Workshop Proceedings

Promoting transfer of energy efficient industrial technologies from Japan to India

11th December, 2015 at Pune

Organised by

The Energy and Resources Institute (TERI)

With support from

Shakti Sustainable Energy Foundation

&

Institute for Global Environmental Strategies

Summary

A dissemination workshop on 'Promoting transfer of energy efficient industrial technologies from Japan to India' was organised on 11th December, 2015, at Hotel Courtyard Marriott, Pune by TERI in collaboration with Maharashtra Energy Development Agency (MEDA) and Mahratta Chamber of Commerce, Industries and Agriculture (MCCIA). The event was supported by Institute for Global Environmental Strategies (IGES), Japan and Shakti Sustainable Energy Foundation. The agenda of the event is given in Annexure 1. A summary of the deliberations of the workshop is given below.

Mr Girish Sethi from TERI welcomed the Japanese experts and other delegates to the event. He recalled the long and fruitful cooperation between TERI-Shakti-IGES in promoting energy efficient Japanese technologies among Indian industries. He mentioned that officials from Hyogo prefecture will be visiting Gujarat in January 2016. A joint workshop between India and Japan side is proposed to be organised in Ahmedabad. Also, a number of Japanese companies are showing a keen interest to work in India. He briefed about the recent field visits carried out by boiler expert from Miura (Japan) and steam experts from TLV (Japan) to various industries. These Japanese experts will also present their findings during this workshop.

Mr Shashank Jain from Shakti Sustainable Energy Foundation gave an overview of energy saving possibilities through energy efficiency. He mentioned that India is the fourth largest economy in the world and the country's energy demand is expected to double in next 15-20 years. Energy efficiency is the most attractive option as the country's energy imports is likely to rise from 30% in 2010 to more than 50% in 2030. He mentioned that energy efficiency could help to reduce production cost, improve competitiveness and reduce CO_2 emissions considerably. It has been estimated that India could save 800 million tonnes of oil equivalent of energy through energy efficiency alone. He mentioned that if the human development index (HDI) of India is to rise to that of developed country levels, the per capita energy consumption of the country will increase by 5 to 6 times of the present level. He mentioned that climate change issues and associated impacts are matter of high concern at the global level and is a challenge for all organizations to tackle it. Japan is well known for energy efficient technologies and hence bilateral cooperation with Japan will be of great mutual benefit for India. He urged industries to come forward to take help from organisations such as TERI for improving their energy efficiency. India has some of the best as well as worst energy performing plants in the world in several sectors. Although the country has good policies like Energy Conservation Act, Electricity Act, PAT scheme and so on to promote energy efficiency, there is scope to improve the implementation of the policies. TERI can act as catalyst for promoting energy efficient technologies in India. Under the present initiative, all partners are playing an important role viz. TERI is identifying the industries for implementing energy efficient Japanese technologies; IGES is helping to provide Japanese experts and technologies and Shakti is supporting the India side with financial and other resources.

Dr Rabhi Abdessalem, IGES provided an overview about IGES and the IGES-Shakti-TERI collaboration in India. He mentioned that feasibility studies, detailed studies and demonstration project have been undertaken under the collaboration in a number of Japanese energy efficient technologies and best practices. He emphasised the importance of capacity building for improving the operating and maintenance practices. During 2015, the focus of activities has been on building on previous achievements and strengthening partnership. An empirical technology assessment framework has been used by IGES to identify priority technologies in 6 focus countries – Bangladesh, India, Indonesia, Mongolia, Thailand and Vietnam. The framework is using technology mapping technique to develop recommendations/proposals on increasing strengths and minimizing weaknesses (and/or enhancing opportunities and minimizing threats) to promote Japanese technologies overseas. Based on the technology mapping exercise the three technologies – high efficient air compressors, once-through boilers and steam control system – have been shortlisted for India. In conclusion he mentioned that the differences in perspectives between supply and demand sides can be addressed by strengthening and widening the partnership among different stakeholders (government, industry associations, research institutes and funding organisations) to continue the matchmaking between business to business (B2B) and business to finance (B2F) and open further Japan-India Environmental Technology Gateway. A copy of his presentation is provided in Annexure 2.

Mr Prosanto Pal, TERI gave an overview of Japanese energy efficient technologies for industries. He mentioned that the demonstrated EHP and GHP technologies have resulted in energy savings between 35-50% and corresponding CO2 reduction between 40-50%. He explained the approach of promoting Japanese energy efficient technologies being followed by TERI-Shakti-IGES mainly with regard to selection of large industries/designated consumers (DCs), conducting detailed feasibility studies jointly with Japanese experts and facilitating MOUs between Japanese technology suppliers and Indian industry. A copy of his presentation is provided in Annexure 3.

Mr Chetan Sangole, TERI, presented in details the activities and results of the TERI-Shakti-IGES project. He shared case-studies from feasibility studies of adoption of energy efficient air compressors from five DCs/large industries in textile sector. Replacement of reciprocating/screw air compressors with high energy efficient inverter type screw air compressors in capacity range 30 to 75 kW (200 to 400 CFM), result in energy savings of Rs 19 lakhs per annum. The payback on investment is between 2 – 3 years. A copy of the presentation is provided in Annexure 4.

Mr Kenichiro IKEUCHI, MIURA, Japan made presentation on 'Energy efficient once-through boilers'. He mentioned 87% of boilers in Japan are once through type. Miura has about 50% share in these type of boilers. He shared some of the salient construction features of these boilers like no drum (more safe), compact (due to vertical piping) and shorter evaporation time (boiler start-up time is between 3-5 minutes). Hence the efficiency of the boilers are very high (about 96%). He also shared about the energy savings diagnosis techniques, case studies of once through boiler and online services of maintenance support for overseas customer. A copy of the presentation is provided in Annexure 5.

Mr Hayato KIDA, TLV, Japan made presentation on Energy efficiency in Steam Systems' – Japanese Experience. He mentioned about some special products of TLV like free float traps, special PRV systems for which life is high compared to other brands. He mentioned TLV provides CDL (condensate discharge locations) solutions to optimise and reduce steam. He shared methodology used for phase wise implementation for optimization of steam. He mentioned that there is huge potential for steam system optimization and can be achieved through SSOP (steam system optimization program) He later shared the case study and resulted savings from the study. A copy of the presentation is provided in Annexure 6.

The presentations were followed by panel discussion in which experts from Indian industry (Mahindra and Century Enka), Japanese industry (Miura, TLV), government (MEDA), funding organisation (Shakti, SIDBI) and research organisations (TERI, IGES) participated. The panel addressed the following three questions raised by Dr Rabhi Abdessalem, IGES earlier in his presentation, viz.,

- What are key advantages of Japanese technologies over competing ones (e.g: Japanese once through boiler vs. non Japanese once through boiler)?

- What are key opportunities and threats (barriers) to promote Japanese technology dissemination in India (e.g: Japanese once through boiler)?
- What strategy could be taken to enhance the strengths and minimize weaknesses and/or to enhance opportunities and minimize threats to promote Japanese technology dissemination in India

The discussions gave an insight about the advantages of EE Japanese technologies, key opportunities and threats to promote them in Indian industries and strategies that could enhance the strength and reduce the threats while achieving the common goal of reduction of emissions and improving energy efficiency. It was felt by the entire panel that Japanese technologies have high quality, safety, reliability and durability.

Specifically, in steam systems, mechanical steam traps offered by TLV are good, having longer life and possibility to recover the condensate. Some of the challenges highlighted by TLV to market the technology are regulations such as Indian Boilers Regulation (IBR) for boilers and steam systems and higher cost of Japanese equipment.

The representative of Miura outlined some of the advantages of their technology viz., low energy consumption and carbon-dioxide emissions, large number of commercially viable replications, micro-processor for data storage, on-line maintenance services for remote location from Japan, safety and maintenance agreements with the parent company etc. One of the major barriers to marketing the technology in India is the need to meet local regulations like IBR (which adds to product cost).

The panelist from Shakti mentioned that there is good demand for energy efficiency services in India due to regulations such as PAT scheme and climate action plans (INDC) formulated recently. There are several international technology suppliers are providing efficient equipment in Indian market. In order to compete with products from other countries, Japanese businesses could consider reviewing the specifications of their equipment so as to reduce their level of sophistication for Indian market. Also in order to reduce cost, the equipment should be manufactured in India. He mentioned that a Climate Fund for Technology Transfer can be created under multilateral climate change processes for transfer of cleaner technologies to developed countries.

TERI recommended that in order to reduce cost of EE Japanese technologies, Japanese companies should explore procuring some of the simple sub-systems like motors, heat exchangers and so on locally.

SIDBI representative outlined the JICA credit line for energy efficiency which is handled by the bank. He mentioned that SIDBI is providing concessions on loans between 75-100 basis points (0.75-1%) on energy efficient equipment procured under JICA credit line by SMEs. He mentioned that SIDBI also has a scheme (4E) to help SMEs undertake energy audits.

The representative from Mahindra mentioned that they have been able to save energy by 5-6% in their air compressors after adoption of best operating practices suggested by expert from Hitachi, Japan who visited their plant under the IGES-TERI project. He mentioned that their company is seriously considering purchasing Japanese air compressors for their plant. However, lack of availability of after-sales service for Japanese equipment at the local level could a barrier in India. He mentioned that there is a good scope to enhance the soft skills of factory personnel of Indian plants and urged IGES and TERI to undertake more capacity building activities in the future.

The representative of Centry Enka mentioned that the once-through boiler technology of Miura is very good. However he mentioned that the Japanese manufacturers should design the boilers for furnace oil as well, as it is a cheaper and more economical fuel for industrial boilers in India.

There was an active discussion after the inputs from the panelists. To overcome IBR certification, one of the participants suggested TLV to make a representation to Central Boilers Board under Directorate of Steam Boilers under Ministry of Commerce and Industry for necessary certification enclosing all the necessary design details and certifications. It was further pointed out that IBR is not required for low pressure steam (less that 3.5 kg/cm2). ESCO funding and bilateral two step credit lines should be leveraged to the extent possible to push Japanese technologies in India.

About 55 participants from industry, government, consultancy agencies and donor organisations attended the event.

Some photographs of the event is provided in Annexure 7.

Annexures

Annexure 1 Agenda of the workshop

Dissemination Workshop

Promoting transfer of energy efficient industrial technologies from Japan to India

Venue:
Courtyard Marriott, Pune City Centre
C.T.S. No. 37 & 37/1 Bund Garden Road
Next to Jehangir Hospital, Pune

Date:
December 11, 2015
(Duration: 9:30 – 16:20 hrs)

Tentative Agenda

09:30 – 10:30 hrs	**Registration & Tea**	
Inaugural Session		
10:30 – 11:00 hrs	**Welcome Address**	**Mr Girish Sethi,** The Energy and Resources Institute (TERI)
	Opening Remarks	**Mr Shashank Jain** Shakti Sustainable Energy Foundation (SSEF)
	Special Address	**Dr Abdessalem RABHI,** Institute for Global Environmental Strategies (IGES), Japan
Technical Session – Energy Efficient Technologies: Opportunities for cooperation		
11:00 – 13:45 hrs	**Overview of TERI-Shakti-IGES Project**	**Mr Prosanto Pal/ Chetankumar Sangole** The Energy and Resources Institute (TERI)
	Energy efficient once-through boilers	**Mr Kenichiro IKEUCHI** Miura, Japan
	Energy efficiency in Steam Systems' – Japanese Experience	**Mr Hayato KIDA,** TLV, Japan
	Discussion/Q & A	
13:45 – 14:45 hrs	**Lunch**	
Panel Discussion		
14:45 – 15:15 hrs	**Background presentation on Potential of transfer and application of low carbon technologies from Japan to India: Assessment and matchmaking**	**Dr Abdessalem RABHI** IGES, Japan
15:15 – 16:15 hrs	***Panel discussion***	*Moderator: Mr Girish Sethi, TERI* **Mr. Shashank Jain,** Shakti Sustainable Energy Foundation (SSEF) **Dr. Abdessalem RABHI,** IGES, Japan **Mr Hemant H Patil,** Maharashtra Energy Development Agency (MEDA) **Mr. Kenichiro IKEUCHI,** Miura, Japan **Mr. Pushkar Mishra,** SIDBI, Pune **Mr Hayato KIDA,** TLV, Japan **Mr S R Rane,** Mahindra CIE **Mr D R Parkarle,** DGM, Century Enka
16:15 – 16:20 hrs	**Vote of Thanks**	**Mr. Kailash Tarde,** The Energy and Resources Institute (TERI)
16:20 hrs	**Tea**	

Annexure 2

IGES

Background presentation on Potential of Transfer and application of low carbon technologies from Japan to India: Assessment and Matchmaking

Rabhi Abdessalem, IGES
11 Dec. 2015, Pune

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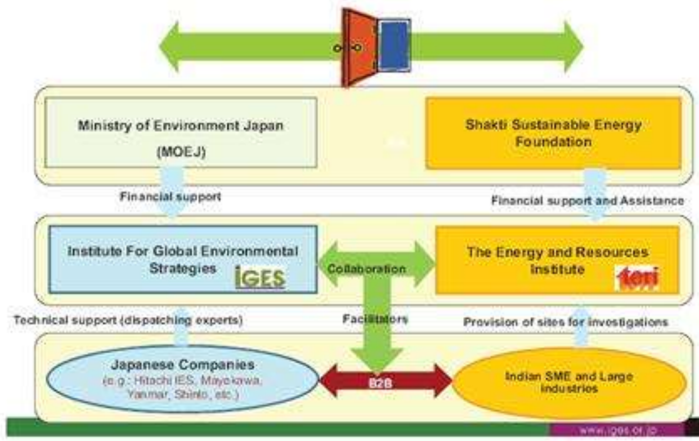
IGES-TERI-SSEF: Opening further Japan-India Environmental Technology Gateway



IGES

About IGES: Outline

- **Name of the Institute**

Institute for Global Environmental Strategies (IGES)

- **Establishment**
  March 31, 1998

- **Location**

>Headquarter: Hayama, Miura-gun, Kanagawa
>Tokyo Office: Chiyoda-ku, Tokyo
>Kitakyushu Office: Kitakyushu-city, Fukuoka
>Kansai Research Centre (KRC): Kobe, Hyogo
>Overseas Offices: Bangkok (Thailand), Beijing (China)

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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 (In India and in Japan)

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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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FY2015:
Building up on previous achievement and strengthening partnership

9

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List of selected countries/technologies

	Targeted countries
1	Bangladesh
2	India
3	Indonesia
4	Mongolia
5	Thailand
6	Vietnam

	Selected Technologies
1	Once Through Boiler/Steam control and management system
2	Heat Pump for Industrial use
3	High Efficient air compressor
4	Biogas Micro cogeneration system
5	Solar PV
6	Waste to Energy
7	Waste Heat Recovery
8	Efficient lighting (LED)

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Technology Assessment Framework

Selection of 6 countries

Selection of 8 technologies

Assessment of the mutual interests (supply/Demand sides) and of the local conditions to identify best matching of "seeds" and "needs"

Assess the Opportunities/Threats for 2-3 prioritized tech. for each targeted country

Assess the Strengths/Weaknesses of 2-3 prioritized tech. for each targeted country

SWOT Mapping

Recommendations/Proposal(s) on way forwards

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Table used for the assessment of Strengths & Weaknesses

Aspect	Criteria	Importance a	Strength b 0,1 or 2	Weakness c 0,1,or2	Reason for scoring	a*(b-c)
Technological	Innovativeness					
	Reliability					
	Durability (life span)					
	Energy efficiency					
	Size and weight					
	Ease of installation					
	Ease of maintenance					
	Operational performance					
Economic	Initial cost					
	Maintenance cost					
	Investment payback period					
Environmental	Carbon dioxide (CO2) emissions reduction					
	Other environmental benefit (waste water reduction, water consumption reduction, better air quality, etc.)					
Business	Supplier's aftersales service availability in the country					
	Supplier's business experience in the country					
	Delivery time					

Table used for the assessment of Opportunities & Threats

Aspect	Criteria	Importance a	Opportunity b 0,1 or 2	Threats c 0,1,or2	Reason for scoring	a*(b-c)
Political	Domestic and geopolitical stability					
	Diplomatic relations with Japan					
	Presence of strong incentives and policies (subsidies, investment attraction, energy policy, etc.)					
Economic	Market size and economic growth (including population, etc.)					
	Presence and strength of competition					
	Current energy prices (fuel, electricity for commercial) and their future trend					
	Financial strength and purchasing power of end users					
Social	Attitude toward Japanese products (Japanese brand power)					
	Tolerance for long investment payback periods					
	Cultural suitability of product use					
Technological	Presence of infrastructure for product use (electricity, natural gas, water, etc.)					
	Ease of hiring local engineers (design, construction, maintenance)					
	Ease of local procurement of refrigerants, oils, and parts, etc					
Legal	Presence and strength of customs duties					
	Specifications (harmonic content with international standards)					
	Regulations (energy saving, environmental regulations)					
	Standards (labelling, MEPS***, IBR)					
	Presence of protection for intellectual property rights					
Environmental	Natural environment (temperature, humidity, water quality, air quality, disaster frequency etc.)					
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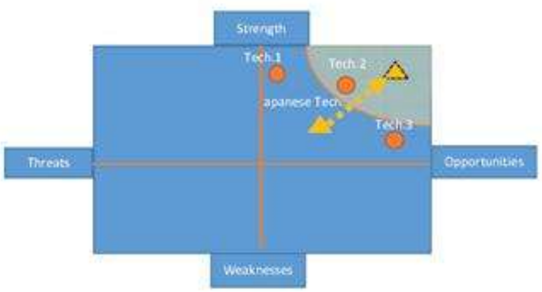
Finding so far from India

Technology Mapping

- Example of mapping a Japanese technology (i) in country (j) based On SWOT analysis



- Based on the technology mapping, recommendations/proposals will be developed on how to increase strengths and minimize weaknesses and/or to enhance opportunities and minimize threats to promote Japanese technology dissemination overseas

Result regarding technology need in India

Targeted technologies	Level of Needs/Applicability Potential
Once-through boiler	Very high
Steam control system	Very high
Industrial heat pump	High
High efficient air compressor	Very high
Micro co-generation	High
Solar power generation (Eco-house)	Low
Waste to energy (Incinerators for power generation)	Low
Waste heat recovery (Cement waste heat power plant)	High
High efficient lighting system (LED)	Low

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Filled Table for the assessment of Strengths & Weaknesses (Energy Efficient Air Compressor)

Aspect	Criteria	Importance (Supply) a	Strength (Demand) b	Average of a&b c	Score Strength/ Weaknesses d	Total score c*d
Technological	Innovativeness	10	3	6.5	2.0	13.0
	Reliability	9	3	6	2.0	12.0
	Durability (life span)	8	3	5.5	2.0	11.0
	Energy efficiency	10	5	7.5	2.0	15.0
	Size and weight	3	3	3	0.0	0.0
	Ease of installation	4	3	3.5	0.0	0.0
	Ease of maintenance	7	10	8.5	2.0	17.0
	Operational performance	8	5	6.5	2.0	13.0
Economic	Initial cost	8	20	14	-2.0	-28.0
	Maintenance cost	3	5	4	0.0	0.0
	Investment payback period	8	10	9	-2.0	-18.0
Environmental	Carbon dioxide (CO2) emissions reduction	8	2	5	2.0	10.0
	Other environmental benefits: (waste water reduction, water consumption reduction, etc.)	5	3	4	2.0	8.0
Business	Supplier's aftersales service availability	3	15	9	0.0	0.0
	Supplier's business experience in the country	3	5	4	0.0	0.0
	Delivery time	3	5	4	-2.0	-8.0

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Filled Table for the Assessment of Strengths & Weaknesses (Once through Boiler)

Aspect	Criteria	Importance (Supply) a	Strength (Demand) b	Average of 1&2 c	Score Strength/ Weaknesses d	Total score c*d
Technological	Innovativeness	0	5	2.5	2	5
	Reliability	10	5	7.5	2	15
	Durability (life span)	10	5	7.5	2	15
	Energy efficiency	20	10	15	2	30
	Size and weight	10	0	5	2	10
	Ease of installation	0	0	0	2	0
	Ease of maintenance	0	10	5	0	0
	Operational performance	0	5	2.5	2	5
Economic	Initial cost	10	20	15	-1	-15
	Maintenance cost	10	5	7.5	-1	-7.5
	Investment payback period	10	10	10	2	20
Environmental	Carbon dioxide (CO2) emissions reduction	10	0	5	2	10
	Other environmental benefits: (waste water reduction, water consumption reduction, etc.)	10	0	5	2	10
Business	Supplier's aftersales service availability	0	10	5	-1	-5
	Supplier's business experience in the country	0	10	5	-1	-5
	Delivery time	0	5	2.5	-1	-2.5

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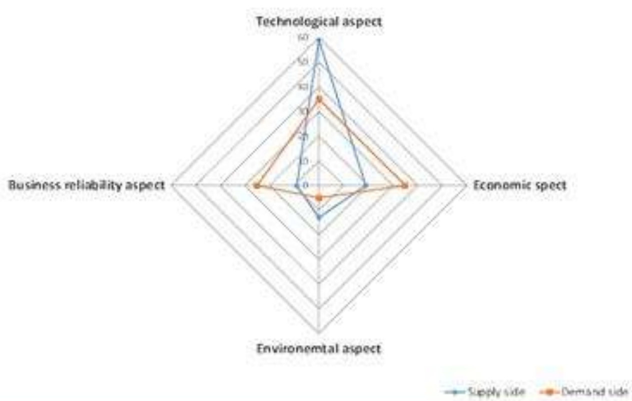
Difference of Perspectives between supply and demand sides



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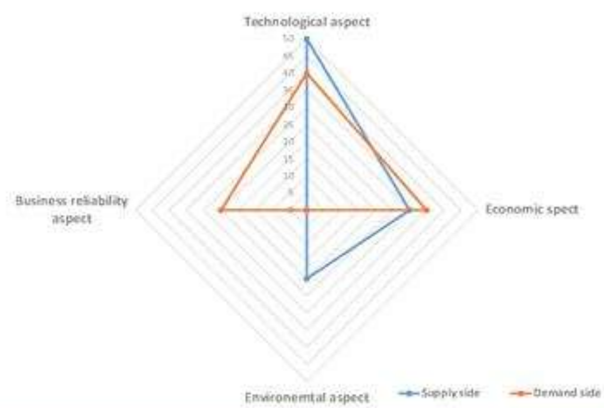
Difference of Perspectives between supply and demand sides



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Filled Table for the assessment of Strengths & Weaknesses (Steam Control and Management System)

Aspect	Criteria	Importance (Supply) a	Strength (Demand) b	Average of 1&2 c	Score Strength/ Weaknesses d	Total score c*d
Technological	Innovativeness	0	5	2.5	2	5
	Reliability	10	5	7.5	2	15
	Durability (life span)	10	5	7.5	2	15
	Energy efficiency	20	10	15	2	30
	Size and weight	10	0	5	2	10
	Ease of installation	0	0	0	2	0
	Ease of maintenance	0	10	5	0	0
	Operational performance	0	5	2.5	2	5
Economic	Initial cost	10	20	15	-1	-15
	Maintenance cost	10	5	7.5	-1	-7.5
	Investment payback period	10	10	10	2	20
Environmental	Carbon dioxide (CO_2) emissions reduction	10	0	5	2	10
	Other environmental benefits: (waste water reduction, water consumption reduction, etc.)	10	0	5	2	10
Business	Supplier's aftersales service availability	0	10	5	-1	-5
	Supplier's business experience in the country	0	10	5	-1	-5
	Delivery time	0	5	2.5	-1	-2.5

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Table used for the assessment of Opportunities & Threats Air Compressor

Aspect	Criteria	Importance a	Opportunity b 0,1 or 2	Threats c 0,1 or 2	Reason for scoring	a*(b-c)
Political	Domestic and geopolitical stability	5	2	0		10
	Diplomatic relations with Japan	3	2	0		6
	Presence of strong incentives and policies (subsidies, investment attraction, energy policy, etc.)	5	1	0		5
Economic	Market size and economic growth (including population, etc.)	10	2	0		20
	Presence and strength of competition	15	0	2		-30
	Current energy prices (fuel, electricity for commercial) and their future trend	15	1	0		15
	Financial strength and purchasing power of end users	5	0	1		-5
Social	Attitude toward Japanese products (Japanese brand power)	10	1	0		10
	Tolerance for long investment payback periods	10	0	2		-20
	Cultural suitability of product use	2	1	0		2
Technological	Presence of infrastructure for product use (electricity, natural gas, water, etc.)	3	1	0		3
	Ease of hiring local engineers (design, construction, maintenance)	5	1	0		5
	Ease of local procurement of refrigerants, oils, and parts, etc.	10	0	1		-10
Legal	Presence and strength of customs duties	10	0	2		-20
	Specifications (harmonic content with international standards)	2	2	0		4
	Regulations (energy saving, environmental regulations)	5	2	0		10
	Standards (labelling, MEPS***, IBR)	3	2	0		6
	Presence of protection for intellectual property rights	3	0	1		-3
Environmental	Natural environment (temperature, humidity, water quality, air quality, disaster frequency, etc.)	2	2	0		4

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Difference of Perspectives between supply and demand sides

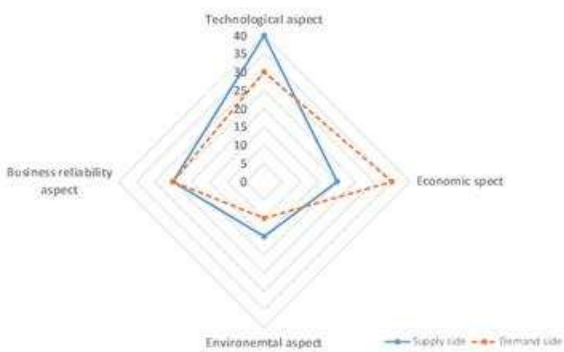

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Table used for the assessment of Opportunities & Threats Once Through Boiler

Aspect	Criteria	Importance a	Opportunity b 0,1 or 2	Threats c 0,1 or2	Reason for scoring	a*(b-c)
Political	Domestic and geopolitical stability	5	2	0		10
	Diplomatic relations with Japan	3	2	0		6
	Presence of strong incentives and policies (subsidies, investment attraction, energy policy, etc.)	5	1	0		5
Economic	Market size and economic growth (including population, etc.)	10	2	0		20
	Presence and strength of competition	5	1	0		5
	Current energy prices (fuel, electricity for commercial) and their future trend	10	2	0		20
	Financial strength and purchasing power of end users	5	0	2		-10
Social	Attitude toward Japanese products (Japanese brand power)	10	2	0		20
	Tolerance for long investment payback periods	10	0	2		-20
	Cultural suitability of product use	5	1	0		5
Technological	Presence of infrastructure for product use (electricity, natural gas, water, etc.)	5	1	0		5
	Ease of hiring local engineers (design, construction, maintenance)	5	1	0		5
	Ease of local procurement of refrigerants, oils, and parts, etc.	10	0	1		-10
Legal	Presence and strength of customs duties	10	0	2		-20
	Specifications (harmonic content with international standards)	5	2	0		10
	Regulations (energy saving, environmental regulations)	10	0	2		-20
	Standards (labelling, MEPS***, IBR)	5	0	0		0
	Presence of protection for intellectual property rights	3	0	1		-3
Environmental	Natural environment (temperature, humidity, water quality, air quality, disaster frequency, etc.)	2	2	0		4

IGES

Table used for the assessment of Opportunities & Threats (Steam Control and Management System)

Aspect	Criteria	Importance a	Opportunity b 0,1 or 2	Threats c 0,1,or2	Reason for scoring	a*(b-c)
Political	Domestic and geopolitical stability	5	2	0		10
	Diplomatic relations with Japan	3	2	0		6
	Presence of strong incentives and policies (subsidies, investment attraction, energy policy, etc.)	5	2	0		10
Economic	Market size and economic growth (including population, etc.)	10	2	0		20
	Presence and strength of competition	10	0	1		-10
	Current energy prices (fuel, electricity for commercial) and their future trend	10	2	0		20
	Financial strength and purchasing power of end users	5	0	2		-10
Social	Attitude toward Japanese products (Japanese brand power)	10	2	0		20
	Tolerance for long investment payback periods	10	0	1		-10
	Cultural suitability of product use	1	2	0		2
Technological	Presence of infrastructure for product use (electricity, natural gas, water, etc.)	1	2	0		2
	Ease of hiring local engineers (design, construction, maintenance)	5	2	0		10
	Ease of local procurement of refrigerants, oils, and parts, etc.	10	0	0		0
Legal	Presence and strength of customs duties	10	0	1		-10
	Specifications (harmonic content with international standards)	10	2	0		20
	Regulations (energy saving, environmental regulations)	10	2	0		20
	Standards (labelling, MEPS***, IBR)	3	1	0		3
	Presence of protection for intellectual property rights	3	0	1		-3
Environmental	Natural environment (temperature, humidity, water quality, air quality, disaster frequency, etc.)	2	1	0		2
		100				

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Way forward

The following points will be discussed/answered during the panel discussion:

- Highlight what are key advantages of Japanese technologies over competing ones (e.g.: Key advantages of Japanese once through boiler vs. Non Japanese once through boiler)?
- Highlight what are key opportunities and threats (barriers) to promote Japanese technology dissemination in India (e.g: key opportunities and threats to disseminate Japanese once through boiler in India)?
- What strategy could be taken to enhance the strengths and minimize weaknesses and/or to enhance opportunities and minimize threats to promote Japanese technology dissemination in India?

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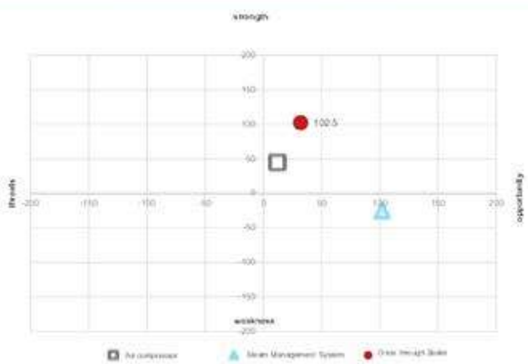
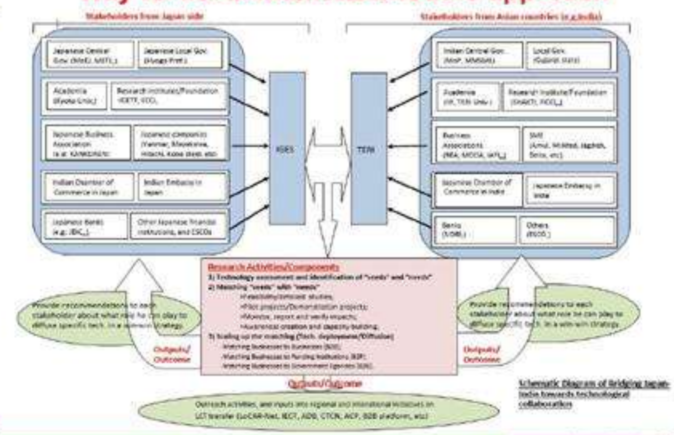
Technology Mapping



IGES

Way forward: Multistakehoders approach



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Way forward:

Strengthen and widen the partnership which has been established among: mcci, TERI, MEDA, IGES, SHAKTI, to continue the matchmaking B2B, and B2F and open further Japan-India Environmental Technology Gateway.

IGES

Thank you for you attention

Annexure 3

Promoting Energy Efficient Japanese Technologies in Indian industry: TERI-Shakti-IGES's activities

Dissemination Workshop

Prosanto Pal, TERI

11 December 2015

Pune

Outline

- Energy efficiency in Japanese industries
- Selected energy efficient Japanese technologies
- Promoting Japanese energy efficient technologies: TERI-Shakti-IGES project
- Opportunities for expansion

Energy Efficiency in Japanese Industry sector

- Japan was one of the first countries to adopt Energy Conservation Law (1979). It has been upgraded several times
- Japanese industries invested hugely in R&D
  - Pioneer in energy efficiency innovations in many sectors
  - Major large industries like steel, cement, chemicals, engineering etc. highly energy efficient
  - Over 99% of Japanese industries are SMEs
- Increasing Government support to Japanese companies for expanding to other countries
  - Lot of interest in Indian industry sector

Examples of EE technologies from Japan

- High performance industrial furnaces with Regenerative burner systems
- Low temperature waste heat recovery options
- Energy efficient ventilation fans
- **Gas heat pump (GHP)**
- **Electric heat pump (EHP)**
- Waste Heat Recovery Systems for cement industry
- High efficiency furnaces for Secondary Aluminium industry
- Infrared Drying systems and Heaters
- Micro cogeneration
- Once through small sized boilers for industries
- Better steam management systems

Examples of LCTs from Japan

- Efficient electric induction melting furnaces
- Compressed air systems – various features (inverter based, nozzles, piping system optimization, decentralization, etc)
- Kaizen and 5S techniques for Total Energy Management (TEM) customized to specific industry segments
- Wireless energy metering and communication system within a factory (Energy Management Systems)
- Energy Efficient Technologies for steel industry (more than 15 technologies)

Gas Heat Pump (GHP)

Existing AC (indoor unit)

Gas heat pump (outdoor unit)

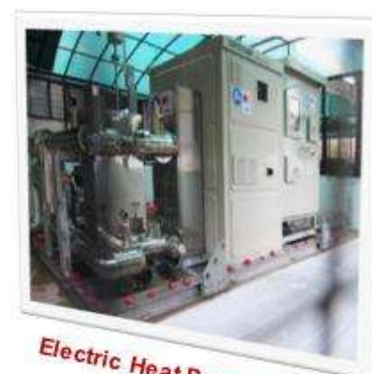
Achievements in GHP

- Saving at primary level
    - Energy saving –50%
    - Avoided CO_2 reduction – 49%

Electric Heat Pump (EHP)

Existing boiler

Chilled water system



Electric Heat Pump (EHP)

Achievements in EHP

- Demonstration plants installed at
  - Milkfed (Chandigarh)
  - Amul Chocolate plant (Anand)
- Saving at primary level
  - Energy saving –35%
  - Avoided CO2 reduction – 40%
- Other benefits
  - Refrigerant used is CO2 having 'zero' ODP and GWP is 1

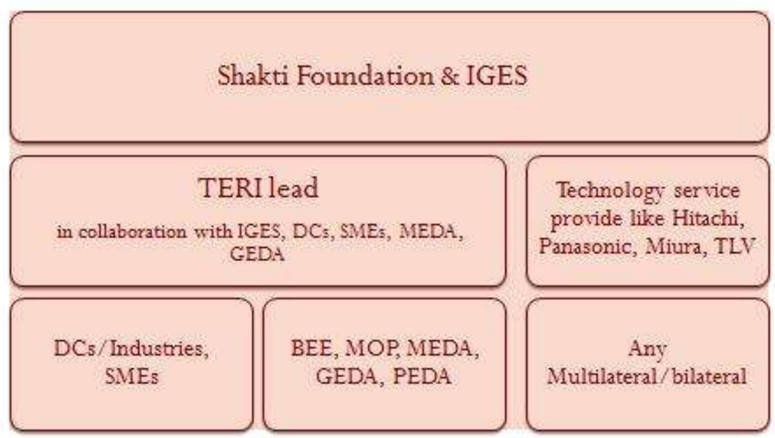
TERI-IGES-Shakti program

- Objective To promote Japanese low carbon technologies and practices in Indian Industry
- Implementation partners
  - Indian TERI, Shakti, private companies
  - Japanese IGES, Japanese private companies
- Focus areas
  - Pre-feasibility /feasibility studies (based on site/technology specific audits and IGDPRs)
  - Awareness generation, one to one meetings with technology suppliers and financing institutions

Approach

- Select suitable large industries/DCs in India
- Conduct baseline audits, estimate energy saving potential
- Detailed feasibility studies jointly with Japanese experts
- Facilitate MOUs
- Follow-up with industry for implementation and capacity building

Stakeholders



Technologies studied

Technologies studied	Sectors where detailed feasibility studies conducted/IGDPRs prepared
Inverter type air compressor system	• **Textile** (Century Rayon, Morarjee, Bombay Dyeing*, Arvind, Raymonds., Reliance) • **Iron and steel** (Mahindra Hinoday, Ahmednagar Forging*) • **Pulp and Paper** (Century)
Industrial fan/blower	• Textile (Bombay Dyeing, Morarjee etc)
Electric heat pump (EHP)	• Food processing (Milkfed, Amul. Indagro)
Gas heat pump (GHP)	• Food processing and hotels (Lemon Tree, KFC Food Chain, Bakery)
Waste Heat Recovery (WHR)	• Cement (ACC, Wadi)

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Initial findings of Shakti-IGES-TERI project

- Poor awareness about new Japanese technologies and practices in Indian industry
- Good potential to replace conventional technologies with EE technologies from Japan
- Energy savings between 20 - 40%
- Payback period 0.9-2.6 years

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Initial thoughts on future activities

- Expand to cover other EE Japanese technologies e.g.
  - VFD – Fuji Electric, Mitsubishi Electric
  - Automatic temperature controller – Yokogawa
  - Once through Boilers – Miura
  - Steam Management Systems – TLV
  - Regenerative burners – Chugai Ro Co
  - WHR - Kawasaki
- Deepen to up-scale demonstrated technologies (Heat Pumps*)
  - Awareness workshops at cluster level
  - Matchmaking activities (detailed studies, replication)
  - Partnership between governments (national/state level)
- Facilitate cooperation with Japanese companies and other Japanese funding organization
  - Feasibility studies
  - Awareness creation
  - Demonstration

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Thank you for you attention

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Annexure 4

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Overview of
TERI-Shakti-IGES Project
Chetankumar Sangole, TERI
Dissemination workshop
Promoting Transfer of Energy Efficient Technologies from Japan to India
December 11, 2015
Pune

Outline
Energy efficiency in Japanese industries
Examples of EETs from Japan
Technology dialogue results: EETs demonstration
Shakti-TERI-IGES Project
Methodology for IGDPR
Compressed air system and Case studies
IGES-TERI technology demonstration project among SMEs
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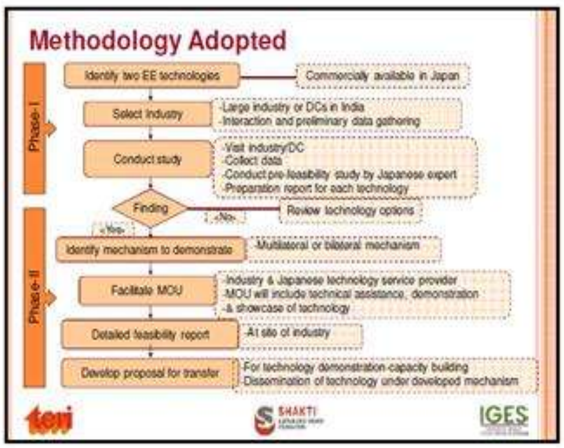

Methodology Adopted
Phase-I
Phase-II
Identify two EE technologies
Commercially available in Japan
Select Industry
-Large industry or DCs in India
-Interaction and preliminary data gathering
Conduct study
-Visit industry/DC
-Collect data
-Conduct pre-feasibility study by Japanese expert
-Preparation report for each technology
Finding
<No>
<Yes>
Review technology options
Identify mechanism to demonstrate
Multilateral or bilateral mechanism
Facilitate MOU
-Industry & Japanese technology service provider
-MOU will include technical assistance, demonstration
-& showcase of technology
Detailed feasibility report
-At site of industry
Develop proposal for transfer
-For technology demonstration-capacity building
-Dissemination of technology under developed mechanism
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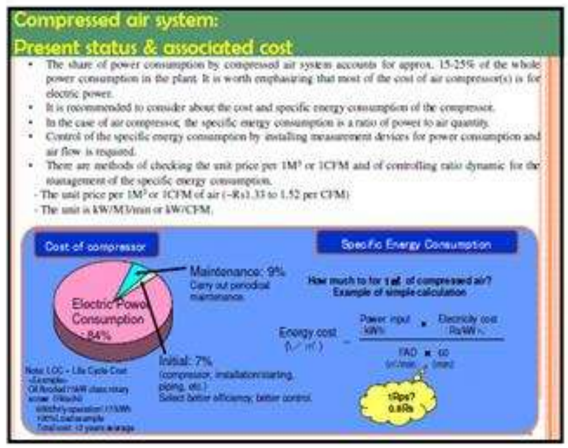
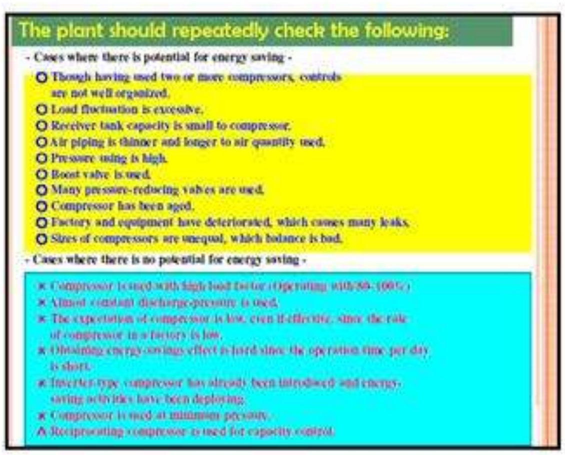


Compressed air system:
Present status & associated cost
The share of power consumption by compressed air system accounts for approx. 15-25% of the whole power consumption in the plant. It is worth emphasizing that most of the cost of air compressor(s) is for electric power.
It is recommended to consider about the cost and specific energy consumption of the compressor.
In the case of air compressor, the specific energy consumption is a ratio of power to air quantity.
Control of the specific energy consumption by installing measurement devices for power consumption and air flow is required.
There are methods of checking the unit price per 1M³ or 1CFM and of controlling ratio dynamic for the management of the specific energy consumption.
- The unit price per 1M³ or 1CFM of air (~Rs1.33 to 1.52 per CFM)
- The unit is kW/M3/min or kW/CFM.
Cost of compressor
Specific Energy Consumption
Maintenance: 9%
Carry out periodical maintenance.
Electric Power Consumption
84%
Initial: 7%
(compressor, installation/starting, piping, etc.)
Select better efficiency, better control.
How much to for 1 m³ of compressed air?
Example of simple calculation
Energy cost
Power input
Electricity cost
FAD
60



The plant should repeatedly check the following:
- Cases where there is potential for energy saving -
Though having used two or more compressors, controls are not well organized.
Load fluctuation is excessive.
Receiver tank capacity is small to compressor.
Air piping is thinner and longer to air quantity used.
Pressure using is high.
Boost valve is used.
Many pressure-reducing valves are used.
Compressor has been aged.
Factory and equipment have deteriorated, which causes many leaks.
Sizes of compressors are unequal, which balance is bad.
- Cases where there is no potential for energy saving -
Almost constant discharge-pressure is used.
Compressor is used at minimum pressure.
Reciprocating compressor is used for capacity control.

COMPRESSED AIR EE TECHNOLOGY
Location: Five large textile units located at Maharashtra & Gujarat
Technology: Replacement of reciprocating/screw air compressors with high energy efficient inverter type screw air compressors
Capacity range: 30 to 75 kW and 200 to 400 CFM
Uses: process application, instrument application
Impacts (select case)
Estimated savings: Rs. ~19/- lakhs per annum
Payback: 2 – 3 years
Technology supplier: Hitachi
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FANS/BLOWERS EE TECHNOLOGY

Location: Two large textile units located at Maharashtra

Technology: Replacement of of fans with high energy efficient fans used in AHU system

Capacity range: 22 to 37 kW

Uses: air ventilation, maintain RH

Impacts (select case)

Estimated savings: Rs. ~11/- lakhs per annum

Payback: 2.5 – 3.5 years

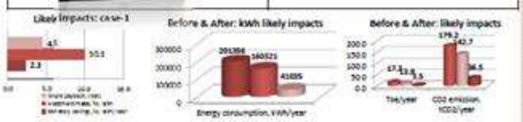
Technology supplier: Showa denki

Case Study for DC-1: EET-Air Compr.

Unit Name	DC-1 (Textile sector)
Introduction of Unit 	- Production: ~45 Mt/day - 24 Hours/day, 6days/week (365 days/year) - ~195,000 kWh/month cons. By air compressors - ~0.92% of total power consumption in the plant
About air compressor infrastructure	- BSD62; 30kW, 200cfm (5.66M³/min), 37kW, 175cfm (for 6 kg/cm²) 2nos. - 200cfm 2nos. (For 4.5 kg/cm²) - 4sets of reciprocating, - 22kW 155cfm 2nos. and 15kW 55cfm 2nos screw type - 2sets GA1106, - 112kW 600cfm 2 nos. - 1set of G132, 132 kW, 800cfm. - Uses: Process applications and instrument application

Case-1: Before-After and Impacts

Before replacement: Screw air compressor of capacity 200 CFM, 30 kW	**Proposed replacement:** Inverter type screw air compressor 30 kW / 241 CFM
	



Case-2: Before-After and Impacts

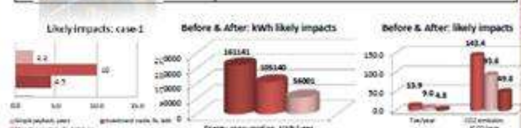
Before replacement: 2 no. of reciprocating air compressor of capacity 37.5kW, 200 CFM	**Proposed replacement:** Inverter type screw air compressor 75 kW/400 CFM
 	

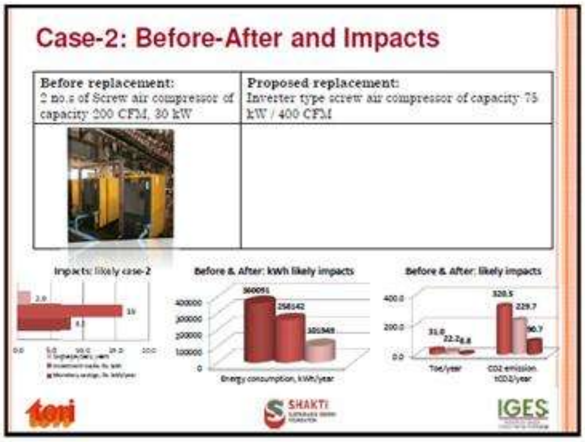
Case Study for DC-2: EET-Air Compr.

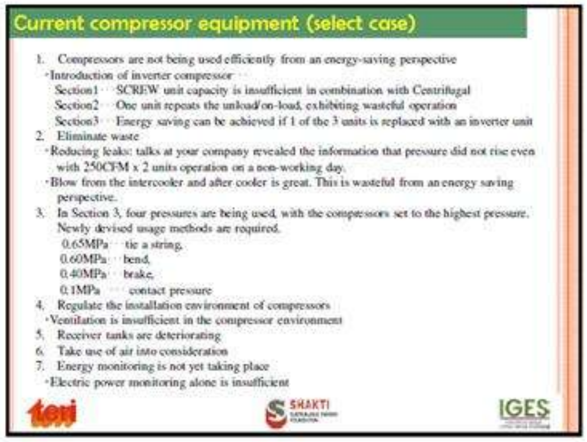
Unit Name	DC-2 (Textile sector)
Introduction of Unit 	- Fabric Production: 100,000mtr/day - 24Hours/day, 6days/week (312days/year) - 2,246,000kWh/month cons. of plant - share compressed air energy cons. 8% of total plant
About air compressor infrastructure	- 3sets BSD62 30kW 200cfm (5.66m³/min) - 3sets BSD62 30kW 200cfm (5.66M³/min) - Uses: process applications

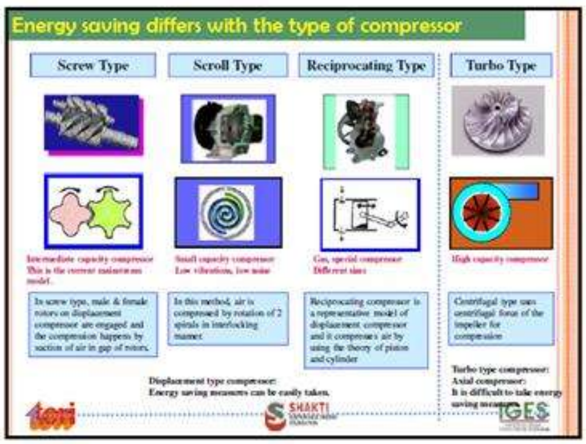
Case-1: Before-After and Impacts

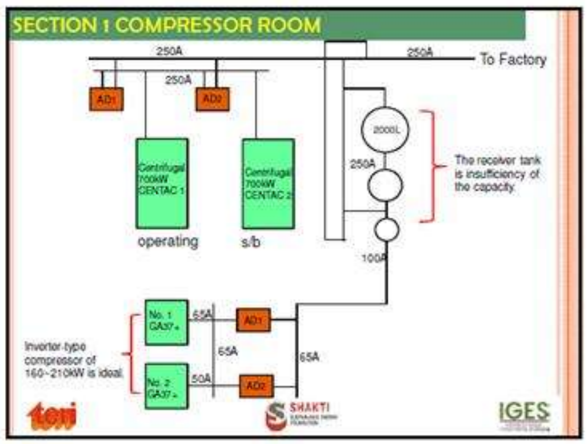
Before replacement: Screw air compressor of capacity 200 CFM, 30 kW	**Proposed replacement:** Inverter type screw air compressor of capacity 30 kW / 241 CFM
	

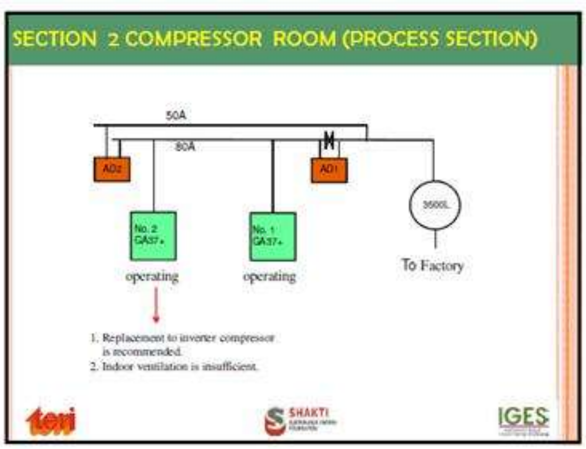


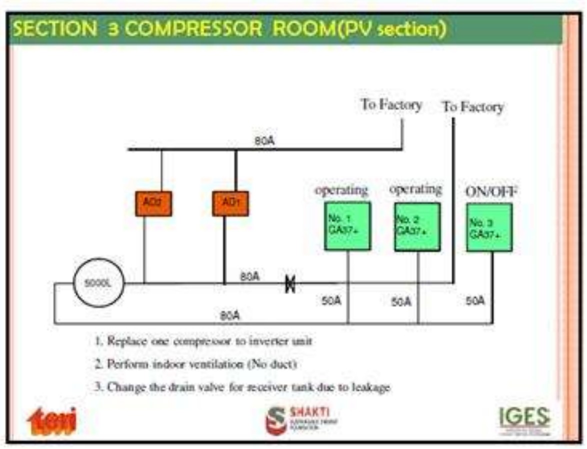

Case-2: Before-After and Impacts
Before replacement:
2 no.s of Screw air compressor of capacity 200 CFM, 30 kW
Proposed replacement:
Inverter type screw air compressor of capacity 75 kW / 400 CFM
Impacts: likely case-2
Before & After: kWh likely impacts
360051
258142
101949
Energy consumption, kWh/year
Before & After: likely impacts
320.5
229.7
90.7
31.0
22.2
Toe/year
CO2 emission tCO2/year


Current compressor equipment (select case)
1. Compressors are not being used efficiently from an energy-saving perspective
・Introduction of inverter compressor
Section1 ･･･ SCREW unit capacity is insufficient in combination with Centrifugal
Section2 ･･･ One unit repeats the unload/on-load, exhibiting wasteful operation
Section3 ･･･ Energy saving can be achieved if 1 of the 3 units is replaced with an inverter unit
2. Eliminate waste
・Reducing leaks: talks at your company revealed the information that pressure did not rise even with 250CFM x 2 units operation on a non-working day.
・Blow from the intercooler and after cooler is great. This is wasteful from an energy saving perspective.
3. In Section 3, four pressures are being used, with the compressors set to the highest pressure. Newly devised usage methods are required.
0.65MPa ･･･ tie a string,
0.60MPa ･･･ bend,
0.40MPa ･･･ brake,
0.1MPa ･･･ contact pressure
4. Regulate the installation environment of compressors
・Ventilation is insufficient in the compressor environment
5. Receiver tanks are deteriorating
6. Take use of air into consideration
7. Energy monitoring is not yet taking place
・Electric power monitoring alone is insufficient


Energy saving differs with the type of compressor
Screw Type
Scroll Type
Reciprocating Type
Turbo Type
In screw type, male & female rotors on displacement compressor are engaged and the compression happens by suction of air in gap of rotors.
In this method, air is compressed by rotation of 2 spirals in interlocking manner.
Reciprocating compressor is a representative model of displacement compressor and it compresses air by using the theory of piston and cylinder
Centrifugal type uses centrifugal force of the impeller for compression
Displacement type compressor:
Energy saving measures can be easily taken.
Turbo type compressor:
Axial compressor:
It is difficult to take energy saving measures.


SECTION 1 COMPRESSOR ROOM
250A
250A
To Factory
250A
AD1
AD2
Centrifugal 700kW CENTAC 1
Centrifugal 700kW CENTAC 2
operating
s/b
2000L
250A
The receiver tank is insufficiency of the capacity.
100A
No. 1 GA37+
No. 2 GA37+
65A
50A
AD1
AD2
65A
65A
Inverter-type compressor of 160~210kW is ideal.


SECTION 2 COMPRESSOR ROOM (PROCESS SECTION)
50A
80A
AD2
AD1
3500L
No. 2 GA37+
No. 1 GA37+
operating
operating
To Factory
1. Replacement to inverter compressor is recommended.
2. Indoor ventilation is insufficient.


SECTION 3 COMPRESSOR ROOM(PV section)
To Factory
To Factory
80A
AD2
AD1
operating
operating
ON/OFF
No. 1 GA37+
No. 2 GA37+
No. 3 GA37+
5000L
80A
80A
50A
50A
50A
1. Replace one compressor to inverter unit
2. Perform indoor ventilation (No duct)
3. Change the drain valve for receiver tank due to leakage


Use of CENTRIFUGAL・・・Proposal of system of absorbing load fluctuation
Recommendation for CO2 reduction
・・・CENTRIFUGAL + Screw compressor
Screw compressor
Machine for capacitance adjusting (Inverter type)
Base load
In SECTION1, CENTRIFUGAL is the base load, and the screw compressor is used for capacity control.
The combination is best as combination, but this doesn't suit control due to small capacity at the screw side. The capacity of approx. 25~30% of whole compressor is required as for control area.
Since the capacity of CENTRIFUGAL is 700kW, please consider a screw compressor with about 160-210 kW. There also seems to be lack of air at present, so please consider to add about the one with G160VSD.
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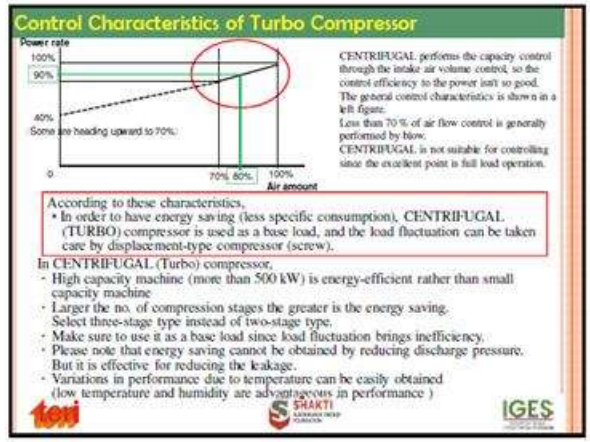
Control Characteristics of Turbo Compressor
Power rate
100%
90%
40%
Some are heading upward to 70%.
0
70%
80%
100%
Air amount
CENTRIFUGAL performs the capacity control through the intake air volume control, so the control efficiency to the power isn't so good.
The general control characteristics is shown in a left figure.
Less than 70 % of air flow control is generally performed by blow.
CENTRIFUGAL is not suitable for controlling since the excellent point is full load operation.
According to these characteristics,
• In order to have energy saving (less specific consumption), CENTRIFUGAL (TURBO) compressor is used as a base load, and the load fluctuation can be taken care by displacement-type compressor (screw).
In CENTRIFUGAL (Turbo) compressor,
- High capacity machine (more than 500 kW) is energy-efficient rather than small capacity machine
- Larger the no. of compression stages the greater is the energy saving. Select three-stage type instead of two-stage type.
- Make sure to use it as a base load since load fluctuation brings inefficiency.
- Please note that energy saving cannot be obtained by reducing discharge pressure. But it is effective for reducing the leakage.
- Variations in performance due to temperature can be easily obtained (low temperature and humidity are advantageous in performance)
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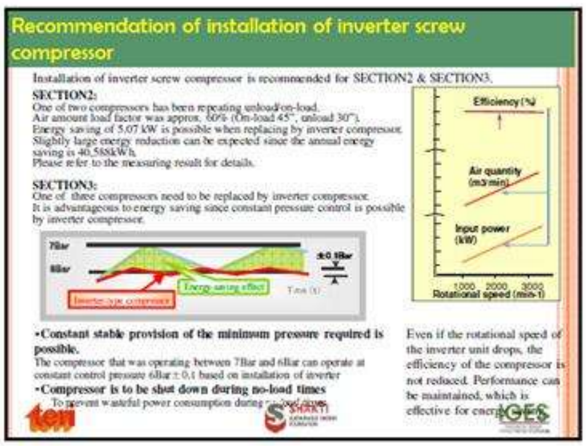
Recommendation of installation of inverter screw compressor
Installation of inverter screw compressor is recommended for SECTION2 & SECTION3.
SECTION2:
One of two compressors has been repeating unload/on-load.
Air amount load factor was approx. 60% (On-load 45", unload 30").
Energy saving of 5.07 kW is possible when replacing by inverter compressor.
Slightly large energy reduction can be expected since the annual energy saving is 40,588kWh.
Please refer to the measuring result for details.
SECTION3:
One of three compressors need to be replaced by inverter compressor.
It is advantageous to energy saving since constant pressure control is possible by inverter compressor.
7Bar
6Bar
±0.1Bar
Energy-saving effect
Time (s)
Inverter-type compressor
Efficiency (%)
Air quantity (m3/min)
Input power (kW)
1000 2000 3000
Rotational speed (min-1)
•Constant stable provision of the minimum pressure required is possible.
The compressor that was operating between 7Bar and 6Bar can operate at constant control pressure 6Bar ± 0.1 based on installation of inverter
•Compressor is to be shut down during no-load times
To prevent wasteful power consumption during no-load times
Even if the rotational speed of the inverter unit drops, the efficiency of the compressor is not reduced. Performance can be maintained, which is effective for energy saving.
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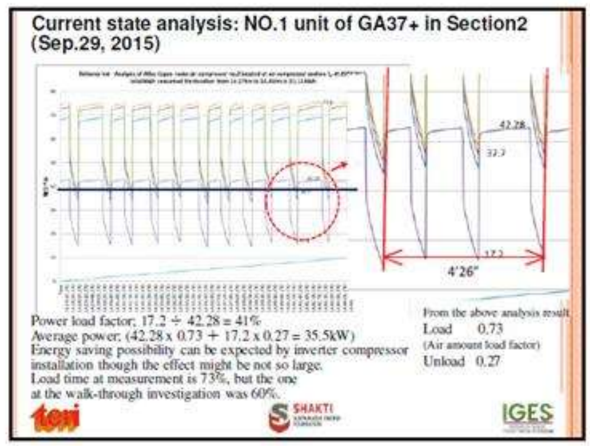
Current state analysis: NO.1 unit of GA37+ in Section2 (Sep.29, 2015)
42.28
32.7
17.2
4'26"
Power load factor: 17.2 ÷ 42.28 = 41%
Average power: (42.28 x 0.73 + 17.2 x 0.27 = 35.5kW)
Energy saving possibility can be expected by inverter compressor installation though the effect might be not so large.
Load time at measurement is 73%, but the one at the walk-through investigation was 60%.
From the above analysis result
Load 0.73
(Air amount load factor)
Unload 0.27
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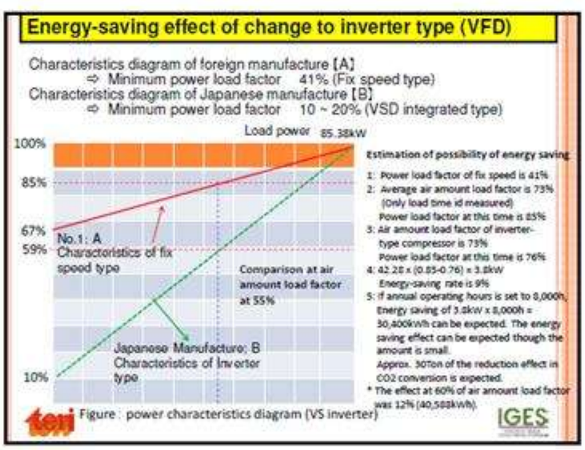
Energy-saving effect of change to inverter type (VFD)
Characteristics diagram of foreign manufacture [A]
⇨ Minimum power load factor 41% (Fix speed type)
Characteristics diagram of Japanese manufacture [B]
⇨ Minimum power load factor 10 ~ 20% (VSD integrated type)
Load power 85.38kW
100%
85%
67%
59%
10%
No.1: A
Characteristics of fix speed type
Comparison at air amount load factor at 55%
Japanese Manufacture: B
Characteristics of Inverter type
Estimation of possibility of energy saving
1: Power load factor of fix speed is 41%
2: Average air amount load factor is 73% (Only load time id measured)
Power load factor at this time is 85%
3: Air amount load factor of inverter-type compressor is 73%
Power load factor at this time is 76%
4: 42.28 x (0.85-0.76) = 3.8kW
Energy-saving rate is 9%
5: If annual operating hours is set to 8,000h, Energy saving of 3.8kW x 8,000h = 30,400kWh can be expected. The energy saving effect can be expected though the amount is small.
Approx. 30Ton of the reduction effect in CO2 conversion is expected.
* The effect at 60% of air amount load factor was 12% (40,588kWh).
Figure : power characteristics diagram (VS inverter)
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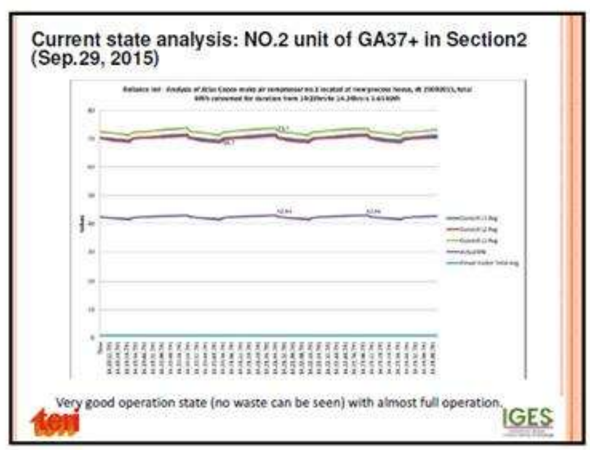
Current state analysis: NO.2 unit of GA37+ in Section2 (Sep.29, 2015)
Very good operation state (no waste can be seen) with almost full operation.
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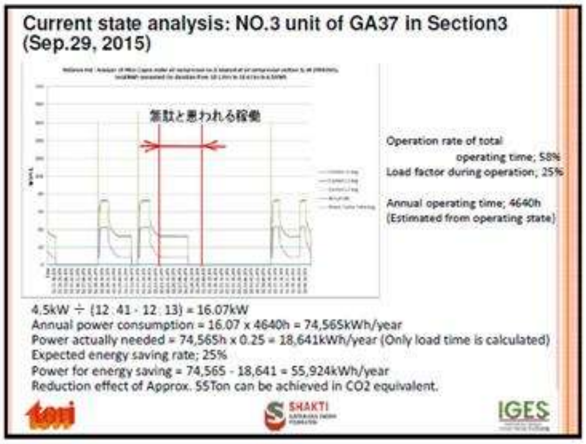
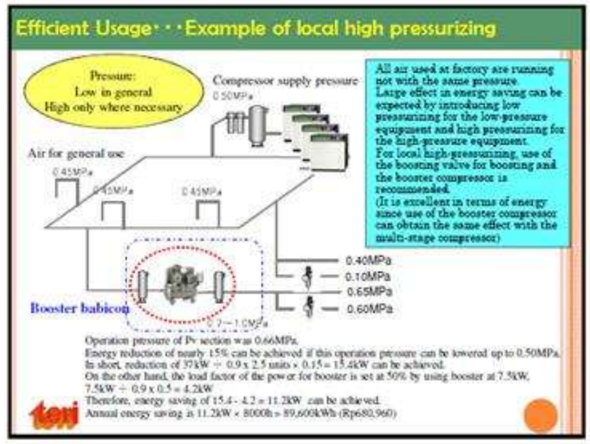
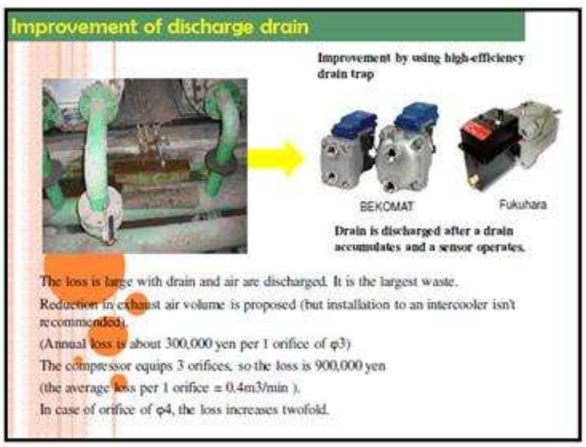
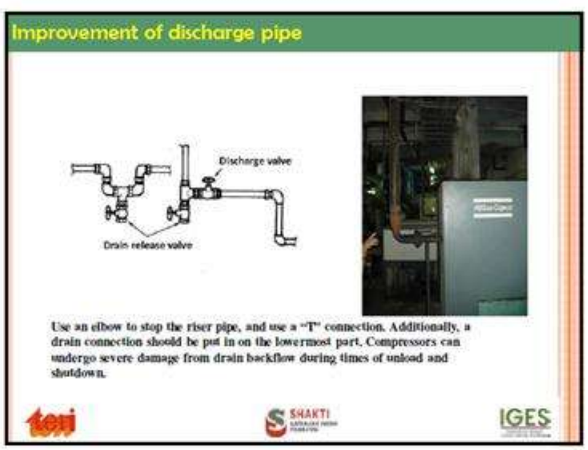

Current state analysis: NO.3 unit of GA37 in Section3 (Sep.29, 2015)
無駄と思われる稼働
Operation rate of total operating time; 58%
Load factor during operation; 25%
Annual operating time; 4640h
(Estimated from operating state)
4.5kW ÷ (12 41 - 12 13) = 16.07kW
Annual power consumption = 16.07 x 4640h = 74,565kWh/year
Power actually needed = 74,565h x 0.25 = 18,641kWh/year (Only load time is calculated)
Expected energy saving rate; 25%
Power for energy saving = 74,565 - 18,641 = 55,924kWh/year
Reduction effect of Approx. 55Ton can be achieved in CO2 equivalent.
SHAKTI
IGES

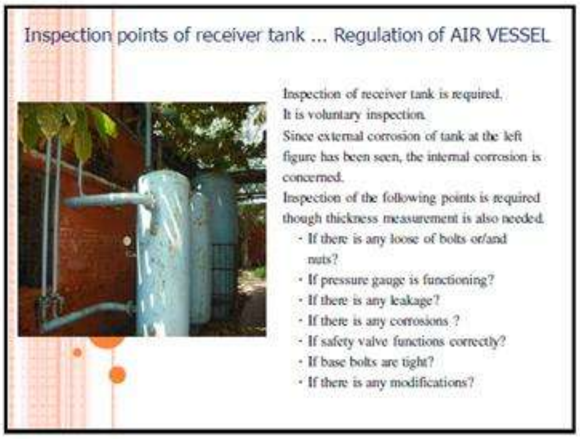

Efficient Usage・・・Example of local high pressurizing
Pressure:
Low in general
High only where necessary
Compressor supply pressure
0.50MPa
Air for general use
0.45MPa
0.45MPa
0.45MPa
All air used at factory are running not with the same pressure.
Large effect in energy saving can be expected by introducing low pressurizing for the low-pressure equipment and high pressurizing for the high-pressure equipment.
For local high-pressurizing, use of the boosting valve for boosting and the booster compressor is recommended.
(It is excellent in terms of energy since use of the booster compressor can obtain the same effect with the multi-stage compressor)
0.40MPa
0.10MPa
0.65MPa
0.60MPa
Booster babicon
0.7～1.0MPa
Operation pressure of Pv section was 0.66MPa.
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 x 0.15 = 15.4kW can be achieved.
On the other hand, 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 saving is 11.2kW x 8000h = 89,600kWh (Rp680,960)

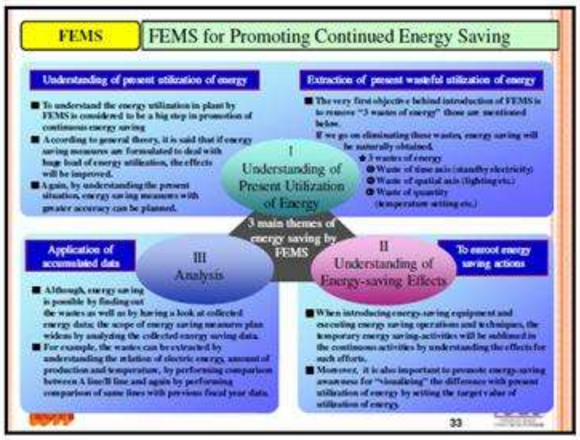

Improvement of discharge drain
Improvement by using high-efficiency drain trap
BEKOMAT
Fukuhara
Drain is discharged after a drain accumulates and a sensor operates.
The loss is large with drain and air are discharged. It is the largest waste.
Reduction in exhaust air volume is proposed (but installation to an intercooler isn't recommended).
(Annual loss is about 300,000 yen per 1 orifice of φ3)
The compressor equips 3 orifices, so the loss is 900,000 yen
(the average loss per 1 orifice = 0.4m3/min).
In case of orifice of φ4, the loss increases twofold.

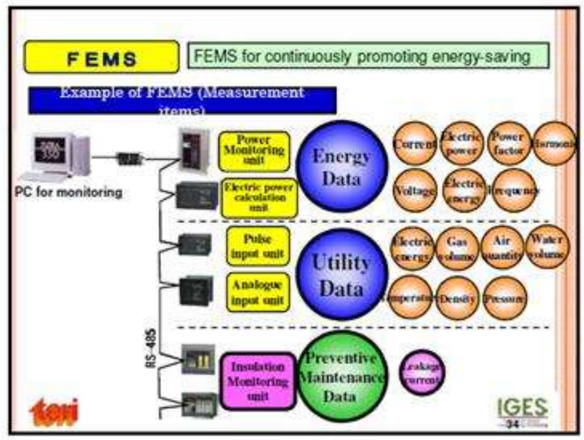

Recommendation of high-efficiency drain trap
(Reduction of discharge air)
Cited from BEKOMAT website.
Drain discharge according to the actual drain amount is required in order to efficiently avoid unnecessary damage and cost associated with generating process of compressed air.
Intelligent electronic control system keeps the loss of compressed air and energy consumption to a minimum by BEKOMAT drain discharge equipped with capacity levelling sensor for this.
Therefore, comparing to the case when adopting an time-controlled type exhaust valve, it's possible to pay back the initial investment in half year
[Reference]
Amount of air jetted out from hole (φ3mm)
・2Bar 0.24m3/min (8.4cfm)
・4Bar 0.41m3/min (14cfm)
・7Bar 0.65m3/min (23cfm)
Amount of air jetted out from hole (φ4mm)
・2Bar 0.44m3/min (15cfm)
・4Bar 0.73m3/min (26cfm)
・7Bar 1.16m3/min (41cfm)
Q=687 60Ca/J √P1/V1
Q; Jetting out amount
C; Number of flowmeters
a; Area of the narrowest part of hole
J; Density of air
P1; Absolute pressure of the gas in front of the hole
V1; Volume ratio of the gas in front of the hole
SHAKTI
IGES

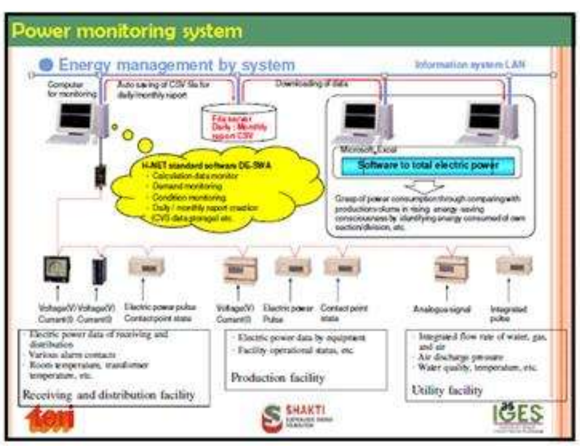

Improvement of discharge pipe
Discharge valve
Drain release valve
Use an elbow to stop the riser pipe, and use a "T" connection. Additionally, a drain connection should be put in on the lowermost part. Compressors can undergo severe damage from drain backflow during times of unload and shutdown.
SHAKTI
IGES

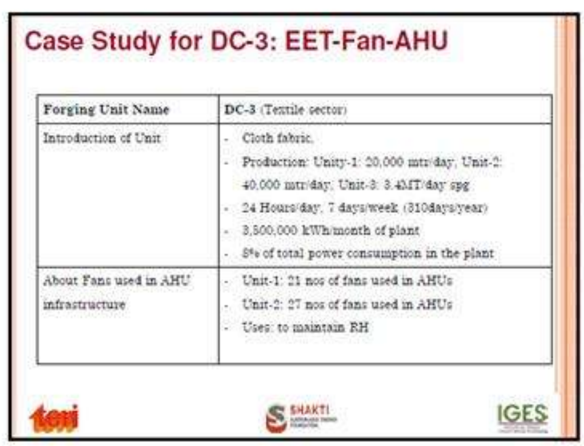

Inspection points of receiver tank ... Regulation of AIR VESSEL
Corrosion, leakage, function set pressure, operation
Display, dirt, function
Crack, damage, galling, corrosion
Galling, corrosion, deformation, loose bolts, detaching
Periodic check of corrosion condition
Measurement of tank thickness
Internal carbon removal
Prevention of fire or ignition accident
Corrosion, leakage, crack
IGES



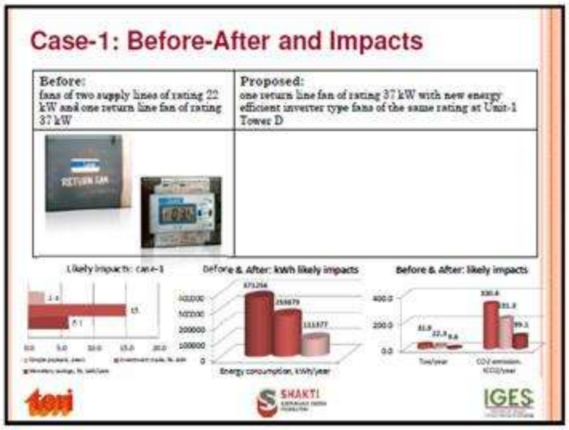


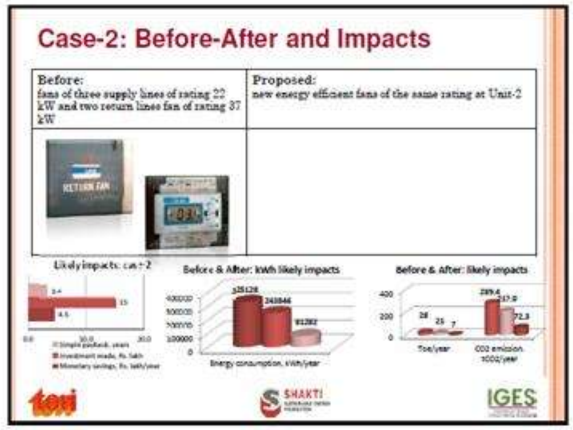


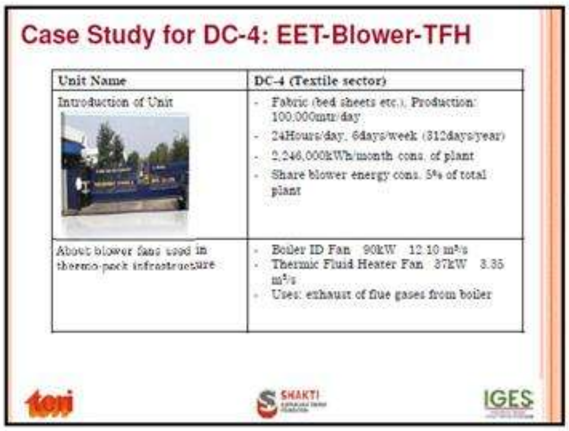


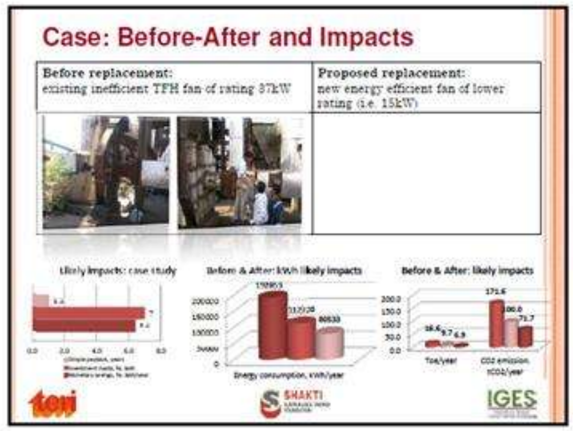


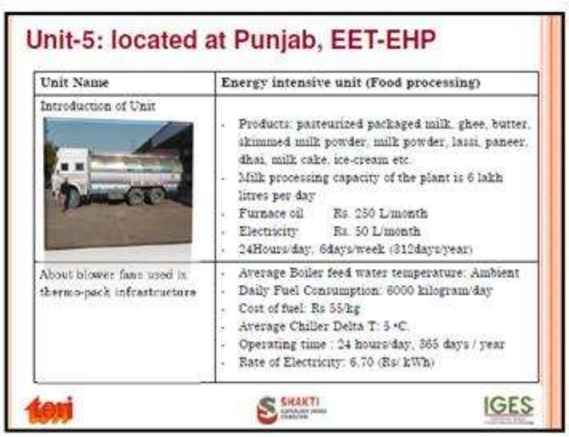
Forging Unit Name	DC-3 (Textile sector)
Introduction of Unit	- Cloth fabric. - Production: Unity-1: 20,000 mtr/day; Unit-2: 40,000 mtr/day; Unit-3: 3.4MT/day spg - 24 Hours/day, 7 days/week (310days/year) - 3,500,000 kWh/month of plant - 8% of total power consumption in the plant
About Fans used in AHU infrastructure	- Unit-1: 21 nos of fans used in AHUs - Unit-2: 27 nos of fans used in AHUs - Uses: to maintain RH

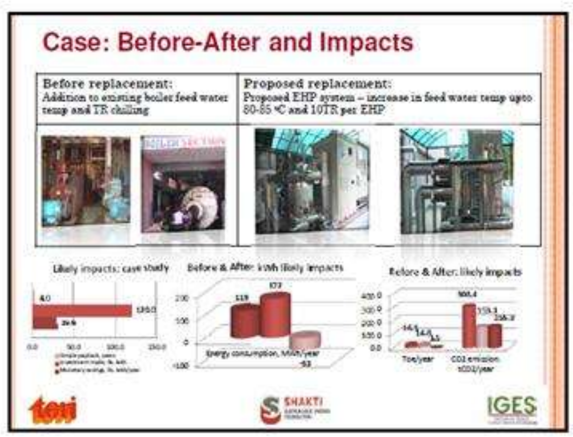

Case-1: Before-After and Impacts
Before:
fans of two supply lines of rating 22 kW and one return line fan of rating 37 kW
Proposed:
one return line fan of rating 37 kW with new energy efficient inverter type fans of the same rating at Unit-1 Tower D
Likely impacts: case-1
Before & After: kWh likely impacts
Before & After: likely impacts
Energy consumption, kWh/year
Toe/year
SHAKTI
IGES


Case-2: Before-After and Impacts
Before:
fans of three supply lines of rating 22 kW and two return lines fan of rating 37 kW
Proposed:
new energy efficient fans of the same rating at Unit-2
Before & After: kWh likely impacts
Before & After: likely impacts
Energy consumption, kWh/year
Toe/year
SHAKTI
IGES


Case Study for DC-4: EET-Blower-TFH
Unit Name
DC-4 (Textile sector)
Introduction of Unit
- Fabric (bed sheets etc.), Production: 100,000mtr/day
- 24Hours/day, 6days/week (312days/year)
- 2,246,000kWh/month cons. of plant
- Share blower energy cons. 5% of total plant
About blower fans used in thermo-pack infrastructure
- Boiler ID Fan 90kW 12.10 m³/s
- Thermic Fluid Heater Fan 37kW 3.35 m³/s
- Uses: exhaust of flue gases from boiler
SHAKTI
IGES


Case: Before-After and Impacts
Before replacement:
existing inefficient TFH fan of rating 37kW
Proposed replacement:
new energy efficient fan of lower rating (i.e. 15kW)
Likely impacts: case study
Before & After: kWh likely impacts
Before & After: likely impacts
Energy consumption, kWh/year
Toe/year
SHAKTI
IGES


Unit-5: located at Punjab, EET-EHP
Unit Name
Energy intensive unit (Food processing)
Introduction of Unit
- Products: pasteurized packaged milk, ghee, butter, skimmed milk powder, milk powder, lassi, paneer, dhai, milk cake, ice-cream etc.
- Milk processing capacity of the plant is 6 lakh litres per day
- Furnace oil Rs. 250 L/month
- Electricity Rs. 50 L/month
- 24Hours/day, 6days/week (312days/year)
About blower fans used in thermo-pack infrastructure
- Average Boiler feed water temperature: Ambient
- Daily Fuel Consumption: 6000 kilogram/day
- Cost of fuel: Rs 55/kg
- Average Chiller Delta T: 5 °C
- Operating time : 24 hours/day, 365 days / year
- Rate of Electricity: 6.70 (Rs/ kWh)
SHAKTI
IGES


Case: Before-After and Impacts
Before replacement:
Addition to existing boiler feed water temp and TR chilling
Proposed replacement:
Proposed EHP system – increase in feed water temp upto 80-85 °C and 10TR per EHP
Likely impacts: case study
Before & After: kWh likely impacts
Before & After: likely impacts
Toe/year
SHAKTI
IGES

DC-6: located at Karnataka, EET-WHR

Unit Name	DC-6 (Cement sector)
Introduction of Unit 	- Products: Cement, Kiln - Production: 12,500 TPD - 24 Hours/day, 6days/week (365days/year)
About kiln, core plant infrastructure	- The core plant and machinery like kiln, kiln hood, cooler length, of capacity of up to 12,500 tpd. - and some material handling equipment for above

Case: WHR Likely impact

S.No.	Parameter	Unit	Details
1.	Clinker capacity	Ton/day	12,500
2.	Power output (net)	MW	20
3.	Technology		Steam Rankline cycle
4.	Investment	Rs Crores	180
5.	Power generation	kWh/year	175200
6.	Cost of power saved#	Rs Crores/year	49.1
7.	Simple payback period	Years	3.67
8.	CO_2 reduction	T CO_2/year	155928
9.	Energy savings	Toe/year	15067

THANK YOU !

Annexure 5

INTRODUCTION OF

ONCE-THROUGH BOILERS

&

MUTIPLE INSTALLATION SYSTEM

The Best Partner of
Energy, Water and Environment

MIURA

1

Company Profile

Name
MIURA Co., Ltd.

Location (所在地)
7 Horie, Matsuyama, Ehime
799-2696, Japan

Founded (創立)
December 1, 1927

Established (設立)
May 1, 1959

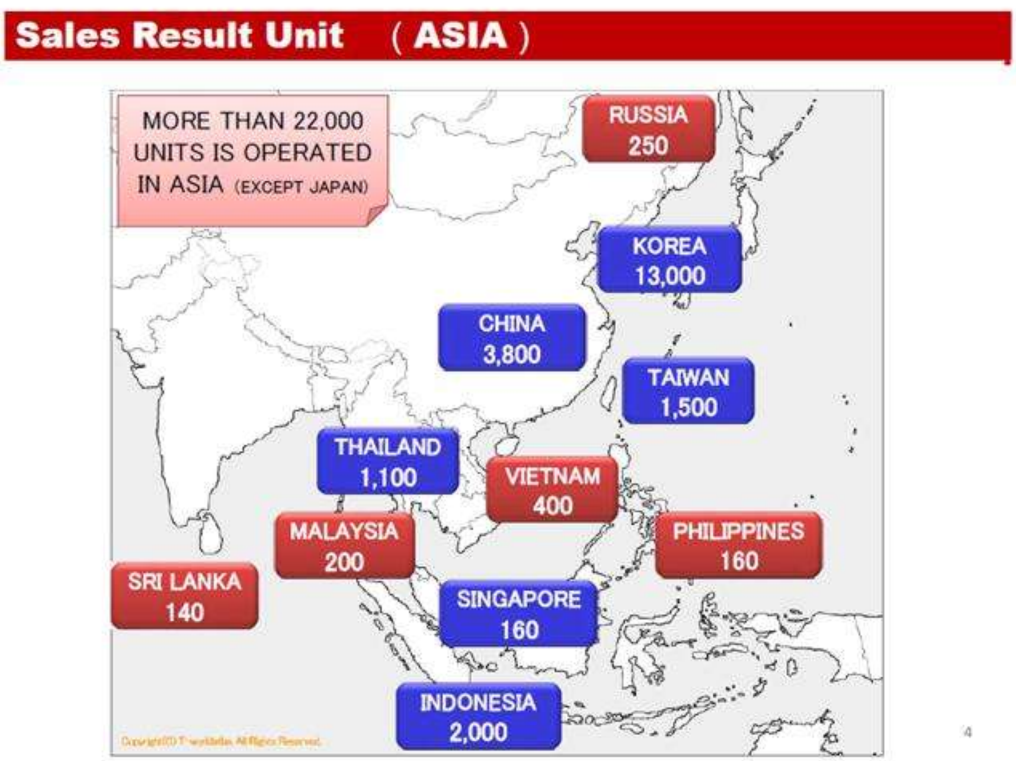
Capital (資本金)
9,544 million yen (82million dollars)

Issued stock(発行株式数)
125.29 million
The first sections of the Tokyo Stock Exchange and Osaka Securities Exchange

Employees (従業員数)
4,409
Miura group total

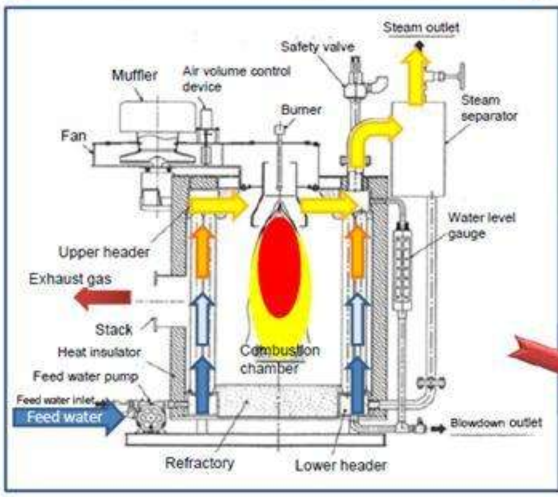
2


Miura Worldwide Expansion
18 nations 6 Factories in overseas
RUSSIA
HOLLAND
KOREA
CHINA
TAIWAN
ASEAN
CANADA
USA
MEXICO
BRAZIL
MIURA SUBSIDIARY
AGENT
MIURA
3


Sales Result Unit (ASIA)
MORE THAN 22,000 UNITS IS OPERATED IN ASIA (EXCEPT JAPAN)
RUSSIA 250
KOREA 13,000
CHINA 3,800
TAIWAN 1,500
THAILAND 1,100
VIETNAM 400
MALAYSIA 200
PHILIPPINES 160
SRI LANKA 140
SINGAPORE 160
INDONESIA 2,000
4

Structure of Once-through Boiler

Sectional view of boiler



◆ This small boiler has a structure that does not include a drum and once-through stores a small amount of energy inside it, providing high intrinsic safety against destruction.

◆ It is compact and lightweight as compared with another boiler.

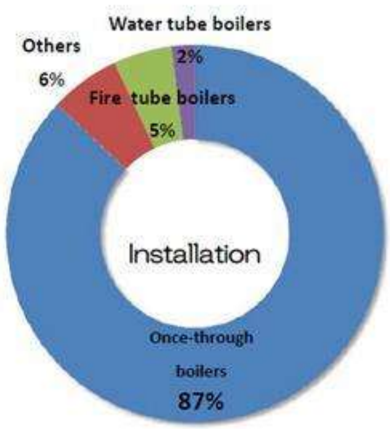
◆ The low water content results in a very short evaporation time, 3 to 5 min.

ω flow structure
with proprietary heat transfer fin

Number of boiler related fatalities by boiler type

Year	Boilers	Small boilers	Simple boilers
2012	1	0	0
2011	1	0	0
2010	0	0	0
2009	0	0	0
2008	1	0	0
2007	0	0	0
2006	2	0	0
2005	0	0	0
2004	1	0	0
2003	0	0	0
2002	3	0	0
2001	0	0	0
2000	0	0	0
Total	9	0	0

Source: Boiler & Crane Safety Association Homepage as of June 2014



Boiler installation status
Boiler types installed by percentages

※ Above figures are our estimates

Features of Once-through Boiler

High Efficiency Boiler

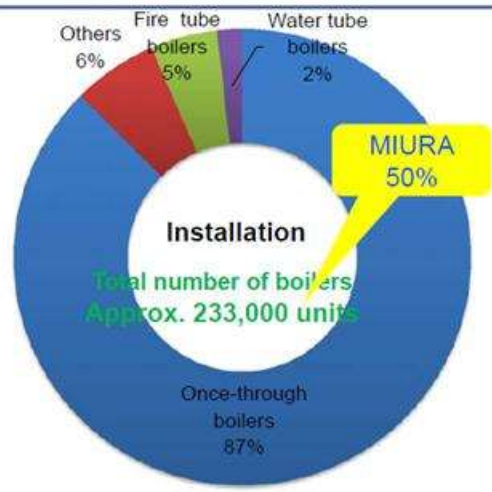
EI-2000SG

- ✓ High Efficiency
  - Maximum Efficiency of 96% is achieved !
  - Original "special heat transfer fins" = ω flow structure, Economizer with superior corrosion-resistant
- ✓ Compact
  - The high efficient boiler structure and smart layout of the products offer surprisingly space-saving, compared to conventional fire-tube boilers.
- ✓ Safety
  - The once-through boiler offers a high level of safety !

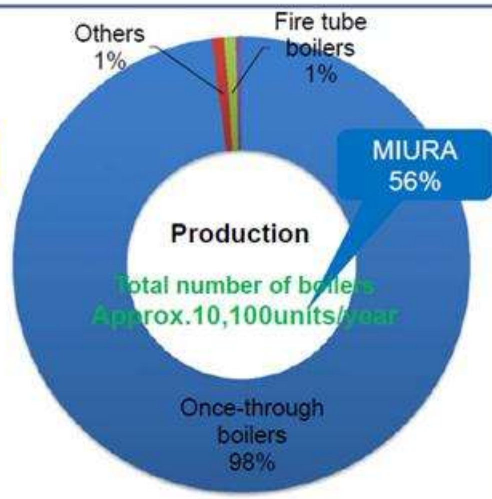
7

Boiler Market in Japan

(excluding boilers for power plant)



Boiler installation status
Boiler types installed by percentages

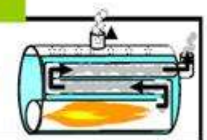


Fiscal 2011 boiler production status
Boiler types produced by percentages

Above figures are our estimates

Comparison of Once-through Boiler & Fire tube Boiler

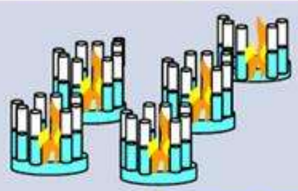
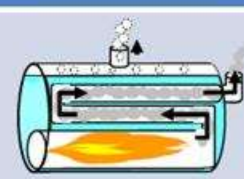
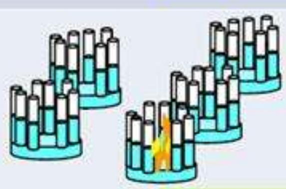
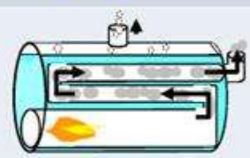
2 ton/h : 2 ton/h

	Once-through boiler 		Fire tube boiler 
Water contents (Liter)	Low	120 < 2500	High
Time required to generate steam (min)	Short	5 < 50	Long
Radiatoin loss	Low	1 < 3	High

Energy saving / Design efficiency	High	Low

Note: Ratio with the same quantity of evaporation.
All values are actual measurement values based on Miura data.

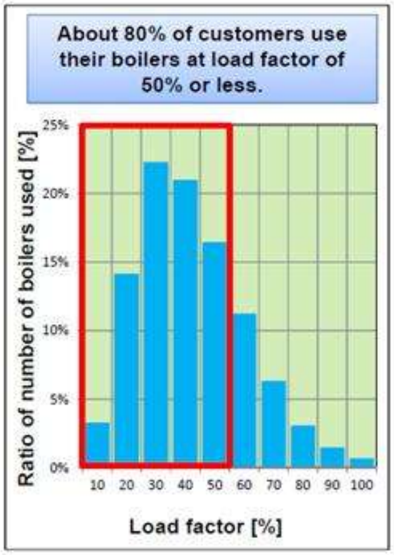
Comparison of Radiation Loss

	Once-through Boiler	Fire tube Boiler
Steam Out Put 20 ton/h		
	52kg/h <	160kg/h
Steam Out Put 4 ton/h		
	10kg/h <	160kg/h

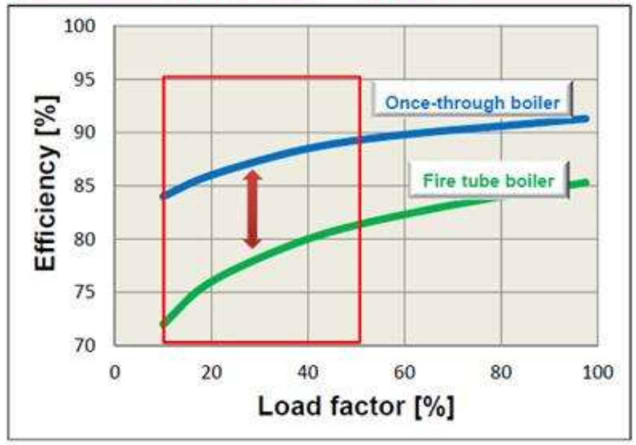
Radiation Loss Ratio : Once-through Boiler : 0.26%
Fire tube Boiler : 0.8%

Steam Load Factor & Boiler Efficiency

Multiple Installation System of Once-through Boiler
VS Fire tube Boiler

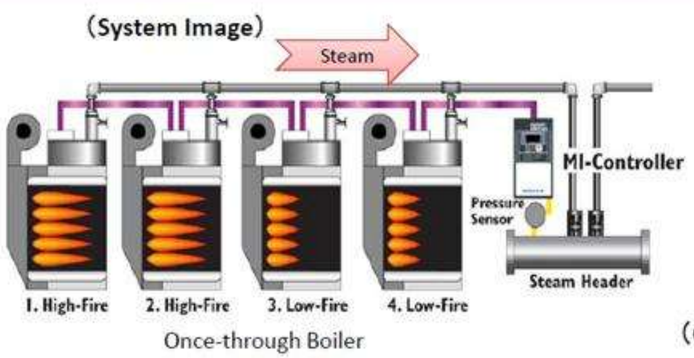


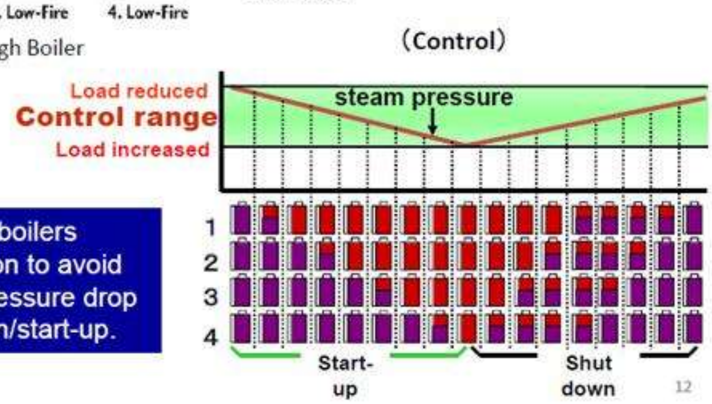
KEEP THE HIGHER EFFICIENCY THAN FIRE TUBE BOILER AT ALL LOAD AREA



11

Multiple Installation(MI)System of Once-through Boiler



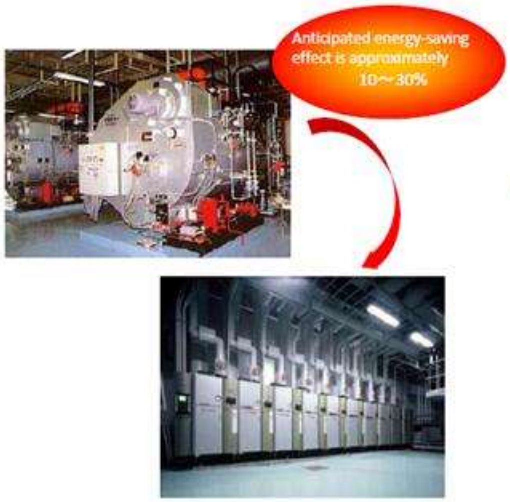


When the load reduces, boilers continue low fire operation to avoid purge loss and steam pressure drop due to purge at shutdown/start-up.

12

Features of MI System

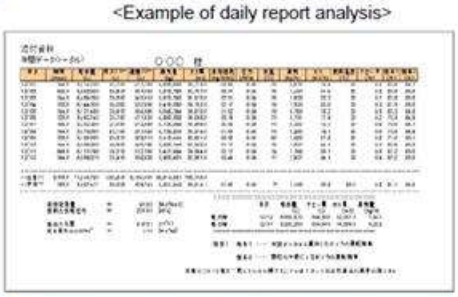
- ✓ Multi-unit installation of high-efficiency once-through boilers can maintain higher level of operating efficiency than large-scale fire-tube boilers.
- ✓ Multiple installations take much less space than large-scale fire-tube boilers.



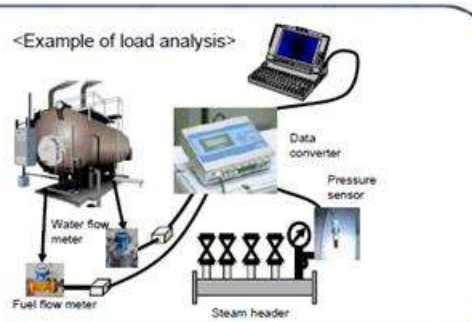
Energy-saving Diagnosis

To implement improvement of the boiler system, it is necessary to understand the current situation at first. Using the methods of "Daily report analysis" which is grasping the efficiency of boiler operation and the steam usage through out the year or "Load analysis" which is measuring the instantaneous steam load by installing some sensor to the boiler.

<Example of daily report analysis>



<Example of load analysis>



Example of MI System 1

Example of energy saving by boiler update (in Japan)

	BEFORE	AFTER	
EQUIPMENT	No Image		
BOILER TYPE	Firee tube boiler	Small once-through boiler	
BOILER CAPACITY	9.5 ton/h×1 14.4 ton/h×1	3 ton/h	
NUMBER OF BOILER	2	7	
FUEL	Japanese A-type fuel oil	Natural gas	
EFFICIENCY	84.8 %	96.5 %	14% UP
CO_2	430.6 ton/year	292.9 ton/year	32% DOWN

- Small once-through boiler is a standard of industrial steam equipment in Japan.
- MI system at large facility is expanding by enhancing the capacity of once-through boiler.
- The improvement of operating efficiency is in progress by the MI system upgrade and efficiency improvement.

	BEFORE	AFTER	
EQUIPMENT	No Image		
BOILER TYPE	Water tube boiler	Small once-through boiler	
BOILER CAPACITY	3.6 ton/h	2 ton/h	
NUMBER OF BOILER	2	3	
FUEL	Natural gas	Natural gas	
EFFICIENCY	79.6 %	96.9 %	22% UP
CO_2	1,014 ton/year	871 ton/year	14% DOWN

15

MIURA

Example of MI System 2

Example of energy saving by boiler update (in Korea)

	BEFORE	AFTER	
EQUIPMENT			
BOILER TYPE	Fire tube boiler	Small once-through boiler	
BOILER CAPACITY	12 ton/h	2 ton/h	
NUMBER OF BOILER	1	5	
FUEL	Natural gas	Natural gas	
EFFICIENCY	84.4 %	93.0%	10% UP
CO_2	3,782 ton/ year	3,432 ton/year	9% DOWN

- Small once-through boiler and MI system are spreading in KOREA.
- Boiler installation to large facility is also progressing like Japan.
- Natural gas is the mainstream.

	BEFORE	AFTER	
EQUIPMENT			
BOILER TYPE	Water tube boiler	Small once-through boiler	
BOILER CAPACITY	15 ton/h	2 ton/h	
NUMBER OF BOILER	2	15	
FUEL	Natural gas	Natural gas	
EFFICIENCY	86.0 %	92.0 %	7% UP
CO_2	10,070 ton/ year	9,413 ton/year	7% DOWN

16

MIURA

Example of MI System 3

Example of energy saving by boiler update (in China)

	BEFORE	AFTER	
EQUIPMENT			
BOILER TYPE	Water tube boiler	Small once-through boiler	
BOILER CAPACITY	10 ton/h	2 ton/h	
NUMBER OF BOILER	3	12	
FUEL	Coal	Natural gas	
EFFICIENCY	72%	93%	(29%UP)
CO_2	26,868 ton/year	9,826 ton/year	(63%DOWN)

- Fire tube boiler or water tube boiler is the mainstream for industrial boiler equipment in China.
- Although coal, diesel oil, or natural gas is used as the boiler fuel, the boiler using coal fuel still exists over 80 % of the total number of current boiler.
- Significant energy-saving and the emissions-reduction of air pollutant is realized by adopting MI system of once-through boiler and the fuel conversion to gas.

	BEFORE	AFTER	
EQUIPMENT			
BOILER TYPE	Fire tube boiler	Small once-through boiler	
BOILER CAPACITY	7 ton/h	2 ton/h	
NUMBER OF BOILER	3	3	
FUEL	Diesel oil	Natural gas	
EFFICIENCY	82.20%	91.20%	(11%UP)
CO_2	3,355 ton/year	2,145 ton/year	(36%DOWN)

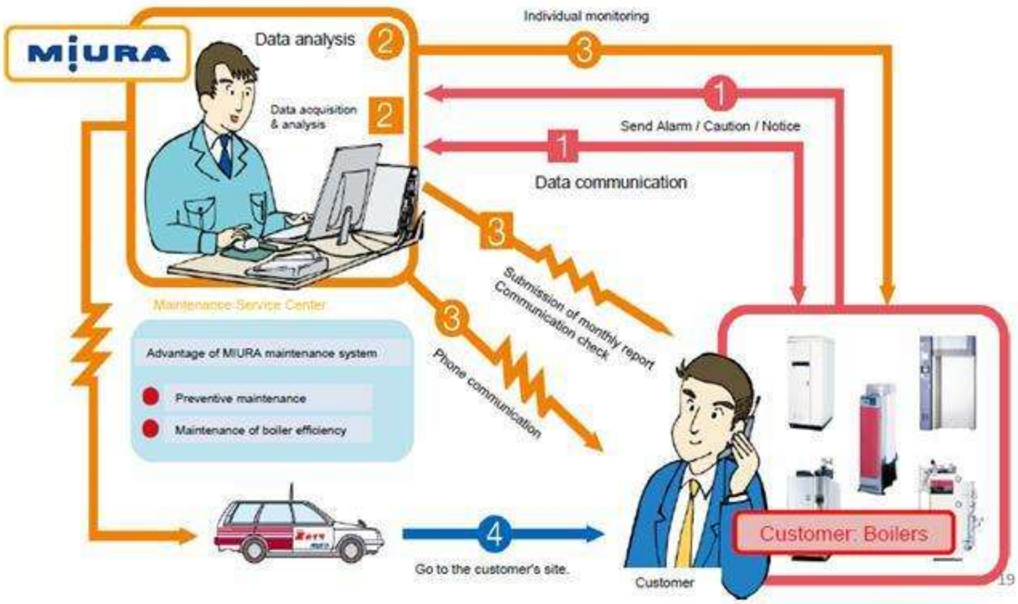
7

MI System Worldwide Expansion

18

Miura Online Maintenance System

A single telephone line allows MIURA to conduct online maintenance.



19

The Best Partner of Energy, Water and Environment

MIURA

http://www.miuraz.co.jp/en/

20

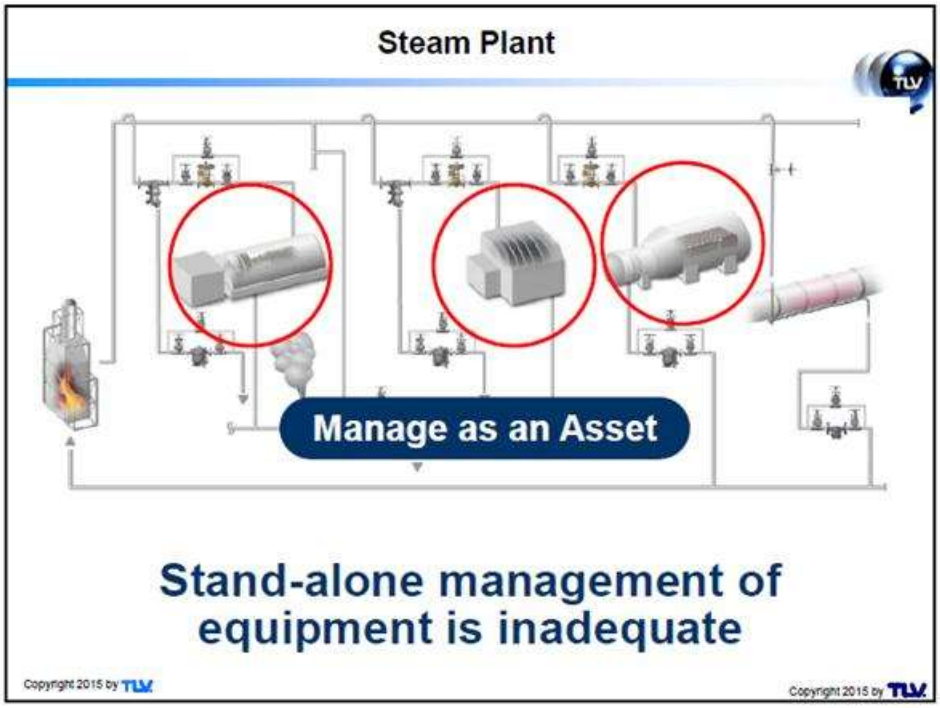
Annexure 6


CES
A Chemical Company in India
One Day SSOP® Feasibility Study
TLV
Survey Date: 9th December 2015
Report Date: 10th December 2015
TLV Members
Hayato Kida / Consulting Engineer
Ashwin Sanyal / TLV India Sales Manager
Copyright 2015 by TLV


Steam System Optimization Program
SSOP®
Peace of Mind through Steam System Optimization
TLV
Copyright 2015 by TLV
Copyright 2015 by TLV


Typical Scenes from a Steam Plant


Peace of Mind



Steam Plant
Manage as an Asset
Stand-alone management of equipment is inadequate
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Contributing to Safe & Stable Plant Operation
Bring Forth Full Function and Capability of Equipment
Steam is an Asset
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The Structure of SSOP®

Phase 3 How can the entire steam system be optimized?

Create optimum balance with the entire steam system treated as a valuable asset.

Phase 2 How can all SA (Steam Applications such as steam-using equipment, tracing) be optimized?

Newly define everything from steam supply to condensate discharge as an asset.

Phase 1 How can all CDLs (ex. 10,000) be optimized?

Necessary conditions for the steam system to function.

The Structure of SSOP®

Phase 3 **Steam System Balance** — Optimize Steam System

- ⇨ Steam System (Electricity & BFW) Balance Optimization
- ⇨ Steam Load & Generation Balance Optimization

Phase 2 **BPSSM®** (Best Practice of Steam System Management) — Optimize Steam

- ⇨ Safety, Reliability & Productivity Improvements
- ⇨ Recover and Re-use Condensate and Waste Heat

Phase 1 **BPSTM®** (Best Practice of Steam Trap Management) — Create Infrastructure

- ⇨ Eliminate Problems Caused by Condensate
- ⇨ Reduce Steam Loss

BPSTM.NET - Executive Summary

Feasibility Study Result Summary

Improvement Items

CDL survey item + 2 steam application items

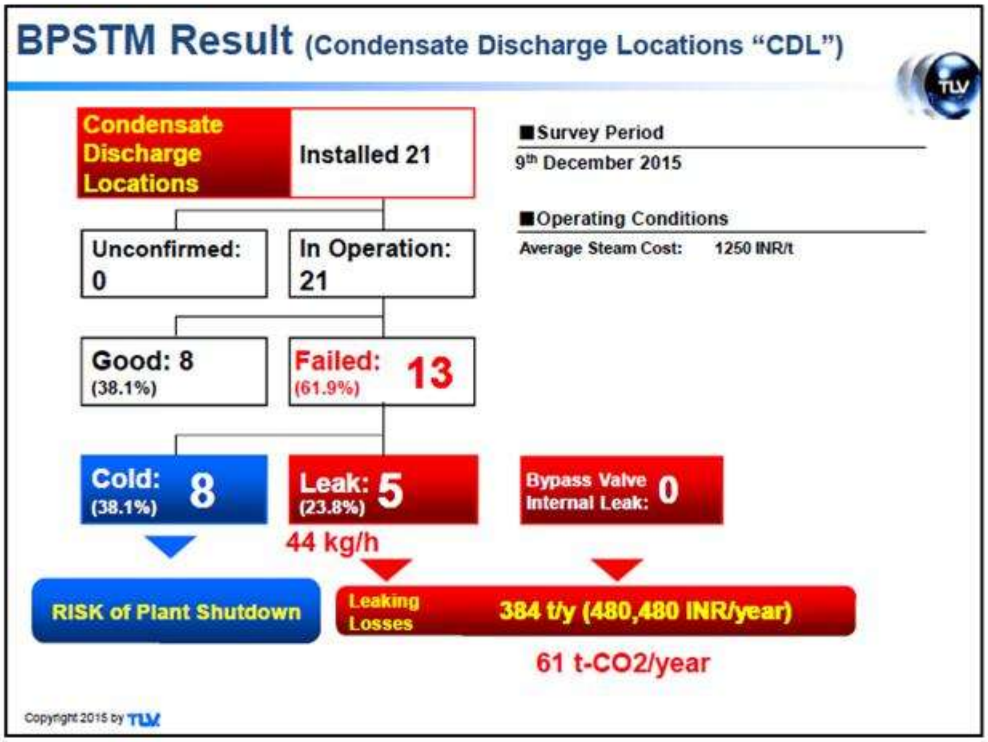
Steam Reduction	:	**120 kg/h**
CO2 Reduction	:	**166 t-CO_2/Year**
Total Merit	:	**1,317,000 INR/Year**

This time surveyed 21CDLs and 6 steam applications out of 118CDLs and 30 steam applications during one day.

Estimated Total Energy Saving Potential

Steam Reduction	:	**629 kg/h**
CO2 Reduction	:	**865 t-CO_2/Year**
Total Merit	:	**6,881,000 INR/Year**

Used following condition
CO2 emission factor:0.157 tCO2/tSteam (IPCC standard/Refinery Gas)
Operating hour:8760hours/year
Steam cost:1250 INR/t


BPSTM Result (Condensate Discharge Locations "CDL")
Condensate Discharge Locations
Installed 21
Unconfirmed: 0
In Operation: 21
Good: 8 (38.1%)
Failed: 13 (61.9%)
Cold: 8 (38.1%)
Leak: 5 (23.8%)
44 kg/h
Bypass Valve Internal Leak: 0
RISK of Plant Shutdown
Leaking Losses
384 t/y (480,480 INR/year)
61 t-CO2/year
■Survey Period
9th December 2015
■Operating Conditions
Average Steam Cost: 1250 INR/t
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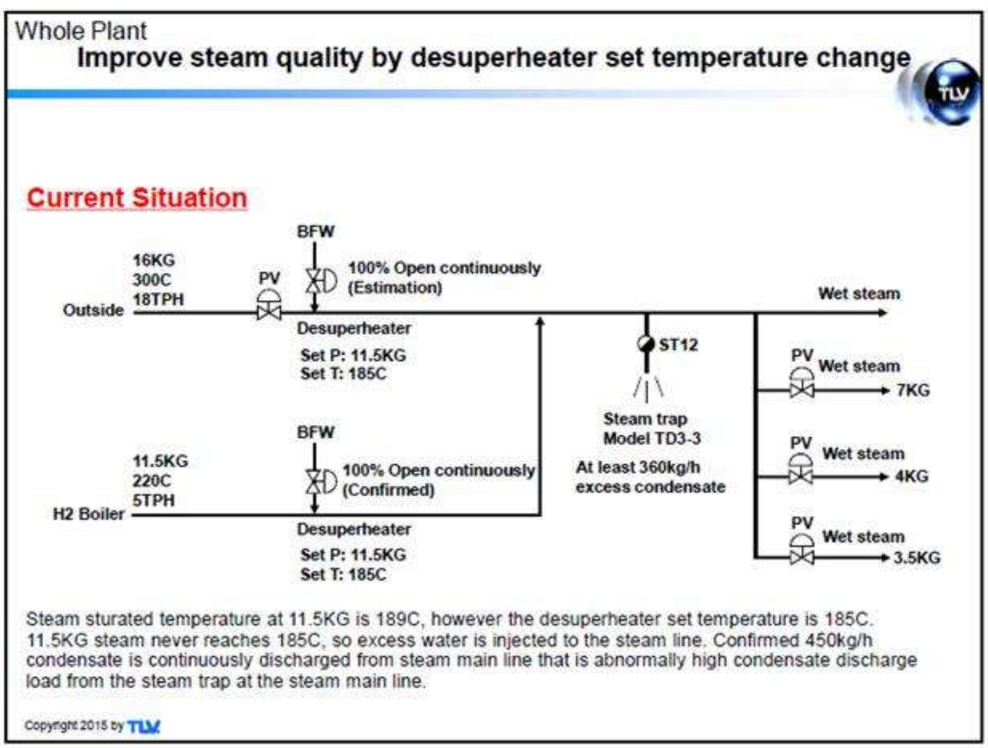
Whole Plant
Improve steam quality by desuperheater set temperature change
Current Situation
BFW
16KG
300C
18TPH
Outside
PV
100% Open continuously
(Estimation)
Desuperheater
Set P: 11.5KG
Set T: 185C
Wet steam
ST12
Steam trap
Model TD3-3
At least 360kg/h
excess condensate
PV
Wet steam
7KG
BFW
11.5KG
220C
5TPH
H2 Boiler
100% Open continuously
(Confirmed)
Desuperheater
Set P: 11.5KG
Set T: 185C
PV
Wet steam
4KG
PV
Wet steam
3.5KG
Steam sturated temperature at 11.5KG is 189C, however the desuperheater set temperature is 185C. 11.5KG steam never reaches 185C, so excess water is injected to the steam line. Confirmed 450kg/h condensate is continuously discharged from steam main line that is abnormally high condensate discharge load from the steam trap at the steam main line.
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Whole Plant

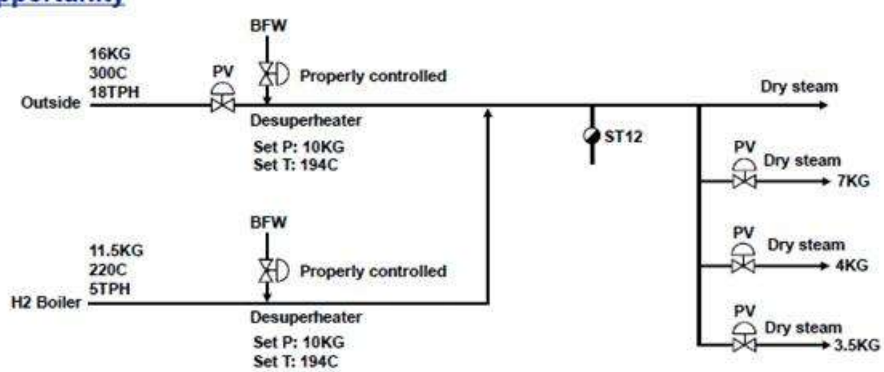
Improve steam quality by desuperheater set temperature change

Whole Plant

Improve steam quality by desuperheater set temperature change

Potential benefit: Steam reduction 76kg/h, 836,000 INR/year, 105 t CO_2/year, Steam quality improvement

Opportunity

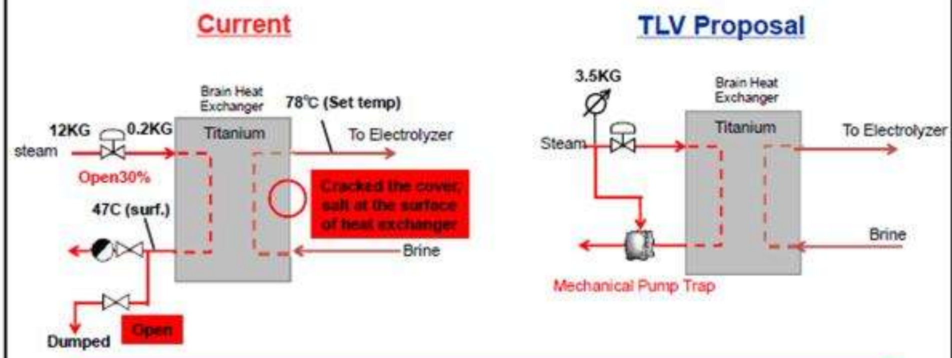


Change the steam set pressure to 10KG (Tsat=184C). Change the desuperheater set temperature to 194C (10C + Steam saturated temperature) . Excess desuperheater water is not injected steam line and reduce losses. Reduce risk caused by wet steam.

MC1

Reduce risk and steam loss from plate heat exchanger by pump trap

Potential benefit: Reduce risk of steam leakage and improve system reliability



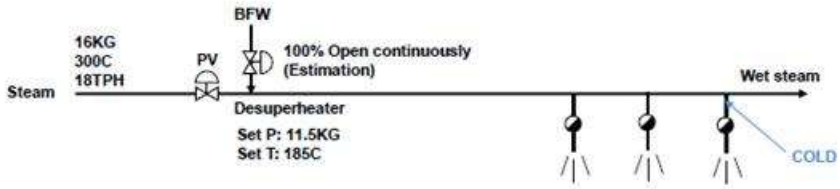
Safety Reliability is one of the most important issue

Next Action

1) Implement improvement items
- Many CDLs judged as Low temperature (less than 60% of steam saturated temperature) 6 Low temperature CDLs out of 8 cold CDLs
- Desuperheater temperature setting may affect this (too much condensate cannot be discharged by small steam traps)
- Recommend to review desuperheater setting first then re inspect CDLs
- Some valves in CDLs are wrongly operated (Steam trap inlet valve closed). Need whole area survey and optimize CDL operation.

2) Survey for whole plant
- This is feasibility study. The survey time was very short. However even this short period, there are some important findings. Need whole plant survey to maximize your profit.

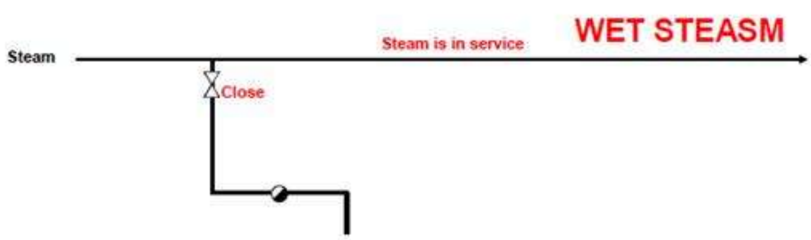
Next Action



Is this steam trap failure?
Is this because of too much water from desuperheater?

Normal steam trap survey cannot find this

Next Action



Normal steam trap survey could judge this trap as COLD!

SSOP Achievement

Surveyed 105 plants (in Japan)

CO_2 emission reduction	**320,000 t/year**
Steam loss reduction	**260 t/hour**
Cost reduction	**2.8 billion INR/year**

Potential in India comparison by refinery capacity

India	Japan
4,355,000 barrels / day	3,916,700 barrels / day
22 Plants	23 Plants

FS CDL failure rate 61.9%	Japan CDL average failure rate 25.6%
? billion INR/year	**2.8 billion INR/year**

TLV Contact in India

Steam System Optimization Program(SSOP®) by TLV

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Annexure 7. Selected photos from the workshop