



# Review of Japanese R&D Activity on Thermal Energy Transportation -Pre-questionnaire survey in Japan for Annex 18-

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Energy Storage Technology”

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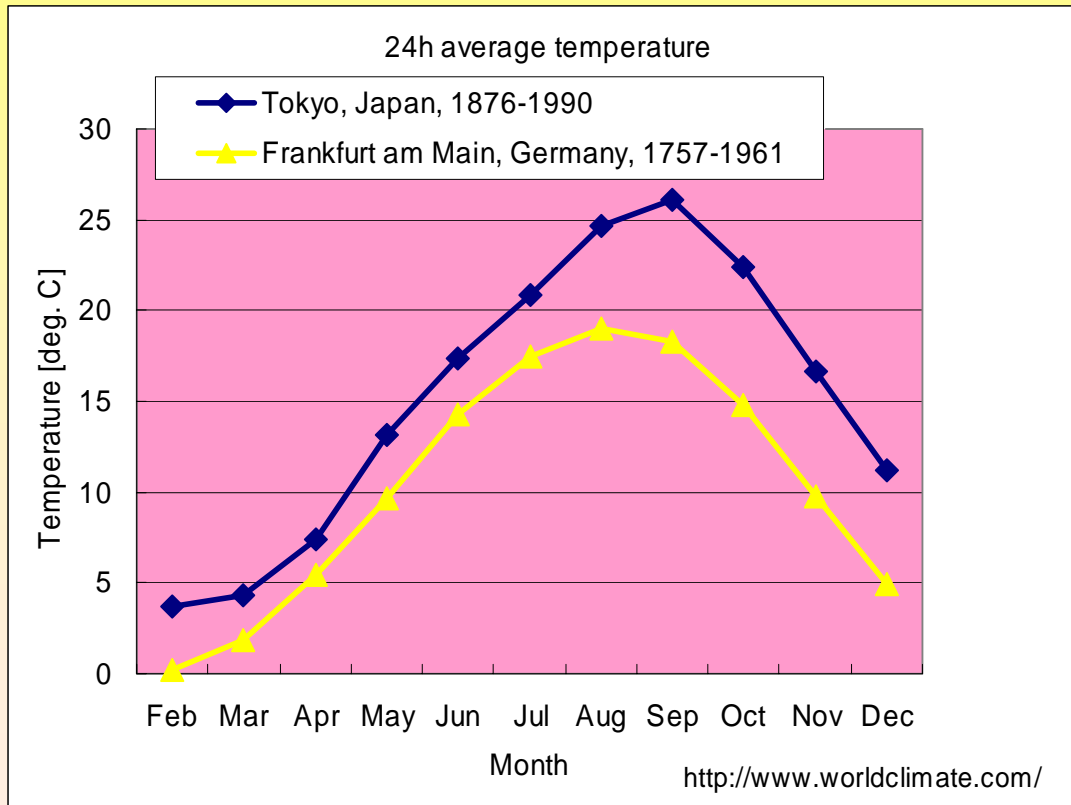


# Introduction: Energy trend in Japan

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# Climate





# Questionnaire Survey in Japan for Annex 18

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# Method of pre-questionnaire survey



- Answerers: Japanese members for Annex 18
- To grasp members' intention to Annex 18 program, and interest to heat storage R&D.
- Free volunteer on the condition that personal data does not open to the public.
- Survey period: July, 2005
- Survey way: excel file exchanging via e-mail
- Number of answers: 8
  - Constructors 4, Power companies 2, Universities 2

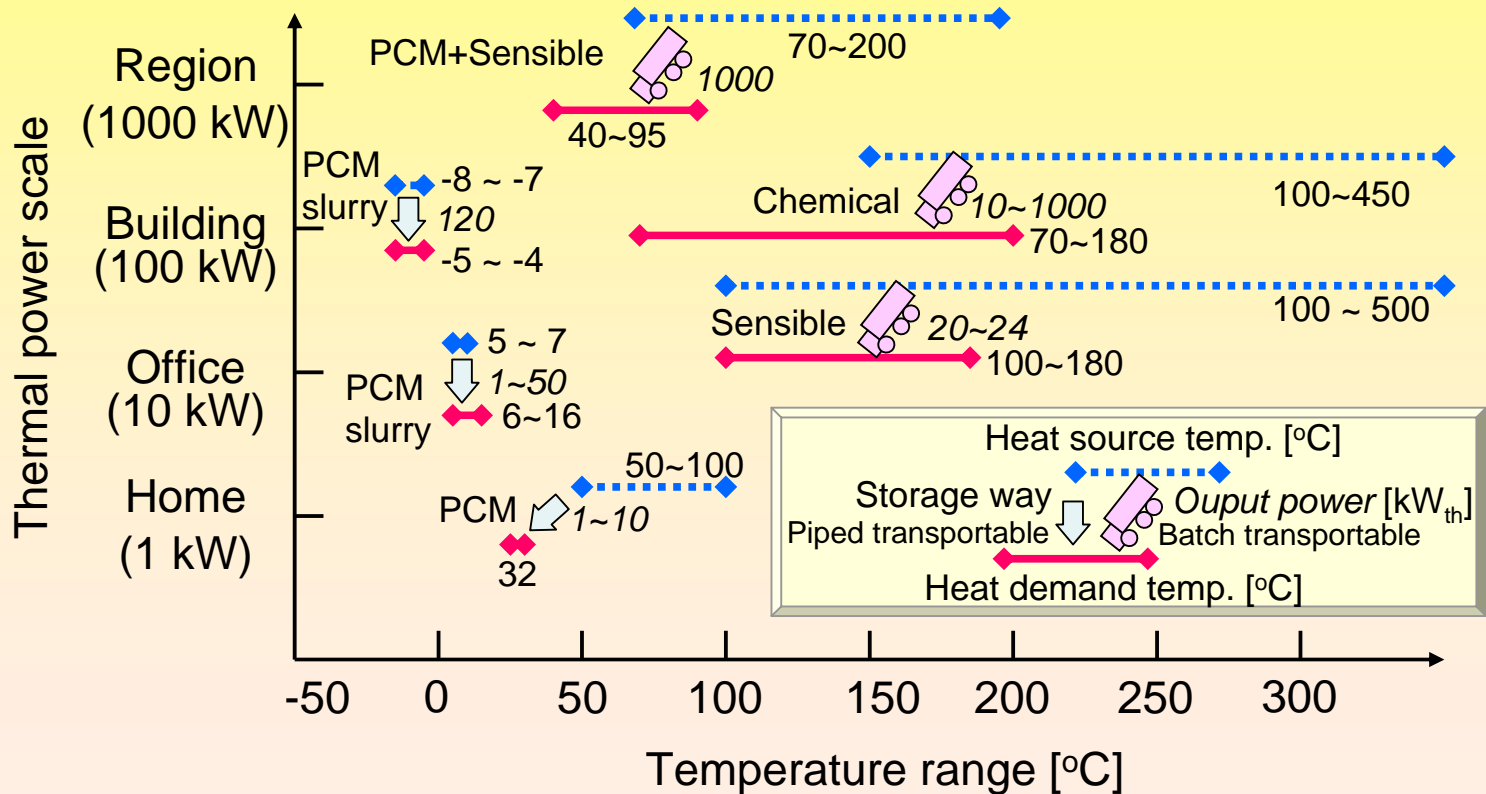


# Results

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# Heat source and output





# Heat sources

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- Exhaust heats from
  - Incinerator (70-200°C, 1MW, 5-10 GJ)
  - Industrial plant (70-200°C, 1MW, 5-10 GJ)
  - Power plant (70-200°C, 1MW, 5-10 GJ)
  - Cogeneration plant (50-450°C, 10-200kW, 6.5 GJ)
- Off-peak electricity (32 kW, 0.92 GJ)
- Solar heat



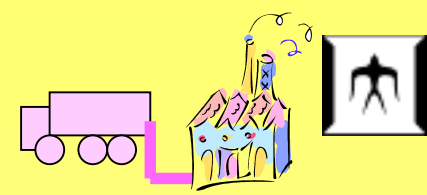
# Heat storage methods

- PCM heating
  - For 70-200°C by latent&sensible heats of Erythritol(122°C), Sodium acetate(58°C) for 1.0-3.5 h
  - For solar heat by  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  (30-32°C)
  - For 100-500°C by sensible heat of MgO etc.
- PCM cooling
  - For 5-7°C by PCM-slurries of hydrates of sodium sulfate, calcium chloride etc.
  - For -8 - -7°C by ice slurry(0°C)
- Chemical
  - For 100-450°C by  $\text{MgO}/\text{H}_2\text{O}$ (70-250°C)



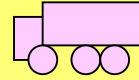
# Thermal Energy Transportation

- **PCM Heating**
  - 1 MW & 3.6-12.6 GJ(>3.5h)/truck
  - Input 70-200 °C from exhaust gas, Output 40-95 °C to hospital, municipal building, apartment, office
  - 20 km
- **PCM cooling, (dynamic ice)**
  - 120 kW, 4.3 GJ (10 h)
  - Input -8 - - 7 °C from refrigerator, Output -5 - - 4 °C to cold warehouse
  - 30 m
- **Sensible heat storage**
  - 25 kW, 0.88-0.92 GJ (10 h)
  - Input 100-500 °C from off-peak electricity, Output 100-180 °C to cold warehouse
  - N/A for distance
- **Chemical heating**
  - 1 MW & 6.5 GJ (1.8 h)/ truck of 10 ton capacity
  - Input 100-450 °C from Joule heat of surplus-electricity, cogeneration exhaust heat, Output 50-200 °C to hospital, apartment, office
  - 10 km



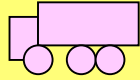
# Discussion and conclusions (1)

1. Hot heat transportation: Batch-wise transportation from heat source of industrial waste heat, to apartment houses, office building and small community.
2. Cold heat transportation: Transportation through pipe using PCM slurries. Cold heat demand is large in Japan locating in Asia. Cold heat storage and transportation are big issues and has already well studied in Japan. Surplus-electricity is the first candidate for energy source for cold production.
3. High-density heat storage:
  1. Hot heat storage: Sensible heat storage by inorganic materials, chemical storage.
  2. Cold heat storage: Ice slurry storage has been well studied as the first PCM candidate. Others material are required for other temp. range
  3. Heat storage period: Chemical storage is possible relatively longer heat storage in comparison with sensible and latent heat storage.



# Discussion and conclusions (2)

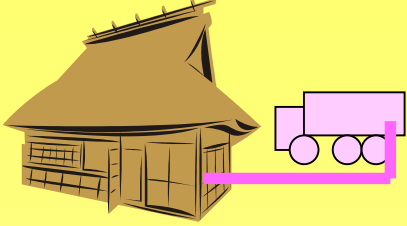
4. Technological subjects for the development
  1. High temperature heat storage: high-performance for slurry pump for high temperature media and Heat exchanger
  2. Chemical: high performance reaction material and reactor
  3. Cold PCM slurry: Improvement of Transportation through pipe
  4. High heat storage density material
  5. Market development for heat transportation
5. Requests to new Annex 18
  1. R&D information for heat storage and transportation internationally and domestically
  2. R&D information for elemental technologies
  3. Development of market for heat transportation
  4. Improvement of Juristic system for enhancement of heat transfer market
  5. Technology road map to practical market development
  6. Plant and research tours
  7. Mutual communication internationally



# For making the roadmap of Annex 18

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- Image the goal
- Widen the view of the “transportation”
  - Variety of size; District, block, building, micro, nano
  - From fixed object to mobile object
- Good marriage with principle and application
  - Cooperate with another Annex activities
  - Leadership to the transportation application



Danke schön

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