Economics of Energy Efficiency: The Case of Natural Gas Utilization in the Boiler-using Industries of Bangladesh

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Abstract

The present paper deals with the cost-benefit analysis (CBA) for an energy-efficiency improvement project for the boiler-using industries of Bangladesh. It considers five different price scenarios of natural gas (NG), a discount rate of 12% and the expected gas savings of about 6.88% of the total gas consumption in these industries of Bangladesh. The output of CBA has been used to suggest commensurate NG pricing and provide policy inputs for encouraging energy use efficiency among these end-users. The high IRR of 18%, which is much greater that the hurdle rate 12%, at the present weighted average NG price of Tk. 10.29 indicates that the project is worth undertaking even at a financing rate below 18%. NG price for which the project is financially viable (NPV=0) is Tk. 9.52/cubic meter and IRR at this price is 12.53%. The present industrial gas price is Tk. 10.70/cubic meter. Therefore, it is evident that this energy efficiency project is financially acceptable at the present industrial price of natural gas. The IRR-NG price relationship reveals that the project becomes more lucrative financially as NG price increases.

Keywords: Natural gas, Natural gas utilization efficiency, Financial analysis, Net present value, Internal rate of return, Cost-benefit analysis

1. Introduction

Natural gas is Bangladesh's most important indigenous, exhaustible and non-renewable natural resource. Natural gas plays an important role in many key sectors of the economy of Bangladesh. With time, the proven stock of indigenous natural gas is exhausting quite fast, thus putting an extra pressure on those sectors and the economic health of the country. The remaining proven and probable reserve of natural gas is estimated to be only 11.91 TCF, with a remaining proven reserve of 5.97 TCF (Petrobangla, 2017), The reserve is expected to deplete within the next 12 years at the present demand of 2700 MMCFD, if the attainment of discovery of new gas field is not available. Now appropriate measures should be taken by the users so that utilization efficiency of existing and future operations gets enhanced. In this context, proper demand side management with its responsible use may significantly contribute in ensuring energy security in the years to come.

Any good energy policy regards energy efficiency and renewable energy as its two vital components. Energy efficiency, in some countries, brings about a national security benefit as well by reducing the level of energy imports and thus retarding the depletion rate of domestic energy resources. This also reduces opportunity cost of energy resources by slowing down the gas extraction rate and thus keeping it for future uses.

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Natural gas is a non-renewable natural resource. Its utilization is associated with two common types of inefficiency. One is regulated price related inefficiency, which, in some way, discourages the end users about the efficient utilization of natural gas. This also discourages their shifting to alternative fuels because the price of natural gas stands lower than that of alternative fuels and using alternative energy cannot render the industries competitive. Petrobangla (2015) stated that the low price of natural gas constitutes a significant financial obstacle to the improvement of gas utilization efficiency and often makes its pursuit uneconomic and that the inequity created by fossil fuel subsidies, constitutes a significant financial obstacle to the introduction of energy efficiency initiatives making their introduction uneconomic.

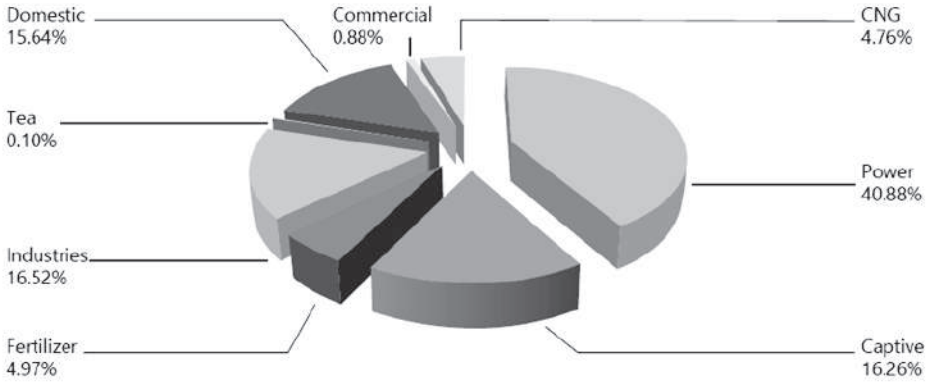
The existing natural gas pricing in Bangladesh is not based on the economic rationality for setting up a market-clearing price that ensures economic efficiency. It is not based on marginal cost of extraction of gas and the opportunity cost natural gas or user cost of current extraction. Cross-subsidies exist in this pricing framework. This is also not inflation adjusted. This of course leads to economic inefficiency through market failure (inappropriate market price-led economic inefficiency here). Moreover, widespread wastage in gas utilization and transmission-distribution channels are also quite common characteristics in the gas sector of Bangladesh. The pricing inefficiency inspires end-users not to combat this wastage and thus refrain from applying energy efficiency measures. The existing end user price of natural gas for different customers in Bangladesh is shown below:

Table 1: Natural Gas Tariff Structure in Bangladesh

Sl No.	Category of Customers	Tariff (Tk./CM)			
		Effective from 1st September, 2015	Effective from 1st March, 2017	Effective from 1st June, 2017	Effective from 1st July, 2019
01.	Power	2.82	2.99	3.16	4.45
02.	Captive Power	8.36	8.98	9.62	13.85
03.	Fertilizer	2.58	2.64	2.71	4.45
04.	Industrial	6.74	7.24	7.76	10.70
05.	Tea Estate	6.45	6.93	7.42	10.70
06.	Commercial	11.36	14.20	17.04	
	a. Hotel & restaurant				23.00
	b. Small & cottage industries				17.00
07.	CNG	35.00	38.00	40.00	43.00
08.	Domestic				
	a. Metered	7.00	9.10	11.20	12.60
	b. Single Burner	600.00	750.00	900.00	925.00
	c. Double Burner	650.00	800.00	950.00	975.00

Source: Bangladesh Energy Regulatory Commission (BERC)

In Bangladesh, natural gas is mainly used in seven sectors, including domestic, CNG, commercial, power, captive power, industry and fertilizer production. Studies identified rampant wastage of natural gas in domestic, industrial and captive power end users of Bangladesh. A sector-wise natural gas consumption picture is presented in the figure-1 below:



Source: Petrobangla Annual Report, 2017

Figure 1: Gas Consumption in Different Category of Users

Recognizing the importance of efficient utilization of natural gas, Petrobangla has implemented a project titled "TA to Review the Approach for Increasing the Efficiency of Gas Utilization in Certain Major Users (TAIEGU)" under the Japan Debt Cancellation Fund (JDCF) financing. Its objective was to identify the areas where lie the opportunities of enhancing gas utilization efficiency in major users such as fertilizer, industries, captive power plants, glass industries, steel re-rolling mills and other industrial establishments that use boilers through consultancy services. 3 pilot programs have been implemented as a part of this project. The findings of the Boiler Economizer Pilot Programme that involved fitting of an economizer to exhaust the boiler in order to recover waste heat for heating the boiler feed water suggested a possibility of reducing the gas consumption by 4.4% (Petrobangla, 2017).

Table 2: Potential Gas Savings and Carbon Emission Reduction for Boiler-using Industries

	From Audited Industries		Nationwide projection			
Energy Management Opportunities	Possible Annual Gas savings (MMSCF)	Savings to Consumption Ratio of Gas	Total Gas consumption (MMSCFD)	Potential Gas savings		Carbon Emission reduction (Ton/year)
				(MMSCFD)	%	
Industrial Boilers	664	0.17	350	58	17	1,172,254
Captive Generator	1054	0.50	444	224	50	4,167,538
Re-heating Furnace	202	0.18	22	4	18	11,172
Total			816	286		5,350,964

Source: Petrobangla Annual Report, 2017

The indigenous natural gas reserve of the country is dwindling quite fast.To sustain the economic growth and development, the country has already started importing LNG, 500 and 1000 MMCFD respectively in 2018 and 2019.This import related energy policy involves market risks. So, as a demand side management policy, ensuring efficiency is pivotal to energy security of Bangladesh.

Considering her energy security, Bangladesh has constituted the Sustainable and Renewable Energy Development Authority (SREDA) by the law no. 48 of 2012.This authority has been expediting the activities related to energy efficiency and the expansion of renewable energy. It has formulated the "Efficiency and Conservation Master Plan up to 2030" and "Energy Efficiency and Conservation Regulations". The said Master Plan envisages 15% energy savings by 2030 and 20% energy savings by 2030, which are in line with goal number 07 of the Sustainable Development Goals (SDGs) and the targets of the Seventh Five Year Plan (FY2016-FY2020). Noteworthy that the illustration of Sustainable Development Goal 7 (SDG7) of the Seventh Five Year Plan (Planning Commission, 2016) is to "ensure access to affordable, reliable, sustainable and modern energy for all" and the target of the Seventh Five Year Plan is to increase energy efficiency by 10%.

In Bangladesh most of the industries use boilers, which are again mostly driven by natural gas. Most of the boiler-using industries of Bangladesh do not exhibit efficient utilization of natural gas. These industries involve textile, garments, spinning, dyeing and printing, pharmaceuticals etc.

There is thus a huge prospect of gas savings from ensuring efficient utilization of natural gas in industrial sector of Bangladesh. It is worth noting that this industrial sector use nearly 16.52 % of the total natural gas consumption (Petrobangla, 2017). This gas savings may play a very important role for the energy security of Bangladesh. And this warrants a policy framework conducive to ensuring efficient utilization of natural gas in the aforesaid industrial units of Bangladesh. This paper aims to carry out a cost-benefit analysis of efficient utilization of natural gas in the boiler-using industries of Bangladesh so as to furnish policy inputs warranted for promoting efficiency in the utilization of natural gas in these industries in Bangladesh against a dwindling gas reserve situation and high cost of procuring gas from abroad.

2. Literature Review

Deriving energy efficiency benefits warrants investment in energy efficiency improvement project. For taking energy-efficient investment decision, it is a must to compare the initial capital investment with the inflow of future savings. This future saving comes out of the future energy prices, changes in other operating costs related to energy use (e.g., pollution charges), intensity of use of the product and equipment lifetime. These expected future cash flows are compared with the initial cost requirement, thus requiring discounting of the future cash flows to present values.

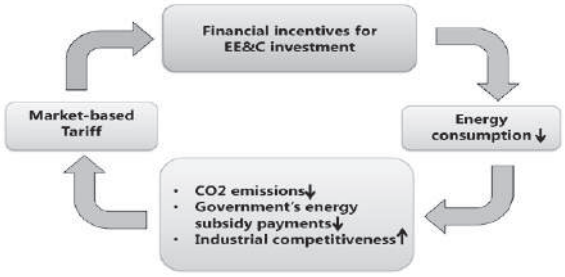
A number of studies came into light in the late 1970s and early 1980s which clearly exhibit the empirical evidences of the benefits of energy efficiency investment. The implicit discount rates are found from 25 percent to over 100 percent (Gillingham, Newell & Palmer; 2009). Standard financial procedures used for the evaluation of energy efficiency

projects are simple payback, return on investment and net present value. Time span is taken to a three-year lifespan with no salvage value. The estimated mean IRR (25 percent) rose with each additional year of life, to 37 percent for 4 years, 43 percent for 5 years and 50 percent for 10 years (UNIDO, 2011, p.78). The timing of energy efficiency improvement costs and benefits and discounting of the cash flows play a pivotal role in the analyses of adopting energy-efficient technology. To cater for uncertainties involved in energy efficiency investments, a different hurdle rate greater than the discount rate is recommended (Jaffe, Newell & Stavins, 2004, p.86). It is argued that lower capital costs may facilitate energy efficiency investment decision (Raihan, 2014 & Goyal, 2006).

Empirical estimates displayed a tangible responsiveness of energy consumption, energy-efficient technology adoption and innovation of different energy price (Gillingham, Newell & Palmer; 2009).

Low energy prices invite a market barrier which leads to less adoption of more energy-efficient technologies (Jaffe, Newell & Stavins, 2004). Higher energy prices lead to significantly higher rates of adoption of industrial energy-efficient equipment (UNIDO, 2011, p.90). The energy sector has also failed to attract adequate private investments due to poor pricing policies and other bottlenecks (Mujeri, Chowdhury & Shahana; 2014). Cropper (2010) found out the causes for not using energy-efficient technologies in India. These include energy pricing policies (e.g., low electricity prices for households and agriculture), other government policies (e.g., tariffs), high start-up costs, scarce opportunities for investments, related risks about the benefits of investments, and lack of information and awareness. World Energy Council (2001) states that market prices do not necessarily reflect marginal social benefits or costs, and that market profitability is not based on net social benefits and costs. Taxes and subsidies might be considered to be the two best known and commonly used intervention devices to it.

Gillingham, Newell & Palmer (2009, p.13) considered liquidity constraints as a market barrier and that they block access to financing for energy-efficient investments. Incentive programs such as direct subsidies, tax credits, tax deductions, rebates, or loan subsides provide financial motivation for energy efficiency investments (Gillingham, Newell & Palmer 2009, p.22). Government of Bangladesh (2015, p.61) emphasizes that financial incentives will bring a positive economic impact which will help the government to adopt a market-based pricing system.



Source: Government of Bangladesh, 2015

Figure 2: Virtuous Circle of Financial Incentives

3. Methodology

With a view to delving deep into the matter whether the energy efficiency improvement project for the boiler-using industries of Bangladesh is financially worth taking or not and to investigate into the economics behind, it is necessary to conduct a cost-benefit analysis of this project. The cost-benefit analysis of efficient utilization of natural gas in boiler-using industries of Bangladesh has been carried out following the criteria presented below:

Data requirements: Data used for this paper have been collected from secondary sources.

Project formulation: Energy efficiency improvement project for 5400 gas-driven boilers used in different boiler-using industries in Bangladesh (Annual Report of the Office of the Chief Boiler Inspector, 2018) has been considered for the paper.

Initial investment cost: Initial capital investment for 5400 boilers has been considered Tk. 77366.94 lac only (Energy Efficiency Team of TGTDCL, 2019). The data set for calculating gas savings and inititial investment required is furnished in Annexure-1.

Operation and maintenance cost: Additional operation & maintenance cost has been considered to be 8% of the total financial value of gas savings for the first year, with 5% escalation for the consecutive years of the project life (Energy Efficiency Team of TGTDCL, 2019).

*Depreciation method:*Accelerated Depreciation, here Declining Balance Method in which depreciation rate equal to twice that for Straight Line depreciation method, has been considered. Depreciation schedule is shown in the Table 3 below:

Table 3: Accelerated Depreciation for Energy Efficiency Project (Declining Balance Method)

Year	Book value (lac BDT)	Straight Line Method Depreciation rate (Considering, equipment life =10 years and salvage value =0)	Declining Depreciation rate =2X Straight Line Method (lac BDT)	The remaining Balance (lac BDT)
0	77366.94	7736.69		
1	77366.94		15473.39	61893.56
2	61893.56		15473.39	46420.17
3	46420.17		15473.39	30946.78
4	30946.78		15473.39	15473.39
5	15473.39		15473.39	0.00

Tax rate: In calculating cash flow after tax, tax rate has been taken to be 25%.

Project financing: This project is to be financed by domestic/international loan.

Discount rate: The rate of 10-year Treasury Bond of Bangladesh Government is 9.260% (Bangladesh Bank, September 2019). Planning Commission of Bangladesh currently applies a discount rate of 12% for appraising the projects of Bangladesh Government. In the "Report and Recommendation of the President to the Board of Directors", economic opportunity cost of capital has been considered to be 9% for the assessment of "Proposed

Loans for People's Republic of Bangladesh: Second City Region Development Project" (Project Number: 49329-006) (ADB, 2019). Taking into account the risk free rate of 9.26% of Bangladesh Govt. Guaranteed 10-year Treasury Bond and ADB's economic discount rate of 9%, opportunity based discount rate for the said Cost-benefit Analysis (CBA) of efficient utilization of natural in the industrial sector of Bangladesh has been rationally set to be 12%.

Project life: The economic project life is taken to be 10 years.

Calculation of gas savings: Based on the calculation of natural gas savings from energy efficiency improvement measures to be taken for 100 gas-driven boilers, energy savings has been considered to be 6.88% of the total gas consumption in the boiler using industries in Bangladesh (Energy Efficiency Team of TGTDCL, 2019). The data set for calculating gas savings and inititial investment required is shown in Annexure-1.

Value of saved natural gas: For estimating annual benefits out of natural gas savings, the volume of natural gas saved has been multiplied by five different price scenarios for the financial and economic analysis of investment in efficiency improvement for these price scenarios. The price scenarios are Tk. 8.03/cubic meter, Tk. 10.29/cubic meter, Tk. 14.70/cubic meter, Tk. 31.11/cubic meter and Tk. 35.17/cubic meter. The five pricing scenarios are presented below:

Scenario 1:

The weighted average price of natural gas, effective from 1st June, 2017 to 1st July, 2019, Tk. 8.03/cubic meter, which has been calculated based on the argument presented in the following table.

Table 4: Weighted Average Price of Natural Gas, Effective from 1st June, 2017 to 1st July, 2019 in Bangladesh

Serial no	Type of users	Price BDT/Cubic Meter)	Weightage (percent of total use of gas)	Weightage (percentage of total use of gas)	Product of price and Weightage	Weighted average price of NG
1	Power	3.16	41.33	0.4133	1.306028	8.03
2	Captive Power	9.62	16.63	0.1663	1.599806	
3	Fertilizer	2.71	5.44	0.0544	0.147424	
4	Industrial	7.76	16.13	0.1613	1.251688	
5	Tea Estate	7.42	0.09	0.0009	0.006678	
6	Commercial	17.04	0.93	0.0093	0.158472	
7	CNG	40.00	4.81	0.0481	1.924	
8	Domestic (Metered)	11.20	14.63	0.1463	1.63856	

Scenario 2:

The present weighted average price of natural gas effective from 1st July, 2019, Tk. 10.29/cubic meter, which has been calculated based on natural gas data presented in the following table.

Table 5: Weighted Average Price of Natural Gas in Bangladesh Considering Natural Gas Price Effective from July 1, 2019

Serial no	Type of users	Price BDT/Cubic Meter)	Weightage (percent of total use of gas)	Weightage (percentage of total use of gas)	Product of price and Weightage	Weighted average price
1	Power	4.45	40.88	0.4088	1.81916	
2	Captive Power	13.85	16.26	0.1626	2.25201	
3	Fertilizer	4.45	4.97	0.0497	0.221165	
4	Industrial	10.70	16.52	0.1652	1.76764	
5	Tea Estate	10.70	0.1	0.001	0.0107	10.29
6	Commercial	23.00	0.88	0.0088	0.2024	
7	CNG	43.00	4.76	0.0476	2.0468	
8	Domestic (Metered)	12.60	15.64	0.1564	1.97064	

Source: BERC, Petrobangla (2017)

Scenario 3:

Natural gas (NG) price commensurate with willingness to pay (WTP) for power (bulk) use of natural gas, Tk.14.70/cubic meter, as per a study carried out by Asian Development Bank (ADB, 2013), is exhibited below:

Table 6: Willingness to Pay (WTP) for Power (bulk) and Domestic Use of Natural Gas According to a Study Carried out by Asian Development Bank

	Present	Present price of NG (Taka per CM)		NG price in case 100% of WTP is captured
		11.20		31.11
Willingness to pay (WTP) for		900.00	[1]	2500.00
NG use in household sector	36%	950.00	[2]	2638.89
Willingness to pay (WTP) for NG use in CNG	66%	40.00		60.61
Willingness to pay (WTP) for NG use in power sector	21.50%	3.16		14.70
Willingness to pay (WTP) for NG use in fertilizer sector	12%	2.71		22.58

[1] Household Domestic NG Price Per Single Burner
[2]Household Domestic NG Price Per Double Burner
Source: ADB, 2013

Scenario 4:

Natural gas (NG) price commensurate with willingness to pay (WTP) for domestic (metered) use of natural gas, Tk. 31.11/cubic meter, as per a study carried out by Asian Development Bank (ADB, 2013), which is shown above in table-6.

Scenario 5:

Natural gas pricing based on opportunity cost or cost of alternative fuel, LNG, which is Tk. 35.17/cubic meter, has been considered as presented below:

Table 7: LNG Price in Bangladesh, 2017

LNG price in Taka, 2017	LNG price in taka/CFT	LNG price in Taka/cubic meter
A	B=AX83/1000	C=BX35.3147
US$12/mmbtu	0.996	35.17

Source: Rahman et al. 2017

Tools for analysis: The net present value (NPV), internal rate of return (IRR) and BCR have been applied for the CBA (financial analysis) of this paper. For carrying out the CBA (financial analysis), a project has been conceptualized by means of domestic loan financing. Considering it a loan-financed project, an amortization schedule has been prepared. The outcome of CBA for NG price Tk.10.29 /Cubic Meter and an amortization schedule are shown in Annexure-2 and 3 respectively.

The Net Present Value (NPV) Approach:

Net present value (NPV) of an investment project can be derived as the difference between the present value of benefits (PVB) and present value of costs (PVC) i.e. NPV =PVB –PVC. The NPV criterion is an absolute figure to decide whether a particular project or a number of alternative projects should be undertaken or not.

$$NPV= \sum_{i=o}^{n} \frac{b_i - c_i}{(1+r)^i}$$

$$NPV= \frac{b_0 - c_0}{(1+r)^0} + \frac{b_1 - c_1}{(1+r)^1} + \frac{b_2 - c_2}{(1+r)^2} + \ldots\ldots\ldots\ldots\ldots + \frac{b_n - c_n}{(1+r)^n}$$

Where,

b_i = benefit derived from the project in year i

c_i = Cost (Investment, operating and other associated expense) incurred by the project in year i

r = discount rate

i = time period which runs from year zero to year n.

The Internal Rate of Return Approach:

The internal rate of return (IRR) represents the discount rate at which net present value is zero and benefit-cost ratio is one i.e. it is the discount rate that equates the sum of present values of project's benefits and costs. IRR does not depend upon externally given social rate of discount. Conversely, what it represents is essentially the average earning power of money used in a project over its lifespan (Chandra, 2014, p.8.14).

A cut-off rate is used in adopting any investment decision for comparing IRR of a specific project. This is the minimum required rate of return on investment. To select one project from two or more projects, we use the criterion of the highest IRR. But in this case this internal rate of return must exceed the cut-off rate.

Based on this, the cost-benefit analysis has been carried out for five different price scenarios, considering the rational rate of discount as stated in the previous section.

The outcome of cost-benefit analysis has been analyzed with a view to finding out the threshold-level pricing of natural gas for which boiler-using industries of Bangladesh would get incentivized for the investment in the efficiency improvement measures and this investment would be worth justifying and worthwhile

4. Results of the Cost-benefit Analysis

Cost-benefit Analysis for energy-efficiency improvement project for all boiler-using industries of Bangladesh have been carried out at five different price scenarios, Tk. 8.03, Tk. 10.29, Tk. 14.70, Tk. 31.11 and Tk. 35.17 per cubic meter of gas, as mentioned above. The outputs of the cost-benefit analyses are presented below:

Table 8: Output of the Financial Analyses of the Energy Efficiency Project for Boiler-using Industries of Bangladesh

Price of natural gas(BDT/Cubic Meter)	NPV (lac BDT)	IRR (%)	BCR
8.03	-16532.33	7.00	0.79
10.29	21103.00	18.00	1.27
14.70	51427.00	27.00	1.66
31.11	245931.00	74.00	4.18
35.17	335867.00	93.00	5.34

The financial analysis reveals that the energy efficiency improvement project for the boiler-using industries of Bangladesh is financially viable, even at the weighted average of present natural gas prices (Tk. 10.29 per cubic meter of natural gas) in Bangladesh by means of a loan financing with an interest rate below 18%. Because an IRR of 18% at Tk. 10.29 per cubic meter of natural gas suggests that NPV of the proposed project becomes zero at a discount rate of 18%, which necessarily means the project to be financially viable at a discount rate/required rate of return lower than 18%. Eventually at the present price of natural gas of the industrial category at Tk. 10.70/cubic meter, which is greater than Tk. 10.29/cubic meter, the project will be financially more viable.

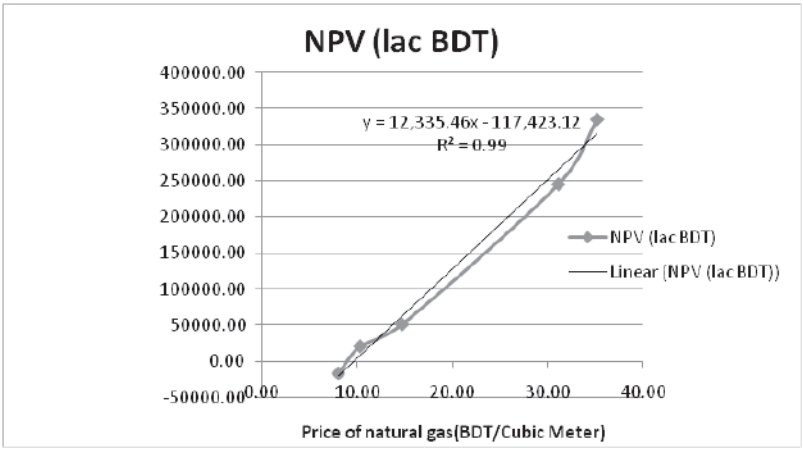


Figure 3: The Relationship Between NPV (finance) and Price of Natural Gas (Tk./cubic meter) for Energy Efficiency Improvement Project of the Boiler-using Industries of Bangladesh

The relationship between NPV and natural gas price (figure 3) indicates that NPV becomes zero at the price of Tk. 9.52 per cubic meter of natural gas. The relationship between IRR (finance) and price of natural gas (Tk./cubic meter) presented below in figure-4 also suggests that the IRR (finance) at the price of Tk. 9.52 per cubic meter of natural gas at which NPV equals zero is 12.53%. This again indicates that the discount rate at which NPV equals zero is 12.53%.

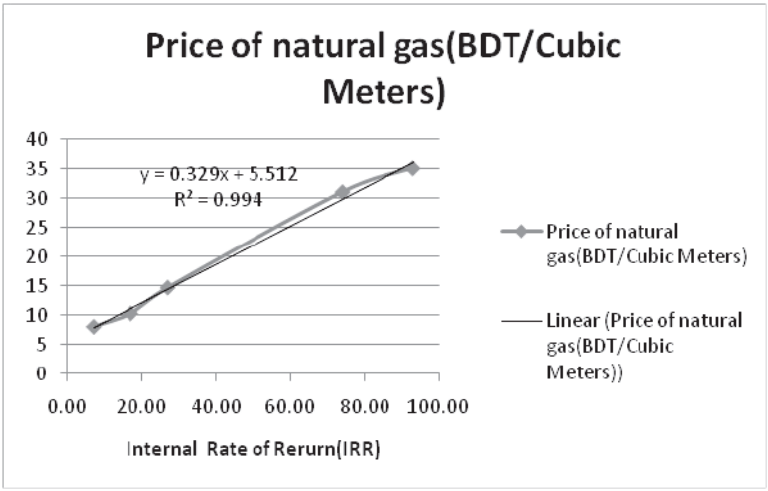


Figure 4: The Relationship Between IRR (finance) and Price of Natural Gas (Tk./cubic meter) for Boiler-using Industries in Bangladesh

5. Conclusion

The findings of the financial analysis suggest that the investment in the proposed energy efficiency improvement project for the boiler-using industries of Bangladesh is financially lucrative even at a financing rate below 18% at a present weighted average natural gas price of Tk. 10.29/cubic meter. This proposed project is expected to exhibit a good quantum of natural gas savings of about 248.82 million cubic meters (mmcm) per annum, which may inevitably substitute the import of nearly the same quantum of LNG. Against this savings, an investment requirement for materializing the proposed project will be about Tk. 77366.94 lac. Positive impacts on the environment in terms of reducing methane and carbon dioxide will also be enormous. Similarly, the conservation of natural resources in terms of reduced water and power requirements induced by natural gas efficiency are also worth mentioning.

Taking into the huge positive impacts on economics, it is high time the government came forward to finance the proposed project by means of soft/subsidized loan from foreign donor agencies such as JICA, ADB, IDA and local sources like Bangladesh Bank (BB), local commercial banks (both government and private) and other financial intermediaries. Government may channel this loan to respective industry owner's association, such as BGMA to avoid lending risks associated with individual industrial owner. Considering a lucrative IRR, energy services company (ESCO) may also be encouraged to invest the project and share the benefit of gas savings with the owners of the industries. The government, Bangladesh Bank, commercial banks and other financial intermediaries should lend to ESCO at a soft/subsidized rate as part of their green investment policies. As the project is financially lucrative, the Govt. should consider adopting regulatory measures against the boiler-using industries that are unwilling to take energy efficiency improvement measures even after getting financing facilities for the sake of arresting rampant wastage of natural gas.

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Annexure 1: Assessment of Natural Gas Utilization Efficiency in the Boiler-using Industries in Bangladesh, Their Savings Potential and Investment Requirement.

Number of boilers	Serial number of industries	Name &Adress of industries using boiler(s)	Boiler Capacity (Ton/hr)	Combustion Efficiency (%)	Boiler Efficiency (%)	Economiser	Condensate Recovery	Blow Down	Baseline Consumption (SCM/Year)	Savings Potentials					Name of Gas Distribution Company	Initial investment required(BDT)						
										Combustion	Condensate	Exhaust	Pressure	Total		Condensate (Material)	Exhaust (Material)	Installiocost (10% of material cost)	Ocean freight(5% of material cost)	Commissioning cost (10% of material cost)	Import duty (3% of condensate material and 40% of exhaust material)	Total initial investment (BDT)
1	1	Bangladesh Edible oil	10	82.70	81.20		1		6574231	14506	75155	75155		333574	TGTDCL	1500000	1200000	405000	135000	270000	525000	4035000
2	2	Classic Composit	7.5	81.29	79.79				5078813	96536	150681	150681	5007	209011	TGTDCL	1125000	1200000	348750	116250	232500	513750	3536250
3	3	Alema Textile	7.71	80.86	79.36		1		3450034	26587	0	153090	16976	195914	TGTDCL	1156500	1200000	353475	117825	235650	514695	3578145
4	4	Arunima Sports wear Ltd	0.5	76.80	75.30		1		249118	20036	18648		0	45903	TGTDCL	100000		15000	5000	10000	3000	133000
5			0.157	75.40	73.90		1		79543	2423	6290		0	11438	TGTDCL	31400		4710	1570	3140	942	41762
6			0.157	74.30	72.80		1		80751	6597	6048		0	15061	TGTDCL	31400		4710	1570	3140	942	41762
7			0.1	74.10	72.60		1		81009	6345	6089		0	14881	TGTDCL	20000		3000	1000	2000	600	26600
8			0.157	74.10	72.60		1		81013	6504	6077		0	15019	TGTDCL	31400		4710	1570	3140	942	41762
9	5	Bay Rubber	1	84.94	83.44		1		303548	484	17885	25665	474	18845	TGTDCL	200000	700000	135000	45000	90000	286000	1456000
10	6	Beacon Knitwear	10	82.67	81.17		1		5306910		218629	218629		210306	TGTDCL	1500000	1500000	450000	150000	300000	645000	4545000
11	7	Colombia Washing	2.5	83.00	81.50		1		91926	11053	41140	41140		108124	TGTDCL	500000	800000	195000	65000	130000	335000	2025000
12	8	Dynamic Sweater Ind Ltd	0.5	78.72	77.22				180695		1100		830	1930	TGTDCL	100000		15000	5000	10000	3000	133000
13			0.5	78.22	76.72				181872		1107		835	1943	TGTDCL	100000		15000	5000	10000	3000	133000
14			0.5	78.85	77.35				180389	0	1098		829	1927	TGTDCL	100000		15000	5000	10000	3000	133000
15	9	Evence Textile	4.7	84.50	83.00				2125362	36363	134061	28596	0	199020	TGTDCL	940000	1000000	291000	97000	194000	428200	2950200
16	10	Fareast Knitting & Dyeing Ltd	6.5	85.97	84.47	1	1	A	4043177						TGTDCL	975000		146250	48750	97500	29250	1296750
17			0.5	81.76	80.26	1	1	A	325659	2502	11273			5641	TGTDCL	100000		15000	5000	10000	3000	133000
18	11	Ismail Anjumanara	4	88.57	87.07				2844968	79458	53453	53453		386144	TGTDCL	800000	1000000	270000	90000	180000	424000	2764000
19			4	88.10	86.60				2754330	16195	52414	52414		319343	TGTDCL	800000	1000000	270000	90000	180000	424000	2764000
20	12	Lucky Dyeing	10	86.70	85.20	1		A	6568760	8889	526927			408612	TGTDCL	1500000		225000	75000	150000	45000	1995000
21	13	Model D Capirtal	8	**80.95**	**79.25**				4248533	0	0	164407	25419	189826	TGTDCL	1200000	1500000	405000	135000	270000	636000	4146000
22	14	NRG Composite Yarn Dyeing	10.2	83.69	82.19		1		4378423	12582	36566	99956	21794	170415	TGTDCL	1530000	1500000	454500	151500	303000	645900	4584900
23			10.2	83.78	82.28		1		4373995	21146	36457	92547	21729	171432	TGTDCL	1530000	1500000	454500	151500	303000	645900	4584900
24			10.2	83.83	83.33		1		4371252	16634	36472	93785	21738	168176	TGTDCL	1530000	1500000	454500	151500	303000	645900	4584900
25	15	Pantex	0.5	74.77	73.27		1								TGTDCL	100000		15000	5000	10000	3000	133000
26	16	Ploy Fabrics Ltd	0.5	83.90	82.40				1337542	16382	23534			21794	TGTDCL	100000		15000	5000	10000	3000	133000
27	17	RobinTex Ltd	7	86.22	85.72	1	1	A	4152396	18315	0	9379		13467	TGTDCL	1400000		210000	70000	140000	42000	1862000
28	18	Sahaba Textile	3.5	**82.50**	**81.00**		1		1555308	15001	43498	44052	7530	109872	TGTDCL	700000	700000	210000	70000	140000	301000	2121000
29	19	Sam Ree ltd	8	86.00	84.50				3593044	3619	288930	50418	0	342967	TGTDCL	1200000	1000000	330000	110000	220000	436000	3296000
30			4	82.60	81.10				1863752	62780	145585	30468	0	238832	TGTDCL	800000	1000000	270000	90000	180000	424000	2764000
31	20	SAP Fashions	0.412	79.41	78.91	1			203005	4317	5337		814	5131	TGTDCL	82400	0	12360	4120	8240	2472	109592
32			0.292	78.86	77.36	1			142723	3097	3986		572	3669	TGTDCL	58400	0	8760	2920	5840	1752	77672
33	21	Sim Fabrics	5	87.46	85.96	1	1		2674038	74309	51266		10649	84958	TGTDCL		0	0	0	0	0	0
34	22	Suba Nuba Garments	0.35	77.65	76.15				83881	1832	6735	9980	0	8567	TGTDCL	70000	500000	85500	28500	57000	202100	943100
35	23	Zarba Textile	3	84.80	83.30		1		1930145	2042	59472	27809		95168	TGTDCL		800000	120000	40000	80000	320000	1360000
36	24	A Sobhan	1.8	82.56	81.06	1	1		747657.21	50906	23634	30569		120167	TGTDCL		0	0	0	0	0	0
37	25	Abdul Monem Ice Cream	2.8	84.80	83.30				871492	0	71663	13239	0	84902	TGTDCL	560000	700000	189000	63000	126000	296800	1934800
38	26	Abontl Color	6	80.90	79.40				2779722	53557	151019	111455	0	316030	TGTDCL	1200000	1000000	330000	110000	220000	436000	3296000
39	27	Adhunic Paper	7.5	83.80	82.30		1		4895907	14921	100962	107762		198351	TGTDCL		1000000	150000	50000	100000	400000	1700000
40	28	AMC Knit	7.7	81.90	80.40		1		2893071		53939	110905	0	162502	TGTDCL		1000000	150000	50000	100000	400000	1700000
41	29	Amex Knitting & Dyeing Ltd Boiler	3.5	81.50	80.00		1	TDS	1368664	7696	0	56772	0	56772	TGTDCL		800000	120000	40000	80000	320000	1360000
42			4	86.10	84.60	1	1	TDS	1489421	0	0	0	11754	0	TGTDCL		0	0	0	0	0	0
43	30	Ananta Denim	6	81.90	80.40		1		298354	139516	0	141529		135530 7	TGTDCL		800000	120000	40000	80000	320000	1360000

44	31	Apollo Ispat	6	81.80	80.30				2824262	66523	222836	62349	0	297076	TGTDCL	900000	800000	255000	85000	170000	347000	2557000
45			2.5	84.20	82.70				1141133	29586	89965	3375	0	61224	TGTDCL	500000	700000	180000	60000	120000	295000	1855000
46	32	Apparel 21	10	83.60	82.10		1		3730562	3089	27997	127037	10085	167868	TGTDCL		1500000	225000	75000	150000	600000	2550000
47	33	ASM Chemical	4	82.91	81.41		1		886397	6003	869	23826	4790	34495	TGTDCL		1000000	150000	50000	100000	400000	1700000
48			5	82.52	81.02		1		1113359	14814	1084	29016	5977	49657	TGTDCL		1000000	150000	50000	100000	400000	1700000
49	34	Astex Garments	0.1	69.13	67.63			TDS	50452	9923	0	0	0	9923	TGTDCL	20000	500000	78000	26000	52000	200600	876600
50	35	Baly	7	86.53	85.03				2651740	315122	193249	0	0	508371	TGTDCL	1050000	1000000	307500	102500	205000	431500	3096500
51			7	84.90	83.40				2708450	87027	216801	0	0	303828	TGTDCL	1050000	1000000	307500	102500	205000	431500	3096500
52	36	Becon Pharma	3.6	81.58	80.08		1		2553979	15563	50489	93794	63616	160223	TGTDCL		800000	120000	40000	80000	320000	1360000
53	37	Comfit Knit composit	6	80.60	79.10		1		4307375	252685	177125	145835	89849	55601	TGTDCL		1000000	150000	50000	100000	400000	1700000
54			6	83.00	81.50		1		4182547	24536	124367	104744	33288	7497	TGTDCL		1000000	150000	50000	100000	400000	1700000
55	38	DB Tex Ltd	3	85.60	85.10	1	1		1299145	7739	9741	28699	0	46179	TGTDCL		0	0	0	0	0	0
56			10.2	83.46	88.50	1	1		3731134	-1684	68752	0	0	67067	TGTDCL		0	0	0	0	0	0
57			10.2	83.45	88.49	1	1		3731604	-3511	68794	0	0	65283	TGTDCL		0	0	0	0	0	0
58			10.2	83.58	88.63	1	1		3725749	0	68621	0	0	68621	TGTDCL		0	0	0	0	0	0
59	39	DirdCompos it Ltd	1.5	83.45	80.95		1		1018631	13538	19138	23028	0	55030	TGTDCL		700000	105000	35000	70000	280000	1190000
60			5.443	83.45	80.95		1		3657326	5831	31474	116592	0	150515	TGTDCL		1000000	150000	50000	100000	400000	1700000
61			7.257	83.86	82.36		1		4857178	6533	58517	0	0	65049	TGTDCL		1000000	150000	50000	100000	400000	1700000
62			10.9	73.09	71.59		1		8418120	1196730	187444	77619	0	145949 6	TGTDCL		1500000	225000	75000	150000	600000	2550000
63	40	East Asia Cox	4	81.32	79.82		1		1769445	5609	13597	73717	5095	97820	TGTDCL		1000000	150000	50000	100000	400000	1700000
64	41	Envoy Textile Ltd	7.7	81.44	79.94		1		3620848	6258	94576	241767	11543	259106	TGTDCL		1000000	150000	50000	100000	400000	1700000
65			7.7	80.91	79.41		1		3649440	59951	88129	219118	16878	295346	TGTDCL		1000000	150000	50000	100000	400000	1700000
66	42	Fakhruddin Textiles	4.5	81.60	80.10		1		1978357	16899	15171	109907	20124	144102	TGTDCL		1000000	150000	50000	100000	400000	1700000
67			4.5	82.86	81.36		1		1947765	33064	31377	75614	19644	125881	TGTDCL		1000000	150000	50000	100000	400000	1700000
68			6.0	82.16	80.66		1		2619762	34668	32391	124322	26523	181992	TGTDCL		1000000	150000	50000	100000	400000	1700000
69	43	Garments Export Village	3.5	86.96	85.46		1		2205565	92215	4152	63529	0	159898	TGTDCL		800000	120000	40000	80000	320000	1360000
70			1	86.11	84.61		1		636452	26034	1199	18347	0	45581	TGTDCL		700000	105000	35000	70000	280000	1190000
71	44	Hams Garments	7.7	82.06	80.56		1		1980398	0	0	68365	0	68365	TGTDCL		1000000	150000	50000	100000	400000	1700000
72			4.5	82.02	80.52		1		1157962	0	0	40384	0	40384	TGTDCL		1000000	150000	50000	100000	400000	1700000
73	45	Incepta Pharmaceut ical	5	83.34	82.84		1		1368141	20772	0	18891	0	46401	TGTDCL		1000000	150000	50000	100000	400000	1700000
74			2	82.50	81.00		1		598297	9209	37639	15790	0	70119	TGTDCL		700000	105000	35000	70000	280000	1190000
75	46	Interstoff	5.9	80.25	78.75		1		2478026	88053	119005	186698	161419	431353	TGTDCL		1000000	150000	50000	100000	400000	1700000
76	47	JM Fabrics Ltd	7.8	86.17	85.48	1	1		3326092	11066	129762	12014	25878	178641	TGTDCL		0	0	0	0	0	0
77			7.8	86.16	85.39	1	1		3199258	12890	0	12771	25903	51462	TGTDCL		0	0	0	0	0	0
78	48	Limvotex	7.7	82.80	81.30		1		3382668	28834	92666	143038	4995	351416	TGTDCL		1000000	150000	50000	100000	400000	1700000
79	49	Lion Feed Ltd	1.5	82.80	81.30		1		425688	17205	0	11673	0	28878	TGTDCL		800000	120000	40000	80000	320000	1360000
80	50	Megha Yarn Dyeing	10	79.79	78.20		1		6972457	89204	82483	344564		432000	TGTDCL		1500000	225000	75000	150000	600000	2550000
81	51	Modele De Capital		82.70	81.20		1		4248533	0	0	164407		164407	TGTDCL		1000000	150000	50000	100000	400000	1700000
82	52	P.N. Composite	6	83.44	81.94		1		2628632	34806	49859	70739	0	155404	TGTDCL		1000000	150000	50000	100000	400000	1700000
83			10	82.27	80.77		1		4318566	-5916	83127	115264	0	192475	TGTDCL		1500000	225000	75000	150000	600000	2550000
84	53	Tamim Agro Ind. Ltd.	0.5	83.76	82.26			M	231181	535	18874	6859	85	26351	PGDCL	100000	500000	90000	30000	60000	203000	983000
85			3	84.44	82.94		1	M	1246836	-13695	-6890	35117	519	15038	PGDCL		800000	120000	40000	80000	320000	1360000
86			8	82.42	80.92		1	M	4931748	8652	11984	181518	29844	230837	PGDCL		1000000	150000	50000	100000	400000	1700000
87	54	Abdul MonemBev arage	3	83.62	82.12		1	M	1299145	7739	9741	28699	0	46179	BGDCL		800000	120000	40000	80000	320000	1360000
88	55	Globe Soft Drinks	5	86.61	85.11	1		M	1928208	7928	147968	0	0	155896	BGDCL	1000000		150000	50000	100000	30000	1330000
89	56	Globe Biscuit & Dairy Milk Ltd.	5	80.01	78.51	1		M	2090236	15264	149304	56862	0	358810	BGDCL	1000000		150000	50000	100000	30000	1330000
90			5	79.94	78.44	1		M	2092293	16381	129988	66752	0	360557	BGDCL	1000000		150000	50000	100000	30000	1330000
91	57	Kenpark Bangladesh (Pvt) Ltd. Unit-1	2	80.63	79.13	1	1	M	692824	0	0	35168	0	35168	KDGCL			0	0	0	0	0
92	58	Kenpark Bangladesh (Pvt) Ltd. Unit-2	4	85.15	83.65	1	1	M	1301555	0	0	13755	6221	19912	KDGCL			0	0	0	0	0
93	59	Kenpark Bangladesh (Pvt) Ltd. Unit-3	1.112	84.43	82.93		1	M	289188	0	7093	12130	0	12130	KDGCL		800000	80000	40000	80000	320000	1320000
94	60	Kenpark Bangladesh (Pvt) Ltd. Unit-4	5	82.41	80.91	1	1	M	1315875	6641	0	41400	0	48041	KDGCL			0	0	0	0	0

95	61	Karnafully Steel Mills Ltd	2	84.97	83.47			M	583834	0	36280	44327	2875	47169	KDGCL			0	0	0	0	0
96	62	Bay Fishing Corporation Ltd.	7	81.10	79.60	1	1	M	2897557	1361	110487	236633	26362	263249	KDGCL			0	0	0	0	0
97			6.3	80.20	78.70	1	1	M	2643268	0	97590	235500	0	235500	KDGCL			0	0	0	0	0
98	63	Ching Hung Fiber Ltd.	7	81.73	80.23	1	1	M	2144601	1358	175297	254630	5272	261060	KDGCL			0	0	0	0	0
99	64	Riff Leather	1.5	83.74	82.24			M	728019	487	36415	71821	0	72308	KDGCL	300000	800000	110000	55000	110000	329000	1704000
100	65	Apex Yarn Dyeing Ltd.	16	84.93	83.43	1	1	M	4498872	252810	0	0	0	252810	KDGCL	0	0	0	0	0	0	0
Total			493.547						23285117	4435173	5883655	7555622	743736	1601595	SCM	30591500	63100000	9369150	4684575	9369150	2615774	143272120
Savings potential										1.90%	2.53%	3.24%	0.32%	6.88%								

Total Boiler no	5400	
Investment /boiler (Tk.)	1432721.2	
Total invest(Tk.)	7736694480	
Total invest (lac Tk.)	77366.9448	

Annexure 2: CBA (Financial analysis) of Natural Gas Utilization Efficiency Improvement Project for the Boiler-using Industries of Bangladesh, at the Present Weighted Average Price of Natural Gas,Tk.10.29/Cubic Meter in Bangladesh.

Project cashflow for financial analysis																Lac BDT
			Project life		0	1	2	3	4	5	6	7	8	9	10
A.	Revenue														
	1	Revenue from gas savings with the project				25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32
	2	Revenue from gas savings without the project				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	Labour and Admin cost with the project				0	0	0	0	0	0	0	0	0	0
	4	Labour and Admin cost without the project													
	5	Electricity cost with the project													
	6	Electricity cost without the project													
	7	Incremental revenue from gas savings				25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32
	8	Incremental revenue revenue from cost savings				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9	Revenue decline for additional Electricity cost				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10	Total Incremental revenue for the project				25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32
B.	Investment cost														
	1	Loan from commercial bank/financial institute			-77366.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	Equity				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C.	Cash inflow (BDT Thousand)														
	1	Incremental revenue from savings				25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32
	2	Eqiuty				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Total cash inflow			25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32	25603.32
D.	Cash outflow (BDT Thousand)														
	1	O&M cost				2048.27	2150.68	2258.21	2371.12	2489.68	2614.16	2744.87	2882.12	3026.22	3177.53
	2	Depreciation				15473.39	15473.39	15473.39	15473.39	15473.39	0.00	0.00	0.00	0.00	0.00
	3	Interest on loan debt				9284.03	8355.63	7427.23	6498.82	5570.42	4642.02	3713.61	2785.21	1856.81	928.40
	4	Scheduled loan repayments				17020.73	16092.32	15163.92	14235.52	13307.11	12378.71	11450.31	10521.90	9593.50	8665.10
E.	Net taxable cash flow(cumulative)					0.00	0.00	444.49	1259.98	2069.83	18347.14	19144.83	19935.99	20720.29	21497.38
	4	Income tax				0.00	0.00	111.12	315.00	517.46	4586.78	4786.21	4984.00	5180.07	5374.35
F.	Net cash flow- after tax				-77366.94	15473.39	15473.39	15917.88	16733.37	17543.22	18347.14	19144.83	19935.99	20720.29	21497.38
			NPV		21,103	lac BDT									
			IRR		18%										
			BCR		1.27										

Annexure 3: Amortization Schedule for the Required Investment for Ensuring Natural Gas Utilization Efficiency for Boiler-using Industries in Bangladesh.

		Amortization schedule			Lac BDT
	Investment required	77366.94			
	Discount rate	12%			
	Tenure of loan payment	10			
year	Beginning balance	Scheduled loan payment (Equal installment)	Interest Payment	Principle amount	Ending Balance
1	77366.94	17020.73	9284.03	7736.69	69630.25
2	69630.25	16092.32	8355.63	7736.69	61893.56
3	61893.56	15163.92	7427.23	7736.69	54156.86
4	54156.86	14235.52	6498.82	7736.69	46420.17
5	46420.17	13307.11	5570.42	7736.69	38683.47
6	38683.47	12378.71	4642.02	7736.69	30946.78
7	30946.78	11450.31	3713.61	7736.69	23210.08
8	23210.08	10521.90	2785.21	7736.69	15473.39
9	15473.39	9593.50	1856.81	7736.69	7736.69
10	7736.69	8665.10	928.40	7736.69	0