LCWS 2024
Industry／Sustainability Session

Commercialization and fundamental research of waste heat recovery technology using adsorption heat storage materials

Higashi-nihon **K**iden**K**aihatsu Co.,Ltd.(**HKK**)
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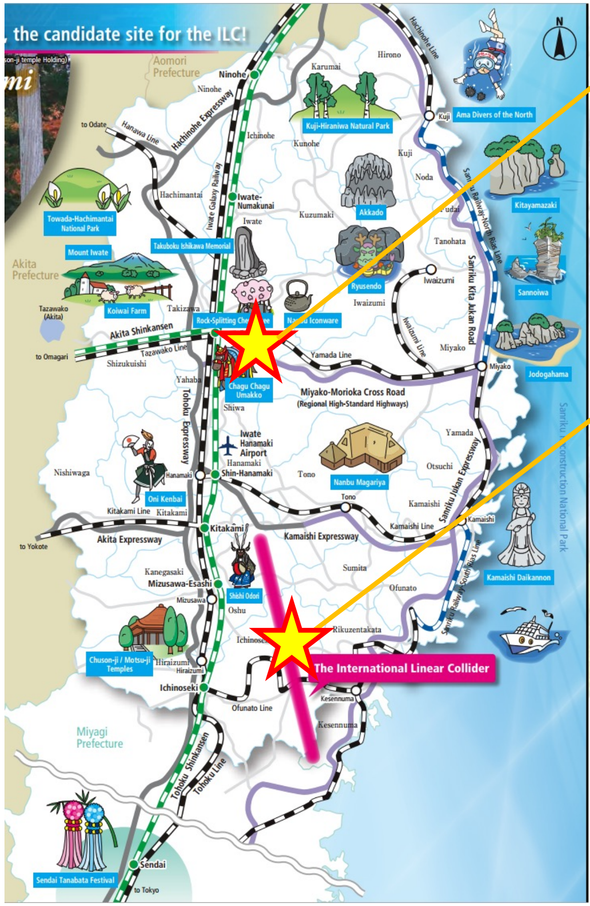
Corporate Introduction



Higashi-nihon KidenKaihatsu Co,.Ltd. (HKK)	
Established in	January 22, 1971
Numbers of employees	53
Business	• Electrical Machinery business Design and manufacture of control and instrumentation systems for various plants(especially water supply and sewage works). • Agriculture-related environmental business Sales of special fertilizers and agricultural materials. Design and construction of enclosed elevated strawberry cultivation systems.

Corporate Introduction



Morioka-city

The capital of Iwate Prefecture.

HKK is located here.

Distance inbetween HKK and ILC candidate site is about 100 km.

1.5 hour by car

Candidate site for the ILC construction

Our company shared the following goals of the Green ILC

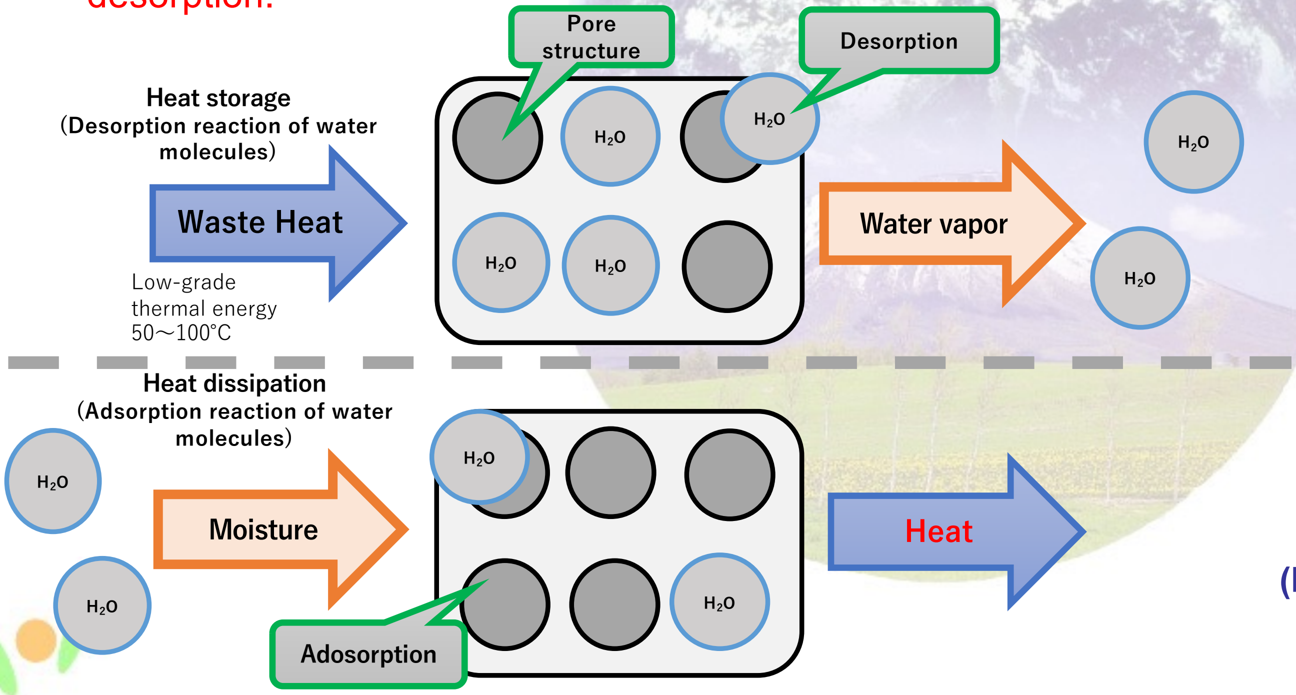
1. To utilize renewable energy in the area where the ILC candidate site is located.
2. Reduce energy consumption by improving energy efficiency.
3. Recover low-grade thermal energy emitted from research facilities and return it to society as much as possible.

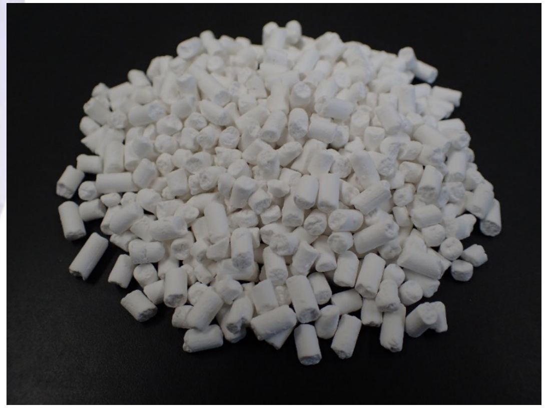
We are conducting research to commercialize a regional thermal energy circulation model that utilizes HASClay.

What’s “HASClay”?

HASClay® is an inorganic adsorbent material composed of a composite of amorphous hydroxyl aluminum silicate (HAS) and low-crystallinity clay.

HASClay® has the ability to store thermal energy with the principle of energy transfer by water vapor desorption.





The appearance of HASClay®
(Developed by Masaya Suzuki of AIST)

What's "HASClay"?

Featuers of HASClay are

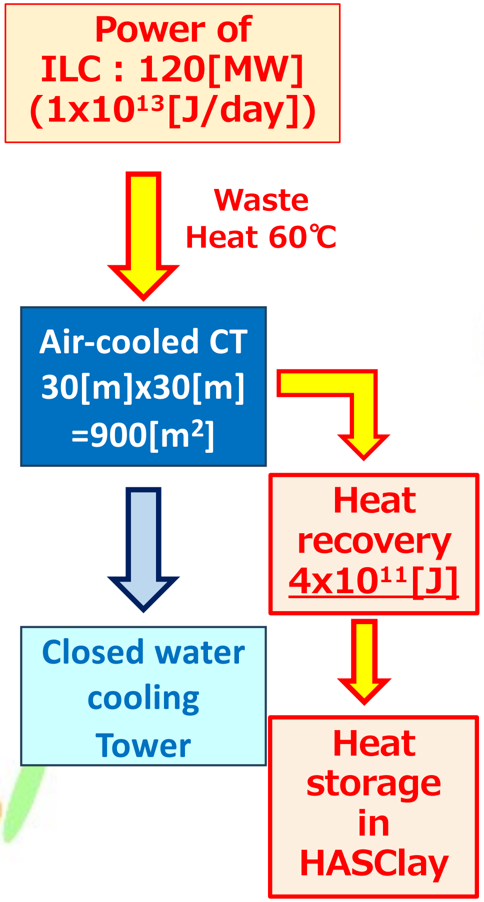
- It has an excellent storage capacity for low-grade thermal energy (<100 ˚C).
- It is capable of repeating the heat storage and dissipation cycle over and over again.
- The heat energy can be stored semi-permanently and will not ignite, making it safe to store.
- Off-line transport allows exhaust heat from ILC and factories to be used effectively.

* The large heat storage capacity is due to a surface area of more than 550 m^2/g and many pore close to the size of water molecules.

Performance of various adsorbents

Adsorbent	Heat storage ability	Heat storage capacity(kJ/L)
HASclay	**40 ˚C or more**	**567** *
Modified zeolite	80 ˚C or more	439

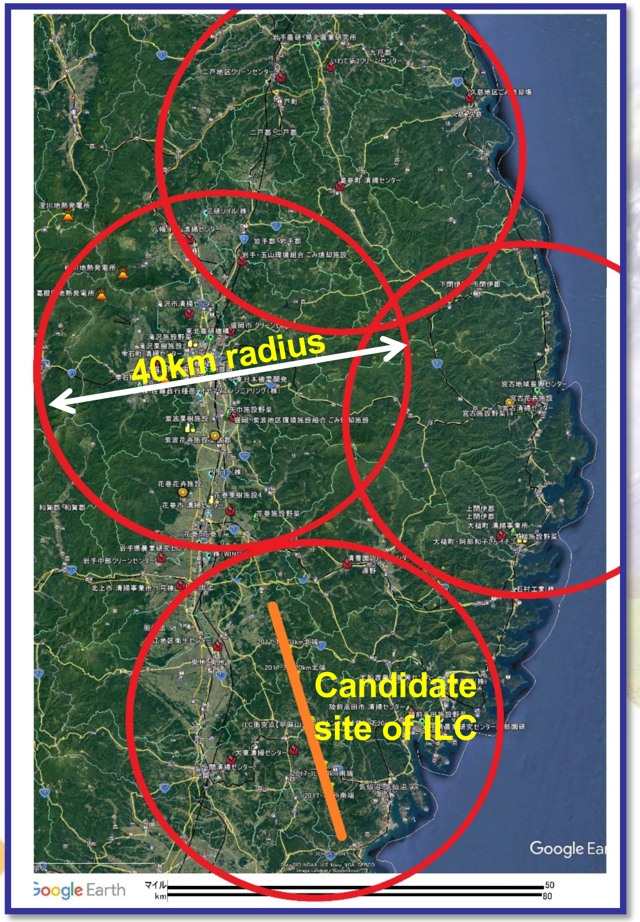
How to use HASClay in ILC



Let's try to show the scale of the facility with the goal of recovering 20% of the waste heat from the ILC.

1. Assume that the power required for ILC operation is **120[MW]**.
2. Assume the heat storage time is **1 day** (While field tests were within10 hours)
3. Assume that sealed water-cooled cooling towers will be installed at five access tunnel entrances.
4. Based on the above assumptions, the energy to be dissipated per day per cooling tower is **4×10^{11} [J]**.
5. Since the thermal energy that can be stored in 1[m3] of HASClay is **500[MJ]**, **800[m^3]** of HASClay is required.
6. If a custom-made air-cooled cooling tower for waste heat recovery is installed in front of the closed water-cooled cooling tower and HASClay is installed with a thickness of 1 [m], the size of the air-cooled cooling tower will be about 30[m] x 30[m], which is a reasonable size.

We are considering a wide-area commercialization model in Iwate Prefecture.



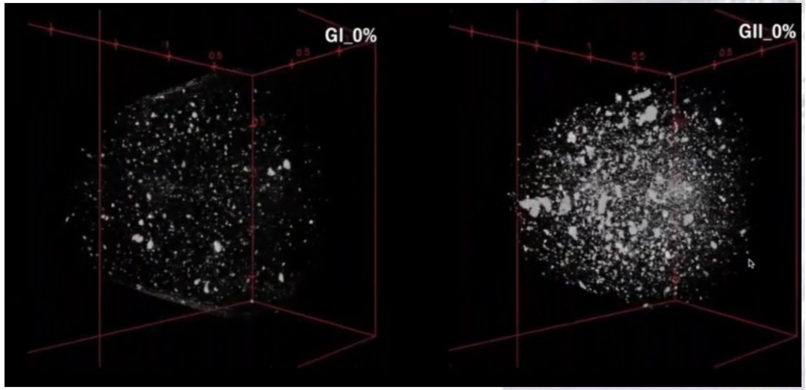
- Thermal energy will be recovered from heat sources dispersed throughout Iwate Prefecture and stored in HASClay, and the recovered heat will be used by thermal energy consumers who consume kerosene in the winter.

- The distance between the heat source and the heat utilization facility must be within an appropriate range ”within 40 km radius”.

- The transportation of HASClay between the heat source and the heat utilization facility is not done by dedicated trucks, but by using the excess capacity of various local transportation systems.

Basic test of HASClay heat storage and emission mechanism using synchrotron radiation

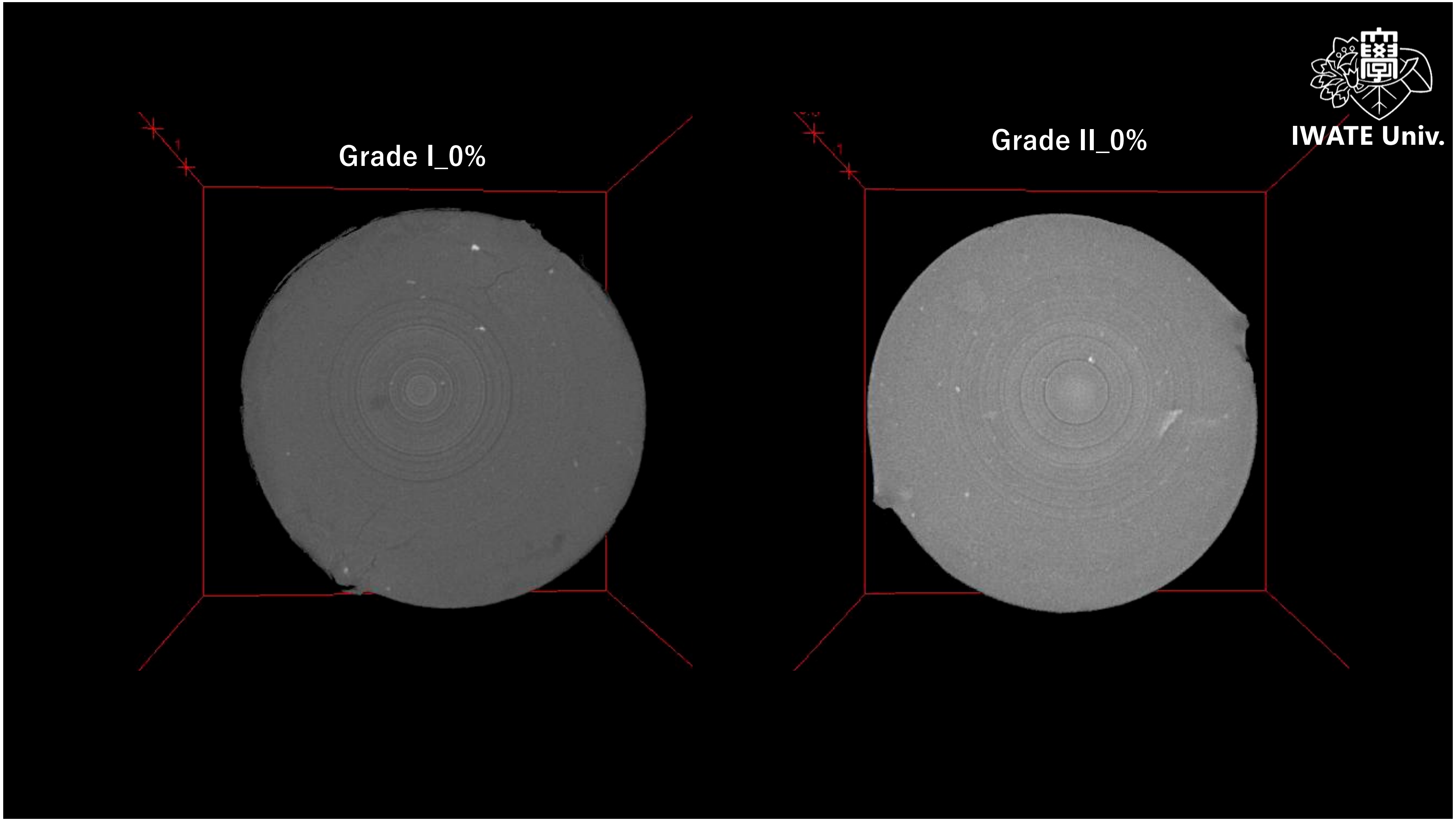
One of the issues for practical application is to elucidate the mechanism of HASClay. We have performed imaging CT and Small Angle X-ray Scattering using synchrotron radiation facilities.



High-density area of samples G1 & G2

In a joint research project with Iwate University, we carried out CT imaging of samples of HASClay Grade1 and Grade2. G1 has better thermal storage and release performance than G2. CT imaging revealed that there are more high-density area distributed in the internal microstructure of G2 compared to G1. This is presumably what is affecting the instability of performance.

This data was obtained from synchrotron radiation experiments conducted by “Yoshimoto Laboratory” at the Iwate University Faculty of Science and Technology at the SPring-8 synchrotron radiation facility.
Data from the Small Angle X-ray Scattering is currently under analysis.


Grade I_0%
Grade II_0%
IWATE Univ.

Summary

During field tests from 2021 to 2023, we understood the usage of HASClay.

We found that the amount of kerosene used to heat the strawberry-growing agricultural greenhouses could be reduced by about 40%. As a side effect, dehumidification prevented crop diseases.

In a thermal storage test, it was found that the thermal storage could be completed in 16 to 24 hours with warm air at 40℃.

Next step is conducting an wide-area demonstration tests.

Preparations are currently underway for a wide-area demonstration in the winter of 2024.

The purpose of this demonstration test is to verify that it is possible for local communities to take the initiative in autonomously circulating thermal energy, and to identify issues that need to be addressed for practical application.

We will proceed with the analysis of microstructures using synchrotron radiation.

In collaboration with Iwate University, we will proceed with the analysis of data obtained in 2023. We will continue to elucidate the temperature dependence of water molecule adsorption/desorption and the effect of frequency of use.

That is all.

Thank you very much