

Supplement information of

“Evaluating Decarbonization Scenario and Energy Management Requirement for the Residential Sector in Japan through Bottom-up Simulations of Energy End-use Demand”.

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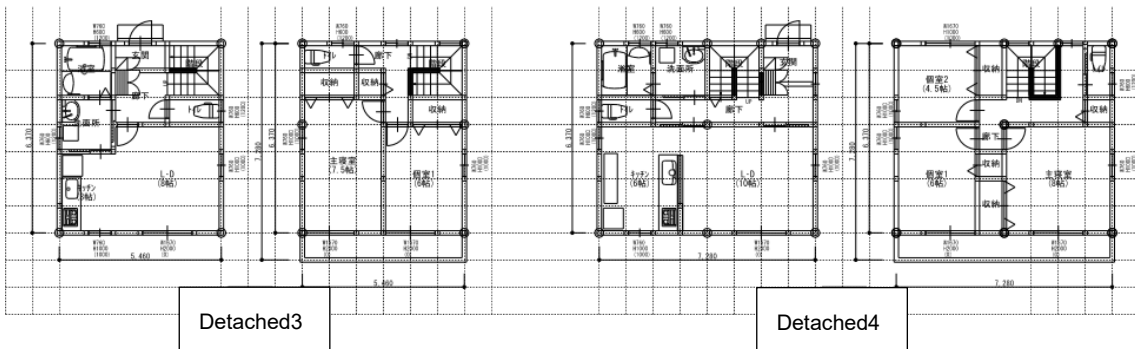
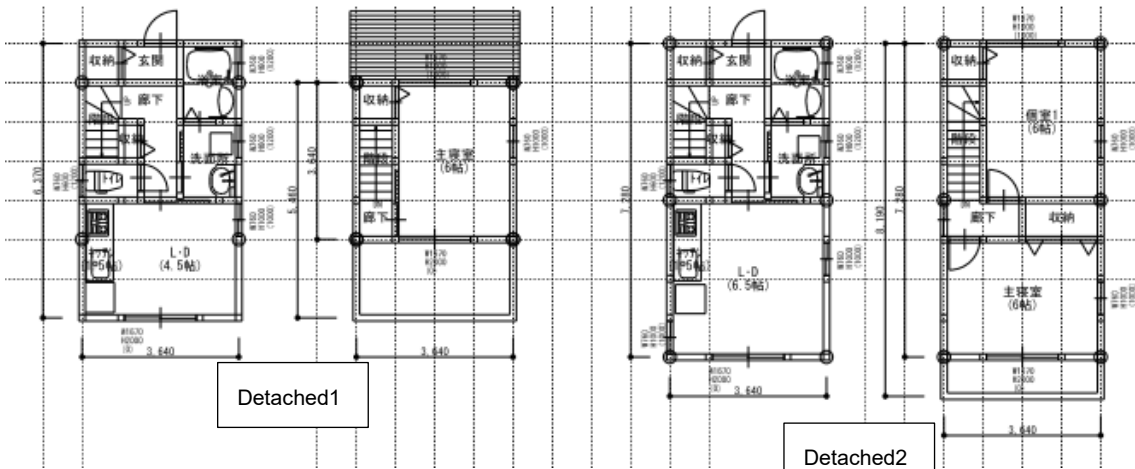
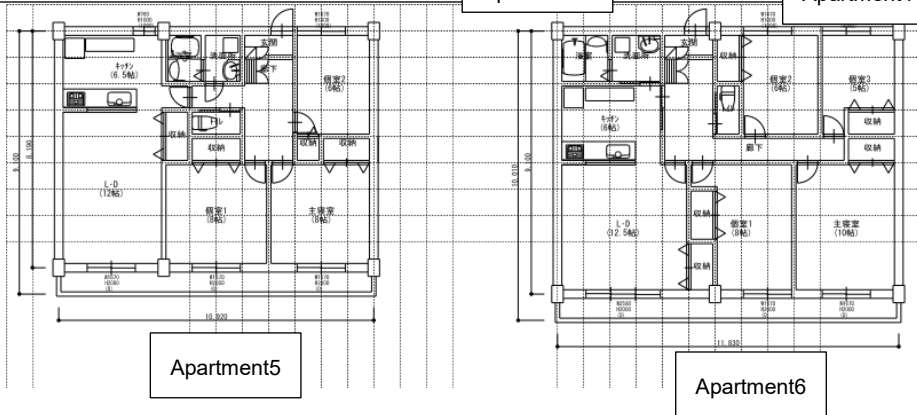
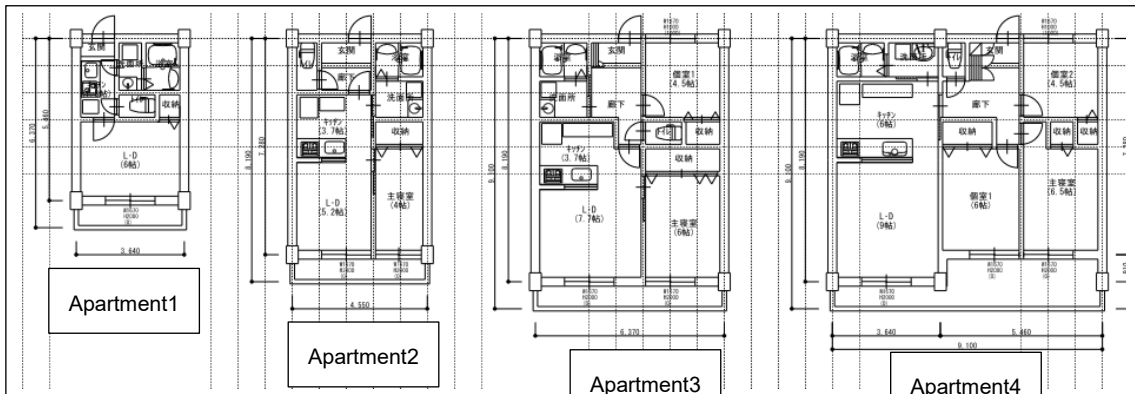
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Table S1 Details of representative house used in TREES.

House Type	Floor Area [m <sup>2</sup> ]	Room Layout	Name	Floor area of each room [m <sup>2</sup> ]												
				Living Room	Kitchen	Bathroom	Lavatory	Toilet 1	Toilet 2	Master's bedroom	Bedroom 1	Bedroom 2	Bedroom 3	Bedroom 4	Corridor & Staircase	Total
Apartment	~20	1K	Apartment1	9.94	2.48	2.48	1.66	1.24							2.07	19.87
	20~40	1LDK	Apartment2	8.70	6.21	2.48	2.48	1.66		6.62					4.97	33.12
	40~60	2LDK	Apartment3	12.84	6.21	2.48	2.48	1.24		9.94	7.45				7.04	49.68
	60~80	3LDK	Apartment4	14.91	9.94	2.48	2.48	1.24		10.77	9.94	7.45			7.87	67.08
	80~100	3LDK	Apartment5	19.87	10.77	2.48	2.48	1.66		13.25	13.25	9.94			10.77	84.47
	100~150	4LDK	Apartment6	20.70	9.94	3.31	3.31	1.66		16.56	13.25	9.94	8.28		14.08	101.03
Detached	~40	1LDK	Detached1	7.45	2.48	2.48	2.48	1.24		9.94					9.53	35.60
	40~60	2LDK	Detached2	10.77	2.48	2.48	2.48	1.24		9.94	9.94				11.18	50.51
	60~80	2LDK	Detached3	13.25	4.97	3.31	3.31	3.32		12.42	9.94				15.74	66.26
	80~100	3LDK	Detached4	16.56	9.94	3.31	3.31	1.66	1.66	13.25	9.94	7.45			21.53	88.61
	100~120	4LDK	Detached5	16.56	9.94	3.31	3.31	1.66	1.66	13.25	9.94	9.94	9.94		24.84	104.35
	120~150	5LDK	Detached6	22.36	9.94	3.31	3.31	1.66	1.66	16.56	13.25	9.94	8.28	10.77	22.36	123.40



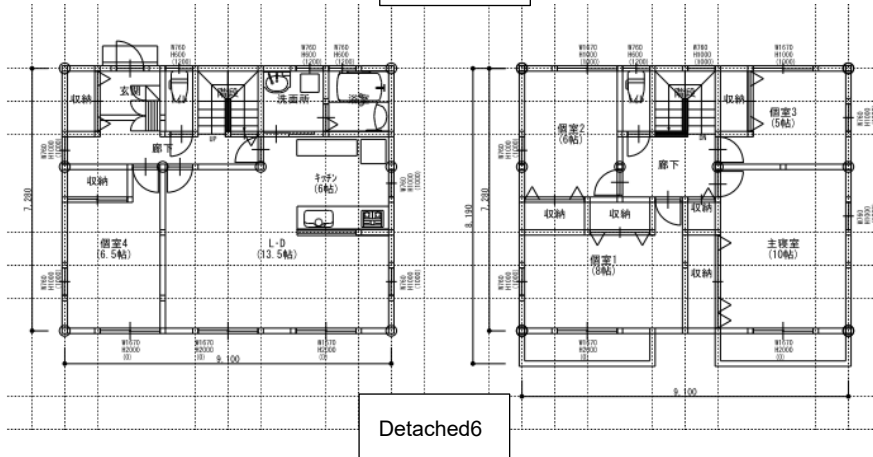
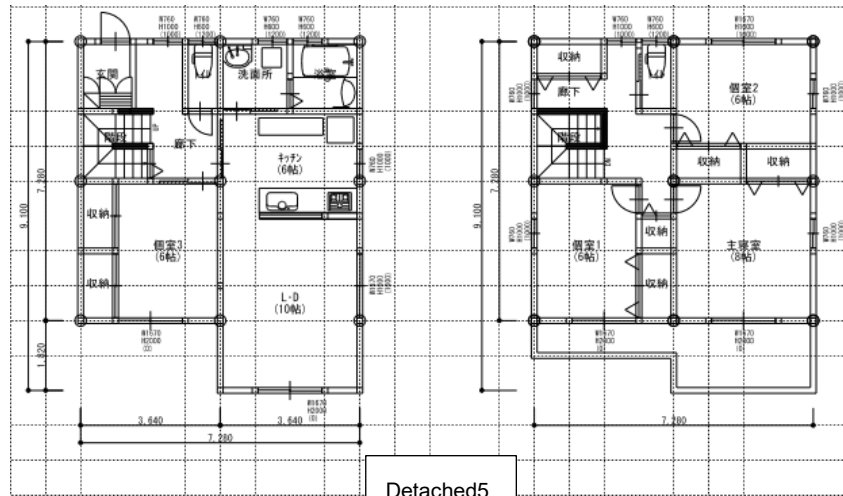


Figure S1 Plan of each representative house

Table S2 Categories of family member used in the TREES model.

Attribute	Description	Classification method	Categories
Worker (Male)	Male aged 20 to 64 with non-self-employed jobs	Classified by the characteristics of working hours	Work in the morning and afternoon
			Long working hours
			Work from afternoon to evening
Worker (Female)	Female aged 20 to 64 with non-self-employed jobs	Classified by the characteristics of working hours	Work in the morning and afternoon
			Work from afternoon to evening
			Part-time work in the morning
			Part-time work in the morning and afternoon
Homemaker	Homemaker aged 20 to 64	Age, with or without children living together and age of children	Under 45 and no children
			Over 45 and no children
			With children under 7 years old
			With children from 7 to 18
			With children over 18
Student (Male)	Male attending school	Age	Elementary school
			Junior high school
			High school
			Collage, Vocational, Graduate school
Student (Female)	Female attending school	Age	Elementary school
			Junior high school
			High school
			Collage, Vocational, Graduate school
Person of 65 years or older (Male)		Number of family member	Single
			More than two
Over 65 years of age or older (Female)		Number of family member	Single
			More than two

From Japanese time-use survey (Statistic Bureau, Ministry of Internal Affairs and Communications, Japan; (2006) Survey on Time Use and Leisure Activities), time use of each attribute was classified into some categories shown in this table and used for input data of TREES.

Table S3 Relationship between Behavior and Appliance use and room

Behavior	Appliance operated with the behavior	Room of behavior
Sleeping		Bedroom
Dining	Television	Living room
Face-wash		Lavatory
Bathing		Bathroom
Change of clothes		Bedroom
Inaction (Living room)		Living room
Study/Reading	Small lamp	Bedroom
Cooking	Rice-cooker, Gas/IH stove, Microwave, Toaster, Exhaust fan	Kitchen
Washing dishes	Dishwasher and dryer	Kitchen
Cleaning(Living room)	Vacuum cleaner	Living room
Washing clothes	Washing machine/dryer	Lavatory
Ironing	Clothes iron	Living room
Blow-dry hair	Hair dryer	Lavatory
TV watching(Living room)	Television	Living room
TV watching (Bedroom)	Television	Bedroom
Listening Radio/CD (Living room)	Audio system	Living room
PC use (Living Room)	Personal computer	Living room
PC use (Bedroom)	Personal computer	Bedroom
Listening Radio/CD (Bedroom)	Audio system	Bedroom
Watching Video	Television, VCR	Living room
Inaction (Bedroom)		Bedroom
Taking shower		Bathroom

Table S4 Relationship between appliance and installation location

Appliance/ Room	Living Room	Kitchen	Lavatory	Bathroom	Corridor	Toilet	Exterior	Master Bedroom	Bedroom 1	Bedroom 2	Bedroom 3	Bedroom 4
Lighting	1	1	1	1	1	1	1	1	1	1	1	1
Refrigerator		1										
Rice cooker		1										
Electric Kettle		1										
Microwave		1										
Toaster		1										
Gas Stove		1										
IH Stove												
Exhaust fan		1										
Television	1							1	1	1	1	1
Washing Machine			1									
Cloth dryer			1									
Hair dryer			1									
Small lamp	1											
Vacuum cleaner	1											
Clothes iron	1											
Shower toilet						1						
VCR	1											
Audio system	2							1	2	2	2	2
24-h ventilation system					1							
Personal computer	2							1	2	2	2	2
PC peripherals								1				
Satellite TV tuner	1											
Telephone	1											
Electric foot warmer	1											
Electric carpet	1											

1: Both Operation electricity and Stand-by power are occurred.

2: Only Operation electricity is considered.

Table S5 Fluorescent lamp power consumption in each room

House Type	Name	Capacity of Fluorescent lamp [w/room]												
		Living room	Kitchen	Bathroom	Lavatory	Toilet 1	Toilet 2	Master bedroom	Bedroom 1	Bedroom 2	Bedroom 3	Bedroom 4	Corridor and	Exterior
Apartment	Apartment 1	62	39	10	10	10	-	-	-	-	-	-	10	-
	Apartment 2	62	39	10	17	10	-	59	-	-	-	-	20	-
	Apartment 3	70	39	10	17	10	-	62	59	-	-	-	30	-
	Apartment 4	124	49	10	17	10	-	62	62	59	-	-	40	-
	Apartment 5	132	49	10	17	10	-	70	70	62	-	-	50	-
	Apartment 6	132	49	10	20	10	-	84	70	62	59	-	60	-
Detached	Detached 1	59	49	10	17	10	-	62	-	-	-	-	31	20
	Detached 2	62	49	10	17	10	-	62	62	-	-	-	41	20
	Detached 3	121	49	10	20	10	10	70	62	-	-	-	51	20
	Detached 4	124	49	10	20	10	10	70	62	59	-	-	81	20
	Detached 5	124	49	10	20	10	10	70	62	62	62	-	81	20
	Detached 6	132	49	10	20	10	10	84	70	62	59	62	71	20



Table S6 Household percentage of lighting status in daytime

House type	Daylight utilization*	Lighting Status	Living room	Bedroom
Detached house	Yes	Always ON	44.8%	19.0%
		Depends on the illuminance level	41.4%	44.0%
		Always OFF	13.8%	36.9%
	No	Always ON	95.5%	92.0%
		Depends on the illuminance level	4.5%	0.0%
		Always OFF	0.0%	8.0%
Apartment house	Yes	Always ON	30.8%	18.4%
		Depends on the illuminance level	51.8%	44.5%
		Always OFF	17.4%	37.1%
	No	Always ON	100.0%	79.5%
		Depends on the illuminance level	0.0%	4.5%
		Always OFF	0.0%	15.9%

\* Daylight utilization:

In living room, Yes : No = 91.4% : 8.6%

In bedroom, Yes : No = 91.4% : 8.6%

Table S7 Amount of hot water supply by each behavior

	Hot water supply amount [liter/behavior]			Hot water temperature [°C]		
	Winter	Summer	Mid- season	Winter	Summer	Mid- Season
Face-wash	14.9	18.4	15.6	40	40	40
Bath with bathtub	42.0	48.5	45.5	40	40	40
Shower	42.0	48.5	45.5	40	40	40
Cooking and washing dishes	16.5	16.8	16.5	40	40	40
Bathtub-filling	189.0	184.0	190.0	40	40	40

Table S8 Thermal Insulation levels of walls

Thermal Resistance [m <sup>2</sup> ·K/W]		Apartment house			Detached house		
		Ceiling	Exterior Wall	Floor	Ceiling	Exterior Wall	Floor
I	No insulation	0.63	0.56	0.44	1.40	1.10	1.10
	1980 Standard	1.25	1.13	0.88	2.80	2.20	2.20
	1992 Standard	2.92	1.72	2.15	4.39	2.49	2.49
	1999 Standard	3.60	2.30	2.20	5.70	3.30	3.30
II	No insulation	-			-		
	1980 Standard	0.75	0.75	0.50	1.30	0.90	0.80
	1992 Standard	1.63	0.95	1.03	1.72	0.95	1.03
	1999 Standard	2.70	1.80	1.80	4.00	2.20	3.30
III	No insulation	-			-		
	1980 Standard	0.75	0.75	0.50	1.30	0.90	0.90
	1992 Standard	1.12	0.95	1.03	1.29	0.95	1.03
	1999 Standard	2.50	1.10	1.50	4.00	2.20	2.20
IV	No insulation	-			-		
	1980 Standard	0.63	0.50	0.13	0.90	0.60	0.50
	1992 Standard	1.12	0.77	0.52	1.29	0.95	1.03
	1999 Standard	2.50	1.10	1.50	4.00	2.20	2.20
V	No insulation	-			-		
	1980 Standard	0.63	0.00	0.00	0.30	0.00	0.00
	1992 Standard	1.12	0.52	0.34	1.29	0.52	0.34
	1999 Standard	2.50	1.10	1.50	4.00	2.20	2.20
VI	No insulation	-			-		
	1980 Standard	-			-		
	1992 Standard	1.12	0.00	0.00	1.29	0.00	0.00
	1999 Standard	2.50	0.30	0.00	4.00	2.20	0.00

Table S9 Thermal Insulation Levels of Window

		Climate region classification					
		I	II	III	IV	V	VI
No insulation	Overall heat transmission coefficient of window [m <sup>2</sup> •K/W]	3.49	4.07	6.98	6.98	6.98	6.98
	Shading coefficient of radiation (SCR) [-]	0.46	0.46	0.49	0.49	0.49	0.49
	Shading coefficient of convection (SCC) [-]	0.15	0.15	0.14	0.14	0.14	0.14
1980 Standard	Overall heat transmission coefficient of window [m <sup>2</sup> •K/W]	3.49	4.07	6.98	6.98	6.98	6.98
	Shading coefficient of radiation (SCR) [-]	0.46	0.46	0.49	0.49	0.49	0.49
	Shading coefficient of convection (SCC) [-]	0.15	0.15	0.14	0.14	0.14	0.14
1992 Standard	Overall heat transmission coefficient of window [m <sup>2</sup> •K/W]	2.33	3.49	4.65	6.51	6.51	6.51
	Shading coefficient of radiation (SCR) [-]	0.44	0.46	0.46	0.49	0.49	0.49
	Shading coefficient of convection (SCC) [-]	0.18	0.15	0.15	0.14	0.14	0.14
1999 Standard	Overall heat transmission coefficient of window [m <sup>2</sup> •K/W]	2.33	2.33	3.49	4.65	4.65	6.51
	Shading coefficient of radiation (SCR) [-]	0.42	0.42	0.39	0.39	0.39	0.34
	Shading coefficient of convection (SCC) [-]	0.17	0.17	0.12	0.12	0.12	0.11

Climate Region (Prefecture):

I : Hokkaido

II : Iwate, Aomori, Akita

III: Miyagi, Fukushima, Yamagata, Ibaragi, Tochigi, Gunma, Yamanashi, Niigata, Toyama, Ishikawa, Fukui, Shiga, Nagano

IV: Saitama, Chiba, Tokyo, Kanagawa, Shizuoka, Gifu, Aichi, Mie, Kyoto, Nara, Osaka, Hyogo, Wakayama, Tottori, Shimane, Okayama, Hiroshima, Kagawa, Ehime, Tokushima, Kochi, Yamaguchi, Fukuoka, Saga, Nagasaki, Kumamoto, Oita

V : Miyazaki, Kagoshima

VI: Okinawa