

AUDIT MANUAL FOR RECP CLUB



A Self Help Approach

AUDIT MANUAL FOR RECP CLUB

(A SELF HELP APPROACH)



**Resource
Efficient and
Cleaner
Production
INDONESIA**

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KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN
REPUBLIK INDONESIA



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The National Resource Efficient and Cleaner Production (RECP) programme of Indonesia aims to bolster the competitiveness and profitability of small and medium enterprises (SMEs) in Indonesia. The RECP programme focuses on key sectors that drive economic development and job creation around Indonesia and which are significant in terms of consumption of materials, energy and water and potential environmental impacts. Small and micro rice milling enterprises were selected for RECP implementation as they provide jobs and income and deliver goods and services that improve the lives of consumers and of communities.

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DISCLAIMER

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LIST OF ABBREVIATIONS

| | | |
|------------------|---|---|
| APO | = | Asian Productivity Organization |
| AOX | = | Toxic Absorb-able Organic Halides |
| BAT | = | Best Available Technology |
| BEE | = | Bureau of Energy Efficiency (India) |
| BOD | = | Biochemical Oxygen Demand |
| BEAT | = | Best Economically Achievable Technology |
| CADGIE | = | Centre for Assessment and Development of Green Industry and Environmental |
| COD | = | Chemical Oxygen Demand |
| CP | = | Cleaner Production |
| CPC'S | = | Cleaner Production Centre |
| CPCB | = | Central Pollution Control Board |
| CRECPI | = | Centre for Resource Efficient and Cleaner Production Indonesia |
| CTA | = | Chief Technical Advisor |
| CTB | = | Centre for Textile Bandung |
| DG | = | Diesel Generation |
| EOP | = | End of Pipe |
| GDP | = | Gross Domestic Product |
| GHG | = | Greenhouse Gas |
| GOI | = | Government of Indonesia |
| H & M | = | Hennes & Mauritz |
| H2O2 | = | Hydrogen Peroxide |
| HVAC | = | Heating, Ventilation and Air-conditioning |
| IA | = | Implementing Agency |
| ITB | = | Bandung Institute of Technology (<i>Institut Teknologi Bandung</i>) |
| ICPC | = | Indonesia Cleaner Production Centre |
| KCal | = | Kilocalorie |
| KL | = | Kilolitre |
| KWh | = | Kilowatt hours |
| LED | = | Light Emitting Diode |
| LRP | = | Local Resource Person |
| MJ | = | Mega Joule |
| MoEF | = | Ministry of Environment and Forestry |
| Mol | = | Ministry of Industry |
| MoT | = | Ministry of Tourism |

| | | |
|------------------|---|--|
| NCPO | = | National Cleaner Production Office |
| NMF | = | Not Me First |
| NPC | = | National Productivity Council |
| OBA | = | Toxic Optical Brighteners |
| OHS | = | Occupational Health & Safety |
| QC'S | = | Quality Circle |
| SECO | = | Swiss State Secretariat for Economic Affairs |
| SME | = | Small and Medium Enterprise |
| RECP | = | Resource Efficient and Cleaner Production |
| RECPC | = | Resource Efficient and Cleaner Production Club |
| R & D | = | Research and Development |
| PAESPBI | = | Association of RECP in Indonesia |
| PMU | = | Project Management Unit |
| PVC | = | Polyvinyl Chloride |
| UNIDO | = | United Nations Industrial Development Organization |
| WM | = | Waste Minimization |
| WMC | = | Waste Minimization Circles |

PREFACE

This manual for the establishment and operation of RECP clubs (RECPCs) has been compiled from a range of experiences. It is envisaged as a tool to enable the RECP multiplier effect of the Indonesian RECP project. This manual is intended as a guide for members as well as Club Facilitators for the establishment and management of RECPCs. Each RECPC is different and the members and facilitators often require different guidance and training and need to adapt as per local conditions. However, there must be a system in place to ensure that RECP facilitators trained both in classroom and on-the-job training will ensure the smooth operation of RECPCs and control the quality of outputs and record the experience gained.

The RECP club training material is developed with sector specific cases and experiences for the benefits of the RECPC members and facilitators. Though there are many CP/RECP guidelines and manuals available globally, the RECPC club manual is designed as a self-help tool for facilitating the RECP multiplier effect. The manual is by no means exhaustive, and aims to only provide a starting point for the establishment and operation of RECPCs, and as an experience sharing mechanism. The information in this manual needs to be adapted, updated, added and changed as required to fit a particular sector profile.

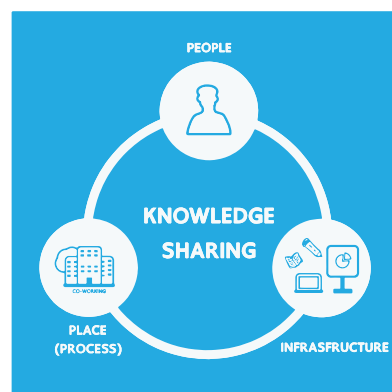
RECP promoting institutions and agencies will have a critical role in successful implementation of this innovative mechanism and their responsibilities/role in supporting RECPC's are to:

- Serve as a source of information on RECP/CP (case studies, training material, information, advice, etc. sectoral/generic)
- Select potential sectors/regions and companies suitable for RECPCs
- Provide training and awareness raising on the modus operandi of RECPCs
- Provide access to information/methodology through RECP help desks
- Undertake RECP quick scans to identify low/no cost, easy to implement RECP measures to encourage and motivate club members
- Suggest and formulate awards for RECPC initiatives (healthy competition mechanism)
- Provide platform to RECPC members, facilitators and encourage stakeholders to share experiences of RECPCs in Indonesia.

These are only suggested roles and obviously need to be discussed – case by case, sector by sector and region by region to ascertain the sustainability of the RECPC concept – by all project partners and other local, regional and sectoral stakeholders.

1.0. PREAMBLE

Industrial sectors in developing countries are growing to alleviate poverty, increase GDP, generate employment and improve the standard of living. However, growth often leads to environmental degradation and the depletion of resources, particularly of non-renewable resources. The earlier concept of waste as “a material which has no use” is changing to “a resource at the wrong place”. This realization is making society rethink how to optimize resource use and minimize or eliminate the generation of so-called wastes. Over the last three decades, this approach has been successfully implemented by individual industries, which possess information, knowledge and resources and can initiate actions on their own. However, the results of these approaches were confined to that specific industry. In those cases where various stakeholders aimed to demonstrate the benefits of RECP (through pollution prevention/waste minimization/cleaner production), these attempts to publicize the efforts of industry and other organizations could not effectively catalyse the industry to adopt RECP (N. Thambiran 2009). To create a multiplier effect and promote RECP across the entire industrial spectrum, it was necessary to develop appropriate supportive mechanisms. To that end, RECP Indonesia initiated the activity termed as RECP Clubs based on the model of Waste Minimization Circles (WMC) developed in India (NPC-1996) in selected sector/industrial zones/clusters of industries. This project is being implemented by RECP Indonesia jointly by MoEF, MoI, MoT, CRECPI and CTB in cooperation with regional authorities.



2.0. INTRODUCTION

As a result of rapid industrialization, patterns of consumption, and parallel growth in urbanization, the quality of the environment has deteriorated steadily over the past few decades. Safe and healthy ambient standards of air, water and soil pollution are routinely exceeded with potentially disastrous consequences. Because Indonesia is a developing country, this problem is severe, and worsening with the ever increasing number of industries. As in the rest of the world, Indonesia has seen a significant rise in environmental problems in the past couple of decades, which has encouraged industry to adopt better resource utilization and waste management practices, whilst ensuring that its products and services are designed to aim for sustainability. In addition to the major focus – on reducing resource consumption and waste generation at source, recovery, reuse and recycling both on-site and off-site (wherever feasible) – an effective outreach/multiplier of RECP implementation self-help approach has been conceived.

The RECP club approach, based upon common goals and mutual support for ease of function in a limited geographical region has much to commend it. The significant benefits include:

1. Inspiration, stimulated by the progress of other members leading the cross fertilization of experiences related to resource consumption and waste generation
2. Pressure, caused by obligation, to keep to targets of consumption and disposal
3. Reassurance that others have similar problems (commonalities)
4. Experience of different approaches and methodologies
5. Strong sense of community

2.1. Resource Efficient Cleaner Production (RECP)

RECP is simply defined as:

“Integrated and continued application of preventive environmental practices and total productivity techniques to processes, products, and services to increase efficiency and reduce risks to humans and environment”. (Rene Van Berkel, 2016)

For the manufacturing and servicing sectors, RECP involves conserving raw materials including water and energy, eliminating the use of toxic substances as much as possible, reducing quantity and toxicity of emissions and wastes before they leave the process or service facilities (such as hotels or hospitals, for example) and other interventions. For products, it means reducing environmental impact during a product’s entire life cycle, from raw material extraction until ultimate disposal, including the servicing period, where costs and environmental damage are reduced.

The RECP concept addresses holistically sustainable pattern of industrial production as well as consumption of resources. RECP application plays an important role in the conservation of resources, reduced impact of environmental footprints, positive impact on Occupational Safety and Health (OSH) and reduced production cost through improved productivity (NCPO, 2012).

2.2. Introduction to RECP Clubs

RECP clubs are defined as a group of enterprises coming together to share information, advice and experiences in RECP practices. These clubs generally consist of between five to eight enterprises (RECP members), from either the same industrial sector or the same geographical area. Meetings are generally held every month and these are facilitated by a facilitator that has experience or is trained in RECP applications and is capable of transferring this information to the other club members (APO 2013).

The RECP approach has been successfully applied to provide individual industries with information and knowledge resources to initiate actions on their own. However, the results of these approaches have been confined to that specific industry. To create a multiplier effect and promote Resource Efficient Cleaner Production (RECP) across the entire industrial spectrum it was necessary to develop and adopt appropriate supportive mechanisms. In this regard, the Indonesian Resource Efficient Cleaner Production Centre (IRECPC) decided to adopt a successful model from India – Waste Minimization Circles (WMC) – to implement RECP in industries using the concept of Cleaner Production Circles. This project is being implemented jointly by MoEF, MoI, MoT, CRECPI and CTB in cooperation with provincial and local authorities with the assistance of UNIDO and financial assistance from SECO.

The RECP club concept combines the methodology of RECP and the concept of Quality Circles. The team concept of Quality Circles was extended, from a team of people from various departments of one industry, into a group of entrepreneurs which discusses areas for RECP potential and implementation of RECP as a self-help mechanism.

2.3. What is a Resource Efficient Cleaner Production Club (RECP)?

For the purposes of this document, a Resource Efficient Cleaner Production Club is defined as “A small group of entrepreneurs in the small scale sectors whose units manufacture similar products/ provide the same services and employ more or less the same processes, meeting regularly in the premises of each member unit on a rotating schedule. During the meetings, members collect baseline data and analyze the operation of the host unit to identify resource consumption and sources of waste generation and identify and assist in implementing RECP options. This leads to an increase in individual profitability and a reduction in pollution from the units.” (NPC, 1993)

RECPCs are generally established in a geographical region (sector cluster, industrial estate, river catchments, etc.) and operate through training of project teams and champions from participating companies, alongside limited use of external experts. The earlier batch of clubs was designed to encourage the usage of simplified RECP methodology through group demonstrations and exercises within industry.

2.4. Why the RECPC approach?

Resource Efficient and Cleaner Productions Clubs (RECPCs) are formed to promote the application of RECP within an industry and to facilitate the exchange of information and experience among geographically close companies. The members of a circle represent companies that are committed to reduce the resource consumption per unit of production as well as the reduction of waste generated. In principle RECP clubs may be formed by member industries from the same sector as well as by cross-sector industries.

The club approach to promoting RECP as a self-help tool in SMEs is appropriate because RECP clubs can generate a spirit of cooperation among members. This cooperation extends even beyond conventional RECP for resource consumption and waste reduction, as it can also include cooperative approaches to procurement and marketing.

The function of RECPCs is based on the principle that the implementation and sustainability of RECP options work better when entrepreneurs identify the options themselves. Therefore RECPCs should lead to increased innovation across industry, allowing participants to gain an edge on their competitors through reduced cost structures and greater resource efficiency. Overall financial, environmental, social and improved Occupational Health & Safety (OHS) are of greater interest to industry as a whole.

2.5. What Are RECP Club/Circle objectives?

The RECP club, based on CP clubs and WMCs, is principally a voluntary, self-help tool (R. Mani 2009) and is intended to be established with the following key objectives:

(a) Awareness and information dissemination

- To provide a forum for discussions, sharing views and knowledge about RECP at local level.
- To enable systematic compilation and dissemination of information on RECP Club/Circle.

(b) Demonstration

- To promote group efforts for demonstrating RECP Club/Circle techniques.
- Facilitate adoption of techno-economically viable RECP techniques and technologies

(c) Environmental Compliance

- Reduce environmental footprint during production or services from individual units and region/cluster
- Facilitate compliance with environmental and other related regulations

2.6. How to achieve the RECPC objectives?

The major objectives of RECPC – as a self-help tool for implementing RECP measures and an effective outreach tool among beneficiaries with limited technical and no financial support – can be achieved by:

- * Motivating entrepreneurs in the same business and geographical region (perceived competitors) to work together
- * Creating awareness and disseminating information on Cleaner Production to SMEs both in the manufacturing and service sector
- * Applying a structured methodology for systematic application of the Cleaner Production Energy Efficiency concept
- * Creating a platform for discussion and shared experiences, views, knowledge and innovations in the implementation of RECP techniques and technologies
- * Sharing experience of the success of RECPC elsewhere as well as any failures and reasons thereof
- * Dissemination of information and experiences of RECPC through project partners' annual report, national and sectoral industry associations, etc.
- * Establishment of RECPC by careful selection of sector and RECPC members
- * Running of RECPC by guiding (not dictating) meetings by facilitators, coordinating the RECP and related activities
- * Liaising with a nodal/promoting agency, advising on relevant sector sources of information, success stories and available resources, etc.

2.7. What is the aim of RECPC principles?

The RECPC approach in Indonesia is chiefly designed to promote multiple RECP measures in Indonesia in an efficient and cost effective manner. Some of the aims of RECPC establishment are to:

- * Promote the efficient use of resources by businesses in Indonesia
- * Demonstrate the benefits of resource efficiency and waste reduction to businesses in Indonesia
- * Provide expert assistance in undertaking audits/quick scans to identify the RECP opportunities of individual companies and cross fertilization among club members
- * Achieve resource optimization including energy usage in the member units
- * Achieve reductions in waste quantity/characteristics by the participating companies
- * Disseminate locally and nationally the results achieved by the club
- * Encourage companies to develop their own environmental policies
- * Respond to the specific needs of club members

2.8. Background to the RECP club/circle

With the growing awareness of the adverse impact of pollution and the consequent environmental movement in Indonesia, both regulatory agencies and industry focused environmental protection efforts on controlling the effluent and air pollutant at the point that it enters the environment. This concept is known as end-of-pipe (EOP) treatment. While the EOP approach has to some extent been effective in protecting the environment, it has also presented the following potential disadvantages:

- * It can result in the transfer of pollutant from one medium to another, thereby often resulting in no net environmental benefits. In some instances, this transfer can even increase the risk to human health and the environment.
- * It requires significant upfront expenses (often termed dead investments) as well as recurring expenses, which make the concept highly unsustainable and at times for most of the SMEs not feasible on account of poor profitability and cut-throat competition.
- * There can be a lack of technical know-how to operate, maintain and troubleshoot EOP control systems, as well as often space constraints, etc.

Realizing these drawbacks and looking into other pressing problems (the pollutant assimilation capacity of the receiving bodies nearing exhaustion), the concerned agencies were forced to look back into the industrial production processes and search for alternative approaches for environmental protection. Thus emerged the concept of the proactive approach of RECP “*waste reduction at source*” as a means to achieve environmental protection.

2.9. How to Sustain a RECP club mechanism?

The implementing partners of the RECP Indonesia programme – namely MoEF, MoI, MoT, CRECPI and CTB – will provide external support to an RECPC for a limited period, both in technical as well as administrative aspects. In addition, organizations and institutions such as the Indonesian Cleaner Production Centre (ICPC), the Association of RECP in Indonesia (PAESPBI) and the Institute of Technology Bandung (ITB) will promote the concept nationally beyond the project period.

However, because RECP is a continuous process, it cannot be completed in restricted or short time frames. Industry (RECPC members) will gain sufficient experience and a fair level of expertise in carrying out the RECP programme by themselves at the end of a one-year period of hand holding. It is essential therefore that the RECPC members and nodal agencies (MoEF, MoI, MoT, CRECPI and CTB) shall carry on the established foundations and activities during the course of RECPC implementation and build a sustainable partnership to derive long-term benefits through continuous voluntary initiatives amongst themselves. The participating industries are expected to remain a part of the larger network associated with the RECP Indonesia and productivity movements launched by MoEF and ICPC. It is also expected that RECPC Team Leaders of initial clubs will work as ambassadors for RECPC promotion in the country/region.

2.10. How to achieve satisfactory multiplier effect

Considering the large number of SMEs in developing economies like Indonesia (over 95 per cent of the total number of registered units in the country), RECP and its implementation needs to have an effective mechanism for creating a multiplier effect in regions, sectors and the country as a whole.

The concept and mechanism of the RECPC (both RECP circles/clubs) has succeeded in promoting group efforts in many countries. In India more than 150 CPCs/WMCs have been established successfully and encouraging results have been achieved in many SME clusters and sectors. In South Africa, satisfactory results have been reported from metal finishing sector with large numbers of units in a club. Although it is early days for RECPC in countries like Viet Nam, Lao People’s Democratic Republic and Armenia, results thus far are very encouraging and have the potential to spread the RECP movement further, through the seeding of multiplier effects across a range of diverse sectors. For effective multiplier effects the proposed RECPC mechanism is discussed briefly in Section 3.0.

3.0. CREATING A SELF-HELP MECHANISM FOR RECP

Particularly in SMEs, business owners and managers are generally involved and concerned not only with maximizing production but also with resource consumption and costing. Therefore, even if there are no proper records or reports, they should have informal knowledge of the activities carried out in their respective unit. Adequate knowledge exists within the industry regarding processes, operations, costing, wastes and the potential benefits of an RECP-EE implementation. However, often such an implementation is neglected or not undertaken at all due to constraints, excuses and/or different priorities.

An RECP approach may succeed in rekindling this latent potential, which has so far remained unexplored and consequently does not lead to the generation of innovative RECP options. It can build the entrepreneurs' confidence in the RECP assessment mechanism/tool and encourage entrepreneurs to undertake the RECP methodology/approach on their own for the long-term sustainability of their respective establishments.

In conclusion, it can be stated that the primary aim of this manual is the development of a sustainable method to promote and manage RECP clubs. It is proposed that this can be achieved by the capacity building of RECP promoting institutions and RECP facilitators, as well as developing easy-to-use training manuals, the reference to sector-specific RECP guidelines and the proposed development of a strategy for promoting RECPs. The approach is tailor-made for smooth RECP functioning. The prerequisites of RECP establishment are presented in the following diagram.



Figure 1. Flow Diagram of RECPC Establishment

3.1. Various techniques to be used In RECP Clubs

(Similar to techniques used in RECP pilot demonstration assessment and implementation-but simplified for self-help)

RECP options are very diverse and we shall look into possible measures which could be grouped into three major categories:

1. Resource consumption/Waste Reduction at Source
2. Reuse/recovery/recycle (on-site / off site)
3. Product modification

3.1.1. Resource Consumption/Waste Reduction at Source

☞ Good housekeeping

This usually means changing existing practices or introducing new ways of operating and maintaining equipment. Appropriate provisions to prevent spills and to encourage good workplace attitudes are included in this category of RECP options. Good housekeeping options are normally inexpensive and their payback period is short for both the manufacturing and service sector. Examples include: *repair leakages, close taps when not in use, raw material conveyor to reduce material handling losses, insulation of hot or cold surfaces, etc.*

☞ Process modification/optimization

This includes better process control, which aims to optimize process parameters/conditions like pH, temperature, pressure, residence time, etc., to ensure operation of the existing processes at higher efficiency and with lower waste and emission generation. Examples include: *training operators or adding monitoring and control devices to machinery, optimizing energy consumption in compressed air systems by reducing pressure as per need at different workplaces, optimization of pulping process for extended cooking with NaOH.*

☞ Input material change

The change or substitution of raw materials can include using less hazardous materials or raw materials of higher quality aimed to reduce the quantity/toxicity of waste generated from the process/service. Examples include: *substituting existing raw materials with less polluting alternatives; substituting existing toxic optical brighteners (OBA) in laundry with non-toxic organic brighteners to reduce effluent and product/service toxicity; use of H₂O₂ bleaching instead of chlorine-based bleaching to avoid the generation of toxic absorb-able organic halides (AOX); substitute fossil fuel in boilers with carbon neutral biomass.*

☞ Equipment modification

Examples of equipment modification include small changes to existing equipment, such as: *installing dampers for controlling air for combustion, installing fluid coupling in blenders, steam distribution pipe in dyeing machine etc.,* which aim to reduce the waste generation caused by poor equipment design. This may be achieved effectively by training the operators or by adding monitoring and control devices to the machinery. In some cases like in textile processing, a more resource-efficient process may be introduced, such as *modifying thermic fluid/steam based stentors to direct gas firing stentors.*

☞ Technology change related measures

Technology change constitutes the replacement of technology, processing sequence and/ or synthesis pathway in order to reduce resource consumption, by-products or emissions like waste heat for chilling/cooling/energy generation and minimizing waste and emission generation during the production process. Examples include: *installation of screw press and counter current multistage vacuum washers for pulp washing, employing VAM for chilling cooling replacing compressor technology.*

3.1.2. Recovery/Recycling/Reuse

- **Onsite reuse/recycle:** These RECP techniques are applicable for on-site recovery as well as reuse of wasted materials and energy. *Condensate, hot water, waste heat* are some example of on site recover, reuse and recycle.
- **Offsite reuse:** Recovered materials may either be reused in the same process or used for another purpose. For example: pickling spent bath in metal finishing can be used as a chemical for chrome reduction in a metal plating unit replacing fresh acid and ferric chloride required for reduction, and producing useful by-products, like the *creation of lingo-sulphates from black liquor or lignin recovery from black liquor for use as soil conditioner, organic waste from a hotel composted as soil conditioner.*

3.1.3. Product modification

This RECP technique is applicable for both the manufacturing and service sector. A product can be redesigned using fewer materials, and other resources can be implemented. For example: *off white tissue paper/towel in place of super white tissues, white tissues without toxic optical brighteners, coating of components replacing electroplating wherever feasible.*

3.2. Proposed activities for establishing RECP clubs/circle

During the establishment of an RECP club/circle in Indonesia, the activities envisaged for effective functioning can be divided into three stages:

1. Identification of core groups which will be eligible for RECP club pilot sites as per approved project document sectors/industrial zones/regions, etc.
2. Establishment of RECP clubs/circles in cooperation with local authorities and other stakeholders, including international buyers such as H&M, Puma, Adidas, Nike, etc.
3. Running of RECP clubs with properly documented results and experiences



Figure 2. Consultation meeting with potential RECP club in Tourist Village in Sleman

3.2.1. Identification of core group

To initiate the self-help approach, various project partners/agencies will be requested to support and facilitate the RECP club/circle establishment and operation. This will involve support from implementing agencies, that is MoEF/ICPC, Mol/CADGIE, MoT and CTB. The RECP Indonesia project will arrange necessary assistance (technical support, facilitators and thematic experts) to execute the activities under the RECP club approach as a multiplier tool for RECP application in the country.

The project will provide training to RECP Club Facilitators and project staff selected from sectoral Research and Development (R&D) institutions, environmental/energy managers, consulting organizations/engineers and regional/local government officials. ICPC/CTB/CADGIE/MoT and the CTA will coordinate the establishment and running of an RECP club/circle through the facilitators and provide necessary technical support and guidance, undertake monitoring of the clubs/circles and their review, disseminate information and achievements of the RECP club/circle through case examples and create awareness through mass media for successful replication of the RECP measures in other sectors beyond the selected sector of the project.

3.3. Tasks of nodal partners to establishment an RECP club

In sequence, the main activities to be undertaken for the establishment and operation of an RECP club as per project design where project partners and RECP Club Facilitators coordinate and share responsibility include:

1. Selection of participating units from selected industrial sector(s) and region(s)
2. Identification of a suitable facilitator for the coordination and establishment of RECP clubs/circles
3. Preparation of sectoral/industrial zone/tourism zone profile
4. Selection of local resource person (Group Leader)
5. Running of RECP club awareness workshop and training module
6. Establishment of RECP clubs/circles and formation of unit-level RECP teams
7. Signing of MoU by selected RECP club members
8. Kick-off visit to club members' unit to help baseline data collection
9. Running of RECP clubs/circles – running of RECP clubs/circles meetings, recording minutes, providing guidance to club members, identifying and implementing RECP options, assessing progress, etc.
10. Recording and reporting meeting and progress proceedings and providing feedback to project
11. Regular running of review workshops by facilitators
12. Assessment of economic/environmental benefits as per output/outcome based indicators
13. Running of final workshop and dissemination of results etc.

3.4. Ensuring smooth operation of RECP clubs/circles

After completion of these tasks during establishment, it is essential to get acquainted with the systematic RECP approach used for RECP demo units and modified for RECP clubs (adopted and simplified as a self-help approach for effective implementation of the RECP club programme). The series of activities to be followed for the effective running of a club is as follows:

- ☞ Plan for RECP club meetings and adopt simplified and structured systematic RECP methodology
- ☞ Form unit-level RECP team and quick RECP scan (walkthrough audit) by implementing agency with RECP team to assist in RECP potential estimation
- ☞ Conduct RECP club meetings regularly and special meetings as and when required
- ☞ Identify and assess feasibility of identified RECP options
- ☞ Undertake implementation of agreed techno-economically viable and environmentally desirable RECP options/solutions

- ☞ Provide in-depth technical assistance only for RECP options requiring technical support from implementing agency (for generic low-cost options, fellow club members will act as experts)
- ☞ Organize regular review meetings, consultation workshops, etc.
- ☞ Submit activity reports of club proceedings provided by facilitators to implementing partners and ICPC

During awareness workshops/training programmes where RECP club members, facilitators and implementing agency officials are in attendance, an action plan of the proposed club activities will be developed and finalized as per the consensus of all the members. Thereafter for each subsequent RECP club meeting, the Club Facilitator will prepare a schedule, venue, agenda and other relevant materials. The Facilitator will also record the minutes and deliberations to ensure systematic progress of RECP club activities.

3.5. Formation of unit-level RECP team

Each RECP club member will form an RECP team within their own unit and function as the Team Leader for that in-company RECP team. The team will consist of representatives from all levels of the organization, including shop-floor workers, supervisors and managers. The team will be responsible for the execution of RECP activities in the unit. This step is important since the involvement of shop-floor workers will assist in identifying and implementing RECP measures. The unit-level RECP core team should be represented in the RECP club in order to share actions taken and experience gained in the unit and to encourage cross-fertilization of this information.

3.6. RECP club meetings

The RECP Club Facilitator and the Group Leader will be responsible for organizing regular RECP club meetings. During the meetings, the RECP club members jointly identify and analyze their concerns, help each other to establish a baseline before the club is operational and estimate RECP potential. The meetings should be held within the premises of one of the member units, primarily to encourage workers' participation in the RECP club and as per rotation in each of the member units. This enables the workers who actually execute the job at the shop-floor level to come up with practical solutions related to RECP. Involving workers aims to encourage them to undertake the implementation of identified options, provide a motivating factor in their activities and contribute to enhanced job satisfaction. The frequency of meetings should vary from weekly to fortnightly or monthly, based on the requirements under the project and the progress being achieved. The following points should be kept in mind while organizing the RECP club meetings:

1. Ensure equal participation of all members (no domination by individual members)
2. Well-defined agenda (to avoid irrelevant discussion)
3. Well-defined minutes of meeting (responsible spokesperson assigned for each meeting)
4. Meetings should be needs-based and proposed monthly to review the issues and progress
5. Ensure there is a review of activities carried out in each unit, with a recap of previous decisions and progress achieved
6. Activities should be planned before the next meeting
7. Identify areas in which external assistance is required, for facilitator to convey to implementing agency
8. Consensus on date and venue and timings for the next meeting

3.7. Identification and implementation of techno-economically viable RECP options

The RECP club participating units are strongly advised to follow the systematic RECP approach (simplified for club approach) on which they have been trained to adopt RECP in their units. It is important to avoid the regular tendency to jump to quick solutions or conclusions. Initially, the RECP club members after establishing a club shall start with primary data collection and compilation of available records on their processes, purchases and sales. If required, additional data can be generated during the course of the RECP club implementation, which will enable the units and club members to correctly assess the status of existing operations regarding raw material consumption, product quantum and quality, energy and utilities consumption, etc. In this regard, the RECP Club Facilitator shall provide necessary assistance and where required and feasible they can seek assistance from the implementing agency and ICPC. A simple comparison between material and energy balances and consumption and waste generation needs to be made for participating member units. Having established excess resource consumption and waste generation, cause analysis and suitable RECP options shall be generated. Further, based on the techno-economic feasibility of the RECP options, the units should collectively decide to implement the techno-economically viable RECP options/solutions in their respective units.

3.8. Activity report to implementing agency

The RECP Club Facilitator and Group Leader are encouraged to simultaneously document the activities of the RECP club. The participating unit Team Leader shall compile the experiences of the RECP club and send the quarterly progress report (short and informal) of the Club to the respective implementing agency, club members and copy to the RECP project implementing agency, ICPC. In addition to club proceedings and reporting on individual member units, any progress and/or concerns should be recorded and reported to the implementing agency.

3.9. Technical assistance (external)

Club members will identify the areas requiring external assistance and the RECP Club Facilitator will inform the implementing agency of the area or areas where participating members need assistance. The implementing agency is expected to provide technical assistance to the RECP club as much as is feasible with the available resources. When assistance is required in a specialized field, then specialists in the respective field will be shortlisted and requested by project. Implementing agency coordinators will make follow-up visits to the RECP club to review progress and address any issues to facilitate the smooth functioning of the Club.

In addition, RECPs can also post their concerns to RECP help desks which are to be established in ICPC.

3.10. Review & consultation workshops

In order to assess the performance, effectiveness and non-implementation (if any) from the established RECP club, periodic reviews and consultation workshops have to be conducted in each of the RECP clubs. RECP club members will be encouraged to share their experiences and present the results which they have been able to achieve as an outcome of the club's establishment, including experience of failure if relevant. For effective multiplier/outreach effect, it is advised to invite other non-member units also from the region/sector.

4.0. METHODOLOGY FOR ESTABLISHING RECP CIRCLE

To function effectively and promote synergy among club members, RECP clubs can be broadly divided into four stages:

1. Identification of sector and group of companies willing to participate and having significant potential for savings to encourage effective implementation with early results
2. Establishment of RECPCs of like-minded members with proper feedback on modus operandi and honest sharing of ideas and results
3. Running of RECPCs with proper recording of meeting proceedings with follow-up plan for implementation
4. Sharing of experimentation decided and agreed in RECPC meetings to share perceived risks and successes.

The chronology of RECP methodology and functioning is discussed step-by-step as below:

4.1. Conduction of awareness workshop

In order to propagate the innovative concept of RECPC and its benefits, it is necessary to create awareness amongst entrepreneurs. An awareness workshop on the needs, benefits and expected outcomes should be conducted in the selected industrial cluster/area with the assistance of the local resource person (LRP). The prime objective of the awareness workshop is to create awareness of RECP and to motivate industries to come together to form RECPCs. The awareness workshop should cover the following aspects:

- ☞ Generic concept and benefits of RECP
- ☞ Potential for RECP in the selected industrial sector
- ☞ RECP success stories highlighting monetary savings, quality improvement, production capacity enhancement, improved working environment and reduction in environmental management costs
- ☞ Concept and philosophy of RECPC and Dos and Don'ts based on existing experience from elsewhere

4.2. Step-by-step methodology for RECP clubs

A structured step-by-step methodology helps to assess RECP potential in detail and to identify causes of excess consumption/waste generation rather than leaping to conclusions based on incomplete data. It also helps to set the targets/benchmark more objectively depending on the availability of technical and financial resources with the circle members.

Presented below (and in Figure 3) are basic, easy to understand process steps and practice, recommended for RECPC methodology:

- Step-1** : Establishment of RECP team in participating units
- Step-2** : Collection and compilation of baseline data (product, production, consumption of raw materials, energy, water and waste generation) before RECP club
- Step-3** : Estimation of RECP potential as per benchmark and/or based on experience of club members/Club Facilitator/implementation agency
- Step-4** : Identify RECP audit focus (production process/auxiliary services/thematic areas) by participating units

- Step-5** : Material and energy balances (primary) for selected focus
- Step-6** : Cause analysis for possible high resource consumption and waste generation
- Step-7** : Identify RECP options to apply RECP techniques
- Step-8** : Select option for implementation based on feasibility analysis and available resources
- Step-9** : Start implementing RECP solutions from Step-8 and solicit external assistance if required for implementation support
- Step-10** : Record and report implementation results including untold experiences
- Step-11** : Sustain RECP in member unit

All RECP club members will provide experience-based advice/support at club meetings as well as on site visits, which will enable all members to benefit from every member's experience.

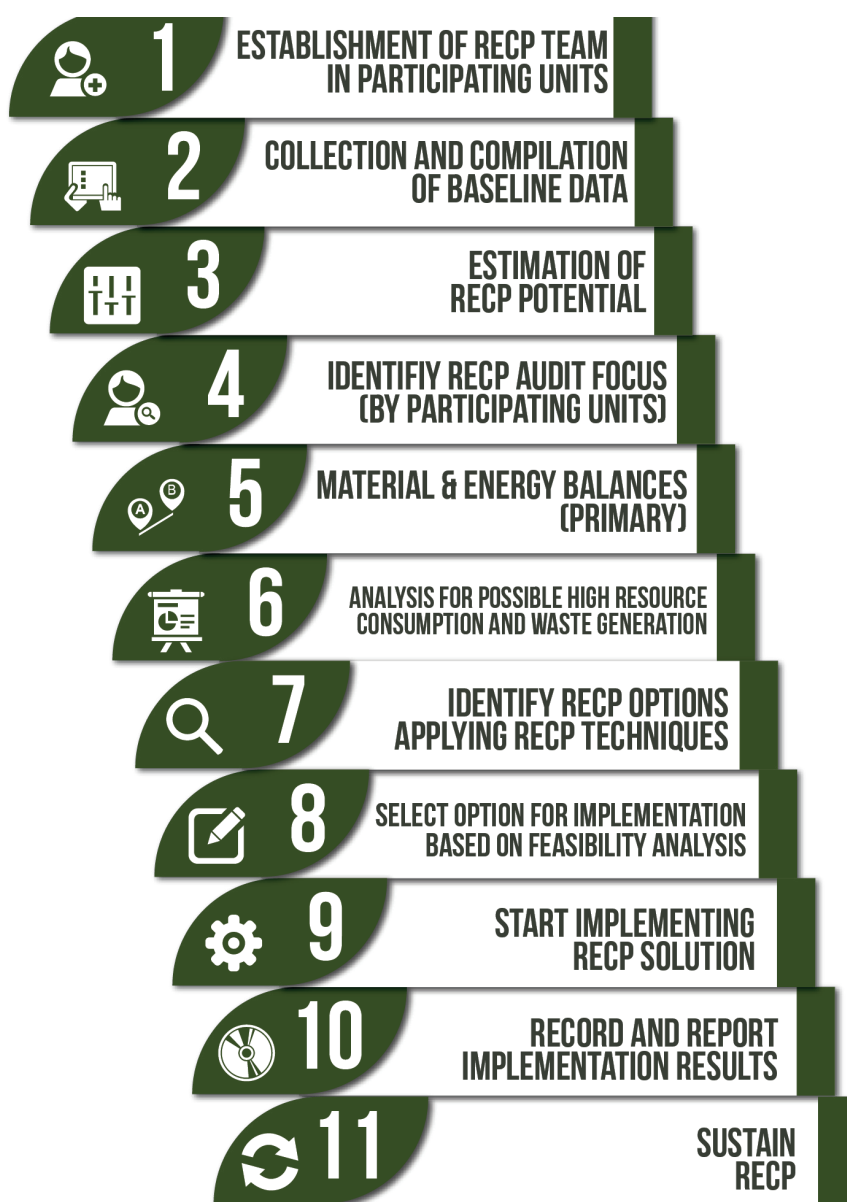


Figure 3. Modified Methodology For RECP Club

4.3. RECP club meetings and training

An important aspect of managing a RECP circle is to hold regular circle meetings. Regular meetings allow the club members and facilitators to provide updates on important issues and developments, and to obtain feedback from members. Members are required to report back to the implementing agency on RECP activities and any progress or obstacles encountered within their companies. The quantification and reporting of savings resulting from the implementation of RECP options both in economic and environmental terms is encouraged. In addition results which cannot be quantified should be recorded and reported in qualitative form. The facilitator should compile a checklist of information and feedback from external experts to send to the implementing agency. These meetings also serve as a forum for members to discuss problems that the companies encounter while conducting trials.

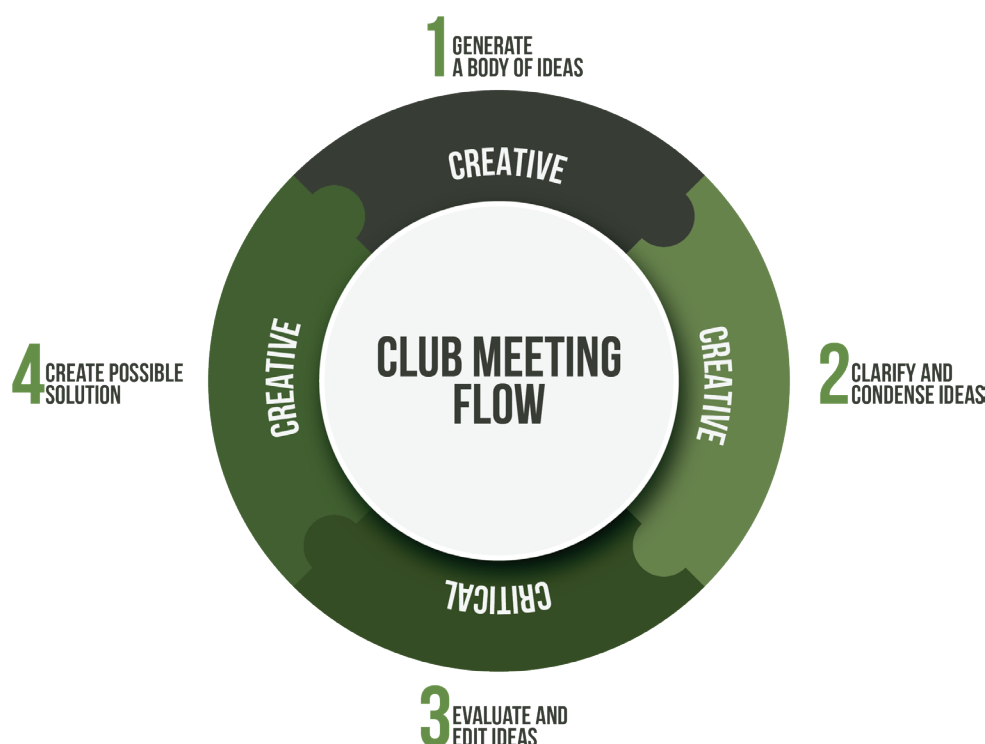


Figure 4. Club Meeting Flow

Owner/managers from non-RECP member units should also be invited occasionally to meetings to share their experience of resource consumption, quality improvement and waste reduction. Additional meetings and site visits shall be arranged by RECP members whenever necessary. RECP members shall be trained in the basics of RECP, as well as the more detailed aspects of maintaining a CP programme, thus enabling club members to continue with RECP and related activities at their sites. In the training modules, a case example from the particular sector will be developed and used for a specific group exercise to understand the concept of material and energy balance, cause analysis and option generation. Most sessions will be interactive, where companies either form groups or work by themselves to solve typical problems related to waste generation. Resource specific audits shall be carried out in more detail by sector specific experts (depending on availability).

During meetings and intensive training sessions, members will also be made aware of additional sources of information on RECP, efficient technologies for specific sectors and case examples from other countries.

4.4. RECPC progress review/follow-up visits

Based on mutual convenience, members generally decide the duration and frequency of CPC meetings. When possible, local facilitators guide the meeting. In addition, implementing agencies and local agencies/ local resource person (LRP) shall make regular follow-up visits to the CPCs to review progress on implementation related to economic, environmental and social performance and also to address any issues (technical as well as administrative) arising in the RECPCs to facilitate smooth functioning of the RECPCs.

4.5. Review & final workshops

In order to assess the performance of the CPC, periodic reviews need to be conducted. In workshops (mid-term and final) members shall be encouraged to present snapshots of the experience. The recommended approach is to highlight major success as well as failure if relevant. The final workshops must be conducted in each of the RECPCs to share the experiences of RECPC and compare with similar experiences elsewhere. In the workshops, RECPC members will share their experiences and present the results which they have been able to achieve as an outcome of the club's establishment. For outreach effect, it is advantageous to also invite other non-member units. This will enrich the knowledge of club members as well as motivating other units to adopt the RECPC concept.

5.0. HISTORY OF CLEANER PRODUCTION CIRCLES

In Indonesia this concept is being promoted for the first time as a tool to institute multiplier effect of RECP benefits from demo/pilot projects.

Development of the RECP Club Concept

The RECP concept was first introduced in Europe in the late 1980s. Similar initiatives have been introduced in India (Waste Minimization Circles or WMCs) and New Zealand. In the United Kingdom, more than 100 WMCs are in existence.

Recognized WM and CP circles/clubs have been successfully established and managed in other countries include as part of the PRISMA study (The Netherlands), the Aire and Calder Project (Yorkshire, United Kingdom), Project Catalyst (Merseyside, United Kingdom), CPC/WMC in India, as well as examples in Lao People's Democratic Republic, South Africa and New Zealand. Some of these are briefly described in this section.

5.1. The PRISMA Project, The Netherlands

This project involved ten companies from two districts, Rotterdam and Amsterdam. They represented five different industrial sectors, namely: food, chemical, metal processing, electroplating and public transport. The main aims of the project were to show that pollution prevention could be successfully implemented, and to use the results obtained to develop a pollution prevention policy. [Johnson, 1995]

5.2. The Aire and Calder Project, Yorkshire, United Kingdom

The Aire and Calder project was initiated following the success of the PRISMA Project. Its circle members consisted of representatives from different industries including the chemical, beverage and printing industries. Site reviews were carried out to identify a number of CP options resulting in an improvement in the state of the environment and significant financial savings for the circle members. The project concentrated on one river basin and aimed to reduce the volume or pollution load in wastewater. A total of GBP£3.3 million savings was reported per annum in addition to reduced waste volume and load.

5.3. Project CATALYST, Merseyside, United Kingdom

The Mersey River basin was the site of this project, which involved a number of manufacturers covering a range of operations. An outcome of the project was the generation of 399 WM options. The majority of these options had little or no costs associated with them for implementation. The overall results are not available for this document.

5.4. Waste Minimization Circle (WMC'S), India

In contrast to developed countries, in India, WMCs are established to promote sustainable industrial development for small industries. These differ from the clubs, in that membership is limited to five or six circles in the same area that follow similar manufacturing processes. During the first two years of this project, 263 waste minimization options were identified. [National Productivity Council, 1993]

WMCs Modus Operandi

The National Productivity Council (NPC) WMC started in 1994 and has undergone three phases after monitoring and review of the initial results. The author of this manual was associated with the programme. A total of 158 WMCs have been established in 17 states, representing more than 40 industrial sectors. The consolidated results of each phase are summarized below:

Phase I: In this pilot phase (1994–1997), 15 WMCs were established, covering five industrial sectors (pulp and paper, textiles, electroplating, etc.) in three states. They involved more than 75 SME units and identified over 170 WM options, of which more than 120 were implemented. Some 25 workshops/ training courses were organized in this phase. The participating units achieved savings of \$0.28 million, including a 10 to 30 per cent reduction in energy use and 5 to 20 per cent in water use.

Phase II: Phase II covered the period from July 1997 to 2005. By the end of this phase, 118 WMCs had been established. The number of industrial sectors covered expanded to 41, with the addition of the foundry, tannery, textile-processing, ceramic and hosiery sub-sectors. The numerous WMCs in operation identified more than 600 WM options, of which over 250 were undertaken in SME industrial units. While circle members made investments of \$5.56 million in WM efforts, they reaped annual savings of \$3.7 million, bringing total savings to \$9.26 million by the end of 2005.

Phase III: Phase III of the project started in July 2007 with the initial target of establishing 20 more WMCs across the country, especially in priority industrial sectors. As of 2012, 25 additional WMCs were established covering 14 industrial sectors namely earthen tile, steel rolling, paint and resin, engineering, and pharmaceutical (ayurvedic) sub-sectors.

5.5. Waste Minimization Club (WMC) in South Africa

Successful examples in other countries served as a valuable lesson for South African industries, which were experiencing increasing regulatory pressure with regard to their environmental impact. While a number of clubs had been formed internationally, there was an apparent lack of published material on the methodology of managing a club.

A WMC was initiated for the metal finishing industry in June 1998. The club consisted of 29 members of which the majority were SMEs. The club was run over a period of 30 months. A core group of 16 companies actively participated in club activities.

During the period of investigation, a total of 391 waste minimization options were identified for club members and 147 of these options were implemented. This resulted in a total financial saving in excess of \$310,000 (4 million rand) for the duration of the club's existence. This represents combined savings in water, chemicals, metals, energy, effluent treatment and waste disposal.

Corresponding environmental benefits were achieved including a reduced demand for water, reduced toxicity of effluent from chemical and metal reduction, and a reduction in energy requirements.

5.6. Cleaner production Club In Lao PDR

Following the success of WMC in India, Lao People's Democratic Republic initiated a CPC approach, which was implemented successfully in two sectors, brick-making and the hotel sector. The initiative saved over \$100,000 and 32-67 per cent of resource consumption and waste generation. Please refer to Section 6.0 for a case study of the brick-making sector in Lao People's Democratic Republic.

5.7. RECP Green Clubs in Armenia

In Armenia, the foundation of “RECP green clubs” in pilot projects in the cities of Ararat and Dilijan were established by the Armenia RECP centre. This approach to RECP was replicated in other cities and regions to include local SMEs dealing with food, beverage, construction and chemical production. The principal idea of an RECP club is to bring together up to a dozen small businesses from the same region and take them jointly through intensive training and coaching, leading to a customized RECP action plan for all member companies on completion of the Club.

5.8. WMC in South Africa

Since the inception of the WMC concept in South Africa in 1998, 27 WMCs have been established. Of these 4 have ended; 4 have merged; 3 have closed; 3 failed to start up; 3 are in the start-up phase; and 11 are still running. The lifetime of a WMC is generally in the region of 18 months to 2 years, after which time it will either end, merge with other activities or change its focus to continue operating. Those WMCs that closed did so mostly due to a lack of continued support or interest on the part of the members.

The experience gained from the development of these WMCs has provided a great deal of insight into the best methods of establishing, managing and reporting on WMCs, and these methods have been outlined in the manual.

The success factors to establish and manage a WMC include:

- A good awareness-raising meeting to highlight benefits of WMC
- Commitment from WMC members to attend meetings and share information
- Mutual site visits by WMC members to one another’s sites
- A well-defined constitution outlining the role of the members, facilitator, etc. as well as the “rules” of the WMC
- Step-by-step training of the WMC members in waste minimization techniques
- Access for students to assist companies in determining RECP opportunities
- On-site assistance by the facilitator (or other consultant) to highlight areas for improvement
- An enthusiastic project champion within each WMC/RECPC member organization
- Detailed record-keeping of savings achieved by each WMC/RECPC member, both financial and environmental

6.0. REPC CASE STUDIES

Selected case studies from RECP clubs are briefly discussed in this manual. For detailed information concerned CP /RECP centers can be contacted.

6.1. Rice milling sector

Rice is a staple diet for many globally and a significant portion of arable agricultural land is cultivated for growing paddy. The facilitator/LRP observed that small rice mills use obsolete technologies like poorly rewound motors, poorly designed electrical distribution systems and modified versions of Lancashire boilers with efficiencies as low as 40 per cent. This information catalyzed the units to look at ways and means to reduce energy consumption through mutual discussions in a WMC. Based on the waste assessment study, the units identified ways to reduce waste. The most significant WM opportunities were identified and implemented as follows:

Some of the mills installed new boilers with higher efficiency and were thus saving energy and discharging less specific pollution load to the atmosphere. The benefits of this change are given below:

- Investment in new boiler = 14,000US\$
- Savings = 7,000\$/annum
- Payback period = 2 years.

POLLUTION STATUS BEFORE AND AFTER CP IMPLEMENTATION:

The following table shows the overall comparative results achieved due to this cooperative initiative of sharing know-how and information.

| No | Parameter | Before CP (per ton of paddy) | After CP (per ton of paddy) | % change |
|----|------------------------------------|------------------------------|-----------------------------|----------|
| 1. | Production capacity | 40 tons/day | 42 tons/day | +5 |
| 2. | Electricity use for raw rice | 17-23 kWh | 16-20 kWh | -10 |
| 3. | Electricity use for parboiled rice | 27-35 kWh | 23-29 kWh | -15 |
| 4. | Water for parboiled rice | 1.1 -1.3 m ³ | 1.0 m ³ | -20 |
| 5. | Steam used | 750 kg | 650 kg | -15 |
| 6. | Husk used | 300 tons | 200 tons | -13 |

Table 1. *pollution status before and after cp implementation*

6.2. Brick kiln sector, CP club: Lao People's Democratic Republic

The brick sector is not only resource intensive, but also responsible for a significant amount of air pollution emissions due to poor and incomplete combustion of fuel used for baking. The CP club/ circle as a self-help approach used in other countries were applied in Lao People's Democratic Republic in two sectors, the brick kiln and the hotel sector.

Achievements in the brick sector are briefly discussed in this case study and compiled in **Table 2**.

| CPC Unit | SEC* Before CPC | Remark | SEC After CPC (Target 1 st p) | %age Change | SEC After CPC (Target 2 nd p) | %age Change |
|------------------------|-----------------|--------|--|-------------|--|-------------|
| Phouxang brick factory | 4.88 MJ | H | 3.5MJ | 28 | 2.5MJ | 49 |
| Natan brick factory | 5.38MJ | H | 3.5MJ | 35 | 2.5MJ | 53 |
| Phounsab brick factory | 4.40MJ | H | 3.2MJ | 27 | 2.5MJ | 43 |
| Manichan brick factory | 3.33MJ | M | 2.5MJ | 24 | 2.0 MJ | 40 |

* per 1,000 bricks

Table 2. Specific Energy Consumption existing and targeted in 4 CPC units

Related GHG emission reduction was also targeted and presented in **Table 3**.

| CPC Unit | GHG* Before CPC | Remark | GHG After CPC (Target 1 st p) | %age Change | GHG After CPC (Target 2 nd p) | %age Change |
|------------------------|-----------------|--------|--|-------------|--|-------------|
| Phouxang brick factory | 573 Kg | H | 380Kg | 34 | 190 Kg | 67 |
| Natan brick factory | 559Kg | H | 380Kg | 39 | 190Kg | 68 |
| Phounsab brick factory | 540Kg | H | 350Kg | 19 | 190 Kg | 65 |
| Manichan brick factory | 420Kg | M | 300Kg | 28 | 155Kg | 63 |

* per 1,000 bricks

Table 3. Specific GHG Reduction potential (including Biogenic) in 4 CPC units.

Other intangible advantages envisaged are improvements in the working environment, reduced stress on workers and reduced emissions from DO for moulding and kiln firing. Improved production and productivity will also improve bottom line and cash flow. The overall impact of CPC is summarized as below:

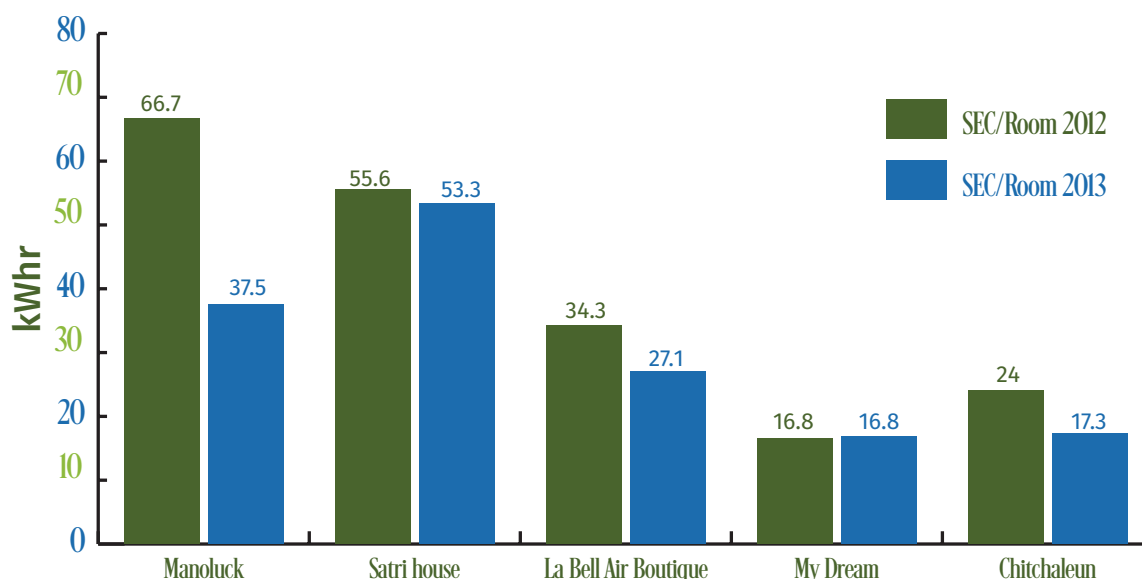
- **Production increased** = 30-50%
- **Average SEC reduction** = 27%
- **Average GHG reduction** = 26%
- **Total Biogenic GHG Red.** = 687 T/year
- **Total Non-Bio GHG Red.** = 13 T/year
- **Total Investments** = 7,000 US\$
- **Direct savings (resource use)** = 27,280 US\$
- **Pay Back** = 4 months

Total savings (Incl. opportunity costs)>50,000US\$

6.3. Hotel sector, CP club: Lao People's Democratic Republic

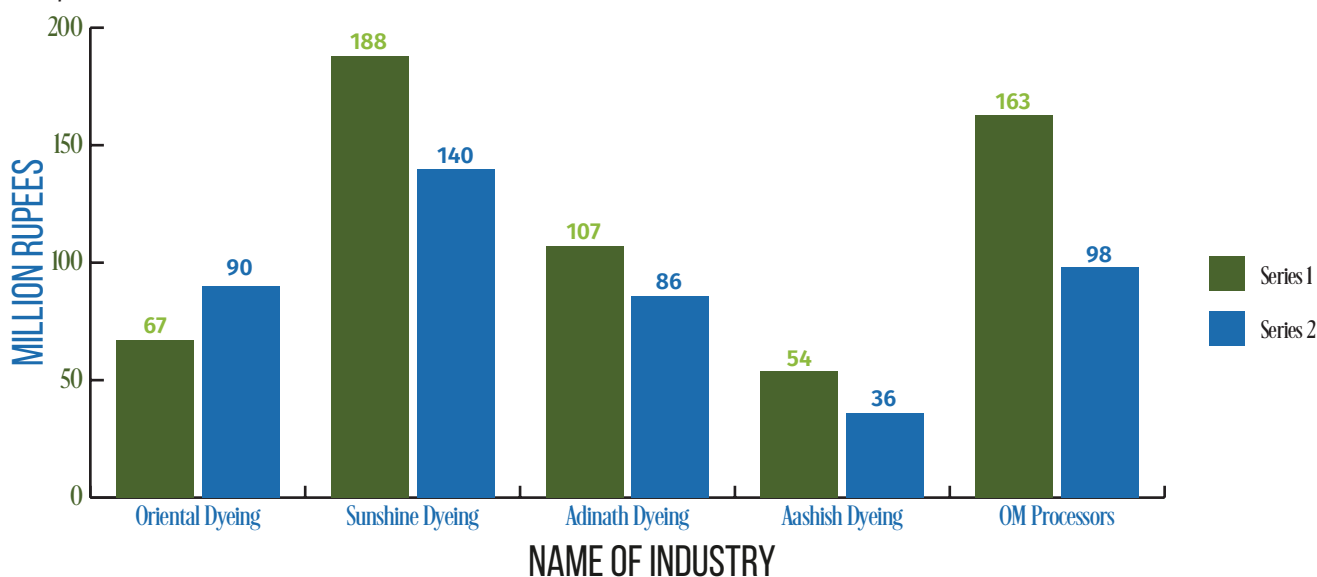
Out of the six selected hotels that participated in the CP circle, five implemented CP options. Results achieved were moderate and could have been better. Energy conservation ranged from 4 to 44 per cent, water consumption and wastewater generation reduced from 10 to 36 per cent, GHG reduction achieved was 145 T/annum which was expected to be >300 T/annum.

There were other benefits beyond the quantified results, such as improved recording and reporting, segregation of waste as per characteristics, partial reuse of waste on-site as fertilizer/soil conditioner after composting, collection of plastic waste for sale and promotion of non-plastic bags for shopping.



6.4. Hosiery sector: Ludhiana, India

5 units formed a WMC and worked in tandem to achieve significant results which are compiled and presented as below:



REDUCTION IN:

- **WATER CONSUMPTION** - 40-58%
- **POLLUTION LOAD (COD LOAD)** - 36-43%
- **FUEL CONSUMPTION** - 10-66%
- **ENERGY CONSUMPTION** - 12-32%
- **GHG & GASEOUS EMISSIONS** - 25-60%

6.5. Examples of RECP potential in selected industrial sectors

6.5.1. Electroplating metal finishing sector

| Total Input Materials | | Total Value (IDR/Month) |
|-----------------------------|------------------------------|-----------------------------|
| Pretreatment | | |
| Chemicals | 200-1000 kg/month | 1,000,000-5,000,000 |
| Rinse water | 30-300 m ³ /month | 60,000- 600,000 |
| Electroplating | | |
| Chemicals | 20-200 Kg/month | 400,000-4,000,000 |
| Rinse water | 60-500 m ³ /month | 12,000-100,000 |
| Post-treatment | | |
| Chemicals | 10-40 kg/month | 60,000-240,000 |
| Wastewater treatment | | |
| Chemicals | 1000-5000 kg/month | 1,600,000-5,000,000 |
| Energy | 1000-5000 kWh/month | 400,000-2,000,000 |
| TOTAL | | 3,532,000-16,940,000 |

6.5.2. Leather tannery sector

| Area | Potential Of RECP |
|-----------------------------------|--|
| UNHAIRING AND LIMING | |
| -Recycling lime sulphide liquor | · 20-50% sulphide reduction |
| | · 60% lime reduction |
| CHROME TANNING | |
| - Recycling chrome tannage | -10-20% chrome saving |
| - Chrome precipitation & recovery | -98% chrome recovery |
| FINISHING | |
| -Direct contact applications | 20-30% reduction in chemical consumption |
| -Non-solvent finishing | 100% solvent reduction |
| -Yield improvement | 2-5% |

For the tannery sector cost is not calculated in IDR but in percentage reduction

6.5.3. Hosiery (knitted fabric) wet processing units (job order)

| Hosiery (knitted fabric) wet processing units (job order) | | | |
|---|-------------------|--------------------|-----------------|
| Item | Unit | Potential For Recp | |
| | | QUANTITY | VALUE (In IDR) |
| Production | % increase | 20-30 | 70,000-100,000 |
| Chemical and Dye stuffs | Kg/T | 10.40% | 200,000-800,000 |
| Water | m ³ /T | 50-100 | 100,000-200,000 |
| Fuel/coal/gas | Kg/T | 200-800 | 80,000-320,000 |
| Energy | kWh/T | 30-60 | 40,000-80,000 |
| Total Potential/T : 490,000-1,500,000* | | | |

Annual savings can be calculated using total fabric processed/year

7.0. CONCERN OF RECP CLUB SUCCESSFUL IMPLEMENTATION

At the same time, analysis of the clubs' global experience has shown that the RECP approach can face obstacles. These include:

1. When companies in the same sector are or envisage that are in direct competition, there can be a reluctance to share recently gained best practice
2. Insufficient time commitment on the part of staff to attend club meetings
3. Poor meeting planning which results in insufficient novel training

It is important to learn lessons from past experience and take corrective measures upfront.

7.1. Do's and don'ts for RECP club members

As the centerpiece of RECP club discussions/meetings are brainstorming sessions, the following points have to be considered to ensure fruitful interaction during the meetings.

Do's

- ☞ Maintain a free and informal atmosphere during RECP club meetings
- ☞ RECP club members should promote harmony and show respect for each other
- ☞ Experimentation/trials (agreed as per meeting outcome) should be encouraged
- ☞ Credit should be given liberally and criticism (individual and existing practice) should be avoided; however, critical analysis of data and situation will be encouraged
- ☞ Simplified RECP methodology and various RECP techniques for self-help should be followed.
- ☞ New and creative ideas should be generated
- ☞ Proper documentation of activities should be made

Don'ts

- ☞ Direct financial assistance should not be expected
- ☞ Ready-made technical solutions should not be looked for
- ☞ Don't allow snubbing and killing of ideas
- ☞ Don't impose ideas on the group and justify ideas where necessary
- ☞ Don't de-motivate by pointing out mistakes, etc.

8.0. INFORMATION SHARING

Information sharing shall occur at various levels to discern the tangible impact of the club on the bottom line of all members' businesses.

1. Intra - Circle
2. Inter - Circle
3. RECP Club/Circle Deliberations

Intra - Circle

It is strongly advised that there should be free and fair exchange of information/knowledge between the RECP club/circle members (confidence of some information/non-disclosure is acceptable). Mutual trust between the units participating in RECP club/circle is important. It is essential that the details of the manufacturing operations (except those that are secret) as well as RECP-related activities are shared amongst the RECP club members. Only units willing to abide by this condition should be selected to participate in an RECP club/circle.

Inter - Circle

Transparency in information sharing between the RECP club/circles established in different regions should be maintained. The periodic RECP club information collection, compilation and documentation will highlight the activities of the RECP club/circle and serve to keep members updated on the latest developments. Depending on interest and resources, inter-RECP club visits in the same industrial sectors can be planned by implementing agencies based on need.

RECP Club/Circle Deliberations

Deliberations of the RECP club/circle meetings should be restricted amongst RECP club/circle members, the RECP club/circle facilitator and the implementing agency Project Management unit (PMU) during the course of running the RECP club/circle to enable confidence building in the member units. This will enable the members to create an environment that encourages free and frank sharing of ideas and successful innovations for the benefit of the RECP club/circle members. The RECP club/circle facilitator and PMU might like to document the experiences under this approach for dissemination to a wider platform and forum. The PMU shall keep the principal project partners (MoEF/MoI/MoT/CTB) informed on the progress and successes achieved under various RECP club/circles under the project.

9.0. MEASURES TO OVERCOME BARRIERS IN RECP CLUB OPERATION

During more than two decades of WM/CP/RECP club operations, a wide range of real and perceived obstacles were encountered and some of the enabling measures to tackle these obstacles were employed and are discussed in this section.

What barriers are generally encountered in implementing RECP measures as well as RECP club establishment and what measures can/shall be adopted for overcoming these barriers?

| RECP SPECIFIC BARRIER | MEASURES TO OVERCOME |
|---|--|
| POLICY BARRIERS | |
| <ol style="list-style-type: none"> 1. Although SMEs are not always competitive due to low resource efficiency they are considered an important employer and get preferential incentives like tax holidays. 2. Policy instruments like feed in tariff (FIT), power purchase agreement (PPA) for renewable energy using captive biomass are not encouraged and energy pricings (fossil fuel based) are subsidized. | <ol style="list-style-type: none"> 1. Introduction to resource-efficient best practice 2. Level playing field: Uniform taxation policy which encourages investment for modernization of SMEs 3. Promoting/encouraging increased usage and generation of renewable energy and waste heat for various usage 4. Rationalizing of resource pricing to encourage investments in renewable and waste/resource recovery 5. Policies conducive to promote RECP like FIT and PPA for renewable energy |
| ECONOMIC BARRIERS | |
| <ol style="list-style-type: none"> 1. Inappropriate resource pricing resulting in excess consumption of resources like water/electricity resulting in wastage and losses. 2. Preconceived notion that RECP costs money, for investments in new machinery etc. and leads to low returns on investments. 3. Notion of steady/increasing demand for the manufactured goods in the country with a steady rate of increasing population | <ol style="list-style-type: none"> 1. Rational costing of resources and do away with subsidy culture for resource consumption 2. Effective implementation of regulatory framework on environmental protection 3. RECP implementation with no/low cost options (low hanging fruit) and depending on savings achieved extend to cost involved measures implementation 4. Improve product quality (apply concepts like Quality Circles/Kaizen/5S etc.) and realize higher profitability 5. Aim to improve competitiveness by improving productivity in a shrinking market if not expanding market. |

| TECHNICAL BARRIERS | |
|---|--|
| <ol style="list-style-type: none"> Limited access to technical information Limited availability of trained manpower Limited availability of technical experts Lack of adequate external infrastructural facilities Limited in-house maintenance facilities and operational expertise Lack of documentation- systematic records Limited availability of relevant, affordable technology | <ol style="list-style-type: none"> Improve access to technical information through industry associations, Cleaner Production Clearing Houses, CP/WM/green productivity related literature / newsletters/websites, etc. Improve operator/supervisor training and introducing RECP concepts in the curriculum Encourage entrepreneurs to provide periodic training/retraining to employees for higher efficiencies in their units Develop suitable infrastructure facilities in industrial estates/zones Encourage entrepreneurs to equip themselves or form partnerships with suitable maintenance/monitoring/testing facilities Create facilities (finance/consultancy etc.) for technology evaluation/upgradation/revamping and re-engineering of enterprises |
| REGULATORY BARRIERS | |
| <ol style="list-style-type: none"> Emphasis on End-of-Pipe Treatment for environmental compliance Mismatch in policies of various Ministries/ Departments | <ol style="list-style-type: none"> Promote and integrate RECP efforts by industry as part of Regulatory approach. Align policies conducive to promote RECP in the country. |
| ATTITUDINAL / CULTURAL BARRIERS | |
| <ol style="list-style-type: none"> Resistance to change may introduce barriers such as: <ul style="list-style-type: none"> Lack of managerial commitment Poor internal communication Restrictive employment practices Lack of effective supervision. Concerns about changes to product/service quality and customer acceptance | <ol style="list-style-type: none"> Education and training programmes with managerial improvements Encourage employees at all levels to provide valuable information about operational problems and insights into possible solutions Introduce incentive schemes RECP as a rule should not have a negative impact on product quality; therefore companies should take steps to identify customer needs & improve quality control in manufacture |
| MENTAL BLOCKS | |
| <ol style="list-style-type: none"> Fear of disturbing tradition Fear of criticism Fear of making mistakes (being considered a guinea pig) Fear of making a solitary effort (not me first syndrome) Fear of losing trade secrets Fear of being exposed for inadequacies in existing processes, etc. | <ol style="list-style-type: none"> Exposure to modern units to break traditional mindset Help to conduct trials with assistance from consulting engineers/suppliers Training to enhance risk taking ability Give liberal credit, no criticism, but critical analysis There are no secrets in the internet era and in an RECP club we do not share trade and marketing strategies There is always an opportunity to improve |

Table 4. RECP Specific Barriers and the Measures to Overcome

10.0. RECOMMENDATIONS

The following recommendations can be made from this compiled document:

- ☞ A clear strategy needs to be developed to promote RECPCs in Indonesia. This needs to happen on a national and provincial level, with the local government capacity to implement the actions.
- ☞ Targets for the establishment of RECPCs in Indonesia need to be set and an awareness campaign needs to be initiated.
- ☞ A funding mechanism to provide promotional and technical support of RECPCs needs to be implemented to ensure the continuation of the concept.

ANNEXURE-1

FREQUENTLY ASKED QUESTIONS ON RECP CLUB APPROACH

Generally beneficiaries and stakeholders have a few questions on the RECP club approach and modus operandi. Some of these are answered below:

Why one needs to follow a structured but user friendly methodology?

A structured methodology helps to create a detailed assessment leading to RECP potential estimation based on current practice, rather than making a leap to conclusions based on incomplete data. It also helps to fix targets more objectively, aiding the organization to allocate resources more efficiently.

What is a RECP club?

An RECP club is conceptualized based on the lines of Quality Circles (QCs). The difference is that while in QCs the group is from within the industry, an RECP club is intended to be across industries which preferably have similar process/services and/or utilities.

An RECP club can thus be defined as “A small group of entrepreneurs in the small scale sectors whose units manufacture similar products/provide the same services and employ more or less the same processes, meeting regularly in the premises of each member unit on a rotating schedule (NPC, 1993). During the meetings, members collect baseline data and analyze the operation of the host unit to identify resource consumption and sources of waste generation and identify and assist in implementing RECP options. This leads to an increase in individual profitability and a reduction in pollution from the units.” (NPC, 1993)

Why should I consider the RECP club approach?

- * RECP clubs can generate a spirit of cooperation among their members, even beyond WM.
- * Members of RECP clubs after achieving success can generate the multiplier effect.
- * The RECP club approach focuses on self-help, catalyzed by the facilitator and the club is independent of the regulatory regime.
- * The adoption, acceptance and implementation of RECP can be ensured when options/solutions are identified by entrepreneurs and other club members.
- * The Club approach ensures a greater outreach within the country by utilizing RECP services of RECP network/consultants located at different parts in the country.

What is the objective of the RECP Club/Circle project approach?

As discussed in previous sections, an RECP club aims to catalyze and realize the benefits of the RECP concept and to conserve resources and reduce environmental footprint by implementing identified techno-economically viable RECP measures as a group effort at industrial cluster/sectoral/region level.

How can the RECP club objectives be achieved?

1. Build capacity on RECP assessment, applications through training (classroom and on-the-job) of facilitators

2. Create awareness and disseminate information on RECP and its benefits to SMEs/industrial zones/tourism zones, etc.
3. Provide a structured methodology for the systematic application of the RECP concept
4. Create a platform for RECP help desks for discussions and sharing experiences, views, knowledge and innovations in implementation of RECP measures
5. Enable dissemination of information on club experiences through RECP club case studies and if possible quarterly newsletters

How does an RECP club/circle function?

1. Establish RECP club/circle by careful selection of sector and RECP club/circle.
2. Run RECP club/circle by guiding meetings, and coordinating implementation activities.
3. Liaise with respective project partners responsible for club functioning agency.
4. Advise on sources of information and resources, technology sourcing etc.

What is the envisaged role of the proposed RECP club project partners?

| | |
|---|--|
| ● SECO & UNIDO | Funding and implementation of the Project |
| ● MOEF/MOI (CADGIE)/MOT/CTB | Project partners and Provider of strategic Guidelines |
| ● ICPC/CRECPI | RECP Implementing institution |
| ● INDUSTRIAL (SECTORAL/REGIONAL) ASSOCIATION AND INTERNATIONAL BUYERS | Support for RECP Club establishment and operation |
| ● LOCAL/REGIONAL AUTHORITIES | Assistance in identification of interested and motivated industries to participate in RECP club |
| ● ICPC/CTB/CTA | Identification of RECP facilitator & resource persons |
| ● CADGI/ICPC/CTB/CTA | Identification of sector specific technical experts |
| ● CADGI/ICPC/CTB/RECP CLUB FACILITATOR | Organization of awareness workshop |
| ● RECP CLUB FACILITATOR/RECP CLUB MEMBER UNITS | Establishment and running of RECP club from interested units |
| ● RECP CLUB FACILITATORS | Assistance in organizing training workshop |
| ● CLUB FACILITATORS | Facilitation of RECP club meetings, ensuring a conducive environment, and note-taking of proceedings |

What are the possible issues/dilemmas faced by RECP club facilitators in establishing a circle?

- * Lack of formal certificate/accreditation from national and international agencies as an RECP facilitator
- * Formal introductory letter from PMU/GOI as trained facilitators
- * Often RECP club members expect complete technical solutions like consulting contracts rather than facilitating a self-help approach.
- * Occasionally RECP club/circle members also expect support in terms of environmental or permit to operate clearance from government agencies
- * Often members are suspicious regarding potential misuse of data especially sharing with national authorities (taxation/environment/labor etc.)
- * Possibility of non-cooperation from club/circle members even after forming an RECP club.

What are the possible obstacles encountered by RECP club facilitators in running a circle?

Some possible barriers are discussed in Table 3 and some generic barriers and mental blocks are listed below:

1. “Not Me First” (NMF) syndrome
2. Fear of competition among club members
3. Perceived fear of losing monopoly
4. Fear of information disclosure leading to misuse of information
5. Fear of being exposed, thinking that past inefficiencies might lead to losing jobs
6. Still not convinced by the reported/shared benefits of RECP club/circles.

Who can form RECP club/circles?

- * SMEs both from the manufacturing and service sector
- * Industries categorized under environmentally critical industrial sectors or environmentally sensitive zones
- * Industries willing to open their arms, share information and participate actively in group efforts towards evolving innovative ideas and solutions to effect feasible and agreed on RECP measures
- * Industries that understand RECP needs and are interested in achieving economic and environmental benefits

Who will fund the establishment and running of RECP club's ?

In the current scenario it is envisaged that the RECP Indonesia project will fund the execution of the RECP club programme as part of RECP measures replication efforts in selected sectors/regions/ industrial zones, etc. However, after the project is completed, the facilitator should be self-sustainable both technically and financially. RECP promoting institutions like ICPC and the Association of RECP will facilitate establishment and support of RECPCs through RECP Help Desks.

What will the RECP club Facilitators gain from this project ?

In addition to the chief objective of capacity building and confidence gained in the industrial environment, tangible benefits in terms of professional charges are envisaged and some of them are briefed as below:

- * Receiving training (classroom and on-the-job) on RECP/RECPC assessment methodology and RECP techniques
- * Information source and linkage with RECP global programme and access to large numbers from different sectors as well as thematic case studies
- * Developing professional linkages/networking with national and international agencies
- * Strengthening relations with industries/industry associations and RECP/green industry promoting institutions
- * Gaining insights on existing industrial processes, utilities and applications of best practices (BAT & BEAT)
- * Additional experience in environmental auditing and benchmarking through resource and by-product/waste auditing

What will RECP club member units gain by participating in a club project?

- * Improved productivity, profits (reducing production/service costs), competitiveness
- * Possibility of improved quality of products/services
- * Conservation of valuable resources (energy/water/raw materials/chemicals, etc.)
- * Progress towards achieving/complying with emission norms for the environment
- * Possibility of upgrading rating like PROPER rating scheme of Indonesia
- * Reduced cost of effluent treatment/pollution control
- * Improved working environment and Occupational Safety and Health (OSH) of shop-floor and surrounding environment
- * Compliance with sustainability standards for export market requirements
- * Improved documentation/record keeping/accounting system
- * Developing industry specific/product specific benchmarks for comparison with international and national benchmarks
- * Enhanced image of the enterprise in public as well as in business

ANNEXURE-2

CHECKLIST & TIPS FOR RESOURCE EFFICIENCY CLEANER PRODUCTION

A comprehensive checklist with easy to understand and best practice RECP tips is compiled here from various sources including BEE India.

(a) Water & wastewater

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially when wastewater treatment costs are more than water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water collection and recycling.
- Use the least expensive type of water based on process requirement.
- Fix water leakages, spillages and overflows.
- Test for underground water leaks and seepages. (This is easy to do during a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blow-down to minimize quantity.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Optimize process requirement of water like cloth: liquor ratio in wet processing leading to water and waste water quantity reduction.
- Counter current rinsing operations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets, use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Alternatively feasibility analysis for solar water heater shall be conducted.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Consider leased and mobile water treatment systems, especially for deionized water for small /household industries.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Effective and simple pre-treatment of wastewater like oil and gas removal using simple O/G trap with "T" pipe inlet and outlet to reduce organic content to be treated using energy and resources. This will also be useful in case of any accident of oil spill in the unit.
- For smaller quantity of trade effluent to avoid mixing energy, chemical dosing using baffled channel for effective mixing shall be employed.
- Segregation and pre-treatment of effluent with inhibitive or prohibitive components harmful to bacteria for biological treatment.
- Possible use of biological sludge as soil conditioner.

(b) Process-related and miscellaneous

- Proper control and specification for purchase of raw material and auxiliary materials.
- Proper control on recipe and process parameters like temperature, pH, pressure, etc.
- Substitute toxic chemical or material with less toxic and non-toxic viz. trichloroethylene (carcinogenic compound) for stain removal by isopropyl alcohol or other non-toxic stain removal, optical brighteners with non-toxic whitening agents.
- Equipment and technology modification to reduce resource consumption and waste generation.
- Meter/measure any unmetered utilities. Know what is normal efficient use. Track down causes of deviations/excess consumption.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off, including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Explore possibilities of industrial symbiosis-using waste from neighboring industry as resource by another unit. In industrial zones having captive power generation using natural gas/diesel, waste heat from generator can be used for generating electricity or cooling energy using VAM and sold to the tenants of the zone requiring cooling.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).

(c) Thermal energy

The various energy-efficiency opportunities in boiler systems can be related to combustion, heat transfer, avoidable losses, high auxiliary power consumption, water quality and blowdown. Examining the following factors can indicate if a boiler is being run to maximize its efficiency:

- **Stack temperature:** The stack temperature should be as low as possible. However, it should not be so low that water vapor in the exhaust condenses on the stack walls. Stack temperatures greater than 200°C indicate potential for recovery of waste heat. They also indicate the scaling of heat transfer/recovery equipment and hence the urgency for taking an early shutdown for water/flue side cleaning.
- **Feed water preheating using economizer:** When the flue gases leaving are at temperatures of 200 to 300°C, there is the potential to recover heat from these gases. For a typically older model shell boiler, with a flue gas exit temperature of 260°C, an economizer could be used to reduce it to <150°C, increasing the feed water temperature by 20°C. The increase in the overall thermal efficiency would be in the order of 4 per cent.
- **Combustion air preheat:** Combustion air preheating is an alternative to feedwater heating. In order to improve thermal efficiency by 1 per cent, the combustion air temperature must be raised by 20°C.

- **Incomplete combustion:** Incomplete combustion can be due to shortage of air or surplus of fuel or poor distribution of fuel. A more frequent cause of incomplete combustion is the poor mixing of fuel and air at the burner. Poor oil fires can result from improper viscosity, worn tips, carbonization on tips and deterioration of diffusers or spinner plates. With coal firing, unburned carbon can comprise a big loss. In chain grate stokers, large lumps will not burn out completely, while small pieces and fines may block the air passage, thus causing poor air distribution.
- **Excess air control:** Excess air is required in all practical cases to ensure complete combustion. The optimum excess air level for maximum boiler efficiency occurs when the sum of the losses due to incomplete combustion and loss due to heat in flue gases is minimum. This level varies with furnace design, type of burner, fuel and process variables. It can be determined by conducting tests with different air fuel ratios. Controlling excess air to an optimum level always results in reduction in flue gas losses; for every 1 per cent reduction in excess air there is approximately 0.6 per cent rise in efficiency. Excess air reduction up to 20 per cent is feasible.
- **Radiation and convection heat loss:** The external surfaces of a shell boiler are hotter than the surroundings. The surfaces thus lose heat to the surroundings depending on the surface area and the difference in temperature between the surface and the surroundings. The heat loss from the boiler shell is normally a fixed energy loss, irrespective of the boiler output, but will increase to around 6 per cent, if the boiler operates at only 25 per cent output. Repairing or augmenting insulation can reduce heat loss through boiler walls and piping.
- **Automatic blow-down control:** Uncontrolled continuous blow-down is very wasteful. Automatic blow-down controls can be installed that sense and respond to boiler water conductivity and pH. A 10 per cent blow down in a 15 kg/cm² boiler results in 3 per cent efficiency loss.
- **Reduction of scaling and soot losses:** In oil and coal-fired boilers, soot build-up on tubes acts as an insulator against heat transfer. Any such deposits should be removed on a regular basis. Elevated stack temperatures may indicate excessive soot build-up. Also the same result will occur due to scaling on the water side. High exit gas temperatures at normal excess air indicate poor heat transfer performance. This condition can result from a gradual build-up of gas-side or waterside deposits. Waterside deposits require a review of water treatment procedures and tube cleaning to remove deposits. An estimated 1 per cent efficiency loss occurs with every 22°C increase in stack temperature. Stack temperature should be checked and recorded regularly as an indicator of soot deposits. When the flue gas temperature rises about 20°C above the temperature for a newly cleaned boiler, soot deposits should be removed. It is estimated that 3 mm of soot can cause an increase in fuel consumption by 2.5 per cent due to increased flue gas temperatures. Periodic off-line cleaning of radiant furnace surfaces, boiler tube banks, economizers and air heaters may be necessary to remove deposits.
- **Reduction of boiler steam pressure:** This is an effective means of reducing fuel consumption, if permissible, by as much as 1 to 2 per cent. Lower steam pressure gives a lower saturated steam temperature and without stack heat recovery, a similar reduction in the temperature of the flue gas temperature results. Adverse effects, such as an increase in water carry over from the boiler owing to pressure reduction, may negate any saving. Pressure should be reduced in stages, and no more than a 20 per cent reduction should be considered.
- **Variable speed control for fans, blowers and pumps:** Generally, combustion air control is controlled by throttling dampers fitted at forced and induced draft fans. Though dampers are simple means of control, they lack accuracy, giving poor control characteristics. In general, if the load characteristic of the boiler is variable, the possibility of replacing the dampers by a VSD should be evaluated.

- **Effect of boiler loading on efficiency:** The maximum efficiency of the boiler is at about two-thirds of full load. If the load on the boiler decreases further, efficiency also tends to decrease. At zero output, the efficiency of the boiler is zero, and any fuel fired is used only to supply the losses. The factors affecting boiler efficiency are:
 - As the load falls, so does the value of the mass flow rate of the flue gases through the tubes. This reduction in flow rate for the same heat transfer area, reduced the exit flue gas temperatures by a small extent, reducing the sensible heat loss.
 - Below half load, most combustion appliances need more excess air to burn the fuel completely. This increases the sensible heat loss.
 - In general, efficiency of the boiler reduces significantly below 25 per cent of the rated load and as far as possible, operation of boilers below this level should be avoided.
- **Proper boiler scheduling:** Since, the optimum efficiency of boilers occurs at 65 to 85 per cent of a full load, it is usually more efficient, on the whole, to operate a fewer number of boilers at higher loads, than to operate a large number at lower loads.
- **Boiler replacement:** The potential savings from replacing a boiler depend on the anticipated change in overall efficiency. A change in a boiler can be financially attractive if the existing boiler is old and inefficient, not capable of firing cheaper substitution fuel, or over or under-sized for present requirements. The feasibility study should examine all implications of long-term fuel availability and company growth plans. All financial and engineering factors should be considered. Since boiler plants traditionally have a useful life of well over 25 years, replacement must be carefully studied.

Steam system

- **Flash steam:** This should not be mistaken for a steam leak through the trap. The users sometimes get confused between a flash steam and leaking steam. The flash steam and the leaking steam can be approximately identified as follows:
 - If steam blows out continuously in a blue stream, it is a leaking steam.
 - If a steam floats out intermittently in a whitish cloud, it is a flash steam.
- **Continuous steam blow and no flow:** these indicate that, there is a problem in the trap. Whenever a trap fails to operate and the reasons are not readily apparent, the discharge from the trap should be observed. A step-by-step analysis has to be carried out mainly with reference to lack of discharge from the trap, steam loss, continuous flow, sluggish heating, to find out whether it is a system problem or the mechanical problem in the steam trap.
- **Avoiding steam leakages:** Steam leakage is a visible indicator of waste and must be avoided. It has been estimated that a 3 mm diameter hole on a pipeline carrying 7kg/cm² steam would waste 33 KL of fuel oil per year. By plugging all leakages, the extent of fuel savings may reach up to 5 per cent of steam consumption. To avoid leaks it may be worthwhile considering replacement of the flanged joints which are rarely opened in old plants by welded joints.
- **Providing dry steam for process:** The best steam for industrial process heating is the dry saturated steam. Wet steam reduces total heat in the steam. As steam flows through the pipelines, it undergoes progressive condensation due to the loss of heat to the colder surroundings. The extent of the condensation depends on the effectiveness of the lagging. To remove these suspended water droplets, separators are installed in steam pipelines. The steam produced in a boiler designed to generate saturated steam is inherently wet. A steam separator may be installed on the steam main as well as on the branch lines to reduce wetness in steam and improve the quality of the steam going to the units.

- **Utilizing steam at the low:** A study of the steam tables would indicate that the latent heat in steam reduces as the steam pressure increases. It is only the latent heat of steam, which takes part in the heating process when applied to an indirect heating system. Thus, it is important that its value be kept as high as possible. This can only be achieved if we go in for lower steam pressures. As a guide, *the steam should always be generated and distributed at the highest possible pressure, but utilized at as low a pressure as possible since it then has higher latent heat. However, in equipment where fixed losses are high (e.g. big drying cylinders), there may be an increase in steam consumption at lower pressures due to increased processing time.*
- **Proper utilization of directly injected steam:** The heating of a liquid by direct injection of steam is often desirable as heating is quick, and the sensible heat of the steam is also used up along with the latent heat, making the process thermally efficient. In processes where dilution is not a problem, heating is done by blowing steam into the liquid.

A large number of small diameter holes (2 to 5mm), facing downwards, should be drilled on the separate pipe. This will help in dissipating the velocity of bubbles in the liquid. A thermostatic control of steam admitted is highly desirable.

- **Minimizing heat transfer barriers:** The metal wall may not be the only barrier in a heat transfer process. There is likely to be a film of air, condensate and scale on the steam side. On the product side there may also be baked-on product or scale, and a stagnant film of product. Regular cleaning on the product side and steam side should reduce the scale and increase the rate of heat transfer.

As air is a good insulator, it provides even more resistance to heat transfer which may be between 1,500 and 3,000 times more resistant to heat flow than steel, and 8,000 to 16,000 more resistant than copper. This means that a film of air only 0.025 m thick may resist as much heat transfer as a wall of copper 400 mm thick!

- **Proper air venting:** When steam is first admitted to a pipe after a period of shut-down, the pipe is full of air and precautions should be taken to discharge them. *The consequence of not removing air is a lengthy warming up period, and a reduction in plant efficiency and process performance.*
- **Condensate recovery:** The steam condenses after giving off its latent heat in the heating coil or the jacket a significant portion of steam leaves the process equipment as hot water. If this water is returned to the boiler house, it will reduce the fuel requirements of the boiler. *For every 6°C rise in the feed water temperature, there will be approximately 1 per cent saving of fuel in the boiler.*

Condensate is distilled water, which contains almost no total dissolved solids (TDS). Returning more condensate to the feed tank reduces the need for blow-down and thus reduces the energy lost from the boiler.

Summary of reasons for condensate recovery:

- Water usage and charges are reduced.
- Effluent charges and possible cooling and pumping costs are reduced.
- Fuel costs are reduced.
- More steam can be produced from the boiler.
- Boiler blow-down is reduced - less energy is lost from the boiler.
- Chemical treatment of raw make-up water is reduced.

- **Insulation of steam pipelines and hot process equipment:** Heat is lost due to radiation from steam pipes. The remedy is to provide easily detachable insulation covers, which can be easily removed when necessary. The various insulating materials used are cork, glass wool, rock wool and asbestos. The effective insulation of a steam system can bring down the heat losses to less than 75 kcal/m²/h.

General fuel economy measures in furnaces

- **Generic energy-efficiency measures for an industry with furnace are:**
 - 1) Complete combustion with controlling minimum excess air
 - 2) Correct heat distribution in furnace
 - 3) Operating at the desired temperature
 - 4) Reducing heat losses from furnace openings
 - 5) Maintaining correct amount of furnace drought
 - 6) Optimum capacity utilization of furnace as per design
 - 7) Waste heat recovery from the flue gases
 - 8) Minimum refractory losses
 - 9) Possibility of using ceramic coatings
- **Complete combustion with minimum excess air:** Similar to the boiler the amount of heat lost in the flue gases (stack losses) depends upon the amount of excess air. To obtain complete combustion of fuel with the minimum amount of air, it is necessary to:
 - Control air infiltration
 - Maintain pressure of combustion air,
 - Monitor fuel quality and excess air monitoring.

Higher excess air will reduce flame temperature, furnace temperature and heating rate. The optimization of combustion air is the most attractive and economical measure for energy conservation. The impact of this measure is higher when the temperature of furnace is high.

- **Proper heat distribution:** Furnace design should be such that in a given time, as much of the stock could be heated uniformly to a desired temperature with minimum fuel firing rate. The following care should be taken when using burners, for proper heat distribution:
 - The flame should not touch any solid object and should propagate clear of any solid object.
 - The flames of different burners in the furnace should stay clear of each other.
 - The burner flame has a tendency to travel freely in the combustion space ensure that flame will not hit the roof
 - Single larger burners produce a long flame, which may be difficult to contain within the furnace walls. More burners of less capacity give better heat distribution in the furnace and also increase furnace life.
 - For small furnaces, it is desirable to have a long flame with golden yellow color while firing furnace oil for uniform heating.
- **Maintaining optimum operating temperature of furnace:** It is important to operate the furnace at optimum temperature.
 - Prevention of heat loss through opening: Heat loss through openings consists of the heat loss by radiation through openings and gas that leaks through openings.

- Control of furnace draft: If negative pressures exist in the furnace, air infiltration is liable to occur affecting air-fuel ratio. Neglecting furnaces pressure could mean problems of cold metal and non-uniform metal temperatures, which could affect subsequent operations like forging and rolling and result in increased fuel consumption. For optimum fuel consumption, slight positive pressure should be maintained in the furnace
- Control furnace pressure: In addition to the proper control on furnace pressure, it is important to keep the openings as small as possible and to seal them in order to prevent the release of high temperature gas and intrusion of outside air through openings such as the charging inlet, extracting outlet and peep-hole on furnace walls or the ceiling.
- **Optimum capacity utilization:** One of the most vital factors affecting efficiency is loading. There is a particular loading at which the furnace will operate at maximum thermal efficiency. If the furnace is under loaded a smaller fraction of the available heat in the working chamber will be taken up by the load and therefore efficiency will be low.

The rate of oxidation is dependent upon time and temperature, as well as free oxygen content. The possible increase in surface defects can lead to rejection of the product. It is therefore essential that coordination between the furnace operator, production and planning personnel be maintained.

- **Waste heat recovery from furnace flue gases:** In any industrial furnace the products of combustion leave the furnace at a temperature higher than the stock temperature. Sensible heat losses in the flue gases, while leaving the chimney, carry 35 to 55 per cent of the heat input to the furnace. The higher the quantum of excess air and flue gas temperature, the higher the waste heat availability. Waste heat recovery should be considered after all other energy conservation measures have been taken. Minimizing the generation of waste heat should be the primary objective.

The sensible heat in flue gases can be generally recovered by the following methods.

- **Charge (stock) preheating:** When raw materials are preheated by exhaust gases before being placed in furnace.
- **Preheating of combustion air:** This method is attained by external recuperators. There are two main types of external recuperators:
 - Radiation recuperators
 - Convection recuperators
- **Minimizing wall losses**

About 30-40 per cent of the fuel input to the furnace generally goes to make up for heat losses in intermittent or continuous furnaces. The appropriate choice of refractory and insulation materials goes a long way in achieving fairly high fuel savings in industrial furnaces. The heat losses from furnace walls affect the fuel economy considerably. The extent of wall losses depend on:

- Emissivity of wall
- Thermal conductivity of refractories
- Wall thickness
- Whether a furnace is operated continuously or intermittently

Heat losses can be reduced by increasing the wall thickness, or through the application of insulating bricks. Outside wall temperatures and heat losses of a composite wall of a certain thickness of fire brick and insulation brick are much lower, due to lesser conductivity of insulating

brick as compared to a refractory brick of similar thickness. In the actual operation in most of the small furnaces the operating periods alternate with the idle periods.

- **Prevention of radiation heat loss from surface of furnace**

The quantity of heat released from the surface of the furnace body is the sum of natural convection and thermal radiation. This quantity can be calculated from the surface temperatures and area of the furnace. The temperatures on the furnace surface should be measured at as many points as possible, and their average should be used. If the number of measuring points is too small, the margin of error becomes large.

Economizer

In the case of a boiler system, an economizer can be provided to utilize the flue gas heat to pre-heat the boiler feed water. On the other hand, in an air pre-heater, the waste heat is used to heat combustion air. In both cases, there is a corresponding reduction in the fuel requirements of the boiler.

For every 22°C reduction in flue gas temperature by passing through an economizer or a pre-heater, there is a 1 per cent saving of fuel in the boiler. In other words, for every 6°C rise in feed water temperature through an economizer, or 20°C rise in combustion air temperature through an air pre-heater, there is 1 per cent saving of fuel in the boiler.

Checklists & tips for energy efficiency (thermal utilities)

- Repair damaged insulation. (A bare steam pipe of 150 mm diameter and 100 m length, carrying saturated steam at 8 kg/cm² would waste 25,000 liters furnace oil in a year).
- Insulate any hot or cold metal or insulation.
- Replace wet insulation.
- Use an infrared gun to check for cold wall areas during cold weather or hot wall areas during hot weather.
- Ensure that all insulated surfaces are coated with aluminium.
- Insulate all flanges, valves and couplings.
- Insulate open tanks (70 per cent heat losses can be reduced by floating a layer of 45 mm diameter polypropylene (plastic) balls on the surface of 90°C hot liquid/condensate).

Waste heat recovery

Waste heat is heat which is generated in a process by way of fuel combustion or chemical reaction, and then “dumped” into the environment even though it could still be reused for a useful economic purpose. A large quantity of hot flue gases are generated from boilers, kilns, ovens and furnaces. If some of this waste heat could be recovered, a considerable amount of primary fuel could be saved. The energy lost in waste gases cannot be fully recovered. However, much of the heat could be recovered and loss minimized by adopting the following measures:

- Recover heat from flue gas, engine cooling water, engine exhaust, low pressure waste steam, drying oven exhaust, boiler blow-down, etc.
- Recover heat from incinerator off-gas. Use waste heat for fuel oil heating, boiler feed water heating, outside air heating, etc.
- Use chiller waste heat to preheat hot water.

- Use heat pumps.
- Use absorption refrigeration.
- Use thermal wheels, run-around systems, heat pipe systems, and air-to-air exchangers.

(d) Checklist & tips for energy efficiency in electrical utilities

Electricity

- Optimize the tariff structure with utility supplier.
- Schedule your operations to maintain a high load factor.
- Shift loads to off-peak times if possible.
- Minimize maximum demand by tripping loads through a demand controller.
- Stagger start-up times for equipment with large starting currents to minimize load peaking.
- Correct power factor to 0.90-0.96 under rated load conditions.
- Relocate transformers close to main loads.
- Set transformer taps to optimum settings.
- Consider on-site electric generation or co-generation if thermal and electrical balances matches.
- Shut off unnecessary computers, printers, and copiers at night.

Motors

- Properly size the load for optimum efficiency.
- Use energy-efficient motors where economical (High efficiency motors offer of 4-5 per cent higher efficiency than standard motors).
- Check alignment.
- Provide proper ventilation (for every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved).
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply (An imbalanced voltage can reduce 3-5 per cent in motor input power).
- Demand efficiency restoration after motor rewinding (If rewinding is not done properly, the efficiency can be reduced by 5-8 per cent).

Drives

- Use variable-speed drives for large variable loads.
- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives tov-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings. Shut them off when not needed.

Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aero foil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motor for continuous or nearly continuous operation.
- Eliminate leaks in duct work and minimize bends in ductwork.
- Turn fans off when not needed.

Blowers

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.
- Minimize blower speed.
- Use low-slip or no-slip belts and check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Turn blowers off when they are not needed.

Pumps

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: do not waste pumping head with a free-fall (gravity) return.

Compressors

- Consider variable speed drive for variable load on positive displacement compressors.
- Use a synthetic lubricant if the compressor manufacturer permits it.
- Change the oil filter regularly.
- Periodically inspect compressor inter-coolers for proper functioning.
- Use waste heat from a very large compressor to power an absorption chiller or preheat process or utility feeds.
- Establish a compressor efficiency-maintenance programme. Start with an energy audit and follow-up, then make a compressor efficiency-maintenance programme a part of your continuous energy management programme.

Compressed air

- Install a control system to coordinate multiple air compressors.
- Avoid over sizing - match the connected load.
- Load up modulation-controlled air compressors. (They use almost as much power at partial load as at full load).
- Turn off the back-up air compressor until it is needed.
- Reduce air compressor discharge pressure to the lowest acceptable setting. (Reduction of 1 kg/cm² air pressure (8 kg/cm² to 7 kg/cm²) would result in 9 per cent input power savings. This will also reduce compressed air leakage rates by 10 per cent).
- Use the highest reasonable dryer dew point settings.
- Turn off refrigerated and heated air dryers when the air compressors are off.
- Use a control system to minimize heat-less desiccant dryer purging.
- Minimize purges, leaks, excessive pressure drops, and condensation accumulation.
- Use drain controls instead of continuous air bleeds through the drains.
- Consider engine-driven or steam-driven air compression to reduce electrical demand charges
- Replace standard v-belts with high-efficiency flat belts as the old v-belts wear out.
- Use a small air compressor when major production load is off.
- Take air compressor intake air from the coolest location. (Every 5°C reduction in intake air temperature result in 1 per cent reduction in compressor power consumption).
- Use an air-cooled after cooler to heat building makeup air in winter.
- Ensure that heat exchangers are not fouled (e.g. -- with oil) also that air/oil separators are not fouled.
- Monitor pressure drops across suction and discharge filters and clean or replace filters regularly
- Use a properly sized compressed air storage receiver.
- Consider alternatives to compressed air such as blowers for cooling, hydraulic rather than air cylinders, electric rather than air actuators, and electronic rather than pneumatic controls.
- Use nozzles or venturi-type devices rather than blowing with open compressed air lines.
- Check for leaking drain valves on compressed air filter/regulator sets. Certain rubber-type valves may leak continuously after they age and crack.

- Establish a compressed air efficiency-maintenance programme. Start with an energy audit and follow up then make a compressed air efficiency maintenance program a part of your continuous energy management programme.

Chillers

- Increase the chilled water temperature set point if possible.
- Use the lowest temperature condenser water available that the chiller can handle. (Reducing condensing temperature by 5.5°C, results in a 20-25 per cent decrease in compressor power consumption).
- Increase the evaporator temperature (5.5°C increase in evaporator temperature reduces compressor power consumption by 20 to 25 per cent).
- Clean heat exchangers when fouled (1 mm scale build-up on condenser tubes can increase energy consumption by 40 per cent).
- Optimize condenser water flow rate and refrigerated water flow rate.
- Replace old chillers or compressors with new higher-efficiency models.
- Use water-cooled rather than air-cooled chiller condensers.
- Use energy-efficient motors for continuous or near-continuous operation.
- Specify appropriate fouling factors for condensers.
- Do not overcharge oil.
- Install a control system to coordinate multiple chillers.
- Run the chillers with the lowest operating costs to serve base load.
- Avoid over-sizing - match the connected load.
- Isolate off-line chillers and cooling towers.
- Establish a chiller efficiency-maintenance programme. Start with an energy audit and follow-up, then make a chiller efficiency-maintenance programme a part of your continuous energy management program.

HVAC (heating / ventilation / air conditioning)

- Consider installing a building automation system
- Balance the system to minimize flows and reduce blower/fan/pump power requirements
- Eliminate or reduce reheat whenever possible
- Use appropriate HVAC thermostat setback
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air
- Use evaporative cooling in dry climates
- Reduce humidification or dehumidification during unoccupied periods
- Clean HVAC unit coils periodically and comb mashed fins
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate

- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in areas applicable.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapour control.
- Install multi-fuelling capability and run with the cheapest fuel available at the time.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Consider ground source heat pumps.
- Seal leaky HVAC ductwork and all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling units).
- Inspect, clean, lubricate, and adjust damper blades and linkages.

Refrigeration

- Use water-cooled condensers rather than air-cooled condensers.
- Challenge the need for refrigeration, particularly for old batch processes.
- Avoid over-sizing - match the connected load.
- Consider gas-powered refrigeration equipment to minimize electrical demand charges.
- Use “free cooling” to allow chiller shutdown in comparatively cold weather.
- Correct inappropriate brine or glycol concentration that adversely affects heat transfer and/or pumping energy. If it sweats, insulate it, but if it is corroding, replace it first.
- Make adjustments to minimize hot gas bypass operation.
- Inspect moisture/liquid indicators.
- Consider change of refrigerant type if it will improve efficiency.
- Check for correct refrigerant charge level.
- Inspect the purge for air and water leaks.
- Establish a refrigeration efficiency-maintenance programme. Start with an energy audit and follow-up, then make a refrigeration efficiency-maintenance programme a part of your continuous energy management programme.

Cooling towers

- Control cooling tower fans based on leaving water temperatures.
- Control to the optimum water temperature as determined from cooling tower and chiller performance data.
- Use two-speed or variable-speed drives for cooling tower fan control if the fans are few. Stage the cooling tower fans with on-off control if there are many.
- Turn off unnecessary cooling tower fans when loads are reduced.

- Cover hot water basins (to minimize algae growth that contributes to fouling).
- Balance flow to cooling tower hot water basins.
- Periodically clean plugged cooling tower water distribution nozzles.
- Install new nozzles to obtain a more-uniform water pattern.
- Replace splash bars with self-extinguishing PVC cellular-film fill.
- On old counter flow cooling towers, replace old spray-type nozzles with new square-spray ABS practically-non-clogging nozzles.
- Replace slat-type drift eliminators with high-efficiency, low-pressure-drop, self-extinguishing, PVC cellular units.
- Optimize cooling tower fan blade angle on a seasonal and/or load basis.
- Correct excessive and/or uneven fan blade tip clearance and poor fan balance.
- Use a velocity pressure recovery fan ring.
- Re-line leaking cooling tower cold water basins.
- Check water overflow pipes for proper operating level.
- Install interlocks to prevent fan operating when there is no water flow.
- Establish a cooling tower efficiency-maintenance programme. Start with an energy audit and follow-up, then make a cooling tower efficiency-maintenance programme a part of your continuous energy management programme.

Lighting

- Reduce excessive illumination levels to standard levels using switching, delamping, etc. (Know the electrical effects before delamping).
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapour lighting, etc. Efficiency (lumen's/watt) of various technologies range from best to worst approximately as follows: *low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapour, incandescent.*
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to LED and electronic ballasts.
- Consider lowering the fixtures to enable using fewer of them.
- Consider day lighting, skylights, etc.
- Consider painting the walls a lighter colour and using fewer lighting fixtures or lower wattages.
- Change exit signs from incandescent to LED.

DG sets

- Optimize loading whenever feasible.
- Use waste heat to generate steam/hot water/an-absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs.

- Clean air filters regularly.
- Insulate exhaust pipes to reduce DG set room temperatures.
- Use cheaper heavy fuel oil for capacities more than 1MW.

Buildings/hotels

- Seal exterior cracks/openings/gaps with caulk, gasketing, weather stripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.

Miscellaneous

- Meter any unmetered utilities. Know what normal efficient use is. Track down causes of deviations.
- Shutdown spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high pressure drops across valves.

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