Funding Guidelines

for the

“FC Nepal Energy Efficiency Programme”

March 2017
(Second Amendment, January 2020)

Financed by BMZ

With the support of...
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# Abbreviations

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<th><strong>Banks</strong></th>
<th>A-class license Financial Institution in Nepal by Nepal Rastra Bank</th>
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<tr>
<td><strong>BMZ</strong></td>
<td>Federal Ministry for Economic Cooperation and Development (Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung)</td>
</tr>
<tr>
<td><strong>EE</strong></td>
<td>Energy Efficiency</td>
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<tr>
<td><strong>EEC</strong></td>
<td>Energy Efficiency Centre</td>
</tr>
<tr>
<td><strong>FC</strong></td>
<td>Financial Cooperation</td>
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<tr>
<td><strong>FCFS</strong></td>
<td>first-come, first-served</td>
</tr>
<tr>
<td><strong>GIZ</strong></td>
<td>Deutsche Gesellschaft für Internationale Zusammenarbeit (German Technical Cooperation)</td>
</tr>
<tr>
<td><strong>IGEA</strong></td>
<td>Investment Grade Energy Audit</td>
</tr>
<tr>
<td><strong>KIW</strong></td>
<td>Kreditanstalt für Wiederaufbau (German Financial Cooperation)</td>
</tr>
<tr>
<td><strong>MOF</strong></td>
<td>Ministry of Finance (Nepal)</td>
</tr>
<tr>
<td><strong>NEEP</strong></td>
<td>Nepal Energy Efficiency Programme</td>
</tr>
<tr>
<td><strong>RBBL</strong></td>
<td>Rastriya Banijya Bank Limited</td>
</tr>
<tr>
<td><strong>RE</strong></td>
<td>Renewable Energy</td>
</tr>
<tr>
<td><strong>TC</strong></td>
<td>Technical Cooperation</td>
</tr>
</tbody>
</table>
1. Purpose of the Grant

Due to the energy crisis in Nepal, energy efficiency (EE) plays an important role to secure energy supply in general and enhance productivity and competitiveness of the Nepalese industry in particular. However, the lack of financial instruments and incentives for investment in EE measures is felt to be one of the major reasons for industry’s reluctance to implement EE projects.

Given the great potential for energy efficiency in the Nepalese industry, the German Federal Ministry for Economic Cooperation and Development (BMZ) has designed the “Nepal Energy Efficiency Programme” (NEEP). In the framework of the Financial Cooperation (FC), the Ministry has assigned EUR 2 million through KfW for the financial component of NEEP to finance pilot-investments / projects improving EE in the industrial sector. In cooperation with the Nepalese Ministry of Finance (MOF) and Rastriya Banijya Bank Limited (RBBL), these funds shall be provided as grants to private companies in energy-intensive industry sectors to encourage the investment in EE measures and thus further enhance the Nepalese market for EE technologies.

2. How to Apply for a Grant

As an applicant to the Grant Fund under FC NEEP you have to follow a number of steps that are listed below:

1) Go carefully through the procedures. [Chapter 3]

2) Check whether you and your project meet the eligibility criteria. [Chapter 4]

3) Fill in the Application Form. [Annex I]

4) Send the completed Application Form with annexes to RBBL. The address is indicated on the Application Form.

5) Should you need support or should you have any questions, please contact:

Rastriya Banijya Bank Limited
Mr. Hom Raj Bhattarai +977 (1) 425-2595 3724 homraj.bhattarai@rbb.com.np
Mr. Ramji Bhandari +977 (1) 425-2595 1718 ramji.bhandari@rbb.com.np

or

adelphi
Mr. Gyanendra Upadhyay +977 (985) 1064353 upadhyay@adelphi.de
Mr. Ram Maharjan +977 (984) 9285012 maharjan@adelphi.de
3. General Procedure

The general procedure from application to grant disbursement is illustrated in Figure 1 below, where for each step the responsible institution is indicated in the white part of the box.

Figure 1: General Procedure from Application to Grant Disbursement

**Step 1:** The company (applicant) fills in the *Application Form* for a project and attaches all necessary annexes. There are three possible routes for submitting an application to RBBL: directly by the company, directly by the company including a bank letter attesting the provision and amount of a loan, or through a bank as intermediary.

**Step 2:** RBBL conducts an eligibility check, evaluates the project and takes the decision on grant disbursement and the grant volume together with KfW. A letter of acceptance is signed with a clause indicating that the grant money shall be released subject to the project completion.

**Step 3:** RBBL informs the client about the outcome of the evaluation through an approval or rejection letter.

**Step 4:** The company implements the approved measure(s), installing and commissioning the equipment received from technology suppliers.

**Step 5:** Authorised representatives of the Grant Fund verify the installed measures – either through pictures and notary certified invoices for small projects or through a technical expert on-site for big projects.

**Step 6:** A *Grant Contract* is signed between RBBL and the client and the grant money is disbursed.
4. Eligibility Criteria

In order to successfully apply for a grant, the following eligibility criteria and requirements must be fulfilled.

4.1. Eligible Applicants

a) Eligible applicants:

Only industrial companies established according to

- the Industrial Enterprise Act 2073 (2016)
- the Companies Act 2063 (2006)

are eligible as final recipients of grants.

b) Excluded sectors/firms:

- Sectors and firms that are involved in:
  - production of weapons, ammunition, arms, military or police equipment, and equipment or infrastructure which result in limiting people’s individual rights and freedom (i.e. prisons, detention centres of any form) or in violation of human rights
  - production of gambling and related equipment
  - tobacco manufacturing, processing or distribution
  - activities involving live animals for experimental and scientific purposes insofar as compliance with the "Council of Europe's Convention for the protection of vertebrate animals used for experimental and other scientific purposes"
  - activities which give rise to negative environmental impacts that are not largely mitigated and/or compensated

c) The client signs a declaration of not having breached any of the relevant Nepalese legal codes of conduct:

- Asset (Money) Laundering Prevention Act 2064 (2008)
- Labour Act 2048 (1992)
- Child Labour (Prohibition and Regulation) Act 2056 (2000)
- Environmental Protection Act (EPA) 2053 (1997)
- Environmental Protection Rules (EPR) 2054 (1997), and
- of not being blacklisted by Credit Information Bureau of Nepal, and
- that there is no legal case pending against the industry in the Labour Court or any other court of Nepal.
4.2. Eligible Measures

a) Eligible measures, including also renewable energy measures, are measures proposed by
   • an approved investment grade energy audit conducted by the Energy Efficiency Centre (EEC) under the NEEP project, or
   • an investment grade energy audit of equivalent standard (please check Annex III & IV as reference of a good practice energy audit).

b) The energy audit report that justifies the measure must
   • provide specific saving figures for each measure, and
   • be dated after 01.01.2012.

c) Only measures are eligible for which machinery and/or equipment has been purchased after 18.05.2017 (call for applications). The purchase date is defined as the date of the final tax invoice raised by the supplier.

d) Measures are only eligible for a grant, if there are no additional subsidies available for the respective project in this sector.

e) A fuel switch from conventional fossil fuel to biomass fuel is considered as an EE measure.

f) Thermal gasification projects are not eligible.

g) No second-hand equipment and machinery is eligible.

h) All projects must pass an environmental and social check (during ex-post verification).

4.3. Nature, Scope and Amount of Grants

a) The grant amount is calculated as a percentage of the total final and verified investment cost of each project (see Chapter 4.6 on verification).

   • The grant rate is:
     o 30% for small companies;
     o 20% for medium sized companies;
     o 15% for large companies.

   • An additional grant of 5% of the investment amount will be made available for projects if the application is routed through a bank.

   • Firms holding an ISO 14001 certificate and/or an ISO 26000 certificate will receive an additional grant of 2% for each certificate.
• For the determination of the company size (small, medium, large), the national classification according to the *Industrial Enterprises Act 2073 (2016)* is applied.

b) The minimum investment amount of projects applying to the Grant Fund is NPR 1,000,000.

c) The maximum grant amount that can be received by one company is NPR 10,000,000. The application to several measures by one company is possible, but the cumulated grant volume is capped at NPR 10,000,000.

d) Eligible investment costs:

- The following costs are eligible (included costs): technology, equipment and machinery, shipping, instalment, and commissioning costs.
- The following costs are not eligible (excluded costs): VAT, project preparation and management costs.

---

### 4.4. Subsidy for Energy Audits

In addition to the grant for implementing energy efficiency measures, a subsidy for energy audits, realised after the call for applications (18.05.2017), can be provided.

a) Re-audits: For industries that have been audited under NEEP and that have already implemented energy efficiency measures, 70% of the audit costs can be subsidised.

b) First time energy audits: For industries that are audited for the first time, 50% of the audit costs can be subsidised.

c) The maximum subsidy amount for (re-)audits is:

- for large industries: NPR 350,000
- for medium-sized industries: NPR 210,000
- for small industries: NPR 105,000

d) Costs for energy audits are not considered part of the project investment costs. The subsidy for energy audits will be provided in addition to the grant (also if the company receives the maximum grant amount of NPR 10,000,000).

e) The subsidy for energy audits depends on the successful implementation and verification of the project and will be paid together with the final grant disbursement.

f) The subsidy can also be made available for industries that have applied based on the first version of the Funding Guidelines (March 2017).
g) Industries are not entitled to receive a subsidy for energy audits, if the audits have been already subsidised under any other programme in Nepal.

h) Industries have to provide the tax invoice for the audit and proof of payment as well as the energy audit report.

### 4.5. Application Process

**a) Order of acceptance of applications:**

- The principle of “first-come, first-served” (FCFS) is executed on the incoming applications. Grants are given out to the first applications until the total Grant Fund is depleted.

- The decisive date is the date of receipt of the completed application.

**b) Completeness of application:**

- The client has to fill in the Funding Application Form (Annex I) and submit it with the following annexes:
  
  o Energy audit report
  
  o Financial offers of equipment suppliers
  
  o Latest financial audit report
  
  o Declaration of Undertaking

- Only if all documents are submitted and all information asked for in the application form is provided, the application is considered as completed.

- Further documents justifying the economic and technical feasibility as well as the compliance with environmental standards of the measures should be submitted (e.g. Feasibility study of the project, technical project descriptions, ISO 14001 and/or ISO 26000 certificates).

**c) Application routes: EE projects with an investment amount**

- below or equal to NPR 5,000,000:
  
  o can use their own equity for the investment or cover a part of the investment amount with a loan by a bank, and

  o can either apply directly to the Grant Fund (RBBL) or through the bank on behalf of the final beneficiary.

- of more than NPR 5,000,000:
must cover at least 30% of the investment amount with a loan by a bank,
and
can either apply directly to the Grant Fund (RBBL), submitting a letter of
the bank that attests the provision and amount of the loan, or through the
bank on behalf of the final beneficiary.

If no bank loan is utilised, the grant will be calculated on the basis of
investment costs of NPR 5,000,000 (i.e. maximum size of small projects).

4.6. Verification

a) Verification process:

- Small projects (investment costs below or equal to NPR 5,000,000) have to
  provide pictures of the installed equipment and machinery and notary certified
  invoices.

- For big projects (investment costs above NPR 5,000,000), the installation of the
  equipment and machinery and notary certified invoices will be physically verified at
  the company by technical experts of the Grant Fund.

b) The grant will be disbursed only after successful verification, environmental and social
check, and invoice checking.

c) If the final costs of the investment are lower as initially provided in the application, the
grant amount will be corrected accordingly.

d) Only for projects that are implemented and verified before 30.11.2020, a grant will be
disbursed. In exceptional cases a substantiated request for extension of the deadline
can be made.

4.7. Disclaimer

a) There is no legal entitlement of applicants to receiving a grant.

b) RBBL can reject applications without stating any reasons.

c) In each company that has received a grant the measures can be verified again at a
later point of time. Companies are obligated to provide disclosure to KfW.

d) The ultimate responsibility in respect of the acceptance or refusal of all donations
rests with KfW.
5. Annex

Annex I: Application Form
Annex II: Declaration of Undertaking
Annex III: IGEA Report Guidelines
Annex IV: IGEA Report Example
Nepal Energy Efficiency Programme

Please submit the application and all annexes by postal mail or hand delivery AND e-mail to:

FC Nepal Energy Efficiency Programme
Rastriya Banijya Bank Limited
Corporate and SME Credit Department
Central Office, Singhadurbar Plaza
Kathmandu, Nepal

E-Mail: homraj.bhattarai@rbb.com.np
Fax: +977 (1) 422-5302
Phone: +977 (1) 425-2595 3724

Company Details

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Main Contact Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector</td>
<td>(Person in charge of the project)</td>
</tr>
<tr>
<td>Address</td>
<td>Name</td>
</tr>
<tr>
<td></td>
<td>Position</td>
</tr>
</tbody>
</table>

Telephone
Fax

Company Size (according to 4.3 of the Guidelines): small ☐ medium ☐ large ☐

<table>
<thead>
<tr>
<th>Energy Efficiency Measure(s) / Investment(s)</th>
<th>Cost (NPR)</th>
<th>Energy savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>6</td>
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</tr>
</tbody>
</table>

Total Investment Costs: ____________________

Measures identified by:

Title of Energy Audit Report: ____________________

Name of Auditor(s): ____________________ Date of Audit: ____________________

Type of Funding

Own Equity: ____________________ NPR
Bank Loan: ____________________ NPR

Estimated Implementation

Start Date: ____________________ End Date: ____________________

Energy Audit

First time audit ☐ Re-audit ☐ Cost: ____________________ NPR
Declaration
I hereby declare that the information provided is true and correct to the best of my knowledge and belief and that the following codes of conduct have not been breached by my/our company:

- Asset (Money) Laundering Prevention Act 2064 (2008)
- Labour Act 2048 (1992)
- Child Labour (Prohibition and Regulation) Act 2056 (2000)
- Environmental Protection Act (EPA) 2053 (1997)
- Environmental Protection Rules (EPR) 2054 (1997), and
- the company is not blacklisted by Credit Information Bureau of Nepal, and
- there is no legal case pending against the company in the Labour Court or any other Court of Nepal.

Signature of Applicant:

__________________________________________________________
Date, Signature

Signature of Bank:
(only if the application is routed through a bank)

__________________________________________________________
Date, Signature and Bank Stamp

Attachments
Mandatory:
Energy Audit Report ☐ Offers of Equipment Suppliers ☐
Latest Financial Audit Report ☐ Declaration of Undertaking ☐
Registration Certificate from Company Registrar in Nepal ☐

If available/applicable:
Business Plan ☐ Feasibility Study ☐
ISO 14001 / ISO 26000 ☐ Technical Project Descriptions ☐
Invoice of Energy Audit ☐ Bank letter attesting the provision and amount of loan ☐
Others: ____________________ ☐
Description of Energy Efficiency Measure / Investment

(Please add a new page for each measure)

No. (as in table on p.1): ________ Title: ____________________________

Description of Measure / Investment

Please describe the planned investments and measures and provide information on how they improve the energy efficiency of your company.

Savings

Electricity savings per year: _____________________________ kWh/a

Thermal energy savings per year (diesel, biomass, coal etc.): _____________________________

Estimated Implementation

Start Date: _____________________________ End Date: _____________________________

Technical Lifetime

__________ year(s) or ___________ month(s)

Countries of origin of goods and services for the implementation of the measure:

________________________

Financing

Investment costs: ____________ NPR

Of total investment costs, costs related to:

Machinery and equipment: ____________ NPR

Project preparation and management: ____________ NPR

Shipping, instalment, commissioning etc.: ____________ NPR

Value Added Tax: ____________ NPR

Cost savings per year: ____________ NPR/a

Payback period: ____________ Months
Declaration of Undertaking

We underscore the importance of a free, fair and competitive procurement process that precludes abusive practices. In this respect we have neither offered nor granted directly or indirectly any inadmissible advantages to any public servant or other person nor accepted such advantages in connection with our bid, nor will we offer or grant or accept any such incentives or conditions in the present procurement process or, in the event that we are awarded the contract, in the subsequent execution of the contract. We also declare that no conflict of interest exists in the meaning of the kind described in the corresponding Guidelines1.

We also underscore the importance of adhering to environmental and social standards in the implementation of the project. We undertake to comply with applicable labour laws and the Core Labour Standards of the International Labour Organization (ILO) as well as national and applicable international standards of environmental protection and health and safety standards.

We will inform our staff about their respective obligations and about their obligation to fulfil this declaration of undertaking and to obey the laws of the country of @ (name of country).

We also declare that our company/all members of the consortium has/have not been included in the list of sanctions of the United Nations, nor of the EU, nor of the German Government, nor in any other list of sanctions and affirm that our company/all members of the consortium will immediately inform the client and KfW if this situation should occur at a later stage.

We acknowledge that, in the event that our company (or a member of the consortium) is added to a list of sanctions that is legally binding on the client and/or KfW, the client is entitled to exclude our company/the consortium from the procurement procedure and, if the contract is awarded to our company/the consortium, to terminate the contract immediately if the statements made in the Declaration of Undertaking were objectively false or the reason for exclusion occurs after the Declaration of Undertaking has been issued.

..........................................................
(Place) (Date) (Name of company)

..........................................................
(Signature(s))

Annexure 1.2.1

IGEA report guideline

Energy Efficiency Market
Nepal Energy Efficiency Programme (NEEP)

D. Pawan Kumar
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Towards ensuring desirable quality requirements and also as a consistent template for IGEA reports, to enhance their utility for M & E, an IGEA report structure along the following lines is recommended for adoption.

While the report structure compliance in entirety is desirable from programmatic perspective, flexibility needs to be accommodated, as, the extent of detailing; customization and client centric information may vary as per specific situations, warranting simplified presentation on the one hand or far more elaborate detailing on the other.

In presentation part, a good balance between quantitative and qualitative detailing and text and visual content is desirable, for the purpose of readability, understandability, and utility from client perspective.

Based on experiences acceptance and feedback from stakeholders like beneficiary industry, a standardized flow of an IGEA report with illustrative examples is presented as follows.
TITLE SHEET OF THE REPORT TO INDICATE:

- Nature of audit namely: Investment grade energy audit. (Or other as relevant)
- Name of the industry/audited entity
- Name of the auditing entity
- Duration of audit
- Sponsors, stakeholders as applicable

OPENING PAGE:
Opening page of report may contain table of contents of IGEA report indicating referred item and page number in a chronological sequence.

ACKNOWLEDGEMENTS:
The acknowledgements page may acknowledge contributions of key stakeholders associated in audit activity from client side as well as any other sponsors as relevant, preferably signed by team leader of audit with date.

STUDY TEAM:
On this page, the list of study team members with designations may be presented, for future references.

ABBREVIATIONS/NOMENCLATURE USED IN REPORT:
In this page, the report may list the abbreviations, nomenclature used in report, for ease of understanding purposes.

LIST OF INSTRUMENTS USED:
In this page, the list of instruments used in energy audit need to be mentioned

EXECUTIVE SUMMARY:
In this section, the report may present the synopsis of study findings, which would at-least, include:

- Baseline details of the audited entity.
- EE Option summary listing in a table, covering all EE opportunities identified in electrical and thermal areas the option wise identified annual energy savings potential, Rupee savings potential per annum, Investment needs and simple payback period.
Prioritized options listing as short term (less than one year simple payback period); medium term (one to three year simple payback period); long term (over three year simple payback period).

An illustrative template of executive summary is presented as exhibit 1 of these guidelines.

**HEADERS AND FOOTERS:**

The report may have consistent headers and footers as per relevance for easy accessibility.

**CHAPTER 1: INTRODUCTION:**

1.1 Background of the study:

*(Suggested text for IGEA reports as part of NEEP is as follows):*

As part of “Nepal Energy Efficiency Programme,” (a bilateral initiative between Government of Nepal and Government of Germany), GIZ Nepal is supporting Energy Efficiency Center, (an autonomous center functioning under the Federation of Nepalese Chambers of Commerce and Industry FNCCI), in promoting energy efficiency in industrial enterprises, with capacity building in Energy Audit as an area of focus. Accordingly, a team comprising of engineers, after an intensive training on energy audit by experts from National Productivity Council, India, undertook the pilot investment grade energy audit at -------------- , guided by BEE accredited energy auditor/expert -------------- along with local long term expert ------------------ and team leader from GIZ- INTEGRATION.

-------------- , is one of the leading ---------------- in the region, and was selected for the pilot investment grade energy audit based on their expression of interest and a MoU with EEC.

-------------- , is situated in ---------- , --------- . The pilot energy investment grade audit was conducted during ------------------ , covering both electrical and thermal energy utilization areas. This report presents the results of the pilot investment grade energy audit and presents findings along with energy conservation opportunities with cost benefit analysis.

1.2 Scope of pilot energy audit: (Coverage may refer to MoU or ToR)

An illustrative template is presented as exhibit 2 of these guidelines

1.3 About the unit:

*(Coverage may present location, year of establishment, products, production capacity, current level of production, shifts/day and days/year normal operation, Electrical energy and thermal energy consumption and costs per annum.)*
CHAPTER 2.0: PROCESS DESCRIPTION

(IGEA report to present Process overview with relevant flow diagrams especially briefing energy linkages/energy using equipment)

An illustrative template is presented as exhibit 4 of these guidelines.

In case of hotels and commercial buildings, the coverage may be modified to present information along the following lines

Number of floors:
Number of rooms (standard; executive; suites; cottages)
Number of conference facilities
Number of business centers
Number of lounges
Number of restaurants
Total area sq m
Total built up area sq m
(Any illustrative visuals are welcome)

Energy requirements at the hotel are essentially to meet the needs of:
Comfort air conditioning (common areas as well as hospitality areas)
Lighting(Outdoor; common areas and hospitality areas)
Laundry and Kitchen equipment (applications)
Bakery
Captive power plant (as backup source)
Water Pumping
Hot water and steam generation for kitchen and laundry

CHAPTER 3.0: PLANT ENERGY SYSTEMS

3.1 Electrical Energy Use features:
Coverage to present plant/facility features relating to electrical energy and load management practices, grid, diesel generation, cogen costs, power factor, time of use tariffs, maximum demand trends, specific electrical energy consumption, major equipment (like drives, refrigeration, pumping, compressors,) consuming power, breakup and factors affecting consumption.
3.2 Thermal Energy Use features:
Coverage to present plant/facility features relating to thermal energy use areas, sources, costs, major equipment, typical operational and performance indicators, specific thermal energy consumption, major equipment consuming fuels, breakup, and factors affecting consumption.

An illustrative coverage is presented as exhibit 5 of these guidelines.

CHAPTER 4.0: STRATEGIC ENERGY MANAGEMENT PROGRAM

(May cover rationale of a strategic energy management program at the unit, voluntary policy statement desirable as a measure of management commitment to energy efficiency, desirable features of a MIS system and any desirable upgrades in plant automation as relevant)

An illustrative template is presented as exhibit 6 of these guidelines.

CHAPTER 5.0: ENERGY EFFICIENCY OPPORTUNITIES

IGEA report to cover Energy efficiency opportunities in electrical and thermal systems in this chapter in a clear manner, presenting for each opportunity the following aspects:

1. Title of measure (EE opportunity)
2. Present situation
3. Recommendation
4. Cost benefits:
   - Cost benefits may present simple payback period of measure in months or years.
   - For proposals with long simple payback, ie over 3 years, it would be preferable to carry out feasibility analysis by IRR calculations, factoring in internal and external sensitivity factors like interest rates, debt equity ratios, any prevalent incentives, etc.
5. Vendor information as relevant.(Budgetary quotation would enhance comfort level for investment decisions).

The menu of EE measures are very exhaustive and sector and application specific and broadly may include measures such as:

- Maximum demand optimization, Load shifting for Time of Use tariff advantages
- Power factor improvement, Automatic Power Factor Controls (APFC)
- Drive efficiency improvements
• Variable speed drive applications for energy efficient capacity control
• Improving captive and Cogen system efficiency
• Automation for process controls
• EE in process utilities like pumps, fans, compressors, refrigeration and lighting
• Renovation and Modernization and process modifications/upgrades
• Thermal insulation in cold and hot piping
• Combustion efficiency improvements in furnaces, boilers, thermic fluid heaters, hot water generators, ovens, melting baths.
• Waste heat recovery in DG Sets, Furnaces, thermal equipment like boilers, heaters and ovens etc.
• Steam trap and Condensate recovery improvements
• Cogeneration
• Automation like temperature controls, combustion controls, etc.
• Loading improvements for better capacity utilization.
• Housekeeping improvements to abate wastages and leakages.
• Heat Exchanger performance improvements like de-scaling.
• RE applications

An illustrative template of measures assessed, is presented as exhibit 7 of these guidelines.

6- EXHIBITS
Each IGEA report may include exhibits to support the report findings, as deemed necessary, for clarity, better understanding, and may include information like:

• Line diagrams,
• Technical Specifications
• Design data
• Detailed calculations like heat balance
• Details of motor load survey, lighting survey, steam trap survey, insulation survey etc.
• Vendor information on product literature
• Generic tips, Housekeeping measures, maintenance guidelines etc.

Exhibits may also address any incentive schemes available from Government, Ministries, NEA, or Financial Institutions or International institutions, that are prevalent and applicable, to enhance the viability of the EE proposals.
EXECUTIVE SUMMARY

Dairy Kathmandu, Ltd, is one of the leading dairy units in the region, and was selected for the pilot energy audit based on their expression of interest and a MoU with EEC. Pilot energy audit was carried out as part of “Nepal Energy Efficiency Programme,” (a bilateral initiative between Government of Nepal and Government of Germany). GIZ Nepal is supporting Energy Efficiency Center (an autonomous center functioning under the Federation of Nepalese Chambers of Commerce and Industry FNCCI), in promoting energy efficiency in industrial enterprises, with capacity building in Energy Audit as an area of focus. Accordingly, a team comprising of engineers, after an intensive training on energy audit by experts from National Productivity Council, India, undertook the pilot energy audit at Dairy, guided by expert from NPC India along with local long term expert and team leader (GIZ INTEGRATION).

Dairy is situated in Kirtipur, on the outskirts of Kathmandu. The pilot energy audit was conducted during 20-25 September 2012, covering both electrical and thermal energy utilization areas. An overview of the prevalent production and energy consumption related features prior to the study period as a baseline information are presented in the table below.

<table>
<thead>
<tr>
<th>Name of Industry:</th>
<th>.......... Dairy (as a sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of Establishment:</td>
<td>..................</td>
</tr>
<tr>
<td>Scale:</td>
<td>..................</td>
</tr>
<tr>
<td>Product:</td>
<td>............. Dairy</td>
</tr>
<tr>
<td>Capacity in Liters:</td>
<td>............. millions LPA</td>
</tr>
<tr>
<td>Production in liters</td>
<td>........</td>
</tr>
<tr>
<td>Location:</td>
<td>........</td>
</tr>
<tr>
<td>Contact Person:</td>
<td>........</td>
</tr>
<tr>
<td>Designation:</td>
<td>Director/ Finance Manager</td>
</tr>
<tr>
<td>Telephone Number:</td>
<td>........</td>
</tr>
<tr>
<td>E-mail:</td>
<td>........</td>
</tr>
<tr>
<td>Website:</td>
<td>........</td>
</tr>
<tr>
<td>a- No of shift:</td>
<td>........</td>
</tr>
<tr>
<td>b- Annual operation days:</td>
<td>........</td>
</tr>
<tr>
<td>No of Employees:</td>
<td>........</td>
</tr>
<tr>
<td>Presence of Energy Manager:</td>
<td>......</td>
</tr>
<tr>
<td>EOI on NEEP Activity</td>
<td>........</td>
</tr>
<tr>
<td>EOI on EE Investment</td>
<td>......</td>
</tr>
<tr>
<td>Compliance with any International/National Standard:</td>
<td>......</td>
</tr>
</tbody>
</table>

Energy Aspects:

A) Electrical Energy:
A1) From NEA Grid in kWh: | ........ |
<table>
<thead>
<tr>
<th>Total Cost of Grid Electricity in NPR:</th>
<th>..........</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2) From Generators:</td>
<td></td>
</tr>
<tr>
<td>Types of Fuel used:</td>
<td>Diesel</td>
</tr>
<tr>
<td>Fuel Consumed in Liters:</td>
<td>..........</td>
</tr>
<tr>
<td>Total DG Capacity in kVA:</td>
<td>..........</td>
</tr>
<tr>
<td>Diesel Energy Generated in kWh:</td>
<td>..........</td>
</tr>
<tr>
<td>Total Cost of Energy Generated from DG Set in Nrs:</td>
<td>..........</td>
</tr>
<tr>
<td>Energy Generated in kWh per liter</td>
<td>3.73</td>
</tr>
<tr>
<td>% of kWh Generated from DG:</td>
<td>..........</td>
</tr>
<tr>
<td>Total Electrical Energy from NEA and DG in kWhr</td>
<td>..........</td>
</tr>
<tr>
<td>Total Cost of Electrical Energy from NEA and DG</td>
<td>..........</td>
</tr>
<tr>
<td>Per unit cost of Electrical Energy, NRs/kWh</td>
<td>..........</td>
</tr>
<tr>
<td>B) Thermal Energy:</td>
<td></td>
</tr>
<tr>
<td>B1) Types of Fuel used:</td>
<td>Diesel</td>
</tr>
<tr>
<td>Quantity of Fuel Consumed:</td>
<td>..........</td>
</tr>
<tr>
<td>Total cost of Fuel Consumed in NPR:</td>
<td>..........</td>
</tr>
<tr>
<td>B2) Types of Fuel used:</td>
<td>Furnace Oil</td>
</tr>
<tr>
<td>Quantity of Fuel Consumed:</td>
<td>..........</td>
</tr>
<tr>
<td>Total cost of Fuel Consumed in NPR:</td>
<td>..........</td>
</tr>
<tr>
<td>Total Thermal Energy Consumed in liters</td>
<td>..........</td>
</tr>
<tr>
<td>Total Cost of Energy used in Thermal Side</td>
<td>..........</td>
</tr>
<tr>
<td>Key Parameters:</td>
<td></td>
</tr>
<tr>
<td>Annual Turnover in Million in NPR:</td>
<td>..........</td>
</tr>
<tr>
<td>Capacity Utilization in %:</td>
<td>..........</td>
</tr>
<tr>
<td>Total Electrical Energy kWhr per kL</td>
<td>..........</td>
</tr>
<tr>
<td>Total Thermal Energy litre/1000L</td>
<td>..........</td>
</tr>
<tr>
<td>Total Energy Cost in NPR:</td>
<td>..........</td>
</tr>
<tr>
<td>Total Energy Cost as % of turnover</td>
<td>..........</td>
</tr>
<tr>
<td>S. No.</td>
<td>Energy Efficiency option</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Revising the approved electrical demand with NEA from 500 kVA to 400 kVA</td>
</tr>
<tr>
<td>2.</td>
<td>Effective use of Ice Bank System</td>
</tr>
<tr>
<td>3.</td>
<td>Operating the Effluent Treatment Plant (ETP) during low tariff off peak period</td>
</tr>
<tr>
<td>4.</td>
<td>Operating ground water pump at night, off peak hours</td>
</tr>
<tr>
<td>5.</td>
<td>Installation of Desuperheater at ammonia compressor discharge</td>
</tr>
<tr>
<td>6.</td>
<td>Heat recovery from DG set flue gas</td>
</tr>
<tr>
<td>7.</td>
<td>Installation of a 1 KL/Day solar hot water system to generate hot water</td>
</tr>
<tr>
<td>8.</td>
<td>Milk chilling and Pasteurization efficiency improvements</td>
</tr>
<tr>
<td>9.</td>
<td>Insulation of chilled milk pipeline</td>
</tr>
<tr>
<td>10.</td>
<td>Installation of VFD for Chilled water pump</td>
</tr>
<tr>
<td>11.</td>
<td>Performance of Boilers and measures for fuel economy (Replacement of oil fired boilers with rice husk fired boiler)</td>
</tr>
<tr>
<td>12.</td>
<td>Insulation of Ghee boiling pan</td>
</tr>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>13</td>
<td>Condensate Recovery from cream pasteurizer and ghee boiling pan</td>
</tr>
<tr>
<td>14</td>
<td>Recovering condensate during Diesel boiler operation</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>159,815</td>
</tr>
</tbody>
</table>

- On the whole, the identified energy efficiency options add up to 159,815 kWh of potential electrical energy savings per year and 17,998 kL of FO/Diesel savings per year amounting to NRs.11,842,663 per year savings on energy cost.
- Energy consumption reduction envisaged upon implementation will be 25.46 % in electrical energy and 15.55 % in fuel.
- The 14 nos. of Energy saving opportunities identified are worth NRs 11,842,663 annually, against an investment of NRs 79,54,000 and offer an overall simple payback period of 8.06 months.
## Classification of options on the basis of payback period:

<table>
<thead>
<tr>
<th>SN</th>
<th>Energy Efficiency Options</th>
<th>Simple payback period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Term (less than one year payback period)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Revising the approved electrical demand with NEA from 500 kVA</td>
<td>immediate</td>
</tr>
<tr>
<td></td>
<td>to 400 kVA.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Operating the Effluent Treatment Plant (ETP) during low tariff</td>
<td>immediate</td>
</tr>
<tr>
<td></td>
<td>off peak period</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Operating ground water pump at night, off peak hours</td>
<td>immediate</td>
</tr>
<tr>
<td>4.</td>
<td>Effective use of Ice Bank System</td>
<td>2.46 months</td>
</tr>
<tr>
<td>5.</td>
<td>Installation of Desuperheater at ammonia compressor discharge</td>
<td>9.40 months</td>
</tr>
<tr>
<td>6.</td>
<td>Insulation of chilled milk pipeline</td>
<td>Less than a month</td>
</tr>
<tr>
<td>7.</td>
<td>Installation of VFD for Chilled water pump</td>
<td>6.8 months</td>
</tr>
<tr>
<td>8.</td>
<td>Performance of Boilers and measures for fuel economy</td>
<td>8 months</td>
</tr>
<tr>
<td></td>
<td>(Replacement of oil fired boilers with rice husk fired boiler)</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Insulation of Ghee boiling pan</td>
<td>4.3 months</td>
</tr>
<tr>
<td>10.</td>
<td>Condensate Recovery from cream pasteurizer and ghee boiling pan</td>
<td>6 months</td>
</tr>
<tr>
<td>11.</td>
<td>Recovering condensate during Diesel boiler operation</td>
<td>1.8 months</td>
</tr>
<tr>
<td><strong>Medium Term (one to three year payback period)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Heat recovery from DG set flue gas</td>
<td>28 months</td>
</tr>
<tr>
<td>13.</td>
<td>Milk chilling and Pasteurization efficiency improvements</td>
<td>36 months</td>
</tr>
<tr>
<td><strong>Long Term (more than three years payback period)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Installation of a 1 KL/Day solar hot water system to generate</td>
<td>38 months</td>
</tr>
<tr>
<td></td>
<td>hot water</td>
<td></td>
</tr>
</tbody>
</table>
EXHIBIT 2: TEMPLATE SCOPE:

The scope of the pilot energy audit included:

• Brief history of production and energy use
• Measurement and monitoring of plant facilities for energy consumption
• Assess energy efficiency improvements opportunities in the areas of
  • Power Factor improvement
  • Load Management
  • Electrical systems
  • Thermal systems
• Recommendation of potential energy saving options
• Feasibility study of major options

Exhibit 3: Template text on “about the unit”

• ******Dairy Kathmandu, Ltd, situated at Kirtipur, Kathmandu, was established in 1994, with an objective of helping the local farmers and milk vendors to generate substantive income and cater to their daily needs by procuring milk from the surrounding villages and distributing it to the cities. The sourcing milk collection centers for dairy are located at Chitwan, Rupandehi, Kavre, Nawalparasi and Biratnagar.
• Currently, ........Dairy Kathmandu, Ltd is one of Nepal’s leading dairy processing and distributing Industries, with production capacity of more than 51.1 million liters of milk per year (considering 14 hours of operation in a day).
• The dairy currently processes around 40,000 liters per day. The dairy products include standard pasteurized Milk, Butter, and Ghee. The dairy has plans to produce Paneer, Dahee, Flavored Milk, and Lassi in the near future.
• Energy consumption and costs: Furnace oil/Diesel for boilers and NEA/captive diesel electricity for electrical equipment are the major energy sources used in the dairy. For ******Dairy, the annual electricity cost (NEA plus captive diesel) is around Rs. 72.69 lakhs per annum and the fuel bill (Furnace oil and diesel) is Rs. 97.47 lakhs per annum totaling to energy cost of NRs 170.16 Lakhs per annum.
2.1 Main Dairy

The raw milk received from various chilling centers are received and pumped through reception chillers into a silo. From the silo the raw milk is taken for High Temperature Short Time (HTST) pasteurization through the steps given below.

The processes involved include:

- Receipt and filtration/clarification of the raw milk;
- Separation of all or part of the milk fat (for standardization of market milk, production of cream and butter and other fat-based products, and production of milk powders);
- Pasteurization;
- Homogenization (as required);
- Deodorization (as required);
- Product-specific processing;
- Packaging and storage, including cold storage for perishable products
- Distribution of final products.

After being held in storage tanks at the processing site, raw milk is heated to separation temperature in the regeneration zone of the pasteurizer. The milk (now hot) is standardized and homogenized by sending it to a centrifugal separator where the cream fraction is removed. The skim is then usually blended back together with the cream at predefined ratios so that the end product has the desired fat content. Surplus hot cream is cooled and usually processed in a separate pasteurizer ready for bulk storage and transportation to a cream packing plant.

The pasteurization process involves killing most of the bacteria within the raw milk to increase its shelf life. This is done by rapidly heating the incoming standardized milk to the pasteurization temperature in a simple holding tube, ensuring that the pasteurization temperature is held for the correct time (e.g. 72°C for 25 seconds) to destroy the bacteria. The hot milk is then passed through the regeneration zone, giving up its heat to the incoming cold milk, and cooled to a level where the growth of any surviving bacteria is slowed to a minimum, partially sterilizing the milk and increasing shelf life. Typically, this is an in-line process with the heating and cooling conducted in a plate heat exchanger.

Finally, chilled water is used to control the milk exit temperature from the pasteurizer at approximately 4°C. As the milk is heated and cooled within a few seconds there are intense heating and cooling demands. This process is therefore one of the largest emission sources within the industry, even though much of the heat is regenerated and re-used in the pasteurizer.
An overview of milk process flowchart indicating various linkages is presented as follows.

Fig-1: Milk Process Flow Chart

2.2. Butter and Ghee production:
The dairy plant produces on the average 884 kgs of cream, 485 kgs of butter and 325 kgs of ghee per day. Butter is produced by churning cream, a process which damages the membranes of butter fat found in cream resulting in the production of small butter grains. These butter grains float in the water-based portion of the cream called buttermilk. The buttermilk is then drained to get butter and is stored at 18°C. The stored butter is then melted in melting vats to 75°C and then is taken to a ghee boiler where it is heated to 120°C. The molten ghee is clarified, stored and packed. The following figure presents butter and ghee making process linkages adopted.
2.3. Clean-In-Place (CIP)
CIP is the method of cleaning the interior surfaces of pipes, vessels, process equipment, filters and associated fittings without needing to remove them. It is common throughout the industry, as the processing facilities must be constantly cleaned to prevent microbes from growing and to remove fouling/scaling. CIP typically includes an initial rinse of recovered water to remove heavy soiling, followed by a hot detergent wash of caustic or acid solution, and a final rinse of clean potable water. Energy use and emissions associated with CIP are predominantly due to the heating of the processing equipment that is being cleaned as well as the heating of water which is subsequently wasted. CIP is a large consumer of water so there is a cost incentive to reduce CIP water usage as well as minimizing heat and chemical consumption.
3.1 Electrical Energy and Load management Practices:

- The approved maximum demand of the plant is 500 kVA. The dairy receives electric power from Nepal Electricity Authority, through a 500 kVA transformer at 11 kV which stepped down to 415 V for end use. The connected load of plant is about 580 kW.

- The monthly demand charges as charged by Nepal Electricity Authority are at the rate of 230/KVA. The minimum billable demand is 50 % of approved demand of 500 KVA. The energy tariff depends on the time of the day and currently, is as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>NRs/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak time (5 PM to 11 PM)-R1</td>
<td>8.75</td>
</tr>
<tr>
<td>Off peak time (11 PM to 5 AM)-R2</td>
<td>4.30</td>
</tr>
<tr>
<td>Other time (5AM to 6 PM)-R3</td>
<td>7.10</td>
</tr>
</tbody>
</table>

- Two Diesel generator sets of 320 KVA each provide the backup in case of power failure.

- Monthly Electrical energy consumption of dairy plant, indicating share of NEA and Diesel Generated power, for one year is profiled as under.(Fig 3)
• It is seen that the diesel generation share in total reaches up to 52% and on the aggregate accounts for 19% of total electrical energy used.

• The main impact of this feature is that the weighted average price of electricity becomes higher as illustrated below.

**Annual NEA kWh purchased:** 507,939 kWh (2011-2012)

**Annual NEA energy Cost:** NRs. 4,154,144

**Annual DG Power generated:** 119,755 kWh (2011-2012)

**Annual DG Power Cost:** NRs. 3,131,063

**Aggregate annual energy consumption:** 627,694 kWh (2012-2013)

**Aggregate electrical energy cost:** NRs. 7,287,527

**Weighted average electrical energy cost /kWh = NRs. 11.60**

• **Diesel Power Generation Efficacy:**

Based on field trial during energy audit, the kWh/Liter figure was found to be 3.71 at 60% loading that reflects satisfactory efficacy of captive generation.

• **Time of Day Use Pattern of NEA Electricity:**

The Electricity use pattern in three time zones (in accordance with NEA billing criteria) over one year duration is presented in the following Fig 4.
The different time of use tariffs allow feasibility to maximize consumption at lowest billing time-zones for optimizing the NEA billing to be paid.

Analysis reveals the following on annual basis for the year 2011/12

a) 19.40% of energy consumption is at R1 rate 8.75/kWh
b) 65.15% of energy consumption is at R2 rate 4.30/kWh
c) 15.45% of energy consumption is at R3 rate 7.10/kWh.

- The Production planning schedules may be reviewed to benefit from lower billing rates during 11 PM to 6 AM.
- The options could include water pumping for storage; ice bank storage etc.

- **Maximum Demand variation and Charges:**
  The billing demand charged by NEA is seen to be 250 kVA though the actual demand recorded is less. This is, because the contract maximum demand of the plant is 500 kVA and NEA billing demand charges are for 50% of the contract maximum demand or actual demand recorded (whichever is higher).

- **Power Factor Variation:**
  The power factor at tail end of various loads as measured, is from 0.7 to 0.97. The plant has installed capacitor bank with automatic power factor control to ensure achieving a power factor of 0.97 to optimize maximum demand and charges thereof, which was dysfunctional but rectified by the energy audit team during study.

- **Production, Electrical Energy consumption and specific energy consumption trends:**
  The month-wise production and specific electrical energy consumption trends provide an indicator for plant energy performance, benchmarking and target setting.
  The milk production and specific electrical energy consumption trends of SGML as presented below (fig 5) indicate:
  - Monthly specific electrical energy consumption variation from 32 kWh/1000 liters to 58 kWh/1000 Liters during reference year 2011-2012
  - Average specific electrical energy consumption of 44 kWh/1000 Liters for the reference year 2011-2012.
The factors affecting variations in specific electrical energy consumption have been analyzed to include:

- Capacity Utilization
- Product mix
- Incoming milk quality, quantity, temperature and additional chilling needs
- Ambient weather conditions and cold storage operations
- Operational efficiency at plant level
- Given the high average electrical energy cost at NRs 11.60 /kWh, the electrical energy cost contribution per 1000 liters of milk processed works out to . 510.00 corresponding to 44 kWh specific electrical energy consumption, the prevalent norms of 26-30 kWh/1000 liters as being achieved in contemporary Indian dairy plants could be considered as a target for achieving, through various good practices applicable.

- Electrical Energy use in equipment and share:

The major applications drive ratings, indicative hours of use, measured kW loading and daily power consumption estimated are summarized as follows.

<table>
<thead>
<tr>
<th>Application</th>
<th>Rated KW</th>
<th>Measured KW</th>
<th>P.F</th>
<th>Hours of Operation</th>
<th>KWH/Day Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>-</td>
<td>7.91</td>
<td>0.97</td>
<td>11</td>
<td>87.01</td>
</tr>
<tr>
<td>Ref Compressor</td>
<td>55</td>
<td>26 to 42</td>
<td>0.89</td>
<td>19</td>
<td>798</td>
</tr>
<tr>
<td>Chilled water pump</td>
<td>5.5 x 2nos</td>
<td>11</td>
<td>0.86</td>
<td>19</td>
<td>209</td>
</tr>
<tr>
<td>Condensed water pump</td>
<td>3.7 x2 (one run)</td>
<td>4.26</td>
<td>0.86</td>
<td>19</td>
<td>80.94</td>
</tr>
<tr>
<td>Homogenizer</td>
<td>75</td>
<td>39</td>
<td>0.7</td>
<td>5</td>
<td>195</td>
</tr>
<tr>
<td>Equipment</td>
<td>Quantity</td>
<td>Leakage</td>
<td>Eff. (%)</td>
<td>Speed (RPM)</td>
<td>Consumption/kWh</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------</td>
<td>---------</td>
<td>----------</td>
<td>-------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Air Compressor</td>
<td>11 x 3( one run)</td>
<td>9.23</td>
<td>0.8</td>
<td>6</td>
<td>55.38</td>
</tr>
<tr>
<td>Milk pumps</td>
<td>16.5</td>
<td>14</td>
<td>0.85</td>
<td>4.5</td>
<td>63</td>
</tr>
<tr>
<td>Ground water pump</td>
<td>3.7 x 3 nos</td>
<td>5.9</td>
<td>0.82</td>
<td>8</td>
<td>47.2</td>
</tr>
<tr>
<td>ETP</td>
<td>22.25</td>
<td>10</td>
<td>0.7</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>Boiler 1</td>
<td>10.15</td>
<td>9</td>
<td>0.78</td>
<td>2.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Crate Washing</td>
<td>11.1</td>
<td>11</td>
<td>0.76</td>
<td>6</td>
<td>66</td>
</tr>
<tr>
<td>IBT Agitator</td>
<td>5.5</td>
<td>5</td>
<td>0.8</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>Filling machine</td>
<td>13.5</td>
<td>8.19</td>
<td>0.8</td>
<td>6</td>
<td>49.14</td>
</tr>
<tr>
<td>Cream Separator</td>
<td>15</td>
<td>9.5</td>
<td>0.78</td>
<td>5</td>
<td>47.5</td>
</tr>
<tr>
<td>Boiler 2</td>
<td>10.1</td>
<td>9</td>
<td>0.77</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Butter Cold Store 1</td>
<td>10</td>
<td>6.08</td>
<td>0.7</td>
<td>10</td>
<td>60.8</td>
</tr>
<tr>
<td>Raw milk agitator</td>
<td>8.6</td>
<td>6.45</td>
<td>0.8</td>
<td>3.5</td>
<td>22.575</td>
</tr>
<tr>
<td>Cooling unit fan motor</td>
<td>5</td>
<td>3.75</td>
<td>0.8</td>
<td>12</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total Consumption/day</strong></td>
<td>535.22</td>
<td>211.27</td>
<td></td>
<td></td>
<td><strong>2014.045</strong></td>
</tr>
</tbody>
</table>

- Accordingly, for the daily electrical energy consumption of around 2000 kWh, the break-up among various users is presented as follows. (Fig-6)

![Daily energy consumption kWh/day](chart)

**Fig 6: Section wise energy consumption in kWh/day**
• It is recommended that management may initiate a practice of daily monitoring of milk processed, electrical energy consumed (NEA and Captive diesel), specific electrical energy consumption per 1000 Liters, as MIS and control parameter.

• It is recommended that management may incorporate time totalizers to all the major drives with over 10kW rating and monitor and track their hours of use monthly, as a component of MIS.

### 3.2 Thermal Energy Systems

• Steam for process heating and hot water needs are sourced from two boilers. Diesel and furnace oil are the fuels used in the boilers for steam generation. Diesel accounts for 42% of the total fuel fired into the boiler, while furnace oil makes up for balance. Diesel fuel is nearly 1.5 times more expensive than FO while the calorific value of Diesel and Furnace oil are almost the same.

• The technical specifications of the two boilers, namely, Pressels make fire tube type rated 1500 kgs/Hr (F.O. Fired) and Thermax make, once through, coil type, 850 kgs/Hr (Diesel fired), are presented as Exhibit-1 and the steam distribution diagram is presented as Exhibit-2 respectively.

• The steam generated is used mainly for pasteurization and CIP operations. Only condensate from pasteurizer is recovered. The steam costs NRs. 6.25 per kg with furnace oil firing while it is NRs. 8/kg with Diesel firing. The boilers are operated for about 7 hours per day from morning to noon, when the pasteurization is carried out.

• The audit findings about evaporation ratio and efficiency of both boilers are summarized as follows:

#### Thermax Boiler (850kG/HR capacity, diesel fired):

- **Evaporation Ratio =** 13.3 (equivalent)
- **Thermal Efficiency =** 80 %
- **Steam Cost =** NRs 7427/MT

#### Pressels Boiler (1500 kgs/HR capacity, F.O. fired):

- **Evaporation Ratio =** 13.33
- **Thermal Efficiency =** 80 %
Steam cost = NRs. 5626.4/MT

Further details are presented as *Exhibit*.

**Specific fuel consumption:**
The month-wise production and specific oil consumption trends provide an indicator for plant thermal energy performance, benchmarking and target setting. The milk production and specific oil consumption trends of SGML as presented below (fig 7) indicate:

- Monthly specific fuel consumption variation from 7.44 Liters/1000 liters milk to 9.25 Liters/1000 Liters milk during reference year 2011/12.
- Average specific fuel oil consumption of 8 liters per 1000 liters milk for the reference year 2011/12.

- The factors affecting variations in specific fuel consumption have been analyzed to include:
  - Capacity Utilization
  - Product mix
  - Boiler Efficiency
  - Steam use efficiency at plant level

- **Fig 7: Monthly Production v/s sp. Oil consumption (2011/12)**

- Given the high average fuel cost contribution per 1000 liters of milk processed works out to NRs. 687.28 corresponding to 8.16kg specific oil consumption, the prevalent norms of less than 5.0 kg equivalent/1000 as being achieved in contemporary Indian dairy plants could be considered as a target for achieving, through various good practices applicable.
3.3 Refrigeration systems

The refrigeration system consists of 3 chiller compressors, ice bank system, chilled water circuit and condenser water circuit. One chiller compressor is operated at any time.

The refrigeration system using ammonia as the refrigerant is largely used for the ice bank system. The liquid ammonia expands in coils chilling and creating ice around the coils submerged in water. The purpose of the ice bank is to build sufficient storage of ice to meet the peak load in the early hours of morning for pasteurization and for reception chilling of raw milk. The ice bank temperature is maintained between 1-2 °C. The evaporated ammonia is then compressed in a 45 TR reciprocating compressor of Kirloskar make. The compressed ammonia is sent to atmospheric condensers for condensation and collected in a receiver. From the receiver the liquid ammonia is sent to ice bank and also partly to chilling units in cold storage section. The cold storage section stores the sachets of milk packed for next day’s dispatch and is maintained at 0°C.

The cold room which is meant for storage of packed sachet milk before dispatch. Consist of 4 diffusers in the cold room each of 5 TR refrigeration capacities to accomplish the cooling requirements. Overview of ice bank system linkages is presented in figure 8 which follows:

![Ice Bank System Diagram]

**Fig 8: Ice Bank System**
The cold storage system linkages are presented in Figure 9, which follows:

3.4 Compressed Air System

The compressed air system is meant to cater to the needs of pneumatic packaging machines and for operation of control valves. The following are the specifications of compressors in use.

- Manufacturer: ELGI
- Capacity: 1535 liters/min = 50 cfm
- Working Pressure: 12 kg/cm²
- Double stage reciprocating type
  (2 Low pressure cylinders and 1 high Pressure cylinders)
- Receiver Capacity: 500 liters

Motor specification:
- Rating: 15 hp, P.F :0.84, r.p.m(N):1460
- Current: 20.6 A

An overview of the compressed air system along with uses of compressed air in the plant is given in the following figure.
Air Compressor Flow diagram

Fig-10 Compressed air system along with uses
EXHIBIT 6: TEMPLATE TEXT ON “STRATEGIC ENERGY MANAGEMENT”

- Improving how energy is managed by implementing an organization-wide energy management program is one of the most effective ways to bring about energy efficiency improvements.

- Continuous improvements to energy efficiency occur only when a strong organizational commitment exists and a formal energy program is in place. A sound energy management program helps to create a foundation for positive change and to provide guidance for managing energy throughout an organization.

- Energy management programs help to ensure that energy efficiency improvements do not just happen on a one-time basis, but rather are continuously identified and implemented in an ongoing process of continuous improvement. Without the backing of a sound energy management program, energy efficiency improvements might not reach their full potential due to lack of a systems perspective and/or proper maintenance and follow-up.

- It is recommended that the progressive management of ........... Dairy may initiate Implementation of a well-defined energy management policy (an illustration follows):
ENERGY MANAGEMENT POLICY

- Plant management is committed to excel in Energy Management Performance on a continual basis, through:
- Continual Upgradation of Technology, Systems and Services to optimize the Energy Costs.
- Declaring, Monitoring and Controlling the Energy consumption and specific electrical/thermal energy consumption effectively, on continuous basis.
- Providing Resources to achieve measurable objectives whenever necessary.
- Education and motivation of all the people Concerned through effective Communication & Recognition.
- Establishment of Benchmarking Standards in Dairy, in Energy Management.
- The organization has commitment to protect the Environment, by not disposing the effluents without treatment. The water treated with ETP has been used to feed fodder crop plots, medicinal plants, and gardening not discharging as waste.
- Our management is committed for the Health & Safety of its work force. A Safety Committee is constituted with employees working at different levels which meet periodically to analyze all aspects of employee’s health & safety during work. The Safety Committee recommendations are being implemented to improve the working conditions & safety of all.

Signed-------

- Daily Production & Energy Consumption tracking and control chart suggested for adoption:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Description</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quantity Milk Processed (KL/day)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Electricity Consumed NEA plus DG (kWh)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Furnace Oil/Diesel Consumed for steam (KL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Specific electrical consumption kWh/kL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Specific Fuel consumption MkCals/kL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.1. **Revising the approved electrical demand with NEA from 500 kVA to 400 kVA.**

**Present situation:**
- The NEA approved maximum demand is 500 kVA and minimum billing demand is 250 kVA.
- The actual maximum demand over the past two years has been less than 250 kVA.
- As run (normal) Maximum demand from TOD meter: 238kVA
- Operational Power Factor (P.F): 0.81

During study, the APFC panel was rectified and made functional to achieve 0.98 power factor, through housekeeping improvements (loose connections and blown fuses attended to) at zero investment basis.

**Recommendation:**
- By improving the power factor to 0.98, the maximum demand reduces to 196KVA. Maximum Demand reduction achieved by improved PF= 238(present)-200 (minimum billing demand)= 38 kVA/month
- Potential demand charge reduction at Rs 230/kVA x 38kVA= Rs 8740/ month or 104,880 per year
- This benefit will accrue only if the approved demand is revised to 400kVA from the present demand of 500kVA.
- Annual electricity Cost savings achievable by revising maximum Demand agreement with NEA from 500 to 400 kVA demand: 104,880
- Investment: NIL.

5.2. **Effective use of Ice Bank System:**

**Present Situation:**
- The Dairy has an ice-bank refrigeration system through which chilled water is delivered to the milk pasteurizer, raw milk chilling, butter pasteurizer for process and direct expansion with ammonia for cold room chilling where the milk is stored at 4oC.
- The refrigeration plant consists of three compressors 2 nos. of 45 TR and one of 60 TR capacities. Normally one 45 TR compressor is in operation.
- The operating schedule of the 45 TR compressor was observed as follows.

<table>
<thead>
<tr>
<th>Hours of operation</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>19/day</td>
<td>7 am - 2 am</td>
</tr>
<tr>
<td>10/day</td>
<td>7 am - 5 pm</td>
</tr>
<tr>
<td>6/day</td>
<td>5 pm - 11 pm</td>
</tr>
<tr>
<td>3/day</td>
<td>11 pm - 2 am</td>
</tr>
</tbody>
</table>
• The current load works out to 57.26 kW (being 42 + 11 + 4.26) which, in other words amounts to 1088 kWh for 19 hour working a day, towards meeting process, cold room chilling requirements.
• It is seen that the compressor is switched off from 2 AM to 7 AM in the morning when the tariff is the least on one hand and conditions most favorable for ice making on the other. (The cooling water temperature being lowest for good condenser effectiveness and better refrigeration efficiency)
• In addition, the ice buildup over the coils is found to be negligible. Thus, when peak demand for refrigeration occurs at 7 AM in the morning, the compressor is unable to meet the peak demand for raw milk chilling and pasteurizer. This results in higher temperature of the outlet milk from the pasteurizer (about 80°C as against the desired 40°C).

Recommendation:

Adapt revised operational timings of 45 TR chiller for ice bank build up and process needs; provide effective cold storage partitioning and dedicate a new 10 TR chiller for cold room needs

To overcome the quality issues arising from high milk output temperature and to reduce the energy costs by taking advantage of night time tariffs, the following operation schedule is suggested for the refrigeration compressor.

<table>
<thead>
<tr>
<th>Description</th>
<th>TR</th>
<th>Hours</th>
<th>Operation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice making for Ice bank</td>
<td>45</td>
<td>6</td>
<td>11pm-5am</td>
</tr>
<tr>
<td>Process</td>
<td>45</td>
<td>3</td>
<td>9am-12pm</td>
</tr>
<tr>
<td>cold Room</td>
<td>10</td>
<td>5</td>
<td>12pm-5pm</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>6</td>
<td>5pm-11pm</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>6</td>
<td>11pm-4am</td>
</tr>
</tbody>
</table>

• The cold room requirement has been calculated to be 10 TR. It is suggested to provide effective partitioning and assign a new dedicated 10 TR unit for maintaining the cold room temperature rather than running a big 45 TR compressor all through.
• By operating the 45 TR compressor during lean tariff hours from 11 PM to 5 AM, sufficient amount of ice buildup will take place, enabling the stored ice to provide relief during chilling peak load from 7 AM onwards as milk receipts commence.
• Cost benefits of this option are summarized as follows.

<table>
<thead>
<tr>
<th>Description</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Electricity consumption with existing schedule of operation,</td>
<td>3,80,800</td>
</tr>
<tr>
<td>considering 350 day working@1088kWh/day</td>
<td></td>
</tr>
<tr>
<td>Annual Electricity consumption, with suggested schedule of operation of</td>
<td>2,54,744</td>
</tr>
<tr>
<td>45 TR and 10 TR new chiller(57.26kW<em>9Hrs plus 12.5kW</em>17Hrs)@ kWh</td>
<td></td>
</tr>
</tbody>
</table>
It may be appreciated that benefits of better chiller efficiency in night hours, lower tariff advantage and better process efficiency add to the savings potential.

5.3. Operating the Effluent Treatment Plant (ETP) during low tariff off peak period - shifting ETP load of 10 kW over 6 Hr duration, from peak to off peak hours:

Present situation:

- Total measured kW drawn by ETP = 10 kW.
- At present ETP, is operating at peak time and normal time
- For peak tariff duration, electrical energy consumption and cost = 10 KW x 6 hours = 60 KWH and at Rs 8.75/kWh = 525 / day amounting to Rs 1, 91,625 /year considering 350 days working.
- For Normal tariff duration, electrical energy consumption and cost = 10 KW x 2 hours = 20 KWH@ Rs 7.10/kWh = 142 /day amounting to 51,830 /year.
- Total annual ETP running electrical energy cost= 191625 + Rs 51830 = 2, 43,455 per year.

Cost differential of operating ETP at off peak tariff hours:

- For off peak tariff duration, energy consumption and cost = 10 KW x 6 hours = 60 KWH @NRs 4.30 = NRs 258 /day amounting to 94,170 / year
- For normal tariff duration, consumption and cost remain the same as above.
- Thus, running energy cost with revised hours of operation to off peak tariff duration and normal tariff duration = NRs. 94,170 + 51,830 = NRs 1,46,000.
- Electricity cost Saving annually, with availing of off peak tariff advantage= NRs. 243455 – NRs. 146,000 = NRs. 97,455 per year.
- About 10 kVA of Maximum demand drawn is also likely to be saved once off peak operations are made operational.
- Investment: NIL
5.4. Operating ground water pump at night, off peak hours:

Present situation:

- Measured kW drawn by ground water pump = 5.9 kW.
- At present, ground water pump is operating at peak tariff time and normal tariff time.
- For Peak tariff time, energy consumption and cost = 5.9 kW x 6 hours = 35.4 kWhr @ NRs 8.75 = NRs 309.75 /day amounting to NRs. 113058.75 /year at 350 day working.
- For Normal tariff time, energy consumption and cost = 5.9 kW x 2 hours @ NRs 7.10 = NRs 83.78 /day amounting to NRs 30579.70 /year
- Total operating cost/annum=NRs 113058.75 + NRs 30579.70 = NRs 143638.45
- With recommended option of operating ground water pump at off peak hours:
  - Consumption and cost for off peak tariff time = 5.9 kW x 6 hours = 35.4 kWhr = 35.4 x NRs 4.30 = NRs 152 /day = NRs 55560.30 /year
  - Consumption and cost for Normal tariff time remains unchanged as above.
  - Annual operating cost by shifting pump operations to off peak hours = NRs 55560.30 + NRs 30,579.70 = NRs 86,140
  - Annual energy cost Saving by availing of off peak tariff advantage = NRs 143638.45 - NRs 86,140 = NRs 46,183
- Investment : Nil
- Additionally, the peak demand shift would lead to reduction of maximum demand by about 6.0 kVA.

5.5. Installation of Desuperheater at ammonia compressor discharge

Present situation:

The discharge temperature of ammonia refrigerant from the 45 TR compressor is around 130°C and is in superheated condition. This influences condenser load, compressor discharge pressure significantly alongside compressor power consumption. The present power consumption by compressor alone is 42 kW.

Recommendation:

A Desuperheater to be installed as shown in the following figure 11, to recover heat in the form of hot water from the superheated Ammonia refrigerant.

This measure would help:

- To produce hot water at 65deg C for process needs(CIP cleaning, washing, etc)
- To reduce the cooling load in the condenser, compressor discharge pressure
- To reduce compressor power consumption by about 5%.
Cost Benefits of Option:

Potential Hot water generation at 65 deg C, from 27 deg C inlet from 45 TR compressor = 500 LPH

Hot water generated over 9 Hr working per day = 4500 LPD

Heat savings in kCal/day by waste heat recovery = 171,000

Steam equivalent savings a day @ 600 kCal/kg = 285

Fuel oil savings per day in kg at E.R of 13.3 = 21.43

Annual fuel oil savings @ 350 day working, in MT = 7,500

Annual fuel cost savings @ NR 75000/MT in NRs = 562,500

Annual savings in compressor power @ 5% in kWh = 6,615

Annual electricity cost savings @ NRs. 11.60/kWh in NRs. = 76,734

Total annual energy savings potential in NRs = 639,234

Investment envisaged for procurement and installation of Desuperheater = NRs. 500,000

Simple payback period = 9.4 months

Vendor information is provided as part of Exhibit 4
5.6. Heat recovery from DG set flue gas.

**Present situation**

Hot water needs being met by boilers using F.O/Diesel
Diesel Generator exhaust gases leaving at 400 deg C
Average generator running hours per day = 03
Average fuel consumption = 30 liters/hour
Flue gas mass in kgs/Hr = 600
Exhaust temperature = 400°C

**Recommendation**

To incorporate a coil type/shell and tube type waste heat recovery unit for hot water generation from DG Waste flue gases:

**Cost Benefits**

Proposed Exhaust temperature after waste heat recovery = 250°C
Heat recovered from exhaust gases = 600*0.24*(400-250)
= 21600 kcal/hr
Hot water generation potential @80°C from 27degC = 21600/53
= 407 kg/hour
Hot water generation potential per day = 407x 3 hours
= 1221 kg/day
Equivalent fuel saving per day, at 13.3 boiler ER in kgs = 8.10
Annual fuel saving potential @350 day working in kgs = 2835
Annual cost savings potential @ NRs. 9/kG = NRs. 212,625
Envisaged Investment for waste heat recovery unit = NRs. 500,000
Simple payback period = 28 months
Vendor information is provided as part of Exhibit 4
5.7. Installation of a 1 KL/Day solar hot water system to generate hot water.

Present situation:
Hot water needs for CIP, washing etc. are met through costly boiler steam route.

Purpose of Utilization of solar hot Water: CIP Requirements, boiler makeup water preheating replacing corresponding fuel use in boilers:

Recommended capacity of Solar Water Heater = 1000 LPD

Expected temperature of Hot water from 27 deg C = 75 deg C

Cost Benefits:
Thermal energy capture potential per day in kCal = 1000 x (75-27)
= 4,80,00

Fuel savings potential in kG/day @13.3 boiler ER = 48000/600*13.3
= 6.0

Annual fuel oil savings @350 day working = 2100 lit.

Annual fuel cost savings @NRs 75/lit = NRs. 157,500

Envisaged Investment for 10 KLPD solar HW system = NRs. 500,000

Simple Payback period = 3.18 years

Suggested technology: Heat tube collector based SHW system (Australian Technology)

Illustrative Vendor reference: Sun Works Nepal (Niraj Shrestha, Tele: 01-4330854)

http://www.sunworksnepal.com.np/

5.8. Milk chilling and Pasteurization efficiency improvements.

A. Ensuring lowest milk temperature at receipt, close to 4 deg C:
   - Incoming milk is being received at temperature ranging from 7 deg C to 10 deg C (average 8.5 deg C), whereas the pasteurization is designed for 4 deg C basis, leading to additional chilling needs, upon receipt during processing, affecting quality as well.
   - Given a typical 40 KL processing a day, an additional chilling duty of 4.5 deg C relates to an extra chilling load of 59.5 TR (40,000*4.5/3024); valued at 75.6 kWh energy input worth NRs. 877 every day at NR 11.60/kWh.
Ensuring lower receiving temperature of milk receipt by suitable improvements at supply end bulk chillers, and transportation, annual saving of NRs. 71,750 for every deg C margin, in addition to improving quality and process efficiency.

Refrigerated tanks, need based supply side chilling improvements are interventions called for, and an envisaged investment of NRs. 300,000 is justifiable for a 2 deg C margin and 2 year simple payback period.

B. **Ensuring pasteurization regeneration efficiency and temperature controls:**

As per design data, the milk temperature after pasteurization needs to be maintained at 4°C. However due to the higher temperature of the incoming milk which varies from 5-9°C the pasteurizer milk outlet temperature is also high leading to quality problems and returned milk. A comparison of actual versus required parameters in pasteurizer is given in the table below.

<table>
<thead>
<tr>
<th>Requirement as per manufacturer</th>
<th>Actual at site</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 inlet temp</td>
<td>4</td>
</tr>
<tr>
<td>R1 outlet temp</td>
<td>50</td>
</tr>
<tr>
<td>R2 outlet temp</td>
<td>72.5</td>
</tr>
<tr>
<td>Heating outlet Temp</td>
<td>80</td>
</tr>
<tr>
<td>After regeneration from R2</td>
<td>57.6</td>
</tr>
<tr>
<td>After regeneration from R1</td>
<td>11.6</td>
</tr>
<tr>
<td>Chiller outlet temp</td>
<td>4</td>
</tr>
</tbody>
</table>

**ANALYSIS:**

- Design heating cycle regeneration efficiency = \((72.5-4) \times 100/(80-4)\) = 90.13%
- As run heating cycle regeneration efficiency = \((71 – 8) \times 100/(78-8)\) = 90%
- Design cooling cycle regeneration efficiency = \((80-11.6) \times 100/(80-4)\) = 90%
- As run cooling cycle regeneration efficiency not measurable.
- As per design the heat duty from 72.5 deg C to 80 deg C for 40 KL a day works out to:
  - Around 500 KG of steam \((40,000LPD * 7.5 \text{ delta T})/(660kCal/kG-60kCal/ kgs))
  - Around NR 3175 as cost of fuel @ NR 6350 per MT of steam.
- Similarly, chilling duty from 11.6 deg C to 4 deg C would for 40000LPD would mean a TR load of about 100,\((40000*7.4/3024)\)which works out to a power requirement of 125 kWh every day (@1.25kWh/TR)worth NR 1522.5.
- Cost of Pasteurization per KL as per design data amounts to NR 117; or NR 4698 a day or NR 16, 44,300 per annum, a significant sum.
- Present instrumentation and automation level is inadequate and deserves an Upgradation.
- Present temperature profile across pasteurizer indicates shift, mainly on account of higher incoming milk temperature.

**RECOMMENDATIONS:**

Given the importance and significance of energy intensity of pasteurization. It is strongly recommended to:

1. Upgrade, in consultation with OEM, the existing pasteurizer, by way of instrumentation, automatic control, addition of plates as warranted, to ensure operation with a regeneration efficiency of 93%, at full capacity, while enabling monitoring of performance too.
2. An improvement of regeneration efficiency from 90 to 93 % would mean a reduction of heating and chilling duty to an extent of 2.1 deg C. On a pro rata basis, this would mean:
   - A heat duty reduction by 28%, ie by 140 KG steam equivalent(3.684 tons of oil equivalent per annum at E.R. of 13.3 and 350 day working); worth NR 889 a day or NRs. 311,150 per annum plus
   - A Chilling load reduction by 2.1 deg C would mean a pro-rata saving of 27.63% valued as 34.54 kWh a day (12059 kWh an year) worth NRs. 139,884 an year.
   - The total energy savings potential worth NR 4, 58,500 could justify an investment of NRs 1,350,000 towards upgrades and modernization of pasteurizer, for a three year simple payback period.

**5.9. Insulation of chilled milk pipeline**

Milk lines from RMST to pasteurizer, are left bare resulting in heat gain. Insulation of milk lines is suggested, to avoid heat gains and reduce refrigeration load.

<table>
<thead>
<tr>
<th>Rise in temperature from RMST to Balance tank</th>
<th>1.3°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilling load to maintain the same temperature/day</td>
<td>40,000<em>1</em>1.3/3024</td>
</tr>
<tr>
<td></td>
<td>17.20 TR per day</td>
</tr>
<tr>
<td></td>
<td>17.20TR*1.25 kW/TR</td>
</tr>
<tr>
<td></td>
<td>21.5kWh/day (7525 kWh/yr)</td>
</tr>
<tr>
<td>Annual savings at NRs 11.60/kWh</td>
<td>87,290</td>
</tr>
<tr>
<td>Investment envisaged for cold insulation</td>
<td>3,000</td>
</tr>
<tr>
<td>Payback period</td>
<td>Less than a month</td>
</tr>
</tbody>
</table>
5.10. Installation of VFD for Chilled water pump

Present situation:

The common chilled water pump supplies chilled water to pasteurizer, incoming milk (reception) chiller and cream pasteurizer. More than 80% of the time only one of these equipment requires chilled water i.e. they don’t operate simultaneously. This results in idle flow through equipment even if they are not in operation.

Recommendation:

The valves to idle equipment can be closed diligently and a VFD can be fitted to chilled water pump to avoid throttling and reduce the pumping power.

![Location of VFD installation](image)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power drawn by existing chilled water pump</td>
<td>4.8 kW</td>
</tr>
<tr>
<td>Power requirement at rational flow with VFD</td>
<td>2.4 kW</td>
</tr>
<tr>
<td>Savings in power, kW; kWh per day</td>
<td>2.4 kW; 21.6 kWh/day</td>
</tr>
<tr>
<td>Annual energy savings @ 9 hrs operation per day, 350 days, in kWh and in NR @11.60/kWh</td>
<td>7560 kWh/yr</td>
</tr>
<tr>
<td>Annual cost savings in NRs. @11.60/kWh</td>
<td>NRs. 87,696</td>
</tr>
<tr>
<td>Investment towards a variable frequency drive.</td>
<td>NRs. 50,000</td>
</tr>
<tr>
<td>Payback period</td>
<td>6.8 months</td>
</tr>
</tbody>
</table>
5.11. Performance of Boilers and measures for fuel economy:

**Present Situation:**

FO Boiler assessment indicates the following features:

- Efficiency by indirect method: 80%
- Evaporation ratio: 13.3
- Cost per MT of steam generated: NRs. 5626
- Key losses due to high excess air: exit temperature

High cost of FO and steam cost accordingly, a concern.

Diesel fired Boiler is of coil type:

- Efficiency is around 80%
- Steam quality is suspect indicated by ER of 19.78

Indicative cost of steam at equivalent 13.3 ER = NRs. 7427

**Recommendations:**

Going for of a new energy efficient boiler with husk firing is strongly recommended for cost reduction and GHG emission avoidance, and, in immediate context, excess air control and heat recovery can be considered for immediate benefits, as discussed below:

**Reducing excess air by tuning the FO boiler**

The existing level of excess air is 110% reflected by oxygen % of 11 in flue gas. The ideal %oxygen in flue gas should not exceed about 5% corresponding to an excess air of 31%. This will result in 2% improvement in boiler efficiency.

**Heat recovery from the exhaust of FO boiler**

The FO boiler exhaust temperature has been measured to be 260°C. This is quite high compared to best practice of 180°C. Due to the high exhaust temperature the efficiency is only 80%. It is suggested to incorporate a heat exchanger in the exhaust to generate hot water at 80°C. This can be used for CIP cleaning, pasteurizer, butter melting and other heating applications which will in turn reduce the heat demand.
The heat recovery system, envisaged to cost NR 300000 offers one year simple payback period.

**Replacement of oil fired boilers with rice husk fired boiler.**

**Considerations and rationale:**

- Two boilers, (one Furnace oil fired 1500 KG/Hr capacity fire tube boiler, with an operational efficiency of 80% and evaporation ratio of 13.33 and one diesel oil fired coil type boiler of 850 kg/Hr capacity) serve to meet the steam and hot water needs of dairy.
- Annual fuel oil consumption is 67 MT while diesel consumption for boiler is 45 MT.
- The equivalent steam generation per annum at ER of 13.33 is 1493 MT.
- At FO cost of NR 75000/MT and Diesel cost of NR 99000 per MT, the fuel costs for boiler operations work out to NR 94,80,000 reflecting an overall steam cost of NR 6350/MT.
- Findings on boiler performance are presented as exhibit 3.
- Given the high cost of steam and significant cost implication in manufacturing cost, as also the fact that dependence on imported fuel is warranted, it is recommended to install a rice husk based 1.5 TPH capacity state of the art energy efficient boiler, replacing both existing boilers. A turn down ratio of above 4 and Atmospheric Fluidized Bed Combustion technology choice are desirable.
- The Agro fuel use would also enable FO and diesel oil based GHG emission mitigation.
- Supply chain of rice husk at reasonable cost is desirable for viability

**Cost Benefits:**

- At an envisaged evaporation ratio of 3.9, the husk requirements for same annual steam generation Works out to 382.8 TPA, which, at an indicative cost of NR 3000/MT, amounts to NR 1,148,400, leading to a cost reduction of NR 8,331,600.
- The indicative procurement cost of a rice husk boiler of 1.5 TPH rating with efficiency over 75%, is NRs. 55,00,000.
- The measure offers an attractive simple payback period of 8 months and could be considered for implementation in short term.
Names of two illustrative vendor sources are as follows:

Ekta Engineering & Marketing P. Ltd
Flat no.-402, fourth floor, Bagmati Chambers
Tripureshwor- Teku Road,
GPO Box-11482, Kathmandu, Nepal
Phone- 00977 1 4247676
Fax- 00977 1 4238131
Mobile- 00977 9851036530

M/S Industrial boilers; Regional Office, Delhi
79-80, Satkar, Nehru Place, New Delhi – 110 019
Tel. : +91-11-26453194 / 26453195 / 26417983
Fax : +91-11-26453197
Email : delhi@indboilers.com,
www.indboilers.com

5.12. Insulation of Ghee boiling pan

Present situation:
Un insulated hot surface of ghee boiler is leading to avoidable heat losses

Recommendation:
it is recommended to provide thermal insulation to the bare surfaces as assessed in cost benefit analysis which follows:

- Current surface temperature = 76°C
- \( S = \left(10 + \frac{(T_s - T_a)}{20}\right) \times (T_s - T_a) \) = 610KCal/hr.m²
- Surface temp with insulation = 35 °C
- \( S = \left(10 + \frac{(T_s - T_a)}{20}\right) \times (T_s - T_a) \) = 83.2 Kcal /hr.m²
- Surface Area to be insulated = 3.77m²
- Net heat Saving = (610-83.2)\times 3.77 = 1986Kcal/hr = 3.31 kgs steam
- Fuel oil saving = 3.31/13.3 = 0.25 kg per hour
- F.O saving @5 hr/day, 300 days/year = 375lit /year = worth NR 28125
- Investment for thermal insulation = NR 10000
- Simple payback period: = 4.26 months
5.13. Condensate Recovery from cream pasteurizer and ghee boiling pan:

**Present situation:**
At present all the condensate other than from pasteurizer is drained which results in loss of heat as well as good boiler quality feed water.

Cost benefits of recovery are presented as follows:

- Condensate of cream pasteurizer and ghee boiler is at around 75 liter per hour at 85°C which can be returned back to boiler.
- Heat Saving = 75*(85-30)=4350 Kcal per hour (7.25 kg steam equivalent)
- Annual fuel oil saving = 7.25 /13.3 = 0.545 KG F.O/Hr (817.5 lit FO/year)
- Annual Monetary savings @NR 75/KG = NRs. 61,312
- Investment for common pit + Level control pump (0.5HP) and piping = NRs. 30,000
- Operation cost of pump = NRs. 1000/year
- Net Saving annual= NRs. 60,312
- Simple Payback period = **6 months**

5.14. Recovering condensate during Diesel boiler operation

**Present situation:**
Though condensate is recovered from pasteurizer, it is used only with FO fired Pressels boiler, due to non availability of interconnecting piping. Hence, when the Diesel boiler is operating alone, the condensate is drained.

**Recommendation:**
It is suggested to have piping, insulation, interconnection to Diesel boiler so that the condensate can be used at all times.

Measure Cost benefits are as follows:

Estimated condensate loss/day = 365K

Heat loss in kCal and steam = 365 * (85-30)=18250kCal/day =30.42 KG steam.

Diesel loss @13.3 ER = 2.29KG/day

Diesel savings considering 300 day working= 687lit/yr

Diesel cost savings/year@NR99/KG= NRs. 68,013

Envisaged Investment needs for interconnections = NRs. 10,000

Simple payback period = 1.8 months.
Annex IV: IGEA Report Example
Investment Grade Energy Audit Report
for [NAME OF THE COMPANY LOCATION, DISTRICT], Nepal

Conducted by
Energy Efficiency Centre/FNCCI
GIZ/INTEGRATION
09/20-25/2012
ACKNOWLEDGEMENT

Energy Efficiency Center, FNCCI, places on record its profound thanks to GIZ/NEEP for its lead role in guiding and steering the capacity building initiative and especially in conduct of this pilot energy audit, under NEEP component 3, as part of bilateral cooperation between Governments of Germany and Nepal.

EEC is grateful to the progressive management of NAME OF THE COMPANY, DISTRICT for vesting its confidence in EEC’s services for carrying out the pilot energy audit and their full fledged coordination and support throughout the study.

EEC is indebted to MR/MS. NAME OF THE EXECUTIVE, DESIGNATION, and the plant team comprising of the following officials, for their unstinted support and cooperation during study.

1. Mr/Ms. …………………………………
2. Mr/Ms. …………………………………
3. Mr/Ms. …………………………………
4. Mr/Ms. …………………………………
STUDY TEAM

J. Nagesh Kumar                Regional Expert (BEE-India Certified EA)
Gyanendra P. Upadhyay       Energy Efficiency Expert (NEEP, Component-3)
Bhishma Pandit            Energy Efficiency Expert (NEEP, Component-3)
Avishek Malla              Trained Energy Auditor
Anjan Badgami             Trained Energy Auditor
Bhupendra Shakya           Trained Energy Auditor
Govinda Chalise           Trained Energy Auditor
Kripa Sharma              Trained Energy Auditor
Milabh Shrestha           Trained Energy Auditor
Prakash Gupta             Trained Energy Auditor
Yam B. Thapa              Trained Energy Auditor
D. Pawan Kumar        Advisor (Team Leader, NEEP, Component-3)
DIAGNOSTIC INSTRUMENTS DEPLOYED DURING ENERGY AUDIT

- Electrical Power & Energy Analyzer
- Electrical clamp-on Power Analyzer
- Ultrasonic Flow Meter
- Flue Gas Analyzer
- Infrared Thermometer
- Contact Thermometer
- Digital Hygrometer
- Digital Tachometer
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>Percent</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>EE</td>
<td>Energy Efficiency</td>
</tr>
<tr>
<td>EEC</td>
<td>Energy Efficiency Centre</td>
</tr>
<tr>
<td>FNCCI</td>
<td>Federation of Nepalese Chambers of Commerce and Industry</td>
</tr>
<tr>
<td>FO</td>
<td>Furnace Oil</td>
</tr>
<tr>
<td>GIZ</td>
<td>German Agency for International Cooperation</td>
</tr>
<tr>
<td>GJ</td>
<td>Gigajoule</td>
</tr>
<tr>
<td>HP</td>
<td>High Pressure</td>
</tr>
<tr>
<td>kCal</td>
<td>Kilo calorie</td>
</tr>
<tr>
<td>KL</td>
<td>Kiloliter</td>
</tr>
<tr>
<td>kWh</td>
<td>Kilowatt hour</td>
</tr>
<tr>
<td>MJ</td>
<td>Mega joule</td>
</tr>
<tr>
<td>MOI</td>
<td>Ministry of Industry</td>
</tr>
<tr>
<td>MWh</td>
<td>Mega Watt Hour</td>
</tr>
<tr>
<td>NEA</td>
<td>Nepal Electricity Authority</td>
</tr>
<tr>
<td>NEEP</td>
<td>Nepal Energy Efficiency Programme</td>
</tr>
<tr>
<td>NOC</td>
<td>Nepal Oil Corporation</td>
</tr>
<tr>
<td>SEC</td>
<td>Specific Energy Consumption</td>
</tr>
<tr>
<td>S. N./ S. No.</td>
<td>Serial Number</td>
</tr>
<tr>
<td>WECS</td>
<td>Water and Energy Commission Secretariat</td>
</tr>
</tbody>
</table>
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EXECUTIVE SUMMARY

NAME OF THE COMPANY, is one of the leading dairy units in the region, and was selected for the pilot energy audit based on their expression of interest and a MoU with EEC. Pilot energy audit was carried out as part of “Nepal Energy Efficiency Programme,” (a bilateral initiative between Government of Nepal and Government of Germany). GIZ Nepal is supporting Energy Efficiency Center (an autonomous center functioning under the Federation of Nepalese Chambers of Commerce and Industry FNCCI), in promoting energy efficiency in industrial enterprises, with capacity building in Energy Audit as an area of focus. Accordingly, a team comprising of engineers, after an intensive training on energy audit by experts from National Productivity Council, India, undertook the pilot energy audit at NAME OF THE COMPANY, guided by expert from NPC India along with local long term expert and team leader (GIZ INTEGRATION).

NAME OF THE COMPANY is situated at LOCATION, on the outskirts of DISTRICT. The pilot energy audit was conducted during DD-DD MONTH YYYY, covering both electrical and thermal energy utilization areas. An overview of the prevalent production and energy consumption related features prior to the study period as baseline information are presented in the table below.

Baseline information of the Industry

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Industry</td>
<td>NAME OF THE COMPANY</td>
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<tr>
<td>Year of Establishment:</td>
<td>YYYY</td>
</tr>
<tr>
<td>Scale:</td>
<td>SCALE</td>
</tr>
<tr>
<td>Product:</td>
<td>Dairy</td>
</tr>
<tr>
<td>Capacity in Liters:</td>
<td>XXXX LPA</td>
</tr>
<tr>
<td>Production in liters</td>
<td>XXXX L</td>
</tr>
<tr>
<td>Location:</td>
<td>CITY; DISTRICT</td>
</tr>
<tr>
<td>Contact Person:</td>
<td>NAME OF THE EXECUTIVE</td>
</tr>
<tr>
<td>Designation:</td>
<td>POST</td>
</tr>
<tr>
<td>Telephone Number:</td>
<td>XXXXXXXX</td>
</tr>
<tr>
<td>E-mail:</td>
<td><a href="mailto:department@company.np">department@company.np</a></td>
</tr>
<tr>
<td>Website:</td>
<td>NA</td>
</tr>
<tr>
<td>a- No of shift:</td>
<td>1</td>
</tr>
<tr>
<td>b- Annual operation days:</td>
<td>350</td>
</tr>
<tr>
<td>No of Employees:</td>
<td>XXXX</td>
</tr>
<tr>
<td>Presence of Energy Manager:</td>
<td>N</td>
</tr>
<tr>
<td>EOI on NEEP Activity</td>
<td>Y</td>
</tr>
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</table>
## Investment Grade Energy Audit (IGEA) 2012

### Parameters

<table>
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<tbody>
<tr>
<td>EOI on EE Investment</td>
<td>Y</td>
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<tr>
<td>Compliance with any International/National Standard:</td>
<td>No</td>
</tr>
</tbody>
</table>

### Energy Aspects

#### A) Electrical Energy

A1) From NEA Grid in kWh: XXXX

Total Cost of Grid Electricity in NPR: XXXX

A2) From Generators:

- Types of Fuel used: Diesel
- Fuel Consumed in Liters: XXXX
- Total DG Capacity in KVA: XXXX
- Diesel Energy Generated in kWh: XXXX
- Total Cost of Energy Generated from DG Set in Nrs: XXXX
- Energy Generated in kWh per liter: XXXX
- % of kWh Generated from DG: XXXX

Total Electrical Energy from NEA and DG in kWhr: XXXX

Total Cost of Electrical Energy from NEA and DG: XXXX

Per unit cost of Electrical Energy, NRs/kWh: XXXX

#### B) Thermal Energy

B1) Types of Fuel used: Diesel, Furnace oil

- Quantity of Fuel Consumed: XXXX
- Total cost of Fuel Consumed in NPR: XXXX

B2) Types of Fuel used: Furnace Oil

- Quantity of Fuel Consumed: XXXX
- Total cost of Fuel Consumed in NPR: XXXX

Total Thermal Energy Consumed in liters: XXXX

Total Cost of Energy used in Thermal Side: XXXX

### Key Parameters

- Annual Turnover in Million in NPR: XXXX
- Capacity Utilization in %: XXXX
- Total Electrical Energy kWhr per kL: XXXX
- Total Thermal Energy litre/1000L: XXXX
- Total Energy Cost in NPR: XXXX
- Total Energy Cost as% of turnover: XXXX
The report presents the results of the pilot investment grade energy audit along with energy conservation opportunities with cost benefit analysis. Summary of various findings with recommendations and cost benefit analysis is presented in the following section.

### Energy Efficiency Options and Pay Back

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Energy Efficiency Option</th>
<th>Annual Savings</th>
<th>Electrical Energy, kWh</th>
<th>Thermal Energy, (Furnace oil, liters)</th>
<th>Cost (NPR)</th>
<th>Investment (NPR)</th>
<th>Pay Back Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Revising the approved electrical demand with NEA from 500 kVA to 400 kVA.</td>
<td>XXXX</td>
<td>-</td>
<td>XXXX</td>
<td>nil</td>
<td>immediate</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Effective use of Ice Bank System</td>
<td>XXXX</td>
<td>-</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Operating the Effluent Treatment Plant (ETP) during low tariff off peak period</td>
<td>XXXX</td>
<td>-</td>
<td>nil</td>
<td>XXXX</td>
<td>immediate</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Operating ground water pump at night, off peak hours</td>
<td>-</td>
<td>-</td>
<td>XXXX</td>
<td>nil</td>
<td>immediate</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Installation of Desuperheater at ammonia compressor discharge</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Heat recovery from DG set flue gas</td>
<td>-</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Installation of a 1 KL/Day solar hot water system to generate hot water</td>
<td>-</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Milk chilling and Pasteurization efficiency improvements</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Insulation of chilled milk pipeline</td>
<td>XXXX</td>
<td>-</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Installation of VFD for Chilled water pump</td>
<td>XXXX</td>
<td>-</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XX months</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Performance of Boilers and measures for fuel economy (Replacement of oil)</td>
<td>-</td>
<td>-</td>
<td>XXXX</td>
<td>XXXX</td>
<td>8 months</td>
<td></td>
</tr>
<tr>
<td>S. N.</td>
<td>Energy Efficiency Option</td>
<td>Annual Savings</td>
<td>Electrical Energy, kWh</td>
<td>Thermal Energy, (Furnace oil, liters)</td>
<td>Cost (NPR)</td>
<td>Investment (NPR)</td>
<td>Pay Back Period</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------------------</td>
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<td>------------------------</td>
<td>---------------------------------------</td>
<td>------------</td>
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<td>-----------------</td>
</tr>
<tr>
<td></td>
<td>fired boilers with rice husk fired boiler)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Insulation of Ghee boiling pan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>XXXX months</td>
</tr>
<tr>
<td>13.</td>
<td>Condensate Recovery from cream pasteurizer and ghee boiling pan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>XXXX months</td>
</tr>
<tr>
<td>14.</td>
<td>Recovering condensate during Diesel boiler operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>XXXX months</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>XXXX months</td>
</tr>
</tbody>
</table>

- On the whole, the identified energy efficiency options add up to XXXX kWh of potential electrical energy savings per year and XXXX kL of FO/Diesel savings per year amounting to NRs. XXXX per year savings on energy cost.
- Energy consumption reduction envisaged upon implementation will be XXXX % in electrical energy and XXXX % in fuel.
- The 14 nos. of Energy saving opportunities identified are worth NRs XXXX annually, against an investment of NRs XXXX and offer an overall simple payback period of XXXX months.
## Classification of options on the basis of payback period

<table>
<thead>
<tr>
<th>SN</th>
<th>Energy Efficiency Options</th>
<th>Simple payback period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Short Term (less than one year payback period)</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Revising the approved electrical demand with NEA from 500 kVA to 400 kVA.</td>
<td>immediate</td>
</tr>
<tr>
<td>2</td>
<td>Operating the Effluent Treatment Plant (ETP) during low tariff off peak period</td>
<td>immediate</td>
</tr>
<tr>
<td>3</td>
<td>Operating ground water pump at night, off peak hours</td>
<td>immediate</td>
</tr>
<tr>
<td>4</td>
<td>Effective use of Ice Bank System</td>
<td>XX months</td>
</tr>
<tr>
<td>5</td>
<td>Installation of Desuperheater at ammonia compressor discharge</td>
<td>XX months</td>
</tr>
<tr>
<td>6</td>
<td>Insulation of chilled milk pipeline</td>
<td>Less than a month</td>
</tr>
<tr>
<td>7</td>
<td>Installation of VFD for Chilled water pump</td>
<td>XX months</td>
</tr>
<tr>
<td>8</td>
<td>Performance of Boilers and measures for fuel economy (Replacement of oil fired boilers with rice husk fired boiler)</td>
<td>XX months</td>
</tr>
<tr>
<td>9</td>
<td>Insulation of Ghee boiling pan</td>
<td>XX months</td>
</tr>
<tr>
<td>10</td>
<td>Condensate Recovery from cream pasteurizer and ghee boiling pan</td>
<td>XX months</td>
</tr>
<tr>
<td>11</td>
<td>Recovering condensate during Diesel boiler operation</td>
<td>XX months</td>
</tr>
<tr>
<td></td>
<td><strong>Medium Term (one to three year payback period)</strong></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Heat recovery from DG set flue gas</td>
<td>XX months</td>
</tr>
<tr>
<td>13</td>
<td>Milk chilling and Pasteurization efficiency improvements</td>
<td>XX months</td>
</tr>
<tr>
<td></td>
<td><strong>Long Term (more than three years payback period)</strong></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Installation of a 1 KL/Day solar hot water system to generate hot water</td>
<td>XX months</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

1.1 Background of the study
As part of “Nepal Energy Efficiency Programme,” (a bilateral initiative between Government of Nepal and Government of Germany), GIZ Nepal is supporting Energy Efficiency Center (an autonomous center functioning under the Federation of Nepalese Chambers of Commerce and Industry FNCCI), in promoting energy efficiency in industrial enterprises, with capacity building in Energy Audit as an area of focus. Accordingly, a team comprising of engineers, after an intensive training on energy audit by experts from National Productivity Council, India, undertook the pilot energy audit at NAME OF THE COMPANY, guided by expert from NPC India along with local long term expert and team leader (GIZ INTEGRATION).

NAME OF THE COMPANY is one of the leading dairy units in the region, and was selected for the pilot energy audit based on their expression of interest and a MoU with EEC. NAME OF THE COMPANY is situated in LOCATION, on the outskirts of DISTRICT. The pilot energy audit was conducted during TIMESPAN, covering both electrical and thermal energy utilization areas. This report presents the results of the pilot energy audit and presents findings along with energy conservation opportunities with cost benefit analysis.

1.2 Scope of pilot energy audit:
The scope of the pilot energy audit included:
- Brief history of production and energy use
- Measurement and monitoring of plant facilities for energy consumption
- Assess energy efficiency improvements opportunities in the areas of
  - Power Factor improvement
  - Load Management
  - Sizing of electrical motors
  - Lighting system
  - Boiler operation
  - Insulation
  - Waste heat recovery, wherever possible
  - Diesel generation sets
  - House-keeping etc
- Recommendation of potential energy saving options
- Feasibility study of major options

1.3 About the dairy
- NAME OF THE COMPANY, situated at LOCATION, DISTRICT, was established in YYYY with an objective of helping the local farmers and milk vendors to generate substantive income and cater to their daily needs by procuring milk from the surrounding villages and distributing it to the cities. The sourcing milk collection centers for dairy are located at LOCATION, LOCATION, LOCATION, LOCATION and LOCATION.
Currently, NAME OF THE COMPANY is one of Nepal’s leading dairy processing and distributing Industries, with production capacity of more than XXXX million liters of milk per year (considering XX hours of operation in a day).

The dairy currently processes around XXXX liters per day. The dairy products include standard pasteurized Milk, Butter, and Ghee. The dairy has plans to produce Paneer, Dahee, Flavored Milk, and Lassi in the near future.

Energy consumption and costs: Furnace oil/Diesel for boilers and NEA/captive diesel electricity for electrical equipment are the major energy sources used in the dairy. For NAME OF THE COMPANY the annual electricity cost (NEA plus captive diesel) is around Rs. XXXX lakhs per annum and the fuel bill (Furnace oil and diesel) is Rs. XXXX lakhs per annum totaling to energy cost of NRs XXXX Lakhs per annum.

2.0 PROCESS DESCRIPTION

2.1 Main Dairy

The raw milk received from various chilling centers are received and pumped through reception chillers into a silo. From the silo the raw milk is taken for High Temperature Short Time (HTST) pasteurization through the steps given below.

The processes involved include:

- Receipt and filtration/clarification of the raw milk
- Separation of all or part of the milk fat (for standardization of market milk, production of cream and butter and other fat-based products, and production of milk powders);
- Pasteurization;
- Homogenization (as required);
- Deodorization (as required);
- Product-specific processing;
- Packaging and storage, including cold storage for perishable products
- Distribution of final products.

After being held in storage tanks at the processing site, raw milk is heated to separation temperature in the regeneration zone of the pasteurizer. The milk (now hot) is standardized and homogenized by sending it to a centrifugal separator where the cream fraction is removed. The skim is then usually blended back together with the cream at predefined ratios so that the end product has the desired fat content. Surplus hot cream is cooled and usually processed in a separate pasteurizer ready for bulk storage and transportation to a cream packing plant.

The pasteurization process involves killing most of the bacteria within the raw milk to increase its shelf life. This is done by rapidly heating the incoming standardized milk to the pasteurization temperature in a simple holding tube, ensuring that the pasteurization temperature is held for the correct time (e.g. XX °C for XX seconds) to destroy the bacteria. The hot milk is then passed through the regeneration zone, giving up its heat to the incoming cold milk, and cooled to a level.
where the growth of any surviving bacteria is slowed to a minimum, partially sterilizing the milk and increasing shelf life. Typically, this is an in-line process with the heating and cooling conducted in a plate heat exchanger.

Finally, chilled water is used to control the milk exit temperature from the pasteurizer at approximately XX °C. As the milk is heated and cooled within a few seconds there are intense heating and cooling demands. This process is therefore one of the largest emission sources within the industry, even though much of the heat is regenerated and re-used in the pasteurizer.

An overview of milk process flowchart indicating various linkages is presented as follows.
2.3. Clean-In-Place (CIP)

CIP is the method of cleaning the interior surfaces of pipes, vessels, process equipment, filters and associated fittings without needing to remove them. It is common throughout the industry, as the processing facilities must be constantly cleaned to prevent microbes from growing and to remove fouling/scaling. CIP typically includes an initial rinse of recovered water to remove heavy soiling, followed by a hot detergent wash of caustic or acid solution, and a final rinse of clean potable water. Energy use and emissions associated with CIP are predominantly due to the heating of the processing equipment that is being cleaned as well as the heating of water which is subsequently wasted. CIP is a large consumer of water so there is a cost incentive to reduce CIP water usage as well as minimizing heat and chemical consumption.
3.0 PLANT ENERGY SYSTEMS

3.1 Electrical Energy and Load management Practices:
- The approved maximum demand of the plant is 500 kVA. The dairy receives electric power from Nepal Electricity Authority, through a 500 kVA transformer at 11 kV which stepped down to 415 V for end use. The connected load of plant is about XXXX kW.
- The monthly demand charges as charged by Nepal Electricity Authority are at the rate of 230/KVA. The minimum billable demand is 50 % of approved demand of 500 KVA. The energy tariff depends on the time of the day and currently, is as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak time (5 PM to 11 PM)</td>
<td>XXXX</td>
</tr>
<tr>
<td>Off peak time (11 PM to 5 AM)</td>
<td>XXXX</td>
</tr>
<tr>
<td>Other time (5AM to 6 PM)</td>
<td>XXXX</td>
</tr>
</tbody>
</table>

- Two Diesel generator sets of XXXX KVA each provide the backup in case of power failure.
- Monthly Electrical energy consumption of dairy plant, indicating share of NEA and Diesel Generated power, for one year is profiled as under. (Fig 3)

Fig 3: Share of Grid and DG generated Electricity in kWh

- It is seen that the diesel generation share in total reaches up to XX % and on the aggregate accounts for XX % of total electrical energy used.
- The main impact of this feature is that the weighted average price of electricity becomes higher as illustrated below.
  - Annual NEA kWh purchased: XXXX kWh (2011-2012)
  - Annual NEA energy Cost: NRs. XXXX
Investment Grade Energy Audit (IGEA) 2012

- Annual DG Power generated: XXXX kWh (2011-2012)
- Annual DG Power Cost: NRs. XXXX
- Aggregate annual energy consumption: XXXX kWh (2012-2013)
- Aggregate electrical energy cost: NRs. XXXX
- Weighted average electrical energy cost/kWh: NRs. XXXX

**Diesel Power Generation Efficacy:**
Based on field trial during energy audit, the kWh/Liter figure was found to be XXXX at XX% loading that reflects satisfactory efficacy of captive generation.

**Time of Day Use Pattern of NEA Electricity:**
The electricity use pattern in three time zones (in accordance with NEA billing criteria) over one year duration is presented as follows. (Fig 4).

The different time of use tariffs allow feasibility to maximize consumption at lowest billing time-zones for optimizing the NEA billing to be paid.

Analysis reveals the following on annual basis for the year 2011/12
- XX% of energy consumption is at R1 rate XXXX/kWh
- XX% of energy consumption is at R2 rate XXXX/kWh
- XX% of energy consumption is at R3 rate XXXX/kWh

The production planning schedules may be reviewed to benefit from lower billing rates during 11 PM to 6AM.
The options could include water pumping for storage; ice bank storage etc.

Fig 4: Grid electricity consumption in three time zones
Maximum Demand variation and Charges:
The billing demand charged by NEA is seen to be 250 kVA though the actual demand recorded is less. This is, because the contract maximum demand of the plant is 500 kVA and NEA billing demand charges are for 50% of the contract maximum demand or actual demand recorded (whichever is higher).

Power Factor Variation:
The power factor at tail end of various loads as measured is from XX to XX. The plant has installed capacitor bank with automatic power factor control to ensure achieving a power factor of 0.97 to optimize maximum demand and charges thereof, which was dysfunctional but rectified by the energy audit team during study.

Production, Electrical Energy consumption and specific energy consumption trends:
The month-wise production and specific electrical energy consumption trends provide an indicator for plant energy performance, benchmarking and target setting.

The milk production and specific electrical energy consumption trends of NAME OF THE COMPANY as presented below (fig 5) indicate:
  - Monthly specific electrical energy consumption variation from XXXX kWh/1000liters to XXXX kWh/1000 Liters during reference year 2011-2012
  - Average specific electrical energy consumption of XXXX kWh/1000 Liters for the reference year 2011-2012

![Fig 5: Monthly production versus specific energy consumption](image)

The factors affecting variations in specific electrical energy consumption have been analyzed to include:

- Capacity Utilization
- Product mix
- Incoming milk quality, quantity, temperature and additional chilling needs
- Ambient weather conditions and cold storage operations
- Operational efficiency at plant level

Given the high average electrical energy cost at \( XXXX \)/kWh, the electrical energy cost contribution per 1000 liters of milk processed works out to \( XXXX \) corresponding to \( XXXX \) kWh specific electrical energy consumption, the prevalent norms of 26-30 kWh/1000 liters as being achieved in contemporary Indian dairy plants could be considered as a target for achieving, through various good practices applicable.

**Electrical Energy use in equipment and share:**
The major applications drive ratings, indicative hours of use, measured kW loading and daily power consumption estimated are summarized as follows.

<table>
<thead>
<tr>
<th>Application</th>
<th>Rated KW</th>
<th>Measured KW</th>
<th>P.F</th>
<th>Hours of Operation</th>
<th>KWH/Day Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Ref Compressor</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Chilled water pump</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Condensed water pump</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Homogenizer</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Air Compressor</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Milk pumps</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Ground water pump</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>ETP</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Boiler 1</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Crate Washing</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>IBT Agitator</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Filling machine</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Cream Separator</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Boiler 2</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Butter Cold Store 1</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Raw milk agitator</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>Cooling unit fan motor</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td><strong>Total Consumption/day</strong></td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
</tbody>
</table>
Accordingly, for the daily electrical energy consumption of around 2000 kWh, the break-up among various users is presented as follows. (Fig-6)

![Pie Chart: Section wise energy consumption in kWh/day](image)

**Fig 6: Section wise energy consumption in kWh/day**

It is recommended that management may initiate a practice of daily monitoring of milk processed, electrical energy consumed (NEA and Captive diesel), specific electrical energy consumption per 1000 Liters, as MIS and control parameter.

It is recommended that management may incorporate time totalizers to all the major drives with over 10kW rating and monitor and track their hours of use monthly, as a component of MIS.

### 3.2 Thermal Energy System

- Steam for process heating and hot water needs are sourced from two boilers. Diesel and furnace oil are the fuels used in the boilers for steam generation. Diesel accounts for XX% of the total fuel fired into the boiler, while furnace oil makes up for balance. Diesel fuel is nearly 1.5 times more expensive than FO while the calorific value of Diesel and Furnace oil are almost the same.

- The technical specifications of the two boilers make fire tube type rated XXXX kgs/Hr (F.O. Fired) and Thermax make, once through, coil type, XXXX kgs/Hr (Diesel fired), are presented as Exhibit-1 and the steam distribution diagram is presented as Exhibit-2 respectively.
The steam generated is used mainly for pasteurization and CIP operations. Only condensate from pasteurizer is recovered. The steam costs XXXX per kg with furnace oil firing while it is XXXX with Diesel firing. The boilers are operated for about 7 hours per day from morning to noon, when the pasteurization is carried out.

The audit findings about evaporation ratio and efficiency of both boilers are summarized as follows:

- **Boiler 1 (850kG/HR capacity, diesel fired):**
  - Evaporation Ratio = 13.3 (equivalent)
  - Thermal Efficiency = 80%
  - Steam Cost = NRs XXXX /MT

- **Boiler 2 (1500 kgs/HR capacity, F.O. fired):**
  - Evaporation Ratio = 13.33
  - Thermal Efficiency = 80%
  - Steam cost = NRs. XXXX /MT

Further details are presented as Exhibit 3

**Specific fuel consumption:**

- The month-wise production and specific oil consumption trends provide an indicator for plant thermal energy performance, benchmarking and target setting.
- The milk production and specific oil consumption trends of NAME OF THE COMPANY as presented below (fig 7) indicate:
  - Monthly specific fuel consumption variation from XXXX Liters/1000 liters milk to XXXX Liters/1000 liters milk during reference year 2011/12
  - Average specific fuel oil consumption of XXXX liters per 1000 liters milk for the reference year 2011/12.
- The factors affecting variations in specific fuel consumption have been analyzed to include:
  - Capacity Utilization
  - Product mix
  - Boiler Efficiency
  - Steam use efficiency at plant level
Given the high average fuel cost contribution per 1000 liters of milk processed works out to NRs. XXXX corresponding to XXXX kg specific oil consumption, the prevalent norms of less than 5.0 kg equivalent/1000 as being achieved in contemporary Indian dairy plants could be considered as a target for achieving, through various good practices applicable.

3.3 Refrigeration system
The refrigeration system consists of 3 chiller compressors, ice bank system, chilled water circuit and condenser water circuit. One chiller compressor is operated at any time.

The refrigeration system using ammonia as the refrigerant is largely used for the ice bank system. The liquid ammonia expands in coils chilling and creating ice around the coils submerged in water. The purpose of the ice bank is to build sufficient storage of ice to meet the peak load in the early hours of morning for pasteurization and for reception chilling of raw milk. The ice bank temperature is maintained between XX °C to XX °C. The evaporated ammonia is then compressed in a XXXX TR reciprocating compressor of Kirloskar make. The compressed ammonia is sent to atmospheric condensers for condensation and collected in a receiver. From the receiver the liquid ammonia is sent to ice bank and also partly to chilling units in cold storage section. The cold storage section stores the sachets of milk packed for next day’s dispatch and is maintained at 0°C.

The cold room which is meant for storage of packed sachet milk before dispatch. Consist of 4 diffusers in the cold room each XXXXX 5 TR refrigeration capacities to accomplish the cooling requirements. Overview of ice bank system linkages is presented in figure 8 which follows:
Fig 8: Ice Bank System

The cold storage system linkages are presented in Figure 9, which follows:

Fig 9 Cold Storage refrigeration features:

- Raw milk chiller
- Process (PHE), HTST
- Cream Pasteurizer
- Condenser pumps 3.7 kW each x 2
- Atmospheric condenser
- 2 Numbers of Chilled water pumps, x 5.5 kW pumps common header.
3.4 Compressed Air System

The compressed air system is meant to cater to the needs of pneumatic packaging machines and for operation of control valves. The following are the specifications of compressors in use.

- Manufacturer: ELGI
- Capacity: 1535 liters/min = 50 cfm
- Working Pressure: 12 kg/cm²
- Double stage reciprocating type (2 Low pressure cylinders and 1 high Pressure cylinders)
- Receiver Capacity: 500 liters
- Motor specification:
  - Rating: 15 hp, P.F :0.84, r.p.m (N): 1460
  - Current: 20.6 A

An overview of the compressed air system along with uses of compressed air in the plant is given in the following figure.

![Compressed Air System Flow Diagram](image)
4.0 STRATEGIC ENERGY MANAGEMENT PROGRAM:

Improving how energy is managed by implementing an organization-wide energy management program is one of the most effective ways to bring about energy efficiency improvements.

Continuous improvements to energy efficiency occur only when a strong organizational commitment exists and a formal energy program is in place. A sound energy management program helps to create a foundation for positive change and to provide guidance for managing energy throughout an organization. Energy management programs help to ensure that energy efficiency improvements do not just happen on a one-time basis, but rather are continuously identified and implemented in an ongoing process of continuous improvement. Without the backing of a sound energy management program, energy efficiency improvements might not reach their full potential due to lack of a systems perspective and/or proper maintenance and follow-up.

It is recommended that the progressive management of XXXX may initiate Implementation of a well-defined energy management policy (an illustration follows):

### ENERGY MANAGEMENT POLICY

- **NAME OF THE COMPANY** Plant management is committed to excel in Energy Management Performance on a continual basis, through:
  - Continual Upgradation of Technology, Systems and Services to optimize the Energy Costs.
  - Declaring, Monitoring and Controlling the Energy consumption and specific electrical/thermal energy consumption effectively, on continuous basis.
  - Providing Resources to achieve measurable objectives whenever necessary.
  - Education and motivation of all the people Concerned through effective Communication & Recognition.
  - Establishment of Bench marking Standards in Dairy, in Energy Management.
  - The organization has commitment to protect the Environment, by not disposing the effluents without treatment. The water treated with ETP has been used to feed fodder crop plots, medicinal plants, and gardening not discharging as waste.
  - Our management is committed for the Health & Safety of its work force. A Safety Committee is constituted with employees working at different levels which meet periodically to analyze all aspects of employee’s health & safety during work. The Safety Committee recommendations are being implemented to improve the working conditions & safety of all.

Signed--------
Daily Production & Energy Consumption tracking and control chart suggested for adoption:

<table>
<thead>
<tr>
<th>S. N</th>
<th>Description</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quantity Milk Processed (KL/day)</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>2</td>
<td>Electricity Consumed NEA plus DG (kWh)</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>3</td>
<td>Furnace Oil/Diesel Consumed for steam (KL)</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>4</td>
<td>Specific electrical consumption kWh/kL</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
<tr>
<td>5</td>
<td>Specific Fuel consumption MkCals/kL</td>
<td>XXXX</td>
<td>XXXX</td>
</tr>
</tbody>
</table>

5.0 ENERGY EFFICIENCY OPPORTUNITIES:

5.1. Revising the approved electrical demand with NEA from 500 kVA to 400 kVA.

Present situation:
- The NEA approved maximum demand is 500 kVA and minimum billing demand is 250 kVA. The actual maximum demand over the past two years has been less than 250 kVA.
- As run (normal) Maximum demand from TOD meter is XXXX kVA,
- Operational Power Factor (P.F) is XXXX

*During study, the APFC panel was rectified and made functional to achieve XX power factor, through housekeeping improvements (loose connections and blown fuses attended to) at zero investment basis.*

By improving the power factor to XX, the maximum demand reduces to XXXX kVA.

Maximum Demand reduction achieved by improved PF
\[
= \text{XXXX (present)} - \text{XXXX (minimum billing demand)} \text{ kVA}
\]
\[
= \text{XXXX kVA per month}
\]

Potential demand charge reduction at NRs 230/kVA
\[
= \text{NRs XXXX/kVA x XXXX kVA/month}
\]
\[
= \text{NRs XXXX per month}
\]

Annual Saving = NRs XXXX
**Recommendation**
This benefit will accrue only if the approved demand is revised to 400 kVA from the present demand of 500 kVA. It is recommended that Plant should immediately act to reduce the approved demand from 500 kVA to 400 kVA.

**5.2. Effective use of Ice Bank System:**

**Present Situation**
- The Dairy has an ice-bank refrigeration system through which chilled water is delivered to the milk pasteurizer, raw milk chilling, butter pasteurizer for process and direct expansion with ammonia for cold room chilling where the milk is stored at \( XX ^{\circ} C \).
- The refrigeration plant consists of three compressors 2 nos. of 45 TR and one of 60 TR capacities. Normally one 45 TR compressor is in operation.
- The operating schedule of the 45 TR compressors was observed as follows.

<table>
<thead>
<tr>
<th>Hours of operation</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>19/day</td>
<td>7 am - 2 am</td>
</tr>
<tr>
<td>10/day</td>
<td>7 am - 5 pm</td>
</tr>
<tr>
<td>6/day</td>
<td>5 pm - 11 pm</td>
</tr>
<tr>
<td>3/day</td>
<td>11 pm - 2 am</td>
</tr>
</tbody>
</table>

- The current load works out to \( XXXX \) kW (being \( XXXX + XXXX + XXXX \)) which, in other words amounts to \( XXXX \) kWh for 19 hour working a day, towards meeting process, cold room chilling requirements.
- It is seen that the compressor is switched off from 2 AM to 7 AM in the morning when the tariff is the least on one hand and conditions most favorable for ice making on the other. (The cooling water temperature being lowest for good condenser effectiveness and better refrigeration efficiency)
- In addition, the ice buildup over the coils is found to be negligible. Thus, when peak demand for refrigeration occurs at 7 AM in the morning, the compressor is unable to meet the peak demand for raw milk chilling and pasteurizer. This results in higher temperature of the outlet milk from the pasteurizer (about \( XX ^{\circ} C \) as against the desired \( XX ^{\circ} C \)).

**Recommendation:**
Adapt revised operational timings of 45 TR chiller for ice bank build up and process needs; provide effective cold storage partitioning and dedicate a new 10TR chiller for cold room needs. To overcome the quality issues arising from high milk output temperature and to reduce the energy costs by taking advantage of night time tariffs, the following operation schedule is suggested for the refrigeration compressor.
The cold room requirement has been calculated to be 10 TR. It is suggested to provide effective partitioning and assign a new dedicated 10TR unit for maintaining the cold room temperature rather than running a big 45 TR compressor all through.

By operating the 45 TR compressor during lean tariff hours from 11 PM to 5 AM, sufficient amount of ice buildup will take place, enabling the stored ice to provide relief during chilling peak load from 7 AM onwards as milk receipts commence.

Cost benefit of this option is summarized as follows:

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Electricity consumption with existing schedule of operation,</td>
<td>XXXX</td>
</tr>
<tr>
<td>considering 350 day working @ XXXX kWh/day</td>
<td></td>
</tr>
<tr>
<td>Annual Electricity consumption, with suggested schedule of operation</td>
<td>XXXX</td>
</tr>
<tr>
<td>of 45 TR and 10 TR new chiller (XXX kW * 9 Hrs plus XXXX kW * 17 Hrs)</td>
<td></td>
</tr>
<tr>
<td>kWh daily, over 350 annual working days</td>
<td></td>
</tr>
<tr>
<td>Annual Energy Savings with suggested operating schedule, kWh</td>
<td>XXXX</td>
</tr>
<tr>
<td>Annual energy cost savings potential, @ XXXX/kWh</td>
<td>XXXX</td>
</tr>
<tr>
<td>Procurement cost of a new 10 TR chiller alongside effective partitioning in cold storage area, NR</td>
<td>XXXX</td>
</tr>
<tr>
<td>Simple Payback period</td>
<td>XXXX months</td>
</tr>
</tbody>
</table>

It may be appreciated that benefits of better chiller efficiency in night hours, lower tariff advantage and better process efficiency add to the savings potential.
5.3. Operating the Effluent Treatment Plant (ETP) during low tariff off peak period -shifting ETP load of 10 kW over 6 Hr duration, from peak to off peak hours

Present situation
- Total measured kW drawn by ETP = XXXX kW.
- At present ETP, is operating at peak time and normal time.
- For peak tariff duration, electrical energy consumption and cost = XXXX KW x 6 hours = 60 kWh and at Rs XXXX /kWh = XXXX / day amounting to Rs XXXX /year considering 350 days working.
- For Normal tariff duration, electrical energy consumption and cost = XXXX KW x 2 hours = XXXX KWH@ Rs XXXX /kWh = 142 /day amounting to XXXX /year.
- Total annual ETP running electrical energy cost = XXXX + Rs XXXX = XXXX per year.

Cost differential of operating ETP at off peak tariff hours:
- For off peak tariff duration, energy consumption and cost = XXXX KW x 6 hours = XXXX KWH @NRs XXXX = NRs XXXX /day amounting to XXXX / year
- For normal tariff duration, consumption and cost remain the same as above.
- Thus, running energy cost with revised hours of operation to off peak tariff duration and normal tariff duration = NRs. XXXX + XXXX = NRs XXXX.
- Electricity cost Saving annually, with availing of off peak tariff advantage=
  - NRs. XXXX – NRs. XXXX = NRs. XXXX per year.
- About 10 kVA of Maximum demand drawn is also likely to be saved once off peak operations are made operational.
- Investment: NIL

5.4. Operating ground water pump at night, off peak hours:

Present situation
- Measured kW drawn by ground water pump= XXXX kW.
- At present, ground water pump is operating at peak tariff time and normal tariff time.
- For Peak tariff time, energy consumption and cost= XXXX kW x 6 hours = XXXX kWh@ NRs XXXX = NRs XXXX / day amounting to NRs. XXXX /year @ 350 day working.
- For Normal tariff time, energy consumption and cost = XXXX kW x 2 hours @ NRs XXXX = NRs XXXX /day amounting to NRs XXXX /year
- Total operating cost/annum=NRs XXXX + NRs XXXX = NRs XXXX

With recommended option of operating ground water pump at off peak hours
- Consumption and cost for off peak tariff time = XXXX kW x 6 hours = XXXX kWh = XXXX x NRs XXXX = NRs XXXX /day = NRs XXXX / year
- Consumption and cost for Normal tariff time remains unchanged as above.
- Annual operating cost by shifting pump operations to off peak hours = NRs XXXX + NRs XXXX = NRs XXXX
- Annual energy cost Saving by availing of off peak tariff advantage = NRs XXXX - NRs XXXX = NRs XXXX
- Additionally, the peak demand shift would lead to reduction of maximum demand by about 6.0 kVA.

5.5. Installation of De-superheater at ammonia compressor discharge

Present situation
The discharge temperature of ammonia refrigerant from the 45 TR compressors is around XX°C and is in superheated condition. This influences condenser load, compressor discharge pressure significantly alongside compressor power consumption. The present power consumption by compressor alone is XXXX kW.

Recommendation
A Desuperheater to be installed as shown in the following figure 11, to recover heat in the form of hot water from the superheated Ammonia refrigerant.

This measure would help:
- To produce hot water at XXXX C for process needs (CIP cleaning, washing, etc)
- To reduce the cooling load in the condenser, compressor discharge pressure
- To reduce compressor power consumption by about 5%.

Cost Benefits of Option

Fig-11 Illustrative layout for de-superheater installation
Potential Hot water generation at $XX \, ^\circ C$, from $XX \, ^\circ C$ inlet from 45 TR compressors: $XXXX$ LPH

Hot water generated over 9 Hr working per day: $XXXX$ LPD

Heat savings in kCal/day by waste heat recovery: $XXXX$

Steam equivalent savings a day @ $XXXX$ kCal/kG: $XXXX$

Fuel oil savings per day in kG at E.R of $XXXX$: $XXXX$

Annual fuel oil savings @ 350 day working, in MT: $XXXX$

Annual fuel cost savings @NR 75000/MT in NRs: $XXXX$

Annual savings in compressor power @ 5% in kWh: $XXXX$

Total annual energy cost savings potential in NRs: $XXXX$

Investment envisaged for procurement and installation of De-superheater: NRs. $XXXX$

Simple payback period: $XX$ months

Vendor information is provided as part of Exhibit 4

5.6. Heat recovery from DG set flue gas

Present situation
Hot water needs being met by boilers using F.O/Diesel

Diesel Generator exhausts gases leaving at $XXXX \, ^\circ C$

Average generator running hours per day = $XX$

Average fuel consumption = $XX$ liters/hour

Flue gas mass in kgs/Hr = $XXXX$

Exhaust temperature = $XXXX \, ^\circ C$

Recommendation
To incorporate a coil type/shell and tube type waste heat recovery unit for hot water generation from DG Waste flue gases:

Cost Benefits
Proposed Exhaust temperature after waste heat recovery = $XX \, ^\circ C$

Heat recovered from exhaust gases = $XXXX \times X XXX * (XXXX - X XXX)$

$XXXX$ kcal/hr

Hot water generation potential @ $XX \, ^\circ C$ from $XX \, 27 \, ^\circ C$ = $XXXX / XXXX$

$XXXX$ kg/hour

Hot water generation potential per day = $XXXX \times 3$ hours

$XXXX$ kg/day

Equivalent fuel saving per day, at $XX$ boiler ER in kgs = $XXXX$

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Investment Grade Energy Audit (IGEA) 2012

Annual fuel saving potential @350 day working in kgs = XXXX
Annual cost savings potential @ NRs. XXXX /kG = NRs. XXXX

Envisaged Investment for waste heat recovery unit = NRs. XXXX
Simple payback period = XXXX months

Vendor information is provided as part of Exhibit 4

5.7. Installation of a 1 KL/Day solar hot water system to generate hot water.

Present situation
Hot water needs for CIP, washing etc. are met through costly boiler steam route.

Purpose of Utilization of solar hot Water: CIP Requirements, boiler makeup water pre-heating replacing corresponding fuel use in boilers:
Recommended capacity of Solar Water Heater = XXXX LPD
Expected temperature of Hot water from XX °C = XX °C

Cost Benefits
Thermal energy capture potential per day in kCal = XXXX x (XXXX - XXXX)
Fuel savings potential in kG/day @ XXXX boiler ER = XXXX / XXXX
Annual fuel oil savings @350 day working = XXXX
Annual fuel cost savings @NRs 75/lit = NRs. XXXX
Envisaged Investment for 10 KLPD solar HW system = NRs. XXXX

Simple Payback period = XXXX years
Suggested technology: Heat tube collector based SHW system (Australian Technology)
Illustrative Vendor reference: COMPANY NAME (LOCATION, Tele: XXXX XXXX)

5.8. Milk chilling and Pasteurization efficiency improvements.

A. Ensuring lowest milk temperature at receipt, close to XX deg C:
   • Incoming milk is being received at temperature ranging from XX deg C to XX deg C (average XX deg C), whereas the pasteurization is designed for XX deg C basis, leading to additional chilling needs, upon receipt during processing, affecting quality as well.
   • Given a typical XXXX KL processing a day, an additional chilling duty of XX deg C relates to an extra chilling load of XXXX TR (XXXX * XXXX /V); valued at XXXX kWh energy input worth NRs. XXXX every day at NR XXXX /kWh.
   • Ensuring lower receiving temperature of milk receipt by suitable improvements at supply end bulk chillers, and transportation, annual saving of NRs. XXXX for every deg C margin, in addition to improving quality and process efficiency.
• Refrigerated tanks, need based supply side chilling improvements are interventions called for, and an envisaged investment of NRs. XXXX is justifiable for a XX deg C margin and XX year simple payback period.

B. **Ensuring pasteurization regeneration efficiency and temperature controls:**

As per design data, the milk temperature after pasteurization needs to be maintained at XX °C. However due to the higher temperature of the incoming milk which varies from XX - XX °C the pasteurizer milk outlet temperature is also high leading to quality problems and returned milk. A comparison of actual versus required parameters in pasteurizer is given in the table below.

<table>
<thead>
<tr>
<th>Requirement as per manufacturer (°C)</th>
<th>Actual at site (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 inlet temp</td>
<td>XXXX</td>
</tr>
<tr>
<td>R1 outlet temp</td>
<td>XXXX</td>
</tr>
<tr>
<td>R2 outlet temp</td>
<td>XXXX</td>
</tr>
<tr>
<td>Heating outlet temp</td>
<td>XXXX</td>
</tr>
<tr>
<td>After regeneration from R2</td>
<td>XXXX</td>
</tr>
<tr>
<td>After regeneration from R1</td>
<td>N/A</td>
</tr>
<tr>
<td>Chiller outlet temp</td>
<td>XXXX</td>
</tr>
</tbody>
</table>

**Analysis:**

- Design heating cycle regeneration efficiency = (XXXX - XXXX) * 100/(XXXX - XXXX) = XX %
- As run heating cycle regeneration efficiency = (XXXX - XXXX) *100/(XXXX - XXXX) = XX %
- Design cooling cycle regeneration efficiency = (XXXX - XXXX) * 100/(XXXX - XXXX) = XX %
- As run cooling cycle regeneration efficiency not measurable.
- As per design the heat duty from XX deg C to XX deg C for XXXX KL a day works out to:
  - Around XXXX KG of steam ((XXXX LPD * XXXX delta T)/(XXXX kCal/kG- XXXX kCal/kgs))
  - Around NR XXXX as cost of fuel @ NR XXXX per MT of steam.
- Similarly, chilling duty from XX deg C to XX deg C would for XXXX LPD would mean a TR load of about XXXX (XXXX * XXXX / XXXX) which works out to a power requirement of XXXX kWh every day (@XXX Wh/TR) worth NR XXXX.
- Cost of Pasteurization per KL as per design data amounts to NR XXXX; or NR XXXX a day or NR XXXX per annum, a significant sum.
- Present instrumentation and automation level is inadequate and deserves an Upgradation.
• Present temperature profile across pasteurizer indicates shift, mainly on account of higher incoming milk temperature.

**Recommendation:**
Given the importance and significance of energy intensity of pasteurization, it is strongly recommended to:

- Upgrade, in consultation with OEM, the existing pasteurizer, by way of instrumentation, automatic control, addition of plates as warranted, to ensure operation with a regeneration efficiency of **XX %**, at full capacity, while enabling monitoring of performance too.
- An improvement of regeneration efficiency from **XX %** to **XX %** would mean a reduction of heating and chilling duty to an extent of **XX deg C**. On a pro rata basis, this would mean:
  - A heat duty reduction by **XX %**, i.e., by **XX KG steam equivalent** (XXXX tons of oil equivalent per annum at E.R. of XXXX and XXXX day working); worth NR XXXX a day or NRs. XXXX per annum plus
  - A Chilling load reduction by **XX deg C** would mean a pro-rata saving of **XX %** valued as XXXX kWh a day (XXXX kWh an year) worth NRs. XXXX an year.
- The total energy savings potential worth NR XXXX could justify an investment of NRs XXXX towards upgrades and modernization of pasteurizer, for a three year simple payback period.

5.9. **Insulation of chilled milk pipeline**

Milk lines from RMST to pasteurizer, are left bare resulting in heat gain. Insulation of milk lines is suggested, to avoid heat gains and reduce refrigeration load.

<table>
<thead>
<tr>
<th>Rise in temperature from RMST to Balance tank</th>
<th><strong>XX °C</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilling load to maintain the same temperature/day</td>
<td>XXXX</td>
</tr>
<tr>
<td></td>
<td>XXXX TR per day</td>
</tr>
<tr>
<td></td>
<td>XXXX TR * XXXX kW/TR</td>
</tr>
<tr>
<td></td>
<td>XXXX kWh/day (XXXX kWh/yr)</td>
</tr>
<tr>
<td>Annual savings at NRs 11.60/kWh</td>
<td>XXXX</td>
</tr>
<tr>
<td>Investment envisaged for cold insulation</td>
<td>XXXX</td>
</tr>
<tr>
<td>Payback period</td>
<td>Less than a month</td>
</tr>
</tbody>
</table>
5.10. Installation of VFD for Chilled water pump

Present situation:
The common chilled water pump supplies chilled water to pasteurizer, incoming milk (reception) chiller and cream pasteurizer. More than XX % of the time only one of these equipment requires chilled water ie they don’t operate simultaneously. This results in idle flow through equipment even if they are not in operation.

Recommendation:
The valves to idle equipment can be closed diligently and a VFD can be fitted to chilled water pump to avoid throttling and reduce the pumping power.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power drawn by existing chilled water pump</td>
<td>XXXX kW</td>
</tr>
<tr>
<td>Power requirement at rational flow with VFD</td>
<td>XXXX kW</td>
</tr>
<tr>
<td>Savings in power, kW; kWh per day</td>
<td>XXXX kW</td>
</tr>
<tr>
<td>Annual energy savings @ 9 hrs operation per day, 350 days, in kWh and in NR @ XXXX/kWh</td>
<td>XXXX kWh/yr</td>
</tr>
<tr>
<td>Annual cost savings in NRs. @ XXXX/kWh</td>
<td>NRs. XXXX</td>
</tr>
<tr>
<td>Investment towards a variable frequency drive.</td>
<td>NRs. XXXX</td>
</tr>
<tr>
<td>Payback period</td>
<td>XXXX months</td>
</tr>
</tbody>
</table>
5.11. Performance of Boilers and measures for fuel economy:

Present Situation:
FO Boiler assessment indicates the following features:
Efficiency by indirect method : XX %
Evaporation ratio : XXXX
Cost per MT of steam generated : NRs. XXXX
Key losses due to high excess air; exit temperature
High cost of FO and steam cost accordingly, a concern.
Diesel fired Boiler is of coil type:
Efficiency is around XX %
Steam quality is suspect indicated by ER of XXXX
Indicative cost of steam at equivalent XXXX ER =NRs. XXXX

Recommendations:
Going for of a new energy efficient boiler with husk firing is strongly recommended for cost reduction and GHG emission avoidance, and, in immediate context, excess air control and heat recovery can be considered for immediate benefits, as discussed below:

Reducing excess air by tuning the FO boiler
The existing level of excess air is XX % reflected by oxygen % of XX in flue gas. The ideal % oxygen in flue gas should not exceed about XX % corresponding to an excess air of XX %. This will result in XX % improvement in boiler efficiency.

Heat recovery from the exhaust of FO boiler
The FO boiler exhaust temperature has been measured to be XX °C. This is quite high compared to best practice of XX °C. Due to the high exhaust temperature the efficiency is only XX %. It is suggested to incorporate a heat exchanger in the exhaust to generate hot water at XX °C. This can be used for CIP cleaning, pasteurizer, butter melting and other heating applications which will in turn reduce the heat demand.

| Mass of water that can be heated, kg/hr | XXXX |
| Operating hour | XXXX |
| Capacity of water heated, ton/day | XXXX |
| Saving of fuel oil/day | XXXX |
| Total saving per annum (NRs) | XXXX |

The heat recovery system, envisaged to cost NR XXXX offers one year simple payback period.
**Replacement of oil fired boilers with rice husk fired boiler.**

**Considerations and rationale:**

- Two boilers, (one Furnace oil fired XXXX KG/Hr capacity fire tube boiler, with an operational efficiency of XX % and evaporation ratio of XX and one diesel oil fired coil type boiler of XXXX Kg/Hr capacity) serve to meet the steam and hot water needs of dairy.
- Annual fuel oil consumption is XXXX MT while diesel consumption for boiler is XXXX MT.
- The equivalent steam generation per annum at ER of XXXX is XXXX MT.
- At FO cost of NR XXXX /MT and Diesel cost of NR 99000 per MT, the fuel costs for boiler operations work out to NR XXXX reflecting an overall steam cost of NR XXXX/MT.
- Findings on boiler performance are presented as exhibit 3.
- Given the high cost of steam and significant cost implication in manufacturing cost, as also the fact that dependence on imported fuel is warranted, it is recommended to install a rice husk based XXXX TPH capacity state of the art energy efficient boiler, replacing both existing boilers.
- The Agro fuel use would also enable FO and diesel oil based GHG emission mitigation.
- Supply chain of rice husk at reasonable cost is desirable for viability.

**Cost Benefits:**

- At an envisaged evaporation ratio of XXXX, the husk requirements for same annual steam generation Works out to XXXX TPA, which, at an indicative cost of NR XXXX /MT, amounts to NR XXXX, leading to a cost reduction of NR XXXX.
- The indicative procurement cost of a rice husk boiler of XXXX TPH rating with efficiency over XX %, is NRs. XXXX.
- The measure offers an attractive simple payback period of XXXX months and could be considered for implementation in short term.

**Names of two illustrative vendor sources are as follows:**

<table>
<thead>
<tr>
<th>NAME OF THE COMPANY</th>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME OF THE COMPANY</td>
<td>ADDRESS</td>
</tr>
</tbody>
</table>

**5.12. Insulation of Ghee boiling pan**

**Present situation:**
Un insulated hot surface of ghee boiler is leading to avoidable heat losses

**Recommendation:**
It is recommended to provide thermal insulation to the bare surfaces as assessed in cost benefit analysis which follows:

Current surface temperature = XXXX °C
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\[ S = (10 + (T_s - T_a)/20) \times (T_s - T_a) = XXXX \text{ KCal/hr.m}^2 \]

- Surface temp with insulation = XX °C
- Surface Area to be insulated = XXXX m²
- Net heat Saving = XXXX kgs steam
- Fuel oil saving = XXXX
- F.O saving @5 hr/day, 300 days/year = XXXX lit/year
  = worth NR XXXX
- Investment for thermal insulation = NR XXXX
- Simple payback period = XXXX months

5.13. Condensate Recovery from cream pasteurizer and ghee boiling pan:

**Present situation:**
At present all the condensate other than from pasteurizer is drained which results in loss of heat as well as good boiler quality feed water.

**Recommendation:**
Cost benefits of recovery are presented as follows:
- Condensate of cream pasteurizer and ghee boiler is at around XXXX liter per hour at XX °C which can be returned back to boiler.
- Heat Saving = XXXX
- Annual fuel oil saving = XXXX F.O/Hr (XXXX lit FO/year)
- Annual Monetary savings @NR 75/KG = NRs. XXXX
- Investment for common pit + Level control pump (XXXX HP) and piping = NRs. XXXX
- Operation cost of pump = NRs. XXXX/year
- Net Saving annual = NRs. XXXX
- Simple Payback period = XX months

5.14. Recovering condensate during Diesel boiler operation

**Present situation:**
Though condensate is recovered from pasteurizer, it is used only with FO fired Pressels boiler, due to non-availability of interconnecting piping. Hence, when the Diesel boiler is operating alone, the condensate is drained.

**Recommendation:**
It is suggested to have piping, insulation, interconnection to Diesel boiler so that the condensate can be used at all times.

**Measure Cost benefits are as follows:**
- Estimated condensate loss/day = XXXX K
- Heat loss in kCal and steam = XXXX KG steam.
- Diesel loss @ XXXX ER = XXXX KG/day
- Diesel savings considering 300 day working = XXXX lit/yr
- Diesel cost savings/year@NR XXXX /KG =NRs. XXXX
- Envisaged Investment needs for interconnections =NRs. XXXX
- Simple payback period = XXXX months.
### Exhibit 1: Detailed Specifications of Boilers

#### Boiler 1:

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>Pressels Pvt. Ltd, Cuttack India</td>
</tr>
<tr>
<td>Capacity</td>
<td>XXXX Tons/hr</td>
</tr>
<tr>
<td>Maximum working pressure</td>
<td>XXXX kg/cm²</td>
</tr>
<tr>
<td>Type</td>
<td>Water tube</td>
</tr>
<tr>
<td>Air pre-heater (APH)</td>
<td>Not Installed</td>
</tr>
<tr>
<td>Economizer</td>
<td>Not Installed</td>
</tr>
<tr>
<td>Avg. O₂ %</td>
<td>XXX %</td>
</tr>
<tr>
<td>Flue gas temperature</td>
<td>XXX °C</td>
</tr>
<tr>
<td>Steam pressure (kg/cm²)</td>
<td>XXX</td>
</tr>
<tr>
<td>Chimney height</td>
<td>XXXX Ft</td>
</tr>
<tr>
<td>Fuel</td>
<td>Furnace oil</td>
</tr>
<tr>
<td>No. of blow down</td>
<td>XXXX days</td>
</tr>
<tr>
<td>TDS of boiler water</td>
<td>XXXX ppm</td>
</tr>
<tr>
<td>Temperature of feed water, °C</td>
<td>XXX °C</td>
</tr>
</tbody>
</table>

#### Boiler 2:

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>Thermax- Pune India</td>
</tr>
<tr>
<td>Capacity</td>
<td>XXXX kg/hr</td>
</tr>
<tr>
<td>Maximum working pressure</td>
<td>XXXX kg/cm²</td>
</tr>
<tr>
<td>Type</td>
<td>Water tube</td>
</tr>
<tr>
<td>Air pre-heater (APH)</td>
<td>Not Installed</td>
</tr>
<tr>
<td>Economizer</td>
<td>Installed (leakage was observed in economizer)</td>
</tr>
<tr>
<td>Avg. O₂ %</td>
<td>XXXX %</td>
</tr>
<tr>
<td>Flue gas temperature</td>
<td>XXXX °C</td>
</tr>
<tr>
<td>Steam pressure (kg/cm²)</td>
<td>XXX</td>
</tr>
<tr>
<td>Chimney height</td>
<td>XXXX Ft</td>
</tr>
<tr>
<td>Fuel</td>
<td>Diesel oil</td>
</tr>
<tr>
<td>No. of blow down</td>
<td>XXXX days</td>
</tr>
<tr>
<td>TDS of boiler water</td>
<td>XXXX ppm</td>
</tr>
<tr>
<td>Temperature of feed water, °C</td>
<td>XXX °C</td>
</tr>
</tbody>
</table>
Exhibit 2: Steam Distribution Diagram
Exhibit 3: As run performance assessment of Boilers

Furnace Oil Fired Boiler Efficiency Assessment (Indirect Method)

BASIS:
Furnace oil ultimate analysis:
% Carbon : XX
% Hydrogen : XX
% Nitrogen : XX
% Oxygen : XX
% Sulphur : XX
% Moisture : XX
GCV kCal/kg : XXXX

Boiler as run observations:
Fuel oil consumption/Hr : XXXX Liters (38.7 kg)
Exit flue gas temp deg C : XXXX
Ambient air temp deg C : XXXX
% Oxygen in flue gas : XX
Stoichiometric air fuel ratio : XXXX
Feed water TEMP DEG C : XXXX
Steam Enthalpy kCal/kg : XXXX
Unaccountable losses% : XXXX
Moisture in air : XXXX kg/kg

Calculations:
% Excess air supplied = XX %
Actual air supplied kg/kg oil = XXXX
Flue gas quantity/kg oil fired = XXXX
Heat loss in flue gases kCal/kg oil = Mass of flue gas/kg * sp.ht * temp diff = XX %
Heat Loss due to M & H in Fuel kCal/kg = XX %
Heat Loss due to M in air in kCal/kg = XX %
Unaccounted heat losses % = XX
Total losses assessed % = XX
Boiler efficiency by loss method % = XX %
Heat added per kg fuel oil = XXXX
Heat added per kg steam in kCal = XXXX
Steam to fuel ratio (kg/kg) = XXXX
Cost per ton of steam at 75000NR/MT = XXXX

Diesel Fired Boiler Assessment

BASIS:
Boiler as run observations:
Fuel oil consumption/Hr = XXXX during trial
Water consumption = XXXX liters

Calculations:
Steam to fuel ratio (kg/kg) = XXXX
= XXXX

It is assessed that the quality of steam is wet and the boiler is almost functioning like a hot water generator rather than producing dry steam.

Cost per ton of wet steam/hot water at XXXX nR/MT = XXXX

Diesel cost
Assuming parity with FO fired boiler, at XXXX ER, the cost of steam works out to NR XXXX /MT
# Exhibit 4: Vendor Information

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kind of equipment</td>
<td>Vendor 1</td>
</tr>
<tr>
<td>Technical Parameters</td>
<td>Vendor 1</td>
</tr>
<tr>
<td>Benefits of Equipment</td>
<td>Vendor 1</td>
</tr>
</tbody>
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<tr>
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<td>Benefits of Equipment</td>
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<tbody>
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</tr>
<tr>
<td>Benefits of Equipment</td>
<td>Vendor 1</td>
</tr>
</tbody>
</table>
To
Energy Efficiency Center (EEC)
Federation of Nepalese Chambers of Commerce and Industry (FNCCI).
CITY, DISTRICT, Nepal.

Kind. Attn. Mr. NAME,
Team Leader,
Nepal Energy Efficiency Program (NEEP) / GIZ

Dear Sir,

Subject: Desuperheater for heat recovery hot water from ammonia compressors.

Your enquiry Dated 28:12:2012

This has reference to your enquiry referred above and our telephone talk on above subject. We are pleased to submit our offer for supply of desuperheater as per your requirement for your perusal.

Offer includes

a. Specifications of desuperheater 45 TR
b. Accessories included in scope of supply with desuperheater
c. Ex factory price for supply of desuperheater and its accessories
d. Exclusions such as installation and commissioning. Installation and commissioning service will be quoted extra, if applicable.

We thank you for showing your interest in above innovative product / technology. We are keen to work with EEC DISTRICT office to reduce operating energy cost for Nepalese Industry.

Thanking you

Yours faithfully

For COMPANY NAME

NAME
Director
# Heat Recovery Dairy, DISTRICT:

Technical specifications and data sheet for 45 TR unit

RMS/Nepal Dairy/O_046/ 12  
Date: 4 January 2013

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Description</th>
<th>Data / specifications / Input – Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heat recovery unit – model</td>
<td>ADS – 45 – SS</td>
</tr>
<tr>
<td>2</td>
<td>Heat exchanger Type: as per Tender</td>
<td>Vented Wall Tube in tube Desuperheater</td>
</tr>
<tr>
<td>3</td>
<td>Estimated Gas in // out temperature</td>
<td>125 // 50 (+/- 5) °C</td>
</tr>
<tr>
<td>4</td>
<td>Estimated Water in // out temperature</td>
<td>(in) 28 // (out) 65 °C</td>
</tr>
<tr>
<td>5</td>
<td>Hot water flow.</td>
<td>This will depend on load on compressors in operation, hot gas temperature and temperature of hot water generated</td>
</tr>
<tr>
<td>6</td>
<td>MOC Gas Tube // Water Tube</td>
<td>ASTM – A179 MS /// SS 304</td>
</tr>
<tr>
<td>7</td>
<td>Water inlet / Out let connection</td>
<td>32 mm OD threaded</td>
</tr>
<tr>
<td>8</td>
<td>Gas inlet / out let connection</td>
<td>65 mm OD weld-neck</td>
</tr>
<tr>
<td>9</td>
<td>Over all dimensions mm (approximate)</td>
<td>2250 L X 325 W X 1100 H</td>
</tr>
<tr>
<td>10</td>
<td>Test pressure Gas side // water side</td>
<td>25 kg / cm² // 10 kg / cm²</td>
</tr>
<tr>
<td>11</td>
<td>Scope of supply for 45 TR unit</td>
<td>Accessories included in offer with unit.</td>
</tr>
</tbody>
</table>
a) Desuperheater 45 TR as above b) Weather protection shield c) Base frame / Support structure d) Ammonia Gas isolation valves e) Water flow measuring rotameter f) 20 mm ball valves for rotameter g) Temperature indicator with sensors h) Ammonia Gas pipes, bends, tee |
|        | 1 No. ( Model no.. As above) | 1 set |
|        | 1 set with weld neck design | 1 set |
|        | 250 – 600 LPH range | 1 set for rotameter pipe assembly |

**Investment Grade Energy Audit (IGEA) 2012**
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>12</strong></td>
<td><strong>Accessories required for installation</strong>&lt;br&gt;3000 L Hot water tank and its accessories, support frame, ladder, manhole and nozzles&lt;br&gt;2. Flanges, bends, tee &amp; hardware for 25 mm water piping as required&lt;br&gt;3. Hot water pipe 25 NB, class C&lt;br&gt;4. Water circulation / transfer pump&lt;br&gt;Insulation for hot water pipe and ammonia gas pipe from compressor to Desuperheater</td>
<td><strong>Two point – 1 set ( up to 200° C)</strong>&lt;br&gt;Estimated pipe (62 OD seamless )&lt;br&gt;10 meters, 6 bends , 2 Tee</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td><strong>Delivery</strong></td>
<td><strong>Within 6 – 8 weeks from receipt of order / LOI and advance</strong></td>
</tr>
<tr>
<td><strong>14</strong></td>
<td><strong>Exclusions:</strong>&lt;br&gt;1. Installation of desuperheater, Testing for welding of ammonia and water piping at site&lt;br&gt;2. Insulation material supply and application to ammonia pipes as well as hot water pipes. We will provide technical specifications if required for your contractor&lt;br&gt;3. Accessories as specified in 12 above&lt;br&gt;4. Unloading at site and storing during installation&lt;br&gt;5. Local taxes if any, to be paid by customer directly</td>
<td></td>
</tr>
<tr>
<td><strong>15</strong></td>
<td><strong>Estimated Saving</strong> based on above heat recovery at full load &amp; 10 hours compressor operation per day and working 360 days / year&lt;br&gt;Fuel NR 63/ lit &amp; Electricity NR 12.1/kWh</td>
<td><strong>Equivalent of 22 liters of fuel /day &amp; 15 kWh / day of compressor and condenser cooling pump power. Equivalent cost saving /year is estimated at today’s ( Fuel + Electricity ) cost NR.530,000/-</strong></td>
</tr>
<tr>
<td><strong>16</strong></td>
<td><strong>Packing &amp; forwarding</strong></td>
<td><strong>Rs. Included in in our price</strong></td>
</tr>
<tr>
<td><strong>17</strong></td>
<td><strong>Transport</strong></td>
<td><strong>Extra ( As part-consignment from</strong></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>18</td>
<td>Excise duty</td>
<td>Not applicable at present.</td>
</tr>
<tr>
<td>19</td>
<td>Taxes and duties</td>
<td>All duties extra if applicable as per SARC country norms</td>
</tr>
<tr>
<td>20</td>
<td>Insurance (marine insurance from dispatch from Pune to unloading at site)</td>
<td>Extra, as applicable for export to XXXX country</td>
</tr>
<tr>
<td>21</td>
<td>Price: Ex Works</td>
<td>Rs. As per enclosed price schedule for scope of supply in sr. no. 11 above</td>
</tr>
</tbody>
</table>
| 22 | Terms of payments | 1. Advance 50%.  
2. Balance against LC for equivalent amount + Taxes applicable Valid for period of 90 days from receipt of first advance. |
| 23 | Supervision for installation | 2 visits; one prior to installation for guidance and one at the time of commissioning. (Cost of travel + visa as applicable along with stay at appropriate hotel @ DISTRICT will be born by dairy of EEC, DISTRICT.) |
| 24 | In case you want us to quote for installation, we will quote you separately at the time of finalization of order. | We will provide total engineering support as required for installation. |
| 25 | Guarantee / Warranty | 18 months from date of dispatch or 12 months from date of commissioning whichever is earlier |
| 26 | Investment will have depreciation benefit as per local law of energy conservation |   |

For COMPANY NAME, CITY, DISTRICT

NAME
Desuperheater for heat recovery hot water from ammonia compressors.

**Price Schedule**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description / Items</th>
<th>Price (NR.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Desuperheater 45 TR as per our offer No. : RMS/Nepal Dairy/O_046/ 12 dated 4 January 2013</td>
<td>533,500/- (Rs. Five lac thirty three thousand five hundred only)</td>
</tr>
<tr>
<td>2</td>
<td>Excise Duty</td>
<td>Not applicable</td>
</tr>
<tr>
<td>3</td>
<td>Taxes and duty</td>
<td>Extra as applicable</td>
</tr>
<tr>
<td>4</td>
<td>Freight Charges</td>
<td>Price quoted is FOR Pune Ex-works, Pune</td>
</tr>
<tr>
<td>5</td>
<td>Transit Insurance</td>
<td>Extra as applicable</td>
</tr>
</tbody>
</table>

**Exclusion:**

1. Installation
2. Insulation supply as well as application at site
3. Electrical connection as required at site
4. Water storage and distribution system
5. Unloading at site
6. Visit expenses inclusive of travel (DISTRICT – DISTRICT - DISTRICT) and local accommodation and local travel at DISTRICT. Customer will bear this cost of travel.

For COMPANY NAME, CITY

NAME