

Green ILC Activities in Tohoku

August 29, 2019

LCWS2019 @ Sendai



October 15, 2019

- Geothermal power plant in Matsuo Hachi-man-tai
- Iwate geothermal power plant Inc.
- Start of business in Jan. 29, 2019
- 7.5MW

Masakazu Yoshioka
Iwate/Iwate prefectural/Tohoku University
(KEK Prof. Emeritus)

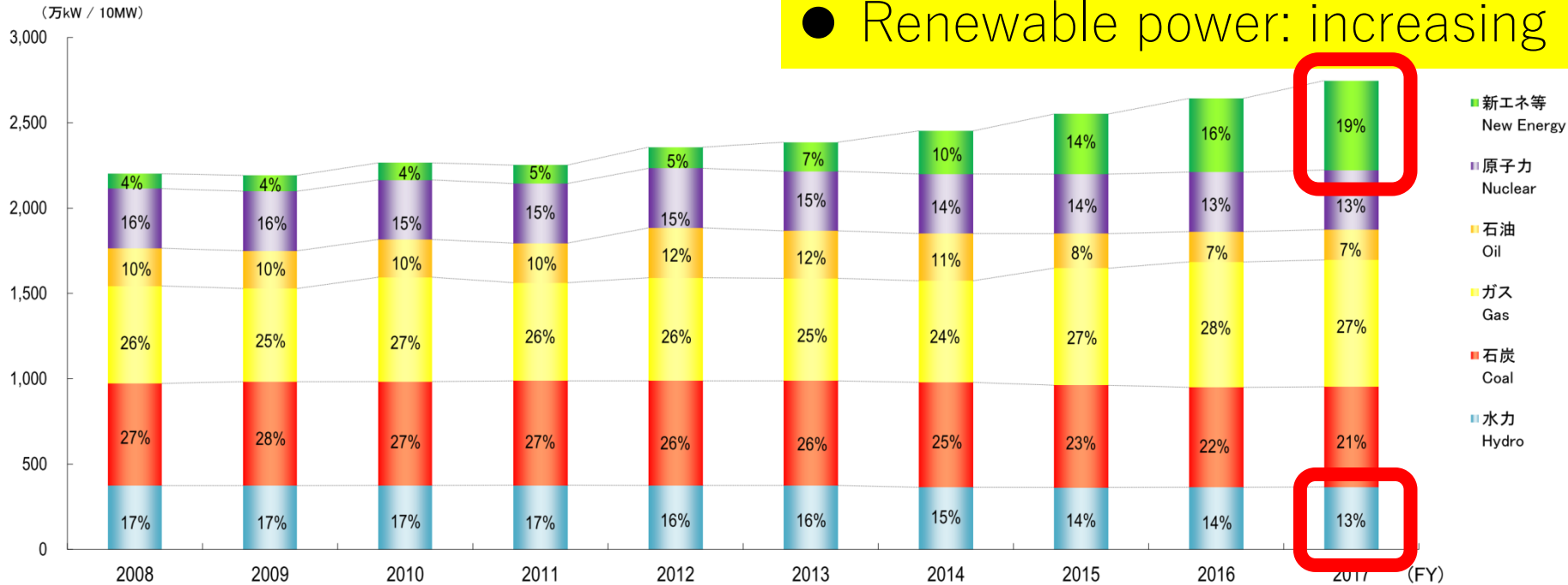
- ① Electrical power situation in TOHOKU
 - i. Electric power supply capacity
 - ii. Power generation
- ② Green ILC activities in Tohoku since 2016 through industry-government-academia collaboration
- ③ Green ILC city planning

Annual report by Tohoku Electric Power Co., Inc.

1. 電力供給 Electric Power Supply capacity

(1) 発電設備容量構成比(含他社受電) Generating Capacity by Energy Source (including)

- Total : 27.5 GW
- Hydro power: constant
- Renewable power: increasing



(万kW / 10MW)

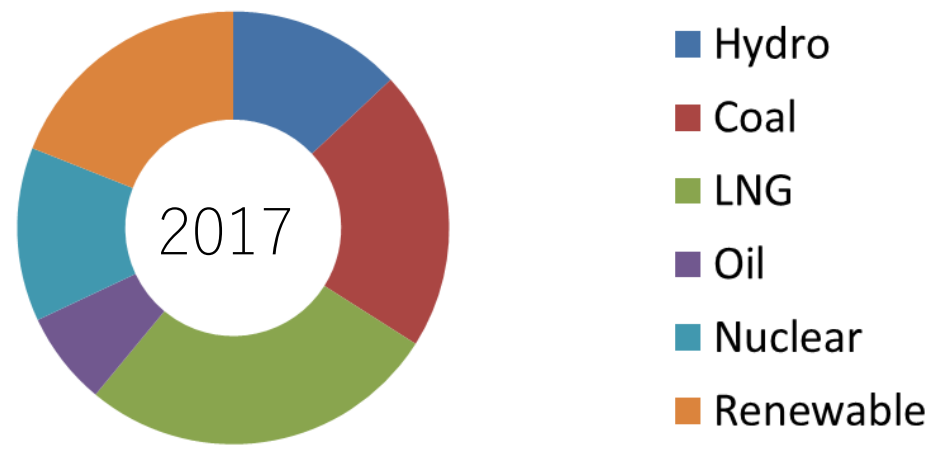
	2008年度 [FY2008]	2009年度 [FY2009]	2010年度 [FY2010]	2011年度 [FY2011]	2012年度 [FY2012]	2013年度 [FY2013]	2014年度 [FY2014]	2015年度 [FY2015]	2016年度 [FY2016]	2017年度 [FY2017]
水力 Hydro	374	374	375	376	375	375	364	363	364	366
火力 Thermal	1,391	1,376	1,441	1,419	1,509	1,492	1,487	1,488	1,498	1,508
石炭 Coal	599	609	609	612	613	613	615	599	586	587
ガス Gas	571	546	611	575	604	601	595	686	735	744
石油 Oil	221	221	221	232	292	278	277	202	177	177
原子力 Nuclear	349	349	349	349	349	349	349	349	349	349
新エネ等 New Energy※	87	93	100	108	124	170	252	352	432	
計 Total	2,202	2,192	2,265	2,252	2,357	2,386	2,452	2,552	2,643	

※ 新エネ等は、風力発電、太陽光発電、バイオマス発電、廃棄物発電、地熱発電を含む既連系の発電設備容量

Generating capacity by New Energy means the capacity of plants of Wind, Solar, Biomass, Waste and Geothermal, which are already connected.

27.5 GW

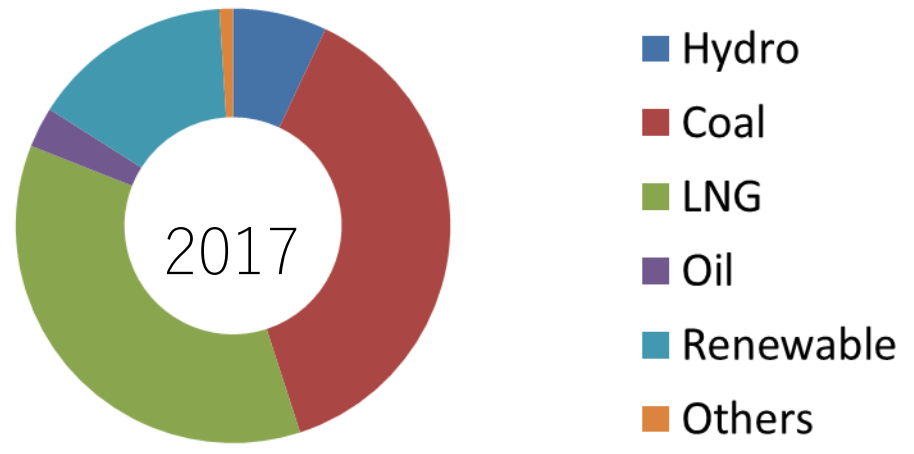
Power generation facility capacity: **Total 27.5GW**



Type	%
Hydro	13
Coal	21
LNG	27
Oil	7
Nuclear	13
Renewable	19

32%

Actual power generation



Type	%
Hydro	7
Coal	38
LNG	36
Oil	3
Renewable	15
Others	1

22%

Electricity sales volume in 2017: **72 TWh/year**
Sustainable power: **22%**

Summary of electric power situation in Tohoku

- Power generation facility capacity: **Total 27.5GW**
 - **Total renewable power: 32 %**
 - **ILC peak power: 0.5 % of total capacity**
- Electricity sales volume in 2017: **72 TWh/year**
 - **Total sustainable power: 22 %**
 - **Nuclear power: 0 %**
 - **ILC power demand: 1 % of total sales**



We can contract with sustainable electric power company

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- ③ Green ILC city planning

Green ILC activities in Tohoku since 2016 through industry-government-academia collaboration

- ① Unused thermal energy recovery (2016~)
- ② Heat utilization from unused biomass
- ③ Green ILC seminar series by ILC promotion division of Iwate prefectural office
- ④ Solar heat utilization project in Iwate Prefectural University based on the existing technology in Denmark
- ⑤ Research on wooden construction of ILC-related facilities
- ⑥ Application of aerial laser surveying technology to forestry industry
- ⑦ Development of accelerator magnets using permanent magnets as magnetomotive force

① Unused thermal energy recovery by industry-academia-government collaboration (2016~)

Low grade thermal energy ($<100^{\circ}\text{C}$)



Waste heat recovery and offline transport of thermal energy

Key technology is the “HAS-Clay”, which is a sintered nano-scale compound of Hydroxy Aluminum Silicate + Amorphous Aluminum Silicate developed by AIST

Latent heat of vaporization(Vapor \Leftrightarrow Liquid) + Chemical absorption

- Specific gravity 1.2
- Adsorption amount 0.37kg/kg(37%)
- Bulk density 50%
- Heat storage 580 MJ/m³
- ➔ 12 times of LNG (Gas state 45 MJ/ m³)



Heat source

Recover heat from ILC equipment cooling water, factory, incinerator, cogeneration, solar heat, hot spring, etc.



Off-line transport

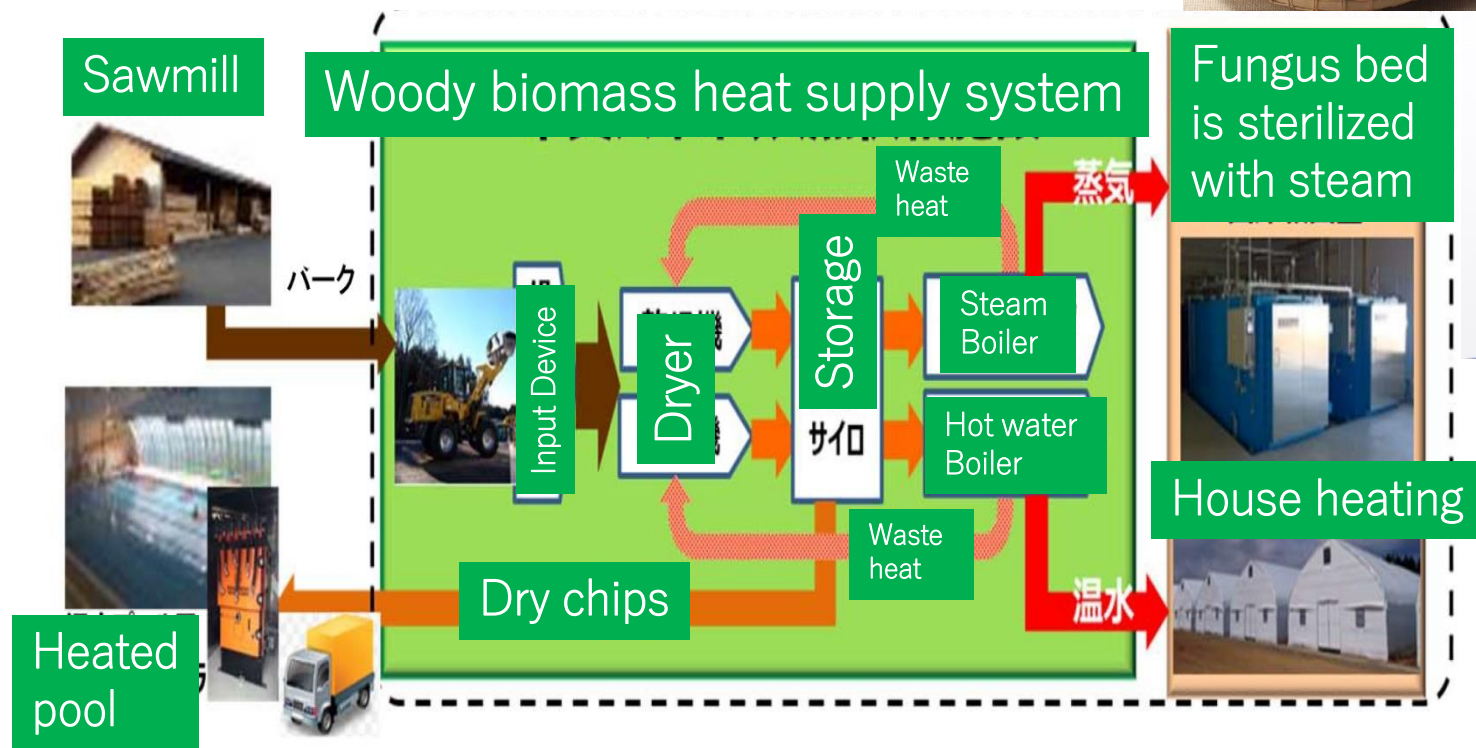
Facilities that requires heat energy

Agricultural house, wood and wood chip drying and other heat supply businesses

② Effort by Maruhi Sawmill Company: Business of heat conversion of unused biomass

Kuji city (Northern Iwate), Business by Kuji Biomass Energy Corporate
Unused biomass : hardwood and red pine bark and timber from sawmill

- ➔ Crush and dry (500 MJ/m³)
- ➔ Large scale shiitake mushroom bed cultivation



Key person:
Mr. Hinata
Senior
Managing
Director of
Maruhi Sawmill
Corporate

③ Green ILC seminar series by ILC promotion division of Iwate prefectural office (every six months)

The most recent seminar : 5th seminar in August 30, 2019

Toward heat utilization of
woody biomass

Two topics were
presented

梶山恵司

Keiji Kajiyama, CEO of BERI Inc.
(Biomass Energy Research and Investment)

wbenergy.co.jp beri.co.jp

第5回グリーンILCセミナー@二戸市シビックセンター 2019.08.30

Japan's forest industry
distribution channel improvement

Shinya Suzuki, CEO of North Japan
Log distribution cooperative

- BERI contracted business of energy center for city hall (4500 m²) of Toh-no city (Middle Iwate)
- Toh-no city is a center of forestry industry of Iwate and can provide enough wood chips
- Heat source: 2 set of 300 kW high performance chip boiler (Intermittent operation is possible, made in Austria)+ heat storage hot water tank (12 ton, 85~90 °C)
- Supply hot water to all heating demand of city hall



City hall of Toh-no



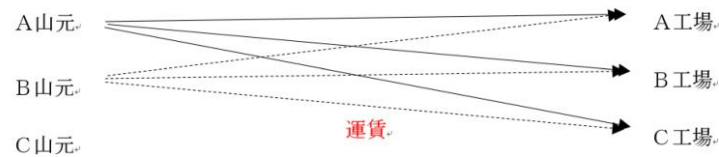
Existing distribution of woods through the wood market

- New direct distribution of woods
- Decrease cost



- この流通は売り手市場で成立。
- しかし現在、並材は買い手市場。

→ 成立しない！



式[

- National forest

North Japan wood material distribution cooperative (175 members in Tohoku and Hokkai-do) plays a central role to realize a direct distribution of wood materials by managing supply and demand information

④Solar heat utilization project by **industry-academia-government** collaboration (2019~)



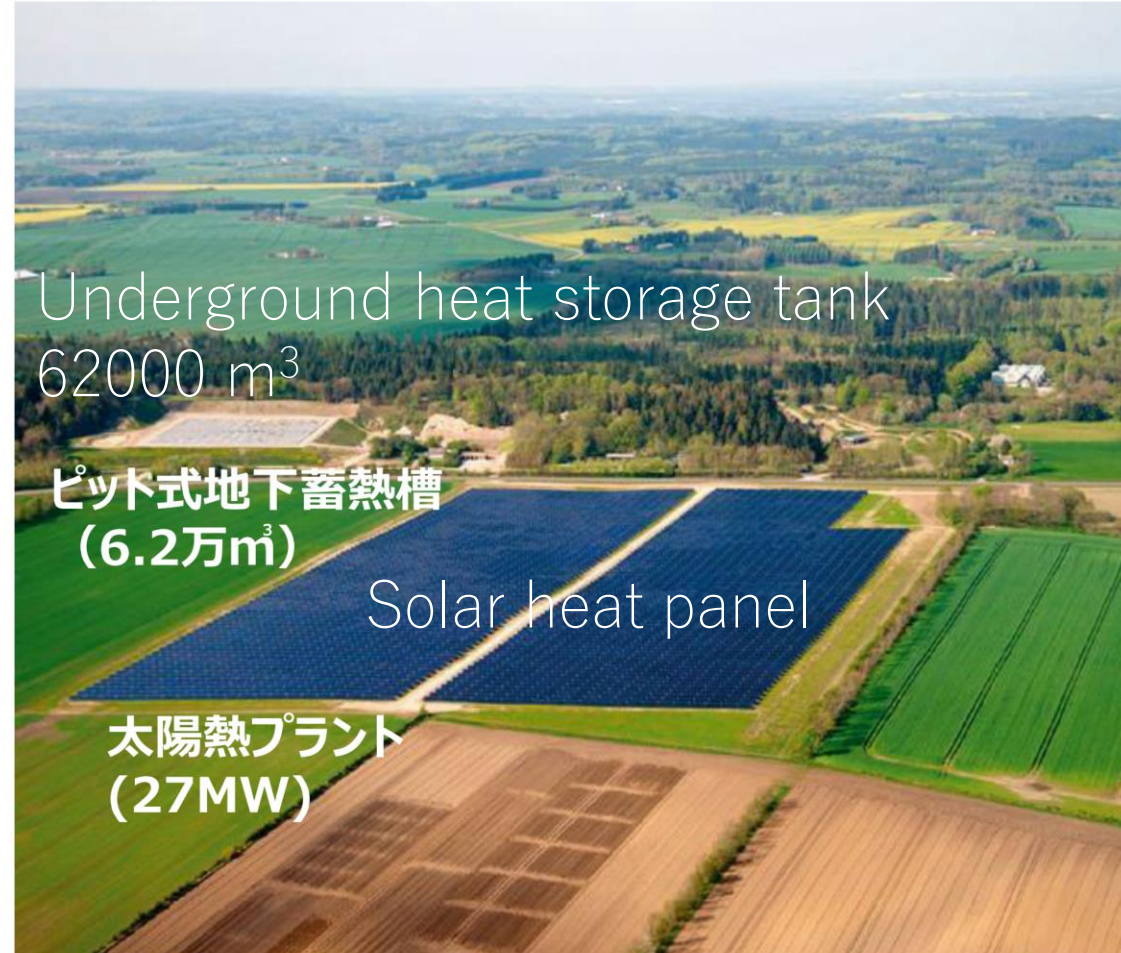
三井住友建設



Solar heat panel + heat energy storage pit (50000 m³) to realize a heat utilization across seasons
Learned from Denmark

Dronninglund Fjernvarmeについて

- ・地域熱供給を目的として1959年に設立された消費者協同組合
- ・熱供給規模：ドロニングルン地区の1,350世帯、3,300人(総需要家の98～99%)
- ・太陽熱＋バイオオイルボイラー＋天然ガスボイラー



Underground heat storage tank
62000 m³

ピット式地下蓄熱槽
(6.2万m³)

Solar heat panel

太陽熱プラント
(27MW)

デンマークでの熱供給事業の特徴

- ・設備、施設を組合で所有・運営
- ・理事は住民から選出され、無給で担当
(デンマーク国内法により、熱供給事業者は利益を出していけない)

Iwate Prefectural University

Established in 1998

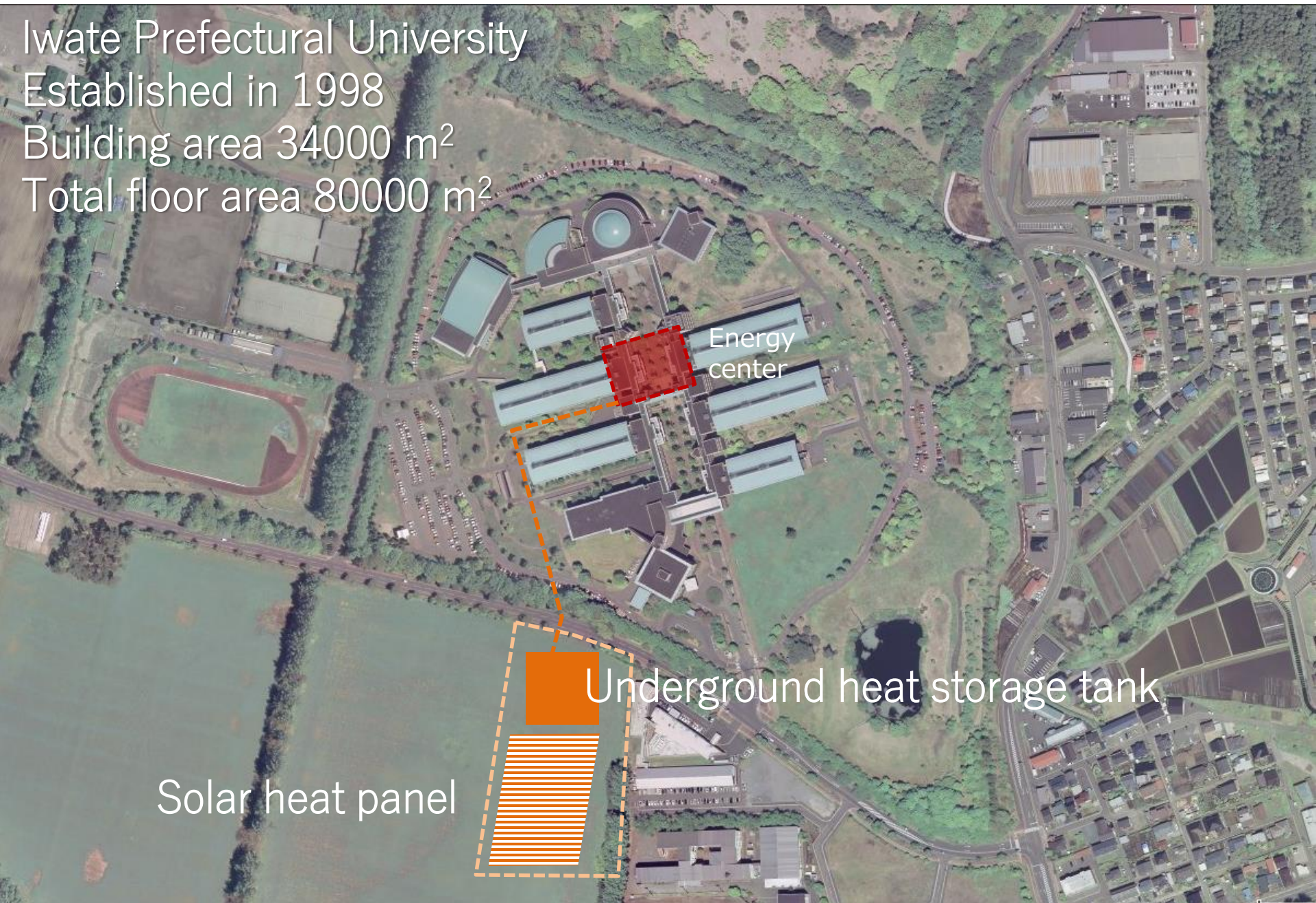
Building area 34000 m²

Total floor area 80000 m²

Energy center

Underground heat storage tank

Solar heat panel

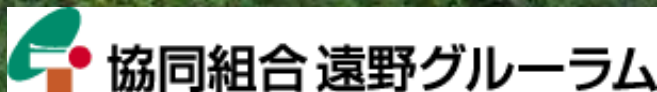


⑤ Industry-government-academia collaboration

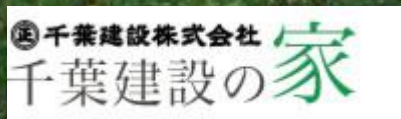
Wood First design cord for ILC-related buildings/houses



Iwate University



“Toh-no Glulam” Laminated wood production,
Local company



“Chiba Kensetsu” Local house builder

- The Shelter Corporation imagines a world of “urban forests” - cities formed of timber-framed buildings.
- In their architectural and urban planning, they study and research the environment and environmental issues.

Examples of Shelter's work:

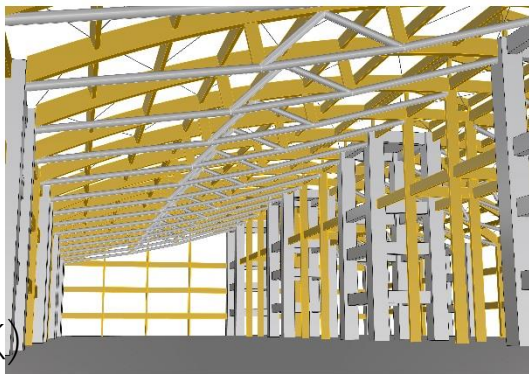
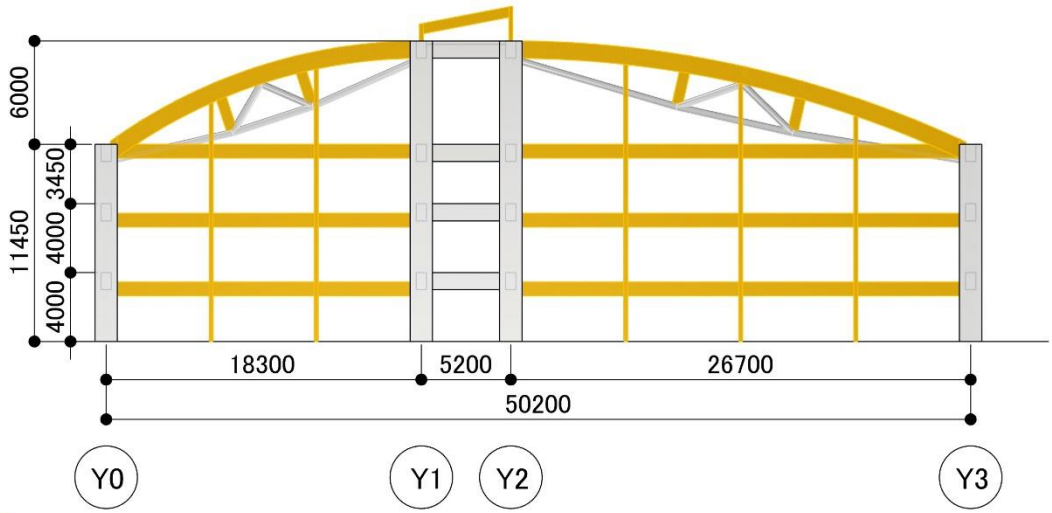
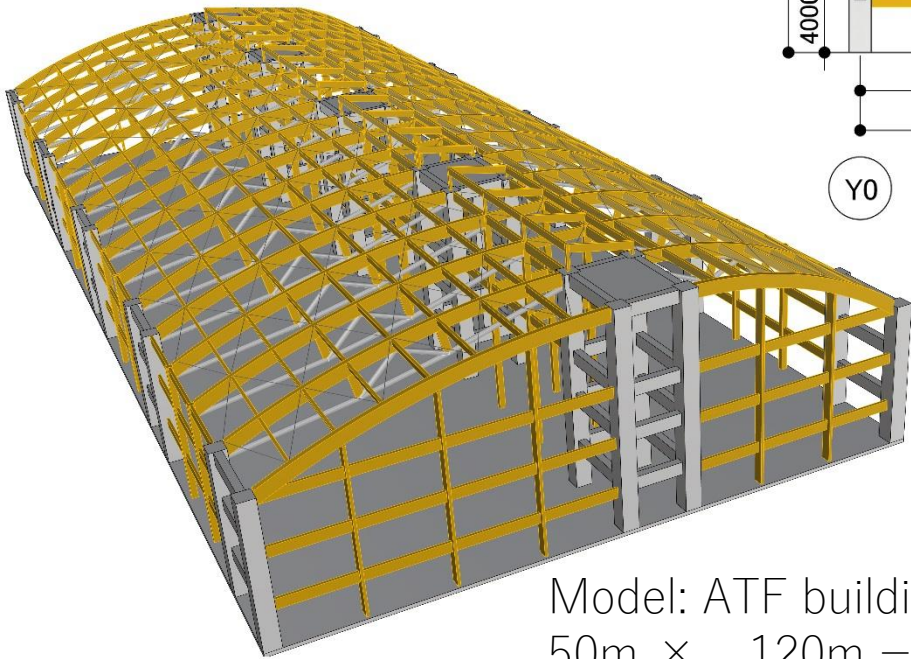
Town hall in Nan-yo city of Yamagata Prefecture

Number of seats : 1403

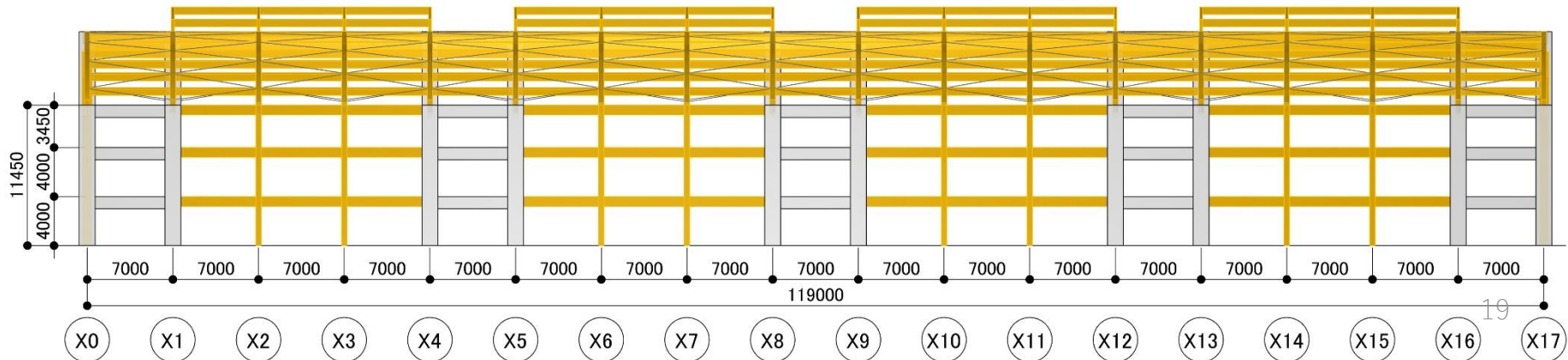


- ① Locally produced wood
- ② Laminated timber production by local companies
- ③ Construction by local companies

Our collaboration has made studies of hybrid of wooden and reinforced concrete structure for ILC experimental facility



Model: ATF building (KEK)
 $50\text{m} \times 120\text{m} = 6000 \text{ m}^2$



⑥ Industry-government-academia collaboration

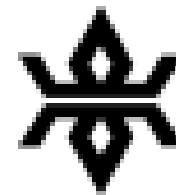
Application of the airborne laser surveying in forestry



Iwate University



アジア航測株式会社



岩手県

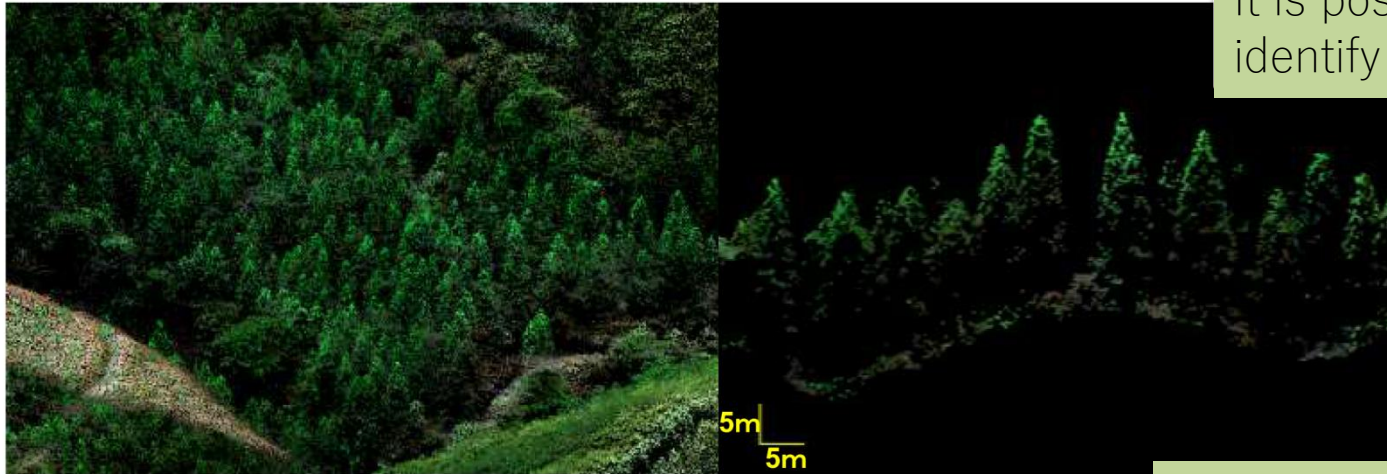
Iwate Prefecture

“Asia Kosoku” technology and business

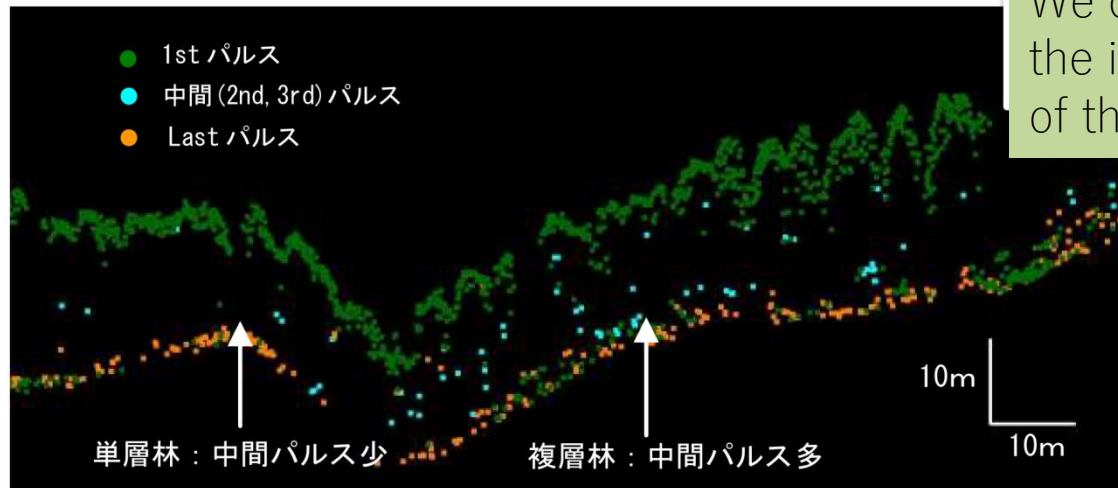
- Airline Survey using Laser ranging technology
- Spatial information consultant
- Digital mapping, geographic Information analysis

Airborne laser surveying to get better sensuous grasp of the terrain by removing Information of trees → in other words, we can get detailed information about trees → It can be utilized in forestry

森林域の航空レーザ計測データの特徴

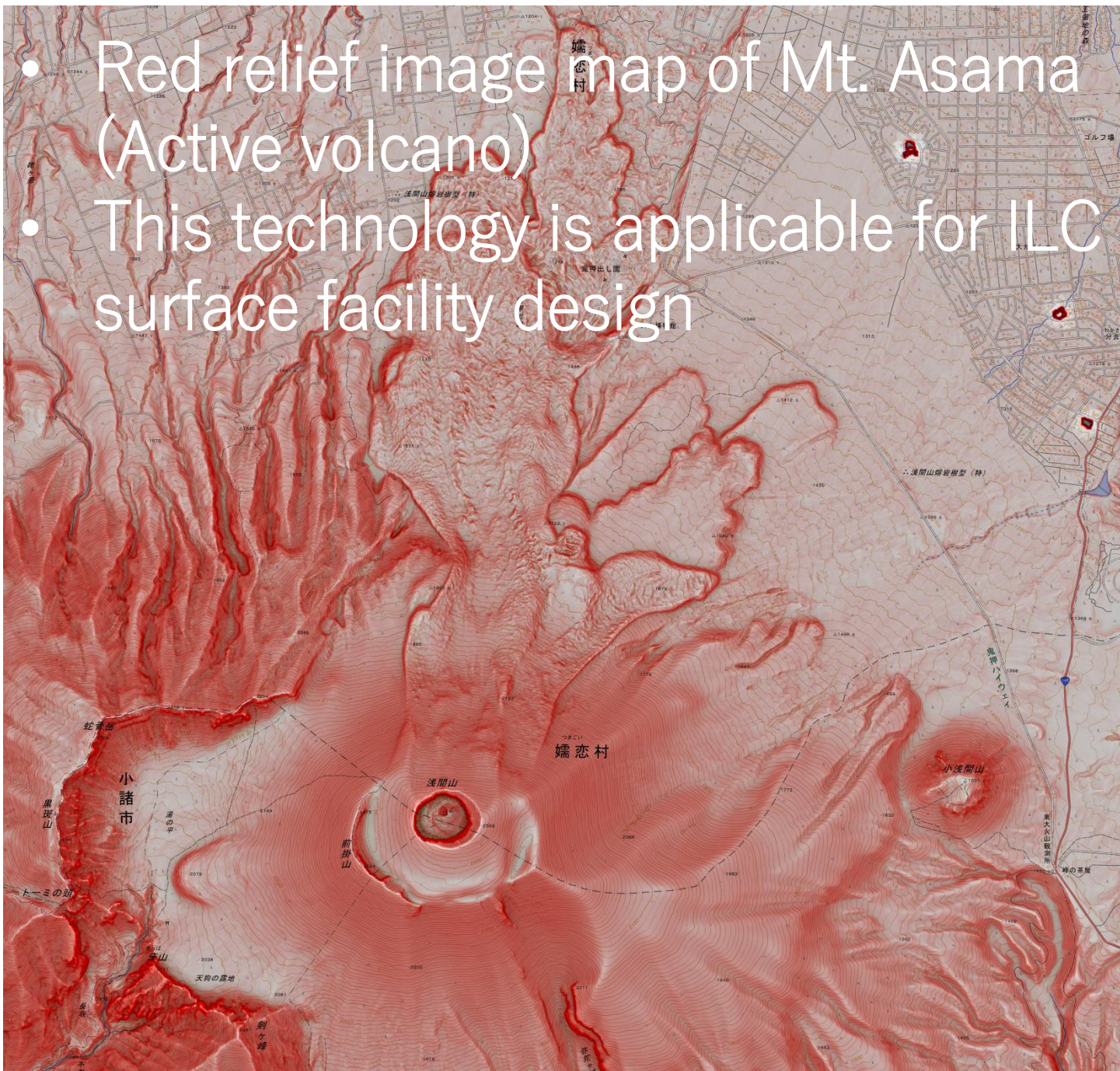


It is possible to identify single tree



We cab understand the internal structure of the forest

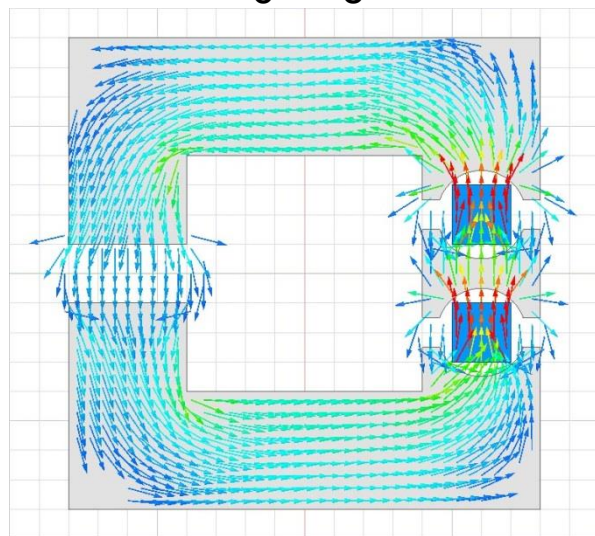
- Red relief image map of Mt. Asama (Active volcano)
- This technology is applicable for ILC surface facility design



⑦ Development of accelerator magnets using permanent magnets as magnetomotive force by Iwate Industrial Research Center, Industry Promotion Center and Private Sectors

矩形磁石を用いた磁気回路シミュレーション結果

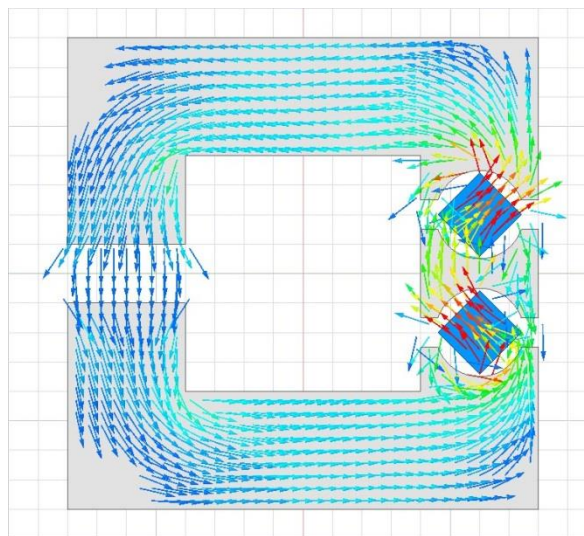
$\theta = 0^\circ$



1,583 G

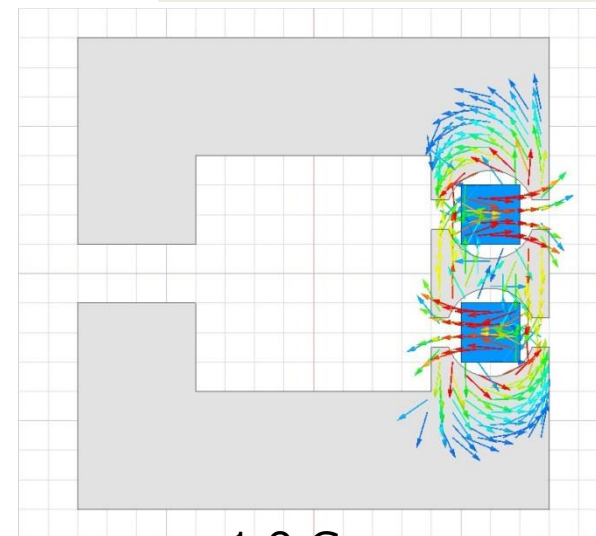
ON

$\theta = 45^\circ$



1,180 G

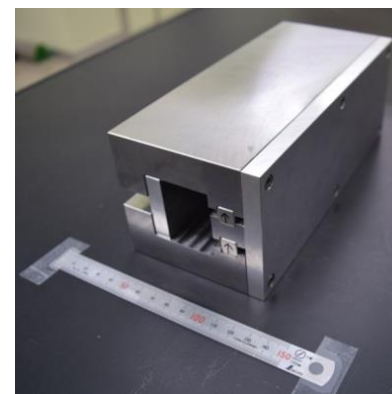
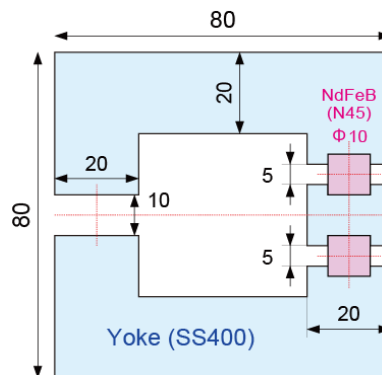
Trial by Tohoku team



1.9 G

OFF

1.0 0.8 0.6 0.4 0.2 0 T



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Regional Revitalization and Community Development Work Group, AAA Project Promotion Study Group

Forest and heat link ILC with the region

- The recycling society of forest and heat activates regional industries
- The establishment of the ILC is considered as an opportunity to resolve various issues of the region, with the creation of a next-generation city that evolves and leads to regional revitalization

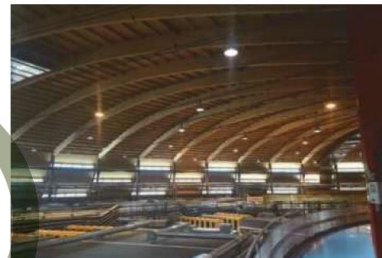
Intraregional forests and woods

- The revitalization of forestry



The utilization of heat in large volumes from ILC (future)

ILC Community



- Wood First:** Erecting buildings entirely with wood and utilizing waste material biomass
- Zero Emissions:** Maximizing renewable energy in the community
- Society 5.0:** Energy, mobility, information and health care

All buildings at the campus community will be converted into wooden structures.

An example of an accelerator facility made of wood (PSI synchrotron radiation facility in Zurich)

Wooden structure ZEB
Research laboratory, experimental facility, as well as conference, accommodation and living facilities



Wooden structure ZEH
Shared type rental residences



4th generation heat supply
(medium to low temperature heat supply)
Acquisition of support for renewable energy, such as solar heat Residential and agricultural use



Green Slow Mobility
Driving electric vehicles and riding bicycles



Wooden house
Agricultural house, culture farm, etc.
Industrial facility



Seasonal heat storage
at Dronninglund



Heat storage tank
at Avedøreplant

The residential district within the environs of Sophia Antipolis in the research university town

* Reference examples

- There are no residences within Sophia Antipolis and people primarily reside in the environs within a driving distance of 30 minutes.



- Residential community of 200 to 300 residences (urban planning that incorporates a diverse range of the population, with detached houses, terrace houses, multiple dwelling complexes, etc.)
- Parks, sporting complexes and school facilities
- * Hotels, supermarkets, restaurants and a golf course are situated nearby.

ILC community model

A community of 500 persons (5 to 10ha) / within a commuting range of up to one hour

Design code

- Exceedingly airtight, highly thermal insulating wooden structure ZEH, district heat supply business operator, lot sales and withdrawal type x → Managed growth type, foreign families: Local residents = 50:50, relocatable residential structure (singles - newlyweds - children raisers - mature aged - elderly)

Environmentally friendly urban development

- Residential community of 200 to 300 rental residences (detached houses, terrace houses, multiple dwelling complex)

Land use planning

- Formulate site plans that suit the geographical features
- Create a core of the community
- Separate pedestrians from cars

Townscape & design

- Architectural design code (raw materials, unification of colors, restrictions on buildings, etc.)
- Street and walkway plans
- Park and planting plans



Society5.0

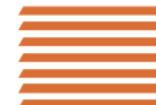
(5th generation urban planning with IoT, AI, etc.)

Mobility, information and health care

- Riding bicycles and sharing cars
- Satellite offices
- Nursing care robots, remote medicine, etc.

4th generation district heat supply

- Renewable energy heat source



- Solar heat plant
- Unused biomass heat utility
- Unused waste heat recovery



- Heat storage facility

- Heat conduit installation
- User facility

ILC related enterprises

(medical care, health care, robotics, ICT, etc.) research test site



- Mechanism for nurturing interactions within the community
- Improvement of regional brand for old city area

ILC-250 TimeLine

Now we are at pre-preparation phase (waiting for the preparation phase).
Four years preparation and 9 years construction.



	P1	P2	P3	P4	1	2	3	4	5	6	7	8	9	10	Phys. Exp.
<u>Preparation</u> CE/Utility, Survey, Design Acc. Industrialization prep.															
<u>Construction</u>															
Civil Eng.															
Building, Utilities															
Acc. Systems															
Installation															
Commissioning															
<u>Physics Exp.</u>															

Tohoku is ready to go ahead