Member Country Report 2021 - Japan

Takahiro ASAHI, Heat Pump and Thermal Storage Technology Center of Japan (HPTCJ)

The HPT TCP is part of a network of autonomous collaborative partnerships focused on a wide range of energy technologies known as Technology Collaboration Programmes or TCPs. The TCPs are organised under the auspices of the International Energy Agency (IEA), but the TCPs are functionally and legally autonomous. Views, findings and publications of the HPT TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.
Japan - Overview

Population: **125.12 million** (92% in urban areas)

Households: **53.33 million** (1/2/3/4/>5 pers.: 35%/28%/18%/13%/7%)

Land Area: **378,000 km²** (≈Germany)

Population Density: **331 people / km²** (≈Belgium)

Rate of multifamily: **46 %**

Mean temperature: **15.8 °C** (Tokyo) (≈Madrid, Spain)

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Temperature

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sapporo</td>
<td>9.2 °C</td>
</tr>
<tr>
<td>Tokyo</td>
<td>15.8 °C</td>
</tr>
<tr>
<td>Naha</td>
<td>23.3 °C</td>
</tr>
</tbody>
</table>

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Source:
- Population: as of 1 Oct. 2021, Statistics Bureau of Japan
- Urban population: as of 2020, World Bank Group
- Households: as of 1 Oct. 2015, Statistics Bureau of Japan (table 2-13)
- Land Area: Ministry of Foreign Affairs of Japan
- Population Density: HPTCJ’s calculation (Population / Land Area)
- Temperature: based on observed data 1991 – 2020, Japan Meteorological Agency Source1, Source2 (JP)
Policy - Decarbonization

46-50% GHG reduction in FY 2030 (from FY 2013 levels) and Net-Zero by 2050

Policy Speech by the Prime Minister to the 203rd Session of the Diet
“We hereby declare that by 2050 Japan will aim to reduce GHG emissions to net-zero, that is, to realize a carbon-neutral, decarbonized society.”

Leaders Summit on Climate
“Japan aims to reduce its GHG emissions by 46% in FY 2030” (Furthermore, the lofty goal of 50%)

Japan’s Nationally Determined Contribution (NDC) | Japan’s Long-term Strategy under the Paris Agreement
Plan for Global Warming Countermeasures | The Sixth Strategic Energy Plan

Enforcement of the amended Act on Promotion of Global Warming Countermeasures “decarbonized society by 2050” will be stipulated

Source
- Policy Speech: Cabinet of Japan
- Leaders Summit on climate: Ministry of Foreign Affairs of Japan
- Date of enforcement of the amended act: Ministry of the Environment (MOEJ) (JP)
- Japan’s NDC, Long-term Strategy, Plan: MOEJ (EN, JP)
- The Sixth strategic Energy Plan: Ministry of Economy, Trade and Industry (METI) (EN, JP)
Policy - Decarbonization

Japan’s commitment to Net-Zero by 2050

CO2 emissions by sector (FY1990 - 2019)

Source:
- Japan’s commitment: “Climate Actions towards net-zero by 2050”, MOEJ
- CO2 emissions by sector: “The GHG Emissions Data of Japan”, National Institute for Environmental Studies

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Policy - Decarbonization

Japan’s Nationally Determined Contribution (NDC)
- 2030, 2050 targets and implementation of policies (e.g. amending the law)

Japan's Long-term Strategy under the Paris Agreement
- Industry: “For the heat demand in low-temperature such as steam and hot water, utilizing electrification technologies including heat pumps and electric heating wires would be a relevant option for decarbonization.”

- Building: “…, the Government aims to achieve the sector coupling of electricity, heat, and mobility in general, using electrified vehicles, heat pump-type water heaters fuel cells and cogeneration, …”, “… improvement of heat energy efficiency such as heat pump.”, “The Government will also look into the potential flexibility of heat storage type air-conditioning equipment, heat pump water heaters in facilities with large demand for hot water supply,”

Source
- Japan’s Nationally Determined Contribution (NDC): UNFCCC
- Japan’s Long-term Strategy under the Paris Agreement: UNFCCC (EN), MOEJ (JP)
Policy - Decarbonization

Plan for Global Warming Countermeasures and The Sixth Strategic Energy Plan

- Quantitative targets are set for industrial HPs and commercial and residential HPWHs

<table>
<thead>
<tr>
<th>[MW]</th>
<th>Industrial HPs</th>
<th>[10k units]</th>
<th>Commercial HPWHs</th>
<th>[10k units]</th>
<th>Residential HPWHs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Progression rate: 8.8 %</td>
<td>Target 2020</td>
<td>Progression rate: 20.7 %</td>
<td>Target 2020</td>
<td>Progression rate: 23.1 %</td>
</tr>
<tr>
<td></td>
<td>1,673</td>
<td>14</td>
<td>1,400</td>
<td>1,590</td>
<td></td>
</tr>
</tbody>
</table>

Progression rate = (2019 result - 2013 result) / (2030 target - 2013 result)

Source
- Plan for Global Warming Countermeasures: MOEI (JP)
- The Sixth Strategic Energy Plan: METI (EN, JP)
- Track record: The document of the Central Environment Council, METI (JP)
Policy - Energy

Energy demand by sector

Electricity mix towards 2030

Carbon intensity of electricity generation

Source
- Energy demand by sector: The document by the METI (P.71) (JP)
- Electricity mix towards 2030: The document by the METI (P.70) (JP)
Policy - Energy

“Top Runner Program”
(Efficiency standards for machinery, equipment and materials)
- 32 items are in scope (as of Nov. 2021).
  Air Conditioners, Electric Refrigerators, Electric Freezers, Gas Water Heaters, Oil Water Heaters, Vending Machines, Electric (HP) Water Heaters, Showcases, etc.

“The uniform energy efficiency labels”
(Energy efficiency labeling)
- The evaluation metric of a 41-point scale (1.0, 1.1, ..., 5.0) are now being used in retail outlets.
- The items mentioned above (except for vending machines and showcases) are covered as of Nov. 2021.

Source
- Top Runner Program: Ministry of Economy, Trade and Industry (JP)
- The uniform energy efficiency labels: “Japan’s ENERGY 2020”, METI
Policy - Awards

Efficiency has improved due to energy efficiency policies.

Awards are another driver for efficiency improvement

- **Energy Conservation Grand Prize Award**
  (Since 1990)
  awards excellent energy conservation activities and advanced energy conservation products achieved by technological development at private companies, ...

- **Minister of the Environment’s Award for Climate Action**
  (Since 1998)
  awards individuals or groups that have made significant contributions towards preventing global warming

Source
- Efficiency improvement of HPs: [Heat Pump and Thermal Storage Technology Center of Japan (HPTCJ)](JP)
- Energy Conservation Grand Prize Award: [The Energy Conservation Center, Japan (ECCJ)]
- Minister of the Environment’s Award for Climate Action: [MOEJ](JP)
Policy - Subsidies

Subsidy for investments for advanced energy conservation project

- A. Advanced equipment (e.g. HP desiccant humidity control, centrifugal chiller, showcase, MVR, etc.)
- B. Custom-made solutions (e.g. specially designed facility, production line, etc.)
- C. Specified equipment (e.g. AC, industrial HP, commercial HPWH, refrigerator, etc.)
- D. Energy management system and service (Specified EM service and EMS needed for the service)

Subsidy for high-efficiency HPs in industrial and commercial sectors

- 1. Air-source HP chiller (for hot water)
- 2. Circular heating hot water HP
- 3. Hot water HP (heat recovery, water-source)
- 4. Hot Wind HP
- 5. Steam Supply HP
- 6. Commercial HPWH

Subsidy for “Net Zero Energy Buildings”

- High efficiency ACs, water heaters, BEMS, etc. installed for “Net Zero Energy Buildings” projects (<50% energy consumption of the reference building)

Source
- Subsidy for investments for advanced energy conservation project: Sustainable open Innovation Initiative (JP)
- Subsidy for high-efficiency HPs in industrial and commercial sectors: Sustainable open Innovation Initiative (JP)
Policy - F-gas Regulation

Laws and GWP target values and years

- **Ozone Layer Protection Law** aims to control consumption and production of controlled substances by regulating their productions and imports.

- **Fluorocarbons Emission Restraining Law** aims to control emissions over the lifecycle of Fluorocarbons.

<table>
<thead>
<tr>
<th>Specified product category</th>
<th>Main refrigerants currently used and GWP</th>
<th>Environmental impact target value</th>
<th>Target fiscal year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household air conditioners (excluding through-the-wall types, etc.)</td>
<td>R410A(2090) R32(779)</td>
<td>750</td>
<td>2018</td>
</tr>
<tr>
<td>Air conditioners for stores and offices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)Statutory refrigeration capacity of less than 3 tons, excluding floor-standing units, etc.</td>
<td>R410A(2090)</td>
<td>750</td>
<td>2020</td>
</tr>
<tr>
<td>(2)Statutory refrigeration capacity of at least 3 tons, excluding floor-standing units, etc., and excluding (3) below</td>
<td>R410A(2090)</td>
<td>750</td>
<td>2023</td>
</tr>
<tr>
<td>(3)Central air conditioners using turbo refrigerators</td>
<td>R134a(1430) R245fa(1030)</td>
<td>100</td>
<td>2023</td>
</tr>
<tr>
<td>Automotive air conditioners (excluding those installed in passenger cars having a capacity of 11 persons or more)</td>
<td>R134a(1430)</td>
<td>150</td>
<td>2023</td>
</tr>
<tr>
<td>Condensing units and stationary freezer-refrigerator units (excluding those having a compressor with rated output of 1.5 kW or less)</td>
<td>R404A(3920) R410A(2090) R407C(1770) CO2(1)</td>
<td>1500</td>
<td>2025</td>
</tr>
<tr>
<td>Central refrigeration equipment (only those shipped for use in new refrigerated warehouses having effective volume of at least 50,000 m³)</td>
<td>R404A(3920) Ammonia (single digit)</td>
<td>100</td>
<td>2019</td>
</tr>
<tr>
<td>Rigid urethane foam (only on-site foaming materials for residential buildings)</td>
<td>HFC-245fa(1030) HFC-365mc(795)</td>
<td>100</td>
<td>2020</td>
</tr>
<tr>
<td>Spray equipment filled with propellant only (excluding those for applications requiring non-combustibility)</td>
<td>HFC-134a(1430) HFC-152a(124) CO2(1), DME(1)</td>
<td>10</td>
<td>2019</td>
</tr>
</tbody>
</table>

Target GWP values and years for manufacturers/importers

www.heatpumpingtechnologies.org
Market - Residential Room Air Conditioners

Around 10 million units annually, increasing by around 2%.

Longer hours at home due to COVID-19 might have boosted the sales in 2020.

Source:
- The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) (JP)
Market - Commercial Packaged Air Conditioners

Stable at around 800,000 units annually.

The surge in sales in 2019 might be attributed to the demand for 2020 Summer Olympics held in Tokyo.

Source:
- The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) (JP)
Market - Residential HPWH (EcoCute)

The financial crisis  The Great East Japan Earthquake

Around 500,000 units annually.
The cumulative sales will reach 8 million units in Spring 2022 at this rate.

Source
- The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) (JP)
Market - Commercial HPWH

- The financial crisis
- The Great East Japan Earthquake
- 2020(1) Summer Olympics

Annual Sales (units)

- 2020: Around 3,000 units annually.
- The surge in sales in 2019 might be attributed to the demand for 2020 Summer Olympics held in Tokyo.

Source:
- The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) (JP)
Ongoing Annexes

Annex 54 “Heat pump systems with low GWP refrigerants”
This annex aims at promoting low GWP refrigerant application to accelerate phase down of high-GWP HFCs by developing design guidelines of optimized heat pump components and system for low-GWP refrigerants through the review of available low-GWP refrigerants, their properties and applicable standards, safety and flammability of refrigerants, and safe use of flammable refrigerants.

Annex 58 “High-Temperature Heat Pumps”
This Annex gives an overview of available technologies and close-to-market technologies regarding high-temperature heat pumps.

Completed Annexes

Annex 46 “Domestic Hot Water Heat Pumps”
Annex 48 “Industrial Heat Pumps, Second Phase”
R&D - Utilizing Waste Heat (NEDO)

R&D Project on Innovative Thermal Management Materials and Technologies (FY 2015 - 2022)

- Technology to effectively **reduce**, **recover** and **reuse** untapped thermal energy
- Crosscutting **heat management** technologies
- HPs can play a role in reusing thermal energy (e.g. high temperature HPs, high-efficiency chiller...)

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**Reduce**

- **HEAT STORAGE**
  - Toyota
  - Mitsubishi Plastics
  - Panasonic
- **THERMAL INSULATION**
  - Toray
  - Mino Ceramic

**Recycle**

- **THERMOELECTRIC**
  - Furukawa
  - Hitachi
  - Fujifilm
  - Furukawa Electric
  - Nippon Thermostat
  - Yasunaga
  - Panasonic

**Reuse**

- **HEAT PUMP**
  - Mayekawa
  - Mitsubishi Heavy Industry
  - Central Glass
  - Hitachi Appliances

**Thermal Management**

www.heatpumpingtechnologies.org
R&D - Utilizing Waste Heat (NEDO)

High temperature HP
(Alternative to boilers and firing furnaces)

- Conventional:
  - Primary Energy 100%
  - Efficiency 90%
- Using high-temperature heat pump:
  - 1.75 times more efficient than boiler steam
  - 200°C supply with over COP3.5 using unutilized thermal energy around 100°C

Prototype of Heat Pump
◆ REMARK
  - 160°C supply with over COP3.5 using unutilized thermal energy around 80°C

Heat Recycle Absorption Chiller
(Driving with low-temperature exhaust heat)

- Double Lift Cycle Absorption Chiller
  - With World’s Highest Efficiency
  - Total Efficiency = 45% x COP 158%

- REMARKs
  - The world’s highest-efficiency double-lift cycle absorption chiller
  - Expands the utilizing temperature
    (Before: 95→75°C After: 95→51°C)

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

It is used for general air-conditioning, freezing, refrigeration, and low-temperature heat sources in district heating networks.

Hitachi Johnson Controls Air Conditioning Co., Ltd.

www.heatpumpingtechnologies.org
Development of Technology and Assessment Techniques for Next-Generation Refrigerants with a Low GWP Value (FY 2018 - 2022)

- The development of assessment techniques for performance, safety, and risks of next-generation refrigerants used in refrigeration and air conditioning equipment
- Dissemination of next-generation refrigerants through the development of technologies to address technological roadblocks in certain domains
# R&D - Low-GWP Refrigerants (NEDO)

<table>
<thead>
<tr>
<th>List of project themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition and evaluation of fundamental characteristics of next-generation refrigerants</td>
</tr>
<tr>
<td>Assessment of thermophysical properties, heat transfer characteristics and basic cycle performance of next-generation refrigerants used for small and medium sized refrigeration and air-conditioning</td>
</tr>
<tr>
<td>Safety evaluation of low GWP, low flammability blend refrigerants</td>
</tr>
<tr>
<td>Research and development of the evaluation of practical use of the next-generation refrigeration and air-conditioning technologies applying low GWP refrigerants</td>
</tr>
<tr>
<td>Development of safety and risk assessment methods for next-generation refrigerants</td>
</tr>
<tr>
<td>Development of next-generation refrigerants and their application technologies</td>
</tr>
<tr>
<td>Research of large cooling unit applying natural refrigerants and ultra-low GWP refrigerants</td>
</tr>
<tr>
<td>Development of the technologies for applying next-generation low GWP refrigerants to condensing</td>
</tr>
<tr>
<td>Development of the energy-saving refrigerator system using the CO2 refrigerant in the low temperature equipment, and their evaluation in commercial buildings</td>
</tr>
<tr>
<td>Development of mildly flammable refrigerants (under GWP10 for direct expansion air-conditioning</td>
</tr>
</tbody>
</table>

Project term: FY2018-FY2022
Project participants: WASEDA University, Kyushu University, National Institute of Advanced Industrial Science and Technology, The University of Tokyo, Tokyo University of Science Suwa, Mitsubishi Electric Corporation, Toshiba Carrier Corporation, Panasonic Corporation, DAIKIN INDUSTRIES, Ltd.
Key Actors

**JRAIA (since 1949)**
The Japan Refrigeration and Air Conditioning Industry Association
- An industrial association of HVAC&R
- “Kobe Symposium” (International Symposium on New Refrigerants and Environmental Technology)
- 165 corporate members

**JSRAE (since 1925)**
The Japan Society of Refrigerating and Air Conditioning Engineers
- A non-profit academic organization in a field of refrigeration, air conditioning, food refrigeration etc.
- Education, training, survey, research, certification, award, international exchange (e.g. IIR), etc.
- 230 corporate and 3,600 individual members

**JEHC (since 2006)**
Japan Electro-Heat Center
- An industrial association
- Promoting thermal technologies, including industrial HPs
- Policy recommendation, communication, training, etc.

**NEDO (since 1980)**
New Energy and Industrial Technology Development Organization
- A national R&D agency, promoting technical development necessary for a sustainable society.
- Signatory body of IEA HPT TCP

**HPTCJ (since 1986)**
Heat Pump and Thermal Storage Technology Center of Japan
- An industrial association of HPs
- Promotion, training, research, survey, policy recommendation, etc.
- Secretariat of IEA HPT TCP

*ExCo delegate Mr. Iwatsubo
ExCo alternate delegate Mr. Fujita
ExCo alternate delegate Mr. Asahi

*JEHC’s website is available only in Japanese*
Summary

- **Decarbonization**: HPs are seen as one of key technologies to achieving Japan’s net-zero 2050 commitment. Quantitative targets for 2030 are set for further deployment of IHPs and commercial and residential HPWHs.

- **Energy**: Cleaner electricity mix including nuclear power is the challenge on the supply side. On the demand side, HP efficiencies have been and will be improving thanks to EE policies like “Top Runner Program” and awards.

- **Incentives**: Along with a subsidy for IHPs and commercial HPWHs, some subsidies for energy efficiency and ZEB are also applicable to HPs.

- **Market**: Japan’s AC market is stable with slight increase in residential room ACs. We need to further deploy IHPs and HPWHs in line with the government’s target.

- **Technology**: R&Ds of such as Low-GWP refrigerants and high temperature HPs are being carried out both in HPT TCP Annexes and domestic research projects.
Thank you for your attention!

Takahiro ASAHI (Executive Committee alternate delegate of Japan)

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