Awareness Workshop on Dissemination of Japanese low carbon technologies in India

16th November, 2016 at Mumbai

Organised by

The Energy and Resources Institute (TERI)
Institute for Global Environmental Strategies (IGES)
Maharashtra Energy Development Agency (MEDA)

With support from

Ministry of the Environment, Government of Japan (MoEJ)

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Summary

An awareness workshop on 'dissemination of Japanese low carbon technologies in India' was organised on November 16, 2016, at Hotel Courtyard Marriott, Mumbai by TERI in collaboration with Maharashtra Energy Development Agency (MEDA). The event was supported by Institute for Global Environmental Strategies (IGES), Japan. The agenda of the workshop is given in annexure 1. A summary of the deliberations of the awareness workshop is given below.

Session-1: Inaugural

Mr Prosanto Pal, TERI welcomed the Japanese experts from IGES and TLV. He gave an overview of IGES-TERI collaboration to promote Japanese low carbon technologies (LCT) among Indian industries and the development of Japan India stakeholders matchmaking platform (JISMAP). He mentioned that the objective of the web-site is to disseminate case studies/feasibility reports prepared on Japanese LCTs and match Japanese technology suppliers with Indian industries. He requested participants to share their views on making the platform effective.

Dr Rabhi Abdessalem, IGES provided an overview about the IGES-TERI collaboration in India. He mentioned that under the collaboration a series of workshops have been organized in India to spread the awareness about selected Japanese LCTs. Mentioning that Japanese LCTs have a good replication potential among Indian industries, he explained the strategy adopted for demonstration and scaling-up. Several examples of Japanese energy efficient technologies and best practices were shared by him. Partnership among different stakeholders (government, industry associations, research institutes and funding organisations) are important for matchmaking between business to business (B2B) and business to finance (B2F). This is the overall rationale for creation of JISMAP platform. A copy of his presentation is provided in Annexure 2.

Mr Hemant Patil, MEDA, mentioned that Japanese technologies are famous for reliability and efficiency. In order to meet their energy reduction targets under Perform, Achieve and Trade (PAT) scheme, it is important for designated consumers (DCs) to adopt energy efficient technologies. Recently under the scheme, three new sectors have been added - refineries, discoms and railways. MEDA is developing an energy conservation fund, which will be made available for implementing energy efficiency projects on ESCO basis. It will be useful to cover other PAT sectors, apart from refineries, for awareness generation about Japanese LCTs.

Session-2: Optimization of steam systems

Mr Takaharu Nakashima, TLV, Japan, mentioned that TLV stands for 'Trouble Less Valve'. The products of TLV include steam traps, vacuum steam generators to generate steam below 100oC for pharmaceutical applications. TLV also conducts Steam System Optimization Program (SSOP) for industries. Major SSOP sectors include refinery and petrochemical (32%), food industry (8%) and pharmaceuticals. The SSOP activity includes steam system audit of entire plant and has sub-systems like Optimize Condensate Discharge Location (BPSTM - Best Practice of Steam Trap Management) and Optimize Steam Application and Steam - Power Balance (CES Survey). TLV has completed SSOP studies in more than 100 plants so far and many of the plants have received awards for steam reduction. In BPSTM, condensate discharge point (steam traps and surrounding valves) are checked for their condition. Steam savings by better condensate discharge location management is estimated. In CES Survey, steam balance of entire plant is prepared and optimization of steam system by tuning of steam pressure, temperature, steam applications, dryness factor for various locations are proposed. Estimates of steam savings by steam optimization and balance are prepared. In summary, the SSOP follows the following structure:

1. Best Practice of Steam Traps Management (BPSTM)
    - Create database
    - Provide Identity to each trap
    - Data analysis: condition of trap (working / malfunctioning / Bypass / Not in operation, etc)
    - Trap replacement
2. Best Practice of Steam System Management (BPSSM) Optimizing all steam using application
3. Steam balancing and Total steam system optimization

    It is the combined effect of BPSTM and BPSSM.

    TLV also has a TrapMan Pro System, an online program for checking the status of steam traps and selection of steam traps. Features of TrapMan Pro include remote monitoring, data collection of steam leakages and selection of trap models as per application.

    A case study of a pilot study undertaken in an Indian refinery was presented. The study has estimated a steam saving potential of 14% of the total steam consumption in the plant is possible. Achieving the steam savings will lead a reduction of 4.9% of the specific energy consumption (or MBN – an unit used for specific energy consumption in refineries) of the plant. Thus the plant will be able to achieve a substantial part of its targeted 6.74% reduction under PAT.

A copy of his presentation is provided in Annexure 3.

Session-3: Case studies from compressed air systems and energy audits

Mr Rabhi Abdessalem, IGES and Mr Chetankumar Sangole, TERI presented case studies of compressed air systems. Inverter type air compressor along with its cost benefit analysis was presented. A copy of his presentation is provided in Annexure 4.

Mr Atulkumar Auti, TERI made a presentation on energy audit in different industries like refinery, petrochemical, thermal power plant, food processing. A copy of the presentation is provided in Annexure 5.

Session-4: Discussion on JISMAP

Summary of the discussions is given below.

- Low grade heat recovery technology and VAM are of interest to refineries
- Information on new process technologies will be helpful
- Servicing and cost issues need to be addressed for Japanese technologies
- Payback period of the technologies should be attractive
- Softer technologies like SSOP will be useful for JISMAP
- PPTs of the workshops can be put in the website

Concluding remarks

Mr Rabhi Abdessalem, IGES mentioned that matchmaking is important to facilitate B2B transactions. Conducting feasibility studies of LCTs help to quantify energy savings and payback which is important for investment decisions. The project output also provides key inputs to policymakers in both countries on overcoming the barriers to promotion of Japanese LCTs.

About 30 participants from industry, government, consultancy agencies and donor organizations attended the event.

Some photographs of the event are provided in Annexure 6.

Annexures

Annexure 1: Agenda of the event

Awareness Workshop

Dissemination of Japanese low carbon technologies in India

16 November 2016, 10:30-17:00 hrs

Courtyard by Marriott, Near Mumbai International Airport, Andheri Kurla Road Andheri (East)

Organised by

The Energy and Resources Institute (TERI)

Institute for Global Environmental Strategies (IGES)

Maharashtra Energy Development Agency (MEDA)

Supported by

Ministry of the Environment, Government of Japan (MoEJ)

Objectives:

- To generate awareness about energy efficient technologies from Japan viz. steam systems for refineries, petrochemical, fertilizer, chemicals and other sectors
- To explore possibilities of strengthening Indo-Japan cooperation through JISMAP

Draft Agenda

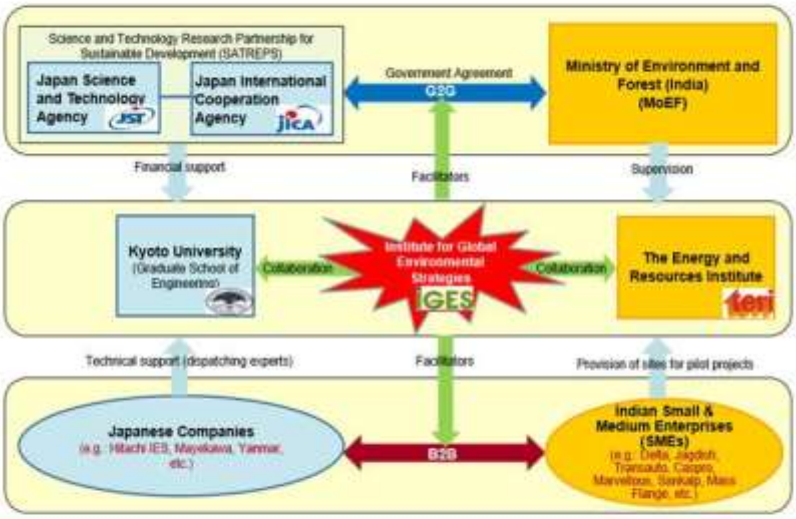
10:00-10:30 hrs Registration	
Session 1: Inaugural Session	
10:30 – 11:15 hrs	**Welcome Address** Mr Prosanto Pal, The Energy and Resources Institute (TERI) Mr Hemant Patil, Maharashtra Energy Development Agency (MEDA) **Background presentation on IGES-TERI's efforts to promote LCT deployment in India with special emphasis on initiating Japan-India stakeholders matchmaking platform (JISMAP)** Dr Rabhi Abdessalem, The Institute for Global Environmental Strategies (IGES), Japan
11.15-11.45 hrs	**Tea/coffee Break**
Session 2: Technical Session 1 – Steam systems	
11:45 – 13:00 hrs	**Presentation on 'Optimisation of steam systems – TLV's experience'** Mr Takaharu NAKASHIMA, TLV, Japan **Q & A**
13:00 – 14:00 hrs	**Lunch**
Session 3: Technical Session – Steam systems (contd.)	
14:00 – 15: 30 hrs	**Presentation on 'Case-studies from compressed air systems'** Dr Rabhi Abdessalem, IGES & Mr Chetan Kumar Sangole, TERI **Presentation on 'TERI's experience in energy audits and case-studies from refinery, petrochemical, fertilizer, chemicals, food processing and other sectors'** Mr Atulkumar Yashwant Auti, TERI **Q & A**
15:30-15:50 hrs	**Tea/Coffee Break**
15:50-17:00 hrs	**Interactive open house session on Information sharing and matchmaking of Japanese technologies through proposed on-line platform JISMAP** Moderated by: Mr Prosanto Pal, TERI **Concluding remarks** Dr Rabhi Abdessalem, IGES

Annexure 2: IGES-TERI efforts to promote the application of Japanese low carbon technologies in India

1. Project funded by JST and JICA (2010~2013)

Stakeholders

Under JST and JICA project, IGES and TERI (The Energy and Resource Institute in India) had successfully engaged and matched various stakeholders to promote Japanese low carbon technology application in India.



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IGES

Activities: FS, DS and Pilot Projects implementation

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Activities: Capacity building and awareness raising (level1)

Onsite capacity building for workers during site visits

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Activities: Capacity building and awareness raising (level2)

Various cluster workshops to introduce technology to business entropreneurs and business associations

IGES–TERI Joint Workshop
(Dec. 2011, Rajkot (India)

IGES–TERI Joint Workshop
Jan. 2012, Chandigarh (India)

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Activities: Capacity building and awareness raising (Level3)

Training workshops to Indian experts (training of trainers)

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Activities: Capacity building and awareness raising (Level4)

Interaction with policy makers through meetings, symposiums, etc.

IGES-TERI workshop
(Feb.2012 New Delhi- India)

India-Japan Energy Forum
(Sep.2013 New Delhi- India)

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Summary of "On the Ground" intervention

	Technology	Number of Onsite Feasibility Studies (FS)	Number of Pilot Projects (PP)
Hard Technologies	Gas Heat Pump	11	2
	Electric heat pump	13	2
Best Practices (Soft technologies)	Compressed air system	13	4
	Induction furnace	8	2

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Results #1 : Demonstration of Electric Heat Pump (EHP)

- **Benefits**
- Reduction in fuel consumption of boiler and electricity consumption of chiller
- **Energy savings: 30%-40%**

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Results #2: Demonstration of Gas Heat Pump (GHP)

- **Benefits**
- Switch from electricity to Natural Gas
- **Energy savings: 35%-45%**

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Results #3: Demonstration of best practices on compressed air

- **Benefits**
- Reduction in air consumption, in air leakage, hence in energy consumption
- **Energy Saving: 20% -30%**

e.g.1: Installation of new receiver and new air compressors (not inverter type)

e.g.2 Adjusting pressure setting

e.g.3 Reduce air leakage through installing foot switch

e.g.4 Reconsider pipe size and design

e.g.5 Start the use of efficient air gun

Notes:
-Installation of inveter type air compressor at the sites could bring additional 10%-20% energy saving.

IGES

2. FY.2014-2015: Building up on previous achievement and strengthening partnership

1
3

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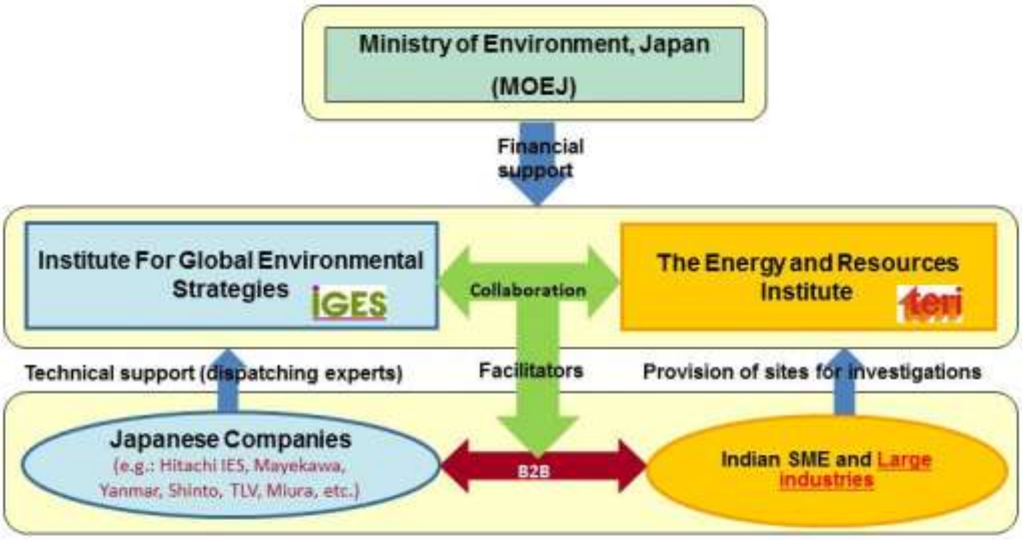
Projects funded by MOEJ (FY2014~2015)

Stakeholders

IGES and TERI built upon the previous achievement and engaged and matched more stakeholders while extending the focus to more technologies and to large industries



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Summary of selected technologies 2014 & 2015

	Technology	Number of onsite feasibility studies
Hard Technologies	Gas Heat Pump	5
	Electric heat pump	3
	Once Through Boiler	5
	Steam System Optimization	1
Best Practices (Soft technologies)	Compressed air system	10
	Induction furnace	2

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Engaging stakeholders

Matching Businesses to Businesses (B2B)

Investigation & capacity building: GHP

Investigation & capacity building: EHP

Investigation & capacity building: CA

Investigation & capacity building: IF

Investigation & capacity building: Boiler

Investigation & capacity building: Steam

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Engaging stakeholders

Matching Businesses to Funding Agencies (B2F)

Mtg. with Gujarat Energy Development Agency

Mtg. with Small Industries development bank in India

Mtg. with JICA (India)

Mtg. with Japan bank for International Cooperation (India)

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Engaging stakeholders

Matching Businesses to Policy Makers (B2P)

e.g. mtg. with Local and Central Boiler Inspectors regarding boiler regulation

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Key findings

- Huge potential/Market for Japanese low carbon technologies deployment in India however:
  - ➢ High upfront cost of Japanese technologies;
  - ➢ Significant information/knowledge gap exists;
  - ➢ Incomplete, fragmented, and uncoordinated efforts to tap opportunities;
  - ➢ Communication related (language, concepts, etc.)
- More efforts and resource should be allocated to creating opportunities to Japanese suppliers to interact with Indian end users (B2B), policy makers (B2P) and funding institutions (B2F);
- **It was concluded that there is a need to initiate a stakeholders' matching platform to address all the above in practical and systematic manner.**

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3. Initiating a demonstrative matching platform (FY2016)

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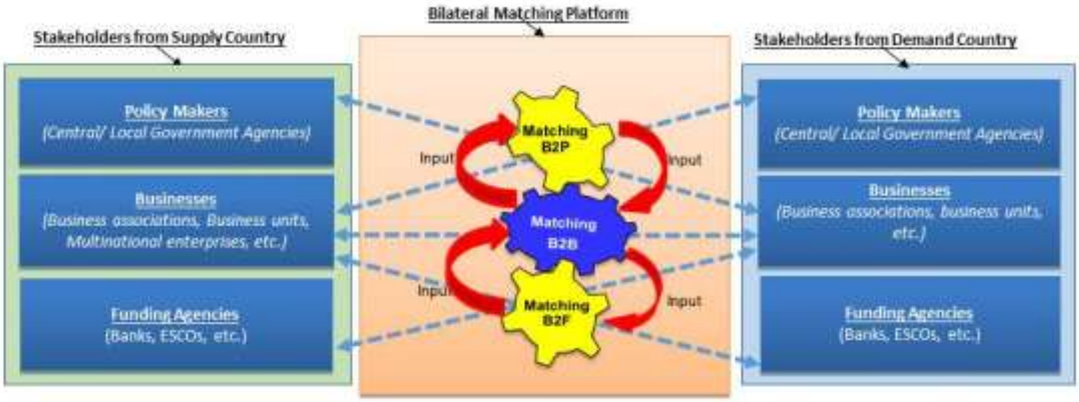
Matching Platform Concept



Note1: The matching platform has to be implemented/executed by a group of matchmakers, mainly non for profit organisations (NPOs), from supply and demand countries;

Note2: The matching is made through two forms:

- ***On the ground matching***: Through actual/direct interaction among stakeholders to conduct market assessments, feasibility studies, project proposals, demonstration projects, technical assistance and capacity building, loan syndication, Training of Trainers, PR and outreach, etc.
- **Online/Virtual matching:** Through collection, mapping and online sharing of relevant knowledge/information (online databases on technologies, policies, financing options, etc.), along with disseminating the findings/lessons learnt from the above on the ground matching.

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Key feature of the platform

1) Practical: unique forum where matching B2B, B2F and B2P can occur on the ground as well as online.
2) Comprehensive: Information and knowledge sharing is about various aspects (technologies data base, policy data base, financing data base, etc. not just about one of them
3) Systematic: It addresses all the stages of Technology Transfer process, with special focus given to follow up activities.
4) Ultimate goal is to materialize the opportunities rather than just identifying them
5) Develop the information rather than just collecting it
6) It is not an alternative option to existing platforms, but rather a complementary one to them.

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Key activities to be conducted under/by the platform

1) Assessment & identification of seeds and needs (Technologies, Financing, Policies, etc.)

2) "On the ground" matching of seeds with needs (based on the findings from 1)):

>Onsite investigations & feasibility studies along with Training of Trainers.
>Development, sharing and discussion of project proposals, and if necessary provision of loans syndications.
>Actual implementation of projects.
>Direct interaction of business with policy makers.

3) Upscaling and technology diffusion (based on findings from 2):

>Follow-up regarding the implemented projects to ensure their continuous operation.
>Identification and/or creation of opportunities at cluster/sector level.
>Explore replicability of implemented projects at cluster/sector level.
>Awareness creation and capacity building.

4) Online Knowledge & Information sharing (based on findings from 1) 2) and 3).

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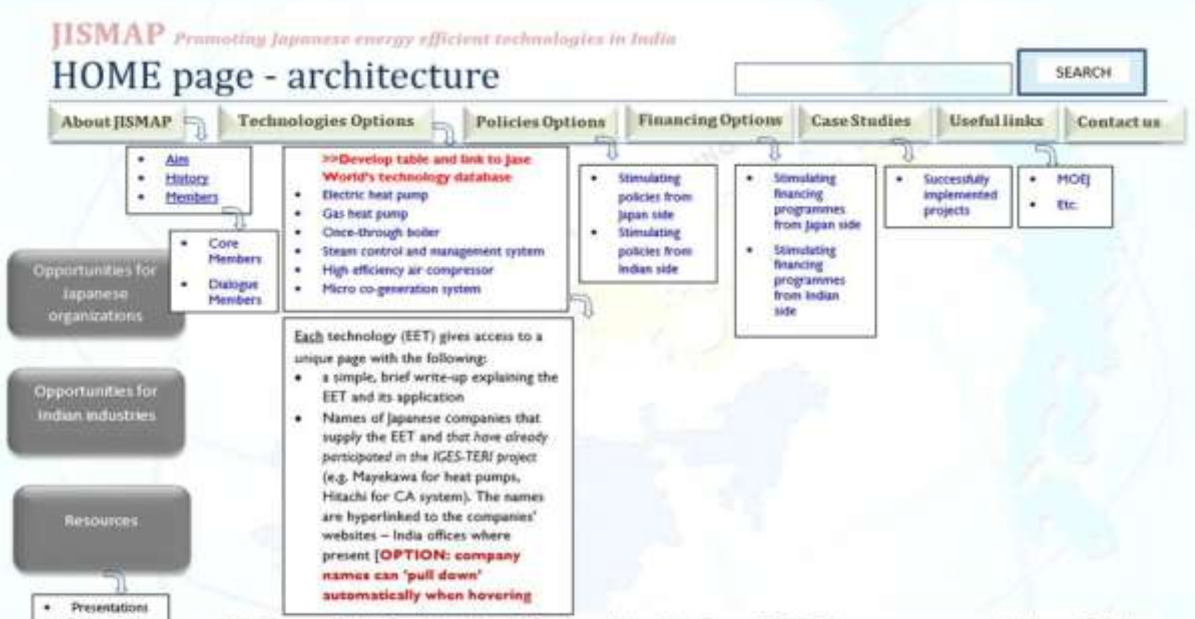
Sample of the online knowledge & information sharing directory/portal

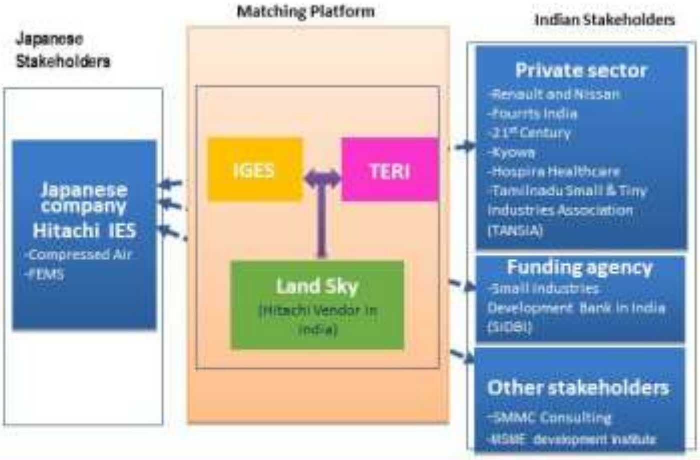


The Japan–India Stakeholders' Matchmaking Platform, JISMAP, promotes mutually beneficial engagements between Japanese manufacturers of energy efficient technologies (EETs) and Indian industries looking for such EETs.

Progress and way forwards on Japan-India-Stakeholders Matching Platform (JISMAP)

1) MOU has been signed between IGES and TERI on July 13th 2016, and JISMAP has been launched as a trial basis;

2) During a business trip conducted on Aug. 21st - Aug.27th IGES and TERI, along with Land Sky, successfully matched Hitachi experts to several stakeholders as shown in the fig.



3) During a business trip conducted on Nov. 13-17, IGES-TERI and MEDA successfully matched TLV experts to several stakeholders.

4) The online matching website is expected to be launched within January, 2016

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Conclusion and way forwards

- There is no shortage of technologies, no shortage of funding, no shortage of efforts, but there is lack of coordination/synergy among efforts to develop projects;
- Key challenges to promote low carbon technologies in India include mainly:
  1) High upfront cost;
  2) Information/knowledge gap about the "needs" and "seeds";
  3) Communication related (not only language).
- Successfully matching Businesses-to-Businesses (B2B), Businesses-to-Funding agencies (B2F), and Businesses-to-Policy makers (B2P) could create synergy among efforts, fill part of the information/knowledge gap, alleviates part of overall business cost (through reduction of transaction cost, information cost, PR cost, etc.)
- To successfully match stakeholders, JISMAP could be considered as a good option. To this end, JISMAP should include adequate stakeholders along IGES and TERI.

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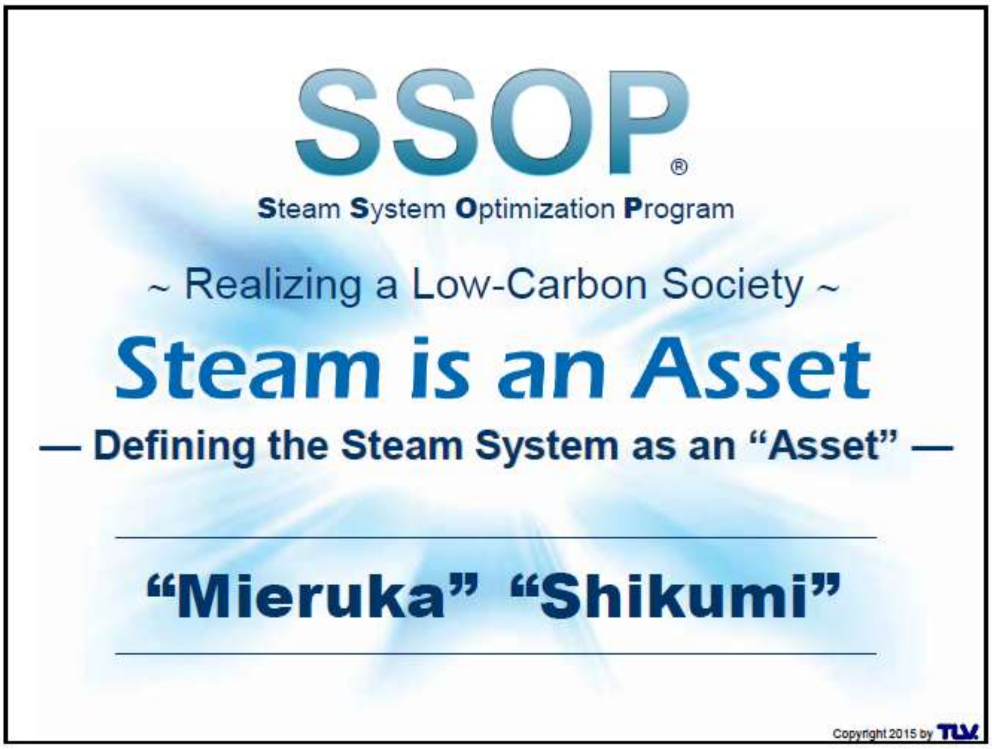
Annexure 3: Steam System Optimization Program (SSOP)




TLV®
A Steam Specialist Company
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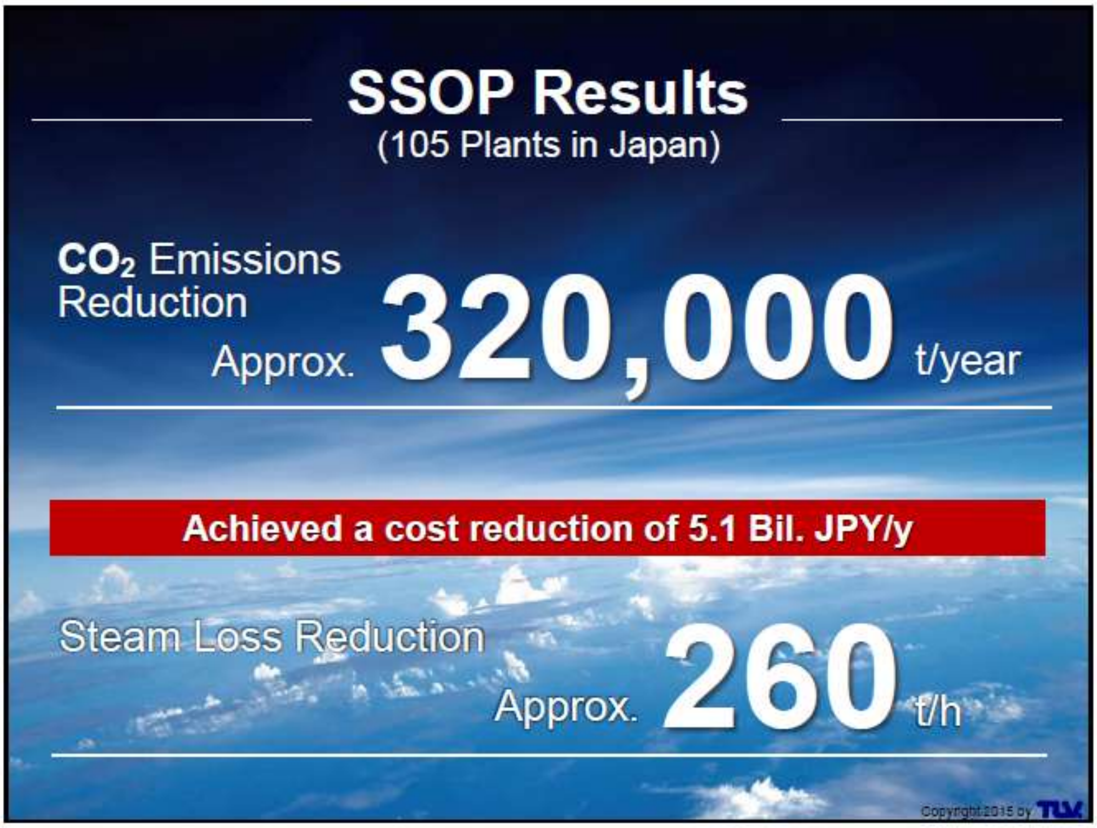
MISSION is to Help
Build a Low Carbon Society
and Create "Peace of Mind" in plants through
SSOP®
Steam System Optimization Program
A Sustainable Asset Management Program
which Improves Safety, Reliability & Profitability
by Continuously Optimizing Performance of
the Entire Steam System through Visualization based on
"Condition Monitoring and Timely Consulting & Engineering Services"
to Minimize Condensate Problems, Energy Losses and CO_2 Emissions
TLV® SteamWorld®


Peace of Mind


SSOP Results
(105 Plants in Japan)
CO_2 Emissions Reduction
Approx. 320,000 t/year
Achieved a cost reduction of 5.1 Bil. JPY/y
Steam Loss Reduction
Approx. 260 t/h
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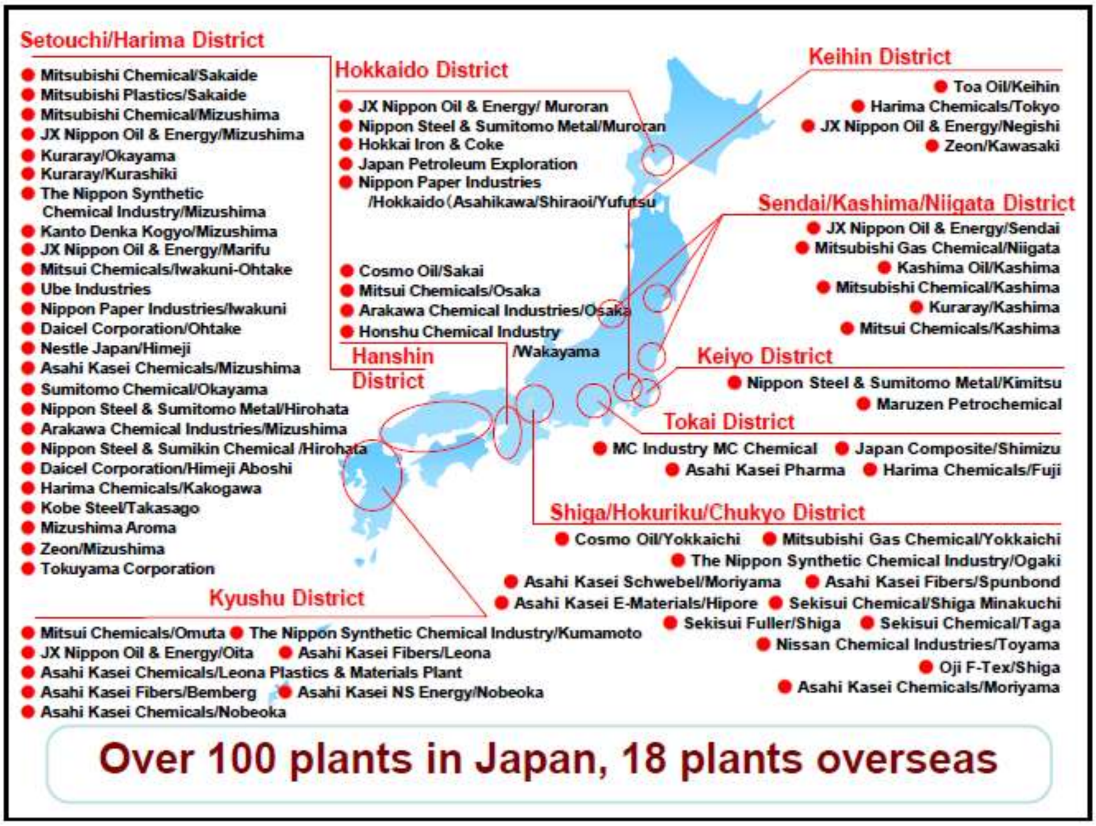
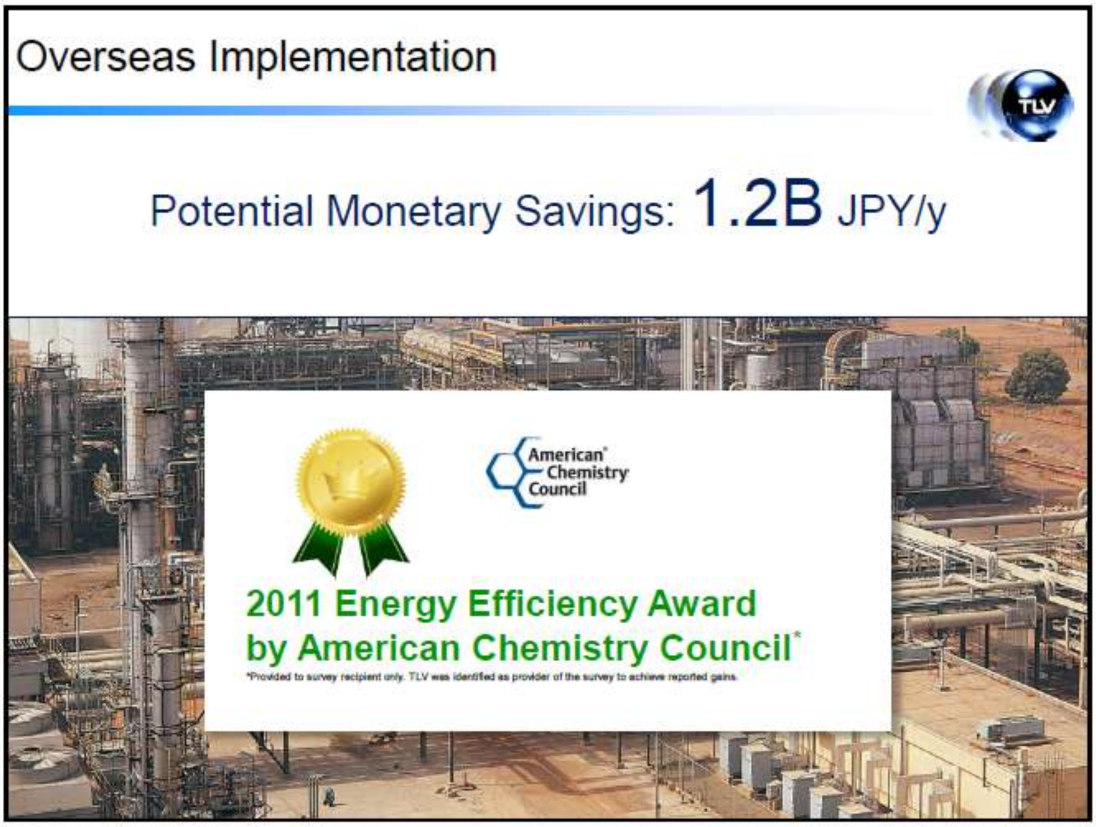
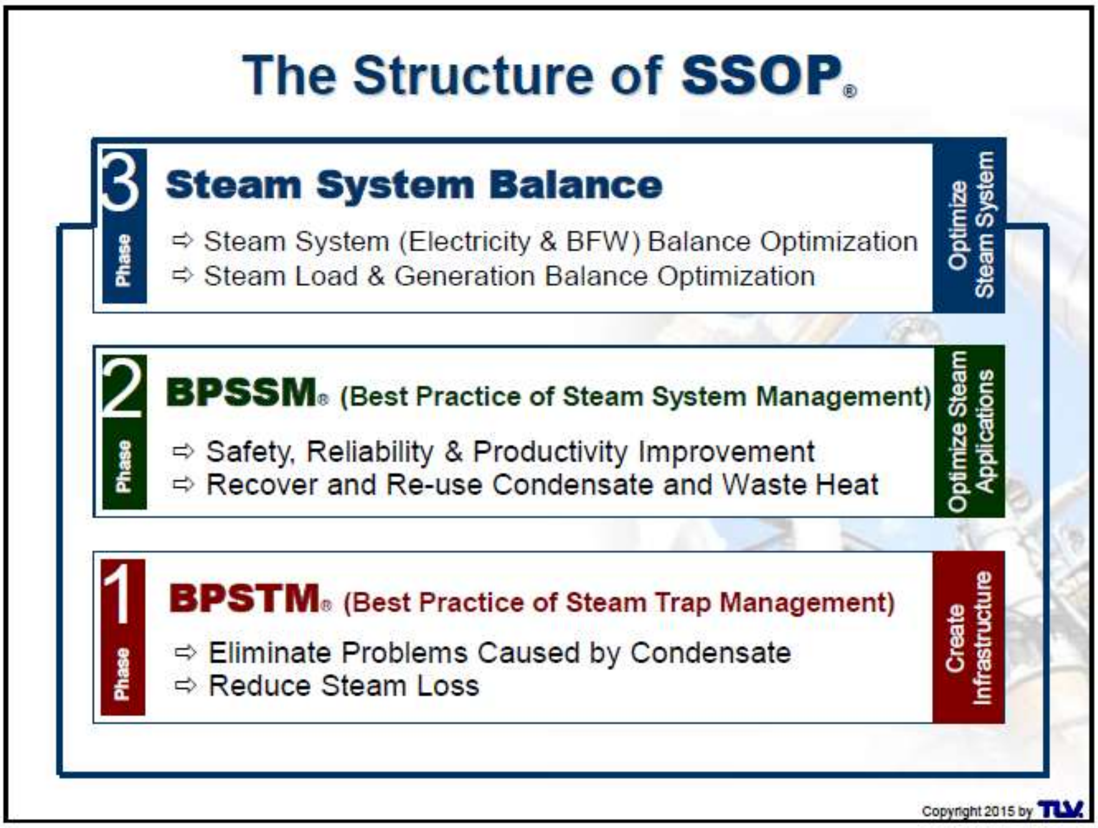

Setouchi/Harima District
Mitsubishi Chemical/Sakaide
Mitsubishi Plastics/Sakaide
Mitsubishi Chemical/Mizushima
JX Nippon Oil & Energy/Mizushima
Kuraray/Okayama
Kuraray/Kurashiki
The Nippon Synthetic Chemical Industry/Mizushima
Kanto Denka Kogyo/Mizushima
JX Nippon Oil & Energy/Marifu
Mitsui Chemicals/Iwakuni-Ohtake
Ube Industries
Nippon Paper Industries/Iwakuni
Daicel Corporation/Ohtake
Nestle Japan/Himeji
Asahi Kasei Chemicals/Mizushima
Sumitomo Chemical/Okayama
Nippon Steel & Sumitomo Metal/Hirohata
Arakawa Chemical Industries/Mizushima
Nippon Steel & Sumikin Chemical /Hirohata
Daicel Corporation/Himeji Aboshi
Harima Chemicals/Kakogawa
Kobe Steel/Takasago
Mizushima Aroma
Zeon/Mizushima
Tokuyama Corporation
Hokkaido District
JX Nippon Oil & Energy/ Muroran
Nippon Steel & Sumitomo Metal/Muroran
Hokkai Iron & Coke
Japan Petroleum Exploration
Nippon Paper Industries /Hokkaido (Asahikawa/Shiraoi/Yufutsu)
Cosmo Oil/Sakai
Mitsui Chemicals/Osaka
Arakawa Chemical Industries/Osaka
Honshu Chemical Industry /Wakayama
Hanshin District
Keihin District
Toa Oil/Keihin
Harima Chemicals/Tokyo
JX Nippon Oil & Energy/Negishi
Zeon/Kawasaki
Sendai/Kashima/Niigata District
JX Nippon Oil & Energy/Sendai
Mitsubishi Gas Chemical/Niigata
Kashima Oil/Kashima
Mitsubishi Chemical/Kashima
Kuraray/Kashima
Mitsui Chemicals/Kashima
Keiyo District
Nippon Steel & Sumitomo Metal/Kimitsu
Maruzen Petrochemical
Tokai District
MC Industry MC Chemical
Japan Composite/Shimizu
Asahi Kasei Pharma
Harima Chemicals/Fuji
Shiga/Hokuriku/Chukyo District
Cosmo Oil/Yokkaichi
Mitsubishi Gas Chemical/Yokkaichi
The Nippon Synthetic Chemical Industry/Ogaki
Asahi Kasei Schwebel/Moriyama
Asahi Kasei Fibers/Spunbond
Asahi Kasei E-Materials/Hipore
Sekisui Chemical/Shiga Minakuchi
Sekisui Fuller/Shiga
Sekisui Chemical/Taga
Nissan Chemical Industries/Toyama
Oji F-Tex/Shiga
Asahi Kasei Chemicals/Moriyama
Kyushu District
Mitsui Chemicals/Omuta
The Nippon Synthetic Chemical Industry/Kumamoto
JX Nippon Oil & Energy/Oita
Asahi Kasei Fibers/Leona
Asahi Kasei Chemicals/Leona Plastics & Materials Plant
Asahi Kasei Fibers/Bemberg
Asahi Kasei NS Energy/Nobeoka
Asahi Kasei Chemicals/Nobeoka
Over 100 plants in Japan, 18 plants overseas


BPSTM® Results
Realized Monetary Benefit: approx. 1BJPY*/y
Steam Loss Reduction from 100,000 Steam Traps
*Assumes fuel cost of 58,000 JPY/KL
2009 Grand Prize for Excellence in Energy Efficiency and Conservation (Association Category)
"Director-General's Prize, the Agency for Natural Resources and Energy"
Joint winner with Nippon Petroleum Refining Company with the activity of "Reduction in Steam Losses from 100,000 Steam Traps"
ENEOS
新日本石油
Your Choice of Energy
TLV®


Overseas Implementation
TLV
Potential Monetary Savings: 1.2B JPY/y
American Chemistry Council
2011 Energy Efficiency Award
by American Chemistry Council*
*Provided to survey recipient only. TLV was identified as provider of the survey to achieve reported gains.


Convert Steam Resource Opportunities
TLV
Steam System Optimization Program (SSOP)
SSOP's Goal - Site Profit Realization
⇨ Reduce Steam Loss
(Maximize Energy Savings & Profits)
⇨ Reduce CO_2 Emissions
(Fulfill Social Commitment to Lower Environmental Impact)
⇨ Eliminate Problems Caused by Condensate
(Improve Reliability by Reducing Risk & Loss)
⇨ Optimize All Steam-Using Applications
(Increase Production)
⇨ Optimize the Energy Balance of the Entire Plant
(Lowest Total System Cost)


The Structure of SSOP®
3 Phase
Steam System Balance
⇨ Steam System (Electricity & BFW) Balance Optimization
⇨ Steam Load & Generation Balance Optimization
Optimize Steam System
2 Phase
BPSSM® (Best Practice of Steam System Management)
⇨ Safety, Reliability & Productivity Improvement
⇨ Recover and Re-use Condensate and Waste Heat
Optimize Steam Applications
1 Phase
BPSTM® (Best Practice of Steam Trap Management)
⇨ Eliminate Problems Caused by Condensate
⇨ Reduce Steam Loss
Create Infrastructure
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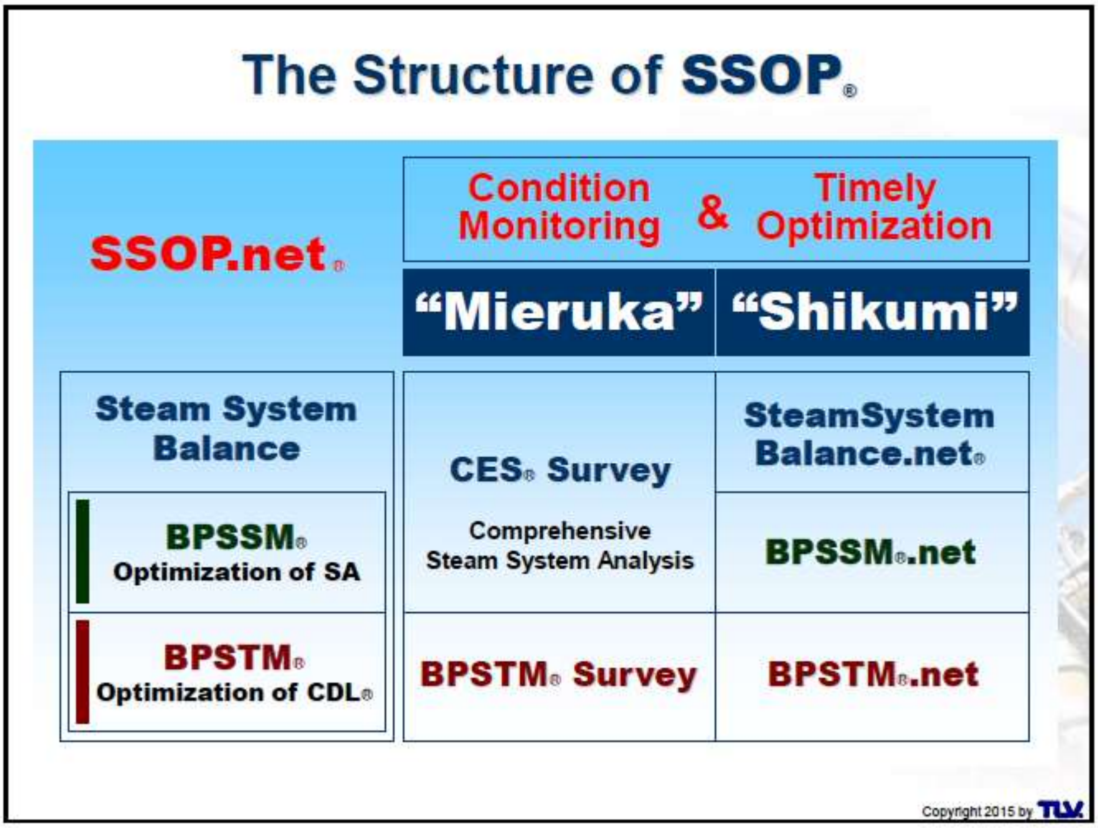
The Structure of SSOP®
SSOP.net®
Condition Monitoring & Timely Optimization
"Mieruka"
"Shikumi"
Steam System Balance
BPSSM® Optimization of SA
BPSTM® Optimization of CDL®
CES® Survey
Comprehensive Steam System Analysis
BPSTM® Survey
SteamSystem Balance.net®
BPSSM®.net
BPSTM®.net
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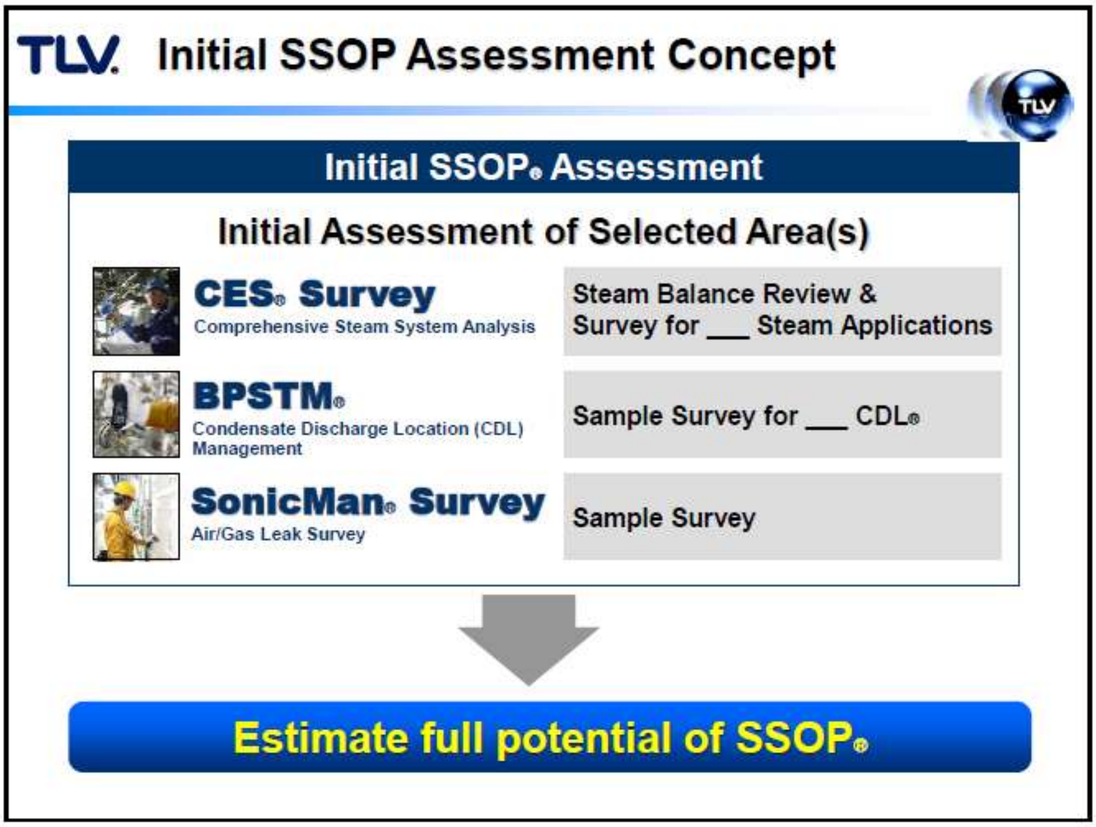
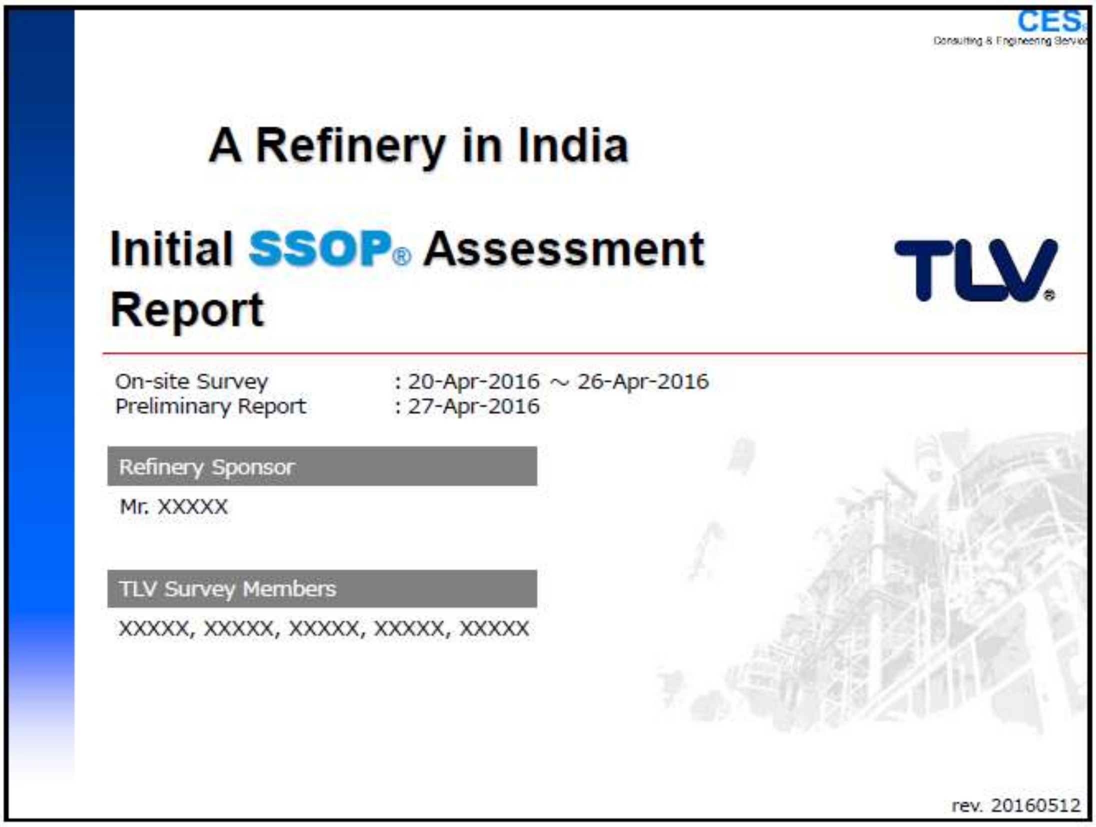
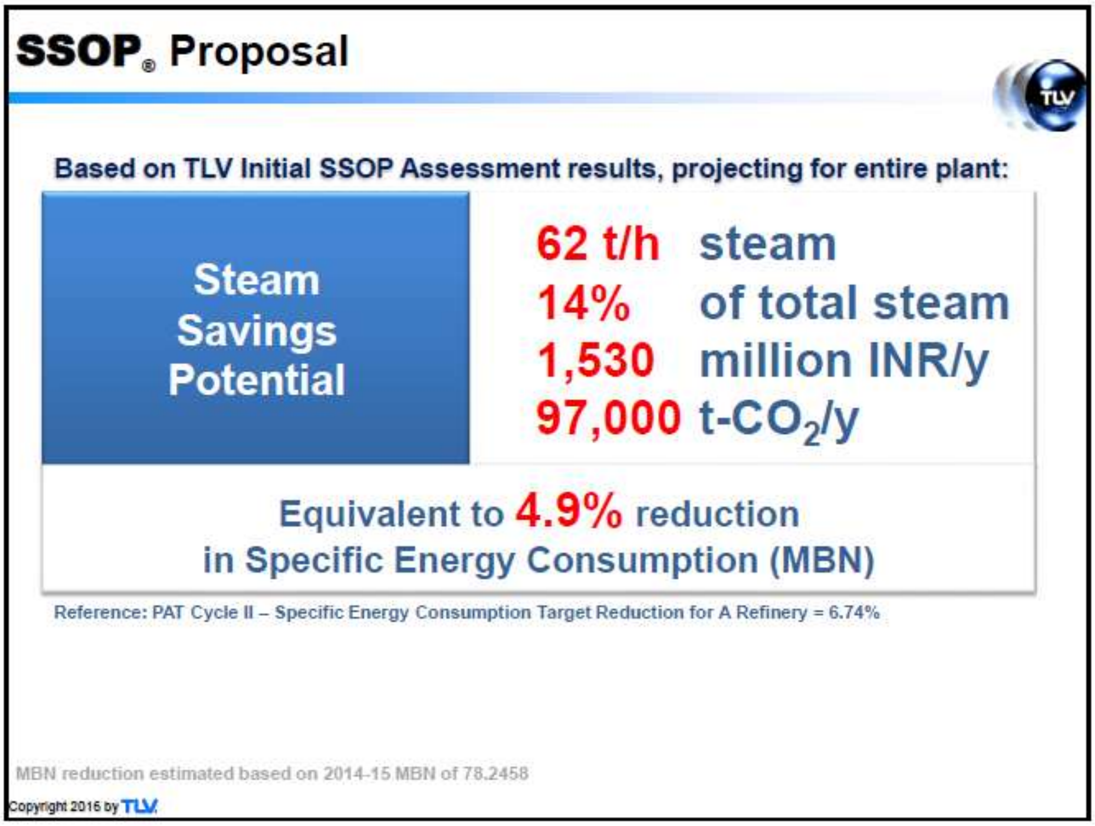

TLV
Initial SSOP Assessment Concept
Initial SSOP® Assessment
Initial Assessment of Selected Area(s)
CES® Survey
Comprehensive Steam System Analysis
Steam Balance Review & Survey for ___ Steam Applications
BPSTM®
Condensate Discharge Location (CDL) Management
Sample Survey for ___ CDL®
SonicMan® Survey
Air/Gas Leak Survey
Sample Survey
Estimate full potential of SSOP®


CES
Consulting & Engineering Service
A Refinery in India
Initial SSOP® Assessment Report
TLV®
On-site Survey : 20-Apr-2016 ～ 26-Apr-2016
Preliminary Report : 27-Apr-2016
Refinery Sponsor
Mr. XXXXX
TLV Survey Members
XXXXX, XXXXX, XXXXX, XXXXX, XXXXX
rev. 20160512


SSOP® Proposal
TLV
Based on TLV Initial SSOP Assessment results, projecting for entire plant:
Steam Savings Potential
62 t/h steam
14% of total steam
1,530 million INR/y
97,000 t-CO2/y
Equivalent to 4.9% reduction in Specific Energy Consumption (MBN)
Reference: PAT Cycle II – Specific Energy Consumption Target Reduction for A Refinery = 6.74%
MBN reduction estimated based on 2014-15 MBN of 78.2458
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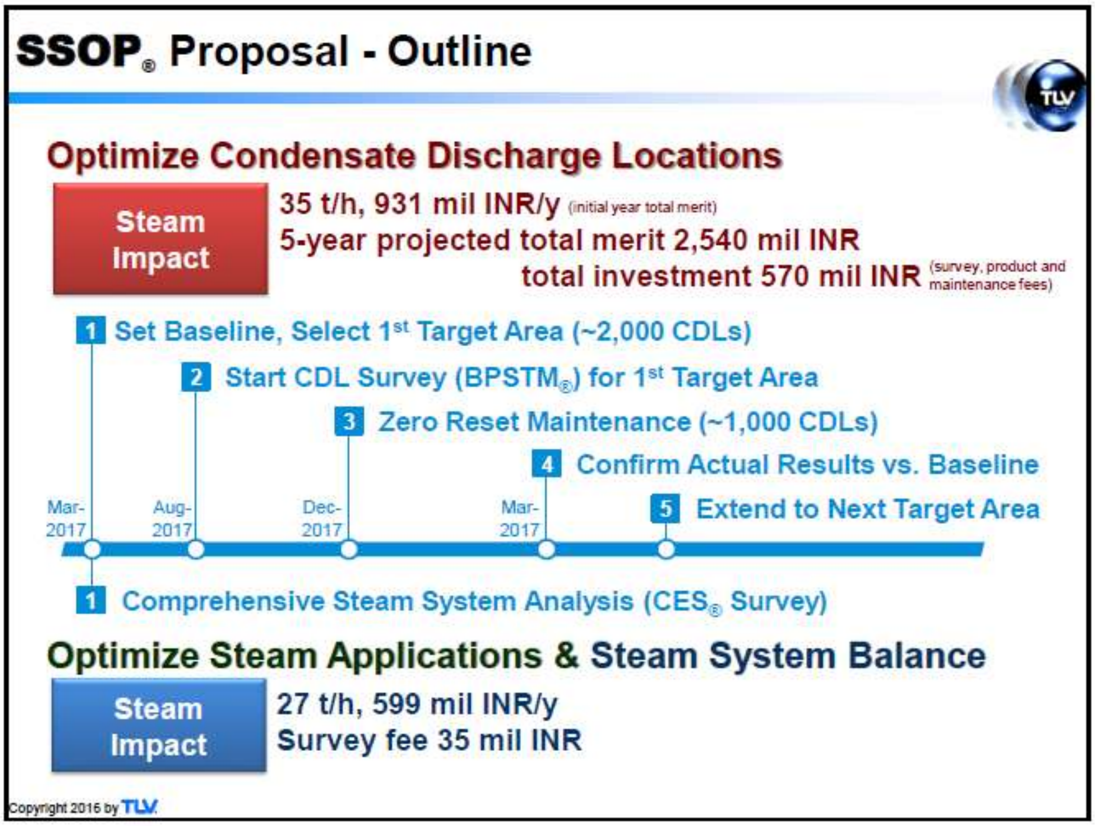

SSOP® Proposal - Outline
TLV
Optimize Condensate Discharge Locations
Steam Impact
35 t/h, 931 mil INR/y (initial year total merit)
5-year projected total merit 2,540 mil INR
total investment 570 mil INR (survey, product and maintenance fees)
1 Set Baseline, Select 1st Target Area (~2,000 CDLs)
2 Start CDL Survey (BPSTM®) for 1st Target Area
3 Zero Reset Maintenance (~1,000 CDLs)
4 Confirm Actual Results vs. Baseline
5 Extend to Next Target Area
Mar-2017
Aug-2017
Dec-2017
Mar-2017
1 Comprehensive Steam System Analysis (CES® Survey)
Optimize Steam Applications & Steam System Balance
Steam Impact
27 t/h, 599 mil INR/y
Survey fee 35 mil INR
Copyright 2016 by TLV

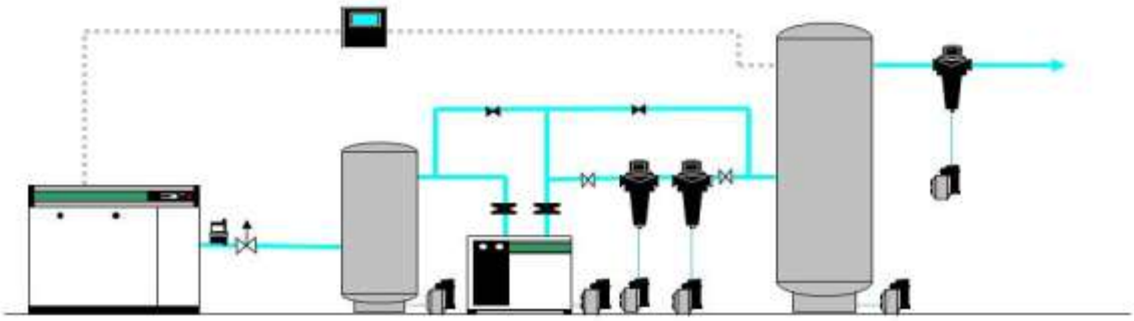

SSOP®
Steam System Optimization Program
~ Realizing a Low-Carbon Society ~
TLV®

Annexure 4: Low carbon technology of compressed air system

Low Carbon Technology of Compressed Air System

Energy savings and environmental friendliness

Chetankumar Sangole
TERI & IGES



Air Compressor

Advantage of Compressed Air

- Easy to use
- Clean
- Air can be returned to atmosphere
- Quick movement
- Light & small actuator
- Safe if leak (no spark)

Hydraulic Power (Powerful)
Electric Power (Accurate)

Volumetric
Boil - Charles's Principle

$$\frac{P1V1}{T1} = \frac{P2V2}{T2}$$

(* P: Pressure, V: Volume, T: Temperature)

When volume decreases, pressure goes up.

Piston

Screw

Scroll

Turbo centrifugal

Bernoulli's Principle

Features of Volumetric Compressor

1. Basic capacity are determined by size of compression room & rotating speed.
2. Basic capacity does not change even by discharge pressure.
3. Power consumption is decreased when discharge pressure is decreased.

Cost and effect in Improvement of Compressed Air System

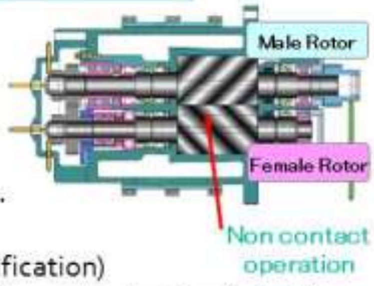
Cost	Small	Medium	Large
Payback period	Very short (less than half year)	Case by case	MAX. 3 - 4 years
Ease of implementation	Easy (Soft technology)	Slightly difficult (Hard + Soft technology)	Difficult (Hard + Soft technology)
Effect	Small ~ medium	Medium	Large
Items to be implemented	1. Reduce air pressure 2. Stop supply for not-in-use area 3. Repair leakage 4. Ventilate compressor room to cool down 5. Efficient air equipment blow gun, air cylinder, nozzle, joint, valves	1. Restructure piping system 2. Size up air-dryer and filter 3. Size up receiver tank 4. Use booster compressor 5. Divide pressure	1. Make clean air system oil-free system 2. Provide drive multi units with multi-controller system 3. Use VFD(VSD) compressor 4. Restructure compressor system choose large size or divide 5. Recover energy

How to choose air compressor system

Variety of Compressor

a) Compression Principle (Volumetric & Centrifugal)
b) Lubricant & Sealing (Oil-flooded & Oil-free)
c) No. of Compression Stages (Single Stage & 2 Stages)
d) Cooling Methods (Air-cooled & Water-cooled)
e) Number of units (Large size or divisible system)

What is Oil-free Compressor?



- High skills and materials are necessary to manufacture.
- Sealing is important even in high-speed operations.
- Maintenance cost is higher than oil-flooded type.
- Efficiency is slightly less than oil-flooded type.
- Price is higher than oil-flooded type; in fact nearly double.

but

- Oil-free compressor can get very clean air (class zero certification)
- It can be used for high technology products and high quality use to develop industries

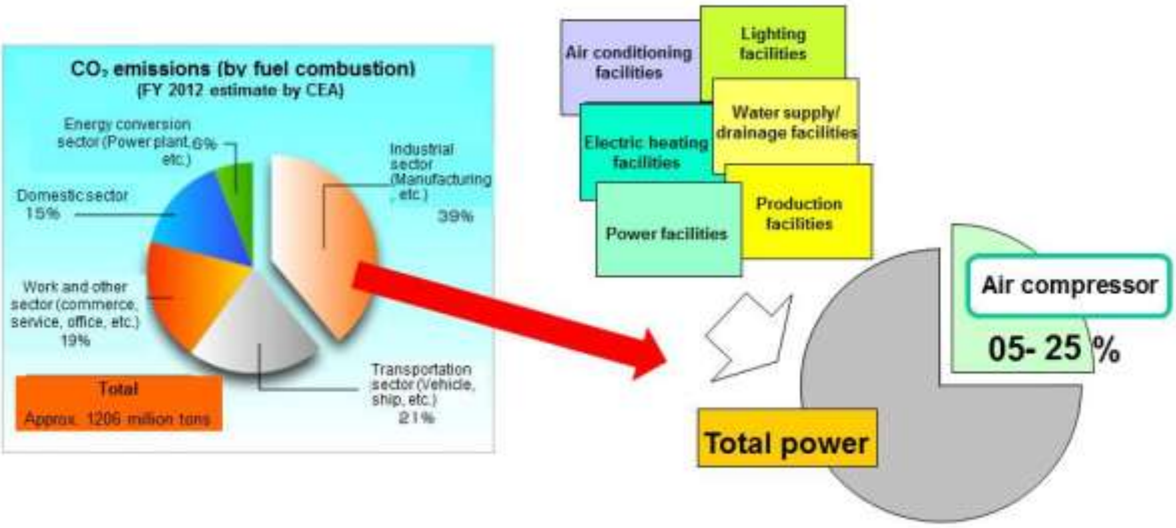
for

- Electronics, semi-conductors, food, medical supplies, textiles, and others
- Oil-free air can meet HACCP, FSSC22000 and GMP regulations.
  - ・HACCP; Hazard Analysis Critical Control Point
  - ・ISO-22000 & FSSC22000; Foundation for Food Safety Certification
  - ・GMP; Good Manufacturing Practice

Advanced technologies below are put into the compressors.

- ・Reciprocating compressor
- ・Screw compressor
- ・Scroll compressor
- ・Centrifugal compressor

Energy Consumption... Case of India

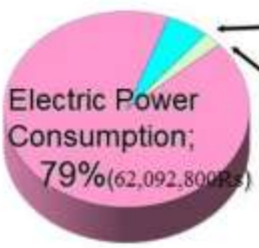


- Industrial energy consumption accounts for approximately 40% of the total energy consumption in India.
- Air compressors energy consumption share is approximately 5% to 25% in almost every industry
- Therefore energy saving for compressors needs to be addressed urgently.

Check out Energy Costs -Specific Power Consumption & Life Cycle Cost

Most of compressor LCC is used for power consumption.

Note: LCC = Life Cycle Cost
<Example>
- Oil flooded 110kW class rotary screw (standard type)
- 6000h/y operation 7.0Rp/kWh
- 60% Load example
- Total cost: 20 years average



Maintenance cost: 12%
(9,500,000 Rs)···full maintenance
Overhaul 3times,
6000hs service 17times.

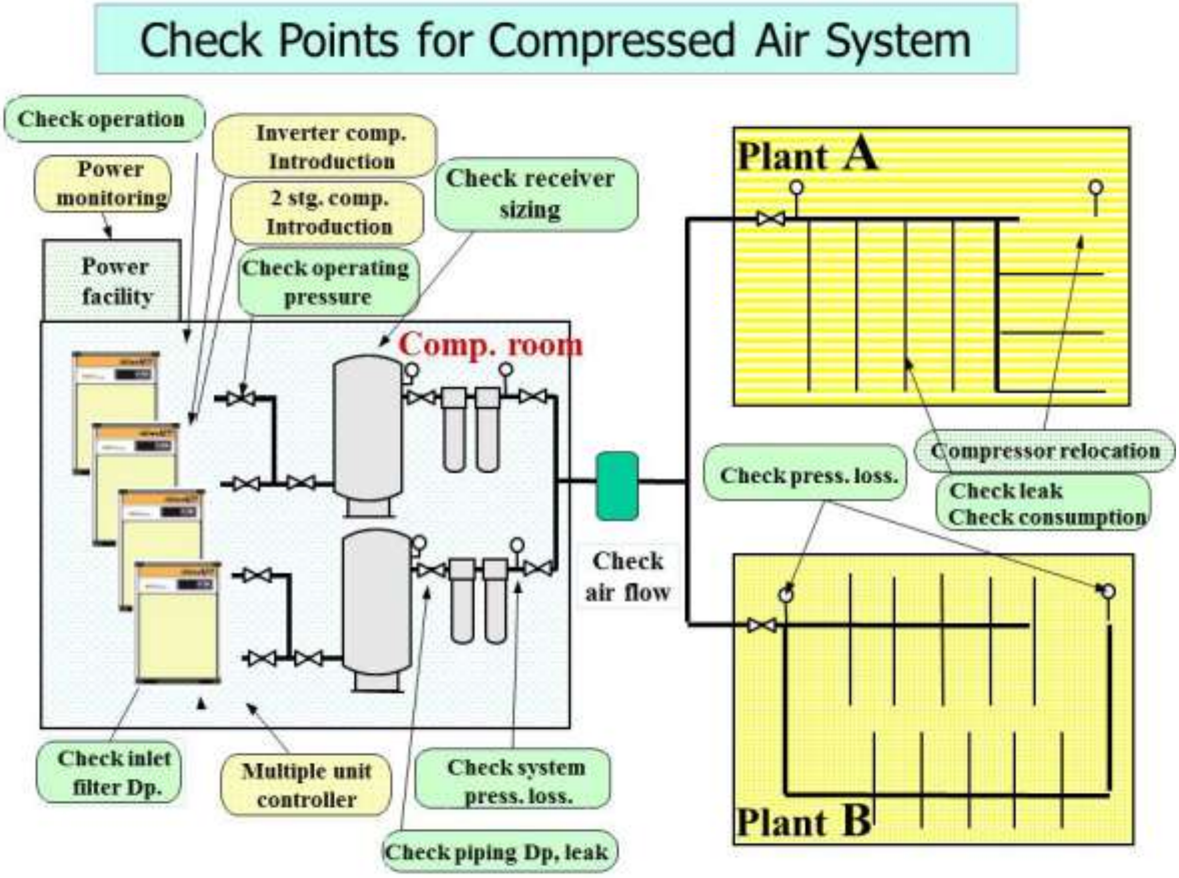
Initial cost: 9%(maximum)
(7,000,000 Rs)···(compressor, air-dryer, filters, air-tank, installation/starting, piping, etc.)

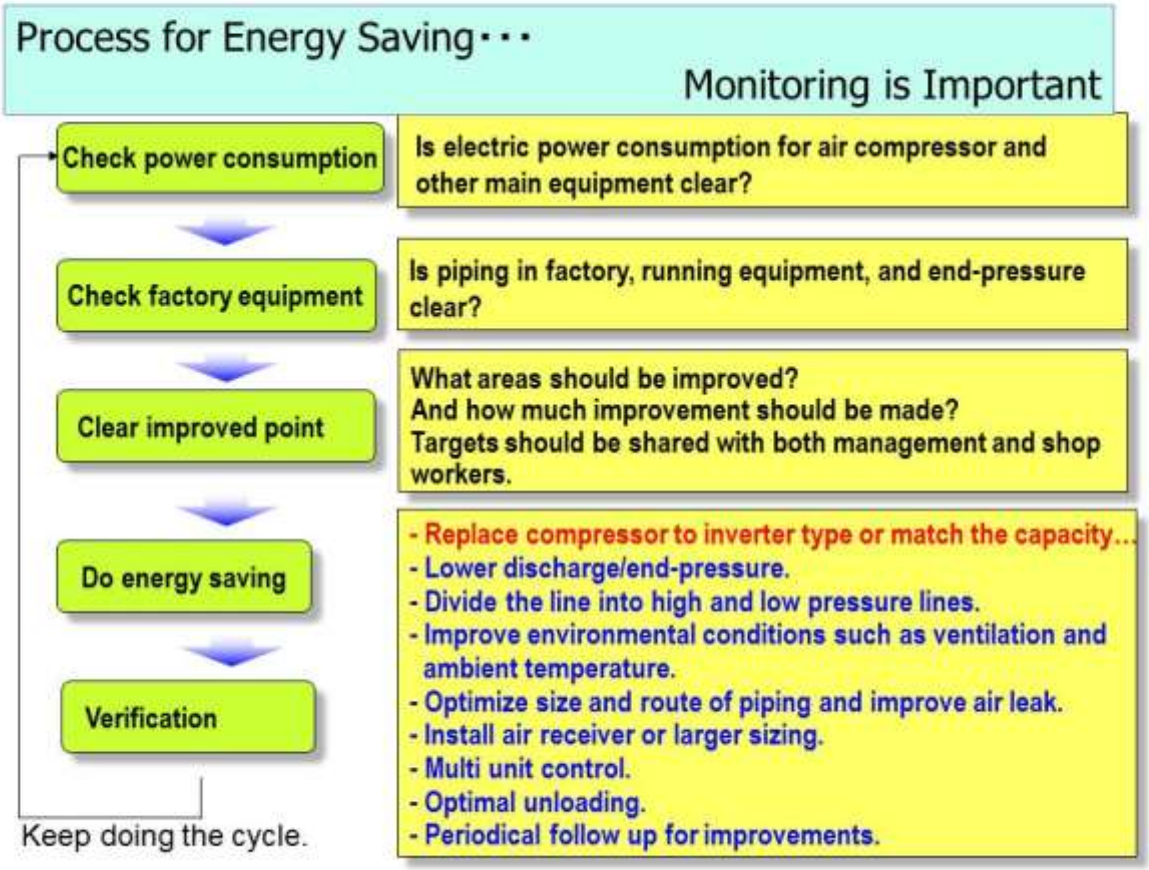
Specific Energy Consumption

How much for 1 m³ of compressed air? --- Example of quick calculation (60%load)

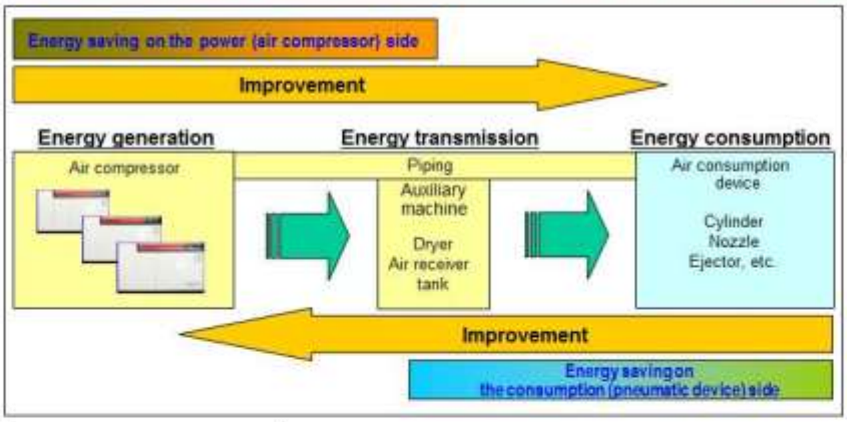
How much cost for your company? 1.2Rs/M3?

$$\text{Energy cost } (1.09\text{Rs}/\text{m}^3) = \frac{\text{Input Power } 84\ (\text{kWh}) \times 0.88 \times \text{Electricity cost } 7.0(\text{Rs/kWh})}{\text{FAD } 13.2\ (\text{m}^3/\text{min}) \times 0.6 \times 60\ (\text{min})}$$


Check Points for Compressed Air System
Check operation
Power monitoring
Power facility
Inverter comp. Introduction
2 stg. comp. Introduction
Check operating pressure
Check receiver sizing
Comp. room
Plant A
Check air flow
Check press. loss.
Compressor relocation
Check leak
Check consumption
Plant B
Check inlet filter Dp.
Multiple unit controller
Check system press. loss.
Check piping Dp, leak


Process for Energy Saving・・・
Monitoring is Important
Check power consumption
Is electric power consumption for air compressor and other main equipment clear?
Check factory equipment
Is piping in factory, running equipment, and end-pressure clear?
Clear improved point
What areas should be improved?
And how much improvement should be made?
Targets should be shared with both management and shop workers.
Do energy saving
- Replace compressor to inverter type or match the capacity...
- Lower discharge/end-pressure.
- Divide the line into high and low pressure lines.
- Improve environmental conditions such as ventilation and ambient temperature.
- Optimize size and route of piping and improve air leak.
- Install air receiver or larger sizing.
- Multi unit control.
- Optimal unloading.
- Periodical follow up for improvements.
Verification
Keep doing the cycle.

Energy Saving from the Viewpoint of the System



Energy management

Energy generation source (electricity consumption)

- Dispersion management / pressure dividing control
- Use of high-efficiency compressors, introduction of multiple unit control

Supply air loss control

Flowability due to pipe size, loss due to pipe length, leakage loss

Management of air usage method

Energy consumption

Actuator driven by air

"Energy for operating production equipment"

Air blow - accounts for 70% of the total.

"Energy for quality control, such as drying and dust/chip removal"

Synchronization between energy generation source (compressor) and devices

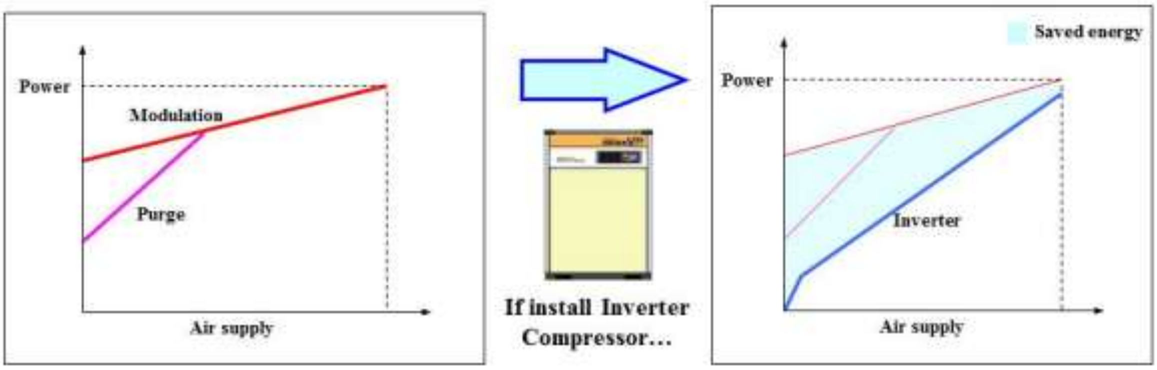
Efficient compressor ~ Most Efficient Position

In this practice, we verify the importance of proper pressure design at positions in air supply lines.

1. Air compressor・・・if air compressor is operated with low power, how does the input power change if compressor is driven by inverter? (VSD…Variable Speed Driven, VFD…Variable Frequency Driven)
2. Local pressurization
   What is "booster compressor"?
3. The pressure is separated.

Compressor Unloading Method Optimization – Inverter Drive

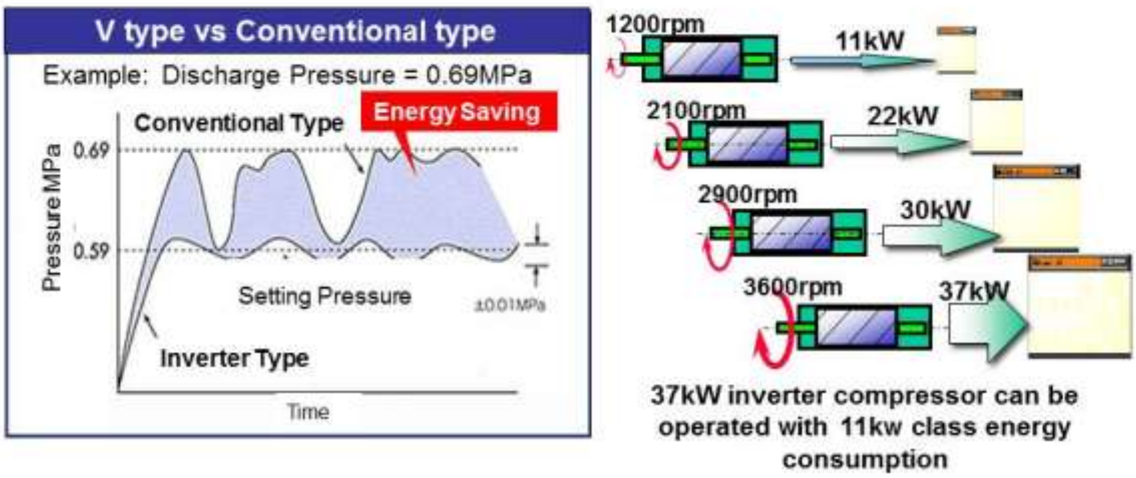
Conventional unloading method (modulation and/or purge) consumes unnecessary power during unloading. Inverter drive can save power!!!



When you calculate the cost for several years, you can pay back the cost within 2 or 3 years. (reducing power consumption=energy cost down=profit) Not only reduction in energy but also protect the environment which reduces CO_2.

Inverter Type: Ideal Choice for Energy Saving

- Controls revolution of compressor according to the load
  No waste of power & ideal capacity control
- Operation with minimum pressure fluctuation
  Inverter type: Keeps the setting pressure
  Conventional type: Fluctuates around the setting pressure (*Refer to the below chart)
- Operation stops during unload
  Avoids waste of electricity (Conventional type runs during unload and consumes unnecessary electricity.)



Example of Power Consumption Reduction with Inverter Compressor

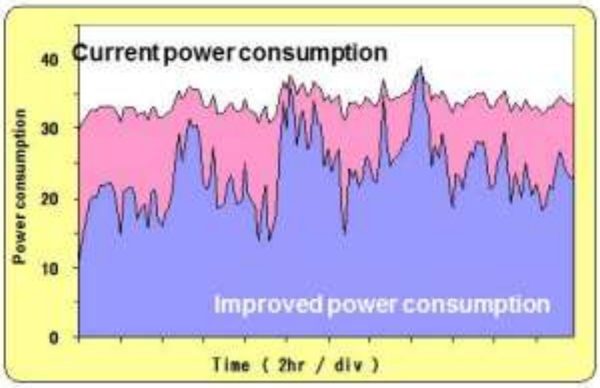
■ Installation procedure

Energy-saving diagnosis of air compressor (Measurement of 37-kW conventional compressor x 1 unit)

Diagnosis result		Improvement content
- Average load factor: 52% - Power consumption: 23,600 kWh/month	→	- 37-kW inverter compressor x 1 unit installed - 34% power reduction

■ Investment and effect

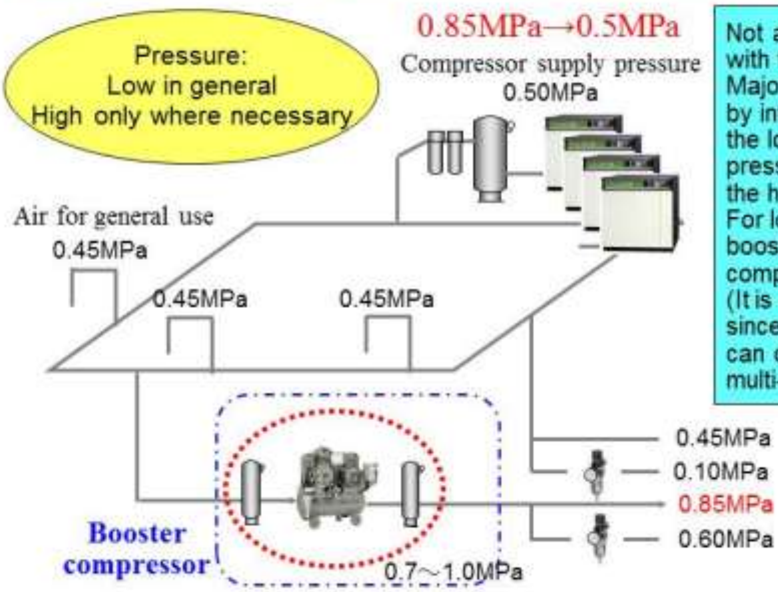
- Investment amount: 1.25 million INRfor a 37-kW inverter compressor
- Energy-saving effect: 0.55 million INR/ year



■ Spillover effects

- Investment in protection of global environment through CO_2 reduction (-34%)
- Investment in longer overhaul cycle (8 years) because of improved component durability, leading to reduced maintenance cost (-30%)

Efficient Usage··Example of Local High Pressurizing

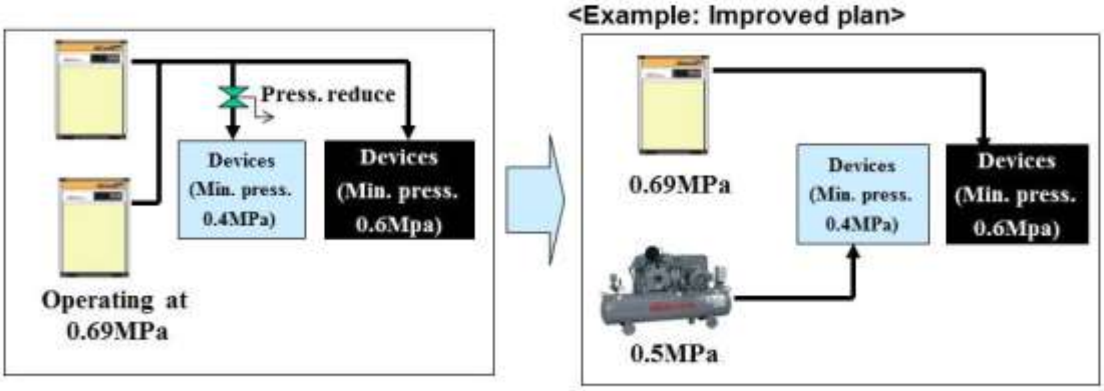


Not all air used at factory is running with the same pressure.
Major energy saving can be expected by introducing low pressurizing for the low-pressure equipment and high pressurizing for the high-pressure equipment.
For local high-pressurizing, use of the boosting valve and the booster compressor is recommended.
(It is excellent in terms of energy since use of the booster compressor can obtain the same effect as the multi-stage compressor)

- Operation pressure of high pressure use section is 0.85MPa now using 37kW 3 compressors.
- Energy reduction of nearly 15% can be achieved if this operation pressure can be lowered up to
- 0.50MPa. In short, reduction of 37kW ÷ 0.9 x 2.5 units × 0.15 = 15.4kW can be achieved.
- Also, the load factor of the power for booster is set at 50% by using booster at 7.5kW,
- 7.5kW ÷ 0.9 x 0.5 = 4.2kW
- Therefore, energy saving of 15.4 - 4.2 = 11.2kW can be achieved.
- Annual energy savings is 11.2kW × 8000h = 89,600kWh (Rs. 627,200)

Is the Current Pressure Appropriate?

- Investigate application of the compressed air in system.
  - air consumption, minimum pressure (Does the device work at lower pressure?)
- Separate the compressor supply system according to demand pressures?
- If you need higher pressure due to pressure loss through piping system, please study about compressor system change or distributed system.

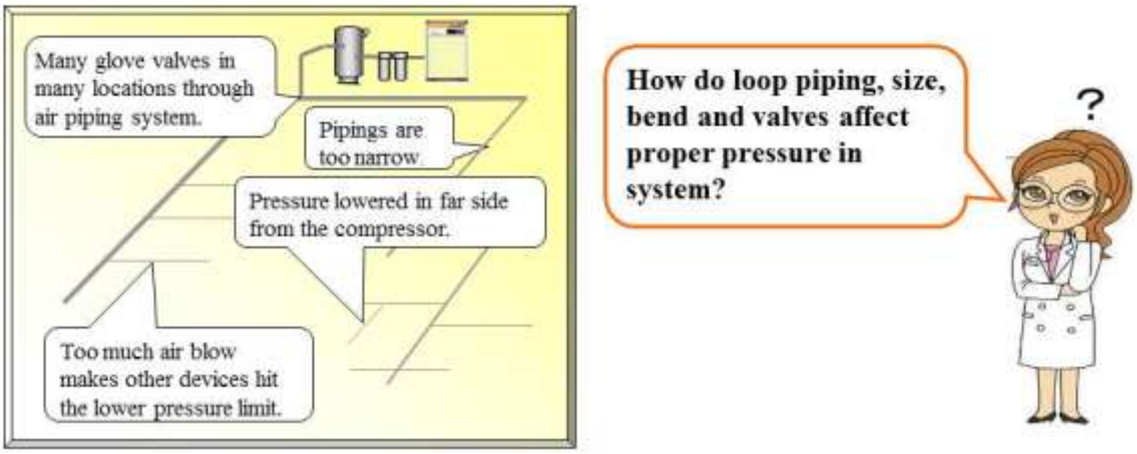


Pressure Optimization by Piping System Redesign

What is an efficient way to deal with local low pressure demand? Do you have similar cases like this in your factory?

1. Un-stabilized factory air.
   [Status] Pressure on far side from compressor unstable.
   Pressure down when other systems are ON.
2. Due to budget allowance, no uniformity on air system such as devices, piping (size, route, valves).

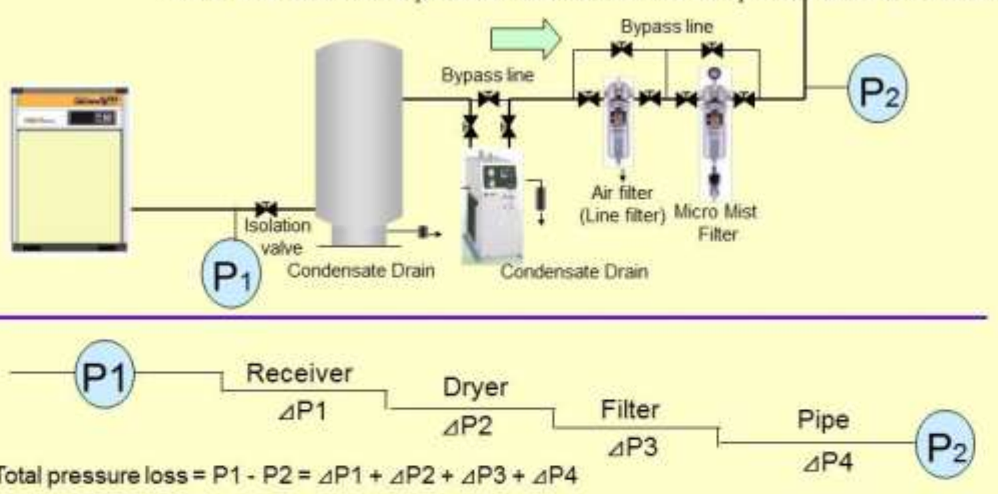
What kind of improvement in this case?



Pressure Loss of Compressor Equipment

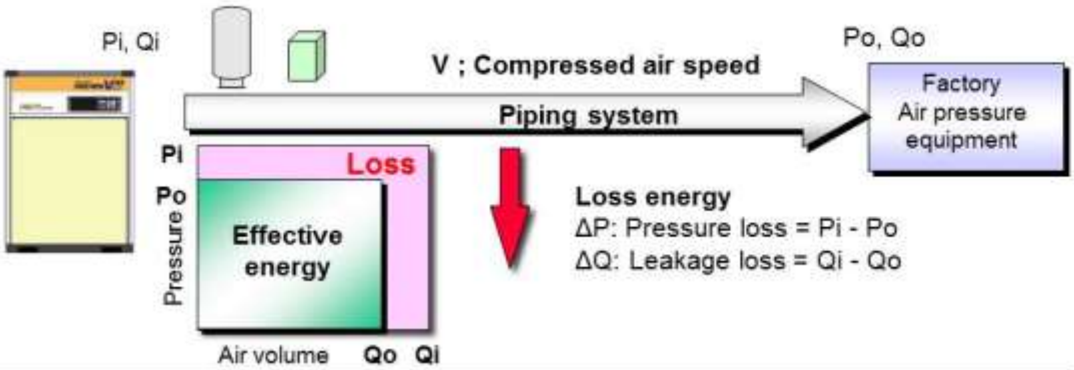
Any system causes a pressure loss.
Think of how to minimize the loss.

Recommended layout (reference example): Compressor -> Receiver -> Dryer -> Filter
Point: This reduces the pressure loss between the compressor and the receiver.



To achieve a higher rate of energy saving, select a pipe having a diameter one size larger than the compressor's discharge pipe diameter. Also, select air dryers and filters having a capacity one size larger.

Pressure Loss Through a Pipe



$$\text{Flow rate in the pipe } V \text{ (m/s)} = \frac{Q_i \text{ Compressor's discharge air volume} \times Ps/Pd}{A \text{ Sectional area of discharge pipe} \times 60}$$

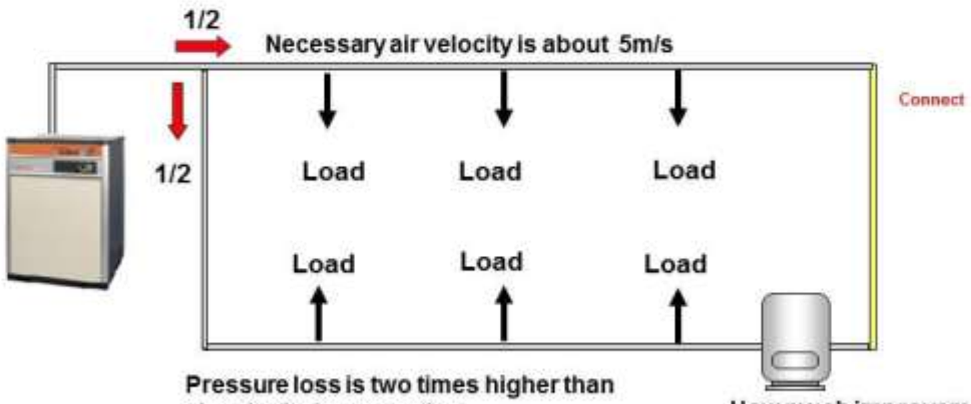
The desired flow rate in the pipe is 4 to 5 m/s. - Economic speed

The smaller the pipe size, the higher the flow rate, causing a larger loss in the pipe. Accordingly energy loss is generated, reducing the energy-saving effect.

- Example of 75kW Air compressor (Japan Model)
  (Discharge pressure: 0.69 MPa, discharge air volume: 13.2 M3/min), size of discharge air pipe: 50A

  V = 13.2 x 0.101 / (0.101 + 0.69) ÷ 0.05 ÷ 0.05 ÷ 3.14 / 4 ÷ 60
  = 14.31 m/sec (This is a very high speed.) The energy-saving effect is low.

Changing Air Velocity Through Internal Pipe···loop piping



Pressure loss is two times higher than air velocity in proportion

Pressure loss is minimized to one quarter, only to make loop piping!

How much improvement can be made with loop piping?

Pressure loss is limited to one quarter, only to make loop piping if there is imbalance in the load.

Improvement Air Compressor System

What is an efficient way to pressurize higher locally within the air supply system?
Do you have similar cases as below?

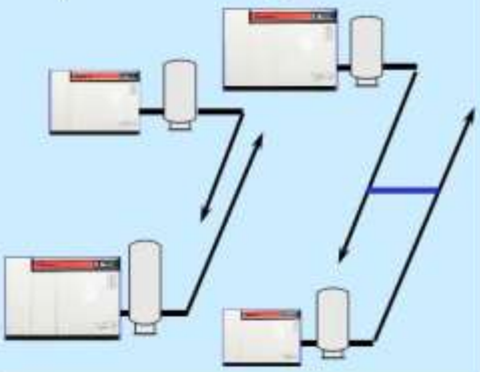
1. What is the best installation "Collective" or "Independent" ?
   If using many compressors, you had better plan to install multi controller system.
2. Compressor still operating even no using air.
   If factory has air leakage, you have to check how much leakage are there and detect leakage point.
3. Air equipment is used efficiently. Blow gun, air cylinder
4. What is the good environment for air compressor system?

The air system is important, isn't it?
We need total system technology!

Which Is More Energy Saving - Collective or Independent?

Collective setting

Independent setting

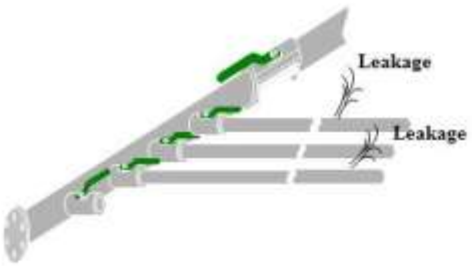


Setting Type	Collective	Independent
Daily Maintenance	Easy	Need to assign staff for each line
Regular maintenance	Easy	Need maintenance in each line
Pressure flexibility	Need to operate with the highest pressure equipment (Some loss)	Able to apply appropriate pressure for each piece of equipment (Min. loss)
Pressure loss	Some Piping tends to be long	Small Piping can be short Adjustment can be made in each line
Air leak	Affects whole air supply system	Affects only line with the leakage
Multi-unit Control	Available	Unavailable

Energy saving can be made using inverter compressor for both collective & independent settings.

1. Collective setting: Inverter compressor absorbs load fluctuation
2. Independent setting: Easy to accomplish energy saving

Leakage Checking Method



- Leakage check is performed at night or on holidays when the plant is not in operation.
- Once the compressor is operated and raised up to predetermined pressure, stop the compressor and measure the time required for pressure reduction of 1bar from the predetermined pressure.
- Since all of this leads to waste of energy, quick actions are vital.
- It is possible to calculate the amount of leakage from the above investigation, then leakage locations need to be identified in the next step.
- Keeping that in mind, take measures from the most leakage prone areas.
- Leakage cannot be completely stopped with one-time measures.
- Continuous monitoring is required.

Places where air leakage is likely to occur

Valve

Blow gun

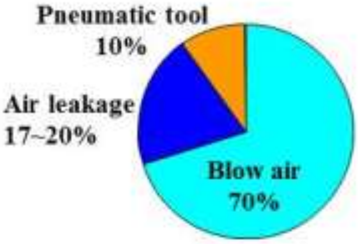
Regulator

Piping coupling

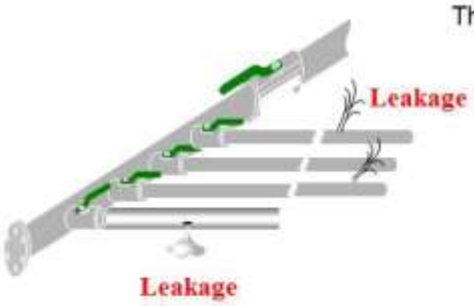
- Air leakage occurring as shown covers as much as 20% of the total average plants.
- The amount of leakage can be calculated by the formula in the next slide, after confirming, the same leakage areas can be identified and effective leakage reduction can be achieved.
- Target reduction is half of the total ratio.

How to Check Air Leakage?

Recommendation:
determine total leakage and reduce it by Leakage Checking Method



1) Operate compressor at night, or on a holiday, and shut it down when achieving a predetermined pressure value.
2) When the compressor is shut down, due to the leakage, the pressure will automatically decrease. The amount of leakage can be known by measuring the <u>time (t) taken to decrease the pressure by 0.1MPa</u>.



The formula to determine the leakage (C) is given below:

$$C = \frac{(P1 - P2) \times V}{Po \times t}$$

With:
C=Volume of leakage (M3/min)
P1= Predetermined pressure (MPa) (gauge pressure + 0.101MPa)
P2= Pressure after leakage (MPa) (gauge pressure + 0.101MPa)
t=Time taken to reduce pressure from P1 to P2 (min)
Po= Atmospheric air pressure(MPa)
V= Piping capacity (Mm3) (In case of your company; ? m3)

Effective Usage of Air

Mainly, usage of air is divided into; ① Air blow, ② Machine driving

① Air blow

◆ Consuming most air in a factory【No.1】
A continuous air sound used in a factory increases the amount of air consumption considerably if having much air blow work and continuous use.
As for blow gun, a nozzle-type gun saves energy.

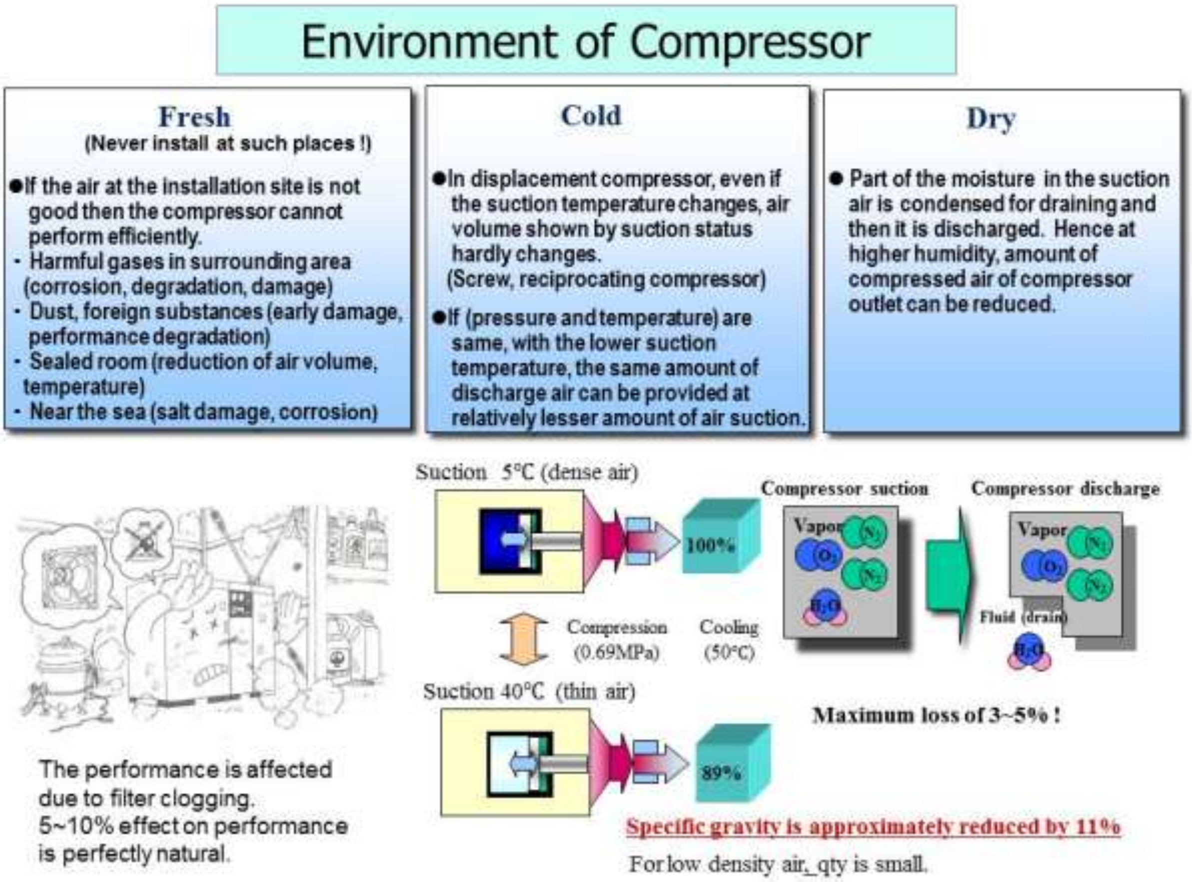
【Checking point】
① Diameter of air blow outlet... (consumption is "large", if the size is large)
② Pressure of outlet (supply pressure) ... (consumption is "large", if the pressure is high)
③ Time and frequency

② For machine driving (Actuator)

◆ The air used for "actuator (air cylinder)" driving isn't so large, but guaranteed minimum pressure is required since it is needed to provide the power.

Note: Are【Supply pressure】and supply amount appropriate?

The air supply amount can be reduced by 30 % when installing air saving valve in the exhaust outlet of air cylinder.
Checking regulator's pressure gauge to confirm whether or not it can be decompressed.
Also, the consumption can be reduced by combining with air saving valve.


Environment of Compressor
Fresh
(Never install at such places !)
●If the air at the installation site is not good then the compressor cannot perform efficiently.
・Harmful gases in surrounding area (corrosion, degradation, damage)
・Dust, foreign substances (early damage, performance degradation)
・Sealed room (reduction of air volume, temperature)
・Near the sea (salt damage, corrosion)
Cold
●In displacement compressor, even if the suction temperature changes, air volume shown by suction status hardly changes.
(Screw, reciprocating compressor)
●If (pressure and temperature) are same, with the lower suction temperature, the same amount of discharge air can be provided at relatively lesser amount of air suction.
Dry
● Part of the moisture in the suction air is condensed for draining and then it is discharged. Hence at higher humidity, amount of compressed air of compressor outlet can be reduced.
Suction 5°C (dense air)
100%
Compression (0.69MPa)
Cooling (50°C)
Suction 40°C (thin air)
89%
Compressor suction
Compressor discharge
Vapor
Fluid (drain)
Maximum loss of 3~5% !
Specific gravity is approximately reduced by 11%
For low density air, qty is small.
The performance is affected due to filter clogging.
5~10% effect on performance is perfectly natural.

Annexure 5: Presentation on TERI Experience in energy audit and case studies on steam system

TERI Experience in Energy Audit and Case studies on steam System

teri Creating Innovative Solutions for a Sustainable Future

16th November 2016
Mumbai

What is TERI

- An independent, not-for-profit research organization established in 1974;
- Pursuing activities related to energy, environment and sustainable development;
- It conducts cutting-edge scientific, technological and policy research with a focus on finding practical solutions to real-life problems faced by the government, corporate sector, urban and rural communities.

teri Creating Innovative Solutions for a Sustainable Future

TERI's structure

Dr Ajay Mathur, Director-General

Directors
- Regulatory Studies and Governance
- Policy Analysis
- Energy-Environment Technology
- Bioresources and Biotechnology
- Earth Sciences & Climate Change
- Information Technology and Services
- TERI University

teri Creating Innovative Solutions for a Sustainable Future

Industrial Energy Group

- Has earned a name for itself in the field of Energy Efficiency
  - Comprehensive Energy Efficiency study,
  - Implementation Assistance :E_η Projects
  - Training on rational use of energy

teri Creating Innovative Solutions for a Sustainable Future

Spectrum of Services

- Comprehensive energy audit for identification of energy saving potential – Industries / Commercial Buildings;
- Energy efficiency services for Water & Electricity utilities;
- Project appraisal for incorporation of energy efficiency parameters during the design stage; (Green Field Projects)
- Evaluation of economically viable alternatives for efficiency improvement projects;
- Energy Efficiency savings monitoring for ESCOs;
- Power plant mapping– Energy Efficiency improvement and monitoring power plant performance;
- Market Research studies – Oil & Gas sectors.

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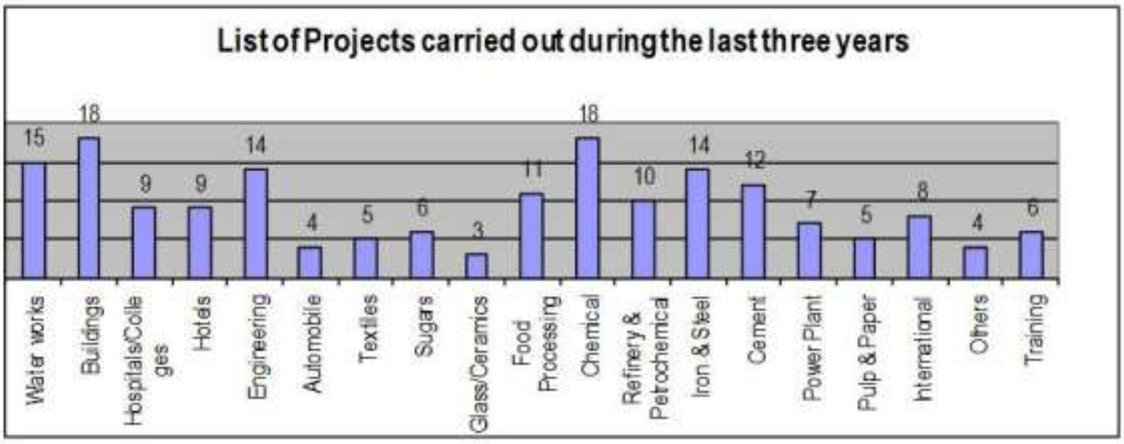
Energy Audit sectors

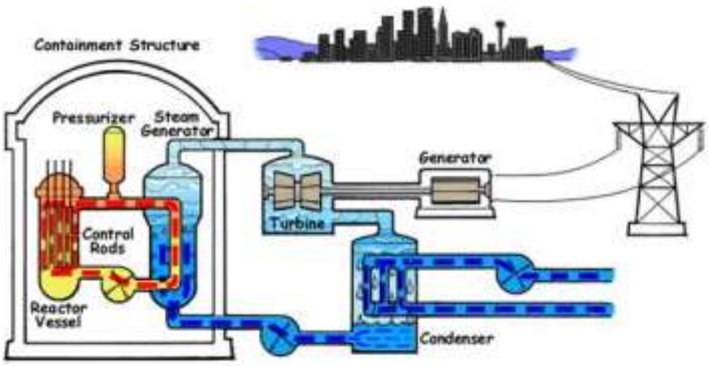


teri Creating Innovative Solutions for a Sustainable Future

International Experience – Eη

- Rendered the services to more than 25 countries, both developed and developing;
- Major sectors
  - Mining sector (Copper, Gold, Platinum)
  - Chemical plant
  - Food Processing
  - Commercial Buildings
  - Public Utilities (mainly water supply / electricity distribution companies)
- Services recognized by
  - World Bank, Asian Development Bank, GIZ, SIDA, UN Habitat etc.

Steam System

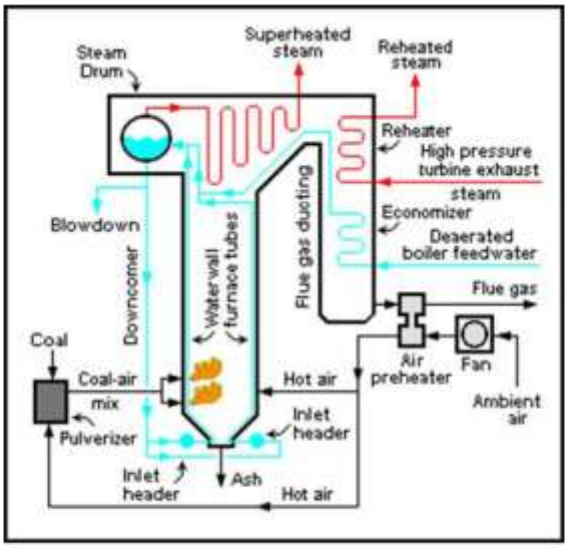


Steam System

- Steam Generation
- Steam Utilization
- Steam Distribution

Creating Innovative Solutions for a Sustainable Future

Steam Generation



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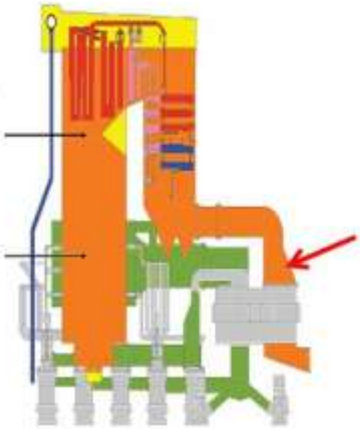
Case Study-1: Improving boiler efficiency by reducing excess air flow

Utility oil fired boiler of capacity 24TPH at 18.5kg/cm² (MP)

Observation:

- Measured percentage of O_2 in flue gas, was 10%.
- Found that FD fan discharge damper 60% open (Steam Driven)
- Excess air supply to the boiler was around 90~130%.
- The evaluated combined boiler efficiency was 78.92%.



Particulars	UB-3
Dry flue gas losses	13.21%
Heat loss due to H_2 in fuel	6.62%
Heat loss due to moisture in fuel	0.02%
Heat loss due to moisture in air	0.20%
Heat loss due to surface radiation and convection	1.02%
Boiler efficiency	**78.92%**

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Case Study-1: Improving boiler efficiency by reducing excess air flow

Recommendation:

- Further close the damper of FD fan and maintain the $\%O_2$ around 6~7%
- Rectify steam turbine governor and operates at lower speed.

Energy Savings:

- Present Fuel oil consumption : 800kg/hr
- Estimated fuel oil saving : 30kg/hr
- Annual operating hours : 7200 hrs
- Annual fuel oil savings : 216 tonne
- Cost savings per annum (@ Rs 21000 / tonne) : Rs 45.41lakh
- Investment : Negligible
- Simple payback period : Nil

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Case Study-2: Supply sufficient excess air to avoid incomplete combustion

Thermal power plant of capacity 300 MW consist of boiler of 1014 TPH steam (BMCR condition) at 172.41kg/cm² (for superheated steam).

Observation:

- Found Carbon monoxide (CO) presence
- Malfunctioning of oxygen sensor
- Low Boiler efficiency

Particulars	Unit	Unit-2
Before APH		
O2%	%	1.46
CO2%	%	17.11
Temperature	⁰C	316
CO	ppm	**128**

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Case Study-2: Supply sufficient excess air to avoid incomplete combustion

Recommendation:

- Supply sufficient excess air (20-25% excess air) to avoid incomplete combustion
- Also suggested to procure good quality portable oxygen analyser for manually measurement of oxygen level and periodically.

Energy Savings:

- Coal consumption during measurement : 209.92TPH
- Coal saving : 1.26TPH
- Annual operating hours (24 hrs x 60 days) : 1440hrs
- Annual energy savings : 1450MT
- Annual cost savings (@ Rs 2700/MT) : Rs 39.15 Lakh
- Simple payback period : 0.2 year

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Summary: Combustion air supply to Boiler

Fuel	Excess Air, %	
	Min	Max
Natural gas	5	7
Light oil	13	20
Heavy oil	20	25
Coal - Pulverised coal	15	40
- Spreader Stoker	30	60

Source: Energy Efficiency Office, UK. The above settings are typical for boilers without low excess air combustion equipment

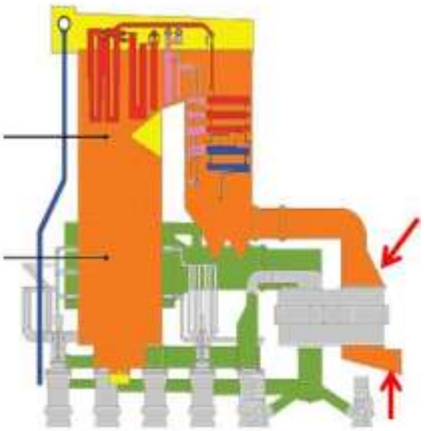
- **Every 1% reduction in excess air there is approximately 0.06% raise in efficiency**

Case Study-3: Air ingression in flue gas path

Thermal power plant of capacity 150 MW consist of CFBC boiler of 500 TPH at 137kg/cm².

- **Observation:**
- Found leakage in air -preheater and ambient air is mixed with flue gas

At APH inlet O2%	: 5.5%
At APH outlet O2%	: 11.5%
Air entry in to APH	: {(11.5-5.5)/(21-11.5)} : 63.0%



- SA fans bellow has ruptured. This is cause for the heavy leakages in to APH
- Flue gas flow is around 643750m³/hr which is higher (9%) as compare to Unit-1 ID fans flow (588980m³/hr).

Case Study-3: Air ingression in flue gas path

Recommendation:

- Minimise the air ingression quantity across Air preheater.
- Reduce present level from 63% of air ingression to 20-25% level.

Energy Savings:

- Measured power consumption : 2079kW (1009+1070)
- Reduction in power consumption : 160kW (8%)
- Coal saving : 0..8TPH
- Annual operating hours : 7920hrs
- Annual cost savings (@ Rs 2700/MT) : Rs 240Lakh
- Simple payback period : 0.4 year

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Other Potential in steam generation

Stack Temperature

- Stack temperatures greater than 200°C indicates potential for recovery of waste heat.

Radiation and Convection Heat Loss

- Fixed energy loss, irrespective of the boiler output.

Automatic Blowdown Control

- Sense and respond to boiler water conductivity and pH.

Reduction of Boiler Steam Pressure

- Permissible, by as much as 1 to 2%

Variable Speed Control for Fans, Blowers and Pumps

Effective Boiler Loading

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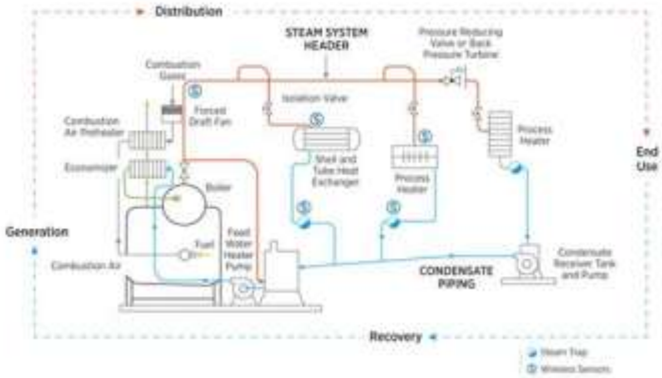
Steam Utilisation



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Case Study-4: Effective utilisation of Saturated steam

- In paper manufacturing, LP steam is used in drying section.
- 16TPH Steam requirement for dryers (4 nos) is supplied from extraction at diff stages of turbine.
- Steam is extracted from the turbine is at superheated condition and then passed through PRDS for making saturate steam for process heating application.

Observation:

- Saturated dry steam is required at around 0.3 to 0.5kg/cm² for pre and 2.2 to 2.5 bar kg/cm² for final drying process
- Suppling high pressure steam at 4.2kg/ cm² &175⁰C (Superheated condition)
- Bypass of steam traps
- Separator also was not working properly and effecting condensate recovery

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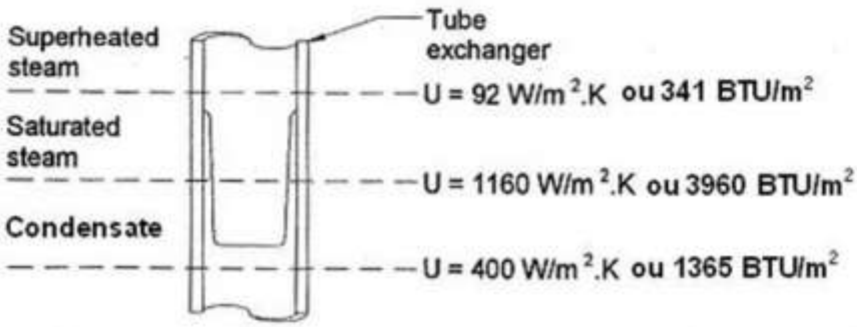
Case Study-4: Effective utilisation of Saturated steam

- **Why is saturated steam generally preferable to superheated steam?**



Heat transfer coefficient (U) of superheated steam has same as air which is good insulator

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Case Study 4: Effective utilisation of Saturated steam

- **Recommendation:**
  - Reduce the steam pressure in PRDS upto 2.8~3.0kg/cm^2 and accordingly maintain the sat. steam temperature slightly higher (+5^{0}C)
  - Supply steam at dry saturated condition to drying section

- **Energy Savings:**

Present LP steam consumption	: 16 TPH
Estimated coal saving	: 28 kg/hr
Annual operating hours	: 8000
Annual coal saving	: 224 tonne
Annual cost savings (@ Rs 4000/ tonne of coal)	: Rs.9.14 lakhs
Investment cost	: Negligible
Simple payback period	: Immediate

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Case Study-5: Condensate Recovery System & Hot Water Generation

Observation:

- In leading food processing industry, Hot water requirement in plant is around 12 to 13 KL/hr for solid- liquid extraction.
- Hot water generator was consist of two insulated tank contain stainless steel steam coil at the bottom.
- PRV valve of steam line was not working due to that 14.5kg/cm^2 steam is passed through steam coil which is inefficient way of heat transfer.
- Condensate from the Evaporator (10-11TPH) and Spray dryer (4 TPH) of temperature 80-85^{0}C was draining.
- Steam was generated by using both wood fired and FO fired boiler to meet the steam demand of 10 TPH.

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Case Study-5: Condensate Recovery System & Hot Water Generation

Recommended:

- Recovery the condensate from evaporator and spray dryer.
- Utilise condensate for boiler feed water and excess condensate water as hot water for process requirement.
- Remaining hot water can be generated by using PHE.
- Investment cost was around Rs. 38 Lakhs.

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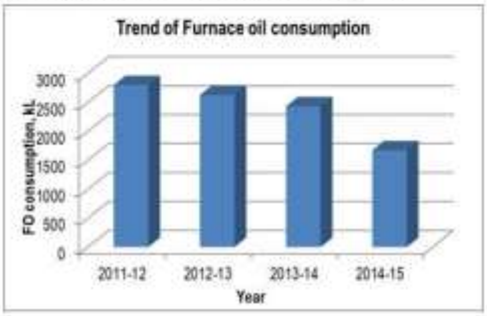
Case Study-5: Condensate Recovery System & Hot Water Generation

Energy Saving:

- It helped to reduce the steam demand for hot water generation from 1.5-2 TPH to 0.5-0.7TPH
- Steam at 0.5kg/cm^2 is used for generating hot water.
- Steam demand has reduced to 5 TPH and only single boiler (Wood fired) is in operation.
- Furnace oil consumption has been reduced by 40% which is around Rs. 447 lakhs and payback period is less than 1 month.



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Case Study-6: Installation of VAM

Observation:

- Plant was using reciprocating type chiller to generate the chilled water for process
- Ammonia was used as refrigerant in chiller which is hazardous and toxic.

- Operating Specific Power Consumption (SPC) of chiller was 0.81 kW/TR.
- Cost of chilled water generation by Compressor-chiller was 6.5 Rs/TR.

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Case Study-6: Installation of VAM

- **Recommended:**
  - Suggested to installed Vapour absorption machine (VAM) to generate the chilled water for process.
  - Investment cost for installing VAM was Rs. 55 Lakhs.
- **Energy Saving:**
  - Specific steam consumption of VAM is 6.93kg/ TR
  - Operating cost of chilled water generation through VAM is 3.44 Rs/TR
  - Saving is 8.8 Lakhs and payback period is 6.25 years.

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Other Potential in steam Utilisation

- **Utilisation of process heat/ Waste heat for heating application**
- **Use low grade heat for space cooling**
- **Effective utilisation of Heat exchangers**
- **Pinch technology**

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Steam Distribution

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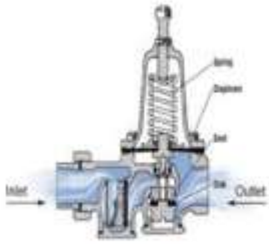
Case Study-7: Power generation using steam turbine in place of using PRV's

HP, MP and LP steam required for process heating

Observation:

- As per process requirement, HP steam is converted to MP steam either through turbine (142.7TPH) or through PRV's (88.3TPH).
- Around 53TPH of MP steam is passed through PRV to convert to LP steam.



Particular	HP (TPH)	MP (TPH)	LP (TPH)
Generation	231.1	35.7	15
Consumption	0.1	213.7	67.6
Net requirement	-231	178	52.6
HP steam convert to MP (through turbine)	142.7		
HP steam convert to MP (through PRV's)	88.3		
Again converting MP to LP (through PRV's)	53.0		

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Case Study-7: Power generation using steam turbine in place of using PRV's

Recommended:

- Install extraction cum back pressure turbine of 3.0MWcapacity.
- It will convert around 40TPH of MP steam and 50TPH of LP steam.
- A noncondensing, extraction cum backpressure steam turbine can perform the same pressure-reducing function as a PRV while converting steam energy into electrical energy and exhaust steam can be connected to MP and LP steam header.

Energy Saving:

• Estimated overall energy savings	: 160 lakh kWh
• Annual Energy Savings (@ Rs. 6.37/kWh)	: Rs 1019 lakh
• Investment Cost	: Rs 1500 lakh
• Payback period	: 1.47 years

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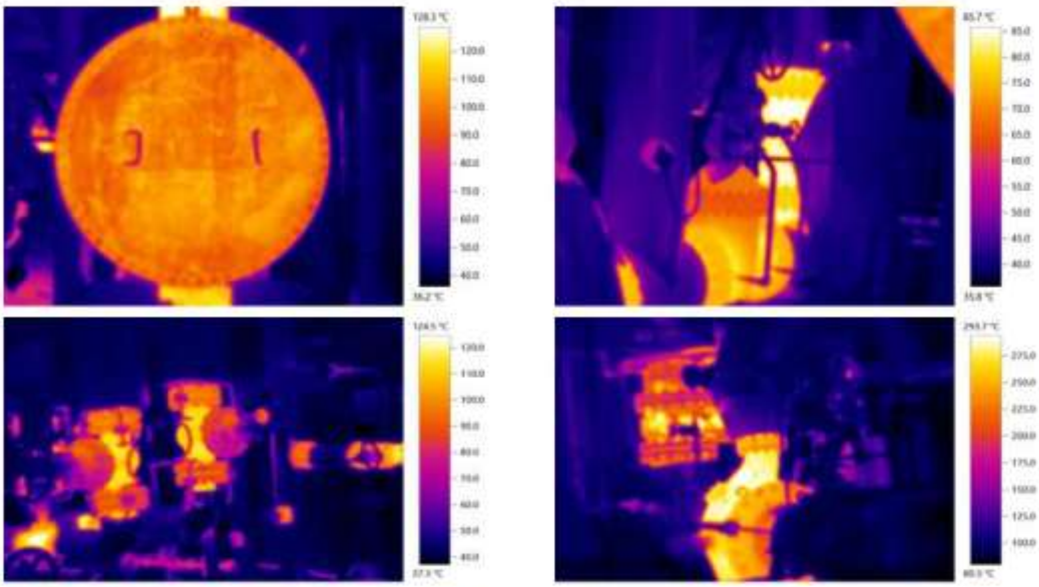
Case Study-8: Reduce the radiation loss by using optimal size of insulation



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Case Study-8: Reduce the radiation loss by using optimal size of insulation

Recommended:

- Install better quality of insulation on bare pips and areas where insulation is damaged.
- Removable type (Jacket) insulation should be installed for PRV, pumps and heat exchangers tube side opening part.

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Case Study-2: Reduce the radiation loss by using optimal size of insulation

Energy Saving:

• Annual fuel oil and gas saving	: 818 tonnes
• Annual Energy Savings (@ Rs. 20000/tonne)	: Rs 163 lakh
• Investment Cost	: Rs 358lakh
• Payback period	: 2.2 years

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Annexure 6: Selected photographs of the event