1G/2G to 4G? Challenges in the Existing District Energy Infrastructure in Japan

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Overview of DHC in Japan

- 136 DHC districts are existed.
- Customers are mostly limited.
- Customers are mainly offices, retails and hotels, but residential units.
- Chilled water is popular even in the winter.
- Air-conditioner is popular even in the office buildings.
I. Issues of DHC in Japan

II. Cases in Sapporo Downtown
Issue 1: Number of Customers is Declining

Number of customers (residential/office)

- Residential (units)
- Office (buildings)

Peak of residential: 2000
Peak of office: 2004

Sum of office customer/DHC is 10.
Questionnaire Survey to DHC Companies

Issues to receive new connections

- Initial cost/high heat price: 78%
- Less – convenience: 20%
- Timing of facility renewal: 9%
- No data: 8%
- All the buildings were on the network etc.: 8%
- 12%

N=97

Issues to renew the contract

- Cost of the heat: 73%
- Less-convenience: 3%
- etc: 20%

N=59

☑️ Cost of the heat is the issue.
✓ Under the Road Act, DHC is not defined as an utility, because of this, where DHC pipes are running is an issue.

☐ More than half cases, pipes put in a private lot, and that affects to the heat price.
☐ Getting a permission of pipes is difficult.
☐ Piping cost is about 1,000,000 yen/m (5800 kr/m) in the large cities. Gas network is just 100,000 yen/m (580 kr). Because under the street is congested, DHC companies need to dig the road about 4m in depth.
Under the Street or Private Lot?

Marunouchi DHC in front of Tokyo Station

Area served: 111ha    building system served: 68 buildings & 6,380,000m2
Energy Centre floor spaces: 41,000m2    Chiller 113,243 RT, boiler 622T/h, HP 576 RT
Energy centre
Steam
Chilled water
Issue 3: Price of Use of Road

- Public sectors charge use of the road (price is different by the area).
- The price is set by each municipality. Downtown Tokyo area cost 2700 yen/m (159kr/m), but Sapporo City does not charge for DHC companies.
- Gas, electricity, telecom networks, they are not charged because they are utility under the Road Act.
Issue 4: the Heat Supply Business Law

✓ Under the previous Heat Supply Business Law, heat price and DHC service area was difficult to change. Firstly DHC companies required to negotiate with METI (Ministry of Economy).

✓ Under the amendment of the Law, liberalisation was introduced to the heat market as well. Cost of the Infrastructure is high, but the Law said that infrastructure should be open to the new DHC companies.
Use of Renewable Energy for DHC is increasing, but total number is limited.

- Old networks have steam system.
- It is far from the 4th generation.
Use of Renewable Energy for DHC

- Reclaimed water use from Sewage Treatment Centre

- Incineration of sewage sludge fuel

- Snow for cooling

- Waste from Construction site
II. A case in Sapporo Downtown
Case in Sapporo

- Largest northern city in Japan
- Population size is 1,914,000 (2014)
Trend of CO2 emissions in Sapporo City

CO2 emissions/capita
Total emissions

Source: Sapporo City
Age of buildings

New buildings are developed in the suburbs.

Heat demand

Heat demand is concentrated in the downtown.
Heat Demand is High in the Downtown Sapporo

downtown

Rest of the area
background

- DHC company was established in 1971 for the Sapporo Winter Olympic Games, because of severe air quality.
- Biomass (wood chip) system was introduced in 2009, and main energy centre has gas CHPs. They covered 106 ha, 44km network and 60% of building floor spaces are covered.
Downtown Energy Plan preparation has started

- Preparation has started for 5 years.
- Local gas, electricity, DHC, real estate, bank, chamber of commerce, BID, central government, related departments in house, and academics invited for the meeting.
- Action plan preparation is stated since 2017.

300ha of downtown energy action area

- Sapporo Energy Co. DH network
- Gas fired CHP
- Energy Centre Wood pellet
- Gas fired CHP
- Subway used DH network

EC: Hot Water
Red: Chilled Water

Hokkaido DH Co. network
Buildings and Energy Use in the Future

- The size of buildings will be larger. Therefore, demand of energy will be increased.

- Reconstruction will be increased.

Green buildings and reduction of CO2 should be essential.

What kind of CO2 emission reduction policies should they establish for 2020–2030?
DH network connection of Buildings over 3000m²

- All the area of Energy demand is over 4.2TJ/ha
- Possibility can be seen in the SW.
- Lots are small in SE.

<table>
<thead>
<tr>
<th>Lot size (1000m²)</th>
<th>No. of buildings</th>
<th>Floor area (1000m²)</th>
<th>Electricity Demand (TJ)</th>
<th>Heat Demand (TJ)</th>
<th>Heat Density (TJ/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NW 1082</td>
<td>105</td>
<td>91</td>
<td>848</td>
<td>807.9</td>
<td>17.3</td>
</tr>
<tr>
<td>NE 192</td>
<td>48</td>
<td>31</td>
<td>131.9</td>
<td>161.6</td>
<td>10.5</td>
</tr>
<tr>
<td>SW 293</td>
<td>98</td>
<td>72</td>
<td>492.6</td>
<td>402.3</td>
<td>34.3</td>
</tr>
<tr>
<td>SE 47</td>
<td>31</td>
<td>6</td>
<td>50.8</td>
<td>66.4</td>
<td>13.3</td>
</tr>
<tr>
<td>Total</td>
<td>282</td>
<td>492</td>
<td>1523.3</td>
<td>1438.2</td>
<td>75.4</td>
</tr>
</tbody>
</table>

Energy price (yen/MJ)

- NW 3.59
- NE 7.09
- SW 4.57
- SE 11.18
Goal based on the Area

- **DHC existed area (90ha)**: how to increase connections.
- **New network area (190ha)**: network will be planned.
- **Low carbon area (300ha)**: reduction of energy use.

【Goal for 2050】
Most of the buildings will be reconstructed up to 2050.

- **Low carbon**: 80% reduction of CO2.
- **BCD**: Buildings will be connected to the network.
Liverbility + Sustainability

Produce and consume in the city
Interaction of people

Nice environment to the next generation
New technology to the city

Low cost and BCD
Energy resources

Sustainable city

Energy network

Renewable Energy
- PV, SHW
- Snow storage
- Biomass
- Hydrogen
- CHP
Conclusions

✓ National Level: DHC network should be included as an infrastructure.

✓ Local Level:
  • New planning tool, such as obligation of the connection, or tax reduction should be considered.
  • Cross relationship between sections in the municipalities should be developed.
  
  • How can we reduce the cost? Construction method or pipes? Hope to work with professionals here!