Good and Best Practices of Industrial Heat Pumps in Japan (Japanese Report for Task 1 and 2)

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Content

- Heat Demand in Industry
- Heat Use and Role of Heat Pump in Industry
- Samples of IHPs Application (Good Practices)
- Selection of Best Practices
- Barriers for Practical Application of IHPs and Countermeasures to overcome the barriers
Heat Demand in Industry
Final Energy Consumption and CO$_2$ Emission (FY2016)

- **Final energy consumption**: 11.91EJ
- **CO$_2$ emission**: 1.15 billion ton

- **Electricity**: 40%
- **Others**: 60%
- **Electricity**: 26%
- **Others**: 74%
Energy Consumption of Different Sectors
(Source: General Energy Statistics, FY2016)

Transportation: 23%
Residential: 14%
Commercial industry: 16%
Manufacturing: 43%
Agriculture/Fishery/Construction: 3%

Fossil fuels
- Coal/Coal products
- Oil products
- Natural gas/Town gas
- Renewable
- Effective recovery
- Heat
- Electricity
Application of Fossil Fuels in Manufacturing Industry
(Source: Fossil Fuels Consumption Statistics in Industrial Sectors (FY2017))

Glass products
Non-ferrous metals
Chemical fibers
Machinery
Ceramics/Clay/Stone
Pulp/Paper/Paper board
Petroleum products
Chemical industry
Iron & steel

Boiler: 17%  Cogeneration: 3%  Process heating: 31%  Materials: 44%  Others: 5%

80%
<table>
<thead>
<tr>
<th>Industries</th>
<th>Auto steam generation (TJ)</th>
<th>Direct process heating (TJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical and allied products</td>
<td>317,616 (43%)</td>
<td>1,927,446 (35%)</td>
</tr>
<tr>
<td>Pulp/paper/paper products</td>
<td>192,282 (26%)</td>
<td>32,730 (0.6%)</td>
</tr>
<tr>
<td>Iron and steel, Non-Ferrous Metals</td>
<td>114,377 (15%)</td>
<td>1,506,880 (27%)</td>
</tr>
<tr>
<td>Textile mill products</td>
<td>43,234 (6%)</td>
<td>37,954 (0.7%)</td>
</tr>
<tr>
<td>Food/beverages</td>
<td>30,000 (4%)</td>
<td>104,441 (2%)</td>
</tr>
<tr>
<td>Machinery</td>
<td>12,820 (2%)</td>
<td>86,166 (1.6%)</td>
</tr>
<tr>
<td>Electronics-information</td>
<td>212 (0%)</td>
<td>121,433 (2.2%)</td>
</tr>
<tr>
<td>Agriculture/forest/fishery</td>
<td>37 (0%)</td>
<td>41,457 (0.8%)</td>
</tr>
<tr>
<td>Others</td>
<td>34,342 (5%)</td>
<td>1,658,497 (30%)</td>
</tr>
<tr>
<td>Total</td>
<td>744,920 (100%)</td>
<td>5,517,000 (100%)</td>
</tr>
</tbody>
</table>
Heat Use and Role of Heat Pump in Industry
Effective steam use is estimated by 54% in average from practical data of 29 factories survey.

Source: JEHC, "Booklet of Industrial Heat Pump Application"
Problems of Heat Use in Factory

- A large amount of heat wasted at the low temperature
  Processes in a factory generate exhausted heat in different forms. Most of input energy in a factory is finally wasted as low level of heat.

- Low effective use of steam boiler system
  Practical steam supply system has nearly 50% of heat loss generated in processes of boiler, piping and drain.

- Uniform temperature of heat supply
  Heat in a factory is used for heating, drying, washing, etc. at different heat levels. However, heat of constant temperature is supplied for those purposes.

- Separate heat supply for heating and cooling
  Different technologies are separately adopted for heating and cooling. Simultaneous heating and cooling enables in production processes by HP application.
Large Primary Energy Saving achieved by IHP Application

- Boiler loss: 10
- Piping loss: 25
- Drain loss: 10
- Primary energy: 100
- Heat: 90
- Heat: 65
- Heat: 55
  - Heating (150°C)
  - Drying (80°C)
  - Cleaning (60°C)
- Conventional boiler combustion
- Energy Saving: 50~70%

Primary energy: 30~50
- Electricity generated: 12~20
- Electricity of end use: 11~18
- Heat Pump (COP 3~5)

Conversion loss: 18~30
- Transmission & transformation loss: 1~2
- Heat Recovery by Heat Pump
Heat Pump is Renewable Energy Technology
(Power plant: fossil fuels 60%, renewable 20%, nuclear 20%)

Share of renewable energy = 100 – (37.5 + 15) = 47.5
Samples of IHPs Application (Good Practices)
<table>
<thead>
<tr>
<th>Literature</th>
<th>Sample Number</th>
<th>Number of Annex 35/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples of heat pump installation in industrial sector, JEHC</td>
<td>No.1~19</td>
<td>No.1~19</td>
</tr>
<tr>
<td>Future Ages, Use More Electricity for Production Vol.5, JEHC (Vol.2,3,4,5)</td>
<td>No.20~48</td>
<td>No.20~26</td>
</tr>
<tr>
<td>ELECTROHEAT HANDBOOK, JEHC, 2011</td>
<td>No.49~62</td>
<td>No.49</td>
</tr>
<tr>
<td>Journal of Electro-heat, JEHC</td>
<td>No.63~88</td>
<td></td>
</tr>
<tr>
<td>Seminar materials of JSRAE</td>
<td>No.89~96</td>
<td></td>
</tr>
<tr>
<td>Process Innovation of Food Factory, JEHC</td>
<td>No.97</td>
<td></td>
</tr>
<tr>
<td>Catalogue of Ebara Refrigeration Equipment &amp; Systems Co., Ltd.</td>
<td>No.98</td>
<td>(MHP or MVR for 98 samples)</td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>27</td>
</tr>
</tbody>
</table>
Matrix Items for Sample Information

- Information on installation
  - Industrial sector of installation
  - Process applied
  - Location
  - Year of installation
  - User name

- Information on technology and system
  - Manufacturer/constructor/consultant
  - Heat pump system
  - Working fluid (refrigerant)
  - Compressor
  - Heating/cooling capacity [kW]
  - Heat sink (In and Out) [°C]
  - Heat source (In and Out) [°C]
  - Heat storage

- Effects of installation
  - Energy savings
  - CO₂ emission savings
  - Energy cost savings
  - Additional effects
| No | Annex | Title of project | Reference | Industry | Process applied | Location (Japan) | Year of installation | User (company) | HP manufacturer/constructor consultant | HP technology | HP system | Working fluid/Refrigerant | Compressor | Heating/cooling capacity (kW) | Heat Sink IN (℃) | Heat Sink OUT (℃) | Heat source/heat sink | Heat Source IN (℃) | Heat storage | Savings energy (%) | Savings CO2 emissions (%) | Savings energy cost (%) | additional effects |
|----|-------|-----------------|-----------|----------|-----------------|-----------------|--------------------|-----------------|------------------------------------------|---------------|-----------|---------------------------------|-------------|-----------------------------|----------------|------------------------|-----------------|------------------------|----------------|-----------------|-----------------|-------------------------|-----------------|------------------|
| 1  | 35/13 | Electric load leveling by ice storage system in cheese production process | Examples of heat pump installation in industrial sector, JEHC | Food | Cooling | Hokkaido | 2007 | Yukijirushi Mejunoki k Co.Ltd | Hitachi Appliances, Inc | MHP | Water cooled chiller | R134a | turbo | | | | | | | | Cooling only | Ice | Saving of contract load by load leveling |
| 2  | 35/13 | Simultaneous heating & cooling system in food production line | Examples of heat pump installation in industrial sector, JEHC | Food | Heating/Cooling | Hyogo | 2010 | Cosmos Food Co.Ltd | MAYEKAWA MFG. CO., LTD | MHP | Water-source hot water supply HP | CO2 | reciprocate | 276 | 90 | Simultaneous heating & cooling | | | 10 | Cold/hot water | 87 | 80 | Shortening of working hours by heat storage system |
| 3  | 35/13 | Simultaneous heating & cooling system in noodle production process | Examples of heat pump installation in industrial sector, JEHC | Food | Heating/Cooling | Okayama | 2009 | Tamura Seimen Ltd | MAYEKAWA MFG. CO., LTD | MHP | Water-source hot water supply HP | CO2 | reciprocate | 56 | 17 | Simultaneous heating & cooling | | | 0 | Ice/hot water | 31 | 25 | Shortening of working hours by heat storage system |
| 4  | 35/13 | Reduction of boiler load by heating supply water in scalding process | Examples of heat pump installation in industrial sector, JEHC | Food | Hot Water Supply | Kagoshima | 2008 | Kagoishi Kumiai Chicken Food Co.Ltd | MAYEKAWA MFG. CO., LTD | MHP | Air-source hot water supply HP | CO2 | reciprocate | 80 | 65 | Outdoor air | | | | Outdoor air | Hot water | 65 | 88 | Shortening of working hours by heat storage system |
| 5  | 35/13 | Steamless heating in broke pulper process | Examples of heat pump installation in industrial sector, JEHC | Paper products | Hot Water Supply | Shizuoka | 2009 | Oji Tokushushiki c.Ltd | Mitsubishi Electric Corporation | MHP | Air-source hot water supply HP | CO2 | scroll | 320 | 75 | Outdoor air | | | | Outdoor air | Hot water | 42 | 50 | |
| 6  | 35/13 | Electric load leveling by water heat storage system in cooling process of reaction tank | Examples of heat pump installation in industrial sector, JEHC | Chemicals | Cooling | Saitama | 2005 | Saiten Chemicals Co.Ltd | Toshiba Carrier Corporation | MHP | Air-cooled chiller | R410A | rotary | 880 | | Simultaneous heating & cooling | | | 5 | Cold water | 48 | 63 | Space saving by module connection system |
| 7  | 35/13 | Introduction of heat pump with hot gas source in dry process of formed styrol | Examples of heat pump installation in industrial sector, JEHC | Chemicals | Drying | Tochigi | 2010 | Dia Chemicals Co.Ltd | MAYEKAWA MFG. CO., LTD | MHP | Hot air generation HP | CO2 | reciprocate | 110 | 90 | Exhausted hot water of shaping machine | | | | Hot water | 48 | 63 | Improving safety by electricity utilization (Improving working condition at night) |
Number of Process Applied for Industrial Sector (N=98)
Number of Process Applied in Different Supply Temperature

Supply temperature [°C]

- HVAC
- Heating
- Heating/cooling
- Cooling
- Dry
- Hot water
- Distillation/concentration

*Graph showing the number of process applications across different supply temperatures.*
Effect of IHPs Application

- **Primary energy saving**: average = 42%
- **CO₂ emission saving**: average = 49%
- **Energy cost saving**: average = 52.5%
Selection of Best Practices
Structure of Hierarchy for Selection of Best Practice

Selection of Best Practices

Criteria of evaluation

- Technology and system
- Market potential
- Effect of installation

- Industrial heat demand

( sub-criteria )

- Heat capacity
- Supply temperature
- Working fluids
- Heat source
- Energy saving
- CO2 reduction
- Energy cost saving
- Additional effect

Evaluated industry

- Food/agriculture/fishery
- Machinery/electronics
- Paper products/pulp
- Chemicals

Samples

- sample1～38
- sample84～90
- sample39～60
- sample74～83
- sample92～93
- sample61～73
## Superiority Evaluated for Criteria Items

<table>
<thead>
<tr>
<th>Items</th>
<th>Superiority</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>High (3 points)</td>
</tr>
<tr>
<td></td>
<td>Medium (2 points)</td>
</tr>
<tr>
<td></td>
<td>Low (1 point)</td>
</tr>
<tr>
<td>Market potential (Heat Demand of auto steam generation)</td>
<td>Large (over 100,000TJ)</td>
</tr>
<tr>
<td>Technology and system</td>
<td>Heating/cooling capacity</td>
</tr>
<tr>
<td></td>
<td>Supply temperature</td>
</tr>
<tr>
<td></td>
<td>low GWP working fluid</td>
</tr>
<tr>
<td></td>
<td>Simultaneous heating/cooling or waste heat recovery</td>
</tr>
<tr>
<td>Effects</td>
<td>Savings energy</td>
</tr>
<tr>
<td></td>
<td>Savings CO2 emissions</td>
</tr>
<tr>
<td></td>
<td>Savings energy cost</td>
</tr>
<tr>
<td></td>
<td>Additional effects (Number of effects)</td>
</tr>
</tbody>
</table>
Evaluation of Criteria weighted by Different Scenario

- **Evaluation method for weight decision** ⇒ The analytic hierarchy process method
- **Main criteria**
  1. Market potential
  2. Technology and system
  3. Effects of application
- **Sub criteria**
  1. Technology and system
     - ① Heating/cooling capacity
     - ② Supply temperature
     - ③ Low GWP working fluids
     - ④ Simultaneous heating and cooling / Heat recovery
  2. Effects of application
     - ① Energy saving
     - ② CO2 reduction
     - ③ Energy cost saving
     - ④ Additional effects
- **Pairwise comparison between j and k criteria**

<table>
<thead>
<tr>
<th>Value of $a_{jk}$</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$j$ and $k$ are equally important</td>
</tr>
<tr>
<td>3</td>
<td>$j$ is more important than $k$</td>
</tr>
<tr>
<td>5</td>
<td>$j$ is strongly more important than $k$</td>
</tr>
</tbody>
</table>

- **Scenario**
  1. Scenario 1: Priority of market potential
  2. Scenario 2: Priority of technology and system
  3. Scenario 3: Priority of application effects
## Best Practices evaluated by Scenario Analysis

<table>
<thead>
<tr>
<th>No</th>
<th>Industry</th>
<th>Location</th>
<th>User company</th>
<th>HP manufacturing company</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Reference [without weight]</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>machinery</td>
<td>Aichi</td>
<td>Aishin•AW Co. Ltd.</td>
<td>General Heat Pump Industry</td>
<td>2.18</td>
<td>2.22</td>
<td>1.38</td>
<td>22 (2.44)</td>
</tr>
<tr>
<td>32</td>
<td>chemicals</td>
<td>Fukui</td>
<td>Suda ind. Co.Ltd.</td>
<td>MAYEKAWA MFG. Co., Ltd</td>
<td>2.66</td>
<td>2.56</td>
<td>1.46</td>
<td>21 (2.33)</td>
</tr>
<tr>
<td>2</td>
<td>food</td>
<td>Hyogo</td>
<td>Cosmo food Co. Ltd.</td>
<td>MAYEKAWA MFG. Co., Ltd</td>
<td>2.16</td>
<td>2.44</td>
<td>1.25</td>
<td>20 (2.22)</td>
</tr>
<tr>
<td>43</td>
<td>chemicals</td>
<td>Hokkaido</td>
<td>Hokkaido Bioethanol Co Ltd.</td>
<td>KOBE STEEL, Ltd.</td>
<td>2.65</td>
<td>2.48</td>
<td>1.46</td>
<td>19 (2.11)</td>
</tr>
<tr>
<td>7</td>
<td>chemicals</td>
<td>Tochigi</td>
<td>Diachemical Co. Ltd.</td>
<td>MAYEKAWA MFG. Co., Ltd</td>
<td>2.42</td>
<td>2.60</td>
<td>1.32</td>
<td>18 (2.00)</td>
</tr>
<tr>
<td>40</td>
<td>food</td>
<td>Yamagata</td>
<td>Flesh Diner Co. Ltd.</td>
<td>MAYEKAWA MFG. Co., Ltd</td>
<td>1.94</td>
<td>2.37</td>
<td>1.1</td>
<td>18 (2.00)</td>
</tr>
<tr>
<td>83</td>
<td>food</td>
<td>Kochi</td>
<td>Muroto Deep Sea Water Co. Ltd.</td>
<td>Sasakura</td>
<td>1.91</td>
<td>2.18</td>
<td>1.06</td>
<td>18 (2.00)</td>
</tr>
</tbody>
</table>

*red: the best value for different industries*
**Best Practice of Machinery Industry (No.21)**

**Process Outline**

<table>
<thead>
<tr>
<th>No</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>Machinery (Parts production of vehicle)</td>
</tr>
<tr>
<td>Process applied</td>
<td>Cutting, Washing</td>
</tr>
<tr>
<td>Heat source</td>
<td>Simultaneous heating/cooling (heating 65°C, cooling 15°C)</td>
</tr>
<tr>
<td>Objective</td>
<td>Eliminating the conventional boiler system</td>
</tr>
</tbody>
</table>
| HP system | Water-water/Air-water heat pump (6+8=14 units)  
Heating capacity: 22kW/unit (6 units), 43kW/unit (8 units)  
Refrigerant: R134a |
| Effects | CO2 reduction 80%, energy cost saving: 79%, Pay back time: 5 year |

Before

- Simultaneous heating for washing liquid and cooling for cutting oil
- 3.0 of heating COP, 2.0 of cooling COP
- Transportation heat loss is reduced by installing HP close to process facility.

After
Effects of Application

### Saving of energy, steam and CO₂ emission

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity consumption</td>
<td>193 MWh/y</td>
<td>570 MWh/y</td>
<td>+377 (+195%)</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>470 kL/y</td>
<td>0</td>
<td>−470 (−100%)</td>
</tr>
<tr>
<td>Steam consumption</td>
<td>6,953 kL/y</td>
<td>0</td>
<td>−6,953 (−100%)</td>
</tr>
<tr>
<td>CO₂ emission</td>
<td>1,364 ton-CO₂/y</td>
<td>270</td>
<td>−1,094 (−80%)</td>
</tr>
</tbody>
</table>

### Economical effect

<table>
<thead>
<tr>
<th></th>
<th>Before (old)</th>
<th>After (new)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment</strong></td>
<td>Boiler/piping 75.3[million yen]</td>
<td>Heat pump system (14 units) 91[million yen]</td>
<td>−45.2 [million yen]</td>
</tr>
<tr>
<td></td>
<td>Steam heating system 10.5[million yen]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling system 50.4[million yen]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total: 136.2[million yen]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operation cost</strong></td>
<td>Electric bill (193MWh) 2.34[million yen/y]</td>
<td>Electric bill (570MWh) 6.89[million yen/y]</td>
<td>−26 [million yen/y] (−79%)</td>
</tr>
<tr>
<td></td>
<td>Heavy oil charges 28.1[million yen/y]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water charges 2.45[million yen/y]</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total 32.9[million yen/y]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Best Practice of Chemicals Industry (No.32)

Process Outline

<table>
<thead>
<tr>
<th>Number</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>Chemicals (Package film production)</td>
</tr>
<tr>
<td>Process applied</td>
<td>Dry (laminating film)</td>
</tr>
<tr>
<td>Heat source</td>
<td>Hot water supply</td>
</tr>
<tr>
<td>Objectives</td>
<td>Effective use of waste heat from VOC processor</td>
</tr>
<tr>
<td>HP system</td>
<td>Water/air heat pump (108kW)</td>
</tr>
<tr>
<td>Effects</td>
<td>CO2 reduction: 72%, Energy cost saving: 75%</td>
</tr>
</tbody>
</table>

Production process

1. Planning and design
2. Design
3. Plate making
4. Printing
5. Laminating
6. Adhesive coating
7. Drying
8. Crimp laminating
9. Inspection
10. Sitting
11. Wrapping
12. Quality inspection
13. Planning and design
Best Practice of Chemicals Industry (No.32)
System Flow and Effects of Application

**System flow**

**Effects of application**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Primary energy saving</td>
<td>60%</td>
</tr>
<tr>
<td>CO2 reduction</td>
<td>72%</td>
</tr>
<tr>
<td>Energy cost saving</td>
<td>75%</td>
</tr>
<tr>
<td>Numbera</td>
<td>2</td>
</tr>
<tr>
<td>---------</td>
<td>---</td>
</tr>
<tr>
<td>Industry</td>
<td>Food (Frozen food production)</td>
</tr>
<tr>
<td>Process applied</td>
<td>Food production, Sterilizing, Washing, HVAC</td>
</tr>
<tr>
<td>Heat utilization</td>
<td>Simultaneous heating and cooling</td>
</tr>
<tr>
<td>Objectives</td>
<td>Energy saving and energy cost saving accompanied by renewal of facilities</td>
</tr>
<tr>
<td>HP system</td>
<td>Water/water heat pump (80kWh/unit, 3 units)</td>
</tr>
<tr>
<td>Effects</td>
<td>CO2 reduction: 87%, Energy cost saving: 80%</td>
</tr>
</tbody>
</table>

**Process Outline**

### Before
- **Heat**
  - Exchanger
- **Boiler**
  - A (Steam: 2ton/h)
  - B (Steam: 0.7ton/h)
- **Absorption Chiller**
  - (Chilled Water: 500kW)
- **Food Processing Machine**
- **Sterilization & Washing Tank**
- **Fan-Coil Unit**
- **Building**
- **A/C**
- **Sterilization & Washing Tank**
- **Boiler**
  - A (Steam: 2ton/h)
- **Heat Pump** (Hot Water: 80kW)
- **Building A/C**

### After
- **Heat**
  - Exchanger
- **Boiler**
  - A (Steam: 2ton/h)
  - B (Steam: 0.7ton/h)
- **Absorption Chiller**
  - (Chilled Water: 500kW)
- **Food Processing Machine**
- **Sterilization & Washing Tank**
- **Fan-Coil Unit**
- **Building**
- **A/C**
- **Sterilization & Washing Tank**
- **Boiler**
  - A (Steam: 2ton/h)
- **Heat Pump** (Hot Water: 80kW)
- **Building A/C**
Best Practice of Food Industry (No.2)
Operation and Effects of Application

**Operational mode**

**Effects of application**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 reduction</td>
<td>−87%</td>
</tr>
<tr>
<td></td>
<td>(−450 [ton-CO2/y])</td>
</tr>
<tr>
<td>Energy cost saving</td>
<td>−80%</td>
</tr>
<tr>
<td>Pay back time</td>
<td>8 year</td>
</tr>
</tbody>
</table>
Barriers and Measures required for Practical Application of IHPs
Barriers of Information and Technology

- **Lack of data about heating demand and exhaust heat**
  - Heat demand needed for IHPs application is not understood for customers in a production process.
  - Correct information of heat demand should be surveyed for a production line.

- **Lack of knowledge and experience with heat pumps**
  - Merits of IHPs are unknown for customers in comparison with the conventional boiler system.
  - The field operator as well as the manager of the firm are lack in the ability required for IHPs application.
  - It is needed to train engineering companies specialized in industrial heat pumps

- **Avoidance of risk to suspend the conventional production line**
  - Renewal of utility facility sometimes involves to suspend the conventional production line. Field manager avoids risk to suspend the production line.

- **Difficulty of information release**
  - Information on a production line is confidential in many firms. Managers are afraid of the leakage of the secret information.
  - Contract of official secrets is needed between a customer and a manufacturing company in order that informative data like heat balance, etc. should not be leaked out.

- **Technical Barriers**
  - Lack of reliability on high temperature heat pump technology
  - Temporal and spatial gap between heating demand and waste heat
### Countermeasures to Improve Barriers

**Information collection and practical education**
- Sample survey of good and best practices
- Preparation of IHPs application guide for customers
- Common information among stakeholders
- Communication by means of seminar etc.

**Monitoring and data accumulation of heat balance at a production process**
- Data accumulation of heat demand and wasted heat at a factory
- Development to reduce costs of a thermometer and a flowmeter

**R&D of high temperature heat pump, etc.**
- Development of compressor without lubricating oil, recovering system of expansion energy and new working fluid
- Development of new technologies such as thermoacoustic HP, active magnetic regenerator, etc.
- Development of high temperature heat storage

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**[Main items of energy use]**
- heating temperature
- heat piping distance
- simultaneous heating & cooling
- exhausted heat of low temperature
- heat loss
- maintenance

**[Main items of a process]**
- process applied
- heating flow of the process
- temperature of the process
- type of heating

**[Main items of a capacity]**
- daily and seasonal load of heat demand and peak demand with time
- Decision of appropriate heating capacity from the demand

**[Main items of HP system]**
- fluctuation of heating load
- renewal plan of the conventional facility
- Necessity of heat storage

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**Step 1**
Understanding of energy use at a production process

**Step 2**
Selection of heating & cooling process

**Step 3**
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**Step 4**
Investigation of heat source and heat balance

**Step 5**
Decision of total design framework for HP system and capacity

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**Main items of HP system**
- fluctuation of heating load
- renewal plan of the conventional facility
- Necessity of heat storage
Economical Barriers and Countermeasures

- **Low motivation of investment for new system to improve utility facilities**
  - Utilities fees such as fuels, electricity and water are lower than other expenses of labor and manufacturing facilities in a production cost in many industries.

- **Avoidance of economical risk such as long term pay back time and operational trouble.**
  - Pay back time for investment cost is required for short period of less than 3 years by company management.
  - A field manager feels anxiety for suspending risk of production line due to troubles of oil leakage and compressor, etc.

**Countermeasures**

- Improving the reliability of IHPs
- Reducing the initial cost
- Reducing the running cost
- Improving COP
- Equalization of annual expense (ex. by lease)
- Correct understanding of performance and life expectancy
- Application of subsidy and lease
【Name of Subsidy Work】
Support Grants to Promote Energy Saving Investments in 2018FY (Energy Use Rationalization, etc., Business Operators Support Project

【Objectives and Work Outline】
In the face of the rapidly growing need to resolve global environmental problems, Japan has been working to promote investment in energy-saving systems and to rationalize energy management. This project aims to promote energy saving in each sector, thereby building a stable and appropriate energy supply and demand structure adapted to the domestic and foreign economic and social environments. From 2018FY, the subsidy can be applied for industrial heat pump which reduce energy consumption of heat supply in the conventional boiler. The budget is approximately 19 billion yen in FY2018. The rate of subsidy is estimated from one third to half for investment cost.

【Name of Subsidy Work】
Initiative Research Project for New Technologies to Solve Middle and Long Term Issues in Energy and Environmental Field

【Objectives and Work Outline】
This project aims to promote initiative R&D technologies expected in the practical use around 2030. The budget is less than 100 million yen per a case.

• Development of untouchable sensor which can measure uncontrolled area with the innovative method.
• Energy saving in processes of dehydration and drying.

【Schedule】
• January, 2019 : Explanatory meeting to appeal to the public
• From January to middle of April : Public announcement
• From April to May, 2019 : Application
• From May to June : Hearing inspection
• End of June : Decision for adoption and contract
• From early in July, 2019 to end of June, 2020 : R&D period

【home page】
Thank you for your attention!