

# **Technology Developments for Utilizing Waste Heat in Japan- current outcomes and future expectations**

New Energy and Industrial Technologies  
Development organization (NEDO)

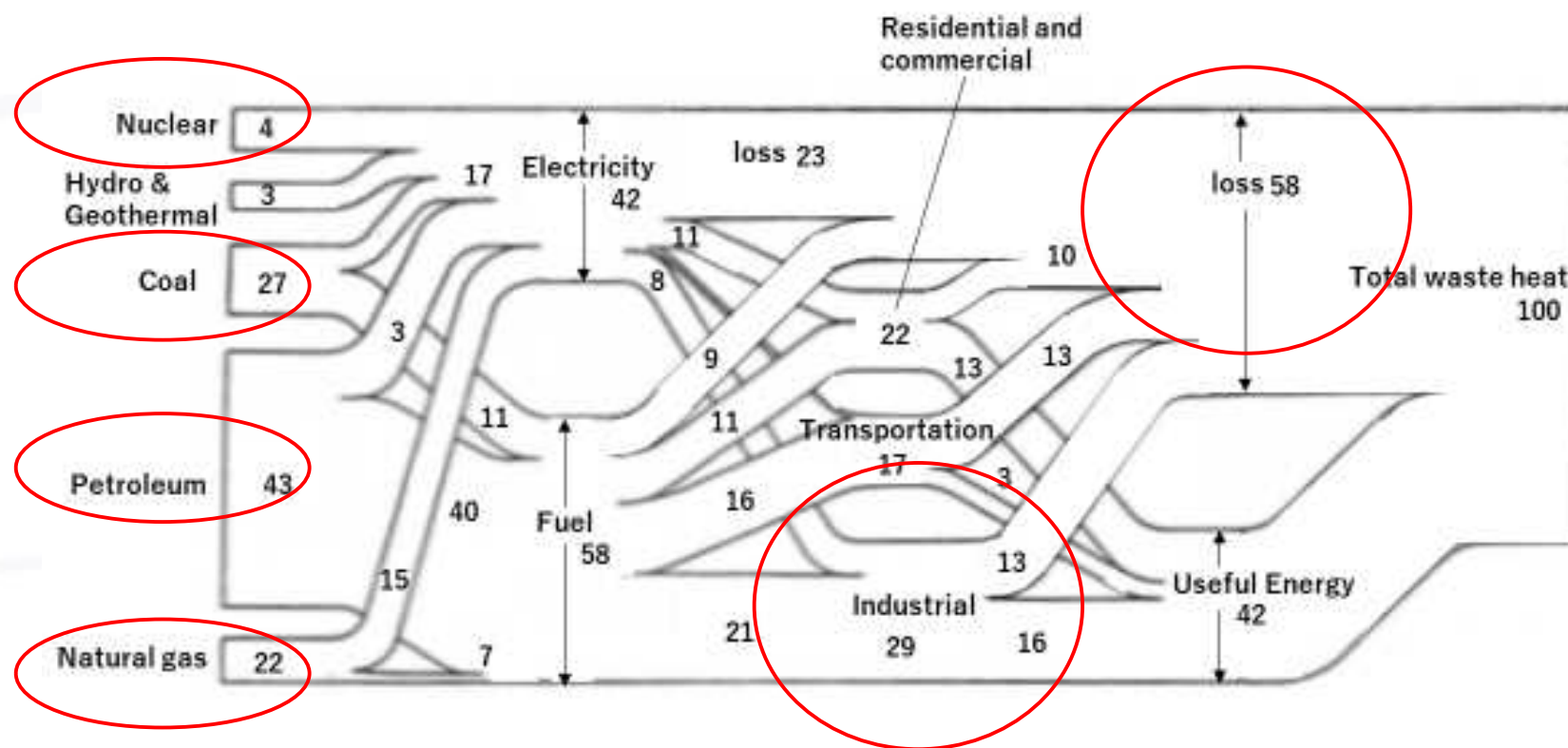
Energy Conservation Technology Department

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# Energy consumption and waste heat in Japan



In Japan, more than 90% of the primary energy depend on resource imports, which costs approximately 130 billion Euro (16 trillion Japanese Yen). Unutilized waste heat reaches almost 65-70% of the primary energy. Therefore, it is very critical to utilize the waste heat, also it is expected as a great solution to achieve net zero emission by 2050.



Primary Energy  
99

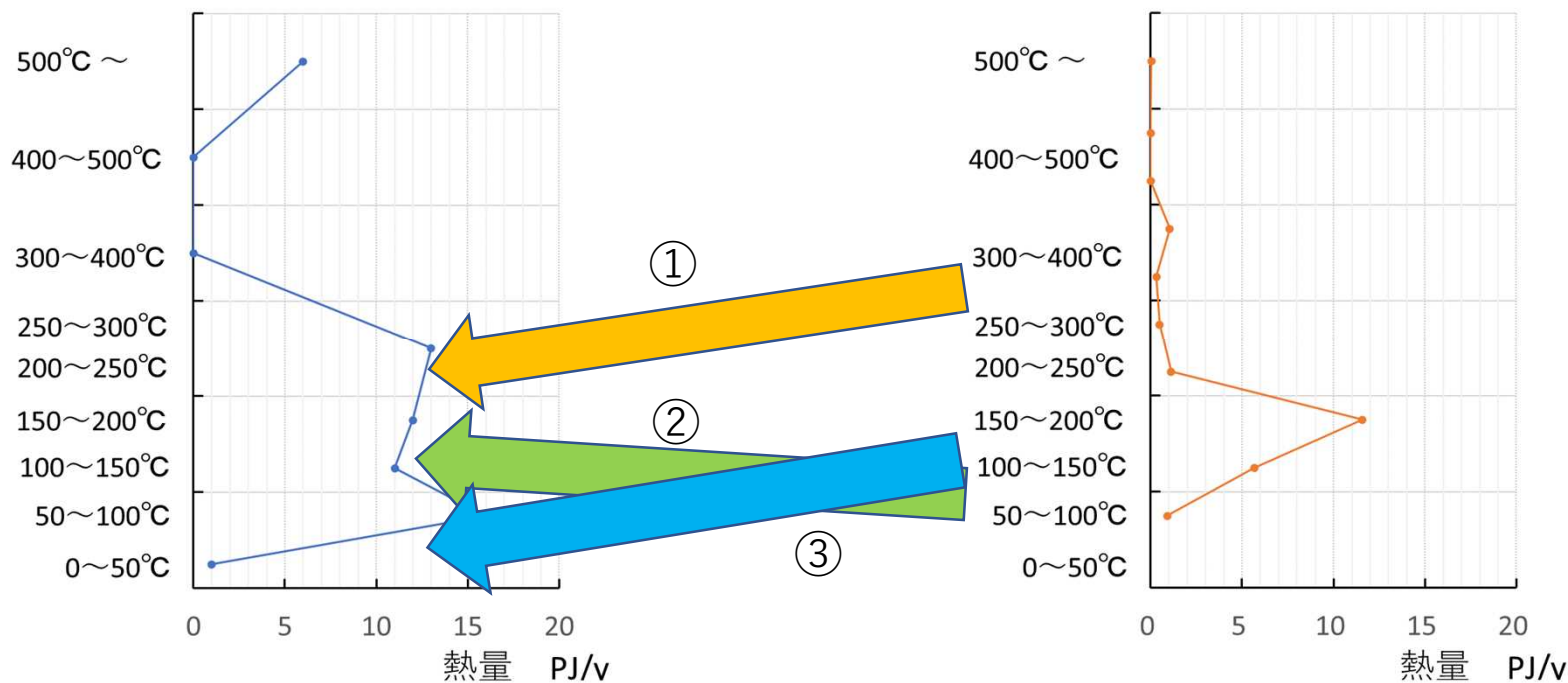
Industrial usage

NEDO, Hirata et al 2019

# How to utilize waste heat in industrial process? (1)



e.g. heat demand and waste heat of food industries in Japan



Heat demand

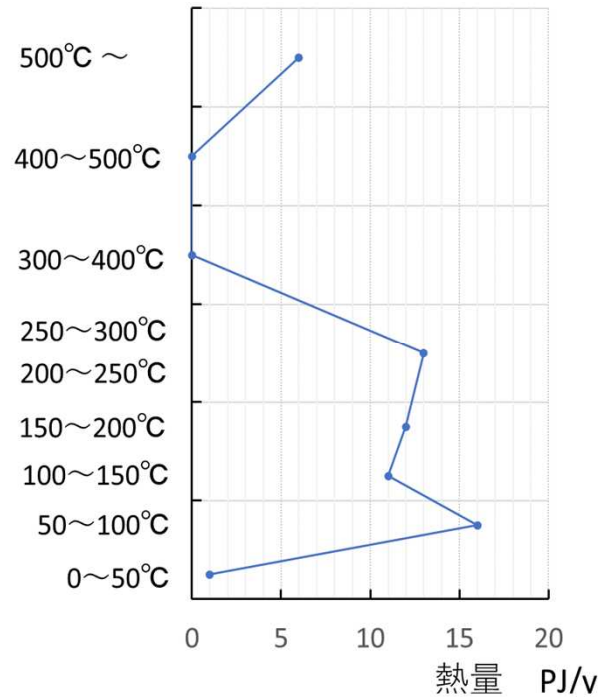
Available waste heat

① Heat to heat (same temperature) Heat exchanger

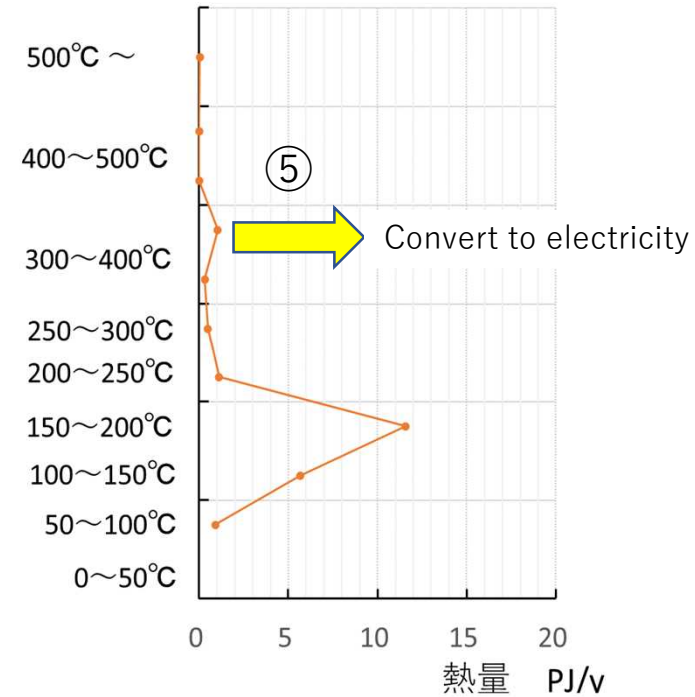
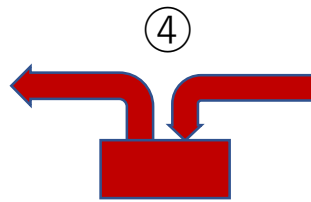
② Heat to heat (convert to higher temperature) compressor heat pump

③ Heat to heat (convert to lower temperature) absorption refrigerator

# How to utilize waste heat in industrial process? (2)



Heat demand



Available waste heat

④ Heat to heat (time lag)

Storage ⇒ transporting heat with storage

⑤ Converting to electricity

waste heat generation, thermoelectric generation

# NEDO R&D Program for energy efficient and conservation technology



## NEDO's R&D Programme for energy efficiency and conservation technology



seeds study -> big scale & long-term R&D -> demonstration to accelerate market-in

# Technology Development for Utilizing Waste Heat —Developed and Success Cases—

## Reduce

### High Efficient Heat Exchanger @ High Temperature

◆ REMARKs

- **High temperature resistance** (1300 °C)
- **3X (three time) performance** compared with the conventional model



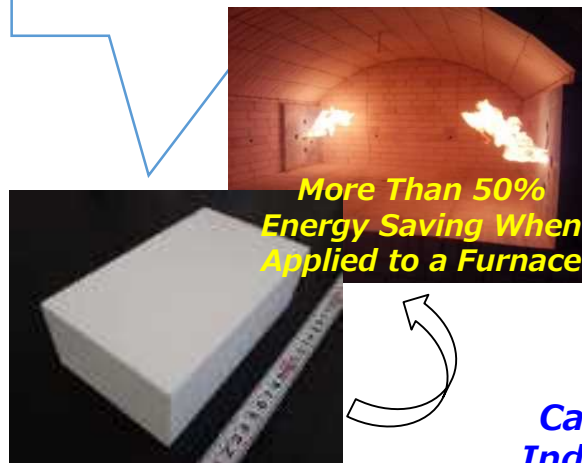
*Installable in a High-temperature Furnace*

• Mino Ceramic CO.,LTD.  
• National Institute of Advanced Industrial Science and Technology (AIST)

### High Performance Heat Insulation @ High Temperature

◆ REMARKs

- **60% power consumption reduction** (case of a small electric furnace電炉)
- **The highest level of heat resistance and strength** under high temperature conditions in the world. (Over 1500°C)
- **Fiberless**



*More Than 50% Energy Saving When Applied to a Furnace*

• Mino Ceramic CO.,LTD.  
• AIST

## Recycle

### Thermoelectric Elements that can Generates Electricity with Direct Fire

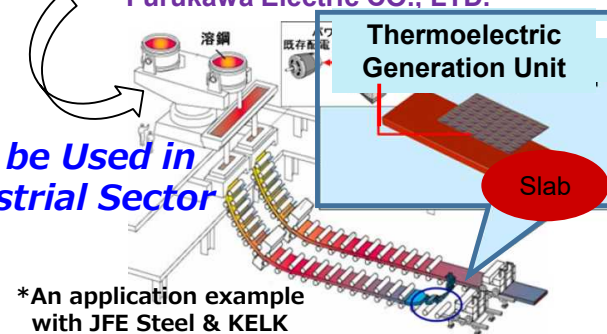
◆ REMARKs

- High temperature resistance without electrode at junction
- **Realization of thermoelectric generation in the mid- & high-temperature region** (First in the world)



Furukawa Electric CO., LTD.

*Can be Used in Industrial Sector*



\*An application example with JFE Steel & KELK



# Technology Development for Utilizing Waste Heat —Developed and Success Cases—

## Reuse

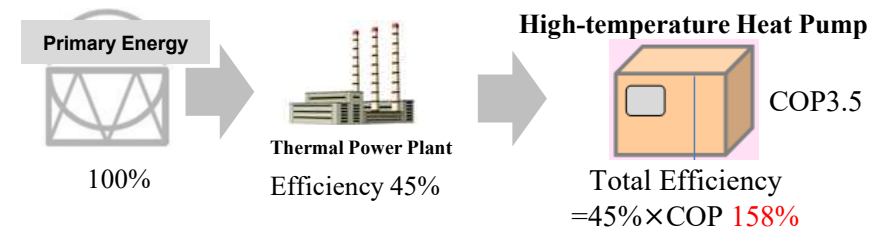
### High-temperature Heat pump (Alternative to boilers and firing furnaces)

#### Conventional:



**200°C supply with over COP3.5 using unutilized thermal energy around 100°C**

#### Using high-temperature heat pump: **1.75 times more efficient than boiler steam**



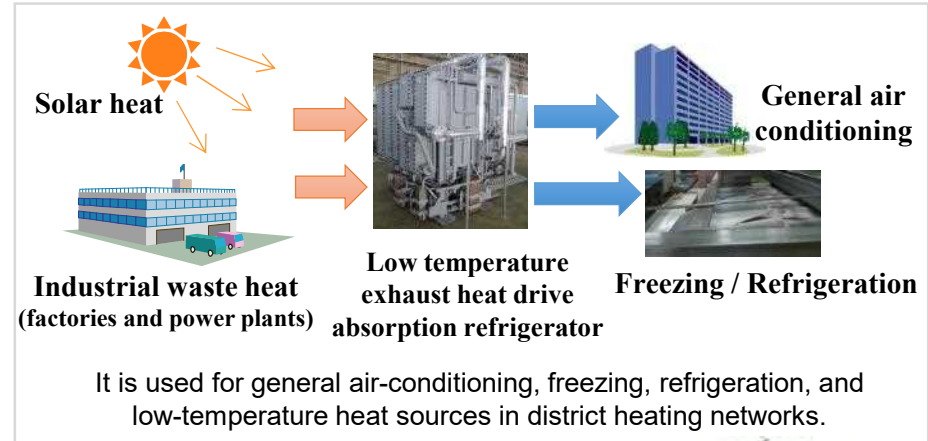
#### Prototype of Heat Pump

- ◆ REMARK
- **160°C supply with over COP3.5 using unutilized thermal energy around 80°C**



•MAYEKAWA MFG. CO., LTD.  
•Mitsubishi Heavy Industries Thermal Systems, Ltd.

### Absorption Refrigerator (Driving with low-temperature exhaust heat)



#### Double Lift Absorption Cycle Type Refrigerator With World's Highest Efficiency

- ◆ REMARKS
- The world's highest-efficiency double-lift absorption cycle type refrigerator
- Expands the utilizing temperature (Before: 95→75°C After:95→51°C)



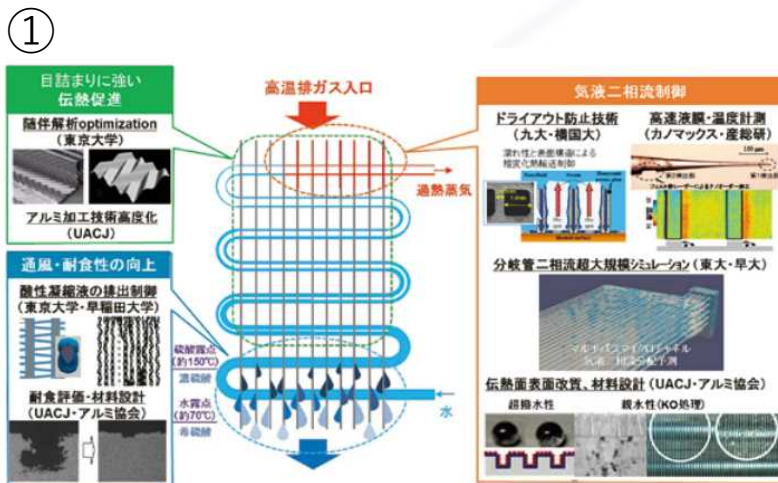
**Productization**

Hitachi Johnson Controls Air Conditioning CO., LTD.

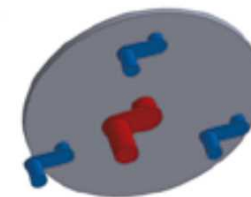
# Unique R&D seeds – expected phase up to R&D project



- ① Heat exchange and control technologies for exergy loss reduction
- ② Development of High-Performance Large-Capacity Scroll Compressor
- ③ Performance Improvement of Refrigerant Compressor by Magnetic Nano-Refrigeration-oil



Heat exchanger to use waste heat





# International collaboration regarding waste heat recovery and utilization



## IEA Heat pumping TCP

IEA Technology Collaboration Programme on Heat Pumping Technologies

Established : 1978

Member Countries(17); Austria, Belgium, Canada, China, Denmark, Finland, France, **Germany**, Italy, **Japan**, Korea, Netherland, Norway, Sweden, Switzerland, UK, US

Scope of technologies: heat pumping technology - all technologies where heat is pumped from a lower temperature level to a higher one, such as heat pumps, air conditioning and refrigeration.

Purpose of activity: The programme carries out a strategy to accelerate the use of heat pumping technologies in all applications where they can reduce energy consumption and increase the use of renewal energy sources for the benefit of the environment.

## Recent Annexes related to waste heat recovery in industry

Annex48 Industrial heat pumps

Annex57 Flexibility by implementation of heat pumps in multi-vector energy systems and thermal networks

Annex58 High temperature heat pumps

# Summary



1. Amount of energy consumption and waste heat are almost equivalent to that of generation of waste heat and demand of heat. Therefore, it is very important to utilize waste heat in the point of energy saving and GHG emission reduction
2. Key technologies are high-performance heat exchanger, heat pumps, thermal storage, waste heat recovery/thermoelectric generation, etc
3. NEDO proceeds above mentioned technologies from technology seeds (feasibility study) to big scale and long-term R&D, even to boost market-in with various support programs.
4. It is also necessary to promote international collaboration for the R&Ds on waste heat recovery technologies in industries. IEA Heat pumping TCP plays an important roll for that. Expected more collaborations between Germany and Japan in future.



**NEDO would like to co-operate with you  
on advanced thermal management technology  
for sustainable development with energy  
efficient and conservation technologies!**

**Vielen Dank  
für Ihre Aufmerksamkeit!!!**

<https://www.nedo.go.jp/english/index.html>