Interview with Tomoyuki Hidaka, Assistant Section Chief in the Engineering Department of TOBU ENERGY MANAGEMENT CO.,LTD.

Utilizing Energy to Create Better Amenities in Large Cities

By *Japan SPOTLIGHT*

Changes in the global environment present a challenge for all nations. But individual efforts to achieve a clean environment, no matter how small, could lead to a significant cumulative improvement. Trying to create environmentally friendly streets in cities would be one example of such efforts, and would also enhance the daily lives of urban residents. In this regard, a district heating and cooling (DHC) system could be a key measure for realizing this goal.

Here, we introduce the DHC in TOKYO SKYTREE TOWN which partly uses geothermal heat. *Japan SPOTLIGHT* interviewed Tomoyuki Hidaka, a technology expert in the Engineering Department of TOBU ENERGY MANAGEMENT CO.,LTD. who is in charge of this system.

(Online interview on May 11, 2023)

Utilization of Geothermal Heat in TOKYO SKYTREE TOWN

JS: Could you tell us why geothermal heat is attracting so much attention around the world as an energy source with fewer CO2 emissions and why it has been introduced in TOKYO SKYTREE TOWN?

Hidaka: Beneath TOKYO SKYTREE TOWN there is a commercial facility named "TOKYO Solamachi" and an office building called "TOKYO SKYTREE East Tower". It is our company, TOBU ENERGY MANAGEMENT CO.,LTD., that introduced DHC into this area located between TOKYO SKYTREE Station and Oshiage Station on the TOBU SKYTREE Line of TOBU RAILWAY CO., LTD.

For such a large scale regional redevelopment in big cities, it is recommended to use so called unutilized energy such as waste heat from factories or the temperature difference in rivers or groundwater, which is a generalized concept of energy sources underdeveloped so far. First, we explored for various options of unused energy sources available near the facility. We examined the possibility of temperature differences in the rivers nearby. But the Kitajukken River flowing at the side of the facility, a canal made in Edo Era (1603-1868), does not have sufficient water and we also found it difficult to pull water from the Sumida River, a much bigger one nearby. However, when we did a soil drilling survey for construction, we found it was possible to use geothermal heat under the building and so decided to use it for our DHC system *(Image 1)*.

Tomoyuki Hidaka

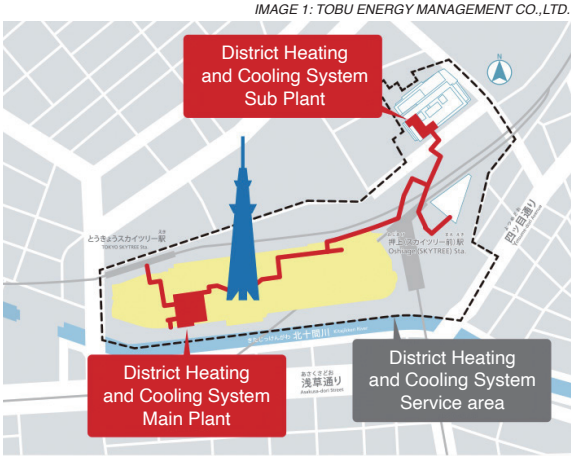
JS: How great is the energy saving effect of your DHC system?

Hidaka: We can reduce annual energy consumption by 48% and annual CO2 emissions by 40% in comparison to an existing similar-scale system.

System for Utilization of Geothermal Heat

JS: We can imagine how temperature differences in rivers or

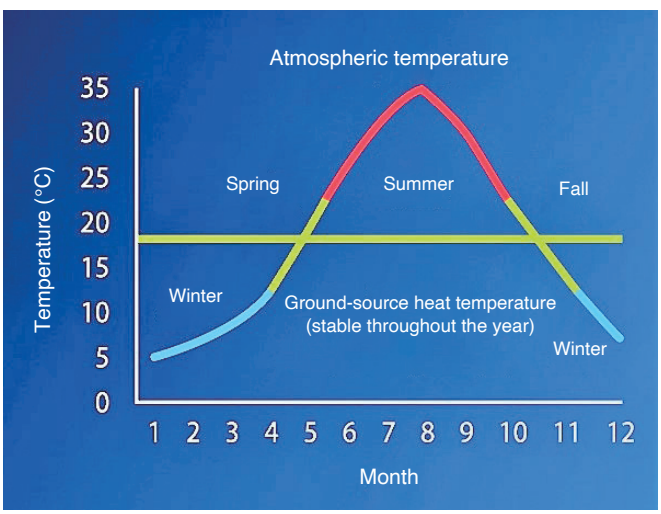
IMAGE 1: TOBU ENERGY MANAGEMENT CO.,LTD.



DHC supply area underground at TOKYO SKYTREE

CHART 1

Atmospheric & underground temperatures at TOKYO SKYTREE TOWN



Source: TOBU ENERGY MANAGEMENT CO.,LTD.

an incinerator's waste heat is used for energy. But very few people seem to know about geothermal heat. Could you tell us how this works as an energy source?

Hidaka: What we introduced for TOKYO SKYTREE TOWN is a system creating cold and hot water by discharging heat deep into the ground or extracting it from there by using water flowing through heat exchange tubes buried underground. Though we have four seasons in Japan and there is rather a high temperature difference in the air between summer and winter, the temperature at certain depths underground is stable throughout the year. So the temperature underground is lower than in the air in summer and higher than in the air in winter *(Chart 1)*.

In our preliminary geological survey, we found that the temperature underground at TOKYO SKYTREE TOWN would be around 17°C throughout the year. Water flows in what we call "Tubes for Heat Exchange" buried underground where 17°C is maintained, discharging heat in summer and extracting it in winter. We create cold and hot water necessary for the DHC system by cooling or heating further the water that is made cooler or warmer by the heat exchange tubes by using a water source heat pump.

Traditional heating and cooling systems discharge heat in the air through a cooling tower set up on the rooftop of a building, and this could cause a heat-island phenomenon. But in the case of a DHC system using a geothermal heating and cooling system, the heat is discharged underground and so it can reduce the environmental burden. This is considered to be the primary merit of this system. While existing systems have 7.176 megajoules per day as discharged heat into the air, this system reduces it to zero.

Utilization of Geothermal Heat in Japan

JS: In Japan, geothermal heat does not seem to be used very well. Is this kind of energy being used more outside Japan?

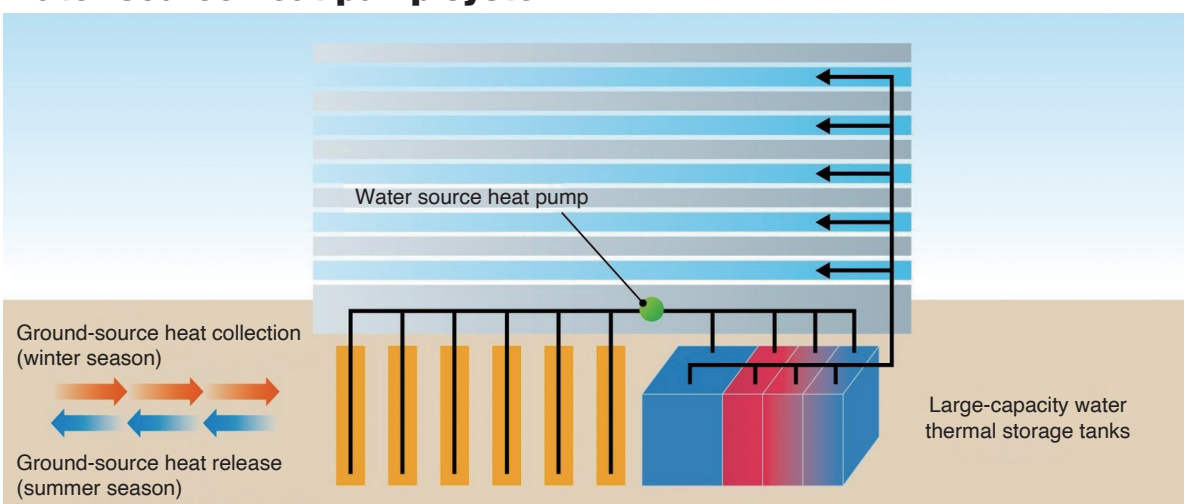
Hidaka: It is China that utilizes geothermal heat the most in the world, followed by the United States. I guess this is because certain large spaces would be needed for utilization of geothermal heat. In reality, with only a water source heat pump system buried underground at TOKYO SKYTREE TOWN we could not afford to meet the needs of the heating and cooling system of the whole facility. The system works for only a part of this facility. But we were convinced of our social contribution to the environment by using renewable energy sources not on a large scale but on a minimum scale, and so decided to introduce this system of geothermal heat *(Charts 2, Image 2-4)*.

JS: There must be many challenges in using geothermal heat in a country like Japan, such a narrow place surrounded by sea and mountains. Do you think the use of geothermal heat will be expanded in Japan?

Hidaka: Facilities for utilizing geothermal heat are not easily recognized and they may not be well known to the public. However, even in Japan with its limited space, there are already some cases where geothermal heat is used for air-conditioning in hospitals or universities in the northern part of Japan, such as in Hokkaido or the Tohoku region. The technology for such utilization is also making progress. However, we need more space to provide energy with DHC

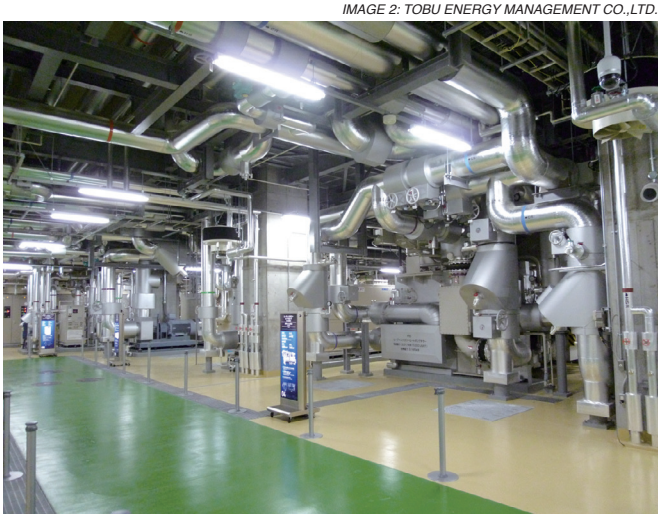
CHART 2

Water source heat pump system



Source: TOBU ENERGY MANAGEMENT CO.,LTD.

IMAGE 2: TOBU ENERGY MANAGEMENT CO.,LTD.



Main plant of DHC system

across a wider region. It is also difficult to introduce geothermal heat in existing urban districts and we need to examine the feasibility of its introduction only in newly developed areas or redeveloped ones. This is the limit of a geothermal heat-based system.

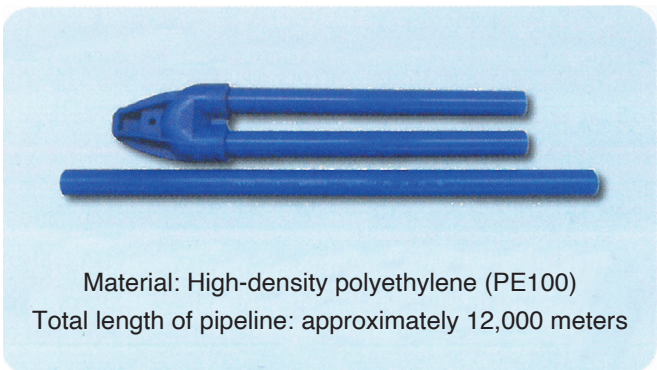
Environmentally Friendly Geothermal Heat

JS: We would certainly need more space in Japan to develop and distribute geothermal heat, but it would be a vital contribution to the reduction of the heat-island phenomenon. In the center of Tokyo there seems to be an increase in redeveloped districts today. Against this background, do you think geothermal heat utilization will increase from now on?

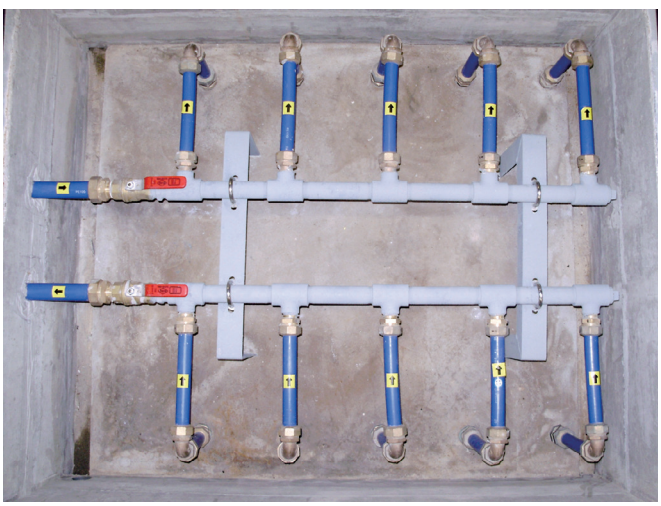
Hidaka: Yes, it would be possible. I have heard that geothermal heat was used at some facilities for the Tokyo 2020 Olympics and Paralympics. According to the Ministry of Environment, Ariake Arena, Tokyo Aquatics Center and the Musashino Forest Sport Plaza are all using geothermal heat systems.

JS: It is good to know of these examples of geothermal heating and cooling system being used at those new facilities. Is there any particular issue or challenge to be tackled in their implementation?

IMAGE 3: TOBU ENERGY MANAGEMENT CO.,LTD.



A pipe for the underground heat exchanging system
(The one in the photo is the 25A nominal diameter pipe)



Tubes for heat exchange buried underground

IMAGE 4: TOBU ENERGY MANAGEMENT CO.,LTD.

Pipes circulating in the DHC supply district

Hidaka: It is necessary to drive the system with some intervals in order to avoid heating the underground excessively. We are adjusting the system's working days to avoid an environmental change due to possible excessive temperature rises underground with the discharge of heat. For example, in TOKYO SKYTREE TOWN, in summertime the system works for 5-6 hours per day and four days a week. In wintertime, the working hours are a little longer at 7-8 hours per day and six days a week.

JS: It is important to implement the system with care for the underground environment. Do you think such technology for use of unutilized energy sources in general will gain further attention from now on?

Hidaka: Our company was awarded the "Grand Prize for Energy Conservation in FY 2018" (in the field of energy conservation) and the "Agency for Natural Resources and Energy Commissioner's Award" (in the field of joint practice) together with our collaborators, a design consulting company and an environment engineering one. They were awarded with us for our achievements in high energy-saving effects by using geothermal heat. I think we produced a good example of a geothermal heating and cooling system as the first trial of a DHC system in Japan. JS

Written and translated by Naoyuki Haraoka, editor-in-chief of *Japan SPOTLIGHT*, with the cooperation of Naoko Sakai who is a freelance writer.