DETAILED PROJECT REPORT
ON
ENERGY EFFICIENT BURNER
(JORHAT TEA CLUSTER)

ENERGY IS LIFE
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Bureau of Energy Efficiency

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ENERGY EFFICIENT NATURAL GAS BURNER (150 kg D.M.T. / HOUR)

BEE, 2010

Detailed Project Report on Energy Efficient Natural Gas Burner (150 kg D.M.T. / Hour)

 Jorhat Tea Cluster, Assam (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **PCRA/JTC/ SAG/ ____**

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Petroleum Conservation Research Association

Guwahati

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List of Abbreviation

BEE	Bureau of Energy Efficiency
MSME	Micro Small and Medium Enterprises
MoMSME	Ministry of Micro Small and Medium Enterprises
SIDBI	Small Industrial Development Bank of India
CDM	Clean Development Mechanism
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
DMT	Dried Made tea
GHG	Green House Gases
IRR	Internal Rate of Return
MT	Million Tonne
MW	Mega Watt
NG	Natural Gas
NPV	Net Present Value
ROI	Return on Investment
SCUM	Standard Cubic Meter

EXECUTIVE SUMMARY

Petroleum Conservation Research Association (PCRA) is executing the BEE – SME program for Jorhat Tea Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Jorhat cluster is one of the largest tea clusters in India; accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient measures/technologies, so as to facilitate maximum replication in other tea clusters in India. The main energy forms used in the cluster units are grid electricity, Natural gas, coal, and Diesel oil mainly to provide power during off – grid period

During tea processing, the bulk of the thermal energy is consumed by the NG fired burner to raise the enthalpy of the atmospheric air. Under the existing condition this energy intensive process operates at a low efficiency rate mainly due to improper burning of the Natural Gas, as the flow rate of NG and combustion air is constant and is independent of the process requirement.

This DPR highlights the details of the study conducted for the use of Energy Efficient Natural Gas Burner used in Drying, possible Energy saving and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis in different scenarios and schedule of Project Implementation.

This bankable DPR also found eligible for subsidy scheme of MoMSME for "Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises" under "National Manufacturing and Competitiveness Programme". The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

S. No	Particular	Unit	Value
1	Project cost	` in Lakh	2.17
2	Expected NG Savings	scum/annum	27000
3	Monetary benefit	` in Lakh /annum	2.24
4	Simple payback period	Yrs	0.97
5	NPV	` in Lakh	6.35
6	IRR	%age	82.27
7	ROI	%age	28.95

S. No	Particular	Unit	Value
8	DSCR	Ratio	4.27
9	Annual CO_2 reduction	Tonne / Annum	59.57
10	Process down time	Days	01

The projected profitability and cash flow statements indicate that the project implementation will be financially viable and technically feasible solution for Jorhat Tea Cluster.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Gujarat Dairy Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

Major activities in the BEE -SME program are furnished below:

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up-gradation project in the clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1.   **INTRODUCTION**

1.1.   **Briefing about Jorhat Tea Cluster**

1.1.1.   **About Jorhat Tea Cluster**

This SME cluster chosen for BEE's SME cluster development program comprises of the tea factories located in the erstwhile undivided Jorhat district of upper Assam that is presently comprised of Jorhat and Golaghat districts. The Jorhat Tea Cluster has about 150 tea factories. Majority of these tea factories have their own plantations, while the tea factories not having their own plantations depends on the tea gardens that does not have tea factories. The tea factories having their own plantation are owned either by group companies like APPL, Williamson & Magor, etc or by families having ownership through inheritance. These tea factories were mostly established during pre – independence period. Whereas the tea factories which does not have their own plantation were established after the late 80's and are owned by first generation entrepreneurs.

Existing Production Process:

The tea factories under Jorhat Tea cluster produces mainly produces CTC (Cut, tear and curl) and Orthodox type of tea. For the production of CTC type of tea the green tea leaves are shredded and then cut, tear and curled in the CTC (cutting, tearing and curling) machine. Whereas for the production of orthodox tea the green tea leaves are twisted through continuous circular motion of the rollers of the rolling machine. But for both these types of tea being manufactured in this cluster, the tea leaves are dried in dryers to remove the moisture before the made tea is finally sorted and packed. The drying process is the most energy intensive and to carry out the drying, the tea factories of this cluster use either coal or natural gas as fuel.

The pictorial representation of the tea manufacturing process that is being presently followed in Jorhat Tea Cluster is depicted in Annexure 1.

Withering:

The green tea leaves plucked from the garden are first withered to remove the surface moisture and partially the internal moisture. Withering promotes the dissipation of heat generated due to continuous respiration. The withering process which takes about 10 hours on an average, reduces the moisture content of green leaves to 55% in case of orthodox tea and to 70% in case of CTC tea production.

In Jorhat tea Cluster two types of withering process is being adopted by the tea factories. The first is the "Open Trough Withering" and second is the "Enclosed Trough Withering". In the first case, the area over the withering trough is kept open and the air from the withering fan passes from the bottom of the withering trough and released to the environment through the tea leaves. In the second case,

the area over the withering trough is enclosed and the air from the withering fan is released to the environment through a single outlet after being passed through the tea leaves.

CTC:

In this process the withered tea leaves are shredded in the rotor – vane and then cut torn and curled in the CTC machine. During this process the enzymes of the tea leaves are released in the rotor – vane and the curling of the tea leaves initiates the fermentation process. Most of the juice that comes out of the tea leaves during shredding in the rotor – vane is evaporated due to friction in the CTC machine, for which the moisture content in the tea leaves after CTC is reduced from 70 % to 55 %.

Rolling:

This process after withering is adopted by tea factories to produce orthodox type of tea. The chemical compounds of the tea leaves are released to initiate oxidation in the fermentation process. Rolling twist the leaves and at the same time, breaks the leaf to release enzymes for oxidation.

Fermentation:

This is the least energy intensive step in the entire tea manufacturing process. During the fermentation process the tea leaves are left for oxidation, to which there occurs notable chemical as well as physical change. The color of the tea leaves is changed to reddish brown. The flavor and liquor of the tea leaves is attained in this stage.

Drying:

The fermented tea particles are dried or fired to arrest the fermentation and to reduce the moisture to about 3%. Clean and odorless hot air is passed through the fermented tea particles in dryers.

The temperature of the hot air varies between 90^0 – 160^0C depending on the type of dryer. Drying or firing is a thermal energy intensive operation that also consumes electrical energy to drive blowers and dryers.

Drying is a critical process that decides the final product quality of black tea. Two types of dryers are used in the tea industry: - Endless Chain type (ECP) dryer or Fluidized Bed Dryer (FBD).

In the ECP dryer, tea particles are spread over continuously moving chain – type trays through which hot air flows. The trays move from top to bottom while the hot air is blown from the bottom. The temperature of hot air is about 90^0. The ECP dryer has an advantage to dry both leafy grades and powered grades. In the VFBD, tea particles are pneumatically fluidized by hot air at 140 – 160^0C. Uniform drying is ensured in VFBD and better quality tea could be produced. This is also more energy efficient method compared to ECP dryers with less mechanical controls.

1.2.   Energy Performance in Existing Situation

1.2.1.   Energy Consumption Profile

For the purpose of tea processing, both electrical as well as thermal energy are required. In the tea factories of Jorhat Tea Cluster, the electrical energy requirement is fulfilled by electrical power available through grid whereas the main source of thermal energy is either coal or Natural Gas.

The summary of the annual energy consumption in different production capacities of the tea factories of this cluster that uses coal as the thermal energy source as revealed during the energy audit is given in Table – 1 below;

Table 1:   Annual Energy Consumption by Tea factories using coal

Parameter	Unit	Up to 500 MT of made tea	500 – 1500 MT of made tea	Above 1500 MT of made tea
Annual electrical energy consumption	kWh	221197.4	688252.8	862896.8
Annual coal consumption	MT	390.64	1107.21	1457.63
Annual HSD consumption	KL	27.66	88.69	136.43
Total Annual Energy consumption	MCal	2034504	5869315	7923604
Total Annual Energy consumption in one unit of the different capacity	Kloe	222.5	646.1	866.6
Average annual Made Tea production	MT	450	1000	1900

And the summary of the annual energy consumption of the tea factories of this cluster that uses NG as the thermal energy source is given in Table – 2 below;

Table 2:   Annual Energy Consumption by Tea factories using Natural Gas

Parameter	Unit	Up to 500 MT of made tea	500 – 1500 MT of made tea	Above 1500 MT of made tea
Annual electrical energy consumption	kWh	234896.8	656332.6	805998.7
Annual NG consumption	Scum	216602	431594.8	629896.2
Annual HSD consumption	KL	30	92	145
Total Annual Energy consumption	MCal	2581390	5627756	8190163
Total Annual Energy consumption in one unit of the different capacity	Kloe	258.1	562.8	819.0
Average annual Made Tea production	MT	480	960	2100

1.2.2.   Average Annual Production

Tea factories are agro based industries, and the operation of the tea factories depends on the availability of the tea leaves in the tea gardens. The tea factories depends on either their own in – house production of green tea leaves or on green tea leaves plucked from tea gardens without factories or both. The peak production season for tea factories in Jorhat Cluster starts with the

beginning of spring, i.e., from the month of March – April and lasts till the end of autumn or beginning of winter, i.e., till the month of October – November. During this period most of the tea factories run on round the clock basis as the green tea leaves cannot be stored. The tea factories remain non – operational for about two to three months in a year between the months of December to March.

The average tea production in the tea factories of Jorhat Cluster where Energy Audit was carried out is 1002 tones of made tea per annum.

1.2.3. Specific Fuel Consumption & Specific Electricity Consumption

Similar to any other type of industry, the specific energy consumption in the tea factories of this cluster also depends on the scale of production, which has been evaluated during the energy audit. Thus keeping this into consideration, the tea factories of this cluster is broadly divided into three groups and the specific energy consumption is evaluated separately.

In this context it is noteworthy to mention that bifurcation of the tea factories base on production is specific to this report only and there is no official notification by any authorized bodies in this regard.

The specific energy consumption by the tea factories is given in Table – 3 below;

Table 3: Specific Energy Consumption by Tea Factories

Type of tea factory	kWh/ kg of made tea	Kgs of coal/ kg of made tea	Liters of HSD/ kg of made tea	Scum of NG/ kg of made tea
Large tea factory	0.55	0.72	0.07	0.32
Medium tea factory	0.65	0.82	0.08	0.39
Small tea factory	0.85	1.02	0.09	0.51

1.3. Existing Technology/Equipment

1.3.1. Description of existing technology

For the purpose of carrying out the drying process, the thermal energy is supplied by the Direct Fired Heaters. The Natural Gas (NG) burners, which are the source of thermal energy required for drying, consumes about 90% of the total thermal energy required for tea processing required by the tea factories. The Natural Gas Burners that are generally found in the tea factories of Jorhat Cluster are of fixed air/ gas ratio with no operator control/ adjustment.

The combustion air is forced into the burner chamber by means of the dryer ID fan and the fuel, i.e. NG is injected into the burner chamber at a constant rate irrespective of the draft created by the dryer ID fan. The draft of the dryer ID fan varies with the process requirement, but there is no variation in the flow rate of the NG simultaneously with the draft. For this there is improper mixing of air – fuel for most of the time during the processing of tea in the dryer as the operator has no control over the air –

fuel ratio as per the process requirement, resulting in under optimum thermal efficiency of the system.

Electrical Energy Charges

Table 4:   Average per unit cost of Electrical Power

Per Unit Cost Of Electrical Energy	
Grid Availability	70%
DG Power	30%
Average cost of grid power	`5.5 per unit
Average cost of DG	`12 per unit
Total Unit Cost	5.5 *0.7 + 12 * 0.3 = ` 7.45/ kWh

NG (Natural Gas) Charges: The main supplier of NG is Assam Gas Company Ltd. And some of the tea factories get the NG from Gas Authority of India Limited. ***The cost of NG at present is ` 8.30 / scum***

1.3.2.   Role in process

During the process of drying, the moisture of fermented leaves is reduced from 55 – 60% to 2.5 – 3% by means of hot air. The role of the NG burner is to raise the enthalpy of the atmospheric air, so that this hot air can be passed through the dryer to remove the moisture from the fermented leaves.

1.4.   Baseline establishment for existing technology

The baseline is prepared on the basis of a typical tea factory of Jorhat Cluster with a production capacity of 500 MT per annum and having a Super Endless Chain Pressure Drier with a capacity to process 150 kg of dry made tea per hour. This drier under the existing condition be supplied with hot air produced in a Direct fired heater with a conventional Natural Gas Burner. The detailed baseline is as detailed below;

Table 5:   Baseline of the Existing Technology

S. No.	Particulars	Unit	Consumption/ Year
1	Drying capacity of the drier	Kg of made tea/ hour	150
2.	Specific Natural Gas Consumption	Scum/ kg of made tea	0.51
3.	Specific Natural Gas Consumption	Scum/ hour	76.50
4.	Hours of operation of the drier	Hours/ Year	3600
5.	Annual Natural Gas consumption by the heater	Scum/ year	275400

1.4.1.   Design and operating parameters

The existing natural gas burners are of fixed air/gas ratio with no operator control/adjustment facility. The SME units generally operate 12 hours a day and 300 days annually. Specifications of the existing burner are listed in Annexure 2.

1.4.2.   Determination of the Operating efficiency of the NG Burners

The objective of the NG burner is produced thermal energy so that the moisture from the fermented leaves is removed. Hence, the operating efficiency of the NG burner is evaluated by the ratio of heat utilized to remove moisture from the tea leaves to the heat actually supplied by the Natural gas burnt at the burner.

It is revealed during the energy audit that as per the industry standard 1.45 kg of moisture is required to be removed from the fermented leaves to get 1 kg of made tea. Considering the ambient temperature as 30^0C and latent heat of evaporation of water as 540 kcal, the heat that is actually required to evaporate 1 kg of water thus is 610.21 kcal.

As 1.45 kg of moisture is required to be removed to produce 1 kg of made tea, so the heat required for removing this moisture content to produce 1 kg of made tea is 884.80 kcal. This amount of heat required can be conservatively considered as 950 kcal per kg of made tea as the moisture particles are not evenly distributed within the fermented tea leaves. Thus the actual thermal energy required during drying process to get 1 kg of made tea is 950 kcal. Considering the calorific value of NG as 9400 kcal/ scum, the operating efficiency of the NG Burner under existing circumstance is as calculated below;

Table 6:   Operating Efficiency of the Existing Technology

S. No.	Particulars	Unit	Value
1	Drier output	kg of made tea/ hour	150
2.	Specific NG Consumption	Scum of NG/ kg of made tea	0.51
3.	Total NG consumption	Scum/ hour	76.5
4.	Calorific value of NG	Kcal/scum	9400
5.	Total Heat supplied	Kcal/ hour	719100
6.	Actual Heat required	Kcal/ kg of made Tea	950
7.	Actual Heat required	Kcal/ hour	142500
8.	Operating efficiency under existing condition	%	19.82

1.5.   Barriers in adoption of proposed equipment

1.5.1.   Technological barrier

➢ Due to absence of any scientifically designed operator training program, the operation and maintenance protocols for optimum utilization of thermal energy equipment are not followed.

➢ Though the thermal energy requirement is highest during the drying process of tea and the acceptability for fuel efficient air heater is expected to have a high acceptability, yet there is lack of technological intervention in this regard.

➢ Majority of the unit's entrepreneurs in Jorhat tea cluster do not have any in – depth technical expertise and knowledge on energy efficiency, and are dependent on local technology suppliers or service companies, who normally rely on established and commonly used technology. The lack of technical know – how has made it difficult for the factory owners to identify the most effective technical measures.

➢ Most of units in Jorhat tea cluster have been established several years ago when energy efficiency was not important issue for the operation of a plant. They are operating with outdated technology and low – end technologies.

➢ As majority of the entrepreneurs in cluster are not aware of the energy losses in the plant, there may be a strong feeling that the energy efficiency initiatives in manufacturing facility can have a cascading effect of failure in critical production areas directly or indirectly connected if the intended performance of the replaced/ retrofitted equipment falls below design values.

➢ There is a strong feeling in the tea factory entrepreneurs that, energy efficiency initiatives are difficult and the drive to save energy will affect the quality of made tea and thus will lead to business loss. These can however be overcome by motivating them to attend the awareness programs and use the detailed report on the benefits of the measures identified and cost benefit analysis. Further, sourcing of expertise on maintenance service provider or training by the equipment supplier will definitely overcome the barriers.

1.5.2.   Financial barrier

➢ The cost of new technology is high. There is inadequate data on return on investment from energy saving alone. This creates barriers to financial decision making for acquisition of new technology.

➢ Banks, although willing to lend to the sector are unable to take decisions about lending in the absence of information about techno economic feasibility of energy saving equipment.

1.5.3. Skilled manpower

➢ The persons working in the tea factories of Jorhat Cluster generally belongs to a particular tribe working for generations in tea factories and they normally lead an isolated life. For this, though the persons are skilled with regard to the operation of the machineries, but innovations as well as consciousness regarding energy conservations lacks amongst the workforce. This is one of the lacunae of the Jorhat Tea Cluster.

➢ Specialized training with local service providers for better operation and maintenance of equipments, importance of the energy and its use will create awareness amongst workforce. These programs should be organized with equipment suppliers.

1.5.4. Barrier specific towards adoption of this technology

➢ For successful implementation of this technology. Proper operator training is a must.

2.   PROPOSED EQUIPMENT FOR ENERGY EFFICENCY IMPROVEMENT

2.1.   Description of proposed equipment

2.1.1.   Details of proposed equipment

For the purpose of achieving the optimum thermal efficiency in a NG burner, the air – fuel ratio should not exceed 5 to 10% of the stiochiometric ratio. In such case the colour of the flame becomes bluish, which is an important indicator reflecting a complete combustion of the fuel with less excess air loss. This proper mixing of air and fuel can be achieved either by varying the flow rate of combustion as per the flow of fuel.

In this proposed NG burners, the flow rate of the fuel, i.e. NG can be varied as per the requirement of the process air necessary for drying the fermented leaves in the dryer. As the flow of NG can be varied, so the operator can adjust the flow of NG till the colour of the flame turns bluish, which is indicative of optimum burning. The optimal burning condition within the burner chamber in which the colour of the flame is bluish is depicted in figure 1. The optimal burning of the natural gas in this Burner will help save about 10% of natural gas consumption as compared with the existing burners, where the flame colour is normally yellowish.

Figure 1:   Flame colour during optimal Burning

For the purpose of obtaining optimal burning, this energy efficient NG burner comes with a knob, the operation of which will make variation in the fuel input quantity into the burner. Also this burner has a built – in fan to supply exact quantity of combustion air into the combustion chamber of the burner. Thus the operator by means of monitoring of the flame colour will make adjustment in the knob and vary the quantity of fuel flow into the burner till the point when the flame colour turns bluish. One of the most important functions of the burner is to burn the entire fuel (natural gas) with the least possible quantity of Excess Air which gives the highest thermal efficiency.

Considering the calorific value of NG as 9400 kcal/ scum and the heat required for to remove the moisture content in fermented tea leaves to produce 1 kg of made tea as 884.80 kcal, the estimated efficiency and savings to be derived from the proposed NG Burner is as calculated below;

Table 7: **Estimated Efficiency from the Proposed Technology**

S. No.	Particulars	Unit	Value
1	Drier output	kg of made tea/ hour	150
2.	Specific NG Consumption	Scum of NG/ kg of made tea	0.46
3.	Total NG consumption	Scum/ hour	69
4.	Calorific value of NG	Kcal/scum	9400
5.	Total Heat supplied	Kcal/ hour	648600
6.	Actual Heat required	Kcal/ kg of made Tea	950
7.	Actual Heat required	Kcal/ hour	142500
8.	Estimated operating efficiency	%	21.97
9.	Overall improvement in efficiency of the system	%	2.15

2.1.2. Equipment/Technology Specification

The energy efficient NG burners required driers with a capacity to dry 150 kg of fermented tea leaves per hour have the following specifications;

1   Gas flow rate of 45 m^3 per second.

2   Adjustable Air and Gas flow control with manual operation.

Specifications are provided at Annexure 3. The side view of the proposed equipment is as depicted below;

Figure 2: **Front View of the Energy Efficient Burner**

And the front view of the proposed equipment is as depicted below;

Figure 3:   Side View of the Energy Efficient Burner

2.1.3.   Integration with Existing Equipment

This energy efficient equipment can be fitted in the same position of the heater where the existing heater is being fitted without any modification. For this the proposed equipment can be suitably integrated with the existing equipment.

2.1.4.   Superiority over existing system

The proposed burner is more energy efficient than the existing one and is technologically superior. Use of this equipment reduces the overall plant energy cost. The proposed measures bear better technology than the existing one results both energy saving and technological up gradation.

2.1.5.   Source of equipment

The recommended technology is proven one and in various industries on normal basis. These are running successfully and the unit owners had observed the savings in terms of energy.

2.1.6.   Availability of technology/equipment

This technology though new to the tea factories in Jorhat Cluster is being in use in other process industries. And as the tea factories of this cluster is shifting to NG as the source of thermal energy, for which some of the reputed companies marketing this products are targeting the tea factories of this cluster.

2.1.7.   Service providers

Details of technology service providers are shown in Annexure 7.

2.1.8. Terms and conditions in sales of equipment

The suppliers have already extended standard warrantee conditions for exchange, replace or repair against manufacturing defects for a period of 12 months after the date of commissioning. Promoters will have to promptly notify the supplier in writing of obvious defects or deficiencies after detection thereof. Replaced parts shall become the property of the supplier upon request of the supplier.

Supplier is not liable or defects or deficiencies which are resulting from the following reasons, as long as they are not resulting from a default of Supplier: Improper, unsuitable or negligent use, handling and/or operation of the system by promoters or by third parties; use of spare parts other than Genuine Parts; normal wear and tear; use of unsuitable consumables (such as, fuel, oil cooling liquid or any other consumables), particularly the use of consumables not conciliated in the operation manuals; improper building ground; chemical, electro- chemical or electric influences.

All conditions associated with this system are standard in nature. No special clause is incorporated. The conditions are very common in most of the plant & machinery sales.

2.1.9. Process down time

01 day is required to install and to give trial run of this proposed burner in place of the existing burner. Thus the process down time required is 01 days.

2.2. Life cycle assessment and risks analysis

Life of the equipment is about 15 years. Risk involves in the installation of proposed project are as follows: Risk involved in ensuring the safe flow of NG within the system.

2.3. Suitable unit for implementation of proposed technology

The measure & technology is suitable for the tea factories of Jorhat Cluster as well as for tea factories outside this cluster, which use Natural Gas as the source of thermal energy. Adoption of this measure will help in building thermal energy efficiency, which is a vital energy consuming area. This measure is suitable for implementation in 15 number units of this cluster, where energy audit was carried out.

3.   ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1.   Technical benefit

3.1.1.   Natural Gas saving

Adoption of the energy efficient NG burner is estimated to yield a saving of 10% in the NG consumption required for producing hot air for drying. The estimated savings in NG is as tabulated in Table below;

Table 8:   Estimated Savings from the Proposed Technology

Particulars	Units	Existing Burner	Proposed Burner
Specific NG Consumption,	Scum of NG/ kg of made tea	0.51	0.46
Total NG consumption	Scum/ hour	76.50	69
Saving in NG per hour	Scum		7.5
Saving in NG per year	Scum		27000

3.1.2.   Electricity saving

There will be no electricity savings due to the adoption of this technology.

3.2.   Monetary benefits

Implementation of project will result in good, consistent monetary benefit. It is estimated that this system will save on an average 27000 scum of NG for the unit. Please refer following table.

Table 9:   Monetary benefit (For One Typical Unit of Jorhat Tea Cluster)

Energy and monetary benefit			
S. No.	Parameters	Unit	Value
1)	Cost of NG	`/ scum	8.30
2)	Expected Saving in scum/ Annum	scum/ year	27000
3)	Expected Monetary Saving per Annum	`/ annum	224100

**Further details of total monetary benefit are given in Annexure 3.

3.3.   Social benefits

3.3.1.   Improvement in working environment

Use of energy efficient NG burner technology in Tea Industry reduces the energy consumption. This improves efficiency of drying section, which is the most energy intensive process in tea manufacturing and thus reduces CO_2 generation.

3.3.2. Improvement in workers skill

Technical skills of persons will definitely be improved. As the training will be provided by equipment suppliers which improve the technical skills of manpower required for operating of the equipment and also the technology implementation will create awareness among the workforce about energy efficiency and energy saving.

3.4. Environmental benefits

3.4.1. Reduction in effluent generation

There is no impact in effluent generation due to implementation of the project.

3.4.2. Reduction in GHG emission

Implementation of this technology will reduce the CO_2 emissions. Reduction in CO_2 emissions will be possible due to Energy saving due to reduction in NG consumption. The CO_2 reduction is tabulated below in table 10.

Table 10: CO_2 Reduction Calculations

S. No.	Parameters	Factors		Unit	Value
		Unit	Value		
1	NG consumed in existing case	Scum/ kg of made tea	0.51	Scum / year	275400
2	NG consumed in Proposed case	Scum/ kg of made tea	0.46	Scum / year	248400
3	Net savings per year	Scum/ kg of made tea	0.05	Scum / year	27000
4	CO_2 Reduction	kg/GJ	56.06	Tonne/year	59.57

3.4.3. Reduction in other emissions like SO_X

Amount of SO_X will be reducing due to improved efficiency of the burning process.

4. INSTALLATION OF PROPOSED EQUIPMENT

4.1. Cost of project

4.1.1. Equipment cost

Cost of the proposed burner with standard accessories and mountings, including taxes @5% works out to be `186755.

4.1.2. Erection, commissioning and other misc. cost

The details of project cost is as given in table 10 given below-

Table 11:   Proposed Technology Cost Details

Details of Proposed Technology Project Cost			
S. N.	Particulars	Unit	Value
1	Cost of proposed burner with standard accessories and mountings	` (in lacs)	1.87
2	Erection & Commissioning cost	` (in lacs)	0.11
3	Other charges (Including Contingency @ 10%)	` (in lacs)	0.19
4	*Total cost*	*`(in lacs)*	*2.17*

4.2. Arrangements of funds

4.2.1. Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost i.e. ` 0.54 Lakh & financial institutes can extend loan of 75%.

4.2.2. Loan Amount

The term loan is 75% of the total project cost i.e. ` 1.63 Lakh, with repayment of 5 years excluding moratorium period of 6 months considered for the estimation purpose.

4.2.3. Terms & conditions of loan

The terms and conditions of the loan with regard to the financial aspect of the loan are; Interest rate of the loan is @ 10% per annum on a reducing balance basis, which is SIDBI's interest rate for energy efficient projects. Moratorium period of 6 months from the date of disbursement of the loan is considered towards repayment of the loan. Depreciation is provided as per the rates provided in the companies act.

4.3. Financial indicators

The financial indicators for this proposed technology is calculated on the following basis;

➢ For calculating the financial indicators, the subsidy from MoMSME is not taken into consideration.

➢ It is considered that the motor will be operative for 12 hours a day and for 300 days a year.

➢ To arrive at a more competitive evaluation, the rise in the energy price is not taken into consideration, as monetary value of the savings is directly proportional to the energy price.

➢ The cost of maintenance and operation is taken as 2% of the capital cost for installation of this technology with a yearly increase @5%.

4.3.1. Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 8 years. The project is expected to achieve monthly savings of ` 2.24 lakhs based on the assumptions as mentioned above.

Considering the above assumptions, the net cash accrual starts with `1.86 lakh in the first year of operation and to `10.23 lakh at the end of eighth year of operation

4.3.2. Simple payback period

The estimated payback period is about 0.97 years or about 12 months.

4.3.3. Net Present Value (NPV)

The Net present value of the investment at 10% works out to be ` 6.35 lakh.

4.3.4. Internal rate of return (IRR)

The after tax IRR of the project works out to be 82.27%.

4.3.5. Return on investment (ROI)

The average return on investment of the project activity works out at 28.95%.

4.4. Sensitivity analysis

Sensitivity analysis is carried out in the following two scenarios;

1. Optimistic Scenario: Under this scenario the financial projections are evaluated on the basis of 5% increase in the fuel savings.
2. Pessimistic Scenario: Under this scenario the financial projections are evaluated on the basis of 5% decrease in the fuel savings.

The result of the sensitivity analysis is as given below;

Table 12:   Sensitivity Analysis

Particulars	IRR	NPV	ROI	DSCR
Normal	82.27 %	` 6.35 lakh	28.95 %	4.27
5% increase in savings	86.08 %	` 6.74 lakh	29.17%	4.47
5% decrease in savings	78.43 %	` 5.95 lakh	28.71%	4.07

4.5. **Procurement and Implementation Schedule**

Total time required for procurement and implementation for proposed project are about 10 to 12 weeks and details of procurement and implementation schedules are shown in Annexure 6.

Table 13: **Procurement and Implementation Schedule**

S. No.	Activities	Weeks			
		1	-	11	12
1	Order Placement	▓			
2	Delivery				▓
3	Erection & commissioning				▓
4	Testing and trial				▓
5	On site operator training				▓

Annexure 1: Process Flow Diagram
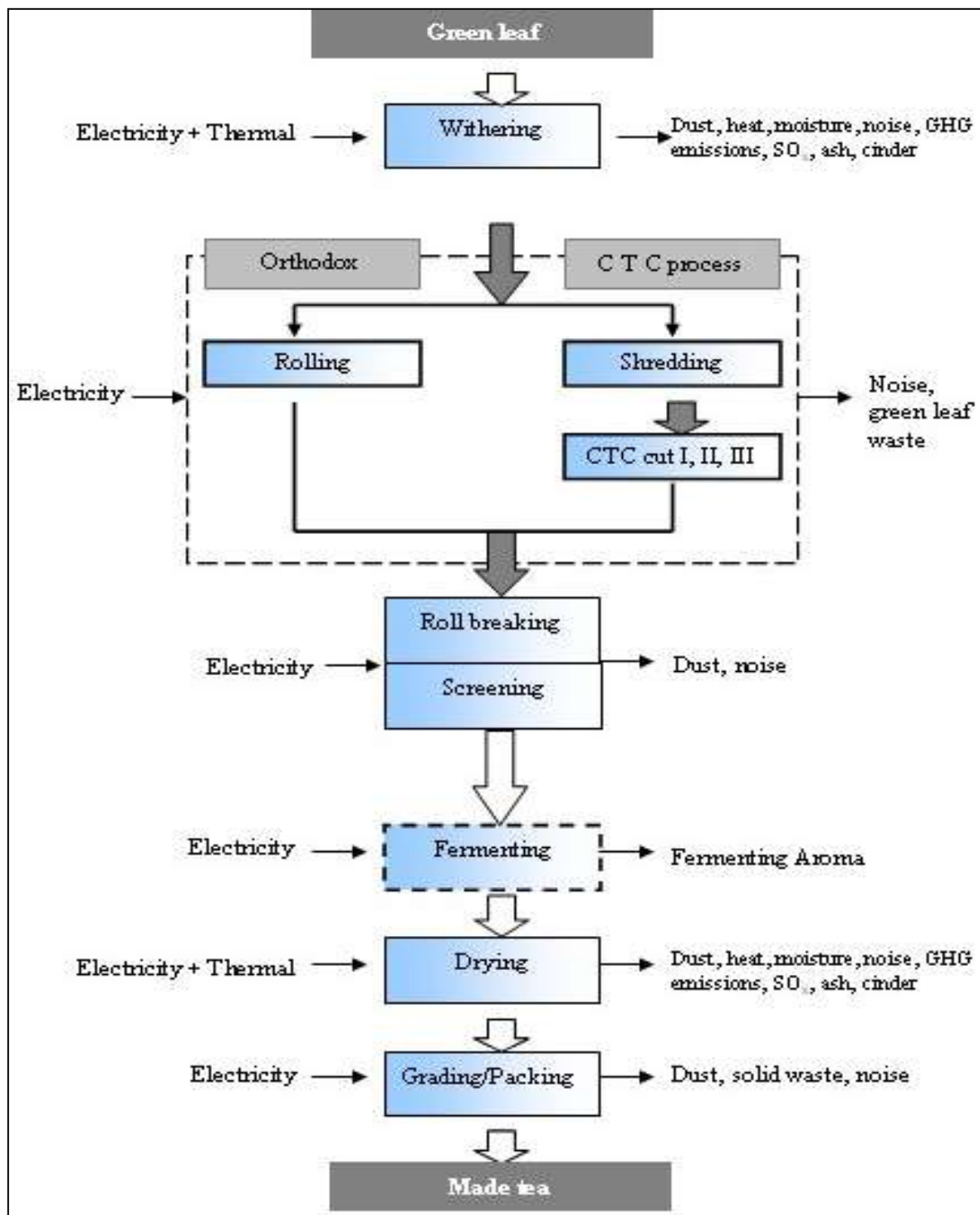
Annexure 2: Energy audit data used for baseline establishment

The dryer of a typical tea factory is as below

S. No.	Drier Particulars	Drier Type	Drier Capacity
1)	Super Endless Chain Pressure Drier/ Combination FBD drier	4M Tempest, etc	130– 150 kg of made tea per hour

The specifications of existing NG burner fitted with the typical drier is

S. No.	Details	Specification
1)	Type	Fixed air/ gas knob
2)	Efficiency Level	19.8%
3)	NG Consumption per hour	76.50 scum

Annexure 3: Detailed technology assessment report

The energy efficient NG Burner will be fitted on a 10mm MS mounting plate duly lagged from inside for thermal insulation ,together with the requisite

1) Gas filter,

2) On/off AUDCO Gas valve,

3) Input pressure gauge (0-1.0Kg/cm^2),

4) PRV (0-45 m^3/hr.) flow rate,

5) Output pressure gauge (0-300 mili bar),

6) High pressure Hose pipe from gas train assembly to Burner input Controller.

7) Efficiency Level 21.95%

The detailed technology assessment of the technology is as detailed

S. No	Parameter	Unit	Value
1	Working Hours for Dryer/ Day	Hrs/Day	12
2	Working Days/ Year	Days/ Year	300
3	Actual NG Consumption under existing condition	Scum/ hour	76.50
4	Expected NG consumption after installation of the EE burner	Scum/ hour	69
5	NG saving	Scum/ hour	7.50
6	Cost of NG	`/ scum	8.30
7	Expected NG energy Saving per Annum	scum/Annum	27000
8	Expected Monetary Saving per Annum	`/ Annum	224100
9	Expected Investment Needed for replacing existing burner with EE burner.	`	217000
10	Simple Payback	Yrs	0.97
		Months	12

Annexure 4: Drawings for proposed electrical & civil works

No electrical and civil works are required for the installation of this proposed energy efficient equipment. Only minor mechanical fabrication works needs to be done for fitment of the burner with Direct Fired heater.

Annexure 5: Detailed financial analysis

Name of the Technology	ENERGY EFFICIENT NG BURNER		
Rated Capacity	TEA of 150 kg/Hour		
Details	Unit	Value	Basis
Installed Capacity	Kg/hour	150	
No of working days	Days	300	
No of Working Hr. per day	Hrs.	12	
Proposed Investment			
Plant & Machinery	` (in lacs)	1.87	
Erection & Commissioning	` (in lacs)	0.11	
Investment without EPC	` (in lacs)	1.98	
Misc. Cost	` (in lacs)	0.19	
Total Investment	` (in lacs)	2.17	
Financing pattern			
Own Funds (Equity)	` (in lacs)	0.54	Feasibility Study
Loan Funds (Term Loan)	` (in lacs)	1.63	Feasibility Study
Loan Tenure	Years	5.00	Assumed
Moratorium Period	Months	6.00	Assumed
Repayment Period	Months	66.00	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	2.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Natural Gas Saving	scum/Year	27000	
Cost of Natural Gas	` /Scum	8.30	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan   ` (in Lacs)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	1.63	0.06	1.57	0.19
2	1.57	0.20	1.37	0.15
3	1.37	0.24	1.13	0.13
4	1.13	0.40	0.73	0.10
5	0.73	0.48	0.25	0.05
6	0.25	0.25	0.00	0.01
		1.63		

WDV Depreciation   ` (in Lacs)

Particulars / years	1	2
Plant and Machinery		
Cost	2.17	0.43
Depreciation	1.73	0.35
WDV	0.43	0.09

Projected Profitability

` **(in Lacs)**

Particulars / Years	1	2	3	4	5	6	7	8
NG Saving	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
Total Revenue (A)	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
Expenses								
O & M Expenses	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06
Total Expenses (B)	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06
PBDIT (A)-(B)	2.20	2.20	2.19	2.19	2.19	2.19	2.18	2.18
Interest	0.19	0.15	0.13	0.10	0.05	0.01	0.00	0.00
PBDT	2.01	2.05	2.07	2.09	2.14	2.18	2.18	2.18
Depreciation	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
PBT	1.89	1.93	1.95	1.98	2.02	2.06	2.07	2.07
Income tax	0.09	0.58	0.70	0.71	0.73	0.74	0.74	0.74
Profit after tax (PAT)	1.80	1.35	1.25	1.27	1.30	1.32	1.33	1.32

Computation of Tax   ` **(in Lacs)**

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	1.89	1.93	1.95	1.98	2.02	2.06	2.07	2.07
Add: Book depreciation	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Less: WDV depreciation	1.73	0.35	-	-	-	-	-	-
Taxable profit	0.28	1.70	2.07	2.09	2.14	2.18	2.18	2.18
Income Tax	0.09	0.58	0.70	0.71	0.73	0.74	0.74	0.74

Projected Balance Sheet   ` **(in Lacs)**

Particulars / Years	1	2	3	4	5	6	7	8
Share Capital (D)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Reserves & Surplus (E)	1.80	3.16	4.41	5.67	6.97	8.29	9.62	10.94
Term Loans (F)	1.57	1.37	1.13	0.73	0.25	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	3.91	5.06	6.07	6.94	7.76	8.83	10.16	11.48
Assets								
Gross Fixed Assets	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
Less Accumulated Depreciation	0.11	0.23	0.34	0.46	0.57	0.69	0.80	0.92
Net Fixed Assets	2.05	1.94	1.82	1.71	1.59	1.48	1.37	1.25
Cash & Bank Balance	1.86	3.12	4.25	5.23	6.16	7.35	8.79	10.23
TOTAL ASSETS	3.91	5.06	6.07	6.94	7.76	8.83	10.16	11.48
Net Worth	2.34	3.70	4.95	6.22	7.51	8.84	10.16	11.49
Debt Equity Ratio	2.89	2.52	2.08	1.34	0.45	-0.01	-0.01	-0.01

Projected Cash Flow   ` **(in Lacs)**

Particulars / Years	0	1	2	3	4	5	6	7	8
Sources									
Share Capital	0.54	-	-	-	-	-	-	-	-
Term Loan	1.63								
Profit After tax		1.80	1.35	1.25	1.27	1.30	1.32	1.33	1.32
Depreciation		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Total Sources	2.17	1.92	1.47	1.36	1.38	1.41	1.44	1.44	1.44

Application								
Capital Expenditure	2.17							
Repayment Of Loan	-	0.06	0.20	0.24	0.40	0.48	0.25	0.00	0.00
Total Application	2.17	0.06	0.20	0.24	0.40	0.48	0.25	0.00	0.00
Net Surplus	-	1.86	1.27	1.12	0.98	0.93	1.19	1.44	1.44
Add: Opening Balance	-	-	1.86	3.12	4.25	5.23	6.16	7.35	8.79
Closing Balance	-	1.86	3.12	4.25	5.23	6.16	7.35	8.79	10.23

IRR   `(in Lacs)`

Particulars / months	0	1	2	3	4	5	6	7	8
Profit after Tax		1.80	1.35	1.25	1.27	1.30	1.32	1.33	1.32
Depreciation		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Interest on Term Loan		0.19	0.15	0.13	0.10	0.05	0.01	-	-
Cash outflow	(2.17)	-	-	-	-	-	-	-	-
Net Cash flow	(2.17)	2.10	1.62	1.49	1.48	1.46	1.45	1.44	1.44
IRR	82.27%								
NPV	6.35								

Break Even Point   `(in Lacs)`

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
O & M Expenses (75%)	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05
Sub Total(G)	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05
Fixed Expenses								
O & M Expenses (25%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Interest on Term Loan	0.19	0.15	0.13	0.10	0.05	0.01	0.00	0.00
Depreciation (H)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Sub Total (I)	0.31	0.27	0.25	0.22	0.18	0.14	0.13	0.13
Sales (J)	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
Contribution (K)	2.21	2.21	2.21	2.20	2.20	2.20	2.20	2.20
Break Even Point (L= G/I)%	14.22%	12.44%	11.43%	10.16%	8.10%	6.16%	5.87%	5.91%
Cash Break Even {(I)-(H)}%	9.04%	7.26%	6.24%	4.97%	2.90%	0.96%	0.66%	0.69%
Break Even Sales (J)*(L)	0.32	0.28	0.26	0.23	0.18	0.14	0.13	0.13

Return on Investment   `(in Lacs)`

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	1.89	1.93	1.95	1.98	2.02	2.06	2.07	2.07	15.98
Net Worth	2.34	3.70	4.95	6.22	7.51	8.84	10.16	11.49	55.20
									28.95 %

Debt Service Coverage Ratio   `(in Lacs)`

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	1.80	1.35	1.25	1.27	1.30	1.32	1.33	1.32	8.29
Depreciation	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.69
Interest on Term Loan	0.19	0.15	0.13	0.10	0.05	0.01	0.00	0.00	0.62
Total (M)	2.10	1.62	1.49	1.48	1.46	1.45	1.44	1.44	9.60

DEBT

Interest on Term Loan	0.19	0.15	0.13	0.10	0.05	0.01	0.00	0.00	0.62
Repayment of Term Loan	0.06	0.20	0.24	0.40	0.48	0.25	0.00	0.00	1.63
Total (N)	0.25	0.35	0.37	0.50	0.53	0.26	0.00	0.00	2.25
DSCR (M/N)	8.45	4.64	4.08	2.98	2.75	5.62	0.00	0.00	4.27
Average DSCR	4.27								

Annexure 6: Procurement and implementation schedule

Week wise break up of implementation Schedule

S. No.	Activities	Days		
		1	2	3
1	Fabrication of the jigs and fixtures	�|		
2.	Installation and commissioning		▪	
3	Testing and trial		▪	▪
4	On site operator training	▪	▪	▪

Annexure 7: Details of technology service providers

S. No.	Name of Service Provider	Address	Contact Person and No.
1	M/s Magnum Automation Systems	A.T. Road, Lahoal, Dibrugarh Assam	Mr. Jasbir Singh: Phone: +919957574040

Annexure 8: Quotations or Techno-commercial bids for new technology/equipment

Magnum Automation Systems

A.T. Road, P.O.Lahoal-786010, Dist. Dibrugarh,(Assam).

Phone: +919957574040
Email:info.magnumauto@gmail.com

Buyer's name,
M/s XYZ,
...................................,
...................................,

Our Ref No: MAS/....
Dated: 29ᵗʰ June, 2011.

Dear Sir,

Subject: Quotation for the 1) **NG350 of UNIGAS make** for your Endless *Chain Pressure Drier* of 130-150 Kg DMT/hour.

Reference: Your query No. ....,

Thanks for the query to us and as required, we are appending below the rates of the ECM noted above, for placement of your Order.

1) To being the cost of the **_EE Automatic N.Gas Burner model NG 350_** for your Drier (model..........) with the Controller configuration programmed to match the requisite *thermal energy* via Process Air flow rate for Drier's rated throughput.

VFD Model No: **NG350 TN** of *UNIGAS CIB*, Italy Make, marketed in NE India by our firm, having rated Power of **330 kW** (thermal) .

The EE N.Gas Burner will be fitted on a 10mm MS mounting plate duly lagged from inside for thermal insulation ,together with the requisite 1) gas filter, 2)on/off AUDCO Gas valve, 3) input pressure gauge(*0-1.0 Kg/cm²*), 4) PRV(*0-30 m3/hr.*) flow rate , 5)Output pressure gauge(*0-300 millibar*), 6) high pressure Hose pipe from gas train assembly to Burner input Controller, all assembled in such fashion that it is possible to connect the original conventional Burner, in 30 minutes, should it be required, as per AGCL's rules & regulations.

Rate: ₹ **1,77,862.00**
Sales tax (VAT extra): 5%.
Installation & Commissioning at your factory: ₹ *10977.00*.

TERMS & Conditions of our Offer:

1) Our QUOTATION **is valid for 4 weeks** from its date & thereafter our written extension will be required.

2) **ADVANCE: 80% of the basic price with order**, and **balance against Proforma Invoice prior** to delivery.

3) Mode of Payment: a) by direct deposit in our account No.**31652358055**; IFSC Code: **SBIN0000071** with SBI, **Dibrugarh**, through any **SBI cbs branch**.

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Magnum Automation Systems

A.T. Road, P.O.Lahoal-786010, Dist. Dibrugarh,(Assam).

Phone: +919957574040
Email:info.magnumauto@gmail.com

b) By *transfer through* **NIFT**.
c) By an a/c Payee Cheque.

4) **Delivery**: within 3-4 *weeks of receipt of Commercial Purchase order* along with Advance.

5) The Customer must place the order in writing especially for EC Products, as the Document may be required for Subsidy claims by BEE, New Delhi.

6) The out state Customer must submit C-Form with the Order.

7) The Electrical equipment supplied must be run within the rated Voltage/Loading range- otherwise the **manufacturer's warranty** will not be enforceable. In the case of **PNG**, the client should ascertain that the fuel supplied is at the right pressure, calorific value, is free from unnatural high %age of Moisture, and other impurities, etc. A *constant Voltage transformer of 1.0 kVA* will be required to be installed, if the factory electrical system voltage is NOT stabilized/regulated.

8) **The delivery date** promised/mentioned is subject to the *"Force majeure Clause"* due to unforeseen circumstances or conditions beyond our Control or within our jurisdiction.

9) **Delivery/transport**: The Client will arrange for the transport of Goods to the place of installation in proper condition with all care necessary for fragile goods.

10) The machine will be *under our AMC for 12 months from the date of commissioning*, and handing over to you.

11) We are one of the **BEE's Approved manufacturer/supplier for this Burner**, and you are free to communicate any problem that you may face from us to **BEE** and/or **ASDA, Guwahati**. Our rates are duly approved by the BEE, New Delhi.

We do hope you will favour us with your valued Order, and it will be our endeavour to give you Excellent products and Services.

Thanking You,

Yours faithfully,
For Magnum Automation Systems,

Jasbir Singh.
Cert.EA.

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