Awareness Workshop on Dissemination of Japanese low carbon technologies in India

26th August, 2016 at Chennai

Organised by

The Energy and Resources Institute (TERI)
&
The Tamilnadu Small and Tiny Industries Association (TANSIA)

With support from

Institute for Global Environmental Strategies (IGES)

Table of contents

Summary

A awareness workshop on 'dissemination of Japanese low carbon technologies in India' was organised on August 26, 2016, at TANSTIA FNF Hall, Guindy at Chennai by TERI in collaboration with The Tamilnadu Small and Tiny Industries Association' (TANSTIA). The event was supported by Institute for Global Environmental Strategies (IGES), Japan. The agenda of the event is given in Annexure 1. A summary of the deliberations of the workshop is given below.

Mr C Muthusami, President, TANSTIA welcomed the delegates to the workshop. He thanked IGES and TERI for organizing the seminar on climate change and energy efficiency issues which are very important topics. He emphasized the need to reduce, reuse and recycle in all aspect of daily life.

Dr Rabhi Abdessalem, IGES made presentation on the application of low carbon technologies (LCTs) from Japan in Indian industries. He explained the matching business-to-business (B2B) strategy for technology demonstration and scale-up of LCTs. A number of feasibility studies as well as demonstration have been successfully undertaken by IGES and TERI in collaboration with Japanese and Indian businesses. He explained that a on-line Japan-India stakeholders matchmaking platform (JISMAP) is proposed during the year in order to promote LCT deployment in India. The proposed platform will help strengthen the existing partnership among different stakeholders (governments, industries, research institutes and funding organisations) in both countries and accelerate the dissemination of cleaner technologies in India. A copy of his presentation is provided in Annexure 2.

Mr Prosanto Pal, TERI made a presentation on probable contents of the JISMAP website. The website could contain information related to Equipment specifications, typical applications, costs (capital, operating etc), savings (energy, others), payback period, local service support, case-studies, financing schemes for EE equipment (government, banks, bilateral schemes) and so on. He requested the panel members to share their views on the contents of the proposed platform. A copy of his presentation is provided in Annexure 3.

The presentations were followed by a panel discussion on 'effective information sharing and matchmaking through proposed on-line platform JISMAP'. Senior representatives from Indian government (Ministry of MSME), banks (SIDBI) and industry (TANSIA, local industries) participated in the panel discussions which was moderated by Mr Girish Sethi, TERI.

Mr C Muthusami, TANSTIA, mentioned that a time frame for technology transfer needs to be defined. He mentioned that Tamilnadu is one of the leading producers of pumps and motors, accounting for 40 percent of domestic production of pumps and motors in India. There is a huge scope to collaborate with Japan in technology transfer of energy efficient pumps and IE3 motors.

Mr S Panikkassery, MSME Development Institute, Chennai mentioned that there is a huge scope to adopt energy efficient production processes and equipment in the Indian industries. Also, alternative materials which lead to reduction in energy consumption should be adopted by industries. The Ministry of MSME is promoting ZED (zero effect, zero defect) scheme as a holistic approach to improving quality, productivity and energy efficiency and to reduce environmental pollution.

Mr V Chandramouli, SIDBI, mentioned that the bank has been financing energy efficient equipment and promoting cleaner production processes. He emphasized the importance of technology demonstrations as a tool to promote energy efficient technologies from Japan. He mentioned that the proposed JISMAP platform could explore linking-up/establishing an on-line financing application/payment for reputed Japanese LCT suppliers which can be useful for Indian SMEs and financial institutions.

Mr S Thyagarajan, Mudhra Fine Blanc (auto ancillary unit) suggested that an approach focused at unit-level feasibility studies and hand-holding during implementation could be followed for implementation of Japanese LCTs by TERI and IGES. He suggested that a certain time period should be set for the JISMAP web-site and unit level implementations.

Mr A Pari, from CRP (India), mentioned that providing case-studies on Japanese LCTs will be an useful feature in the proposal JISMAP web-site. The web-site could be a useful resource for increasing the awareness on energy efficiency by highlighting the costs of utilities like compressed air and SEC benchmarks for energy-intensive equipment.

A detailed technical presentation on ''Low Carbon Technology of Air Compressor System - Energy Saving and Environmentally Friendliness'' was made by Mr Tsukasa Saito. A copy of his presentation is provided in Annexure 4.

A detailed technical presentation on Necessity of Visualization (FEMS) and Example of Energy-Saving of Distribution Facility Through FEMS'' was made by Mr Akio Yoshizaki, Hitachi Industrial Equipment Systems Co. Ltd. A copy of his presentation is provided in Annexure 5.

The workshop ended with a vote of thanks by Mr Chetan Sangole, TERI.

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

Venue:
TANSTIA FNF Hall, 2nd Floor
10, GST Road, Guindy

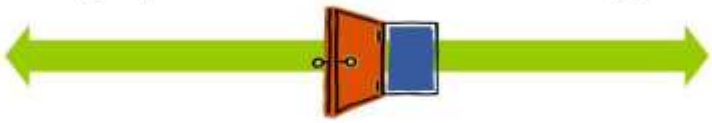
Date:
August 26, 2016
10:00 am – 4:00 pm

AGENDA

10:00 – 10:30 am	**Registration & Tea**	
Session 1: Inaugural Session		
10:30 – 10:35 am	**Welcome address**	**Mr C. Muthusami,** President, Tamilnadu Small and Tiny Industries Association (TANSTIA)
10:35 – 11:10 am	**Background presentations** IGES-TERI efforts to promote LCT deployment in India with special emphasis on initiating Japan-India stakeholders matchmaking platform (JISMAP)	**Dr Abdessalem RABHI,** Institute for Global Environmental Strategies (IGES), Japan **Mr Prosanto Pal,** The Energy and Resources Institute (TERI)
11:10 – 12: 10 am	**Panel Discussion** Effective information sharing and matchmaking through proposed on-line platform JISMAP **Moderator: Mr. Girish Sethi,** TERI **Panelists:** **Mr S Panikkassery,** MSME Development Institute, Chennai **Mr C Muthusami,** TANSTIA **Mr V Chandramouli,** SIDBI **Mr S Thyagarajan,** Mudhra Fine Blanc **Mr A Pari,** CRP (India)	
Session 2: Technical session – Compressed Air System		
12:10 – 13:00 pm	**Presentation on 'Energy efficiency in Compressed Air System' – Japanese Experience**	**Mr Tsukasa SAITO,** Compressed Air System Expert, formerly with Hitachi Industrial Equipment System Co. Ltd, Japan
13:00 – 13:30 pm	**Discussion/Q & A**	
13:30 – 14:30 pm	**Lunch**	
Session 3: Technical session – Factory Energy Management System		
14:30 – 15:15 pm	**Presentation on 'Factory Energy Management System' (FEMS)**	**Mr Akio YOSHIZAKI,** Hitachi Industrial Equipment System Co. Ltd, Japan
15:15 – 15:45 pm	**Discussion/Q & A**	
15:45 – 16:00 pm	**Concluding remarks**	**Mr Chetankumar Sangole,** The Energy and Resources Institute (TERI)
16:00 – 16:30 pm	**Tea**	

Annexure 2: IGES presentation

Widening Japan-India Environmental Technology Gateway



IGES-TERI efforts to promote LCT deployment in India -Special emphasis on initiating Japan-India stakeholders matchmaking platform (JISMAP)

Abdessalem RABHI, PhD.
Senior Policy Researcher, and Task Manager, IGES

IGES
Institute for Global Environmental Strategies

Table of content

1) About IGES: Outline
2) Background on IGES-TERI efforts to promote LCT deployment in India
3) Initiating a Japan-India Stakeholder's Matching Platform (JISMAP) to Promote LCT Technology deployment in India

1) About IGES: Outline

- **Name of the Institute**

The 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/Desks: India, Indonesia, Thailand and China.

IGES headquarters (Hayama, Kanagawa)

Kansai Research Center | Date: July 7th ,2010 | 3

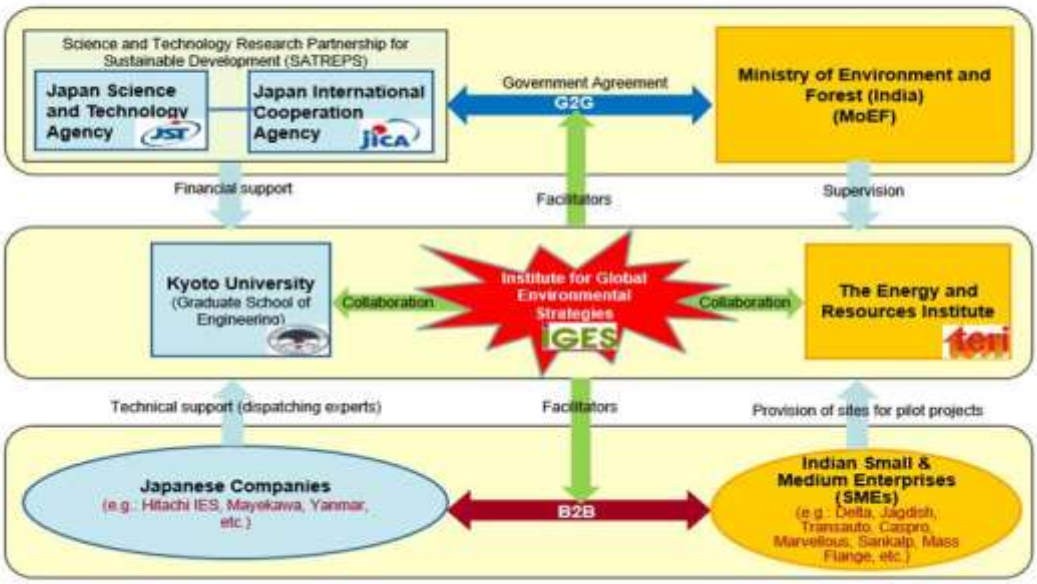
2) Background on IGES-TERI efforts to promote LCT deployment in India

2.1. FY2010~FY2013
Application of Low Carbon Technology project (ALCT)

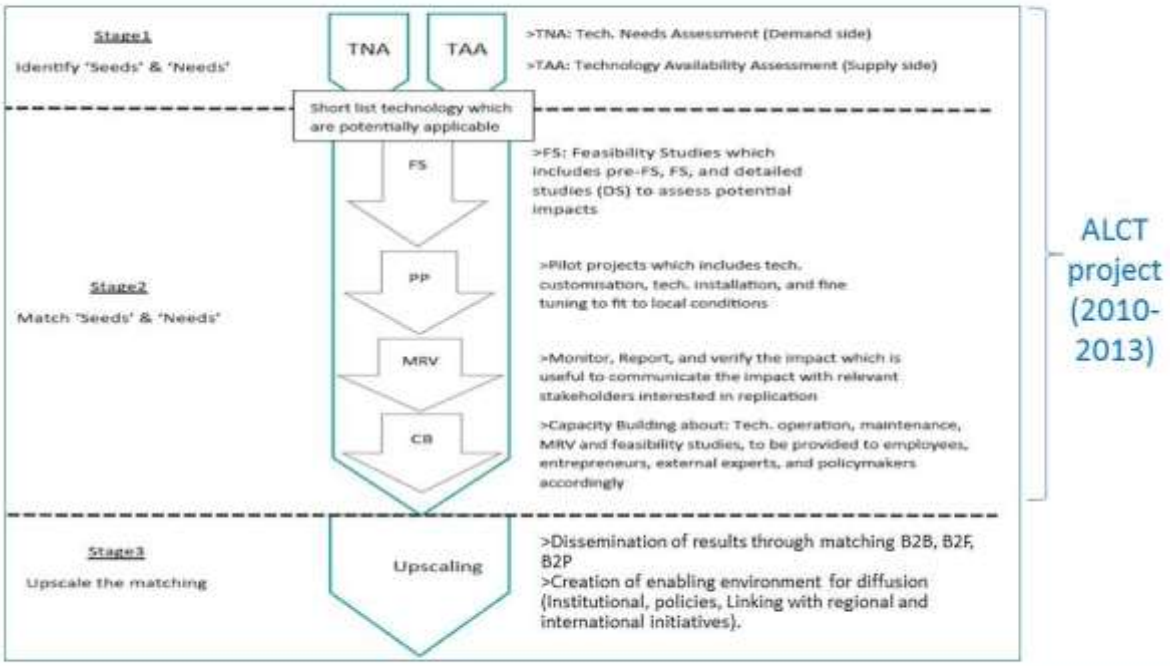
www.iges.or.jp | IGES Institute for Global Environmental Strategies | 4

ALCT Project's Stakeholders

IGES and TERI successfully engaged and matched various stakeholders to promote Japanese low carbon technology application in India under ALTC project



Aspect of strategy under ALCT project



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

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

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

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

- **Benefits**
  - Switch from electricity to natural gas (NG)
  - **Energy savings: 35%-45%**

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:
-SMEs have taken almost all the proposed measures in FS reports, except the installation of inveter type air compressor. Additional 10%-20% could be achived by installing inverter type air compressor.

IGES

Results #4 Enhancing the awareness and capacity of various stakeholders through trainings, workshops, forums, etc.

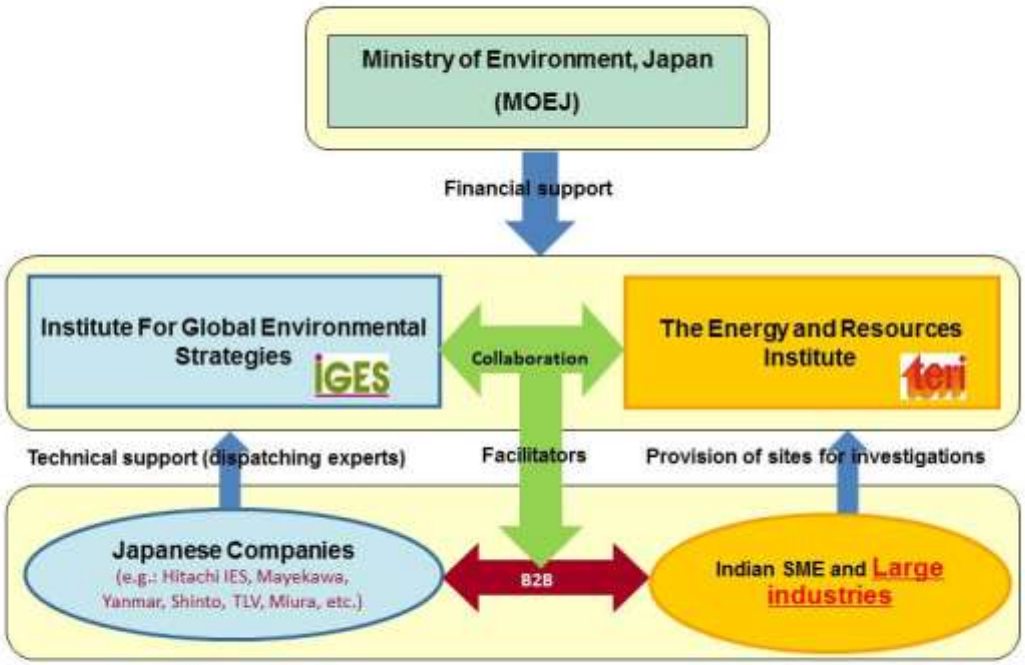
www.iges.or.jp

2) Background on IGES-TERI efforts to promote LCT deployment in India

2.2 FY2014 & FY2015

Building up on previous achievement, and engaging and matching more stakeholders

FY2014 & 2015



Summary of selected technologies 2014 & 2015

	Technology	Number of onsite FS
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

IGES

Engaging stakeholders
Matching Businesses to Businesses (B2B)

Investigation & capacity building regarding GHP (Sep. 2014)


Investigation & capacity building regarding Induction Furnace (Sep. 2014)



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Engaging stakeholders
Matching Businesses to Businesses (B2B) (continue)

Investigation & capacity building regarding EHP (Nov. 2014)



Investigation & capacity building regarding Compressed Air (Oct. 2014 & Sep. 2015)

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Engaging stakeholders
Matching Businesses to Businesses (B2B) (continue)

Investigation & capacity building about Once Through Boiler (Dec.2015)



Investigation & capacity building about Steam Management System (Dec.2015)


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Engaging stakeholders
Matching Businesses to Funding Agencies (B2F)


Mtg. with GEDA


Mtg. with SIDBI


Mtg. with JICA (India)


Mtg. with JBIC (India)


Mtg. with NEDO (India)

Engaging stakeholders
Matching Businesses to Policy Makers (B2P)

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

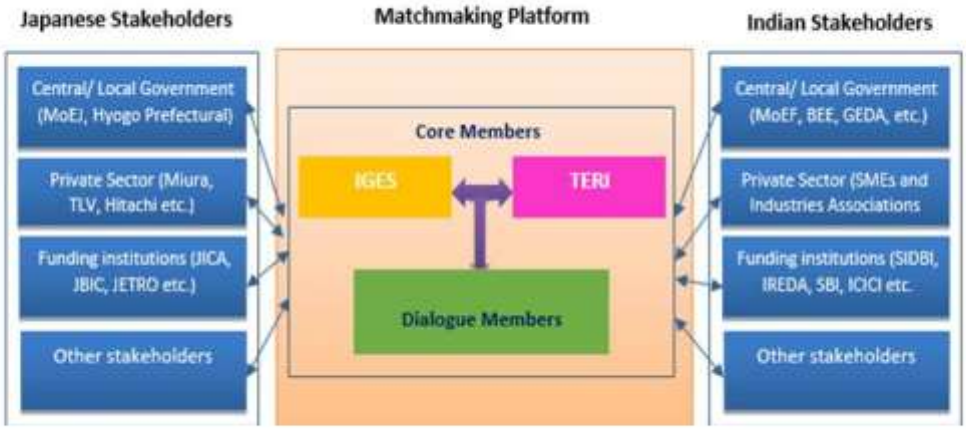
Key findings

- Huge potential/Market for Japanese low carbon technologies diffusion in India.
- Incomplete, fragmented, and uncoordinated efforts to tap opportunities.
- Technologies, policies, financing schemes, etc. are available (in Japan and India) but significant information, knowledge, and expertise gap remains among stakeholders.
- 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).
- **There is a need to initiate a stakeholders' matching platform to address all the above.**

3) Initiating a Japan-India Stakeholder's Matching Platform (JISMAP) to Promote LCT Technology deployment in India

Objective of JISMAP

Initiate Japan-India stakeholders' matchmaking platform (JISMAP) that has a role of assessment, mapping and "on the ground" and "online" matching (including capacity building) of seeds with needs to match B2B, B2F and B2P from India and Japan. The ultimate objective is to actually materialize low carbon businesses opportunities not just identifying them.



Framework

- JISMAP includes IGES and TERI as implementing/executing agencies (core members) and it is open to other relevant agencies from India and Japan to join it as dialogue members.

- The dialogue members should be mainly those who have accumulated wide knowledge and expertise related to LCT deployment and who have strong business networks such as business associations, funding institutions, local and central government agencies, regional and international agencies, etc.

- Core members and dialogue members will coordinate among each other to facilitate the "on the ground" matching of seeds with needs, through facilitating direct interaction among B2B, B2F and B2P as well as "online" matching through information and knowledge sharing regarding: technologies, policies and financing options from supply and demand sides.

Key activities

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 and best operation practices (BOP).
>Direct interaction of business with policy makers.

3) **Upscaling and technology diffusion (based on findings from 2):**
>Follow-up regarding the implemented projects/BOP to ensure their continuous operation.
>Identification and/or creation of opportunities at cluster/sector level.
>Explore replicability of implemented projects/BOP at cluster/sector level.
>Awareness creation and capacity building.

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

Online Knowledge & Information sharing Concept

Technology					Stimulating policies and regulations		Stimulating financing schemes		Note
Category	List	Japanese Maker	Application: Sector	Application: location	From Japan side	From India side	From Japan side	From India side	
Energy Efficiency	-Inverter Type Air Compressor (IAC)	-Hitachi IES -??	-Pharmaceutical	Chennai	JICA Public Private Partnership Program (PPP)	NMEEE	-JBIC export loan -JBIC Green Program	-SIDBI 2 step loan	The size of IAC vary widely which means that not all IAC require supporting financing schemes. -Compressed air is a system, so changing (or upgrading) the hardware to IAC should be coupled with adopting best operating practices (BOP) in order to achieve more saving in term of energy and cost.
			-Forging	Maharashtra (Nagpur forging cluster)					
	Electric heat pump	-Mayekawa	-Food processing	Chandigarh					
Renewable energy	Solar PV		-Commercial Buildings			Jawaharlal Nehru National Solar Mission		-IREDA program -Subsidies under JNNSM	

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 as in the case of existing platforms.

3) Systematic: It addresses all the stages of LCTT, 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) Technology/BOP categorization to craft the need for intervention.

7) It is not an alternative option to existing platforms, but rather a complementary one to them.

Any recommendation on how to make JISMAP operational and beneficial to Indian and Japanese stakeholders, especially businesses, is welcomed.

Thank you for your attention

Annexure 3: TERI presentation

Japan India Stakeholders Matchmaking Platform (JISMAP)

Awareness Workshop on Dissemination of Japanese low carbon technologies in India

Chennai, August 26, 2015

teri IGES

Large number of Japanese energy efficient technologies have application in Indian industries

- Compressed air system
- Factory Energy Management System (FEMS)
- Once through boiler
- Condensate Management System
- Micro cogeneration
- Energy efficient ventilation fan
- Gas heat pump (GHP)
- Electric heat pump (EHP)
- Amorphous transformer
- Electric induction melting furnace
- .....

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Capacity building and awareness raising

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

Workshop
Rajkot

Workshop
Chandigarh

teri IGES

JISMAP WEBSITE

Goal

To help link Japanese EET manufacturers to Indian industries

Specific objectives

- ❑ Showcase benefits of Japanese EETs through brochures, feasibility reports etc
- ❑ Potential market/applications in India
- ❑ Pre-information before B2B interactions

Beneficiaries

– Japanese technology supplier
– Indian industries and consultants

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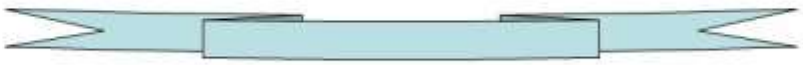
Points for discussion

- Contents in the website which will be most useful for Indian users
  1. Equipment specifications
  2. Typical applications
  3. Costs (capital, operating etc)
  4. Savings (energy, others)
  5. Payback period
  6. Local service support
  7. Case-studies
  8. Financing schemes for EE equipment: government, banks, bilateral available
  9. ……
- Do you know of any other web-sites which services a similar purpose

teri IGES

Thank you for you attention



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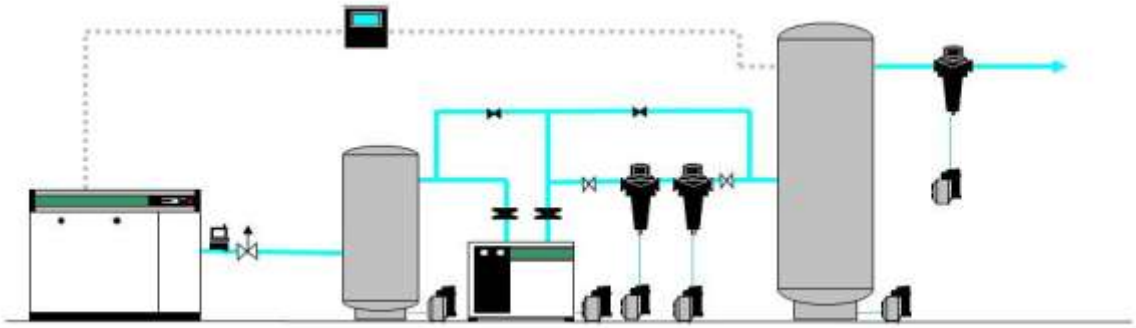
Annexure 4: Low carbon technology of air compressor system

Low Carbon Technology of Air Compressor System (Version 2016)

- Energy Saving and Environmentally Friendliness -

Tsukasa SAITO



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. 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

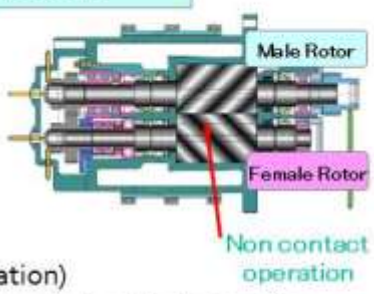
How to choose air compressor system

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

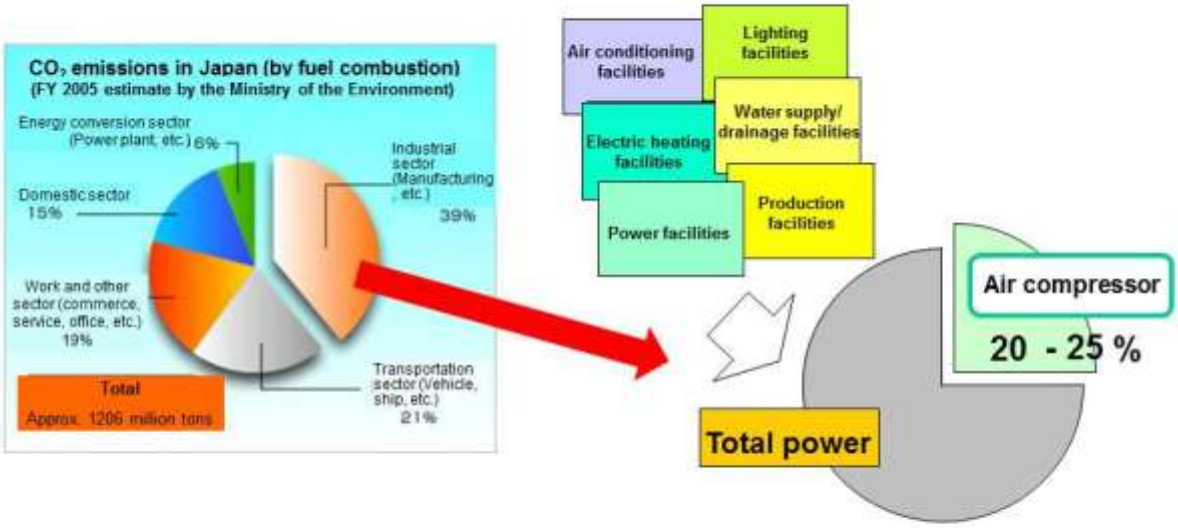
Oil-free compressor can get very clean air (class zero certification)
It can be used for high technology products and high quality use to develop industries for
Electronics, semi-conductors, food, medical supplies, textiles, and others
Oil-free air can meet HACCP, FSSC22000 and GMP regulations.

- 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

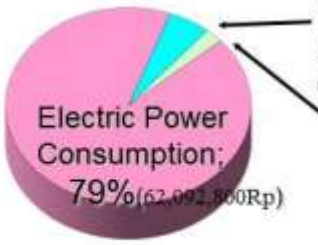
Energy Consumption...
Case of Japan (similar to Gujarat, India)



Energy consumed for the industrial sector (factories) accounts for approximately 40% of the total energy consumption in Japan.
It is considered that approximately a quarter of that amount is used by compressors.
In addition, compressors are regarded as machines for which energy consumption can be reduced relatively easily. As a result, energy saving through rotation control and multiple unit control is strongly requested by the Ministry of Economy, Trade and Industry as well.
Therefore energy saving for compressors needs to be addressed urgently.

Check out Energy Costs
-LCC and Specific Power Consumption

Most of compressor LCC is used for power consumption.



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

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

Note: LCC = Life Cycle Cost
<Example>
- Oil flooded 75kW class rotary screw (standard type)
- 6000h/y operation 7.0Rp/kWh
- 60% Load example
- Total cost: 20 years average

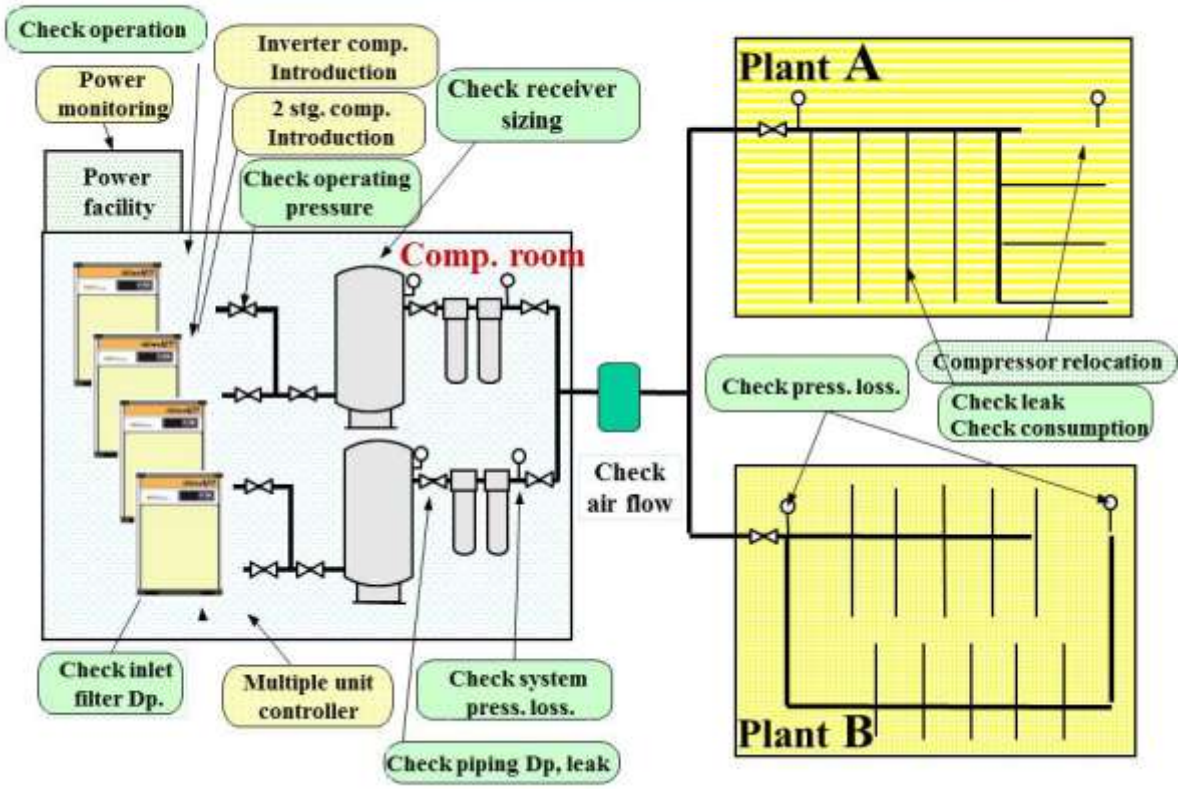
Specific Energy Consumption

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

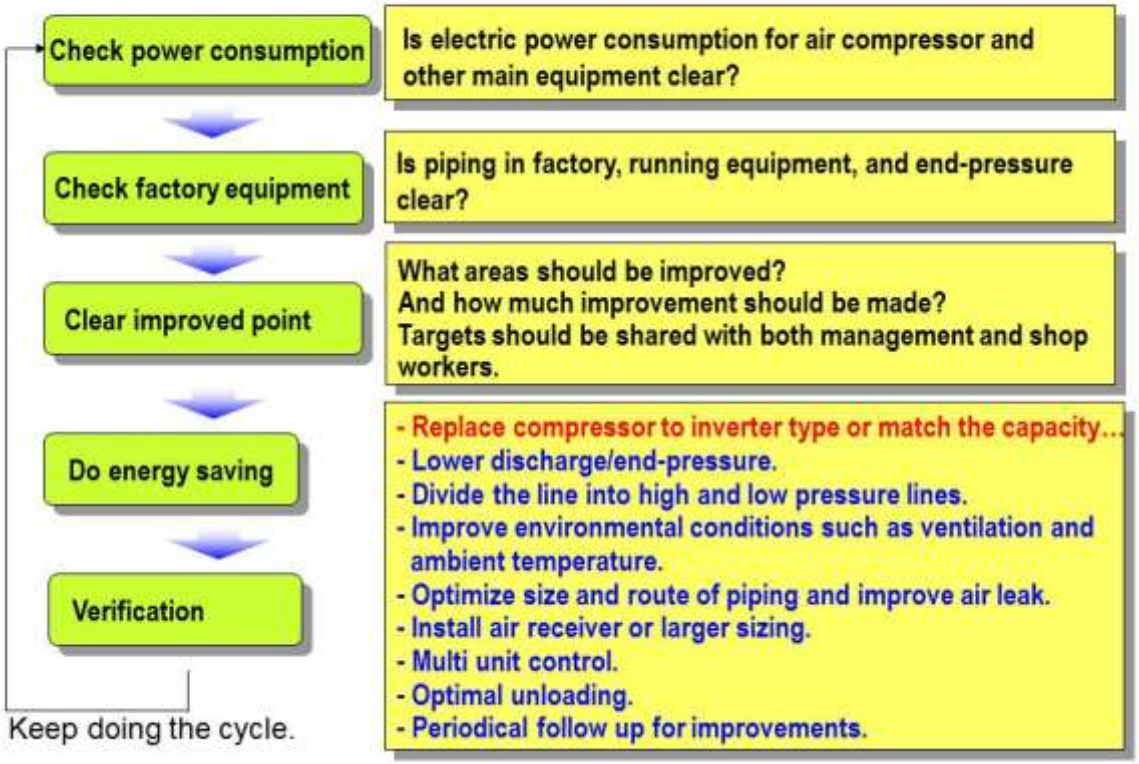
How much cost for your company? 1.2Rp/M3?

Energy cost (1.09Rp／㎥) = $\frac{\text{Input Power } 84\ (\text{kWh}) \times 0.88}{\text{FAD } 13.2\ (\text{㎥/min}) \times 0.6 \times 60\ (\text{min})} \times \text{Electricity cost } 7.0(\text{Rp/kWh})$

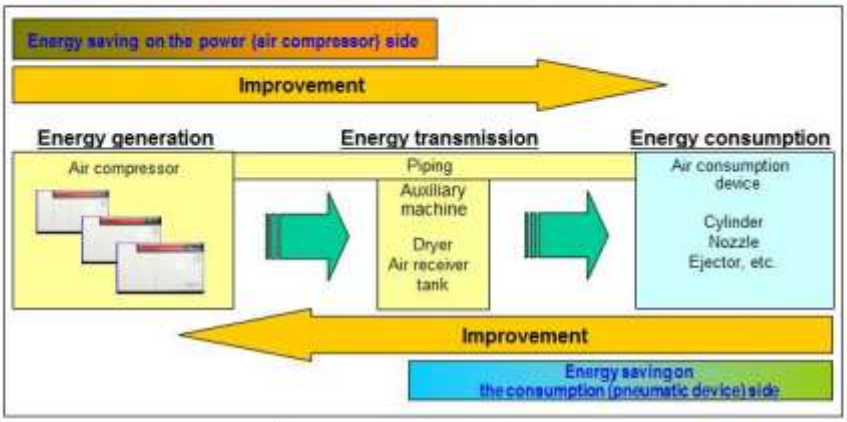
Check Points for Compressed Air System



Process for Energy Saving・・・Monitoring is Important



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

Consumption energy
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

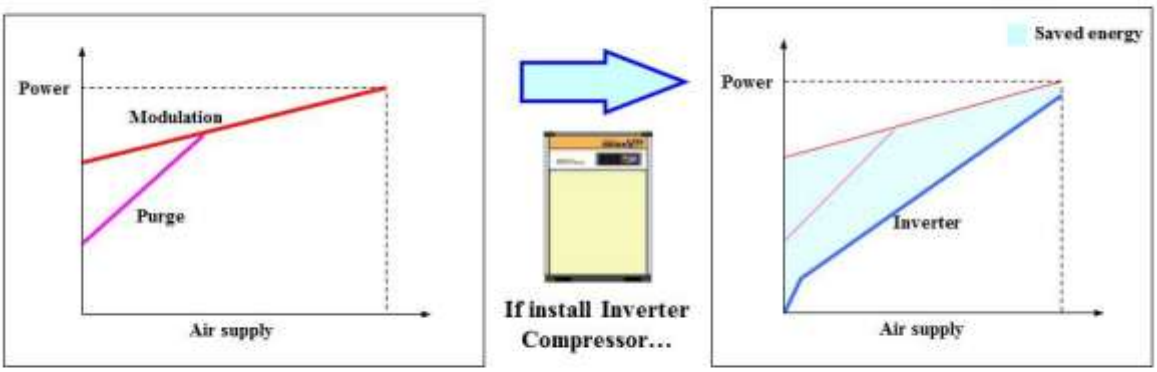
Efficient compressor ~ Most Efficient Position

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

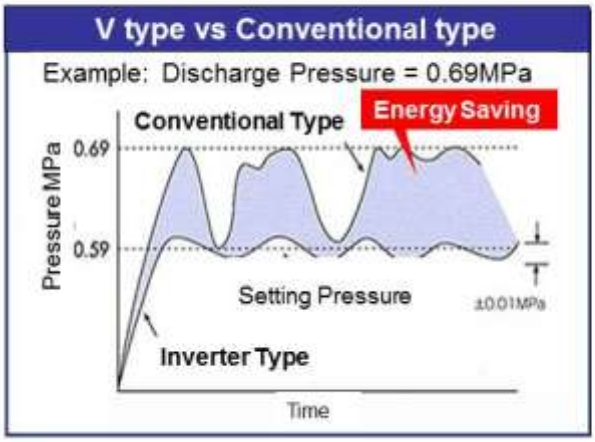
Conventional unloading method (modulation and/or purge) consumes unnecessary power during unloading. Inverter drive can save power!!!

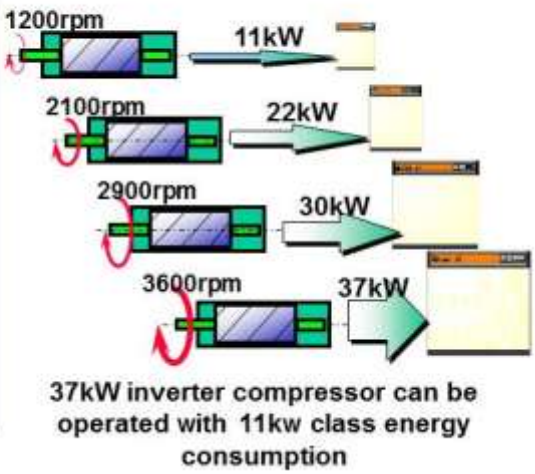


When you calculate the cost for several years, you can pay back the cost within 3 or 4 years. (reducing power consumption=energy cost down=profit) Not only can you reduce energy but you can also protect the environment which reduces CO_2.

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.)





37kW inverter compressor can be operated with 11kw class energy consumption

Example of Power Consumption Reduction with Inverter Compressor

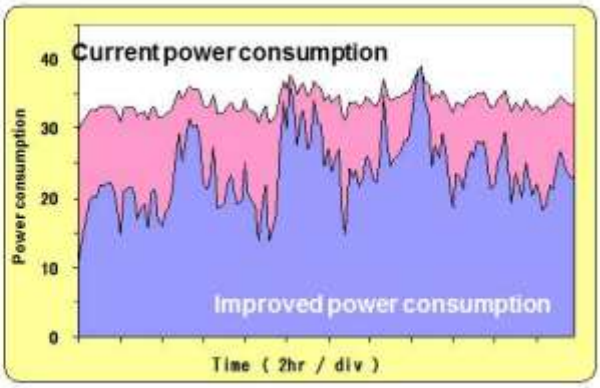
■ Installation procedure

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

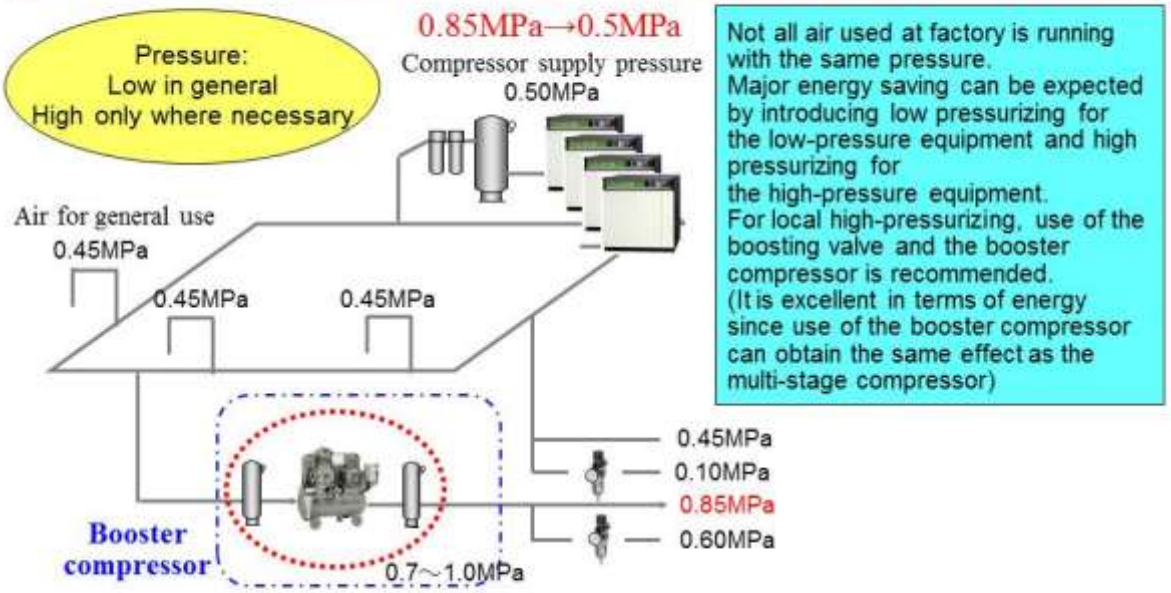
- Investment amount: JPY2.5 million for a 37-kW inverter compressor
- Energy-saving effect: JPY1.1 million/year



■ 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

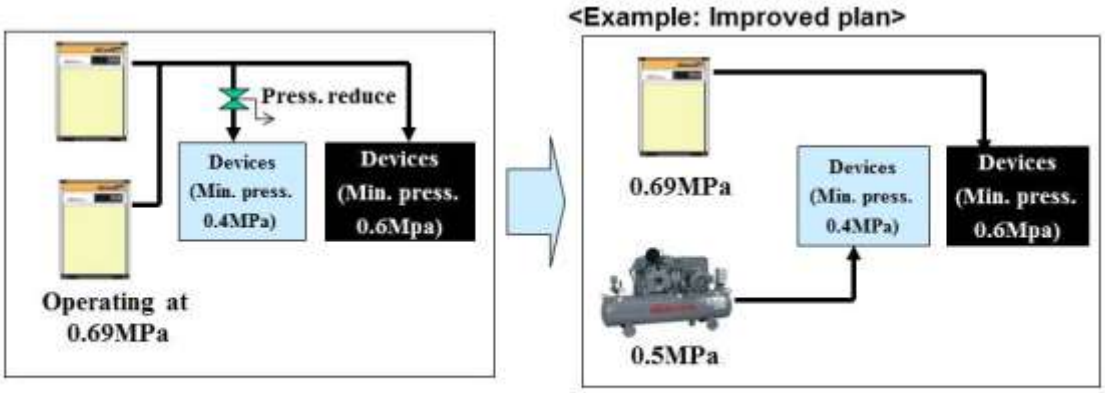


Not all air used at factory is running with the same pressure.
Major energy saving can be expected by introducing low pressurizing for the low-pressure equipment and high pressurizing for the high-pressure equipment.
For local high-pressurizing, use of the boosting valve and the booster compressor is 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.
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 × 8000h = 89,600kWh (Rp627,200)

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.

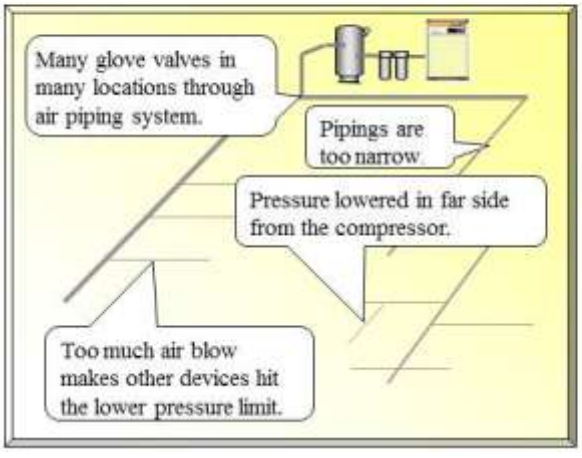


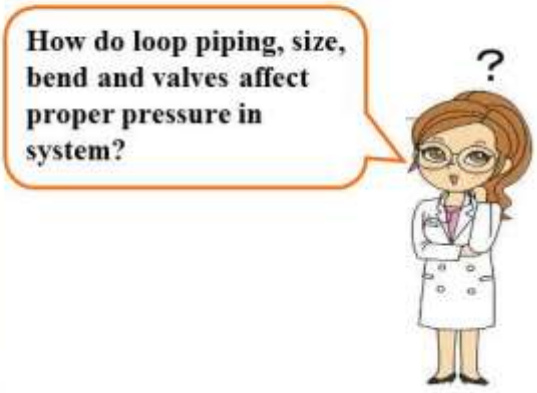
Pressure Optimization by Piping System Redesign

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?

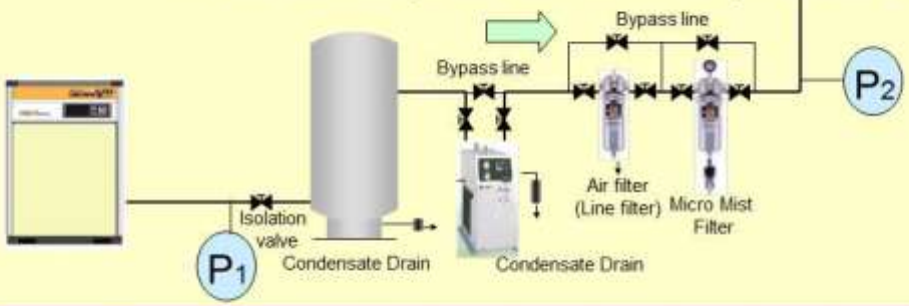


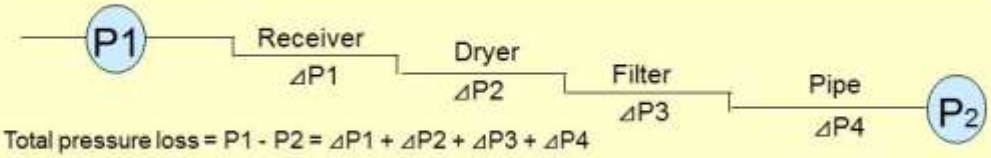


Pressure Loss of Compressor Equipment

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.

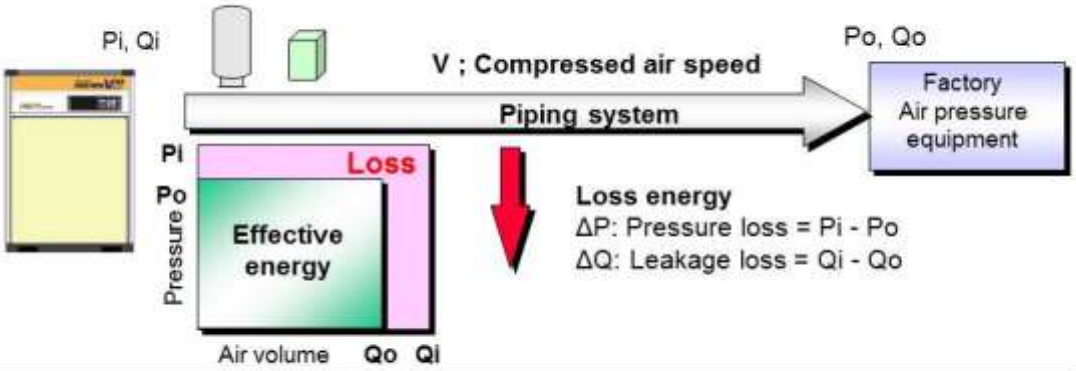




Total pressure loss = P1 - P2 = ⊿P1 + ⊿P2 + ⊿P3 + ⊿P4

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



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

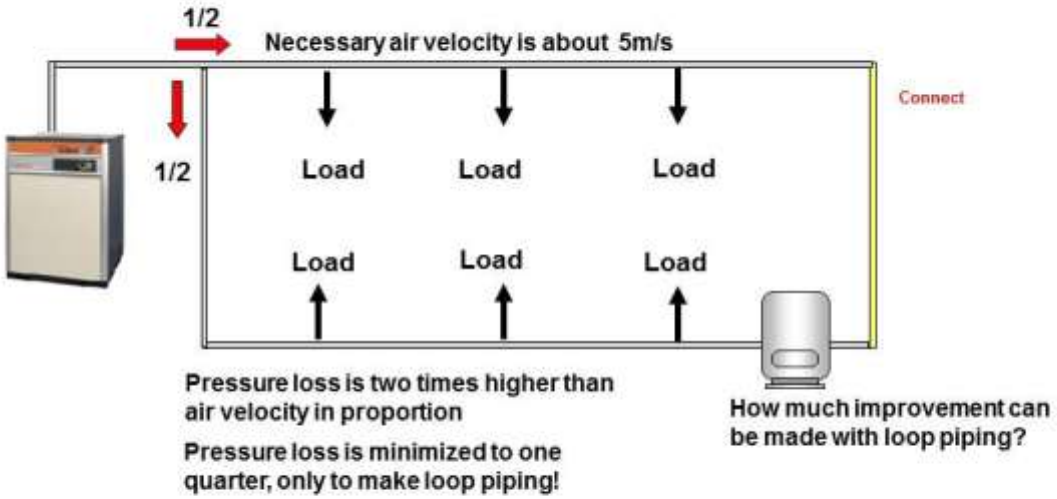
The desired flow rate in the pipe is 4 to 5 m/s. - Economic speed

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

Improvement Air Compressor System

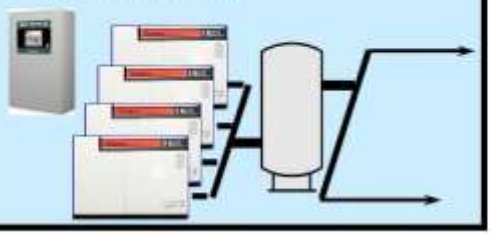
What is an efficient way to pressurize higher locally within the air supply system?
Do you have similar cases as below?

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 your 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?**

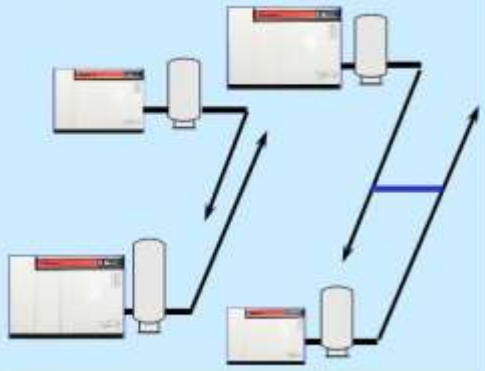
The air system is important, isn't it?
We need total system technology!

Which Is More Energy Saving - Collective or Independent?

Collective setting



Independent setting

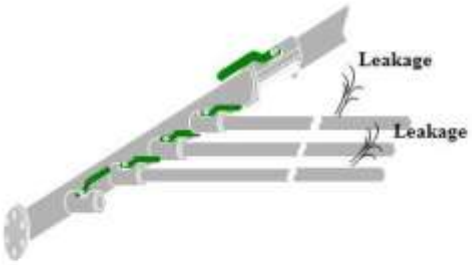


Setting Type	Collective	Independent
Daily Maintenance	Easy	Need to assign staff for each line
Regular maintenance	Easy	Need maintenance in each line
Pressure flexibility	Need to operate with the highest pressure equipment (Some loss)	Able to apply appropriate pressure for each piece of equipment (Min. 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

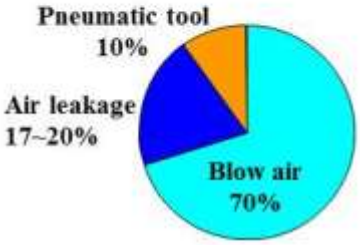

Regulator


Piping coupling

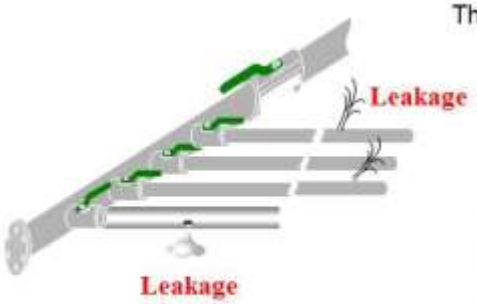
It is said that air leakage occurring at such places covers as much as 20% of the total average plants.
As the amount of leakage can be calculated by the formula in the next slide, after confirming, the same leakage areas can be identified and effective leakage reduction can be achieved.
Target reduction 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 time (t) taken to decrease the pressure by 0.1MPa.



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 !)

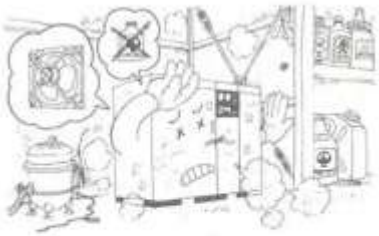
- If the air at the installation site is not good then the compressor cannot perform efficiently.
  - Harmful gases in surrounding area (corrosion, degradation, damage)
  - Dust, foreign substances (early damage, performance degradation)
  - Sealed room (reduction of air volume, temperature)
  - Near the sea (salt damage, corrosion)

Cold

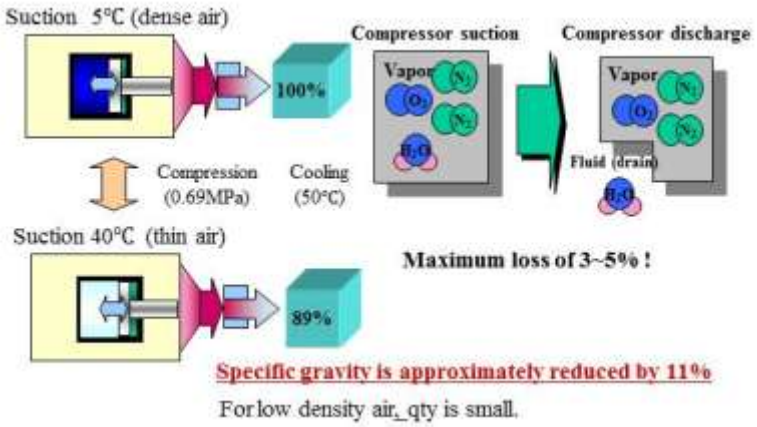
- In displacement compressor, even if the suction temperature changes, air volume shown by suction status hardly changes. (Screw, reciprocating compressor)
- If (pressure and temperature) are same, with the lower suction temperature, the same amount of discharge air can be provided at relatively lesser 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.



The performance is affected due to filter clogging.
5~10% effect on performance is perfectly natural.



Maximum loss of 3~5% !

Specific gravity is approximately reduced by 11%

For low density air, qty is small.

Annexure 5: Hitachi Industrial Equipment Systems presentation

Workshop in India
【Factory Energy Management System: FEMS】

HITACHI
Inspire the Next

Necessity of Visualization (FEMS) and Example of Energy-Saving of Distribution Facility Through FEMS

August 2016

Hitachi Industrial Equipment Systems Co.,Ltd.

2

Table of Contents

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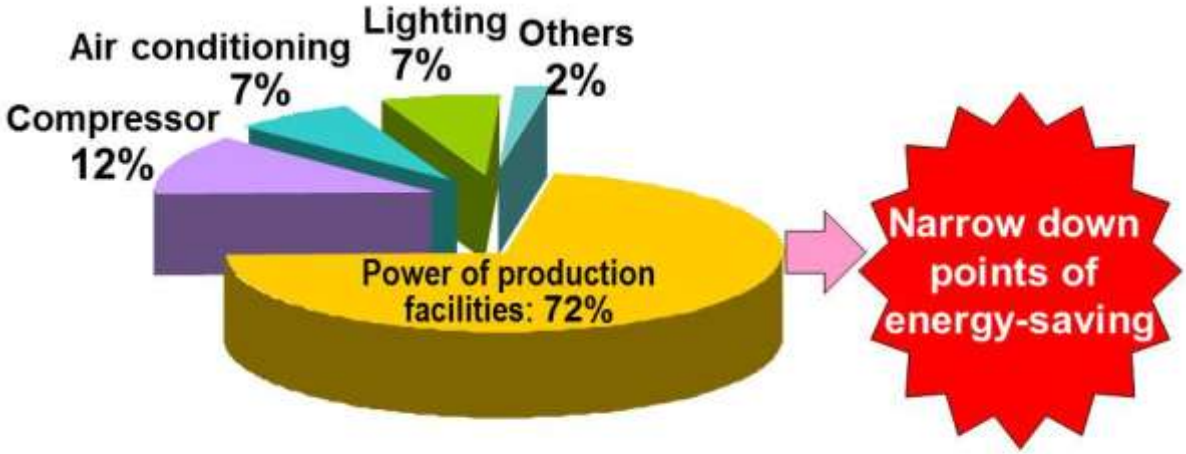
3

1. Necessity and Positioning of Visualization (FEMS)

4

1-1 Necessity of Visualization 1 【Narrowing Down Energy-Saving Measures】

Composition ratio of energy consumed in electrical and machinery manufacturers



Energy-saving measures can be developed by understanding energy use.

1-2 Necessity of Visualization (FEMS) 2 [Extraction of Wastefulness] 1/4

5

Ideal

Energy needed for production
- When needed (year, month, date, hour, minute, second…)
- Where needed (whole place, building, department, production line, facility)
- Amount needed (technical standard, use/operation standard)

Gap

Reality

- No-load power occurs even when production is not carried out.
- Lights are turned on at locations where no production is carried out.
- Unnecessary amount of energy is used despite using an inverter.

1-2 Necessity of Visualization (FEMS) 2 [Extraction of Wastefulness] 2/4

6

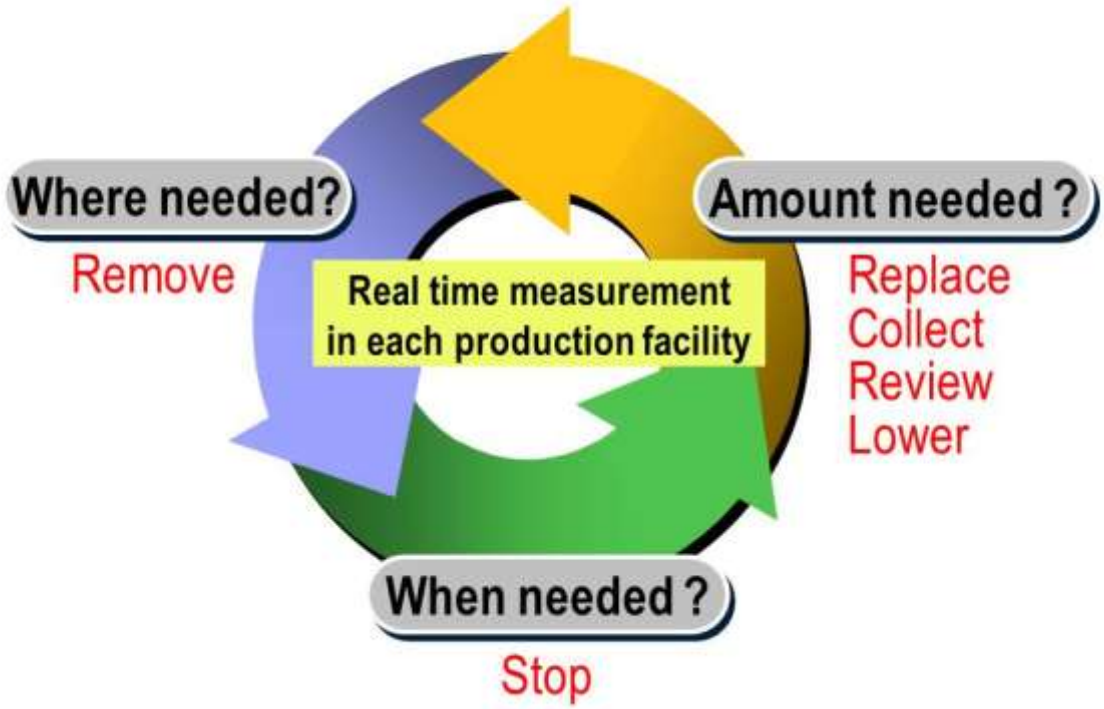
Lights are ON when nobody is around	Production power and compressor are working during lunch break	Temperature setting of air conditioner is * too high (heater) * too low (air conditioner)
Use energy where not needed [Place (spatial axis)]	Use energy when not needed [Time axis]	Use amount of energy more than needed

Visualize by means of monitoring

Energy-saving does not mean not using energy.
It means using energy
"where needed," "when needed," and "amount needed."

1-2 Necessity of Visualization (FEMS) 2 [Extraction of Wastefulness] 3/4

7



1-2 Necessity of Visualization (FEMS) 2 [Extraction of Wastefulness] 4/4

8

Where not needed

•Light is brighter than necessary •Mere aisles are air-conditioned	Abolish	•Un-necessary equipment remove •Substitute with ventilation

When not needed

•Compressor is working even during lunch break •Voltage is applied to a transformer even during summer holidays	Stop	•Turn off the power frequently during break times •Open the transformer

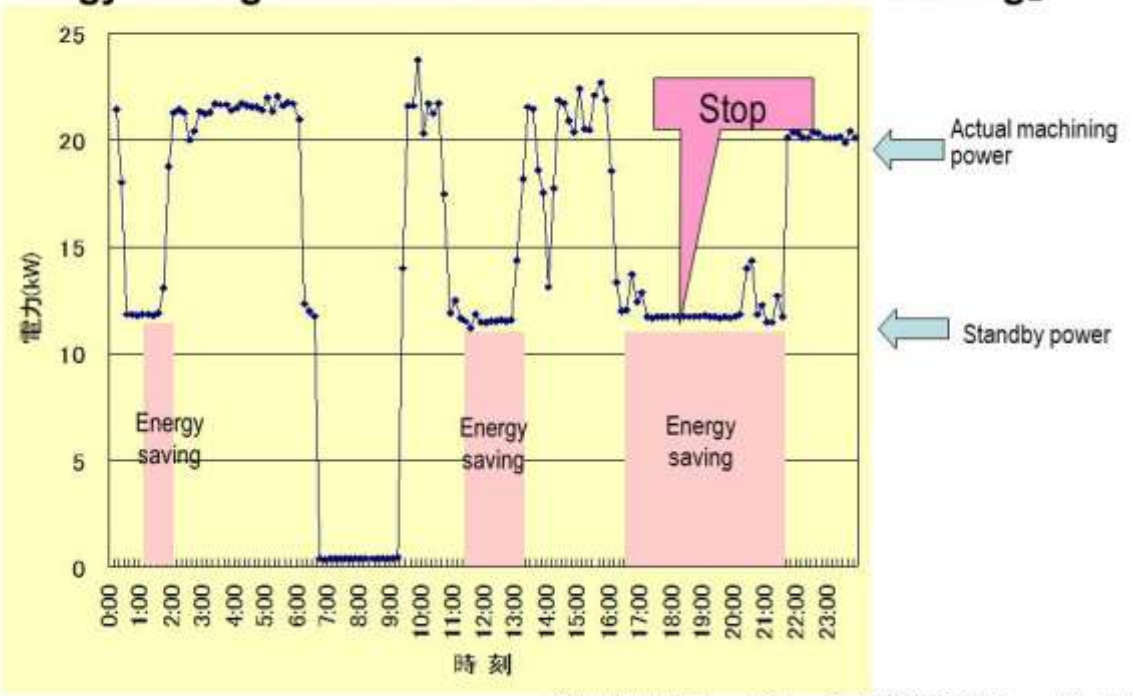
Amount not needed

•Air conditioner setting is inappropriate	Lower	•Appropriate optimization of temperature setting and time period
•There is an air leakage/steam leakage	Repair	•Repair pipes
•Waste heat is merely released	Collect	•Collect and use it
•Machines are old	Replace	•Replace them with inverter machines •Fuel conversion

9

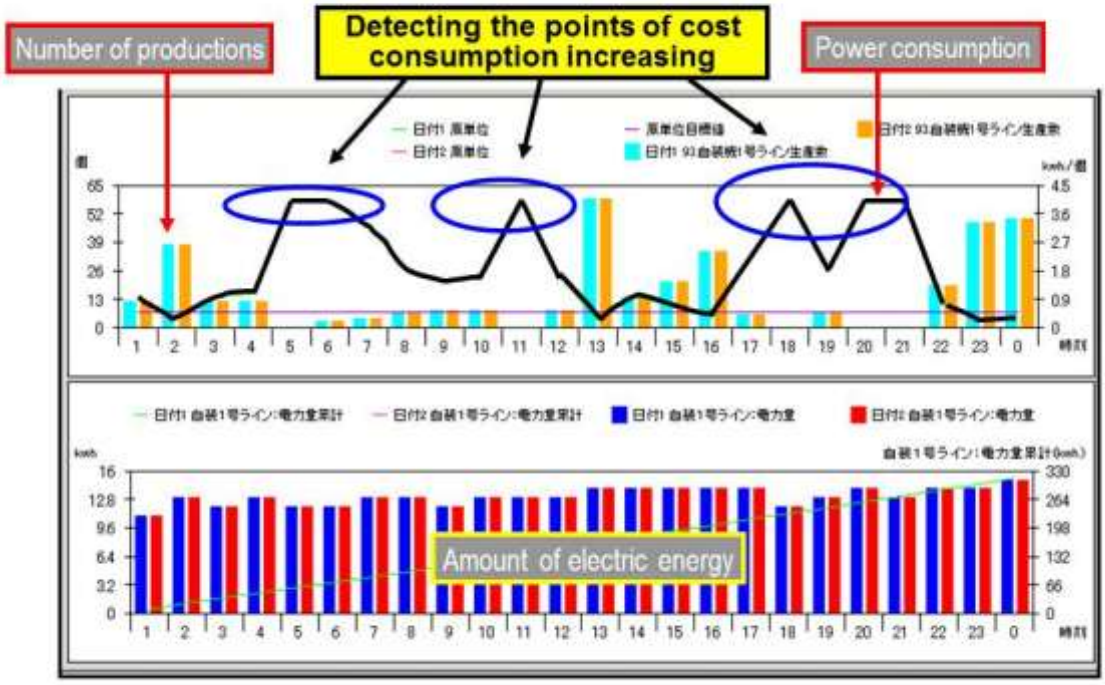
1-3 Detection of Waste by Visualization (FEMS) [Time Axis = Two Axis]

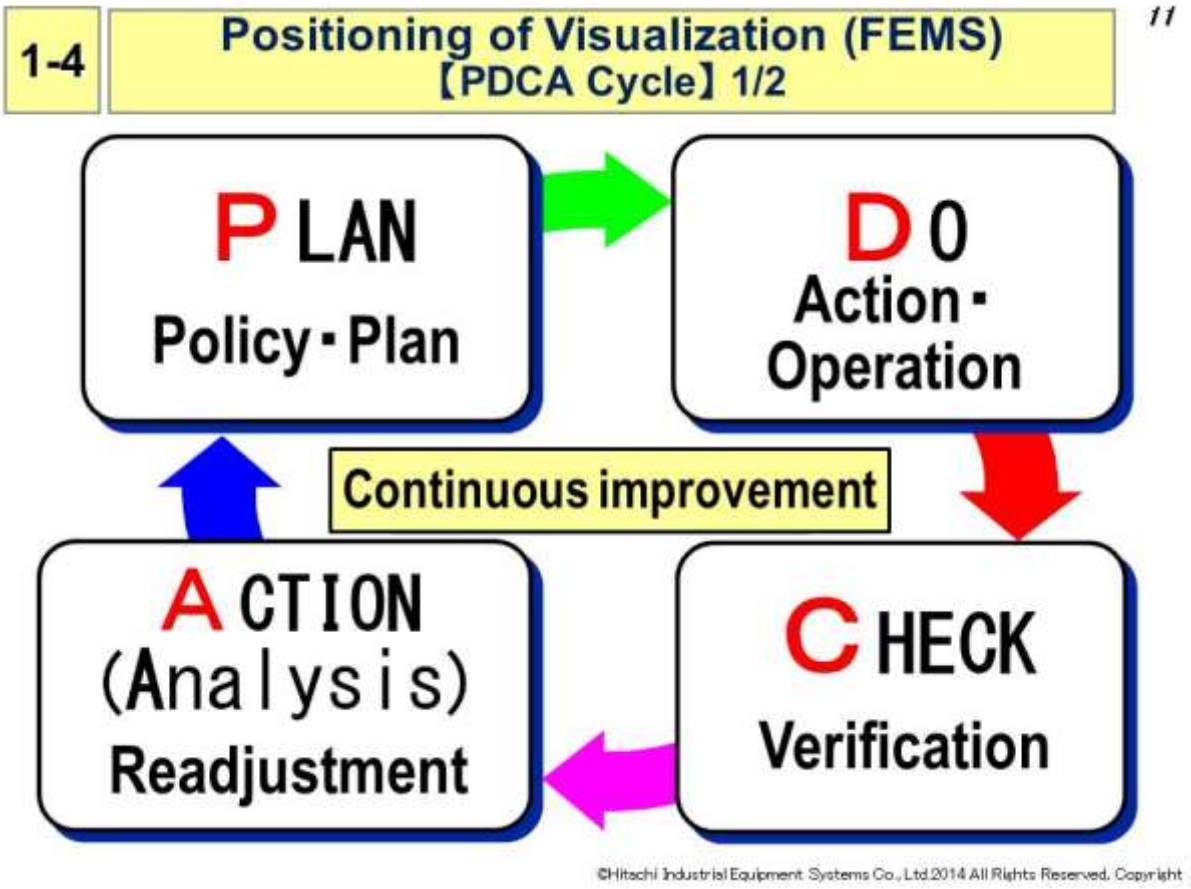
【Energy-saving measurement for aluminum die-casting】



10

1-3 Detection of Waste by Visualization (FEMS) [Power Consumption = Three Axis]




1-4
Positioning of Visualization (FEMS)
【PDCA Cycle】1/2
11
PLAN
Policy・Plan
DO
Action・
Operation
Continuous improvement
ACTION
(Analysis)
Readjustment
CHECK
Verification
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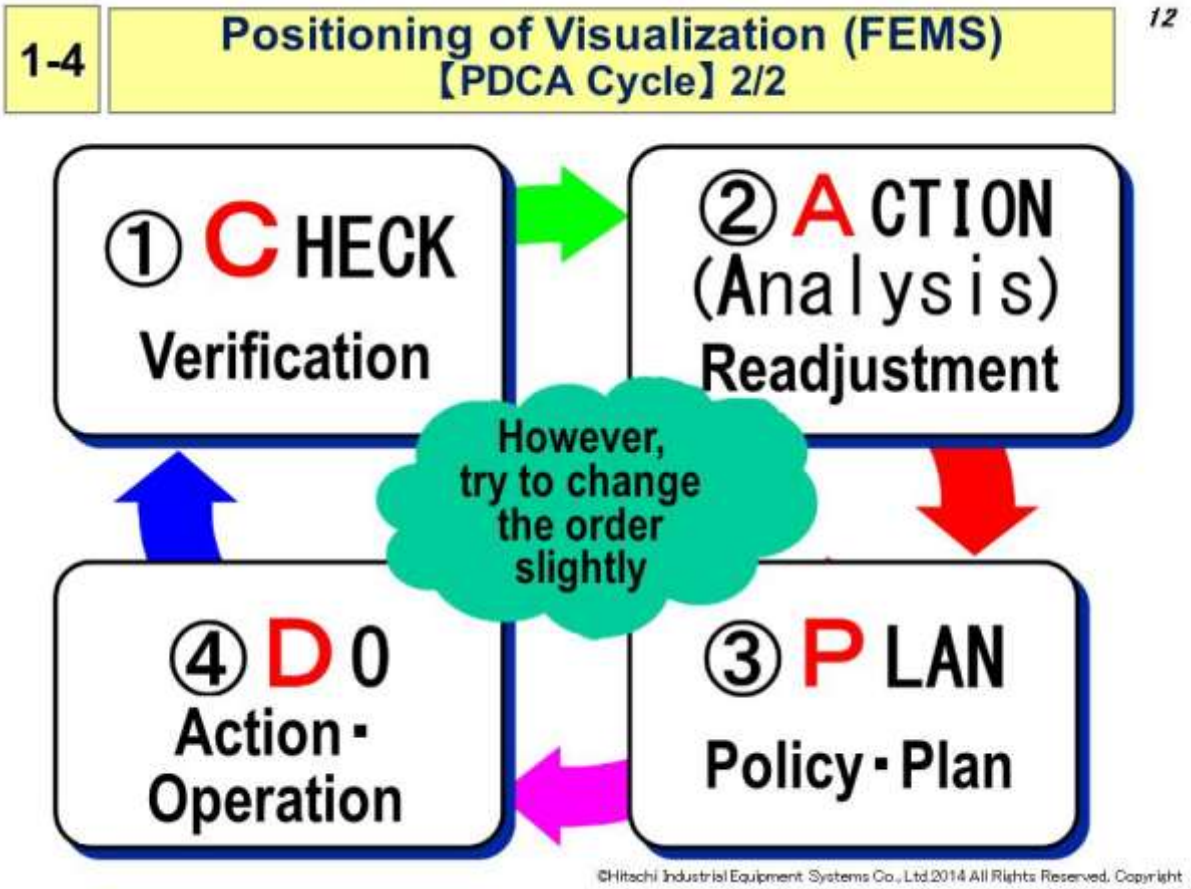
1-4
Positioning of Visualization (FEMS)
【PDCA Cycle】2/2
12
① CHECK
Verification
② ACTION
(Analysis)
Readjustment
However,
try to change
the order
slightly
④ DO
Action・
Operation
③ PLAN
Policy・Plan
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13

2. Practical Example of Energy-Saving by Visualization 【Understanding Actual Situation】

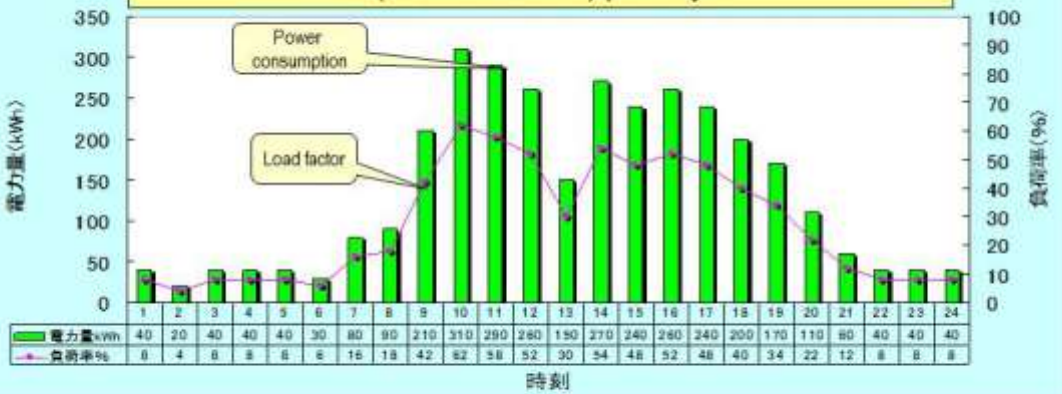
2-1 Example of Energy-Saving ① 【Integration of Transformer + Introduction of Amorphous Transformer】1/4

4

【Point】
The actual status of the usage of the transformer is looked at more closely by "H-NET", and the elimination and consolidation of the transformer can be considered.

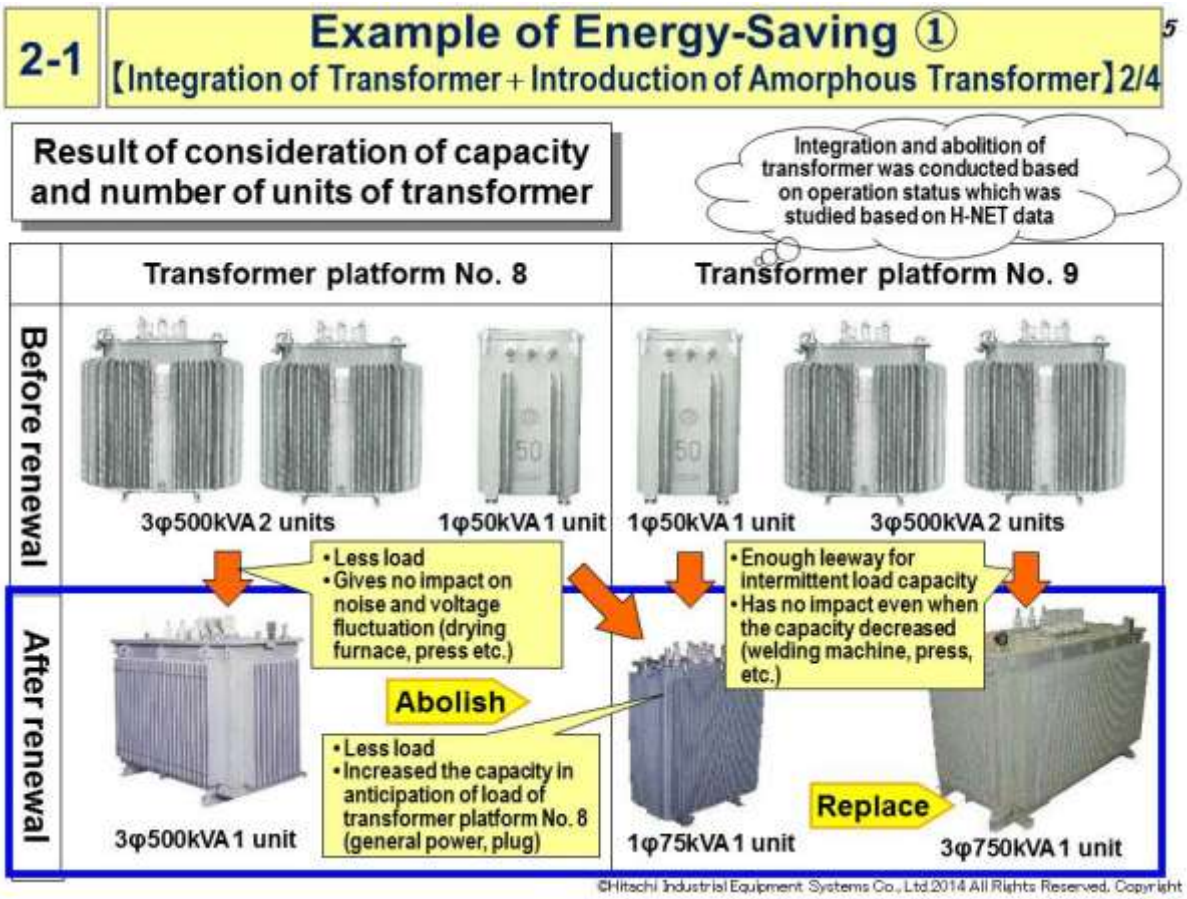
【Impact/Effect】
Elimination and consolidation of transformer and renewal to low loss transformer
* Reducing power consumption and electricity price by reduction of loss
* Improving reliability

Electric energy of No. 8 transformer at 500kVA (Before renewal) per day



時刻	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
電力量kWh	40	20	40	40	40	30	80	90	210	310	290	260	150	270	240	260	240	200	170	110	60	40	40	40
負荷率%	8	4	8	8	8	6	16	18	42	62	58	52	30	54	48	52	48	40	34	22	12	8	8	8

Old transformers increase not only large loss but also degradation of insulation paper, etc.
Renewal to ultralow-loss super amorphous transformer is planned looking at both energy-saving and reliability.


2-1
Example of Energy-Saving ①
【Integration of Transformer + Introduction of Amorphous Transformer】2/4
5
Result of consideration of capacity and number of units of transformer
Integration and abolition of transformer was conducted based on operation status which was studied based on H-NET data
Transformer platform No. 8
Transformer platform No. 9
Before renewal
After renewal
3φ500kVA 2 units
1φ50kVA 1 unit
1φ50kVA 1 unit
3φ500kVA 2 units
• Less load
• Gives no impact on noise and voltage fluctuation (drying furnace, press etc.)
• Enough leeway for intermittent load capacity
• Has no impact even when the capacity decreased (welding machine, press, etc.)
Abolish
• Less load
• Increased the capacity in anticipation of load of transformer platform No. 8 (general power, plug)
Replace
3φ500kVA 1 unit
1φ75kVA 1 unit
3φ750kVA 1 unit
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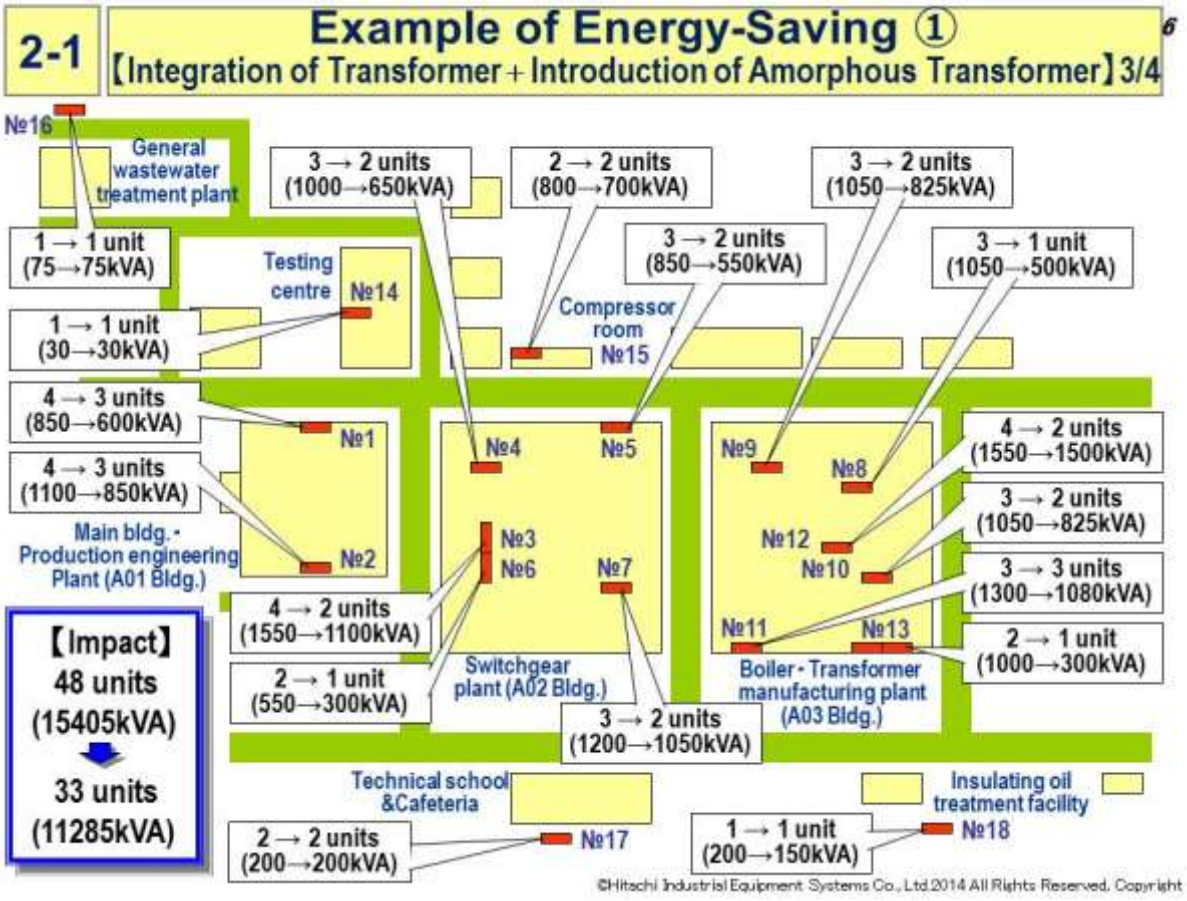
2-1
Example of Energy-Saving ①
【Integration of Transformer + Introduction of Amorphous Transformer】3/4
6
№16
General wastewater treatment plant
1 → 1 unit (75→75kVA)
1 → 1 unit (30→30kVA)
Testing centre
№14
3 → 2 units (1000→650kVA)
2 → 2 units (800→700kVA)
3 → 2 units (850→550kVA)
Compressor room №15
3 → 2 units (1050→825kVA)
3 → 1 unit (1050→500kVA)
4 → 3 units (850→600kVA)
4 → 3 units (1100→850kVA)
Main bldg.・Production engineering Plant (A01 Bldg.)
№1
№2
№4
№5
№3
№6
№7
№9
№8
№12
№10
№11
№13
4 → 2 units (1550→1500kVA)
3 → 2 units (1050→825kVA)
3 → 3 units (1300→1080kVA)
2 → 1 unit (1000→300kVA)
4 → 2 units (1550→1100kVA)
2 → 1 unit (550→300kVA)
Switchgear plant (A02 Bldg.)
Boiler・Transformer manufacturing plant (A03 Bldg.)
3 → 2 units (1200→1050kVA)
【Impact】
48 units
(15405kVA)
33 units
(11285kVA)
Technical school &Cafeteria
Insulating oil treatment facility
2 → 2 units (200→200kVA)
№17
1 → 1 unit (200→150kVA)
№18
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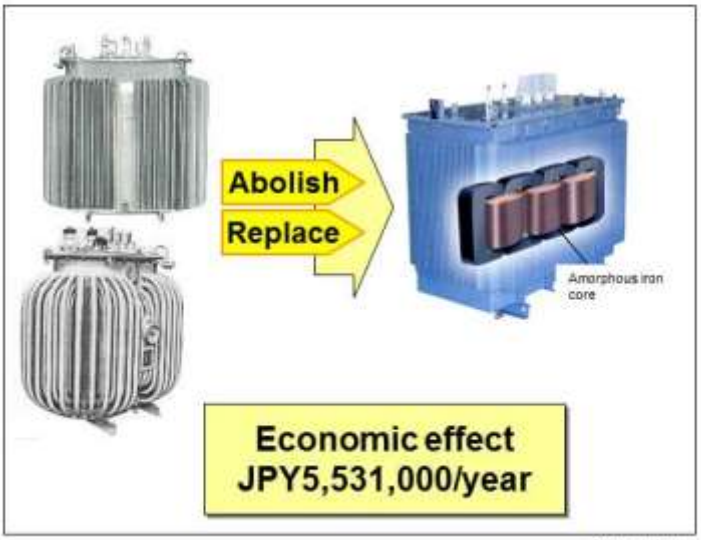
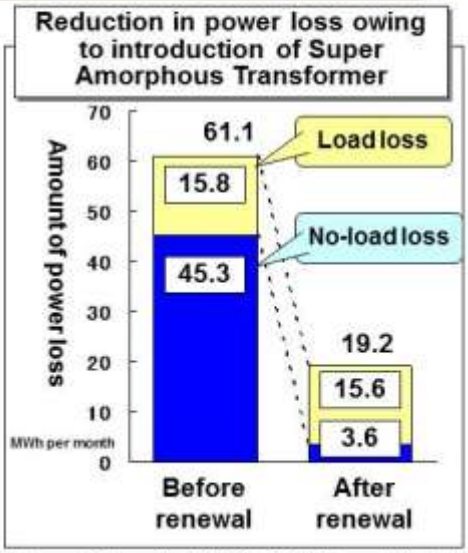
2-1 Example of Energy-Saving ①
【Integration of Transformer + Introduction of Amorphous Transformer】4/4

[Points] 1. To review the capacity of transformation installation according to current workload and seek to reduce power loss and contracted power.
2. To seek to minimize power loss by introducing and properly arranging 'Super Amorphous Transformer'.





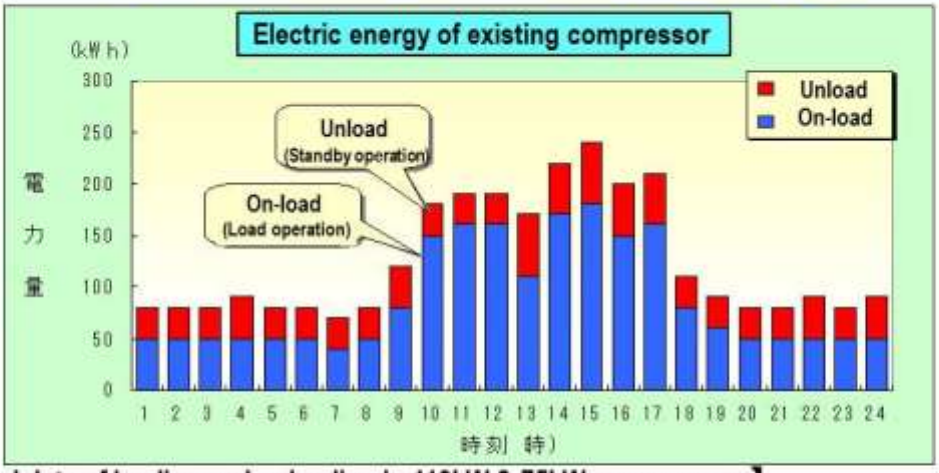
2-2 Example of Energy-Saving ②
【Improvement of Air Compressor】 1/6

<Key points and issues of energy-saving>
1. During the operation in which the number of units of standard machine is controlled, power is wasted during standby because load operations and standby operations are repeated.
2. Since the air compressor is cooled by cold water, coolant water should always be operated.

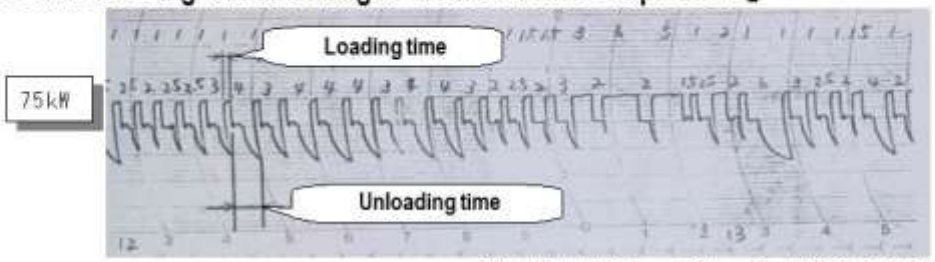
Outline of water-cooled air compressor (before renewal)

2-2 Example of Energy-Saving ② 【Improvement of Air Compressor】 2/6

19



【Measured data of loading and unloading in 110kW & 75kW compressors】

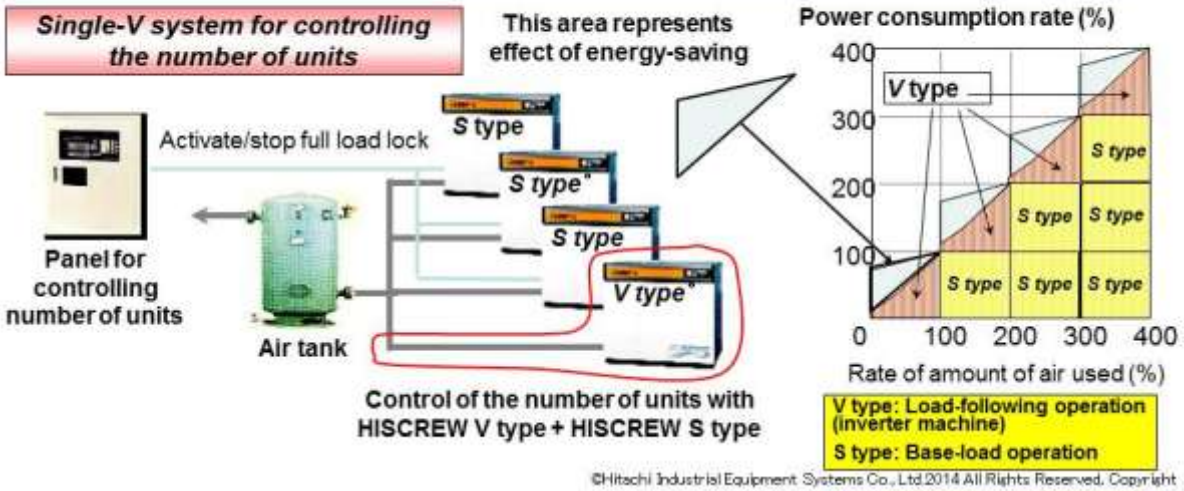


2-2 Example of Energy-Saving ② 【Improvement of Air Compressor】 3/6

20

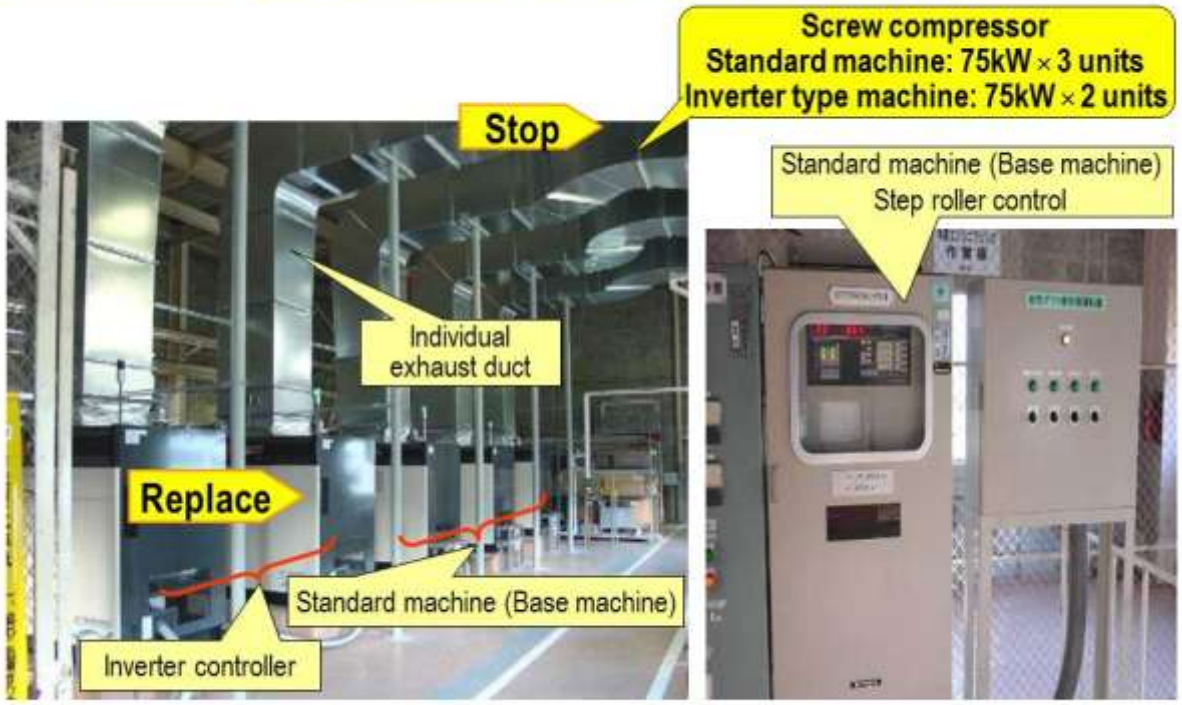
<Improvements>

1. Shift to load-follow operation which is a combination of a standard type air compressor which executes base-load operation by controlling the number of units and an inverter type air compressor which makes up for fluctuation amount (Abolition of unload operation)
2. Minimize the capacity of the cooling system by means of individual exhaust duct method for air-cooled air compressor (Control in which room temperature is detected and an exhaust fan is operated only when the room temperature rises)
3. Reliability of controlling air compressor operation is improved by enhancing monitoring by H-NET.



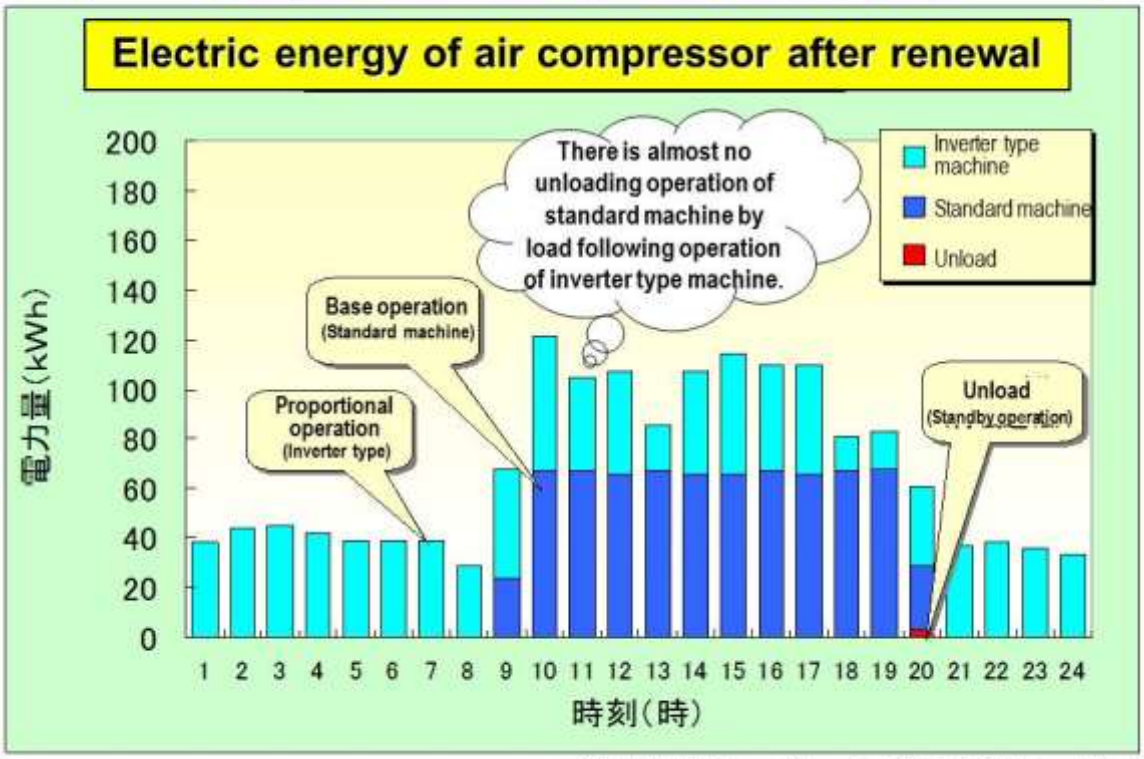
2-2 Example of Energy-Saving ② 【Improvement of Air Compressor】 4/6

21



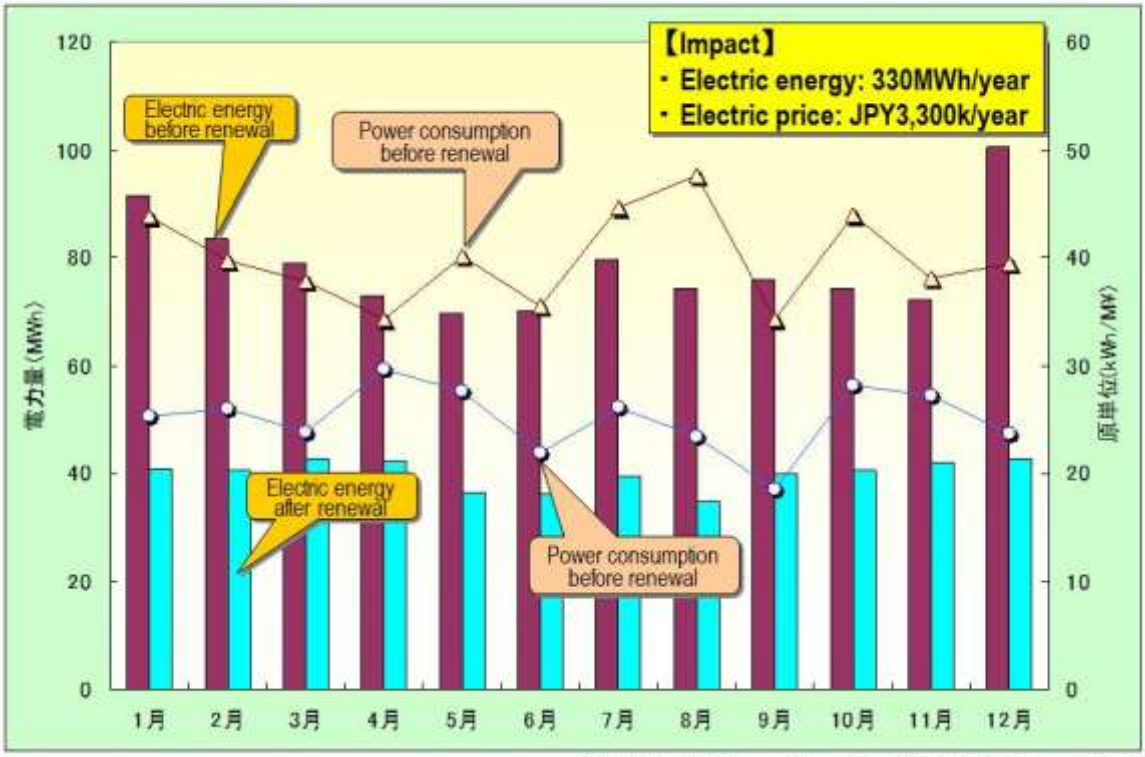
2-2 Example of Energy-Saving ② 【Improvement of Air Compressor】 5/6

22



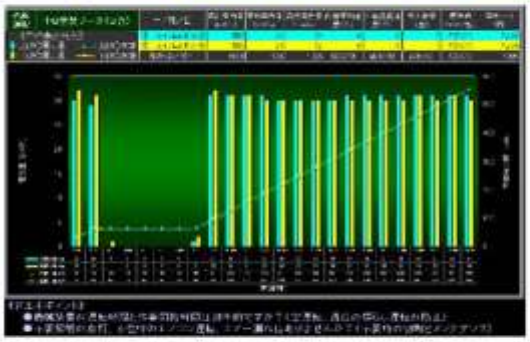
2-2 Example of Energy-Saving ②【Improvement of Air Compressor】6/6

23



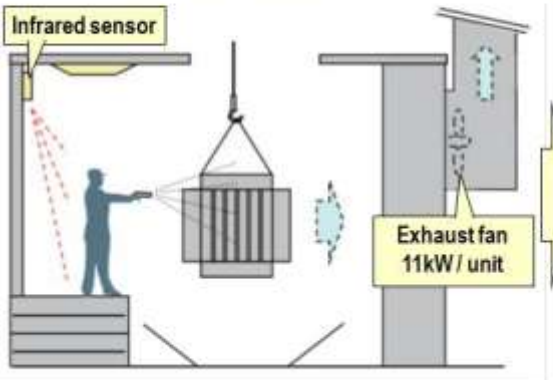
2-3 Example of Energy-Saving ③【Operation Improvement of Painting Booth】1/2

24



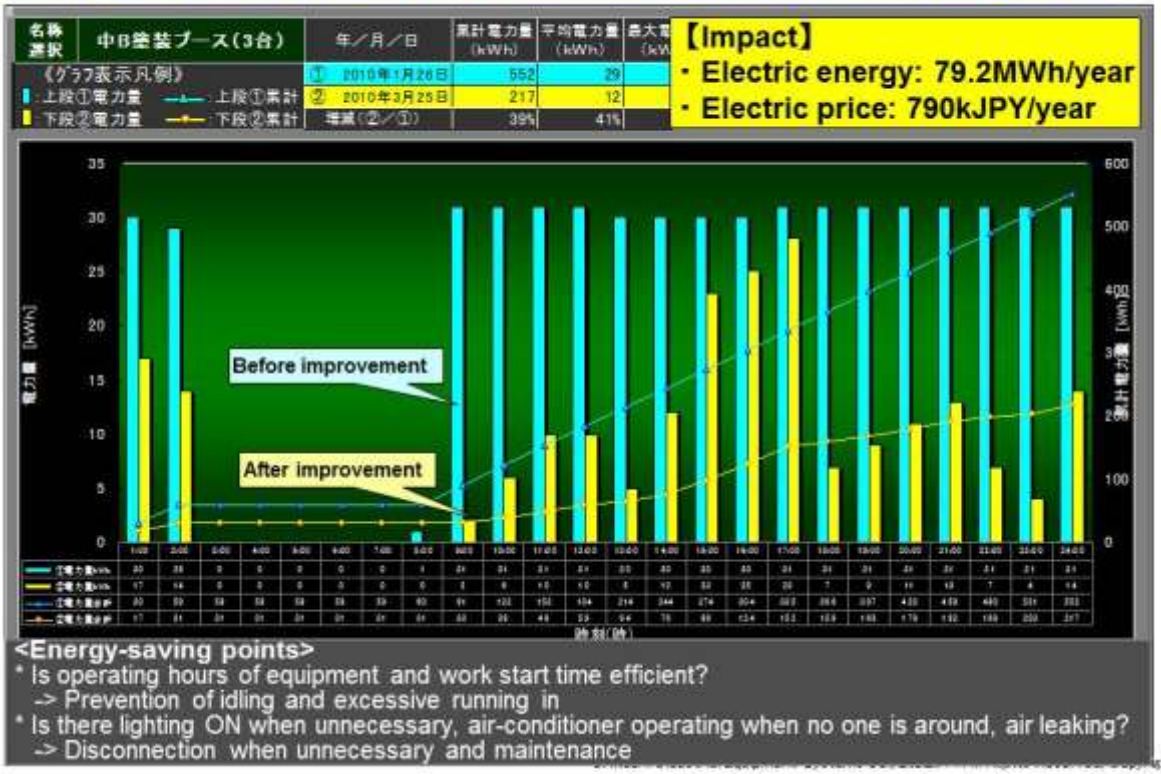
【Before】
Taking a measure was needed since an exhaust fan had been operated even during work not requiring it due to being operated by a person.

【After】
For reducing worker's frequent operations, the operation was improved to automatic operation, which the exhaust fan is operated by a sensor when a worker entering an spraying work area and suspended when coming out of the area.



2-3 Example of Energy-Saving ③ 【Operation Improvement of Painting Booth】 2/2

25

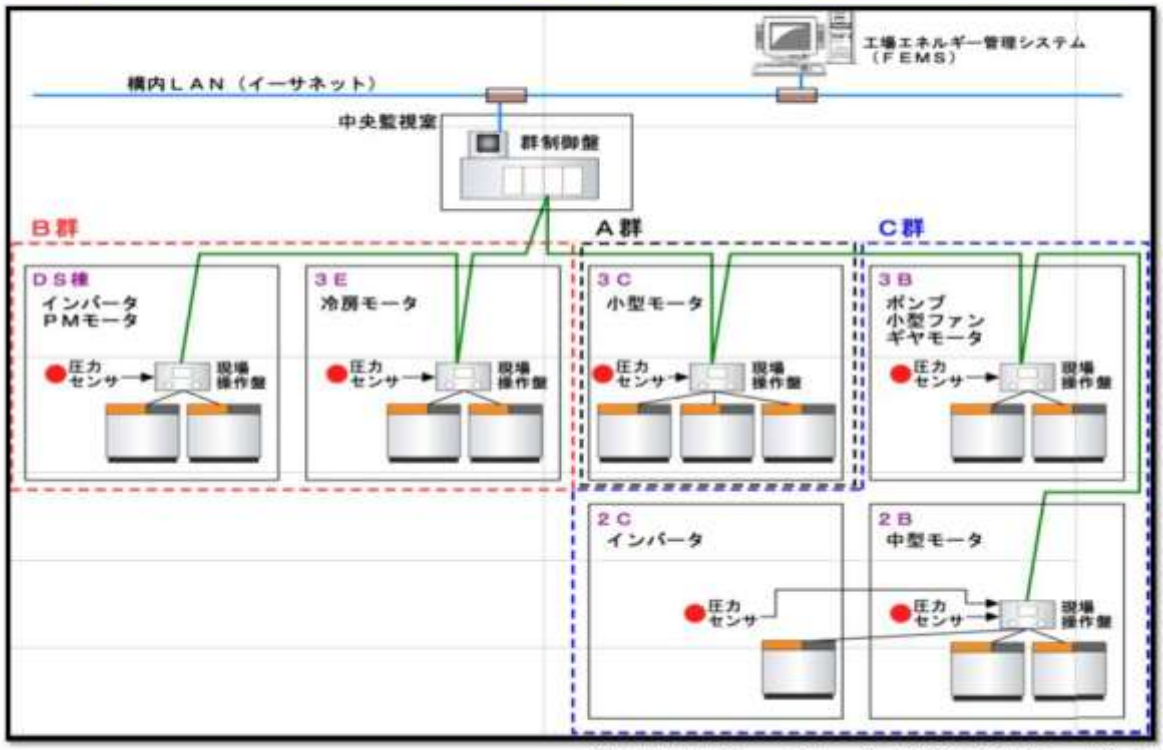


26

3. Practical Example of Energy-Saving by Visualization (FEMS) [Understanding Degradation]

3-1 Example of Energy-Saving ①

【Identification and Measure of Piping Degradation (Air Leakage) of Air Compressor】 1/2

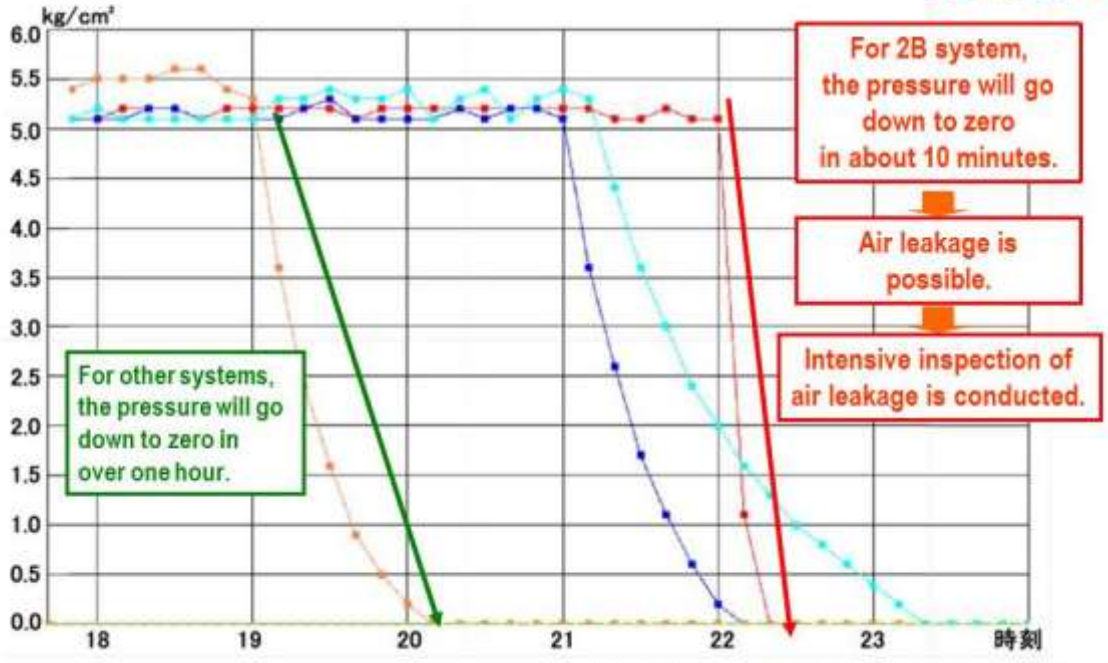


3-1 Example of Energy-Saving ①

【Identification and Measures of Piping Degradation (Air Leakage) of Air Compressor】 2/2

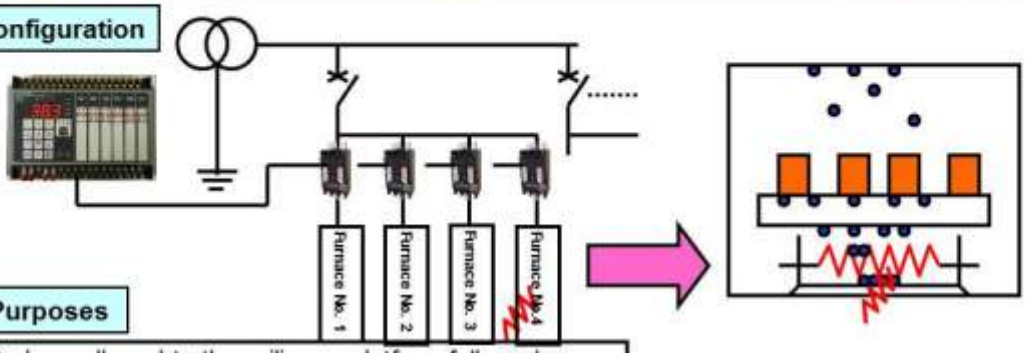
Air pressure transition when compressor stops (Saturday)

Pressure system
2B 2C 3C 3E



3-2 Example of Energy-Saving ②
[Predictive Maintenance of Facility by Means of Insulation Deterioration Measurement] 1/3

1. Configuration



2. Purposes

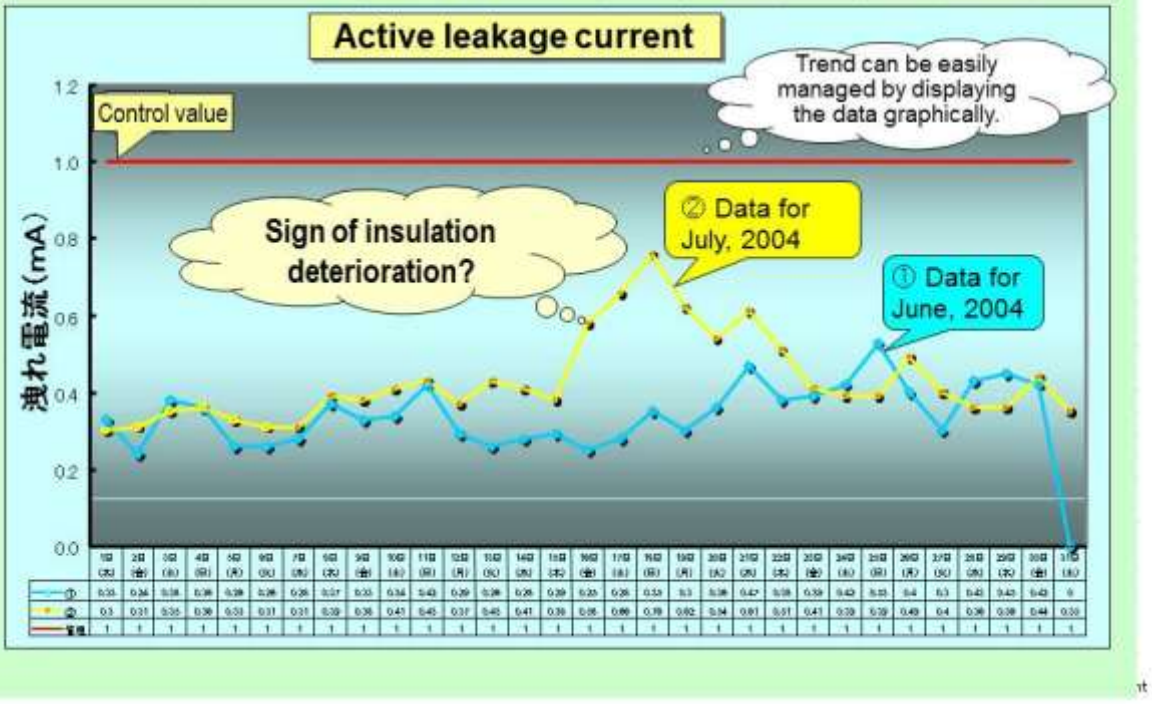
- Carbon adhered to the ceiling or platform falls and accumulates on the heater and causes a failure or deterioration of insulation which causes the furnace to stop. Once the furnace stops, it requires time to establish relationship with a peripheral control device and return to a steady temperature. (It takes a few days to start up)
- It causes variation in product quality, so it is preferable to prevent these troubles.

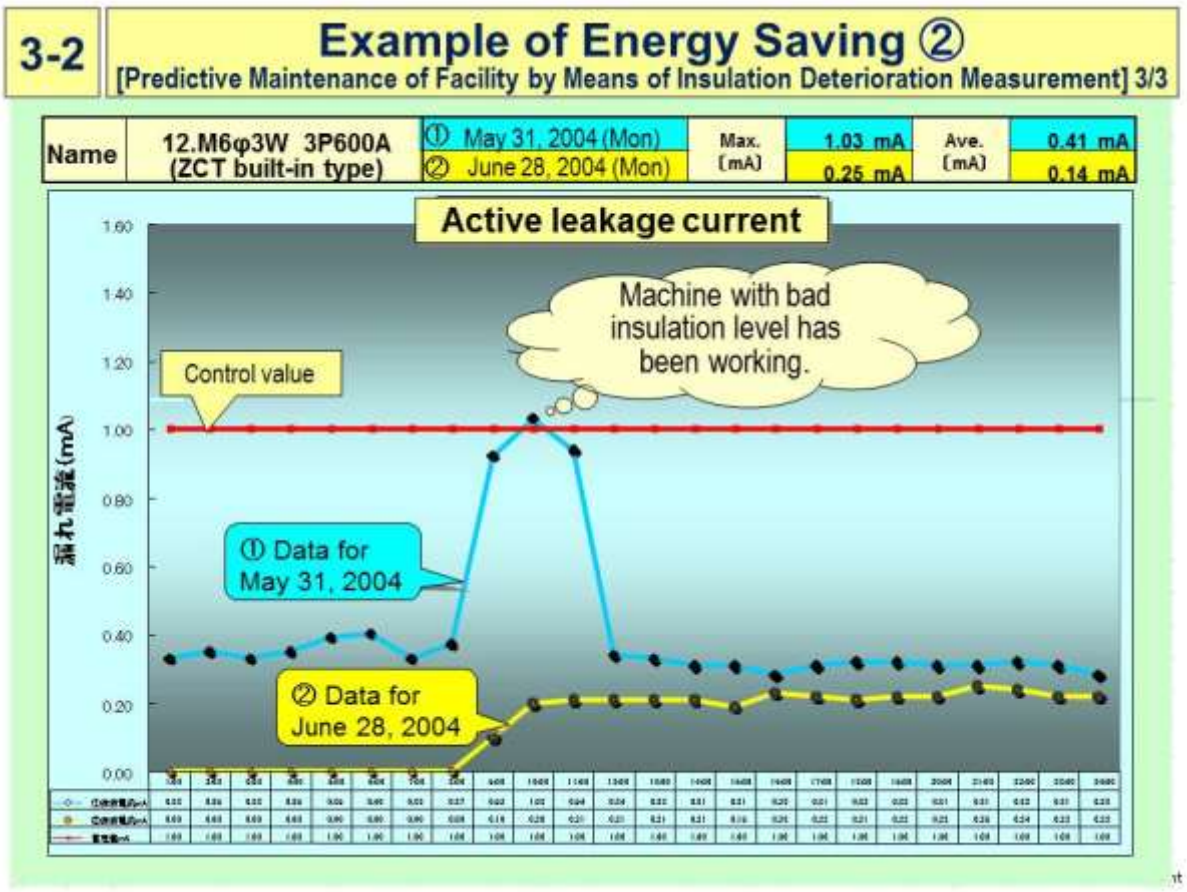
3. Effect

It has become possible to understand conditions beforehand based on values, and formulate a heater replacement plan.

3-2 Example of Energy-Saving ②
[Predictive Maintenance of Facility by Means of Insulation Deterioration Measurement] 2/3

No. 9 L-3 100V	Active leakage current			Ave.			Max.		
		① June, 2004		mA	0.57	②/①	mA	1.15	②/①
		② July, 2004		mA	0.51	89%	mA	1.22	106%





4. Introduction of Tools for Understanding Actual Situation of Energy Use

4-1 Introduction of Tools for Understanding Actual Situation of Energy Use [Configuration]

33

Example: Hitachi Power Distribution and Utility Monitoring System 【H-NET】

System scale

① Central unit: General-purpose PC, compatible with Windows7/WindowsXP
② Number of units that can be connected: 121 units (Repeater, during 3 DE-R2 units in use)
③ Transmission distance: 4.8km (Repeater, during 3 DE-R2 units in use)
(For a transmission-line, chain-connected wiring by twisted pair cable with shield)

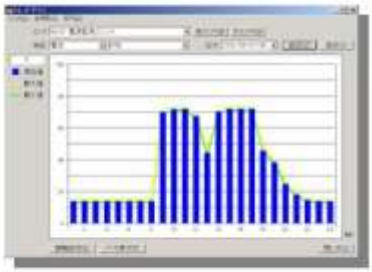
4-1 Introduction of Tools for Understanding Actual Situation of Energy Use [Collection Software]

34

[Menu screen]
Moves to each screen from this screen.

[Measured value screen]
Displays real-time data for each unit (1 unit/1 screen).

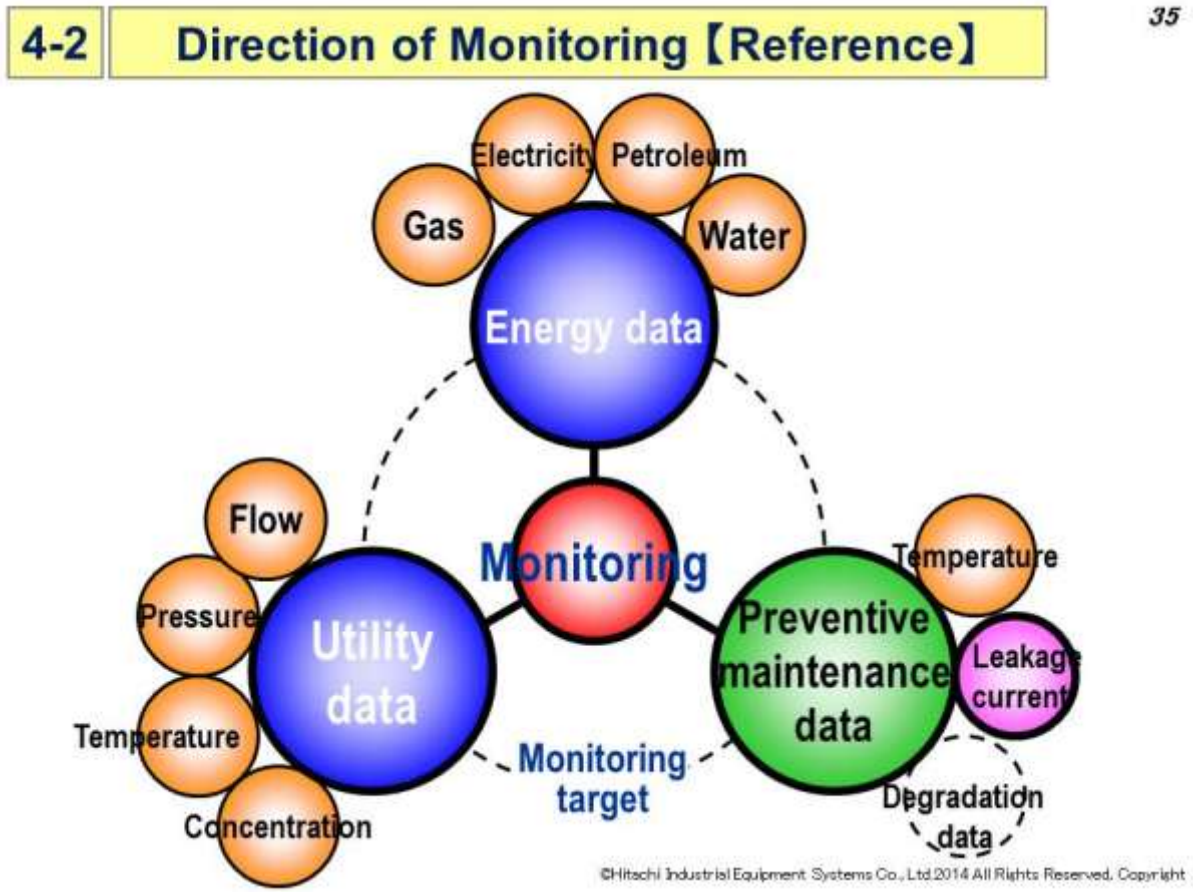
[Demand monitoring screen]
Displays demand situations of specified **5 series of power consumed** for a limit of 30 minutes with line graphs.



[Trend graph screen]
Displays all measured data of all units with 24-hour bar graphs (1 element/1 screen).

[Daily report, monthly report, and annual report screen]
It is possible to display daily reports of past one month and monthly reports of past two years.

[Alarm information screen]
Displays a history of activations/ terminations of software or demand failures in table form.


4-2
Direction of Monitoring【Reference】
35
Electricity
Petroleum
Gas
Water
Energy data
Monitoring
Flow
Pressure
Temperature
Concentration
Utility data
Monitoring target
Temperature
Leakage current
Preventive maintenance data
Degradation data
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Annexure 6: Selected photographs of the event