

## การพัฒนาต่อยอดจาก FEMS ไปเป็น IoT

~ กรณีตัวอย่างจากการใช้งานอุปกรณ์ประหยัดพลังงานภายในโรงงานของบริษัทเอง ~

14 November 2018

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## Contents

1. Starting point: bringing IoT to the factory
2. Changes in energy management of industrial equipment  
(Generation Zero) Logging by manual meter-reading (recording & storage)  
(1<sup>st</sup> Generation) Demonstration and analysis of electricity use based on power monitoring system (H-NET)  
(2<sup>nd</sup> Generation) Demonstration and analysis of multiple types of energy based on factory energy management systems (SANFEMS)
3. From FEMS to IoT  
(3<sup>rd</sup> Generation) Use and application of data, productivity enhancement, preventative maintenance

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2

### 1-1. เกณฑ์ประเมินวิธีประหยัดพลังงาน

#### Standards for rationalization of energy use

Regulates standards for 1) management, 2) measurement and recording, 3) maintenance and inspection, and 4) new measures, for all processes related to the use of energy

- (1) Rationalization of combustion of fuels
- (2) Rationalization of heating and cooling as well as heat transfer
- (3) Recovery and utilization of waste heat
- (4) Rationalization of conversion of heat into power
- (5) Prevention of energy loss due to emission, conduction, resistance, etc.
- (6) Rationalization of conversion of electricity into power, heat, etc.  **Air compressors, etc.**

#### Targets and measures to be taken systematically for rationalization of energy use

Regulates matters that businesses must examine and implement for major facilities

- (1) Combustion facilities
- (2) Heat-using facilities
- (3) Waste heat recovery equipment
- (4) Co-generation facilities
- (5) Electricity-using facilities
- (6) Air-conditioning, water heating, ventilation and raising and lowering equipment
- (7) Lighting
- (8) Factory energy monitoring systems

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3

**Management standards (Kanto Bureau of Economy, Trade and Industry)**

Energy management standards based on the Energy Saving Law		Management standards for "air compressors" (example)		整理番号: A-2
1. Target These energy management standards are aimed achieving rationalization of energy use via appropriate operation management, measurement and recording, maintenance and inspection and new measures based on Article 4 of the Act on Rationalizing Energy Use and notifications on "standards of judgment".				改訂: Ⅵ: 1/1
2. Scope of application To be applied to air compressors installed in factories, etc.				
Item	Details	Standards of judgment number	Management standard	Reference manual
Operation management	1. Power using equipment (1) Shut down when not needed (2) Adjust numbers in operation, appropriate allocation of load factor (3) Adjustment to discharge and discharge pressure by equipment number control, change in frequency, change in piping, impeller cut and rotation control (4) Adjust voltage, current and frequency for each electric equipment (when carrying out inverter control)	(6-1) ①: 2 (6-1) ①: 4 (6-1) ①: 5 (6-1) ①: 9	・ Define "not needed" times ・ Adjustment methods ・ Set up management of number of equipment pieces, speeds ・ Management of rated value	Operation management manual
Measurement and recording	1. Power using equipment (1) Recording of voltage at power supply, current, frequency (for inverter control) (discharge, discharge pressure and shaft power as necessary)	(6-1) ②	・ Items, frequency	Logbook
Maintenance and inspection	1. Power using equipment (1) Less mechanical loss at power transmission parts ① Grease up of shaft and bearing parts as needed at the time of inspection ② Routine inspection and repair of shaft sealing (2) Lessen leakage prevention pipe resistance ① External inspection of machinery, leakage inspection of pipe connection parts ② Check for pipe obstruction and optimization of pipe size from pressure gauges upstream and downstream of pipes	(6-1) ③: 7 (6-1) ③: 7	・ Inspections per day ・ Inspections per year ・ Inspections per day ・ Inspections per year	Maintenance/inspection manual Logbook
New measures	1 Introduction of measure to facilitate adjustment of operation state according to load change, such as rotation control device	(6-1) ④		
改訂履歴	改訂年月日	改訂内容	作成	承認
承認		照査	作成	実施年月日 測定年月日

※出典元: 経済産業省関東経済産業局HP「管理標準の作成例」より抜粋

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4

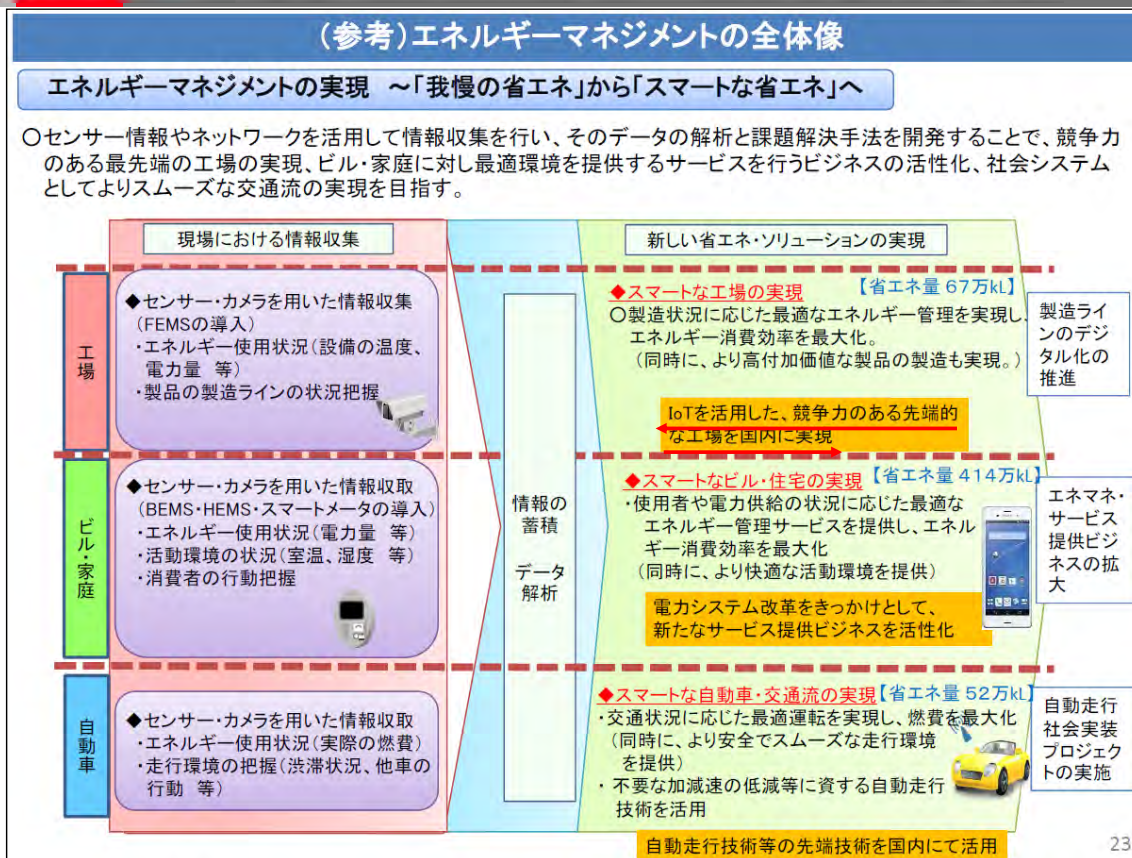
**Management standards (our company)**

Energy management standards		Management standards for compressors		整理番号	06
				改定・初版	項: 1/1
1. Equipment These are energy management standards on operation/management, measurement/recording, maintenance/inspection are aimed at appropriate management and rationalization of energy use for "factory's compressor equipment".					
2. Scope of application All compressors in "factory"					
Item	Details	Standard of judgment	Management standard		
Operation/Management	1. Operation/Management 1) Compressors only operated upon air supply request form, otherwise are shut down. 2) Operation controlling number of equipment pieces based on pressure detection of air piping for standard machines 3) Operate 1 inverter to respond to load change amount 4) Rated voltage, current value within ±10% 5) Ventilation to prevent compressor room temperature from exceeding 40℃ 6) Do not place items within 1m around the compressor	6-1 (1) ①			
Measurement/Recording	1. Measurement/Recording 1) Operation time 2) Discharge pressure 3) Oil temperature 4) Voltage 5) Current	6-1 (2)	Once / day Once / hour Once / hour Once / hour Once / hour		
Maintenance/Inspection	1. Maintenance/Inspection 1) Amount and contamination level of lubricating oil 2) Insulation resistance 3) Wear and tear of power transmission parts 4) Air leaks from piping	6-1 (3) ① 6-1 (3) ②	Once / month Once / year Once / year Once / month		
Measures for new installations	1. Measures for new installations 1) Application of high efficiency compressors (inverters) 2) Adoption of efficient method after deliberation on centralized/dispersed methods 3) Adopt efficient pipe size and routes based on pressure loss	6-1 (4)			
改定履歴	改定年月日	制定・改定理由	作成	承認	
承認	照査	作成	実施年月日	制定年月日	

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5

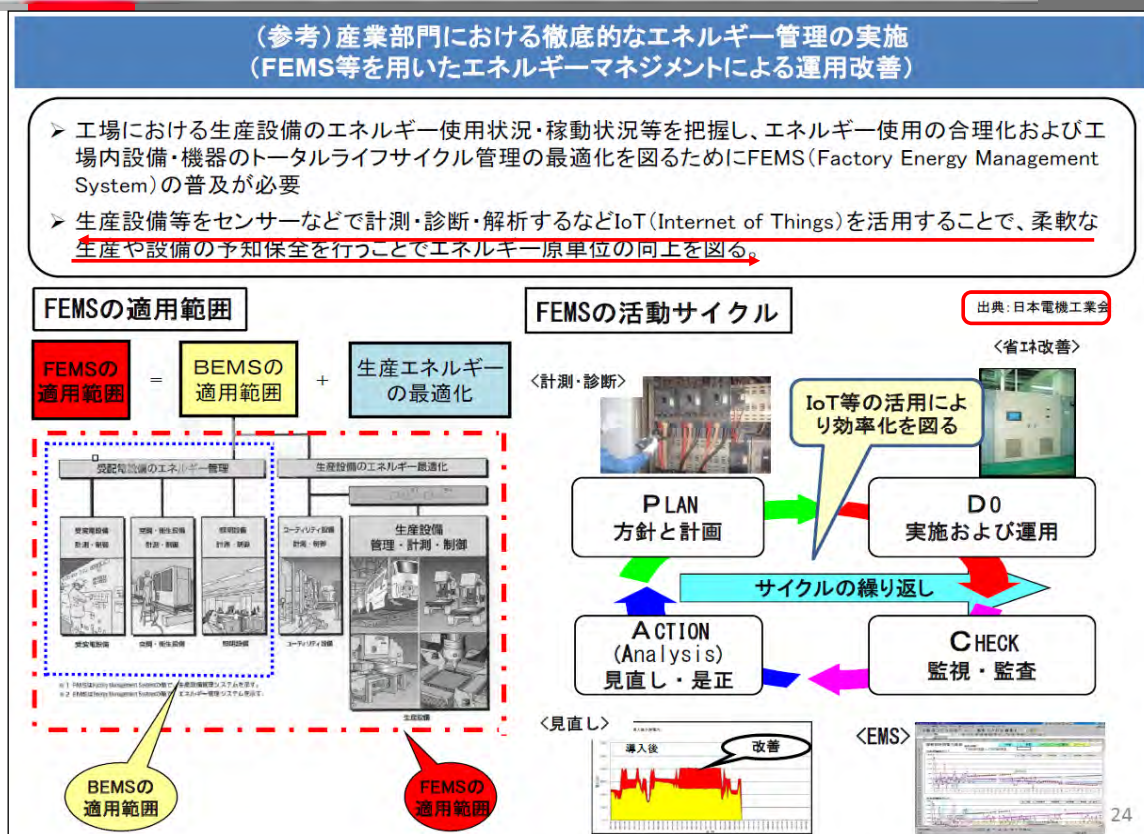




※出典元: 平成27年7月 資源エネルギー庁発行「長期エネルギー需給見通し関連資料」より抜粋

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6



※出典元: 平成27年7月 資源エネルギー庁発行「長期エネルギー需給見通し関連資料」より抜粋

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7

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8

### 2-1. <<ยุคที่ 0>> Logging (บันทึก-เก็บสะสม) โดยการอ่านค่ามิเตอร์ด้วยมือ

**HITACHI**  
Inspire the Next

#### 【Objective】

1. Allocation of power to each division

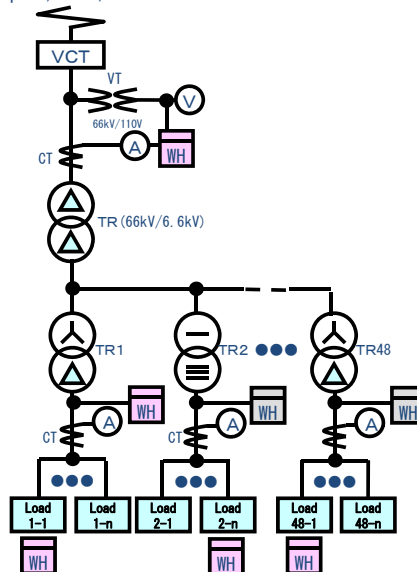
#### 【Manual meter reading】

1. Frequency : once/month
2. Personnel : 2 persons
3. Target circuits : about 100 circuits
4. Work content
  - (1) Read integrating wattmeter (integrated value) and make handwritten note
  - (2) Copy current month's meter value (integrated value) onto energy use monthly report
  - (3) Subtract previous month's meter value from current month's meter value to calculate current month's power usage
  - (4) Double check current month's usage (recalculate)

#### 【Issues】

1. Point data once a month
2. No synchronism in power amounts for each circuit (off and on manner)
3. Hand written, manual calculations leave room for error

Tohoku Electric  
3φ3W, 66kV, 50Hz

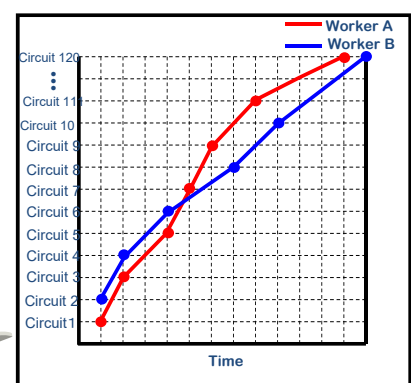


Measurement of large power loads only

Case in point: our company's Nakajo plant



Meter time chart

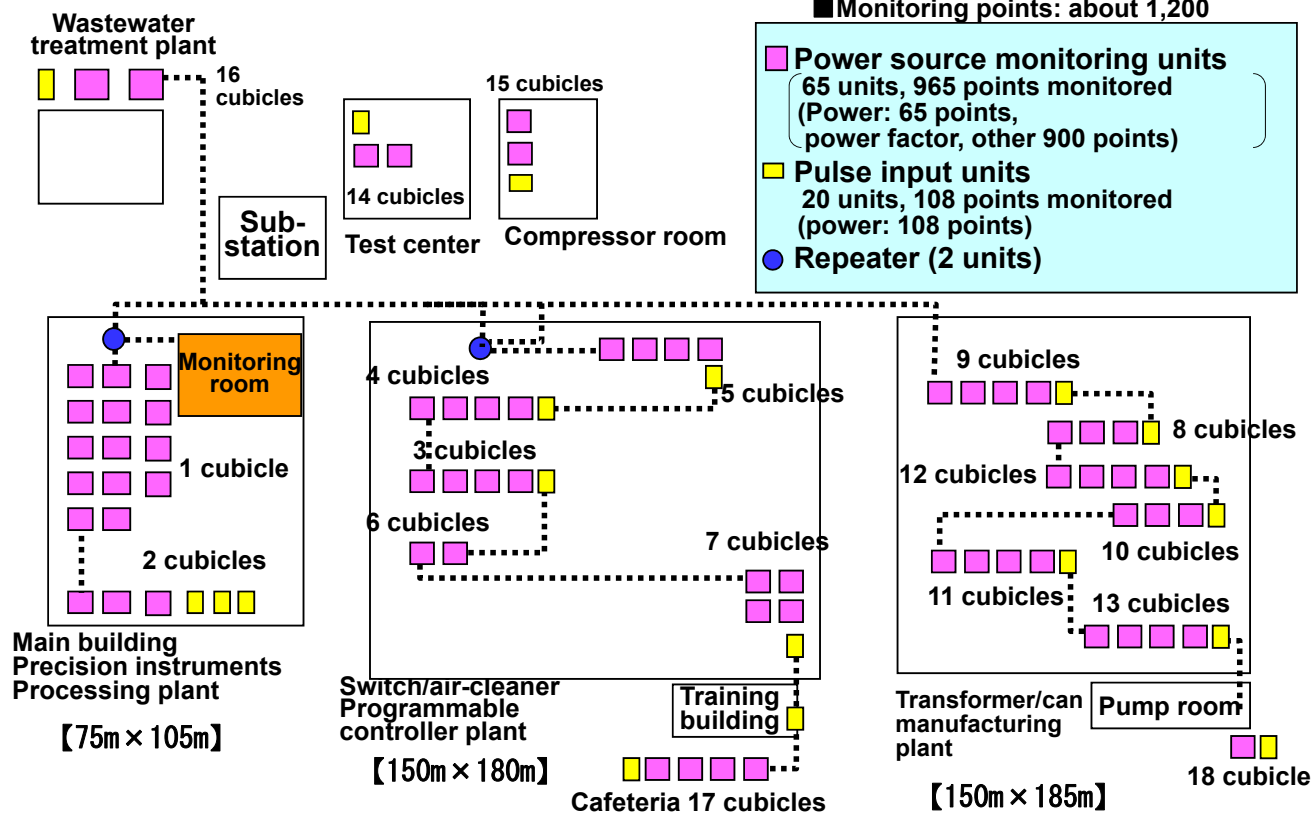


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9



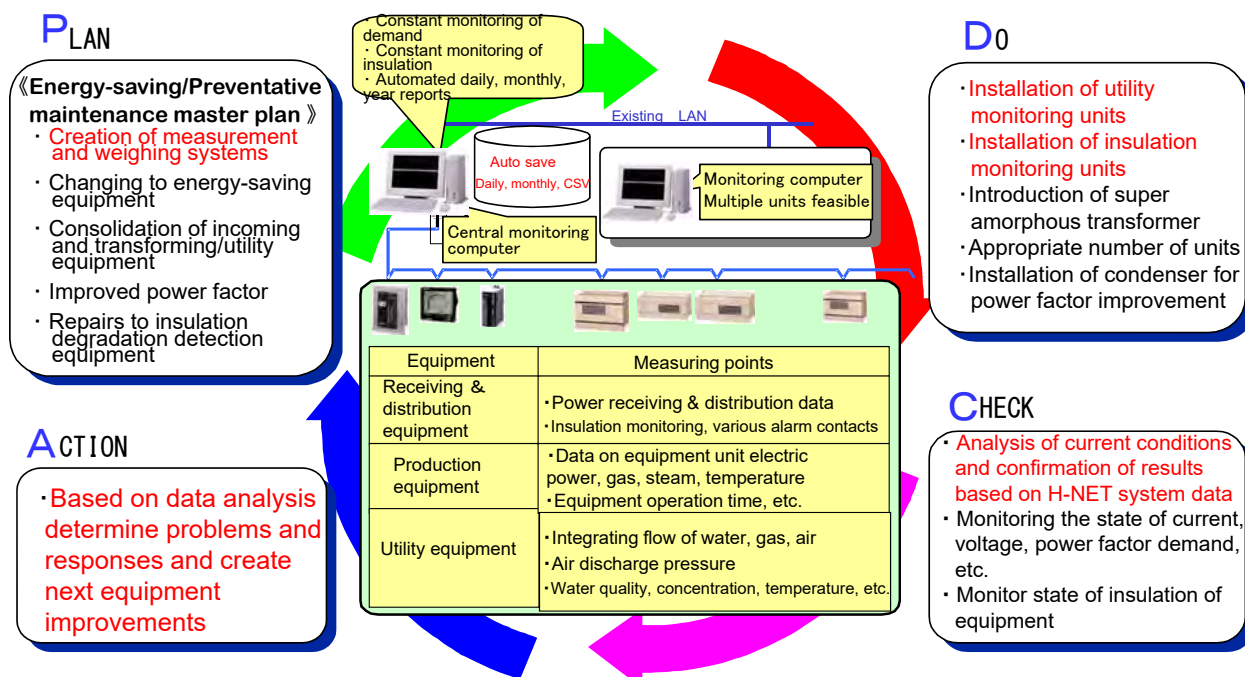
《Energy-saving starts with knowing actual conditions》 ■ Monitoring cable length: about 4,000m  
■ Monitoring points: about 1,200



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10

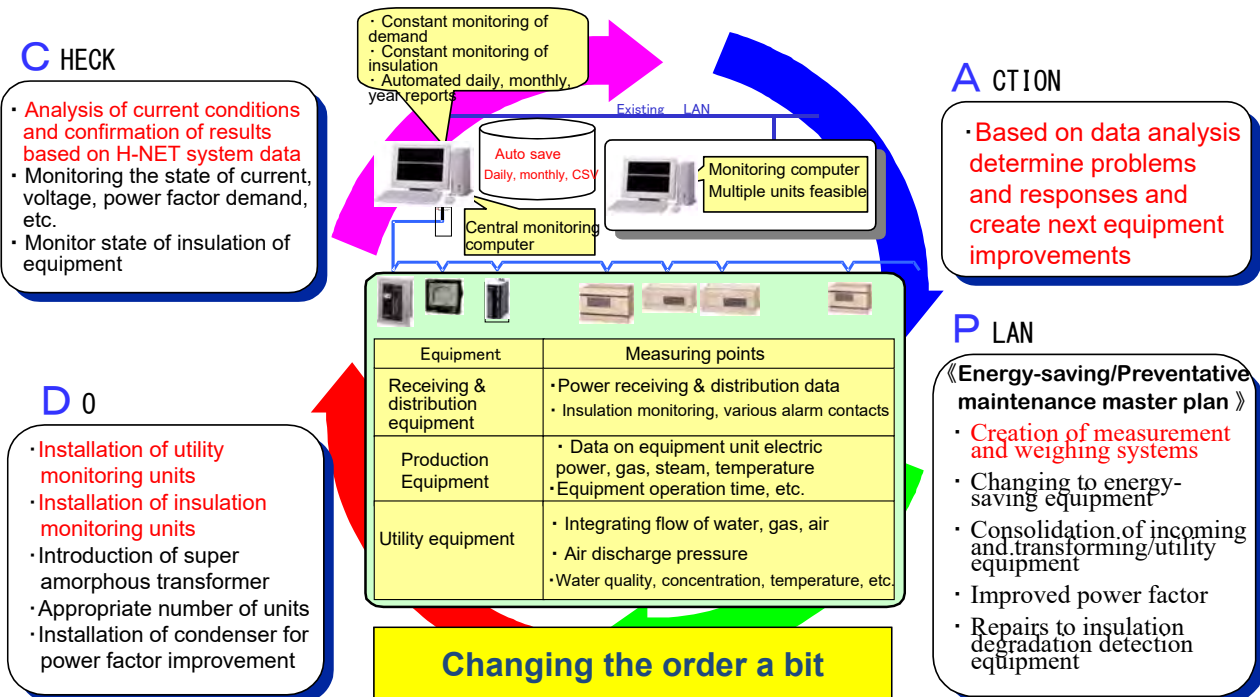
**Energy-saving starts with knowing actual conditions**  
**Utility monitoring/Insulation monitoring (H-NET system)**



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11

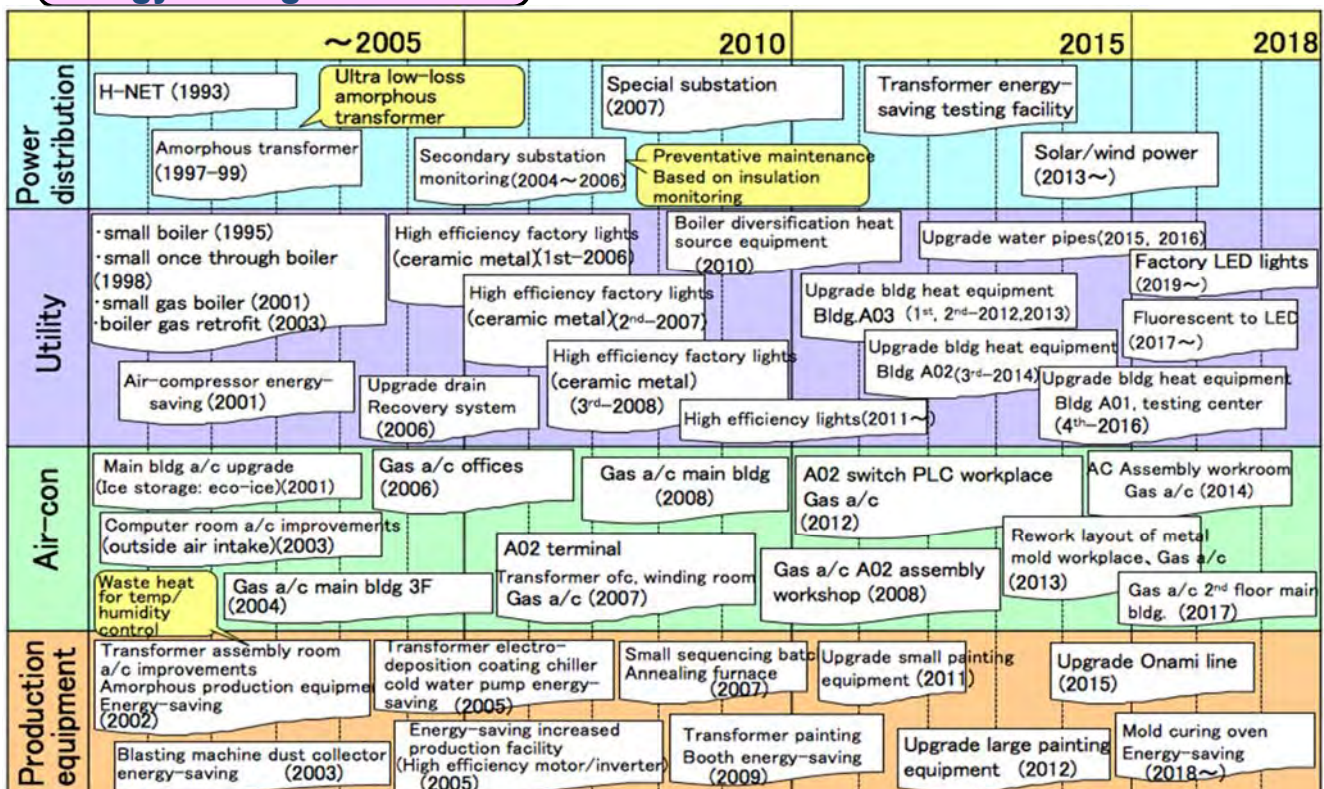
## Energy-saving starts with knowing actual conditions Utility monitoring/Insulation monitoring (H-NET system)



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12

## Energy-saving Master Plan



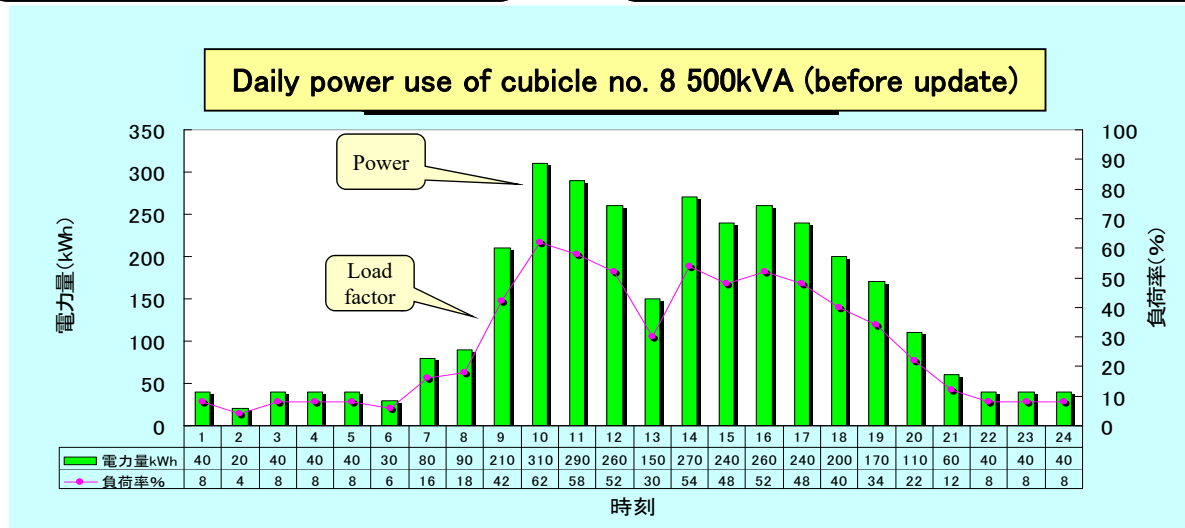
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13

**【Point】**  
Thoroughly check the state of use of transformers with H-NET to enable consideration of elimination/consolidation



**【Outcome】**  
Elimination/consolidation and update to low loss transformers  
 • Reduced power and fees with less loss  
 • Enhanced reliability



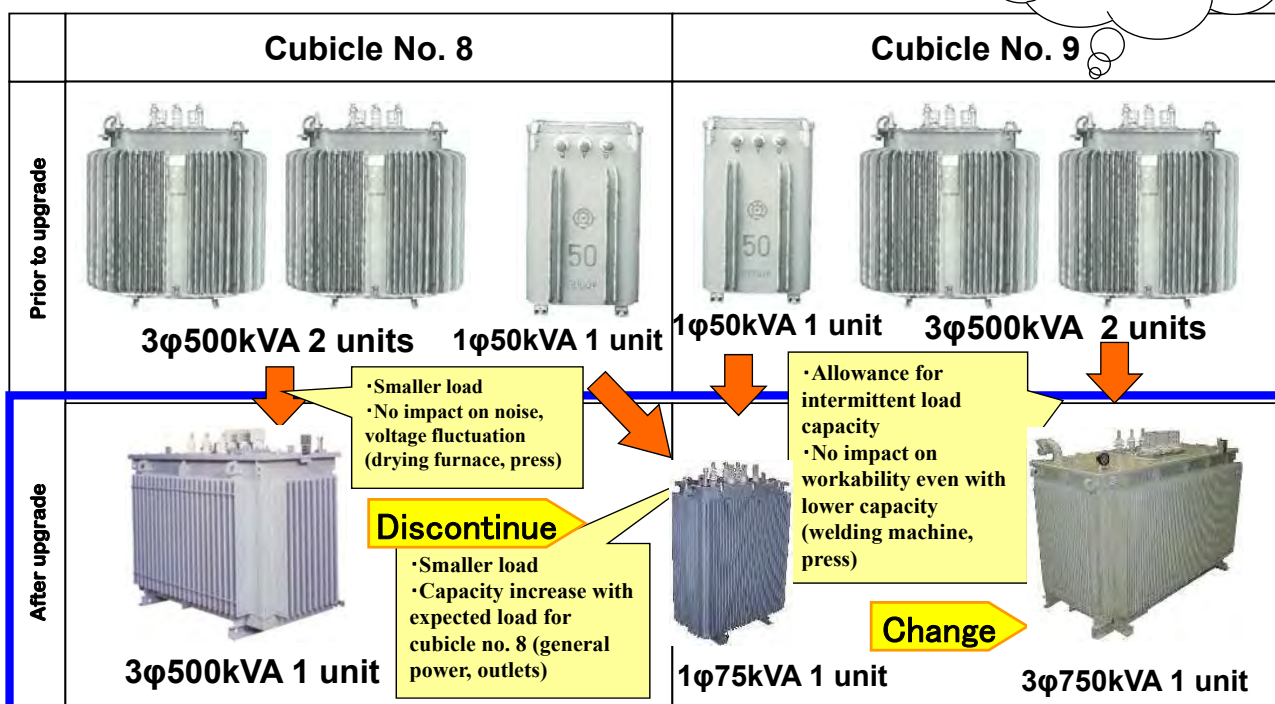
Not only is loss great with old transformers, insulating paper is deteriorated. Upgrades to ultra low-loss super amorphous planned from the viewpoint of energy conservation and reliability.

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14

## Results of analysis of transformer capacity and number of units

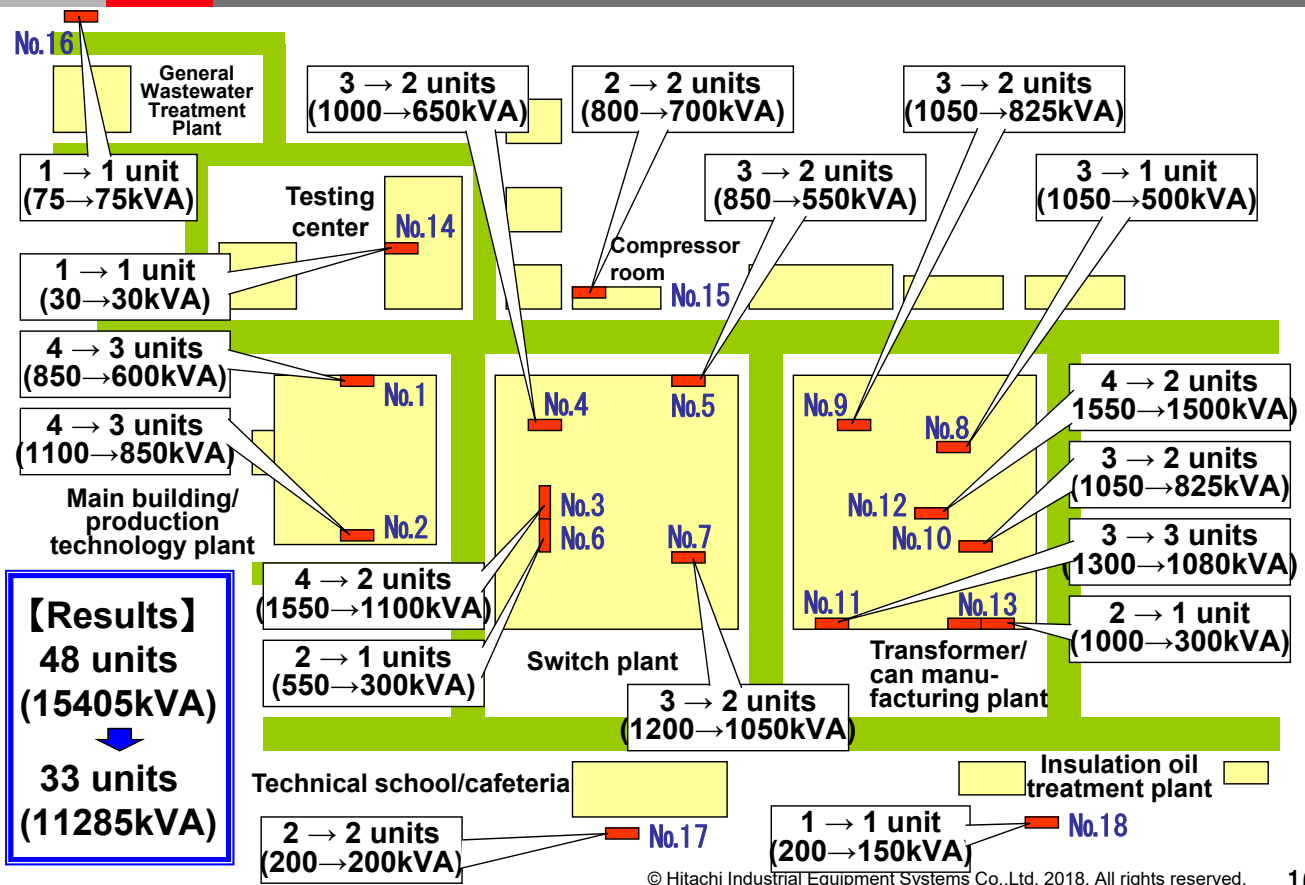
H-NET data on transformer operation used for consolidation



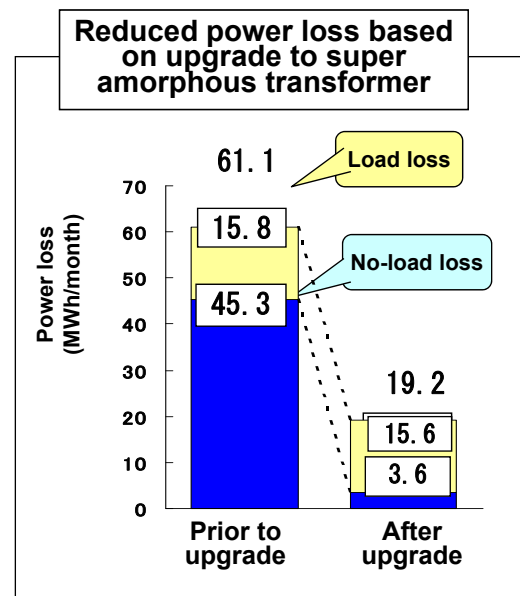
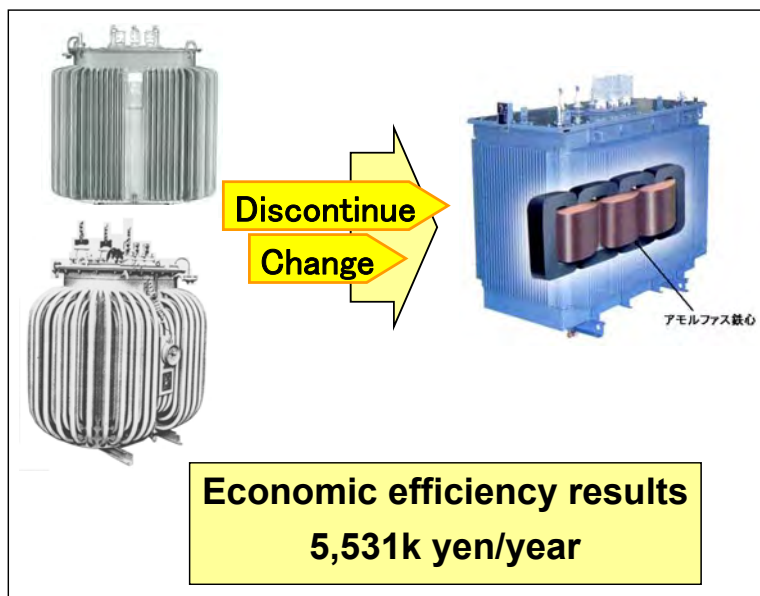
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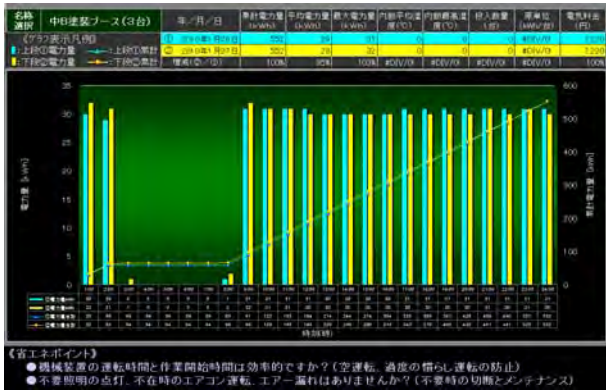
15





- [Point] 1. Reduce power loss and contracted power based on review of transformer capacity according to present work load.**  
**2. Minimize power loss with introduction of super amorphous transformer and proper arrangement.**



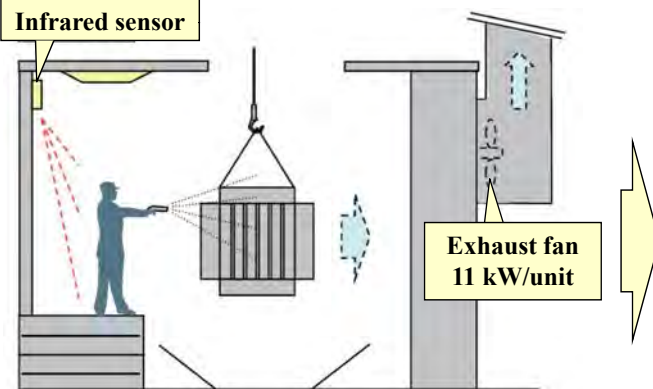


**【Before improvements】**

・Exhaust fan left on when not needed due to human-operation. Response required.

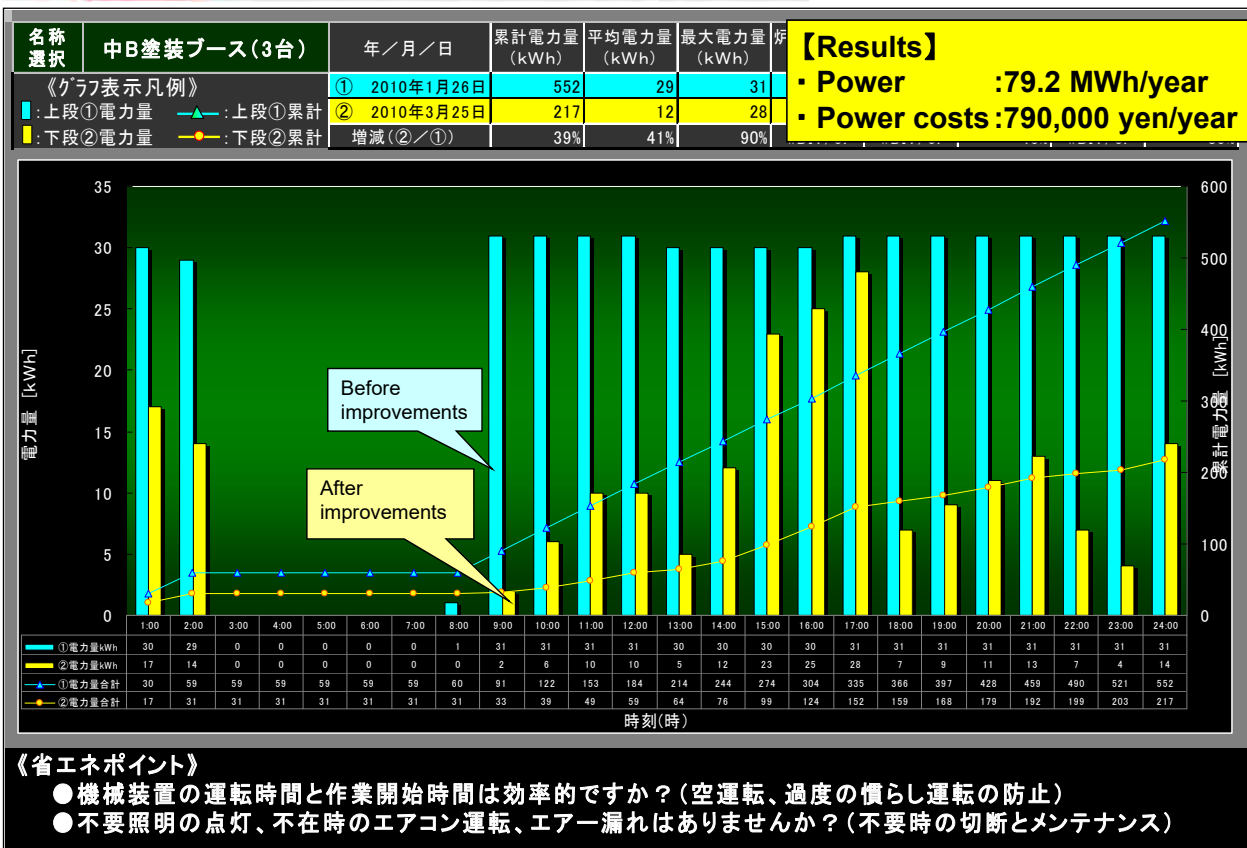
**【After improvements】**

・Automatic operation with sensor that starts exhaust fan when worker detected entering paint-spraying area and shuts it off when worker exits.



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18



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19

## Adjusted operation during summer and winter

Suppress average demand value by over 500kW for contracted power between 9:00-21:00 during period designated by Tohoku Electric for summer and winter when power demand is high.



## 《Power suppression measures》

- ◆ Monitoring with H-NET
- ◆ Limit on number of electric dryer furnaces in operation (10 units)
- ◆ All-out shut-off of lighting and OA equipment when unused
- ◆ Partial shut-off of vending machines
- ◆ Temporary shut-off of snow-melting pipe
- ◆ Permission system for operation of testing equipment (short-circuit generator)
- ◆ Thorough review of management of air-conditioning equipment
- ◆ Generator during peak times (total capacity: 37 kVA)
- ◆ Exhaustive application on site and patrols to thank workers for cooperation

## 【Energy-saving points】

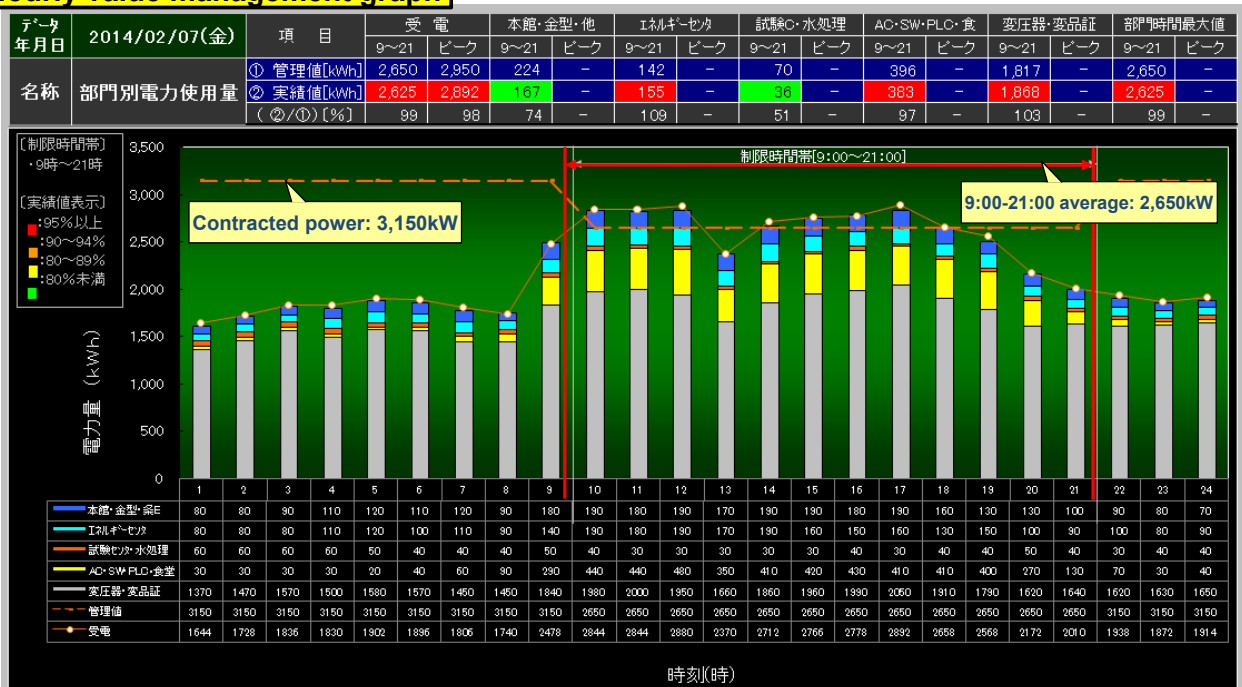
with H-NET

- Ascertainment of power consumption of each piece of equipment
- Monitoring/management during peak power

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20

## Hourly value management graph



## 《省エネポイント》

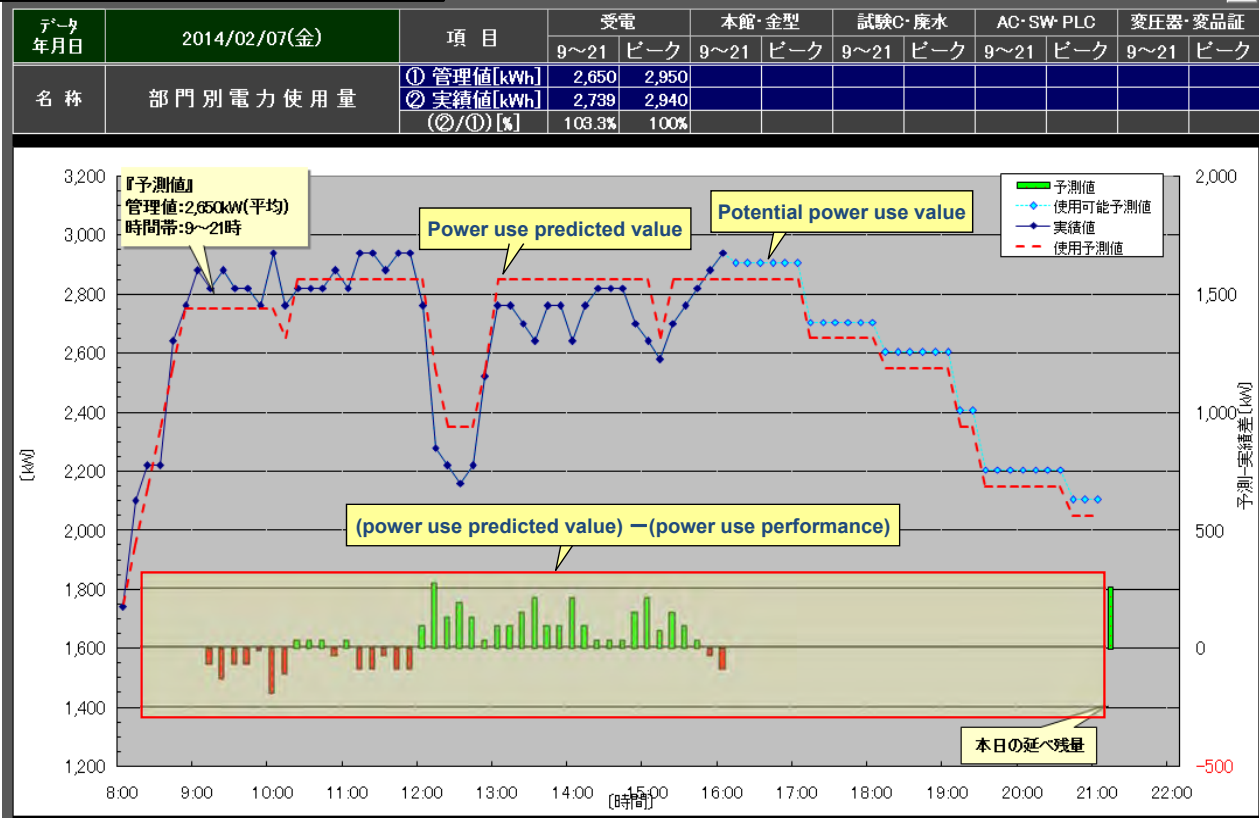
- 機械装置の運転時間と作業開始時間は効率的ですか？（空運転、過度の慣らし運転の防止）
- 不要照明の点灯、不在時のエアコン運転、エア漏れはありませんか？（設定温度:28℃、不要時の切断とメンテナンス）
- 使用していないOA機器の電源が入っていませんか？（不要時のこまめな切断の習慣）

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21



**10 min. value management graph**



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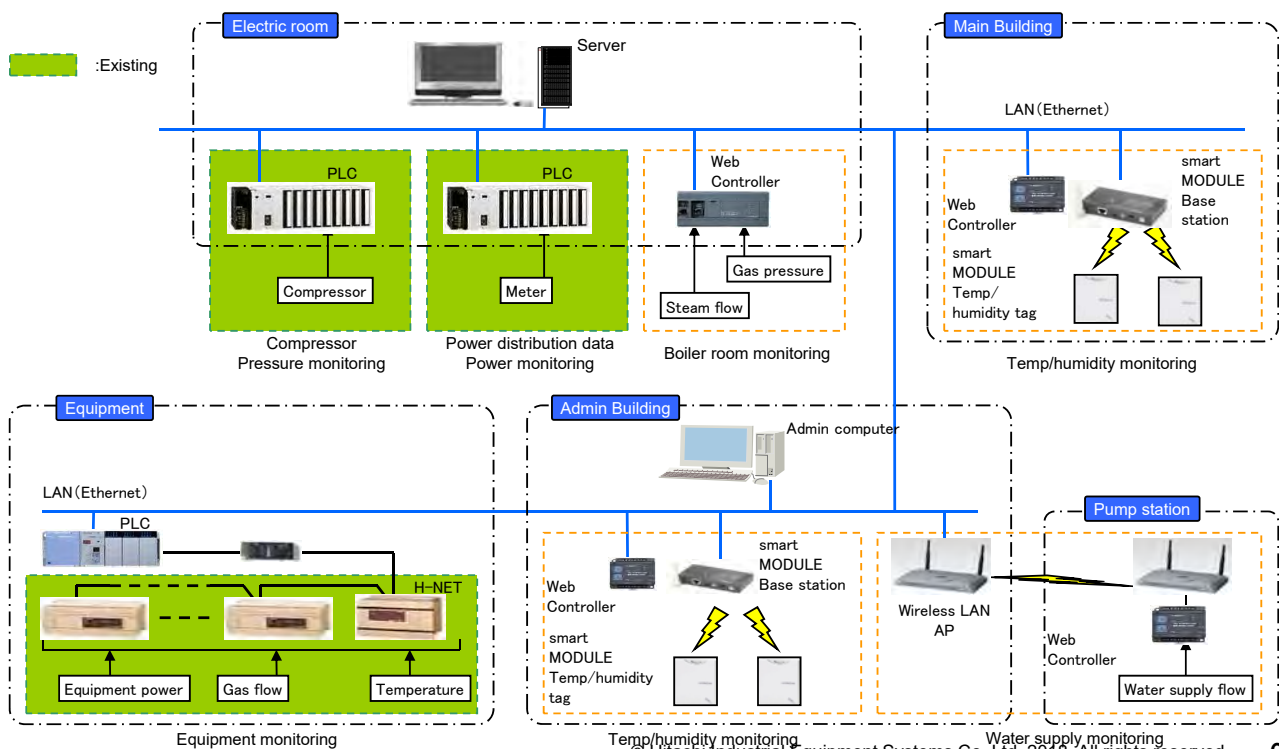
22

2-8. <<ยุคที่ 2>> ระบบดูแลจัดการพลังงานในโรงงาน (SANFEMS) โครงสร้าง

**<Monitoring>: Power, steam, natural gas, water supply, temperature, humidity**

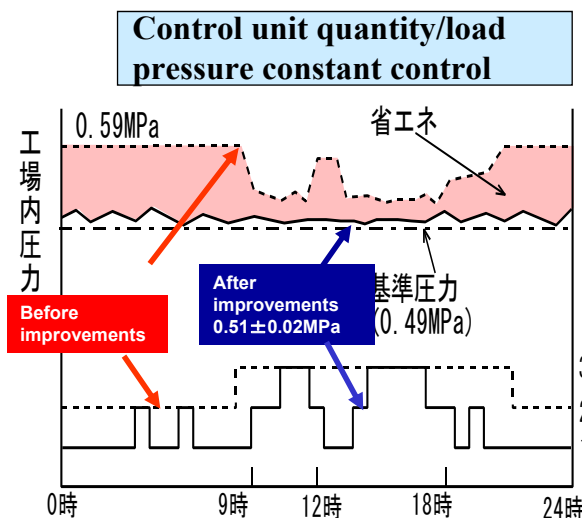
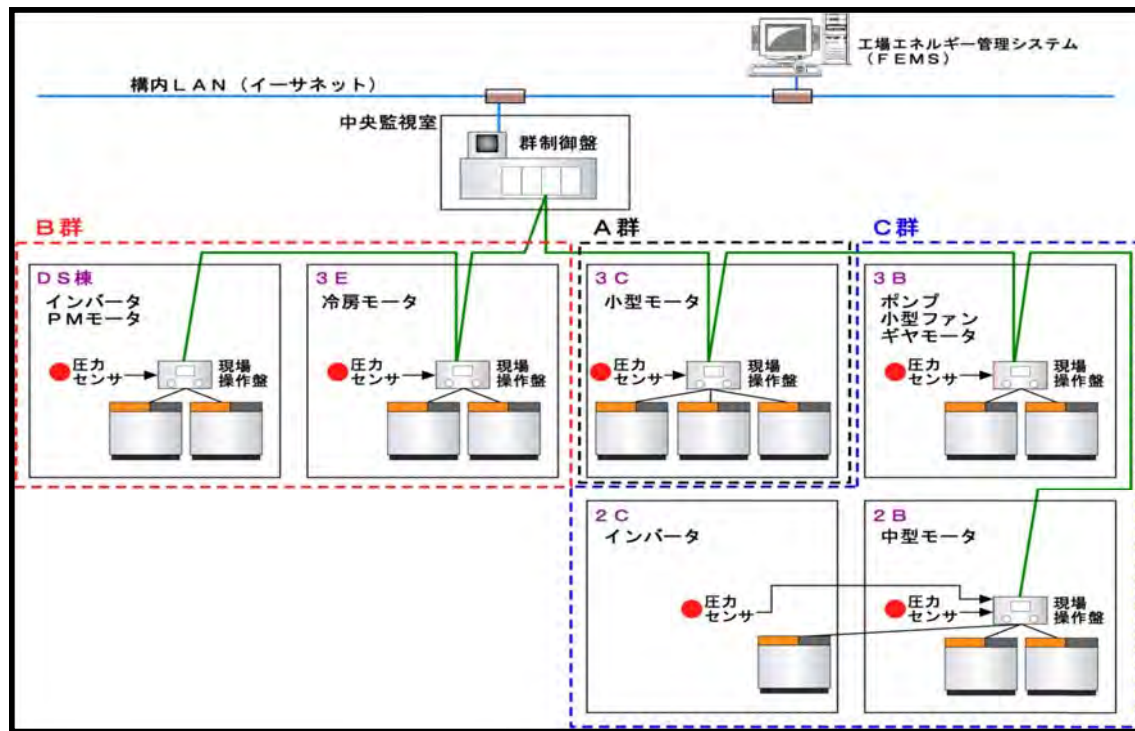
**[Advantages]**

1. Expanded scope of monitoring (utility)
2. Expanded analysis of collected data



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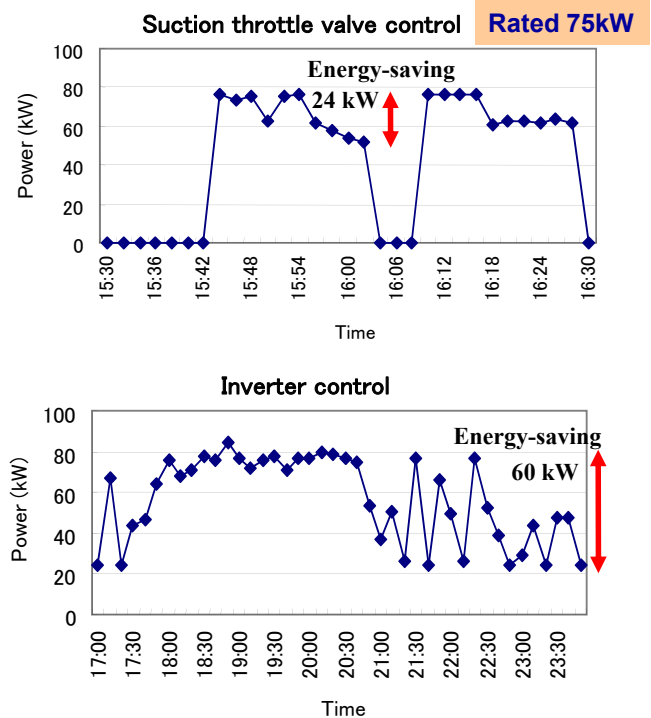
23



**State of load pressure and units in operation (compact motor plant)**

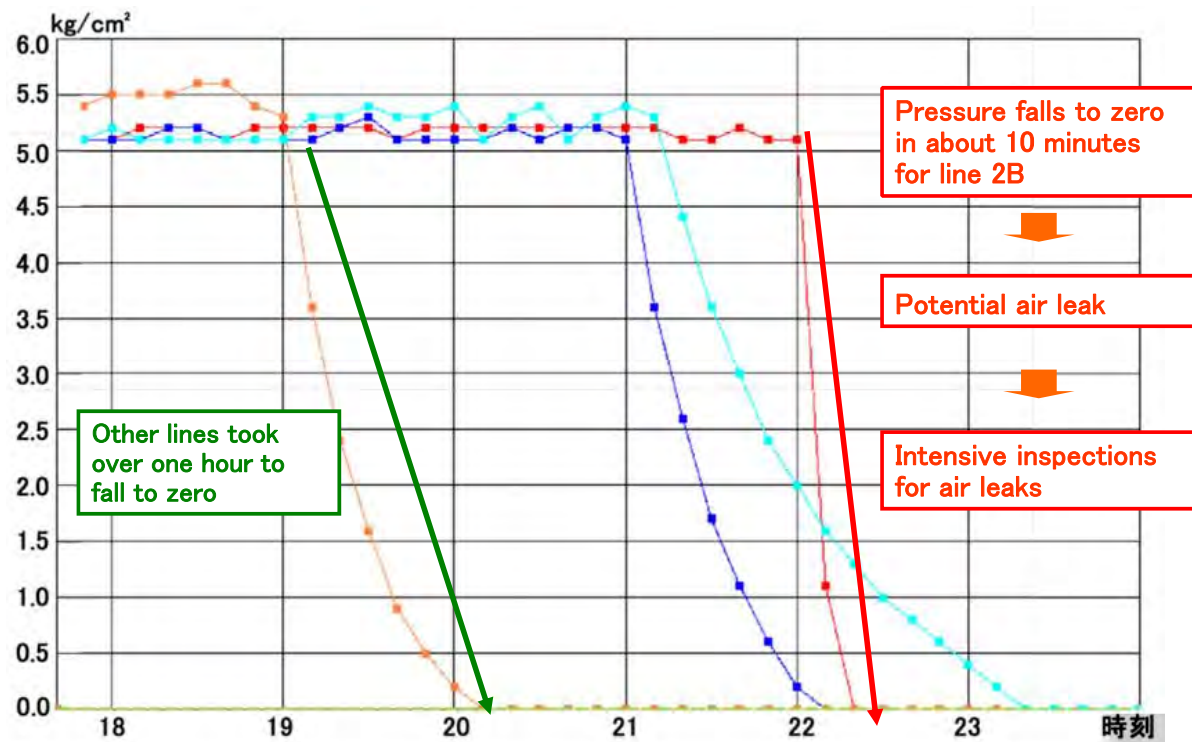
**Energy-saving 1,260 (MWh/year)**

**Energy-saving with inverter control**



## Shift in air pressure during Saturday compressor shutdown

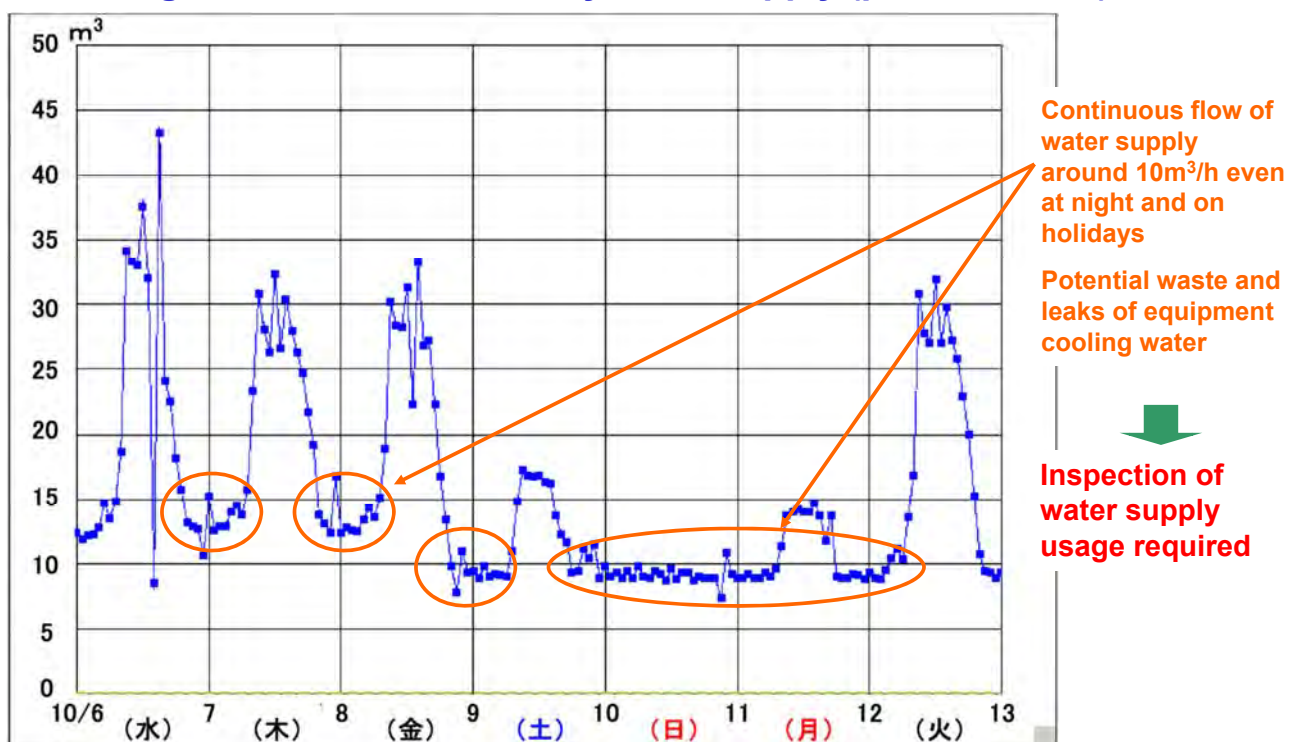
Air pressure line 2B 2C 3C 3E



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26

## ● Usage data on overall factory water supply (potable water)

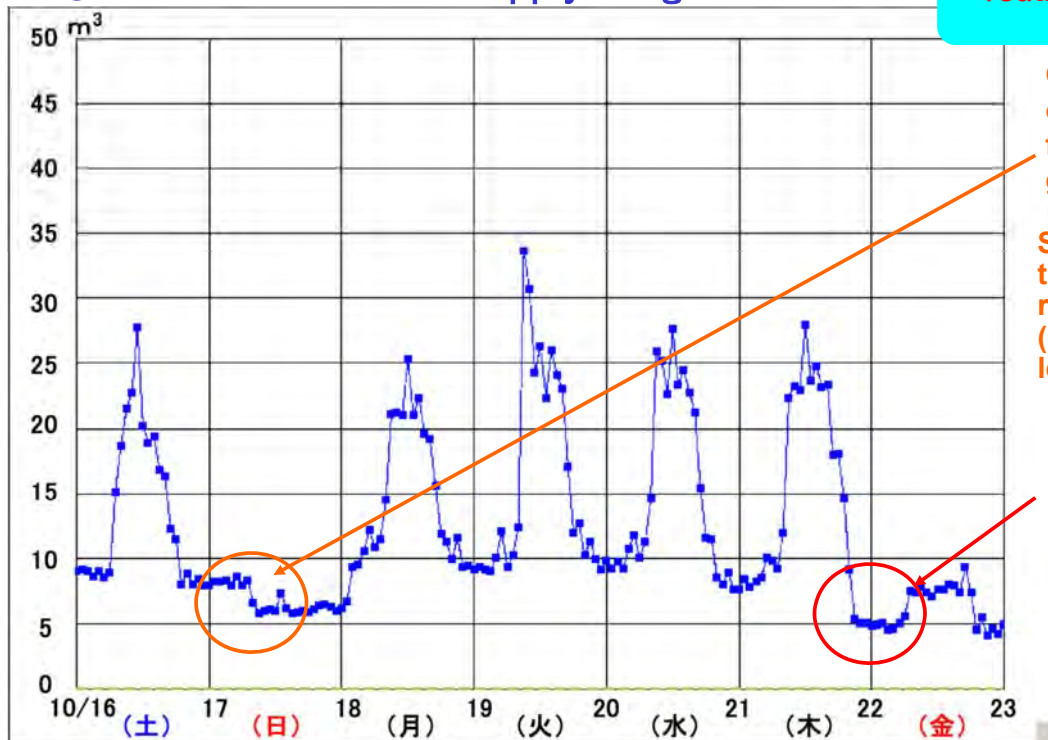


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27



## ● Reduction of water supply usage



**Annual 8 mil. Yen reduction in water charges**

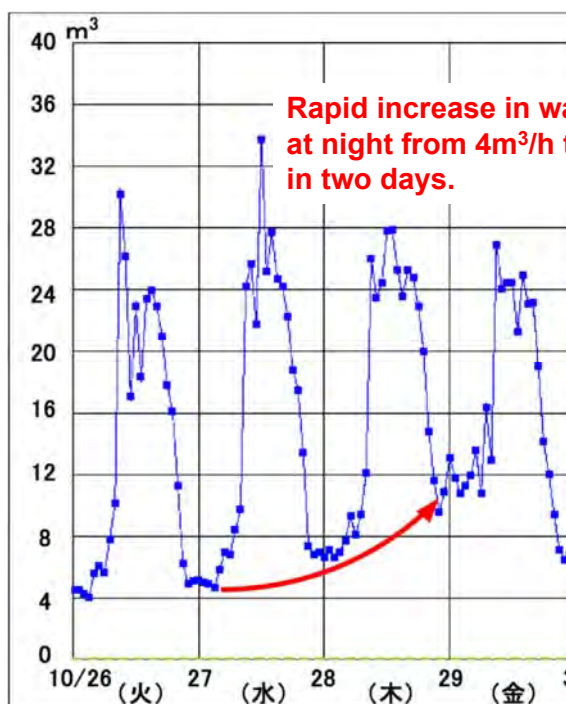
Continuous use of water by fountain at front gate

Shutting valve led to about 2.5m³/h reduction (1,800m³/month less)

Repairs to piping in leaking air-con cooling tower

About 0.5m³/h reduction (about 360m³/month)

## ● Changes on graph due water leak



**Rapid increase in water usage at night from 4m³/h to 12 m³/h in two days.**

**Leak found in deteriorated broken pipes on site**

**Early detection of leaks**



## Registering as a use case on Hitachi's Lumada IoT Platform

### Support for energy-saving based on energy management

#### 《Major know-how》⇒ Potential to be Lumada solution core

##### (1) Realization of CAPD cycle concept

- ・(Check) Visualization of collected data with operation cycle
- ・(Analysis) Comparative analysis with past data. Support for multifaceted discoveries
- ・(Plan) Support for planning energy-saving operation and optimization of operation
- ・(Do) Demand monitoring air-conditioning function, energy-saving by manual operation
- ・(Check) Visualization of improvements, confirmation of outcomes to enhance motivation

##### (2) On-site compressed air (decreased pressure times), discovery of steam energy loss (pressure, temperature)

##### (3) On-site elimination/consolidation of transformers (ascertainment of actual state of load factor)

##### (4) Air compressor end-pressure feedback control

##### (5) Isolation of energy reduction locations based on comparative graph visualization

##### (6) Rescheduling of multiple production line operations based on ascertainment of energy data (future AI topic)

#### 本ユースケースを提供するソリューション・製品

・工場エネルギー管理システム [SAN FEMS®(日立設備システム 工場エネルギー管理システム)]

#### 導入実績のある業種

・株式会社日立設備システム 東北事業所

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30

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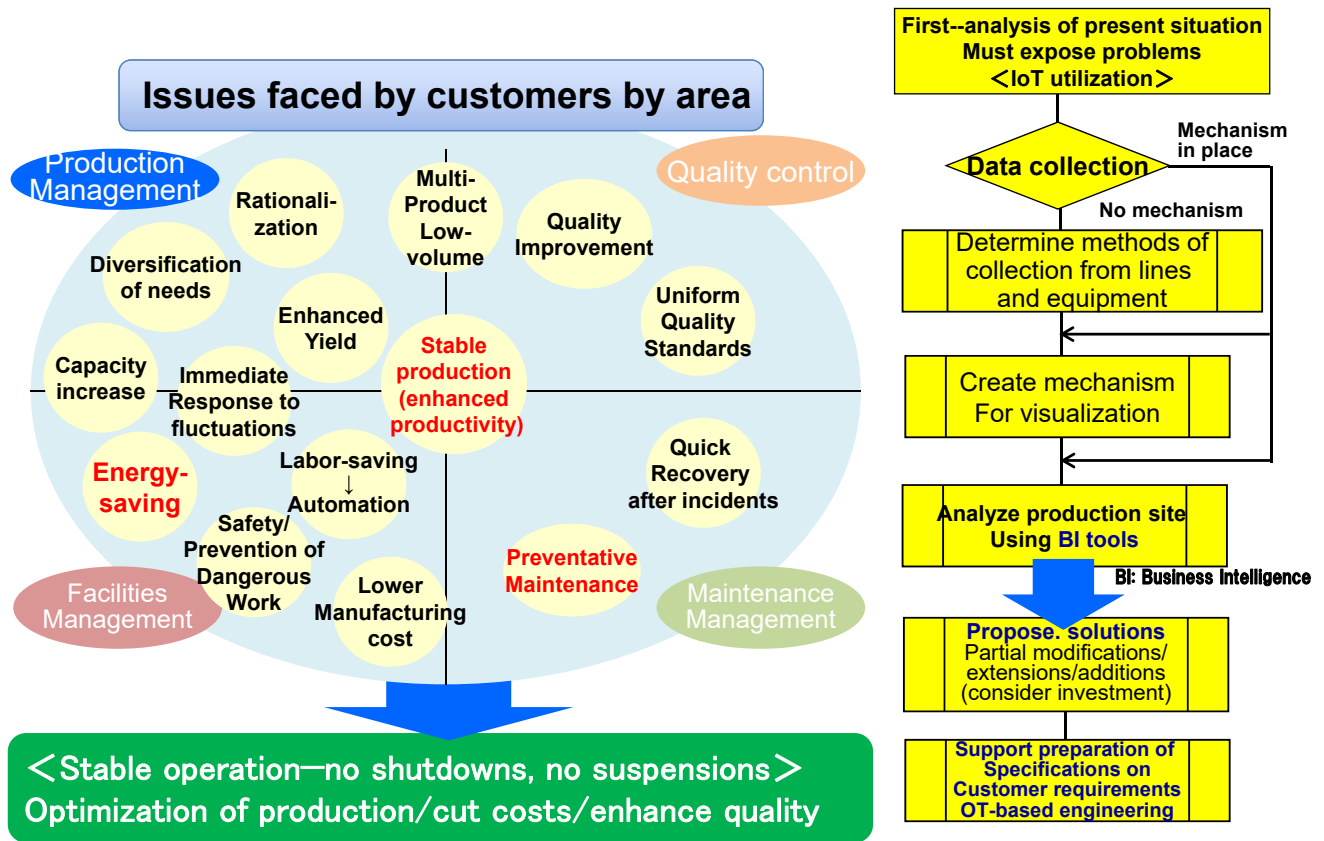
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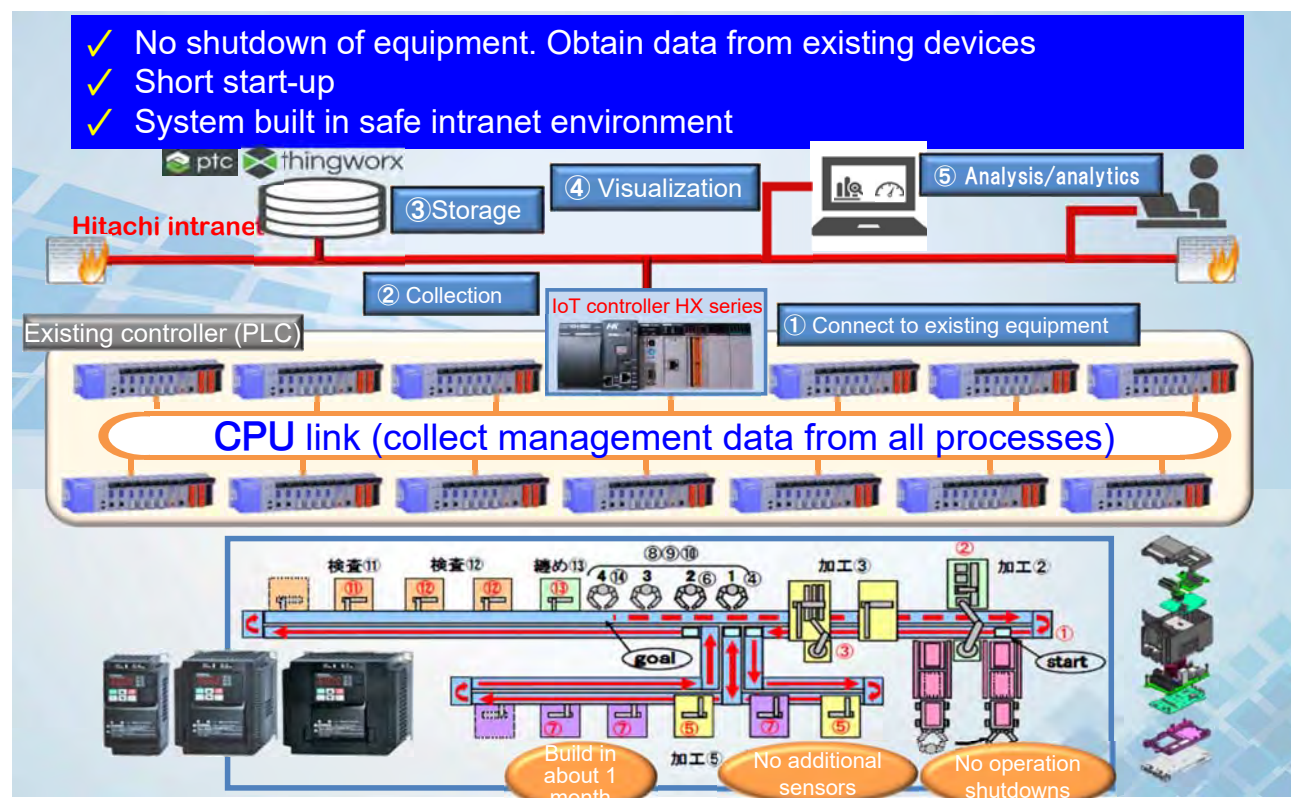
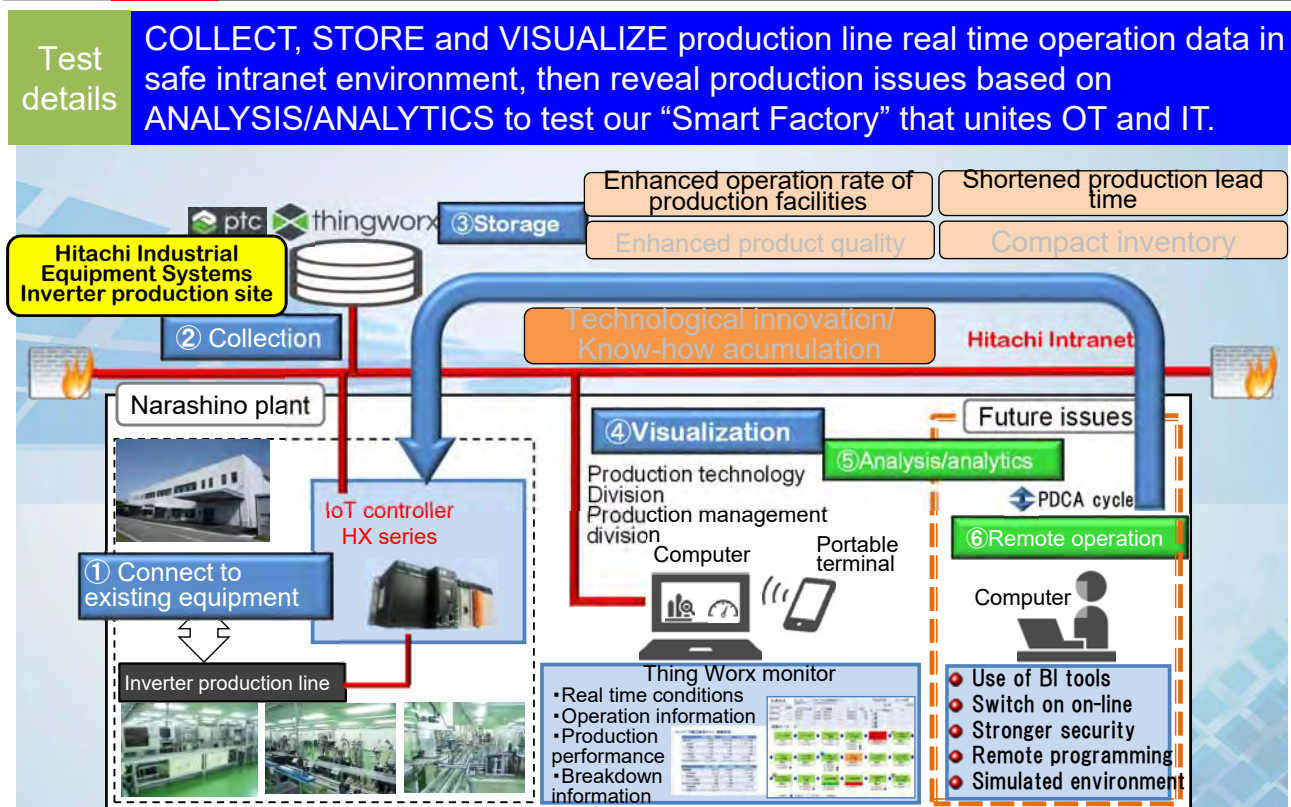
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31

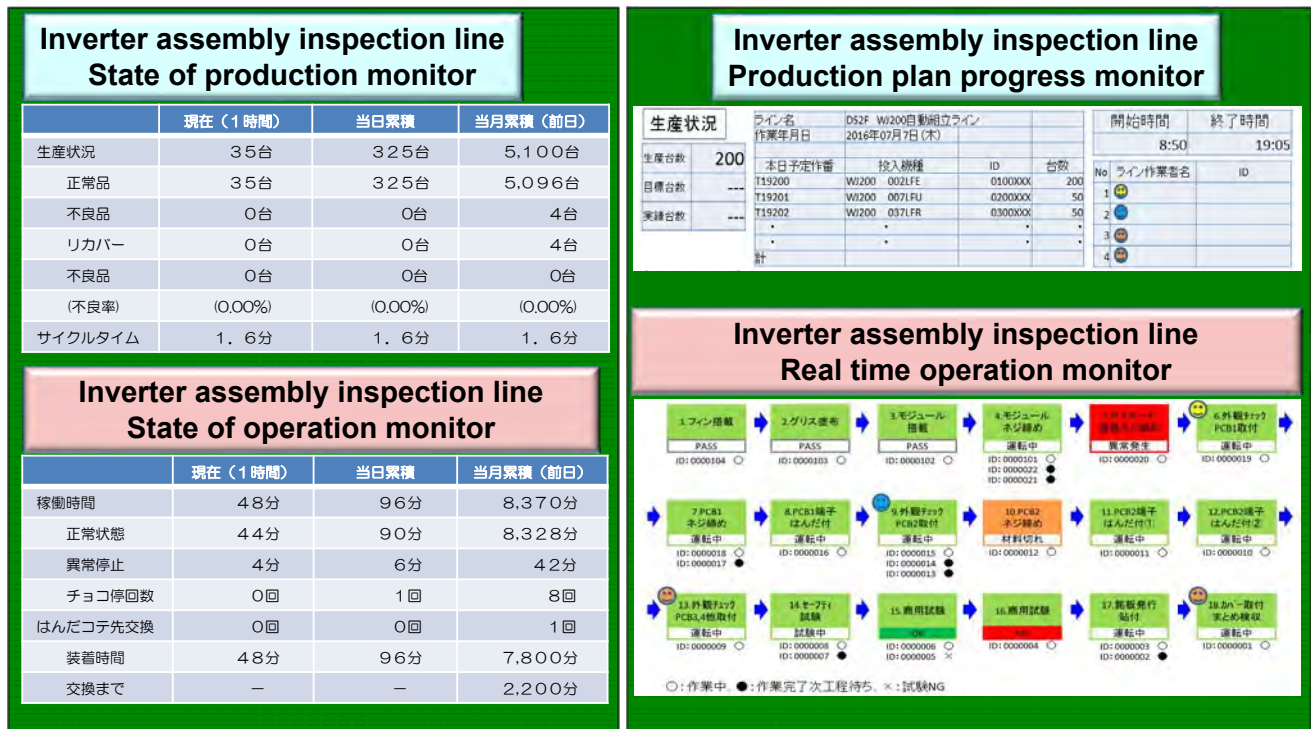


<b>Step 5</b>	<b>Total optimization</b> <ul style="list-style-type: none"> <li>•Total optimization based on central control of multiple positions</li> <li>•Selection of optimal production plant from capacity balance/operation, inventory balance</li> </ul>	<b>Total optimization (using the cloud)</b>
<b>Step 4</b>	<b>Smart factories</b> <ul style="list-style-type: none"> <li>•Realize efficient operation</li> <li>•Reduce total costs with energy information</li> </ul>	<b>On-site optimization</b>
<b>Step 3</b>	<b>Production automation</b> <ul style="list-style-type: none"> <li>•Automate process feasible for labor-saving</li> </ul>	<b>FA/Automation Robotization</b>
<b>Step 2</b>	<b>Data analysis/analytics</b> <ul style="list-style-type: none"> <li>•Analyze variance in state of operation, workers and products</li> <li>•Analysis of production plan and state of operation of all equipment</li> </ul>	<b>Point of production Information management system</b>
<b>Step 1</b>	<b>Information collection and visualization</b> <ul style="list-style-type: none"> <li>•Visualization of state of operation (operation rate, causes of non-operation, work efficiency)</li> </ul>	<b>Operation monitoring system</b> <b>Energy management system</b>





## Monitor screen



## [สำหรับใช้อ้างอิง] ข้อปฏิบัติ 10 ข้อเพื่อการปรับปรุง

1. Seeing is believing ⇒ Check out other companies!
2. Take pride in second place  
⇒ Imitate other companies with proven results
3. Two heads are better than one  
⇒ Learn from other companies!
4. Look at all sides  
⇒ Why steam? Air?
5. Five W's and one H  
⇒ Energy-saving during hard times
6. Use six senses  
⇒ Live by energy-saving and write down ideas
7. Use tools and technologies  
⇒ All experience is good
8. Be a jack of all trades  
⇒ Diversify, electricians should study heat
9. Don't give up  
⇒ Keep searching for a way
10. Don't be a perfectionist  
⇒ Can you prove you're #1?