Business Case: Boiler Economisers

Support to Safety Retrofits and Environmental Upgrades in the Bangladeshi Ready-Made Garment (RMG) Sector

It is Worth to Retrofit Boilers with Economisers

The textile sector is a highly energy-demanding industry. Particularly during dyeing and finishing, large quantities of energy are continuously required to generate hot water and steam. However, a significant fraction (20-50%) of the required energy gets wasted by being released to the environment via exhaust gases from boilers. This waste heat which can be of low grade (<100°C),medium grade (100°C–400°C), or high grade (>400°C) is a valuable resource[1]. Retrofitting boilers with economisers can therefore help to achieve significant cost savings, improving both profitability and competitiveness.

Advantages of Economisers at a glance:

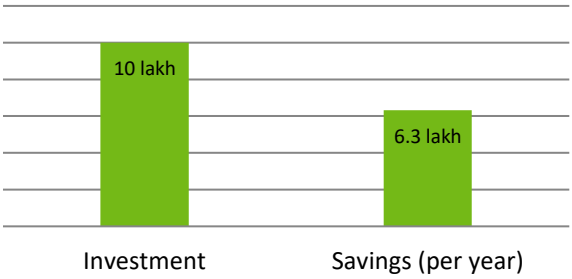
- Enhanced Resource Efficiency
- Reduced energy costs
- Reduced GHG emissions

Boiler economisers work on the basis of extracting and reusing waste heat energy from boiler flue gases or condensate, which otherwise dissipates to the environment at temperatures around 260°C.The recovered heat can be used to pre-heat boiler makeup water, saving on energy inputs which otherwise will be required to pre-heat the water and therefore improving boiler efficiency.

Generally, boiler efficiency can be increased by 1% for every 22°C reduction in flue gas temperature. However, the temperature to which flue gases of natural gas-powered boilers are cooled should not fall below 120°Cto prevent condensation and possible corrosion of the stack. Thus, a conventional feed water economiser can usually improve the boiler efficiency from 80% up to 86%, reducing fuel requirements by 5% to 10%.[2]

In case the boiler efficiency should be further improved, the installation of condensing economisers can be considered. Condensing economisers improve waste heat recovery by cooling the flue gas below its dew point which is 57°C for products of combustion of natural gas. Condensing economisers are able to reclaim both sensible heat(from the flue gas) and latent heat (by condensing flue gas into water vapour) from flue gas, therefore improving overall boiler efficiency up to 95%[3]. However, based on the high investment costs for condensing economisers, which are almost three times as high as those for conventional economisers, condensing systems only make up a small fraction of the industrial boiler market[4].

Approximate Investment Cost and Annual Savings (BDT)



Case study result from Zaber & Zubair Fabrics

Given the significant fuel saving potential, the pay-back period of boiler economisers is usually less than 2 years, depending on the technology, quality and quantity of waste heat and the development of the prices for fossil fuels.

Detailed information about the cost and benefits of retrofitting boilers with economisers can be found on the next page. Moreover, the case study is referring toa real life data from a company in Bangladesh on page 3. The pages 4 to 5 contain further technical details on the installation and implementation process as well as legal requirements and possible means of financing.

[1] PaCT (n.d.). Cleaner Production Case Study: Waste Heat Recovery

[2] US DOE (2012). Steam Tip Sheet #3

[3] US DOE (2012). Steam Tip Sheet #26A

[4] US DOE (2008). Waste Heat Recovery: Technology and Opportunities in U.S. Industry

Saving Energy and Reducing Fuel Consumption

Recovering and reusing waste heat from boilers bears significant energy and fossil fuel saving potentials. The estimated energy and fuel saving potential of economisers relevant for the textile industry are indicated in the boxes below:

Reduced energy costs and fossil fuel demand	Recovering and reusing waste heat from hot boiler flue gases can significantly reduce a factory`s energy demand. By retrofitting a standard 80%-efficient boiler which produces 450kg of 10 bar steam per hour, has a stack temperature of 260°C and an operating time of 8,400 hours per year, with a conventional feed water economiser the factory can realises annual savings of around BDT 1.07 crore (given the prevalent average fuel cost for industrial use natural gas of BDT 8 per m^3).[5,6]When retrofitted with a condensing economiser the boiler efficiency would be further improved, resulting in annual savings of BDT 1.76 crore.[7]

Other Benefits

Reduced Greenhouse Gas (GHG) Emissions	Since the economisers reduce the demand for energy and fossil fuels, the GHG emissions will decrease correspondingly. Experiences from the Bangladesh textile sector show that GHG emissions can be reduced by 14% (from 5 tonnes to 4.3 tonnes per kg fabric)
Reduced wastewater disposal cost	Reusing condensate from boilers reduces the amount of discharged water into the sewer system, therefore leading to lower disposal cost for the factory.

Boiler Economizer at Zaber & Zubair Fabrics Ltd.

[5] Calculation based on US DOE (2012). Steam Tip Sheet #3

[6]Dhaka Tribune (2017). LNG imports to raise price of gas. Available online at : https://www.dhakatribune.com/bangladesh/power-energy/2017/12/24/lng-imports-raise-price-gas/

[7] Calculation based on US DOE (2012). Steam Tip Sheet #26A

Calculating the Cost of Economisers

The costs of retrofitting boilers with economisers depend heavily on the type of technology, the quality, quantity and chemical composition of the available waste heat within the factory as well as the minimum allowable temperature. The costs for this improvement measures can be in the range of BDT 10– 24 lakh.

In addition to the initial investment and installation costs, please take into consideration annual maintenance costs which may arise in your factory.

The following table shows typical investments required for the installation of boiler economisers:

Possible investments Boiler Economisers[8]:

Type of Investment	Average Cost (BDT)[9]
Heat exchanger	6 lakhs
Wiring and piping work	2 lakhs
Submersible water pump	0.4 lakh
Ancillary equipment	0.5 lakh
Control board	0.6 lakh
Auto valve	0.32 lakh
Flow meter	0.24 lakh
Other (instruction, test operation)	
Total Costs and net present value	**Around 10 lakh**
Average amortization/Payback period	**2 Years**

Boiler, Zaber & Zubair Fabrics Ltd.

[8] PEAR Carbon Offset Initiative (2014). Waste Heat Recovery and Utilization in Textile and Garment Factories. Final Report

[9]Remediation cost for the whole factory

Case Study Spotlight: Zaber & Zubair fabrics ltd., Dhaka, Bangladesh

Description of the Factory

Zaber& Zubair Fabrics was incorporated in 1997 and commenced its commercial production in March 2000. The manufacturing process of Zaber & Zubair is vertically integrated, with spinning, weaving, printing and dyeing including back process like a CAD design studio, a continuous bleaching plant as well as a stitching unit. The textile mill is located in Tongi, close to Dhaka. The textile mill has a daily production capacity of about 230,000 meters of finished fabrics or 46,000 sets of various home textile products, including bed linens, window furnishings, and table and kitchen linen.

Implemented Measures

Steam is one of the most vital inputs necessary for dyeing & finishing of garments. The factory's thermal energy demand is met by four natural gas fired steam boilers, each with a capacity of 15 ton per hour (TPH) operated at a pressure of 6 bars. To produce the necessary steam, Zaber & Zubair Fabrics originally was heating up cold water (32 °C) with their natural gas fired boilers. Flue gases with a temperature of about 140 °C generated during this process were not recovered but emitted to the environment.

In order not to waste the substantial heat energy contained in the flue gases, Zaber & Zubair Fabrics decided to invest in a Boiler

Economizer. The economizer preheats (air to water heat exchanger) the supply water using waste heat from flue gases

Before the water is steamed in the boiler, the economizer heats the cold water (32 °C) to 68°C, while the flue gases used in this process are cooled to around 86 °C. By pre-heating the water using waste heat, the boilers require less energy to produce the steam as the water has already been heated to 68°C instead of starting the heating process from the original 32 °C.

The implementation of the system took one month. The works included the modification of the flue gas line and other necessary changes.

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Boiler, Zaber and Zubair Fabric Ltd.

Investments and Savings

In total Zaber & Zubair Fabrics invested BDT 11 lakh to install the Boiler Economizer in their factory. The economic benefit from investing in a Boiler Economizer is reducing the demand for purchased energy as all waste heat is successfully recovered and reused. Through the installation of the economiser Zaber & Zubair Fabrics saves about 2,526 GJ, i.e. about 70,150 m^3in natural gas per year. In financial terms this translates into savings of BDT 6.3 lakh per year. Consequently, the payback period of the Boiler Economiser is roughly 19 months.

Key Performance Measures

Before installing the Boiler Economizer Zaber & Zubair Fabrics energy consumption was 41.9 NGm^3/ton. Upgrading the thermal system resulted in a reduction of energy consumption of 2 NGm^3/ton. Moreover, Green House Gas emissions could be reduced to 142 t CO_2 a year.

Economisers of Zaber and Zubair Ltd.

Closer look of Boiler Economisers of Zaber and Zubair Fabric Ltd.

References for the Installation of WHR Systems in Bangladesh

Although no binding of legal references regarding the efficient use of energy have come into effect in Bangladesh yet (as per May 2018), the Government has recognized the increasing importance of energy as a factor for economic growth and declared Energy Efficiency to be a cross-cutting issue for the country. To improve the countries energy efficiency, the Sustainable and Renewable Energy Development Authority (SREDA) in 2013 published the "Energy Efficiency and Conservation Master Plan (EECMP) up to 2030". The EECMP aims at improving energy intensity (national primary energy consumption per gross domestic product/GDP) by 20% in 2030 compared to the 2013 level.

Under the action-plan of the EECMP, three EE&C programs are being promoted, namely, (1) Energy Management Program, (2) EE Labelling Program and (3) EE Buildings Program. In particular, the Energy Management program targets large industrial energy consumers in Bangladesh. Policy measures which are planned to be implemented in the next years include (amongst others): (i) Mandatory energy audits, (ii) energy consumption reporting and (iii) benchmarking. Furthermore, the authority is planning to develop and recommend procedures and regulations for the implementation of minimum energy performance standards and energy efficiency labelling for equipment and appliances[10].

Apart from this, the further development of energy prices (in particular of gas) in Bangladesh is relevant issue to be taken into account in the context of considering energy efficiency measures. In February 2017, the price of domestic gas was already hiked by 22.70% resulting in a price of BDT 7.35 per cubic meter of gas.[11] For 2018 the Government of Bangladesh plans to include LNG in the national Gas Grid by further increasing imports of LNG and developing the LNG import infrastructure. Since LNG is more expensive than domestic gas, the Energy and Mineral Resources Division took the initiative to off-set the cost by raising commercial consumer prices. To cope with this price hike the Bakhrabad Gas Distribution Company (BGDC) recently proposed the Bangladesh Energy Regulatory Commission (BERC) to again hike commercial prices for gas by up to 70%[12].Given the increasing demand for natural gas, prices are expected to further rise in the future (See table below).

Gas price per cubic meter in Bangladesh[13]

Sector	Current Price	Price if draft of hike passed
Power Sector	Tk 3.16	Tk 4.99
Fertilizer Sector	Tk 2.71	Tk 4.75
Industrial Gas	Tk 7.35	Tk 14.90
Commercial Gas	Tk 17.04	Tk 35
Household Gas	Tk 9.10	Tk 11.20
CNG	Tk 7.42	Tk 12.10

Key Steps Required for Implementation

As per experience from the case study company, the installation of economisers for boilers within a factory can be realized within about one month (including planning and design).

The following steps might help you to implement such a measure in your factory[14,15]:

- Determine the stack temperature after the boiler has been tuned to manufacturer's specifications. The boiler should be operating at close-to-optimum excess air levels with all heat transfer surfaces clean.
- Determine the minimum temperature to which stack gases can be cooled subject to criteria such as dew point, cold-end corrosion, and economic heat transfer surface.
- Study the cost-effectiveness of installing a feed water or condensing economiser in your boiler
- Planning and installation of the selected economiser system
- Monitoring and maintenance

Availability of Materials in Bangladesh

The majority of required materials can be sourced via local traders; certain components still need to be imported. Please contact Zaber & Zubair Fabrics for their recommendation.

Nature of Services Required to Support the Implementation

- Pre assessment for identifying the amount of waste heat based on flue gas temperature and fuel consumed in base boilers, design the boiler capacity based on waste heat availability and steam/ hot water property required.
- Installation and commission conducted by a certified operator is required for the steam system and the chemical water pre-treatment

[10]SREDA (2015). Energy Efficiency and Conservation Master Plan up to 2030

[11]Mahfuj Risad (2018). Titas, Bakhrabad, Karnaphuli sought Price hike of Gas. Available online at: https://energybangla.com/titas-bakhrabad-karnaphuli-sought-price-hike-of-gas/. Last checked on 08.05.2018

[12]Sanchita Shetu (2018). Commercial gas price might rise by 70%, household gas could cost double. Available Online at: https://www.dhakatribune.com/bangladesh/power-energy/2018/03/22/commercial-gas-price-rise/. Last checked on 08.05.2018

[13]Dhaka Tribune (2017). LNG imports to raise price of gas. Available online at : https://www.dhakatribune.com/bangladesh/power-energy/2017/12/24/lng-imports-raise-price-gas/. Last checked on 14.06.2018

[14]Simeone, A. et al. (2014). A decision support system for waste heat recovery in manufacturing

[15] US DOE (2012). Steam Tip Sheet #3

- Maintenance services conducted by either in-house engineers or external service providers

Sources of technical support/expertise used

For further technical details and guidance regarding the installation of economisers the following resources can be used:

- Simeone, A. et al. (2014). A decision support system for waste heat recovery in manufacturing
- Sonawane, V.J &Keste, A.A. (2016). Waste Heat Recovery in Textile Industry: A Review
- US Department of Energy (n.d.). Steam Tip Sheets
- Pattanapunt, P. et al. (2013). Waste Heat Recovery from Boiler of Large-Scale Textile Industry

Possible Sources for Financing

SREUP credit line could be a good source of financing for such an investment.

Main Feature of SREUP Credit Line	
Loan Type	Normally Term Loan
Discount	Provision and possibility of 20% discount from loaned amount
Loan Tenure	3-5 years in general and in special case up to 7 years
Loan Limit	Normally up to 1 Million Euro and can be increased up to 3 Million Euro in special cases
Interest Rate	7% p.a. (maximum)
Grace period. Debt : Equity Ratio. Repayment	All issues are subject to agreement between borrower and lender

Steam pressure meter of Boiler

Steam Flow Meter

Tank

Conclusion

It could be a good investment for energy efficiency in RMG factories which will also contribute to the environment by lower carbon emission.