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Reduction of Environmental Load by Telecommuting in Oku-Nikko

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Abstract. Heat island phenomenon is occurring in the 23 wards of Tokyo and a vacant house is increasing in Oku-Nikko, so carbon dioxide emissions reduction and application of vacant house may happen by working in Oku-Nikko by means of telecommuting in summer. The Oku-Nikko area has a cool climate peculiar to the mountains in the area of Nikko city at an altitude of about 1270m to about 2500m, the average temperature in August is about 19 ° C, about 8 ° C lower than the center of the city, and It has gained a high reputation as a summer resort for a very long time. On the other hand, as the population declines due to young people moving out of the area and natural declines, the depopulation of the area has progressed and the tourism industry is the subject of the local industry, but the aging of facilities and manpower shortage due to depopulation etc. As the tourism industry declined, the number of buildings no longer used increased, the number of empty buildings increased in Oku-Nikko. Therefore, people using the telework usually work in urban areas work in Oku - Nikko in the summer, effectively utilizing the empty buildings, can also be expected to lead to the revitalization of the area. In this study, this study calculated the carbon dioxide emissions due to air conditioning in houses and offices during the two months of summer and the carbon dioxide emissions associated with commuting, and compared the total value with Oku-Nikko in the 23 wards of Tokyo. As a result, it comes out that carbon dioxide emissions of air conditioning and commuting may be able to become less about 70% than before.

1. Introduction

In urban areas, the heat island phenomenon which is a phenomenon that the heat is discharged and the urban temperature becomes higher than the surrounding due to various industrial activities and social activities of the city has occurred. Especially in areas where central population concentrates, it is estimated that the amount of waste heat during the day locally exceeds 100 w / m², and in the case of the Kanto region, the high temperature region is expanding mainly in Tokyo metropolitan area. Therefore, people working in the Tokyo metropolitan area will work at summer resort with cool weather near Kanto using teleworking, thereby reducing the environmental burden in the summer without requiring new technology can be expected. On the other hand, in Oku - Nikko, as vacant houses are increasing due to depopulation of the area, by teleworking at Oku - Nikko, it is possible to utilize many empty houses in Oku - Nikko and to reduce the environmental burden in summer without requiring new technology.



In this study, This study define summer office that people who usually work in the downtown telework in summer at a summer resort. This study selected the Oku-Nikko area, which is located about 2.5 hours by car from the center of Tokyo as the target area. In order to verify the effect of doing summer office at Oku - Nikko, this study investigated the building information of the Oku - Nikko area, investigated environmental resources to improve leisure time, and estimated the reduction rate of CO2 emissions by summer office.

2. Oku-Nikko area overview

The Oku-Nikko area has a cool climate peculiar to the mountains in the area of Nikko city at an altitude of about 1270 m to about 2500 m. The average temperature in August is about 19 ° C., which

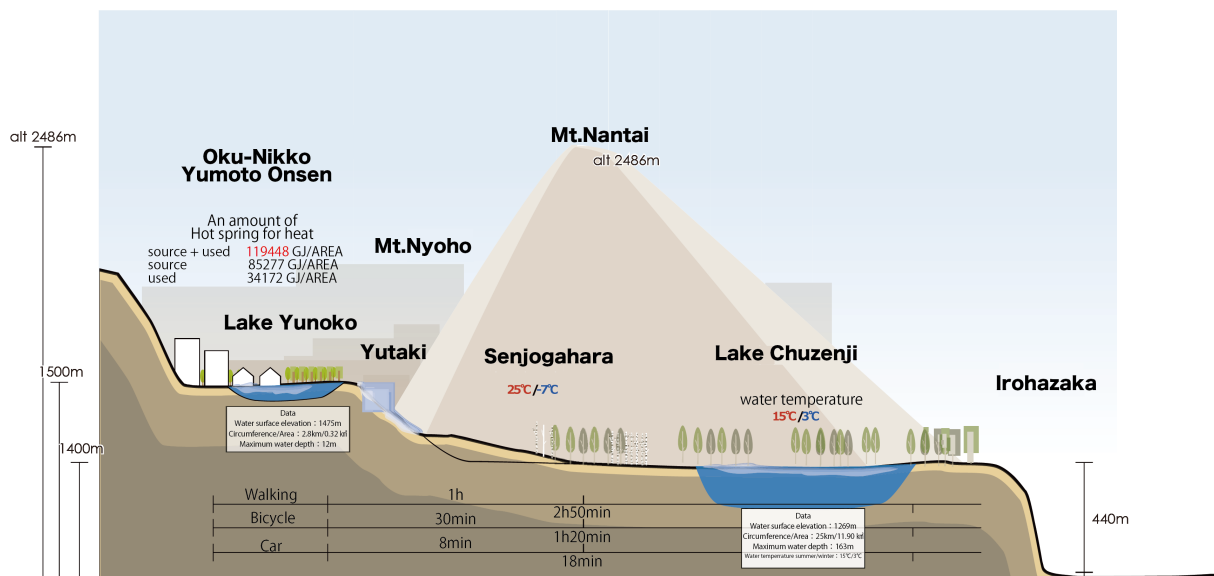


Figure 1. Oku-Nikko overview



Figure 2. Vacant building and Natural environment in Oku-Nikko

is about 8 ° C. lower than in urban area. Also here, many embassy villas line up on the shores of Lake Chuzenji from the Meiji to the early Showa period, has long been highly appreciated as a summer resort. Moreover, it is blessed with abundant nature such as lake and mountains, it is very rugged in a narrow range and various natural environments can be seen along with altitude altitude, so you can see the activities that made use of the nature such as hiking and fishing and a region where many tourists visit for hot springs with Nikko Yumoto as the source. On the other hand, the population decline continues due to young people moving out of the area and spontaneous declines continue, and the tourism industry, which is the subject of the local industry, faded compared to the past due to aging of facilities and labor shortage due to depopulation. As a result, in Oku - Nikko the number of empty

buildings is increasing. Therefore, by performing summer office, it is possible to effectively utilize vacant buildings and to lead to the revitalization of the area.

3. Building information in the Oku-Nikko area

3.1. Building survey overview

This study investigated the building information for each area by using A to G in figure 3 as a survey target, using a commercial residential map and map information on the Web, visual observation, hearing, and camera. This study made empty buildings where damage was not found in foundation, roof, opening that can be expected to be utilized as offices and houses during summer office.

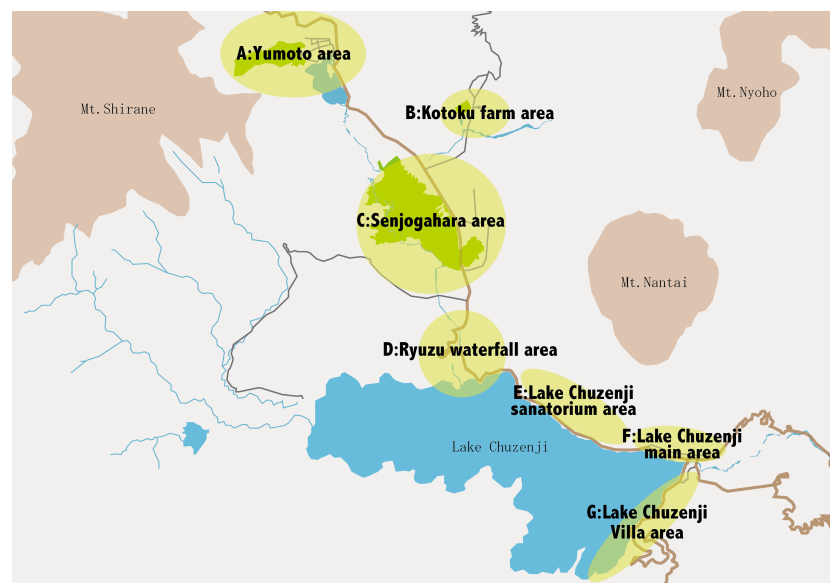


Figure 3. Oku-Nikko area map

3.2. Building survey result

Survey results are shown in table 1 and figure 4 to figure 6. This study surveyed 499 buildings in total in the Oku-Nikko area. In Nikko area overall, the number of commercial facilities was the most common, with 118 buildings, followed by 105 private and residential houses, followed by 88 accommodation facilities. According to the total floor space, the accommodation facility was the largest at 204550 m², followed by commercial facilities at 58010 m², followed by private housing and small housing at 18130 m². Because many industrial facilities and accommodation facilities were seen, it is understood that the tourism industry was active in the Oku-Nikko area. There are 31 empty buildings in total of 206 buildings in commercial facilities and accommodation facilities, the vacant building ratio is about 15%, which is about 5% higher than the average vacant store rate per shopping area across the country in 2017, and the decline of the tourism industry is revealed.

There are 56 empty buildings in the entire Oku-Nikko area, and 30 empty buildings can be expected to be utilized. 16 of the empty buildings that can be expected to be utilized were seen in F. In F, facilities such as hospitals, post offices, grocery stores, etc. were found and found to be the most convenient area in the Oku-Nikko area. In B, C and E, there are no empty buildings, B is a sightseeing spot mainly based on ranches. In C, there are large parking lots, souvenir shops, restaurants, public toilets, etc. It is crowded as a hiking center being held in Oku-Nikko such as Senjakagahara, it is inferred that there is no possibility of doing summer office, there is no need to do. In E, the number of empty buildings that can be expected to be utilized was 0, but there are 20 resort centers. The period of use of a recreation facility is short, so if a company holding a recreation facility during a period not in

use conducts a summer office at a recreation center or you can borrow a recreation center from the owner of a recreation center there is a possibility that you can do a summer office using a recreation center. In addition, there were vacant buildings that could be expected to be utilized, three in A, six in D, and five in G. A had 3 empty buildings that could be expected to be utilized, but there are large vacant buildings of 4 floors apartment trace and about 2,400 m² japanese hotel ruins, so there is a possibility that summer office can be done if they can be utilized. In D, there were one sanitary site, two commercial buildings, three individual houses and small housing dwellings. In G, there were five commercial facilities marks. From these facts, it turned out that there is a possibility that this study can perform summer office in A, D, E, F, G if this study can utilize vacant building and resort.

Table1. Number of buildings by facilities in each area

	A			B	C	D			E			F			G		
Application	(a)	(b)	(c)	(a)	(a)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
Cultural facilities	2	0	0	—	1	—			1	0	0	1	0	0	5	0	0
Sporting facilities	9	0	0	—	4	1	1	0	—			7	0	0	3	0	0
Educational facilities	—			—	—	—			—			2	0	0	1	0	0
Educational facilities (Monument)	1	0	0	—	—	—			—			—			—		
Religious facilities	2	0	0	—	—	1	0	0	—			4	0	0	4	0	0
Welfare facilities	—			—	—	—			—			1	0	0	—		
Medical facilities	—			—	—	—			—			1	0	0	—		
Office	—			—	—	—			—			4	0	0	—		
Testing・Research facilities	—			—	—	—			—			1	0	0	—		
Lodging facilities(not including sanatorium)	29	2	2	2	—	1	5	0	—			13	0	2	9	0	0
Sanatorium	—			2	—	4	0	1	20	1	0	—			—		
Commercial facilities	8	0	0	—	4	5	0	2	—			64	0	10	17	1	5
Transportation facilities	3	0	0	—	1	1	0	0	—			8	0	0	2	0	0
Distribution facilities(mainly warehouse)	6	4	0	11	—	11	0	0	—			31	0	0	7	0	0
General administrative facilities	—			—	—	—			—			2	0	0	—		
Special administrative facilities	9	0	0	—	—	2	0	0	—			3	0	0	—		
Private house・Small apartment house	4	0	0	1	—	8	1	3	—			64	11	3	10	0	0
Condominium(low layer)	1	0	1	—	—	—			—			3	0	0	—		
Dormitory	3	0	0	—	—	1	0	0	—			2	0	1	—		
Private house(Weekend house)	—			—	—	—			—			—			5	0	0
Special appliances facilities	5	0	0	—	—	1	0	0	1	0	0	1	0	0	—		
(a)Buildings are used (b)Vacant buildings where utilization can be expected (c) Vacant buildings where utilization can not be expected																	

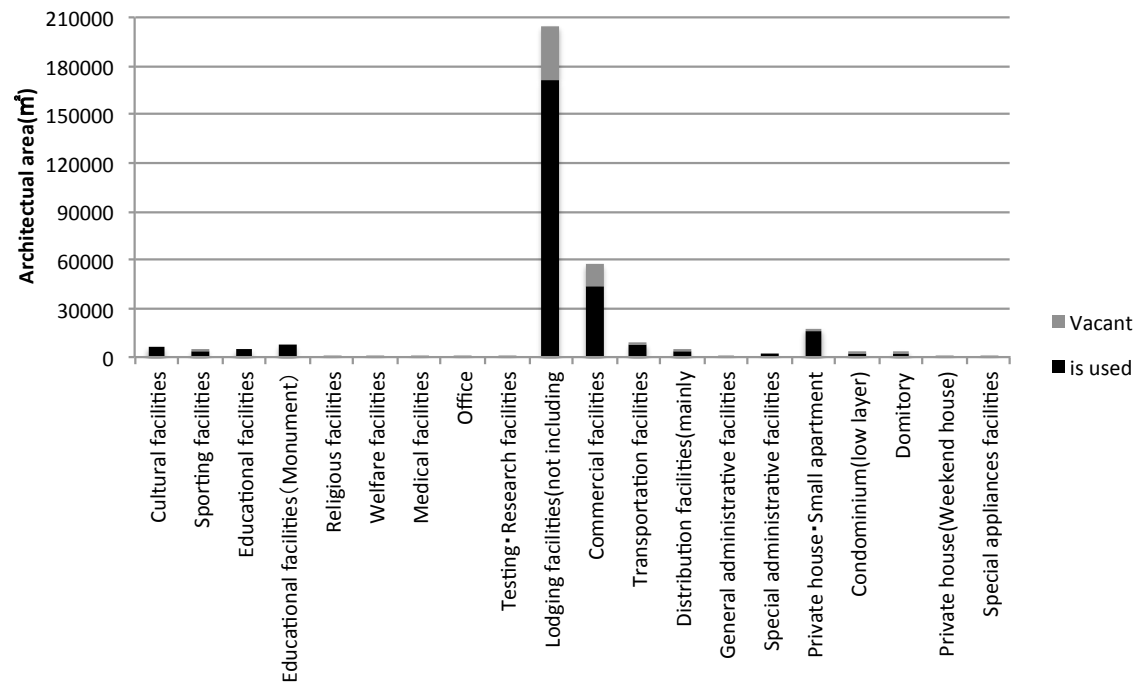


Figure4. Number of buildings by type in Oku-Nikko

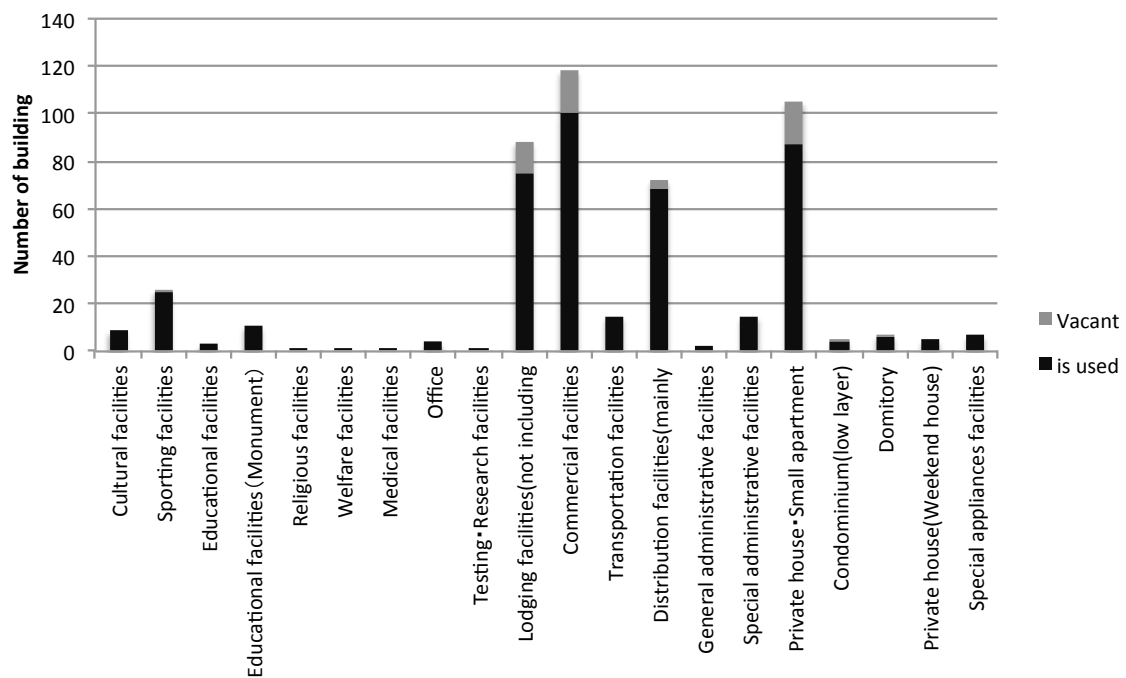


Figure5. Architectural area by type in Oku-Nikko

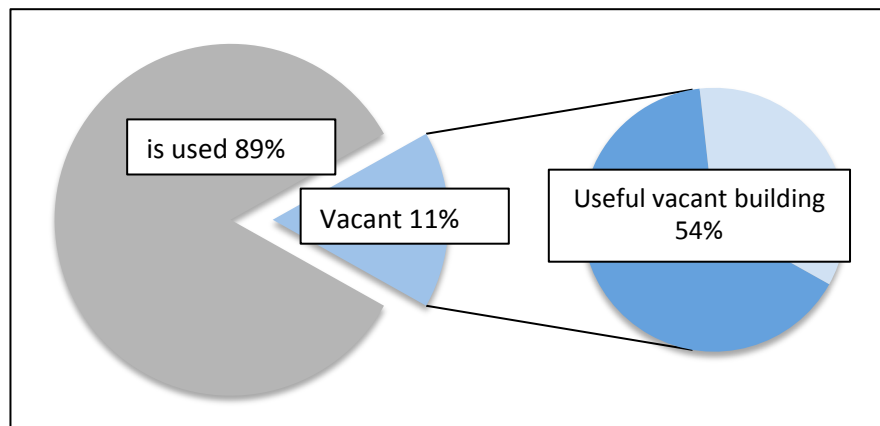


Figure6. Vacant building rate in Oku-Nikko area

4. Calculation of environmental effects by introducing summer office

4.1. Calculation summary

The summer office will be held for about 2 months in July and August, and 18 people working in small offices will do summer office. This study estimated the CO₂ emissions associated with air-conditioning and commuting in offices and houses that occurred within that period and compared it in cases in 23 wards of Tokyo and in Oku-Nikko area.

4.2. Calculation condition

In calculating the CO₂ emissions associated with air conditioning in offices and houses, the same building model was installed in the Oku Nikko area and 23 wards of the Tokyo office (2 stories, about 300 m²) (figure 7) and houses (3 stories, Approximately 30 sq. Per house, 18 apartment houses) (figure 8), respectively, and only the specifications were changed based on the area classification. Table 2 shows the differences between the area / solar classification and building specifications.

In calculating the CO₂ emissions associated with commuting, within the 23 wards of Tokyo, from the statistical data, average commuting time of people working in the Tokyo metropolitan area, commuting methods are 20 minutes by foot or by bicycle and 40 minutes by train Set and calculate CO₂ emissions. In Oku-Nikko, supposing that commuting is only for bicycles and walking, it is assumed that there is no emission of CO₂ relating to commuting. But, because CO₂ emissions occur from Tokyo to do summer office, the amount of CO₂ emissions generated during the round-trip will be taken as the CO₂ emissions caused by Oku-Nikko commuting. Calculation was carried out assuming the four methods shown in table 3 for the method of moving between Tokyo and Oku-Nikko. The distance between Tokyo and Oku Nikko is the distance between Tokyo Station and Lake Chuzenji, and the CO₂ emission intensity (g - CO₂ / person · km) is as follows. Private passenger car: 145, electric car: 67.7, train: 20, Shinkansen: 9.3, bus: 66. In addition, the CO₂ emission coefficient of TEPCO's 2016 value of 0.474 (kg-CO₂ / kwh) was used as the CO₂ emission coefficient when calculating CO₂ emissions from the cooling primary energy.

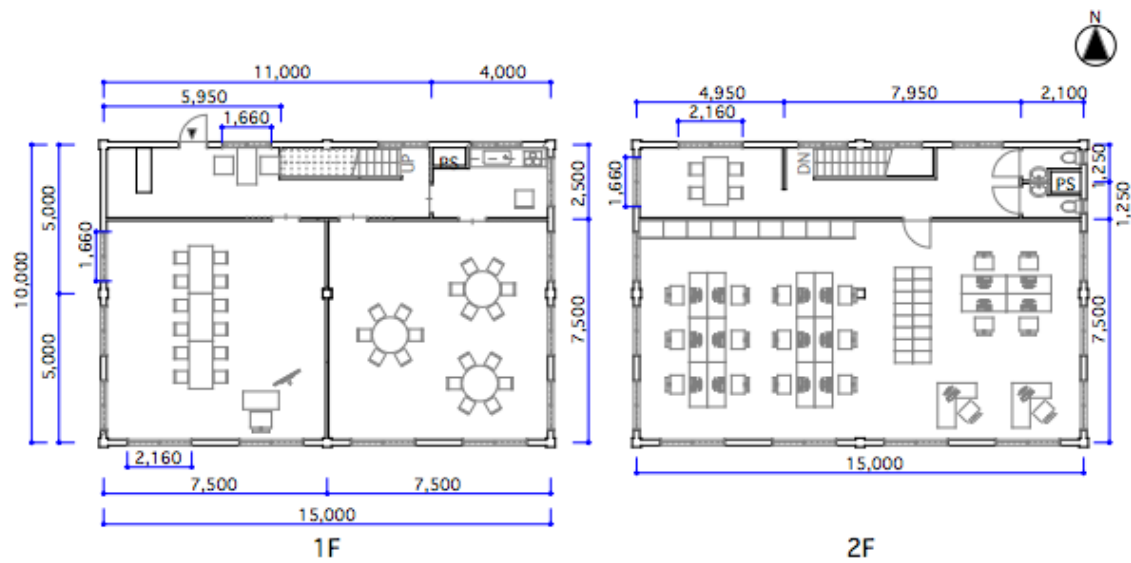


Figure 7. *Small office model plan view*

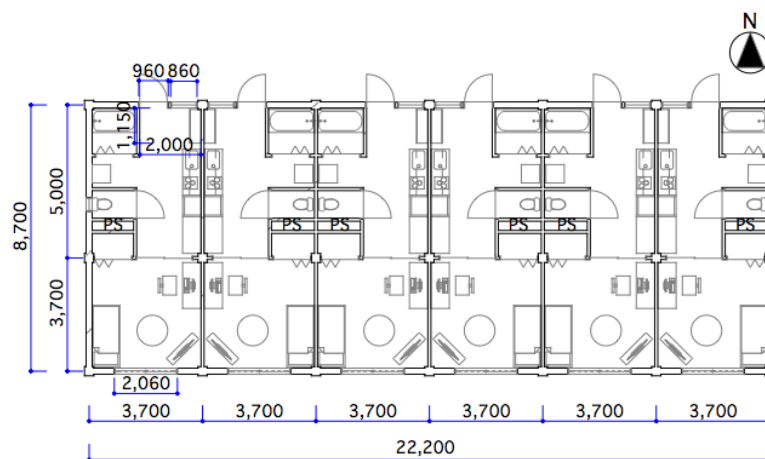


Figure 8. *Housing model standard plan view*

Table 2. *The Difference between Oku-Nikko and 23 wards of Tokyo of specifications of calculation model*

			Office		House
			Outer wall configuration		Thermal transmittance
	Area classification	Solar radiation classification	(roof)Extruded polystyrene foam insulation board type one thickness(mm)	(Outer wall)Extruded polystyrene foam insulation board type one thickness(mm)	Average thermal transmittance construction($W/m^2 \cdot K$)
Oku-Nikko area	1	A3	100	50	Two-layer multi-layer glass(Low-E 1sheet, Dry air, Solar radiation shielded, Width of hollow layer 6mm)
23 wards of Tokyo	6	A3	50	25	Single sheet glass

Table 3. *How to transport between Tokyo and Oku-Nikko*

	Form of transportation
(i)	Transport from Tokyo station to Lake Chuzenji by car 179 km via Tohoku Highway
(ii)	Transport from Tokyo station to Lake Chuzenji by electric car 179 km via Tohoku Highway
(iii)	Transport 109.5 km from Tokyo station to Utsunomiya station by Shinkansen, move by train to 40.5 km from Utsunomiya station to JR Nikko station, 19.6 km from JR Nikko station by bus to Lake Chuzenji
(iv)	Transport 10.3 km from Tokyo station by train to Shinjuku station, 134.9 km from Shinjuku station by express train to Tobu Nikko station, 19.9 km from Tobu Nikko station by bus to Lake Chuzenji

4.3. Calculation result

Table 4 shows the cooling load of the office with and without outside air cooling in the Oku-Nikko area and 23 wards of Tokyo. In both areas the cooling load was lower in the case of outdoor air conditioning, but the difference between being and doing is 18.18 (MJ / m²) in the Oku-Nikko area and 17.34 (MJ / m²) in the 23 wards of Tokyo and the area There was not much difference. In the case of no outside air cooling, the Oku-Nikko area was 181.46 (MJ / m²) smaller than the 23 wards of Tokyo, the cooling load became smaller. There was a big difference depending on the transfer method for CO₂ emissions from Tokyo and Oku-Nikko. (table 5) The largest amount of CO₂ emissions was 934.38 (kg-CO₂) when using the private passenger car in (i), the reason why the smallest CO₂ emissions were made was by using the Shinkansen and bus of (iii) It was 112.39 (kg-CO₂) when traveling by transportation. The CO₂ emissions of electric vehicles of (ii) which seems to increase users from now will be 436.26 (kg - CO₂), which is about half of (i).

Figure 9 and figure 10 show the comparison of the total CO₂ emissions in air conditioning and commuting in offices and houses. For calculation results, CO₂ emissions from air conditioning in the office were used when there was no outside air cooling, and (i) was used for movement between Tokyo and Oku-Nikko. The total value of CO₂ emissions is about 14.11 (t - CO₂) in the 23 wards of Tokyo, about 4.24 (t - CO₂) in the Oku - Nikko region, it was found that there is a possibility of reducing CO₂ emissions of about 9.87 (t - CO₂), which is about 70%, by implementing a summer office of about 2 months.

Table 4. *Cooling load of office*

Case	Cooling load (MJ/m ²)		CO ₂ emissions (kg-CO ₂)
Oku-Nikko area (Without outside air cooling)	61.32	(i)	934.38
Oku-Nikko area (With outside air cooling)	43.14	(ii)	436.26
23 words of Tokyo (Without outside air cooling)	242.78	(iii)	112.39
23 wards of Tokyo (With outside air cooling)	225.44	(iv)	151.83

Table 5. *CO₂ emissions of moving*

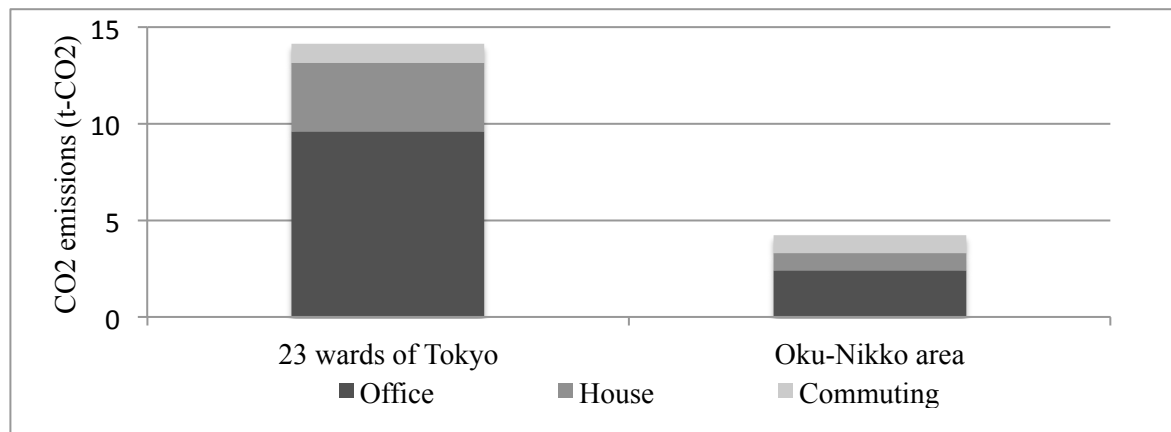


Figure 9. Comparison of CO2 emissions in 23 wards of Tokyo and Oku-Nikko

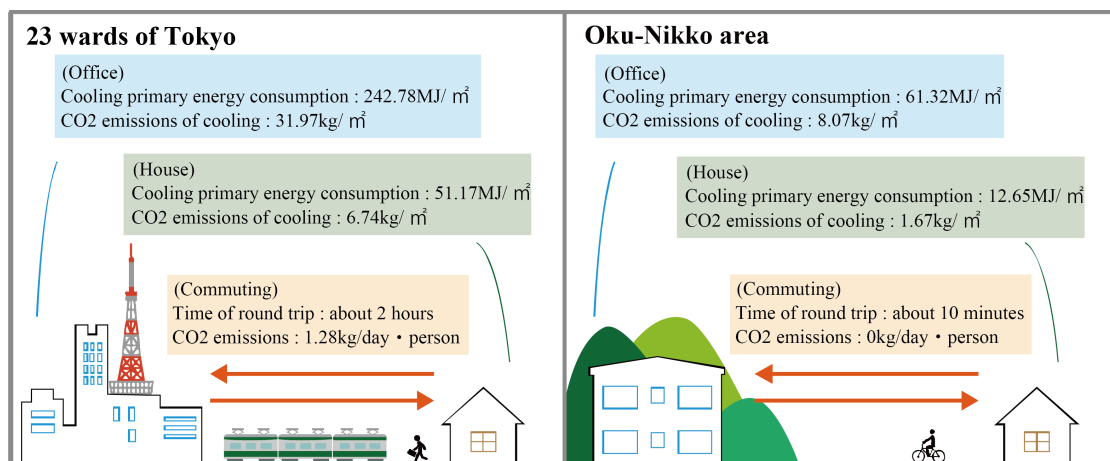


Figure 10. Image of summer office effect

5. Conclusion

In this study, there is a possibility that people working in the downtown work in the summer resort summer resort, so there is a possibility of reducing environmental burden and there are many empty buildings that can be expected to be utilized in Oku-Nikko revealed. As a future prospect, this study will consider improvement of work life balance by reduction of commuting time brought by summer office, a quantitative estimate on secondary effects such as health effects and other effects on humans and economic effects on the Oku-Nikko area.

References

- [1] General Public Building Association 2017 Facility use classification
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- [4] Statistics Bureau of the Ministry of Internal Affairs and Communications 2016 Survey on Social Life - Results on Life Time -