House-45/B, Road-16. Dhanmondi Dhaka. |
| 18 | 0112300991212 | Md. Abdus Sattar Gong | House-27, Road-16, Dhanmondi, Dhaka.Flat-D/1 |
| 19 | 0112300277117 | Western View Malik Samiti | House-79, Road-5 ,Dhanmondhi, Dhaka |
| 20 | 0112401237611 | A. K. M. Diluar Hossan And Others. Lovely | 3/19, Iqbl Road Md. Pur Flat-C/3,Dhaka |
| 21 | 0112300707014 | Harun-Ur-Rashid | Hosse -127/A, Road-9/A, Dhanmondi, Dhakaplot-448 |
| 22 | 0112300844916 | M.D.Mega Builders | House- 128, Road -9/A, Dhanmondi, Dhaka |
| 23 | 0112301180414 | A.F.M.Waliul Haque | House-28.Road-14/A, Dhanmondi, Flat-12/B |
| 24 | 0112301051016 | Shamima-A-Banu | House-77, Road-9/A,Flat-2/A, Dhanmondi, Dhaka. |
| 25 | 0111401032915 | Ferdows Sayedy | 121/12/1,Road 9/A,Flat B/4 |
| 26 | 0112300690318 | Mrs. Pori Banu & Others | House-29, Road-16, Dhanmondi, Dhaka |
| 27 | 0112300549514 | Mrs Meherun Nahar And Otheris | House -11/A Road -13 Dhanmondi Dhaka |
| 28 | 0112300543618 | Iftakhar Ahamed | House-94, Road-9/A, Dhamondi Dhaka |
| 29 | 0112300592411 | Salim A.Khan | Plot # 73, Road # 8/A,. Dhanmondi, Dhaka |
| 30 | 0112300503614 | M. Mosiur Rahman | House-35/A, Road-16, Dhanmondi, Dhaka |
| 31 | 0112300671115 | Samsunnaher Chow. | House-40 Road - 13/A Dhanmondi Dhaka |
| 32 | 0112300512118 | Yasmin Hasina. | House#50, Rosd-7/A, Dhanmondi, Dhaka. |
| 33 | 0112300867517 | Jahan Ara Begum | House - 19, New , Road-9/A(New), Dhanmondi , Flat-2/D,Dhaka |
| 34 | 0112301080413 | Eng.Md.Azizur Rahman | Flat-4/A,House-4/Ka,Road-13,Dhanmondi,Dhaka. |
| 35 | 0112300556016 | Crecent Holding Ltd. | House # 63, Road # 15/A, Dhanmondi, Dhaka |
| 36 | 0112301211813 | Mainuddin Hasan Roshed (Md) | Plot-27,Road-7,Dhandmondi,Dhaka |

| | | | |
|---|---|---|---|
| 37 | 0112300509418 | Mrs. Parveen Imam | House-51/A, Road-6/A, Dhanmondi, Dhaka |
| 38 | 0112300905712 | Syed Abdul Kasem. | Flanto-3/C, Floor-3, House No-85, Road-12/A, Dhanmondi, Dhaka. |
| 39 | 0112300543012 | Real Estate | House-94, Road-9/A, Dhamondi Dhaka |
| 40 | 0112300868913 | Dr. Md. Sofiqul Islam Sikder | House - 19, New , Road-9/A(New), Dhanmondi , Flat-4/F,Dhaka |
| 41 | 0112301124311 | Abdullah Al Hossain | Flat-A/3 Plot-27/A Road-05 Dhandmondi |
| 42 | 0112300849012 | Fatima Sabekun Nahar | Flat No-71,Road No-11/A Dhanmondi Dhaka |

Source: Pre-paid meter cell office, TGTDCL.

## Appendix 2: Gas Savings Calculation

## (Source TGTDCL annual report 2015-16)

| | | |
|---|---|---|
| Yearly Domestic Meter Consumption | 2531 | mmcm |
| Total Number of Domestic customer | 2.06 | Million (ibid) |
| Monthly Consumption per Domestic Customer | 105 | cubic meter/month |
| Domestic Customer paid for | 87 | cubic meter/month |
| Total loss in volume per customer per month | 18 | cubic meter/month |
| Average monthly consumption of prepaid meter customer | 61 | cubic meter/month |
| Gas savings in volume per customer | 44 | cubic meter/month |
| Gas savings in volume in domestic sector | 90.64 | mmcm |
| Gas savings in monetary value | 6.59 | Billion bdt |

**Weighted average gas tariff calculation without domestic gas tariff**

| Customers | Gas sells volume cubic meter | Gas price per cubic meter (bdt) | Total gas sells (bdt) |
|---|---|---|---|
| captive | 3856 | 8.36 | 32236 |
| power | 5030 | 2.82 | 14185 |
| Industry | 3635 | 6.74 | 24500 |
| Fertilizer | 587 | 2.58 | 1514 |
| Commercial | 145 | 11.36 | 1647 |
| CNG | 801 | 35 | 28035 |
| Total | 14054 | | 102117 |
| weighted average gas price per cubic meter except domestic gas tariff | | 7.27 bdt | |

## Appendix 3: Questionnaire filled up by Prepaid Gas Meter Customers

Dear Sir/ Madam,

I am a student from Brac University undertaking Masters in Procurement and Supply Management. As part of my study I am conducting a research with the main objective to determine the acceptability of prepaid metering system to the domestic customers of Titas Gas T&D Co. Ltd. (TGTDCL). I am kindly requesting for your assistance towards the success of this research through filling this questionnaire.

The questionnaires will be treated with high confidentiality and will be only for the academic purpose.

Your participation will be highly appreciated

Customer ID:

Customer Name:

Customer Address:

Meter No:

Please tick (√) in the most appropriate box

| | **Opinion** | **Agree** | **Disagree** | **Neutral** |
|---|---|---|---|---|
| 1. | Using prepaid gas meter helps me to regulate my gas consumption | | | |
| 2. | Using prepaid gas meter enhance my knowledge on gas consumption | | | |
| 3. | It is easy to use Prepaid gas meter | | | |
| 4. | Monthly rent of Prepaid gas meter is acceptable | | | |
| 5. | Card recharging system is customer friendly | | | |
| 6. | Customer service is satisfactory | | | |
| 7. | Traveling cost to recharge point is acceptable | | | |

## Appendix 4a: Financial Analysis when initial investment is 10 % higher

**(Tk.in Lac)**

| Project Life | Investment Cost (PV) | **O&M Cost (PV) In Thou. USD provided by JICA** | Operating Cost (PV) | Total Cost (PV) | Total Benefit (PV) | Net Benefit (PV) | Discount Factor (12%) | Discounted Total Cost (PV) | Discounted Total Benefit (PV) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2152 | | | 2152 | 0 | -2152 | 1.00 | 2152 | 0 |
| 2 | 7996 | | | 7996 | 0 | -7996 | 0.89 | 7996 | 0 |
| 3 | 28138 | | | 28138 | 62 | -28138 | 0.80 | 28138 | 50 |
| 4 | 40044 | 623 | 486 | 40530 | 901 | -40044 | 0.71 | 40044 | 642 |
| 5 | | 659 | 513 | 513 | 2573 | 2059 | 0.64 | 326 | 1635 |
| 6 | | 695 | 541 | 541 | 4413 | 3872 | 0.57 | 307 | 2504 |
| 7 | | 766 | 597 | 597 | 5083 | 4487 | 0.51 | 302 | 2575 |
| 8 | | 766 | 597 | 597 | 5333 | 4736 | 0.45 | 270 | 2412 |
| 9 | | 802 | 624 | 624 | 5587 | 4963 | 0.40 | 252 | 2257 |
| 10 | | 837 | 652 | 652 | 5847 | 5195 | 0.36 | 235 | 2109 |
| 11 | | 873 | 680 | 680 | 6113 | 5433 | 0.32 | 219 | 1968 |
| 12 | | 908 | 708 | 708 | 6384 | 5676 | 0.29 | 203 | 1835 |
| 13 | | 944 | 735 | 735 | 6660 | 5925 | 0.26 | 189 | 1710 |
| 14 | | 980 | 763 | 763 | 6942 | 6178 | 0.23 | 175 | 1591 |
| 15 | | 1015 | 791 | 791 | 7229 | 6438 | 0.20 | 162 | 1479 |
| 16 | | 1051 | 819 | 819 | 7522 | 6703 | 0.18 | 150 | 1374 |
| 17 | | 1086 | 846 | 846 | 7820 | 6974 | 0.16 | 138 | 1275 |
| 18 | | 1122 | 874 | 874 | 8123 | 7249 | 0.15 | 127 | 1183 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 19 | | 1158 | 902 | 902 | 8432 | 7530 | 0.13 | 117 | 1096 |
| 20 | | 1193 | 929 | 929 | 8747 | 7817 | 0.12 | 108 | 1015 |
| | 78333 | **15478** | **12057** | 90392 | **103770** | **12904** | | **81612** | **28710** |

NPV (F) @ 12% D.F. : **-52,901.91** Lakh Taka

BCR (F) : **0.35**

IRR (F) : **1.52%**

## Appendix 4b: Financial Analysis when initial investment is 20 % higher

**(Tk.in Lac)**

| Project Life | Investment Cost (PV) | **O&M Cost (PV) In Thou. USD provided by JICA** | Operating Cost (PV) | Total Cost (PV) | Total Benefit (PV) | Net Benefit (PV) | Discount Factor (12%) | Discounted Total Cost (PV) | Discounted Total Benefit (PV) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2348 | | | 2348 | 0 | -2348 | 1.00 | 2348 | 0 |
| 2 | 8723 | | | 8723 | 0 | -8723 | 0.89 | 8723 | 0 |
| 3 | 30696 | | | 30696 | 62 | -30696 | 0.80 | 30696 | 50 |
| 4 | 43685 | 623 | 486 | 44170 | 901 | -43685 | 0.71 | 43685 | 642 |
| 5 | | 659 | 513 | 513 | 2573 | 2059 | 0.64 | 326 | 1635 |
| 6 | | 695 | 541 | 541 | 4413 | 3872 | 0.57 | 307 | 2504 |
| 7 | | 766 | 597 | 597 | 5083 | 4487 | 0.51 | 302 | 2575 |
| 8 | | 766 | 597 | 597 | 5333 | 4736 | 0.45 | 270 | 2412 |
| 9 | | 802 | 624 | 624 | 5587 | 4963 | 0.40 | 252 | 2257 |
| 10 | | 837 | 652 | 652 | 5847 | 5195 | 0.36 | 235 | 2109 |
| 11 | | 873 | 680 | 680 | 6113 | 5433 | 0.32 | 219 | 1968 |
| 12 | | 908 | 708 | 708 | 6384 | 5676 | 0.29 | 203 | 1835 |
| 13 | | 944 | 735 | 735 | 6660 | 5925 | 0.26 | 189 | 1710 |
| 14 | | 980 | 763 | 763 | 6942 | 6178 | 0.23 | 175 | 1591 |
| 15 | | 1015 | 791 | 791 | 7229 | 6438 | 0.20 | 162 | 1479 |
| 16 | | 1051 | 819 | 819 | 7522 | 6703 | 0.18 | 150 | 1374 |
| 17 | | 1086 | 846 | 846 | 7820 | 6974 | 0.16 | 138 | 1275 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | | 1122 | 874 | 874 | 8123 | 7249 | 0.15 | 127 | 1183 |
| 19 | | 1158 | 902 | 902 | 8432 | 7530 | 0.13 | 117 | 1096 |
| 20 | | 1193 | 929 | 929 | 8747 | 7817 | 0.12 | 108 | 1015 |
| | 85454 | **15478** | **12057** | 97513 | **103770** | **5783** | | **88733** | **28710** |

NPV (F) @ 12% D.F.: -60,022.89 Lakh Taka

BCR (F) : 0.32

IRR (F) : 0.64%

## Appendix 4c: Financial Analysis when initial investment is 10 % lower

**(Tk.in Lac)**

| Project Life | Investment Cost (PV) | **O&M Cost (PV) In Thou. USD provided by JICA** | Operating Cost (PV) | Total Cost (PV) | Total Benefit (PV) | Net Benefit (PV) | Discount Factor (12%) | Discounted Total Cost (PV) | Discounted Total Benefit (PV) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1761 | | | 1761 | 0 | -1761 | 1.00 | 1761 | 0 |
| 2 | 6542 | | | 6542 | 0 | -6542 | 0.89 | 5841 | 0 |
| 3 | 23022 | | | 23022 | 62 | -22960 | 0.80 | 18353 | 50 |
| 4 | 32764 | 623 | 486 | 33249 | 901 | -32348 | 0.71 | 23666 | 642 |
| 5 | | 659 | 513 | 513 | 2573 | 2059 | 0.64 | 326 | 1635 |
| 6 | | 695 | 541 | 541 | 4413 | 3872 | 0.57 | 307 | 2504 |
| 7 | | 766 | 597 | 597 | 5083 | 4487 | 0.51 | 302 | 2575 |
| 8 | | 766 | 597 | 597 | 5333 | 4736 | 0.45 | 270 | 2412 |
| 9 | | 802 | 624 | 624 | 5587 | 4963 | 0.40 | 252 | 2257 |
| 10 | | 837 | 652 | 652 | 5847 | 5195 | 0.36 | 235 | 2109 |
| 11 | | 873 | 680 | 680 | 6113 | 5433 | 0.32 | 219 | 1968 |
| 12 | | 908 | 708 | 708 | 6384 | 5676 | 0.29 | 203 | 1835 |
| 13 | | 944 | 735 | 735 | 6660 | 5925 | 0.26 | 189 | 1709 |
| 14 | | 980 | 763 | 763 | 6942 | 6178 | 0.23 | 175 | 1591 |
| 15 | | 1015 | 791 | 791 | 7229 | 6438 | 0.20 | 162 | 1479 |
| 16 | | 1051 | 819 | 819 | 7522 | 6703 | 0.18 | 150 | 1374 |
| 17 | | 1086 | 846 | 846 | 7820 | 6974 | 0.16 | 138 | 1276 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | | 1122 | 874 | 874 | 8123 | 7249 | 0.15 | 127 | 1183 |
| 19 | | 1158 | 902 | 902 | 8432 | 7530 | 0.13 | 117 | 1097 |
| 20 | | 1193 | 929 | 929 | 8747 | 7817 | 0.12 | 108 | 1016 |
| | 64091 | **15478** | **12057** | 76150 | **103770** | **27624** | | **52902** | **28711** |

NPV (F) @ 12% D.F. : **-24,191.61** Lakh Taka

BCR (F) : **0.54**

IRR (F) : **3.70%**

## Appendix 4d: Financial Analysis when initial investment is 20 % lower

**(Tk.in Lac)**

| Project Life | Investment Cost (PV) | **O&M Cost (PV) In Thou. USD provided by JICA** | Operating Cost (PV) | Total Cost (PV) | Total Benefit (PV) | Net Benefit (PV) | Discount Factor (12%) | Discounted Total Cost (PV) | Discounted Total Benefit (PV) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1565 | | | 1565 | 0 | -1565 | 1.00 | 1565 | 0 |
| 2 | 5815 | | | 5815 | 0 | -5815 | 0.89 | 5192 | 0 |
| 3 | 20464 | | | 20464 | 62 | -20402 | 0.80 | 16314 | 50 |
| 4 | 29123 | 623 | 486 | 29609 | 901 | -28707 | 0.71 | 21075 | 642 |
| 5 | | 659 | 513 | 513 | 2573 | 2059 | 0.64 | 326 | 1635 |
| 6 | | 695 | 541 | 541 | 4413 | 3872 | 0.57 | 307 | 2504 |
| 7 | | 766 | 597 | 597 | 5083 | 4487 | 0.51 | 302 | 2575 |
| 8 | | 766 | 597 | 597 | 5333 | 4736 | 0.45 | 270 | 2412 |
| 9 | | 802 | 624 | 624 | 5587 | 4963 | 0.40 | 252 | 2257 |
| 10 | | 837 | 652 | 652 | 5847 | 5195 | 0.36 | 235 | 2109 |
| 11 | | 873 | 680 | 680 | 6113 | 5433 | 0.32 | 219 | 1968 |
| 12 | | 908 | 708 | 708 | 6384 | 5676 | 0.29 | 203 | 1835 |
| 13 | | 944 | 735 | 735 | 6660 | 5925 | 0.26 | 189 | 1709 |
| 14 | | 980 | 763 | 763 | 6942 | 6178 | 0.23 | 175 | 1591 |
| 15 | | 1015 | 791 | 791 | 7229 | 6438 | 0.20 | 162 | 1479 |
| 16 | | 1051 | 819 | 819 | 7522 | 6703 | 0.18 | 150 | 1374 |
| 17 | | 1086 | 846 | 846 | 7820 | 6974 | 0.16 | 138 | 1276 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | | 1122 | 874 | 874 | 8123 | 7249 | 0.15 | 127 | 1183 |
| 19 | | 1158 | 902 | 902 | 8432 | 7530 | 0.13 | 117 | 1097 |
| 20 | | 1193 | 929 | 929 | 8747 | 7817 | 0.12 | 108 | 1016 |
| | 56970 | **15478** | **12057** | 69029 | **103770** | **34745** | | **47427** | **28711** |

NPV (F) @ 12% D.F. : **-18,716.52** Lakh Taka

BCR (F) : **0.61**

IRR (F) : **5.01%**

## Appendix 5a: Economic Analysis when initial investment is 10 % higher

Economic Analysis (In Lac Taka)

| Year | Cumm Installed Meter | Savings of gas in MMBTU | Cost inc. by LNG import | Cost incurred by natural gas | Eco. benefit | Initial Investment Cost | Operating Cost per annum | Total Cost | Net Benefit | DF (12%) | Discounted conomic benefit | Discounted Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 1870 | | 1870 | -1870 | 1 | 0 | 1870 |
| 2 | | 0 | 0 | 0 | 0 | 5632 | | 5632 | -5632 | 0.8929 | 0 | 5029 |
| 3 | 4000 | 23613 | 281 | 78 | 203 | 19070 | 346 | 19416 | -19213 | 0.7972 | 162 | 15479 |
| 4 | 49111 | 313530 | 3757 | 1096 | 2661 | 27123 | 385 | 27508 | -24847 | 0.7118 | 1894 | 19579 |
| 5 | 113778 | 961579 | 11615 | 3565 | 8050 | | 539 | 539 | 7511 | 0.6355 | 5116 | 343 |
| 6 | 178444 | 1725070 | 21005 | 6761 | 14244 | | 508 | 508 | 13736 | 0.5674 | 8083 | 288 |
| 7 | 200000 | 2234064 | 27420 | 9229 | 18191 | | 539 | 539 | 17652 | 0.5066 | 9216 | 273 |
| 8 | 200000 | 2361312 | 29212 | 10255 | 18957 | | 570 | 570 | 18387 | 0.4523 | 8575 | 258 |
| 9 | 200000 | 2361312 | 29442 | 10755 | 18687 | | 601 | 601 | 18086 | 0.4039 | 7547 | 243 |
| 10 | 200000 | 2361312 | 29672 | 11255 | 18417 | | 631 | 631 | 17785 | 0.3606 | 6641 | 228 |
| 11 | 200000 | 2361312 | 29902 | 11755 | 18146 | | 662 | 662 | 17484 | 0.3220 | 5843 | 213 |
| 12 | 200000 | 2361312 | 30131 | 12255 | 17876 | | 693 | 693 | 17183 | 0.2875 | 5139 | 199 |
| 13 | 200000 | 2361312 | 30361 | 12756 | 17606 | | 724 | 724 | 16882 | 0.2567 | 4519 | 186 |
| 14 | 200000 | 2361312 | 30591 | 13256 | 17335 | | 755 | 755 | 16581 | 0.2292 | 3973 | 173 |
| 15 | 200000 | 2361312 | 30821 | 13756 | 17065 | | 785 | 785 | 16280 | 0.2046 | 3492 | 161 |
| 16 | 200000 | 2361312 | 31051 | 14256 | 16795 | | 816 | 816 | 15979 | 0.1827 | 3068 | 149 |
| 17 | 200000 | 2361312 | 31281 | 14756 | 16525 | | 847 | 847 | 15678 | 0.1631 | 2696 | 138 |
| 18 | 200000 | 2361312 | 31511 | 15257 | 16254 | | 878 | 878 | 15377 | 0.1456 | 2367 | 128 |
| 19 | 200000 | 2361312 | 31741 | 15757 | 15984 | | 909 | 909 | 15075 | 0.1300 | 2079 | 118 |
| 20 | 200000 | 2361312 | 31971 | 16257 | 15714 | | 939 | 939 | 14774 | 0.1161 | 1824 | 109 |
| | | | | | | | | | | Total | **82234** | **45163** |

NPV (E) @ 12% D.F. :**37,071.25** Lac Taka

BCR (E) :**1.82**

IRR (E) :**23.67%**

## Appendix 5b: Economic Analysis when initial investment is 20 % higher

Economic Analysis (In Lac Taka)

| Year | Cumm Installed Meter | Savings of gas in MMBTU | Cost inc. by LNG import | Cost incurred by natural gas | Eco. benefit | Initial Investment Cost | Operating Cost per annum | Total Cost | Net Benefit | DF (12%) | Discounted conomic benefit | Discounted Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 2040 | | 2040 | -2040 | 1 | 0 | 2040 |
| 2 | | 0 | 0 | 0 | 0 | 6144 | | 6144 | -6144 | 0.8929 | 0 | 5486 |
| 3 | 4000 | 23613 | 281 | 78 | 203 | 20804 | 346 | 21150 | -20947 | 0.7972 | 162 | 16861 |
| 4 | 49111 | 313530 | 3757 | 1096 | 2661 | 29588 | 385 | 29973 | -27313 | 0.7118 | 1894 | 21334 |
| 5 | 113778 | 961579 | 11615 | 3565 | 8050 | | 539 | 539 | 7511 | 0.6355 | 5116 | 343 |
| 6 | 178444 | 1725070 | 21005 | 6761 | 14244 | | 508 | 508 | 13736 | 0.5674 | 8083 | 288 |
| 7 | 200000 | 2234064 | 27420 | 9229 | 18191 | | 539 | 539 | 17652 | 0.5066 | 9216 | 273 |
| 8 | 200000 | 2361312 | 29212 | 10255 | 18957 | | 570 | 570 | 18387 | 0.4523 | 8575 | 258 |
| 9 | 200000 | 2361312 | 29442 | 10755 | 18687 | | 601 | 601 | 18086 | 0.4039 | 7547 | 243 |
| 10 | 200000 | 2361312 | 29672 | 11255 | 18417 | | 631 | 631 | 17785 | 0.3606 | 6641 | 228 |
| 11 | 200000 | 2361312 | 29902 | 11755 | 18146 | | 662 | 662 | 17484 | 0.3220 | 5843 | 213 |
| 12 | 200000 | 2361312 | 30131 | 12255 | 17876 | | 693 | 693 | 17183 | 0.2875 | 5139 | 199 |
| 13 | 200000 | 2361312 | 30361 | 12756 | 17606 | | 724 | 724 | 16882 | 0.2567 | 4519 | 186 |
| 14 | 200000 | 2361312 | 30591 | 13256 | 17335 | | 755 | 755 | 16581 | 0.2292 | 3973 | 173 |
| 15 | 200000 | 2361312 | 30821 | 13756 | 17065 | | 785 | 785 | 16280 | 0.2046 | 3492 | 161 |
| 16 | 200000 | 2361312 | 31051 | 14256 | 16795 | | 816 | 816 | 15979 | 0.1827 | 3068 | 149 |
| 17 | 200000 | 2361312 | 31281 | 14756 | 16525 | | 847 | 847 | 15678 | 0.1631 | 2696 | 138 |
| 18 | 200000 | 2361312 | 31511 | 15257 | 16254 | | 878 | 878 | 15377 | 0.1456 | 2367 | 128 |
| 19 | 200000 | 2361312 | 31741 | 15757 | 15984 | | 909 | 909 | 15075 | 0.1300 | 2079 | 118 |
| 20 | 200000 | 2361312 | 31971 | 16257 | 15714 | | 939 | 939 | 14774 | 0.1161 | 1824 | 109 |
| | | | | | | | | | | Total | 82234 | 48927 |

NPV (F) @ 12% D.F. : **33,307.02** Lac Taka
BCR (E) : **1.68**

IRR (E) :**21.85%**