Osaka Gas Experimental Housing

NEXT21

NEXT21 is an experimental housing project built in 1993 by Osaka Gas Co., Ltd. Its purpose is to propose and demonstrate an ideal style of urban multi-unit housing for the near-future society, emphasizing environmental protection, energy-saving comfort for residents and the ability to satisfy evolving individual and societal needs. Our employees and their families are actually living in NEXT 21, and their hands-on experiences with advanced residential environment and facilities have provided the opportunity to analyze and verify new concepts for sustainable multi-unit housing.

History of Osaka Gas' Experimental Housing Projects

1968

Higashi-Toyonaka Experimental Housing

Japan was enjoying unprecedented rapid economic growth when Osaka Gas built this residential complex based on a 10-year future projection. Each dwelling unit is approximately 80 square meters in size, with three bedrooms, and uses modular fittings. Various experiments involving then-advanced facilities and methods were conducted and evaluated, including a central heating system, shared air ventilation ducts, snap-on gas connectors, an automatic remote gas meter reading system, an energy consumption measurement system and work-flow planning of kitchen design.

Site area: 1,449 square meters
Building area: 376 square meters
Total floor area: 2,624 square meters
Number of stories: Six stories above ground and one story underground
Number of dwelling units: 24

1985

Ideal House NEXT

The main themes of this project were: (1) energy efficiency, (2) home-automation and information systems, (3) elderly-friendly housing, and (4) security of dwellers' safety and good health.
To realize these goals, this house introduced high-performance insulating materials, an airtight structure, movable walls and partition furniture. Other experimental systems introduced in this house included a condensing water heater, gas-powered heat pump, chillers utilizing subterranean (geothermal) heat, home automation systems and a fluidic gas meter. The performances of these applications were tested.

Site area: 585 square meters
Building area: 101 square meters
Total floor area: 178 square meters
Number of stories: Two-story house

NEXT21

1990 — NEXT21 Project launched in February; Planning
1991
1992 — Construction
1993 — Completion in October; Released to the public

1994 Phase 1

16 dwelling units

Seeking to simultaneously realize "amenity" and "energy-saving, environmentally-friendly living"

1995
1996 — Experimental remodeling of outer walls. (Unit #402)
1997
1998 — Briefing session in August
1999 — Remodeling; Released to the public; Written report issued in November

| Phase 2 |

2000 Phase 2

16 dwelling units

Special consideration of global environment and comfortable daily living

2001
2002 — Experimental movable infill (interior fit-out) renovation with participation of the residents concerned (Unit #405, 603)
2003
2004 — Briefing session in November
2005
2006 — The NEXT21 (book) published in December; Remodeling; Released to the public

| Phase 3 |

2007 Phase 3

16 dwelling units

Housing and energy systems to support sustainable urban living

2008 — Glass Cube; Experimental movable infill renovation
2009 — Briefing session in August and September
2010 — Renovation project with Unit #304 ("A house for taking over"-adaptable housing for different families and different generations)
2011 — Briefing session and release in October (Unit #304 "House for taking over" through renovation)
2012 — Remodeling

| Phase 4 |

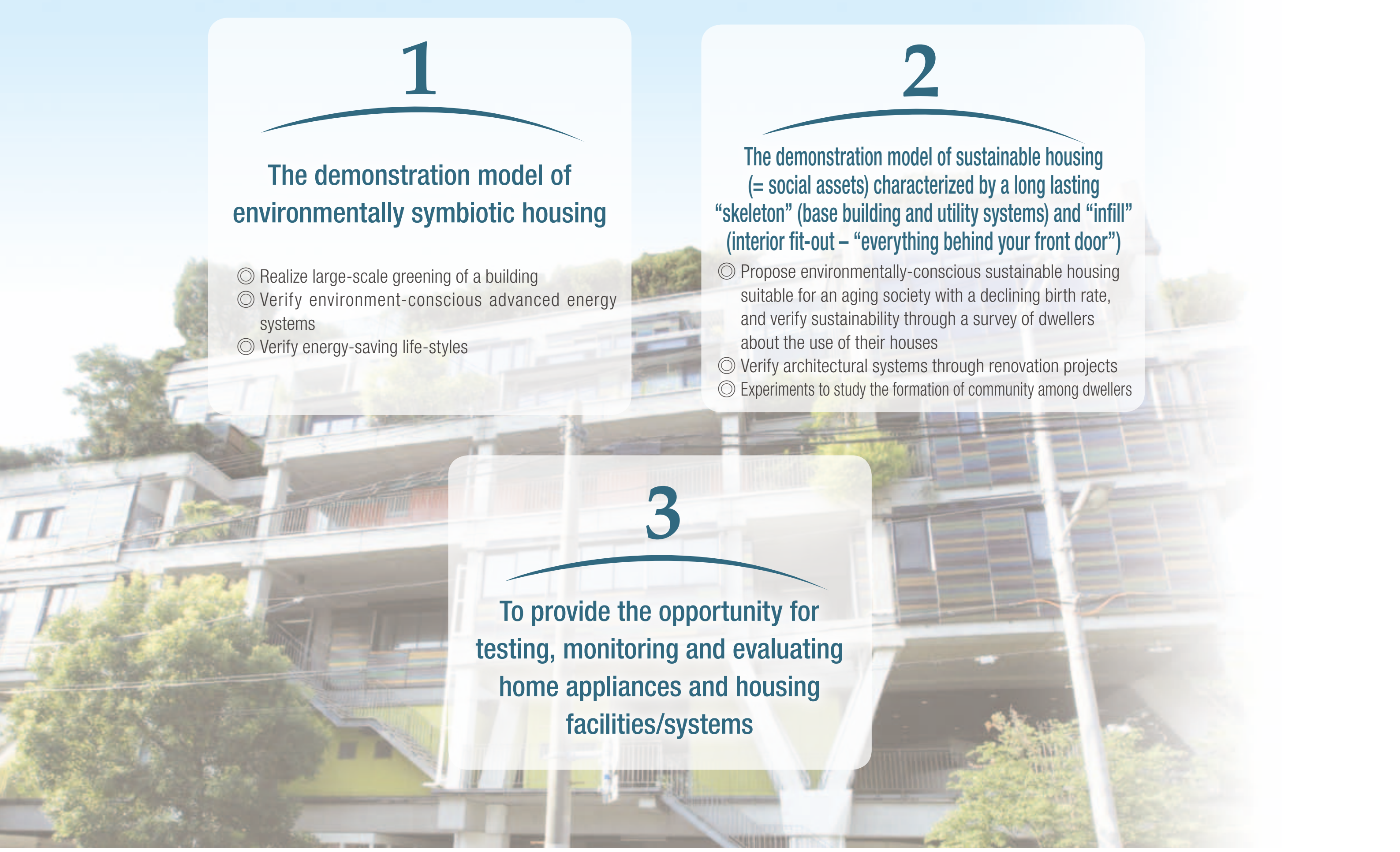
Phase 4 2013

Environmentally friendly, spiritually rich living

Urban multi-unit housing encouraging close relationships among people, nature and energy.

The significance of NEXT 21 and the results of the residential experiments:

- NEXT21 has three points of major significance.
- We have had many achievements and have obtained many findings during the period from Phase 1 to Phase 3.



1

The demonstration model of environmentally symbiotic housing

◎ Realize large-scale greening of a building
◎ Verify environment-conscious advanced energy systems
◎ Verify energy-saving life-styles

2

The demonstration model of sustainable housing (= social assets) characterized by a long lasting "skeleton" (base building and utility systems) and "infill" (interior fit-out – "everything behind your front door")

◎ Propose environmentally-conscious sustainable housing suitable for an aging society with a declining birth rate, and verify sustainability through a survey of dwellers about the use of their houses
◎ Verify architectural systems through renovation projects
◎ Experiments to study the formation of community among dwellers

3

To provide the opportunity for testing, monitoring and evaluating home appliances and housing facilities/systems

The themes and major results of respective phases

Theme	Phase 1 (FY1994 to 1998) Seeking to simultaneously realize "amenity" and "energy-saving, environmentally-friendly living"	Phase 2 (FY2000 to 2004) Special consideration of global environment and comfortable daily living	Phase 3 (FY2007 to 2011) Housing and energy systems to support sustainable urban living
The demonstration model of the environmentally symbiotic housing	• 22 species of wild birds and 21 species of wild plants were identified on site. • Energy consumption in the entire building was reduced by 27% through the gas-powered equipment (together with the use of phosphoric acid fuel cells, solar panels and batteries) and high-performance insulation. • Water consumption was reduced by 19% through recycling of waste-water.	• A survey was conducted regarding residents' involvement in green zone management. • Energy consumption in the entire building was reduced by 30% through the introduction of CHP (Combined Heat and Power) systems. • An assessment was conducted on the performance of the kitchen sink disposer (kitchen refuse processing) system for the disposed paper and plastic materials.	• Energy consumption was reduced by 12% through electricity interchanges among dwelling units with the use of hydrogen fuel cell-powered CHP units. • Energy consumption was reduced by 15% through heat interchanges among dwelling units with the use of CHP systems. • Energy consumption was reduced by 73% through the introduction of energy-saving lifestyles including the use of renewable energy.
The demonstration model of sustainable housing (= social assets) characterized by a long lasting "skeleton" (base building and utility systems) and flexible "infill" (interior fit-out – "everything behind your front door")	• A series of renovation projects with direct user participation demonstrated the capacity of the skeleton-infill (open building) principle to accommodate varied household requirements and provide high-level user satisfaction. • The ability of proposed floor plans and infill solutions to satisfy needs of dwellers was verified.	• Two types of renovation were conducted; a major renovation to divide one dwelling into two and a simple remodeling with infill rearrangement. • An experimental housing project for a SOHO (small office home office) worker/resident was conducted.	• House convenient for taking over (adaptable housing for different families and different generations) was created, as a solution to problems of the aging society with a declining birth rate. • An experiment to promote exchanges among local communities was conducted through the use of showcase exhibitions focused on local cultural/historical resources (U-CoRo or Uemachidaichi Communication Room).
To provide the opportunity for testing, monitoring and evaluating home appliances and housing facilities/systems	• 36 items of home appliances and residential systems were commercialized.	• A project to demonstrate PEFC (polymer electrolyte fuel cell for home use) was conducted. • Energy consumption was reduced by 10% through the introduction of systems that enable visualization of energy use.	• A project to demonstrate SOFC (solid oxide fuel cell for home use) was conducted using three types of SOFC designed for multi-unit housing projects, to confirm the feasibility of the three types in terms of installation and maintenance operations.

NEXT21

The Concept of Phase 4

Environmentally friendly, spiritually rich living

Urban multi-unit housing encouraging close relationships among people, nature and energy

What are ideal housing and energy systems for the future?

Phase 4 of NEXT21 seeks to ensure sustainability up to 2020 by realizing an ideal urban multi-unit housing type that ensures “environmentally-friendly spiritually rich living.”

To this end, the relationship among people, nature, energy and housing is reviewed. We continue our experimental projects to “create people’s network,” “reconstruct relationship between people and nature” and “realize a smart, energy-saving style of living.”

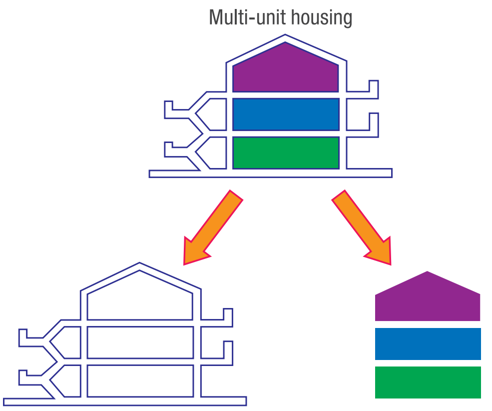
Securing flexibility and long life of housing

Construction system of NEXT21

In order for housing to have a long life, not only physical durability of the base building but also capacity to meet varying requirements are required. Housing can be sustainable for a long period of time if its parts are renewable to satisfy changing needs of dwellers and society. Such sustainable housing can be a social asset, as it can also contribute to reduction of waste generation. A durable skeleton (base building) combined with variable and adaptable infill constitutes a new value–different from a conventional real estate value of land or building–which makes the investment all the more attractive. As an advanced multi-unit housing project responding to the long-term needs of a sustainable society, NEXT21 employs a unique construction system characterized by separation of its skeleton (base building) from cladding (outer walls, etc.) and infill (interior fit-out).

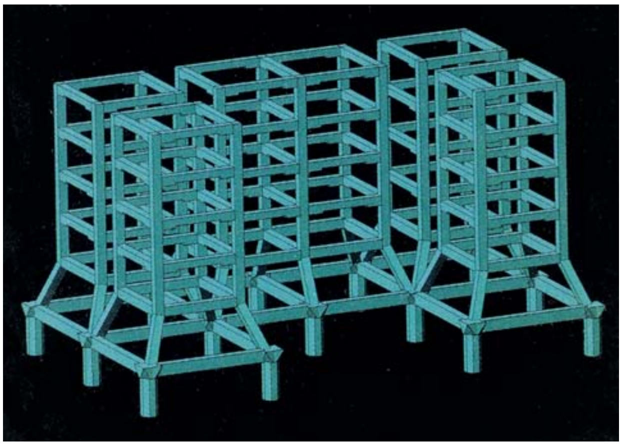
Skeleton-infill construction

Separation of the skeleton (base building) from infill (interior fit-out) ensures efficient renovation without risk of damaging the skeleton which is required to have a long life.



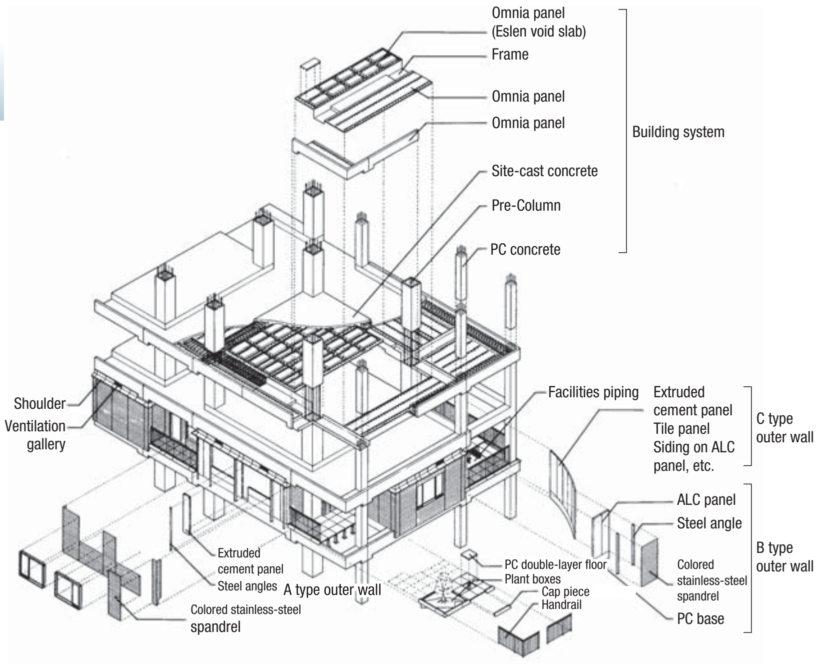
Skeleton of NEXT21

The residential zone on and above the 3rd floor consists of six “towers” of 7.2 by 7.2 meters square, standing 3.6 meters apart from each other.



Systems Building

NEXT21 uses components such as modular outer walls (cladding system), which can be replaced or rearranged easily from inside, and also can be recycled. All components are of modular design. Of particular importance is that the skeleton was designed by one team, the cladding system by another team, and still different designers are responsible for the design of each dwelling, following the “rules” for positioning infill and cladding elements developed by their respective teams.



Securing high-quality of the skeleton

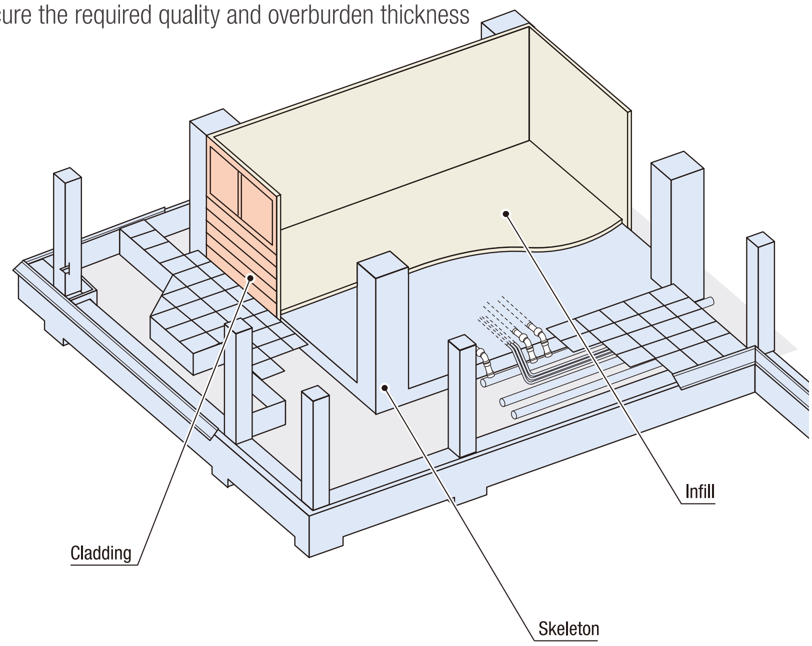
With high quality materials and the well-designed skeleton structure, NEXT21 is guaranteed to achieve 100-year durability.

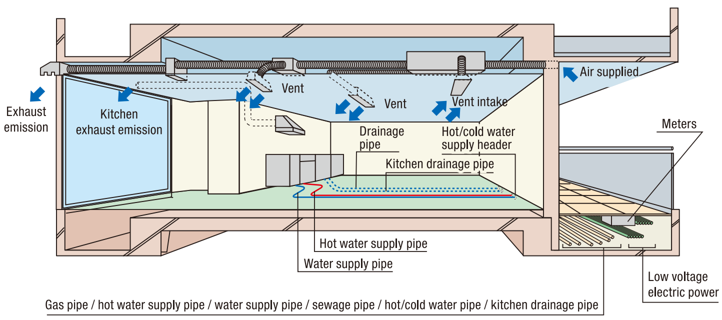
◎The use of pre-cast concrete makes it possible to secure the required quality and overburden thickness of reinforcing steel.

◎Well-designed structure to minimize the impact of rainfall

◎Sufficient story-to-story height is assured, with 4.2 meters for the first and second floors and 3.6 meters for all the other floors. The slab thickness is 240 millimeters.

◎Simple rigid-frame structure without earthquake-resistant walls



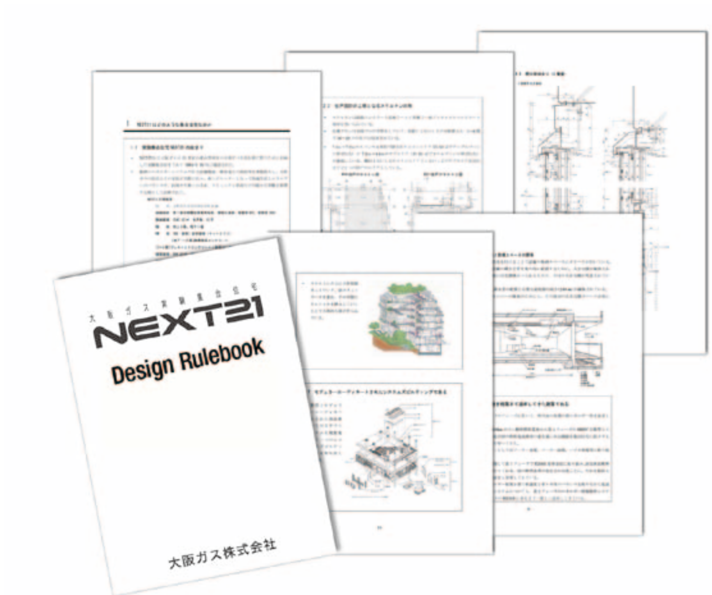


Flexible piping system

Piping space is secured underneath the 3-dimensional streets on all levels of the building, equivalent to common aisles, and a flexible piping system is employed. Such structure and system allow large-scale rearrangement of water-related facilities.

Rulebook

A rulebook describes the rules to be observed at the time of renovation, including the maximum outer wall line position, green zones and modules used in the whole building structure. This book enables the base building to be used for 100 years without the need for involvement by the original designers and builders.



Living with Nature

The site of NEXT21 is full of green zones totaling about 1,000 square meters that spread over entire floors and from the basement to the rooftop. This extensive nature-rich setting offers comfort to residents, and creates an oasis for wild birds and butterflies.
During the 5-year Phase 1 period, 22 species of wild birds and 21 species of wild plants were identified on the site. Also, it has been found that these planted zones play the important role of preventing the building from retaining daytime heat caused by sunlight–thanks to shade created by plants and their transpiration.

Greenery of NEXT21

One of the NEXT21 greenery project themes is "green corridor"–many green zones exist within the residential building site and help create a nature-rich urban living environment where people can enjoy the blessings of plants, breeze and sunlight, thus contributing to the creation of the "green corridor." In addition, NEXT21 aims to function as a biotope to support ecosystems, where residents are encouraged to be involved in promoting a green environment and to reconstruct the people-nature relationship.

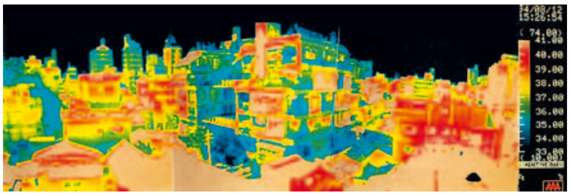
Report 01
Wild birds visit NEXT21

During the 5-year Phase 1 period, 22 species of wild birds visited NEXT21, ten of which settled in the site and five of which made nests. Young birds were seen leaving the nest safely.

Report 02
Thermal environment improved by green zones

Through thermal images photographed during midsummer, we have found that green zones, which block off sunlight and also generate moisture through transpiration, contribute to cooling of the area.

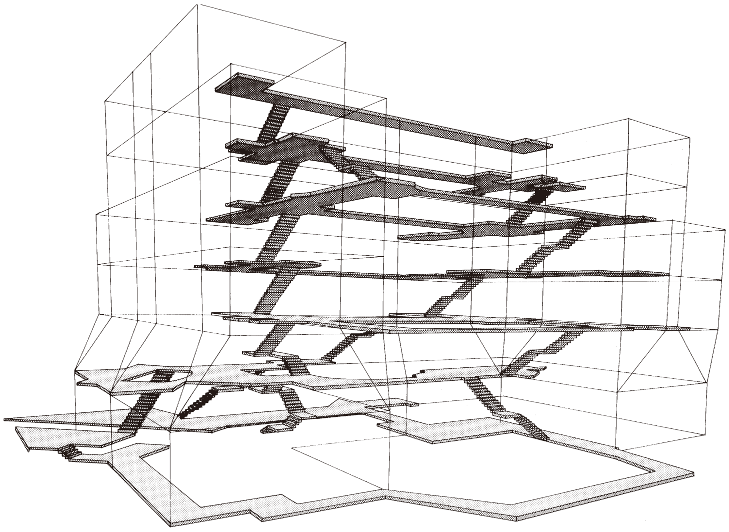
Photo (shows visible light only)



Thermal image photographed at 15:26 on August 12 (34°C)

Diverse urban community

Three-dimensional Street



We consider NEXT21 as a multistory community. Shared spaces such as passages and stairways are positioned as avenues and called “three-dimensional streets,” and these spaces provide residents with communication and exchange opportunities–just like small alleys and sidewalks in a town that traditionally play the important role of communication areas.



Residents’ autonomous management of living environment

An urban living environment can be improved if residents make autonomous efforts to better their place. During Phase 2 of the NEXT21 project, residents were given the opportunity, prior to the start of their living in NEXT21, to meet with other residents to talk about not only basic rules to be observed as residents but also the management and maintenance of facilities in NEXT21 including green zones. It is important for residents to make autonomous commitments to the improvement of their living environment including green zones.

Residents participate in cleaning activities.


Experiment in local communication design

U-CoRo

(Uemachidaichi Communication Room)

During Phase 3 of the NEXT21 project, a window showcase “U-CoRo” was created to exhibit diverse cultural, historical and social resources/events relevant to local communities of the Uemachidaichi area. The objective here was to promote exchanges between NEXT21 residents and local communities.







Experiments on dwelling unit interlinked with changing lifestyles

We are conducting "dwellings-in-use" evaluations to find solutions to problems of the aging society with a declining birth rate

With a rapid decline of birthrates and an increase in the proportion of the elderly population, we see diverse social changes affecting people's lifestyle. Among these changes, we have selected six major subjects that need to be addressed in housing design. Each subject has been the basis for the design of an infill solution, requiring many considerations covering these six target types of family.

Six keywords that represent major social needs to be addressed in aging society with a declining birth rate

- Child raising
- Elderly-only households
- Increasing emphasis on privacy of individual members of family
- Family support including assistance for child-raising, nursing care and housekeeping activities
- Diversification of work styles
- Networking of individuals

Diverse types of households are assumed to clarify the relationship between family types and the selected six social needs.

Category of household	Single(s)				Couple only			Couple and child(ren)				Single parent and his/her child(ren)		Other
Family models / Six social needs	A young or middle-aged single	Shared by multiple young or middle-aged singles	An elderly single	Shared by multiple elderly singles	DINK (double income no kids)	Husband and housewife	Empty nest	Couple and young child(ren)	Working couple and young child(ren)	Middle-aged or elderly couple and their child(ren)	Working middle-aged couple and their child(ren)	Single parent and his/her child(ren)	An elderly person and his/her child(ren)	Three-generation family
Child-raising								○	○			○		△
Elderly-only households			○	○			○						△	
Increasing emphasis on privacy of individual members of family		○		○	○		△		○	○	○		○	△
Family support (for childraising, nursing care, etc.)			○	○			○	△	○			○	○	○
Diversification of work styles	○	○	○	○	○		△		○	○	○	○	○	△
Networking of individuals	○	○	○	○	○	△	○		○	○	○	○	○	△

○ Applicable △ Sometimes applicable

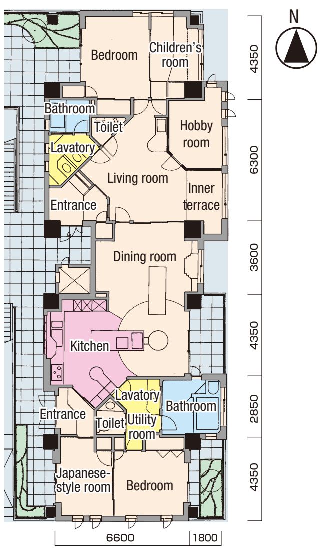
Renovation experiment

By taking advantage of NEXT21's unique construction system (skeleton-infill), large-scale renovations, which are usually considered as infeasible, were carried out.

Dividing a dwelling unit into two

Before

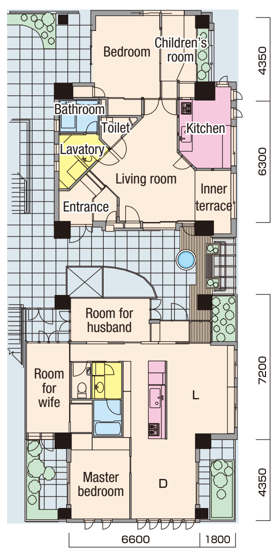
Unit #404
"House of three generation family"
($190.15m^2$)



After

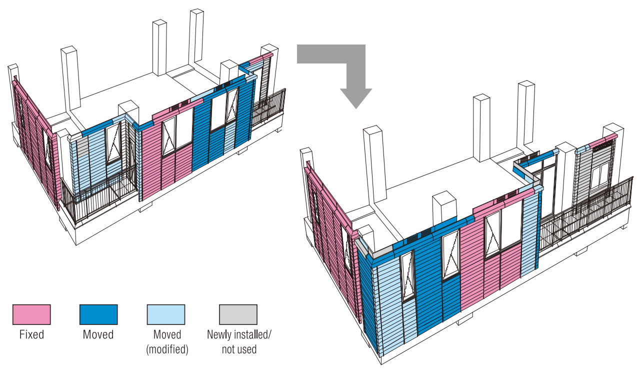
Unit #404 (North) "Woody House" ($81.51m^2$)

Unit #405 (South) "House of Next-Generation Family" ($92.76m^2$)



The outer walls were moved.

About 80% of outer walls were recycled.

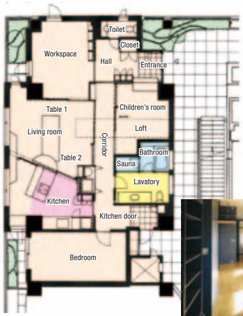


Previous housing experiments

House suitable for child-raising

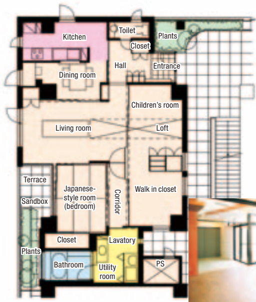
One of the causes of the declining birthrate is the lack of good living environment for child-raising. An infill-solution should be designed to satisfy needs of a family with a young child or children.

Unit #402: House with office



Renovation

Unit #402: House of Wellness



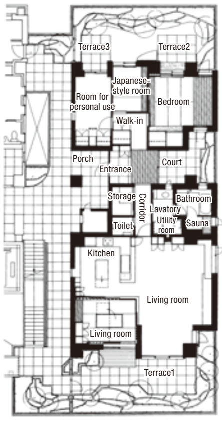
Needs of a family with a young child

- Securing a place for playing: Requires a spacious open space within easy reach of a parent or care-giver
- Securing safety: Fall- and accident-proof design
- Ensuring comfort for a child (or children) and adults at the same time

House suitable for an elderly-only household

Elderly-only households (either singles or couples) are rapidly increasing. Also, in today's aging society, middle-aged or elderly "empty nest" couples tend to live alone for a very long period of time, often exceeding 20 years, after their child(ren) leave home. It is necessary to satisfy needs of these households.

Unit #504: House for Relaxation



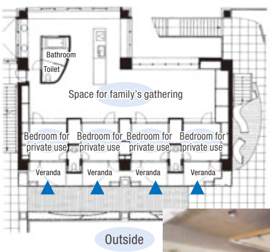
Change of the way of living in the course of becoming an "empty nester"

- Initially, when children were living with their parents, this unit consisted of private spaces and shared spaces. After the children left home, all rooms and spaces came to be "private spaces" for the couple.
- Each household member (now only two) has obtained a personal room/space because there is "room to spare."
- The living room became a free space where the couple can enjoy relaxing time alone, or spend pleasant time with guests.

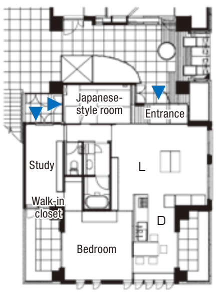
House for privacy of individual family members

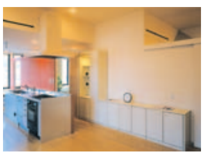
Changes in family styles include "diversification" and "individualization." To respond to these changes, it is necessary to create spaces to satisfy the needs of individual family members.

Unit #303: Independent Family-member House



Unit #405: House of Next Generation Family





Findings on housing needs of families emphasizing privacy

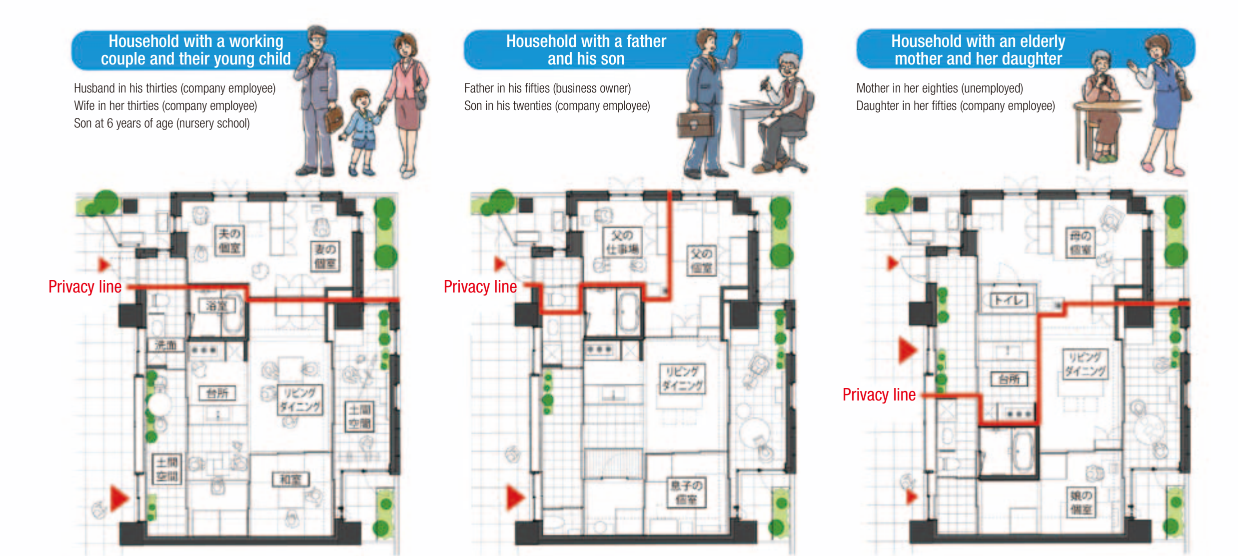
- Privacy-emphasizing families gave a positive evaluation of a floor plan in which bedrooms for each individual family member has direct access both to the outside and to the living room.
- On the other hand, such a floor plan is not acceptable to those families which emphasize shared spaces and is also unable to meet the family needs for the main entrance and the reception room.
- It has been found that the ability to select and change a floor plan is important.
- It is desirable that the unit occupant can select an infill solution and can renovate it later as necessary for responding to emerging family needs.

Experiments on dwelling units interlinked with changing lifestyles New attempts in Phase 4

Experimental dwelling unit suitable for aging society with declining birth rate

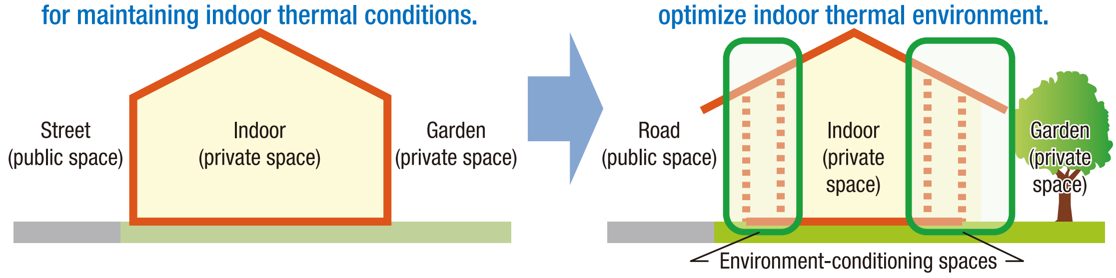
House for taking over (–adaptable housing for different families and different generations) (Unit #304): Floor plans to satisfy the differing needs of families

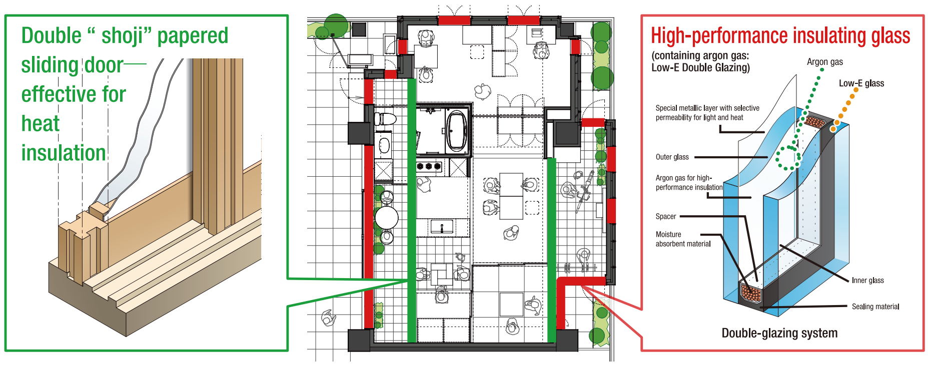
Some specific types of households were selected, and different floor plans designed to satisfy needs of their respective needs. The red lines are referred to as “privacy lines” which separate lockable spaces (into which only dwellers can enter) from other spaces accessible by visitors.



Experiments with “environment-conditioning spaces”

Experiments with “environment-conditioning spaces” have been conducted with the aim of ensuring comfortable living environments for dwellers. The primary goal is to do this in a way that minimizes environmental burdens, while securing sustainability of living culture in the course of multigenerational use of the unit. “Environment-conditioning spaces” can be defined as void spaces created between double walls (“double-skin façade”) as well as an outdoor space having direct contact with the outer wall. The role of these quasi-outdoor spaces is just what a traditional Japanese-style veranda used to play–connecting an indoor space (people) to the outside world (the natural environment or local community). These culturally important spaces also help maintain desirable indoor thermal environment as they insulate the building through the use of multiple “layers.”.



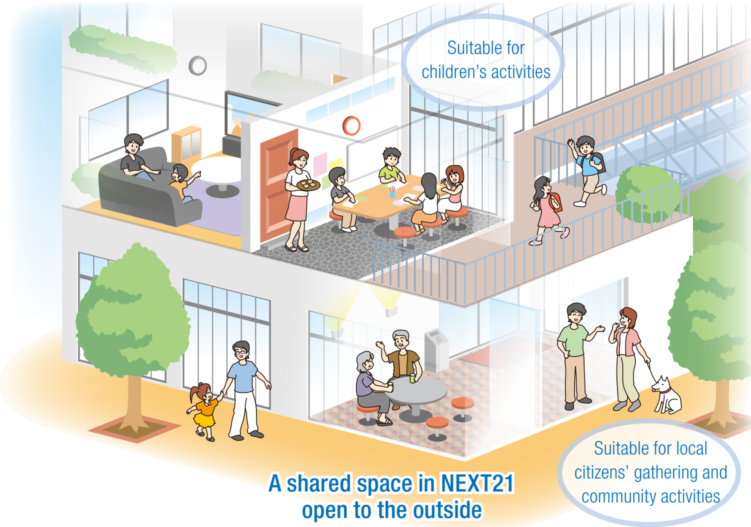


Experiments with “intermediate” spaces

In Phase 4, experiments with “intermediate” spaces will be conducted. The aim is to verify the new role of housing to promote exchanges between dwellers (indoor) and other residents (outside world), or multi-unit housing and the wider community.

In this project, two types of experimental “intermediate” space will be created. One is a private “activity” space inside a dwelling unit that can help create exchange opportunities. Such a space encourages people to turn off the air conditioner in the room and come outside to enjoy fresh air in the outdoor environment. The other “intermediate” space is a shared “activity” space open to local communities. Such a space can be used not only by NEXT21 residents but also by local residents, promoting diverse exchanges among NEXT21 residents, between NEXT21 residents and local residents, and also among local residents.

A private space inside a dwelling unit open to a shared zone



Creating “exchange” zones to facilitate people’s close relationship

Private “exchange” space open to a shared zone

Facilitating people’s exchanges

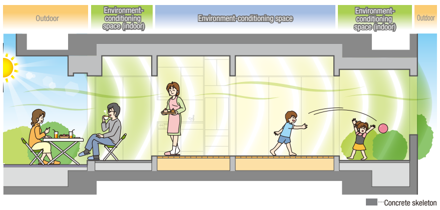
Unit #305

It is assumed that a family living in this unit consists of a husband, a wife and their young child and that the wife operates after-school activities for children at home. Children gather at an intermediate space in this unit, which is open to a shared zone, and such openness makes children feel at ease and feel willing to participate in activities.

Unit #403

It is assumed that a family living in this unit consists of an elderly husband who has already retired from work and his wife who is a former cooking instructor. This unit has a spacious kitchen where a cooking class can be held and a dining space that has direct access to an outside shared zone, allowing visitors to come in easily.

Taking advantage of the benefits of an outdoor environment



You can enjoy comfortable fresh air of the outdoor environment.

You can invite guests and appreciate a sense of the season, even on a hot or chilly day.

You can optimize indoor thermal environment and close windows/doors for insulation.

“Intermediate” space open to the local community

For the purpose of creating opportunities for exchanges between NEXT21 residents and local residents, an “activity” space will be created and made open to the nearby community. Not only NEXT21 residents but also U-CoRo (Uemachidaichi Communication Room) members will use this space, facilitating exchanges with local residents.

To be used by NEXT21 residents to create communication opportunities

To be used by NEXT21 residents and local residents together to promote their exchanges

To be used by U-CoRo members for their activities (to discover, share and utilize understanding of the nearby community).

Community lab
U-CoRo

Unit #305: House with “blank” spaces—Future housing for people seeking nature-rich urban living

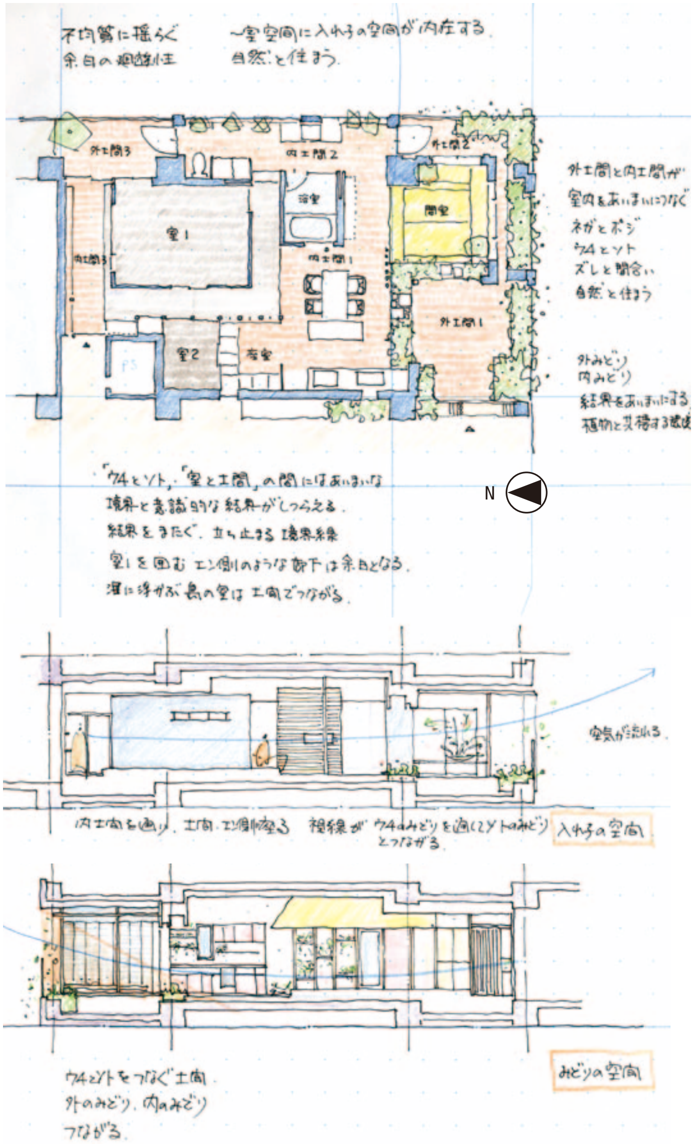
Value-added spaces for family activities

Recent social changes such as a declining birthrate, increasing elderly population, changes in household demography and diversification/ improvement of information systems have led to a rapid development of diverse interactive networks. Today, the scope of activities of urban citizens is quite extensive, and in addition, they seek to network with other people.

People’s interest in housing seems to have been diluted by urban life. At the same time, however, there is a tendency that urban citizens are regaining their interest in the “house” as a place of interaction with people other than their own family members or as a shared dwelling place. Such a concept is introduced to the design of this unit #305, in which diverse unique spaces exist between rooms and can be used freely, enabling dwellers to enjoy sharing of experiences. Such “blank” space is not a mere empty space, but is intentionally designed to satisfy needs of urban residents and also to introduce the natural environment to the house, exhibiting the attractiveness of combining different things.

This unit embodies NEXT21’s key concepts such as “green corridor” and “multistory street” in its inner private area, in the form of “external *doma*” and “internal *doma*,” These spaces are designed to realize “symbiosis with nature” where people can enjoy sunlight, breeze and green. The layout of “rooms” and “blank spaces” are carefully worked out to ensure an optimum spacing. In this unit, dwellers are close to nature, and their nature-friendly, simple and comfortable living can be secured.

Yoshiji Takehara
MOO Architect Workshop



View of a room and an external *doma* (view from an internal *doma* 1)

Rooms and blank spaces/Irregularity and comfortable spacing

Rooms are not uniform in shape and are placed away from each other irregularly, creating diverse “blank *doma* spaces” between rooms. This arrangement makes us feel as if this unit has no partitions. Also, the existence of *doma* spaces gives the impression of an outdoor space. It also allows for a change of pace for residents.

Ambiguous but carefully designed borders and carefully selected materials

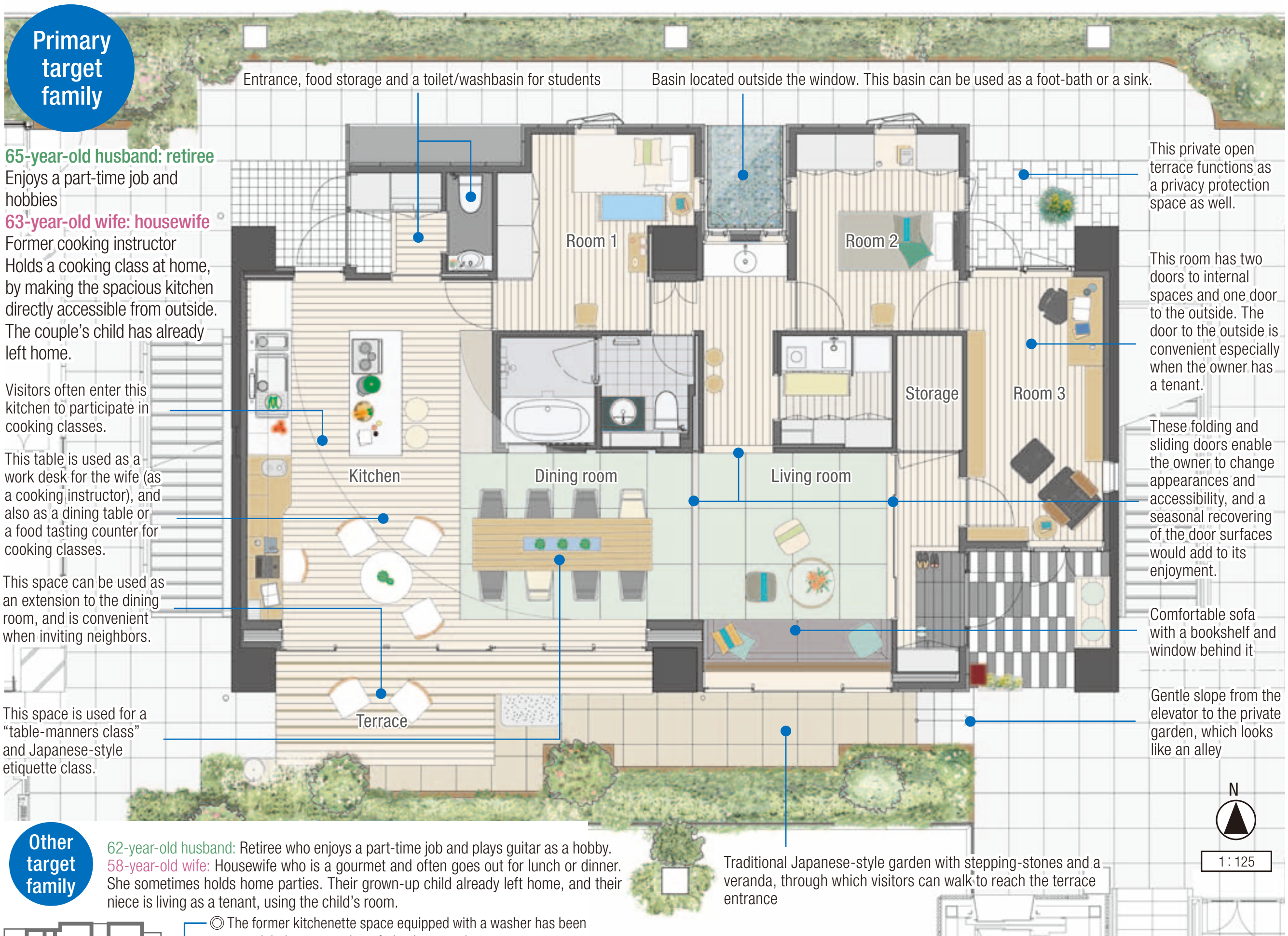
This unit uses a variety of floor materials and the floors (of rooms and blank *doma* spaces) have different elevations. Borders look ambiguous but are carefully designed. Irregular placing of inner walls, hanging partition walls and ceilings creates unique visual effects, where the entire area looks spacious with the combined effects of pillars and windows.

Irregularly arranged blank spaces / stroll-round dwelling

The visual contrast between “rooms” and “blank *doma* spaces” as well as the irregular use of materials, colors and texture creates an impressive appearance throughout. You can enjoy a tour around in this unit, to find your favorite spot, which will probably differ season by season.

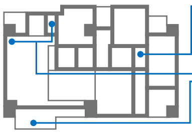
Unit #403: Resilient House

A target family of this unit is a middle-aged couple whose child has grown up and already left home. The multiple access routes to indoor spaces of this unit play the role of facilitating people's exchanges and gatherings. Such accessibility as well as the employment of movable walls–which assumes lifestyle changes in course of time or multigenerational use of this unit–makes it possible for the occupants to maintain sustainability and comfort in this house.



Other target family

62-year-old husband: Retiree who enjoys a part-time job and plays guitar as a hobby.
58-year-old wife: Housewife who is a gourmet and often goes out for lunch or dinner. She sometimes holds home parties. Their grown-up child already left home, and their niece is living as a tenant, using the child's room.

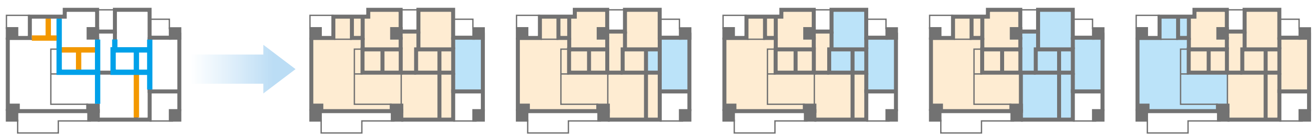


- ◎ The former kitchenette space equipped with a washer has been remodeled as a soundproofed guitar practice room.
- ◎ The former entrance for the students is converted to the kitchen door. The former toilet has been replaced with a washing-machine space.
- ◎ The terrace can be used as an outdoor stage for guitar performance. The terrace has direct access to the spacious kitchen, and therefore can be conveniently used as a garden party space when having many guests.

The target family often has visitors who come to cooking classes or home parties. This unit is designed to facilitate people's exchanges, and its ability to store a large amount of food contributes to saving of emergency provisions. The effective utilization of private outdoor spaces contributes not only to the creation of friendly relationships with neighbors but also to nature-friendly living and good ventilation. For safety and security, it is also important to ensure privacy protection as well as disaster-proof structural arrangement, so as to fully enjoy "openness" of this unit. This unit is designed to be responsive to changing demands of the owner or any change in their lifestyle including a change in constituent members of the family. In summary, this unit can be referred to as "nature-friendly, sustainable home."

Yoko Chikazumi/Yoko Chikazumi Architect Office

Partition patterns respond to changing needs including a change of occupant



Partition modification sequence
Party walls: Walls installed before floors
Partition walls: Floors installed before walls

A tenant is living in a room without any "wet" (bathroom+kitchen) section. The owner and the tenant are living together.

A tenant is living in a room with a minimal wet section. An increased level of privacy for the tenant

Two households of different sizes live together.

Two households of the same size live together.

Makes some space open to neighbors

High-efficiency energy systems

Phase 1

During the five-year Phase 1 period, a CHP (Conbined Heat and Power) system driven mainly by phosphoric acid fuel cells was employed for the entire residential building. This was the first-ever attempt in Japan to use fuel cells for multi-unit housing.
The CHP system, combined with the use of advanced architectural materials ensuring high-level airtightness and insulation, made it possible to reduce energy consumption by 27%, when compared to then-typical conventional multi-unit housing.

Hot water tanks

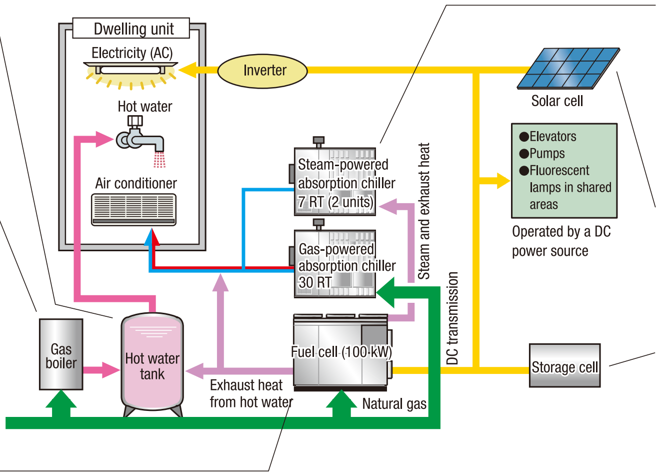
2 units with the capacity of 3 cubic meters each
Two tanks were used, because fuel cells generated two types of exhaust heat of different temperatures, and separated recovery of exhaust heat ensured high efficiency.

Gas boilers

#16-type water heaters (4 units)
The hot water tank was used as an energy source to supplement the recovered waste heat.

Phosphoric acid fuel cells

100 kW
40% Power generation efficiency, low-level noise and clean exhaust gas.



Steam-powered absorption chillers

2 units with the capacity of 7 RT each
Waste heat steam generated from the CHP system is used to power the absorption chiller.

Solar cell

7.5 kW
Single-crystal silicon solar cell has been introduced as a renewable energy system.

Storage cell

1,000Ah lead-acid batteries
Repeated accumulation and discharge of electricity help prevent load fluctuations of fuel cells, thereby maintaining efficiency.

Phase 2

Based on the understanding of the electrical/heating demand of the entire building, optimum energy systems were selected and used during the 5-year Phase 2 period to satisfy demand. 9.8 kW CHP units were used to supply electricity and heat, and as part of energy-saving efforts, the minimum number of CHP units to cover heat demand was calculated and installed (thereby avoiding excessive discharge of heat). In 2000, we introduced PEFCs (polymer electrolyte fuel cells), which was the first attempt in the world in the housing industry. This experiment had successfully led to the launch of ENE-FARM in 2009.

PEFC

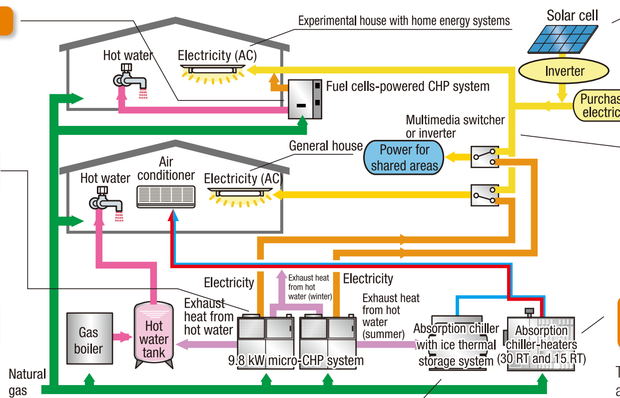
The performance of PEFCs (polymer electrolyte fuel cells) was demonstrated by installation in some dwelling units.

Gas-powered micro-CHP system

Packaged 9.8 kW CHP system with power generation efficiency of 24.5% (LHV) and combined efficiency of 85.2% (LHV)

Absorption chiller with ice thermal storage system

With the use of methyl alcohol and activated charcoal, this chiller stores ice during the night and uses the ice during daytime to run on a cold-water mode.



Solar cell

7.5 kW
This single-crystal silicon solar cell was used in Phase 1, and we continued to use it for Phase 2.

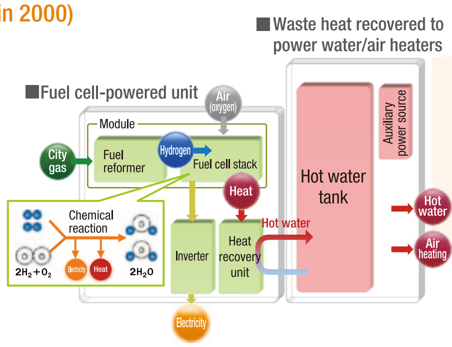
Multimedia switcher

The microcomputer calculates load capacity, enabling fast switching between "purchased electricity" and "CHP."

Gas-powered absorption chiller-heaters

Two units with the capacity of 15 RT and 30 RT respectively
Waste heat is used to power air conditioners, which are CFC-free and are therefore environment-friendly.

PEFCs (polymer electrolyte fuel cells) introduced to housing for the first time in the world (in 2000)



City gas will be reformed to generate hydrogen, which reacts with oxygen in the air to generate electricity. Waste heat will be recovered to power water heaters and air conditioners.

Residential fuel cell-powered CHP system
ENE·FARM
エネファーム
Newly Released

Launched in 2009

Launched in 2012

Phase 3

Hydrogen fuel cell-powered CHP system for multi-unit housing

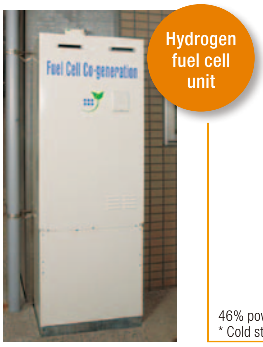
In Phase 3, we demonstrated a hydrogen fuel cell-powered CHP system. The intensive hydrogen production mechanism makes it possible to downsize the fuel cell, improve power generation efficiency and increase the level of responsiveness. We also conducted an experiment with interchanges of electricity among dwelling units to save energy. The results of this experiment showed that 12% reduction in the consumption of purchased electricity can be expected from the introduction of such an interchange mechanism, on the condition that the entire residential zone has approximately 100 dwelling units.

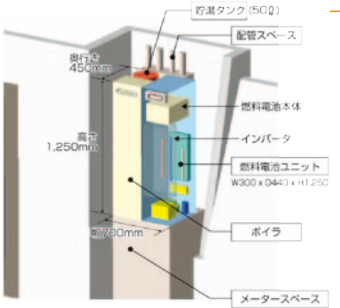
Fuel cell batteries used in this project

City gas → Hydrogen production units (3 units)

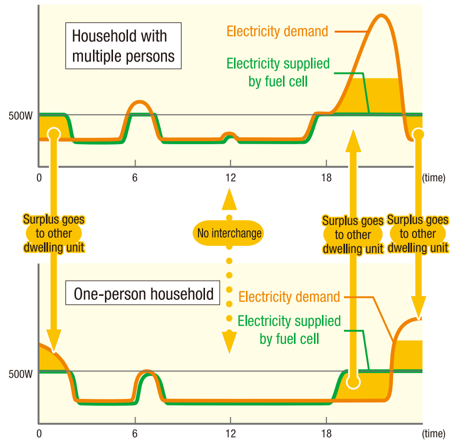
6F	Hydrogen fuel cells (500 W) were installed for respective dwelling units. Eight battery units were used to enable electricity interchanges among dwelling units as well as storage of electricity.	Hydrogen piping
5F		
4F	Two dwelling units share one hydrogen fuel cell unit (700 W), which was placed in a shared zone.	
3F		

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) covered project expenses for the 5th and 6th floors, with a subsidy for the development of advanced technology for housing and architectural industries (fiscal year 2007).
Joint operators of this project included Toshiba Fuel Cell Power Systems Corporation and Chofu Seisakusho Co., Ltd.
AIST (National Institute of Advanced Industrial Science and Technology) and the Energy Technology Laboratories of Osaka Gas Co., Ltd. jointly covered project expenses for the 3rd and 4th floors.





46% power generation efficiency and 31% recovery rate of discharged heat (HHV)
* Cold start-up time of 5 minutes or less

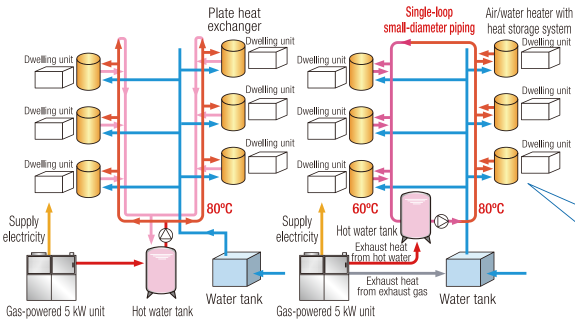


The above diagram shows an image of electricity interchanges between two dwelling units (households), where a 500 W hydrogen fuel cell was used to supply electricity. Assuming that timing of using electricity is different between the two households (one household has multiple persons and the other has only one person), any surplus at either household can be given to the other, to save energy.

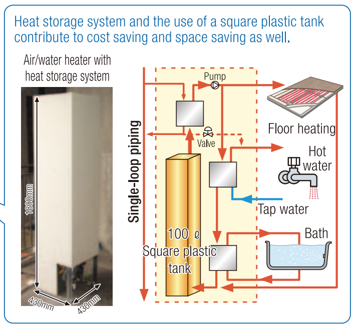
CHP system covering multiple neighboring dwelling units

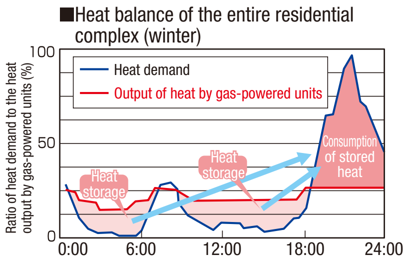
In this project, neighboring dwelling units shared the CHP system through the use of decentralized heat storage and single-loop piping, to ensure high-efficiency heat supply.

◎ The decentralized heat storage system enables each dwelling unit to function as a buffer against any energy shortage of its next neighbor. This mechanism makes it possible to use single-loop piping, thereby minimizing the use of pipes.
◎ Peak-time load of hot water can be shared among dwelling units, making it possible to downsize the hot water tank and reduce the diameter of water pipes.
◎ The entire heat storage capacity is so large that the gas utilization rate can be maximized even during low-demand hours, resulting in significant energy saving.
◎ Assuming that the entire residential complex has 50 dwelling units, use of this system allows energy consumption to be reduced by an estimated 15%.



Air/water heater with heat storage system "*Eco-Yuderu*"

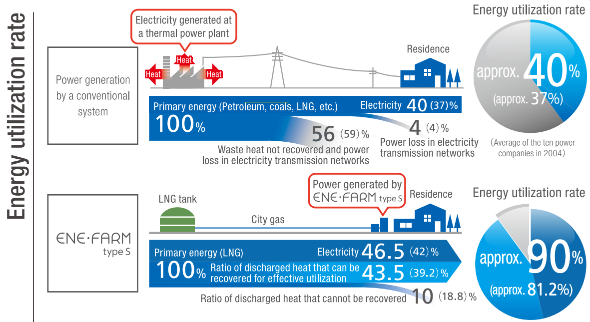




First attempt in Japan to use SOFC for housing (2005)

We demonstrated the SOFC system (solid oxide fuel cell) to evaluate its energy-saving performance and feasibility for a residential complex in terms of installation and maintenance operations. (The New Energy Foundation sponsored this project within the framework of its FY2008 research program.)

Resulting in the launch of ENE-FARM Type S in 2012



* Figures are in LHV (HHV)

Prospective future energy systems

Demonstrating next-generation energy systems to realize “smart multifamily housing”

We will customize energy systems to satisfy needs of multifamily housing, through the effective utilization of high-efficiency fuel cells and CHP systems, while seeking to improve their energy-saving, carbon-reducing performance and also establish their ability to effectively mitigate the impact of disasters or emergency situations. Here, the 2011 earthquake gave us lessons about energy risks and necessary countermeasures (independent power supply, energy efficiency, reduction in peak-time consumption, etc.), and we will demonstrate technology to address such risks.
In Phase 4, we seek not only “efficiency” but also “flexibility.” Based on the Phase 4 concept, we have selected specific objectives to be achieved to improve flexibility of energy systems for residences, housing and urban life, with the aim of realizing environmentally-friendly, comfortable living in urban multifamily housing. To this end, we pay close attention to the relationship among energy, people, nature, housing and urban living.

Direction of energy systems for Phase 4

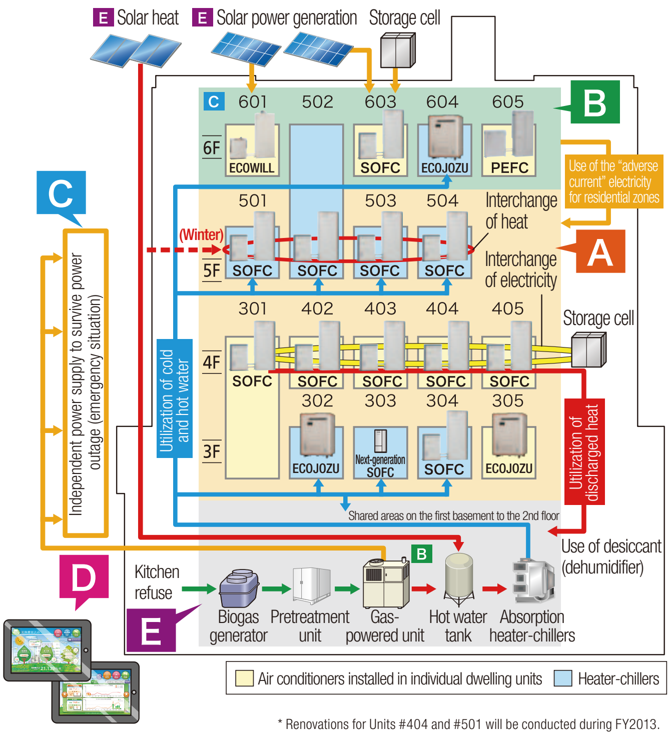
Basic requirements

- Enhance energy-saving, CO_2 reduction performance
- Establish countermeasures against energy supply risks (independent power supply, energy efficiency and reduction in peak-time consumption, etc.)

Objectives to realize ideal relationship among people, nature, housing and urban life

- Promote energy interchanges
- Ensure energy-conscious lifestyle and the smart, safe use of energy
- Ensure compatibility between conventional energy and renewable energy
- Optimize energy systems for houses and residential complex as an urban energy system

Outline of experimental energy systems for Phase 4



* Renovations for Units #404 and #501 will be conducted during FY2013.

A Decentralized installation of SOFCs and energy interchanges

- System configulation utilizing SOFC (solid oxide fuel cell)(0.7 kW)
  - Electricity generated by SOFC can be interchanged between dwelling units (5.5 kWh storage cell)
  - Efficient utilization of heat through the combined use of SOFC and solar heat (6-square meter tube-type solar heat collection panel) (in winter only)
- Test operation of a prototype of the next-generation high-efficiency SOFC (0.7 kW)

B Demand response scheme (DR) and the “adverse current” mechanism

- Residents’ efforts to save energy will be promoted and the power generation performance of home CHP units(*) and CHP units (31 kW) (GENELITE) will be increased.
- The “adverse current” mechanism of home CHP systems(*) is expected to maximize energy-saving performance.

(*) SOFC-powered CHP system (0.7 kW) = ENE-FARM Type S
PEFC-powered CHP system (0.7 kW) = ENE-FARM
Gas Engine-powered CHP system (1 kW) =ECOWILL

C Independent power supply system to survive power outage

- The CHP system (31 kW) can be operated at the time of power outage, making it possible to supply electricity to residential zones. In addition, SOFCs on the 3rd to 5th floors can also be operated to supply electricity to individual dwelling units.
- The CHP units for individual dwelling units on the 5th floor are equipped with the self-operation function.

D Introduction of the HEMS (home energy management system)

- The HEMS (tablet terminal) will be introduced to all dwelling units, to raise residents’ level of interest in energy saving.
- Diverse functions of the next-generation HEMS will be demonstrated.

E Renewable energy in combination with conventional energy

- Energy efficiency of the centralized air condition system can be improved through the combined utilization of solar heat (collected by a tube-type panel of 30 square meters (24 square meters in winter)) and heat discharged from the CHP system.
- Solar power generation (2 dwelling units with the capacity of 2.6 kW each)
  - Combined use with the next-generation HEMS
  - 3-way power system consisting of SOFC, storage cell (4.4 kWh) and solar cell
- Biogas generated from kitchen refuse will be used to fuel the CHP system.

The projects for the above experimental energy systems have been selected by the government to be subsidized under the MLIT’s FY2012 initiative on leading CO_2 reduction technologies in housing and architectural industries.

Experiments: New projects for Phase 4

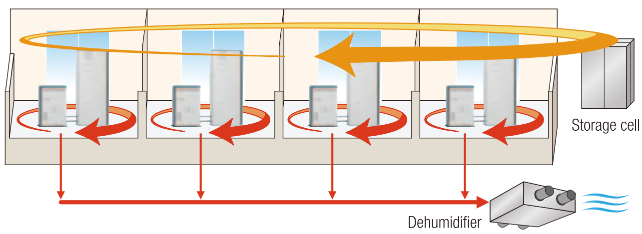
A Decentralized installation of SOFCs and energy interchanges

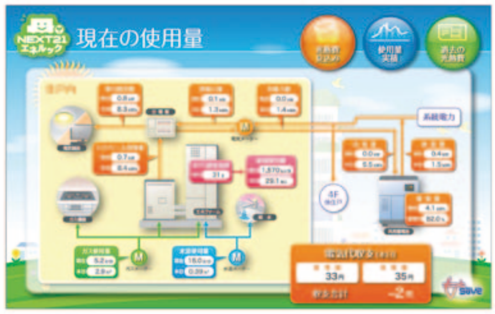
We take advantage of the characteristics of multifamily housing to maximize overall energy-saving performance by effectively utilizing high-efficiency home SOFC-powered CHP system.

Dwelling units share the capacity of SOFCs (4th floor)

4th-floor dwelling units share the capacity of SOFCs through the maintenance of rated-power high-efficiency operation, to promote interchanges of surplus electricity or charging with storage cells. Also, surplus heat discharged from SOFCs will be collected to be used for dehumidifiers(*) installed in shared zones, to contribute to energy saving of residential areas.

(*) Air conditioning system using desiccant. This project uses a prototype unit with the ability to function not only as a dehumidifier but also as a humidifier or air cooler, through the effective utilization of high-performance desiccant.



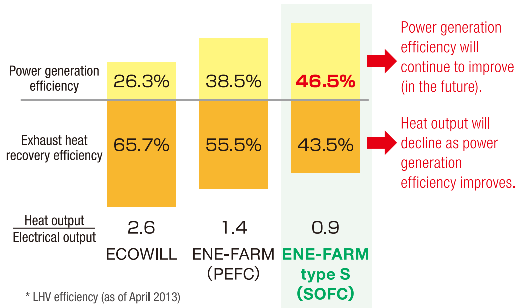


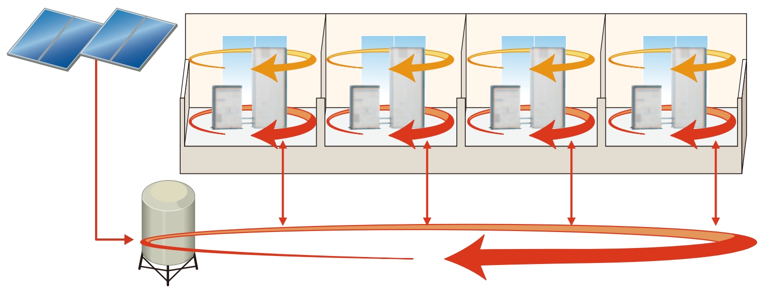
Residents can confirm the status of energy (electricity, gas and water) consumption as well as electricity interchanges through their HEMS installed in individual dwelling units.

Effective heat utilization through the combined use of SOFC and solar heat (5th floor)

Load on the SOFCs for the 5th-floor dwelling units depends on the electricity demand at each dwelling unit. In winter, when discharged heat is insufficient, hot water generated through solar heat panels is also used to save energy. When any dwelling unit has surplus waste heat, it will be sent to another dwelling unit in need.

Power generation efficiency and recovery rates of exhaust heat from respective home CHP units





Shared hot water tank (heat storage)

Test operation of the next-generation, high-efficiency SOFC prototype (Unit #303)

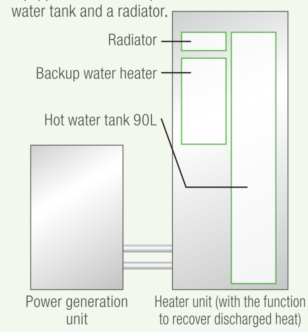
We will conduct a test operation of the next-generation, small-size SOFC-powered CHP prototype system, with the hope of realizing enhanced power generation efficiency.
This testing is expected to give us important data including power generation efficiency, recovery rates of exhaust heat, operational stability and the feasibility in terms of safe installation and reliable maintenance, which help identify opportunities to further improve the design of the next prototype.

	2012 model	Next-generation model (goal)
Power generation efficiency(*)	46.5%	55%
Exhaust heat recovery rate(*)	43.5%	30%
Capacity of hot water tank	90L	10 to 30L

(*) in LHV

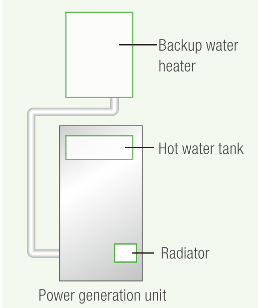
2012 model

This model consists of the power generation unit and the heater unit (with the function to recover discharged heat), and the heater unit is equipped with a backup water heater, a hot water tank and a radiator.



Next-generation model

A power generation unit of this model is equipped with a hot water tank and a radiator. The backup water heater unit is of conventional type.



B Demand response scheme and the "adverse current" mechanism

Demand response scheme (DR) interlinked with home CHP systems (on the 6th floor)

The demand response scheme (DR) in response to any alert such as peak-time electricity shortage or high-price hours encourages residents to change electricity usage from their normal consumption patterns and increase power generation of home CHP system.

DR interlinked with each dwelling unit

Each household is asked, through the HEMS, to restrain energy use on the next day.

① Residents make energy-saving efforts.
② Home CHP systems automatically increase power generation.

HEMS asks all residents to restrain energy use and later informs them of the results of energy consumption (HEMS screen).

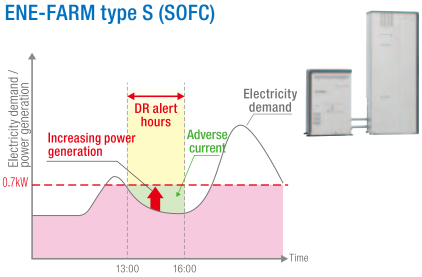
Alert for tomorrow and past data

Alert for today and updates

Report on yesterday's activities and performance

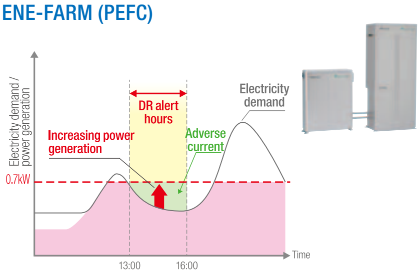
DR patterns for each home CHP system

ENE-FARM type S (SOFC)



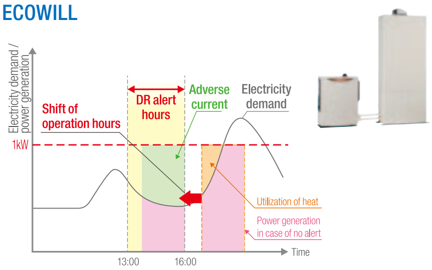
- Power generation is increased, up to rated capacity.
- Rated power is maintained during alert hours. [Power is adjusted according to demand of electricity.]

ENE-FARM (PEFC)



- Power generation is increased, up to rated capacity.
- Power will be reduced when the amount of discharged heat reaches the maximum. [Power is adjusted according to demand of heat.]

ECOWILL



- Operation hours are shifted.
- CHP will be turned off when the amount of discharged heat reaches the maximum. [Power is adjusted according to demand of heat.]

* The above diagrams show the case in which an alert continues from 13:00 to 16:00.
In each home CHP system, amount of power generation that exceeds the load of the dwelling unit at demand response are adverse current in dwelling unit outside. (See the section (*) on page 20.)

Demand response scheme (DR) interlinked with CHP systems for shared zones

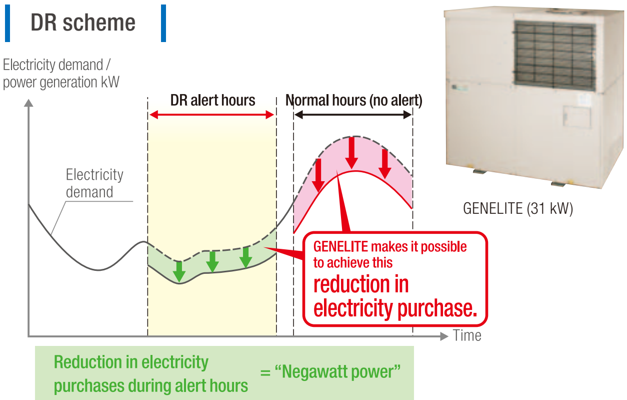
CHP system (GENELITE) for shared areas enables the utilization of surplus electricity, to increase electricity availability or supplement energy at the time of power outage, which helps reduce purchase of electricity.

DR interlinked with GENELITE

Alert (ex. energy supply at risk) is sent to GENELITE.

① GENELITE reacts to increases power generation.
② Negawatt power(*) assessment is made.

DR scheme

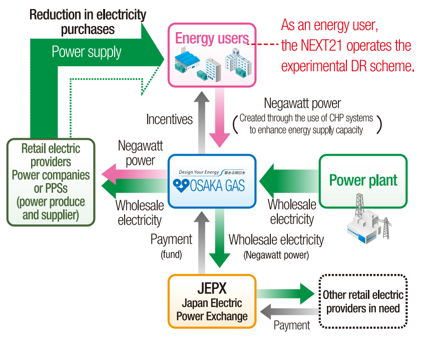


Experimental DR scheme

GENELITE with the ability to react to alert will be combined with the "Smart Saving Power" program of Osaka Gas. Assessment of overall negawatt can be conducted.

SMART SAVING POWER

In the "Smart Saving Power" program, Osaka Gas notifies customers, in a timely manner, of any tight energy condition, to prompt energy users to introduce energy-saving efforts and operate their CHP systems, so that their electricity purchase can be restrained. This program enables customers to reduce their energy costs and also enjoy incentives available according to the level of their energy-saving contribution.



Reduced electricity purchases mean an increased capacity of Osaka Gas to sell wholesale electricity in the JEPX market, resulting in an increased fund for incentives.

(*) Negawatt power is a theoretical unit of power representing an amount of energy saved (measured in watts). As far as demand-supply relationship is concerned, "power generation" and "power saving" coincide, and energy-saving performance is assessed for the purpose of measuring energy supply capacity.

“Adverse current(*)” mechanism with home CHP systems (on the 6th floor)

Operation of home CHP systems on the 6th floor can be controlled through the utilization of the “adverse current” mechanism, maximizing energy-saving contributions of each system.

(*) Generally, “adverse current” means a resale of electricity to a power company as a result of the creation of surplus electricity through the operation of the user’s solar power generation system or CHP system beyond the user’s demand. This project assumes that such surplus electricity generated beyond demand can be utilized within the NEXT21 premises, instead of reselling it back to the power company.

If the “adverse current” mechanism works with home CHP systems……

Benefits to the home
- Further reduces electricity consumption and CO_2 emissions
- Improves cost performance of CHP systems (assuming a fair price of “adverse current” electricity to be repurchased by a power company)

Increasing use of CHP systems

Performance of CHP systems can be maximized, and resulting benefits can be shared by residents and society.

Benefits to society
- Promotes energy saving and reduction in CO_2 emissions
- Stable supply of surplus electricity to an electrical grid
  - Contributes to peak-time energy-saving efforts
  - Mitigates a risk of energy shortage through decentralization of energy sources

“Adverse current” mechanism

ENE-FARM type S (SOFC)

[Operation adjusted according to electricity demand]

Surplus electricity, created through the 24-hour rated-power (700 W) operation, will be repurchased to a power company.

ENE-FARM (PEFC)

[Operation adjusted according to heat demand]

Surplus electricity, created through the selective operation of either a rated-power (700 W) mode or a minimal-power (250 W) mode (in a way that avoids excessive heat discharge), will be repurchased to a power company.

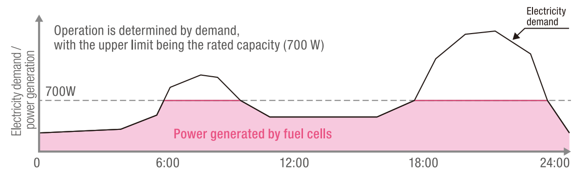
ECOWILL

[Operation adjusted according to heat demand]

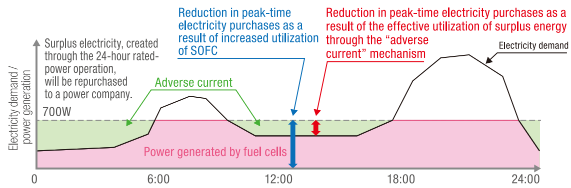
Surplus electricity (for heaters), created through the operation adjusted according to heat demand (1 kW), will be repurchased to a power company.

Image of the “adverse current” mechanism (with SOFC)

No “adverse current” (use of purchased electricity only)



“Adverse current” mechanism



C Independent power supply system to survive power outage

Through the use of the CHP system, an independent power supply system is established to survive power outage while contributing energy saving at the same time.

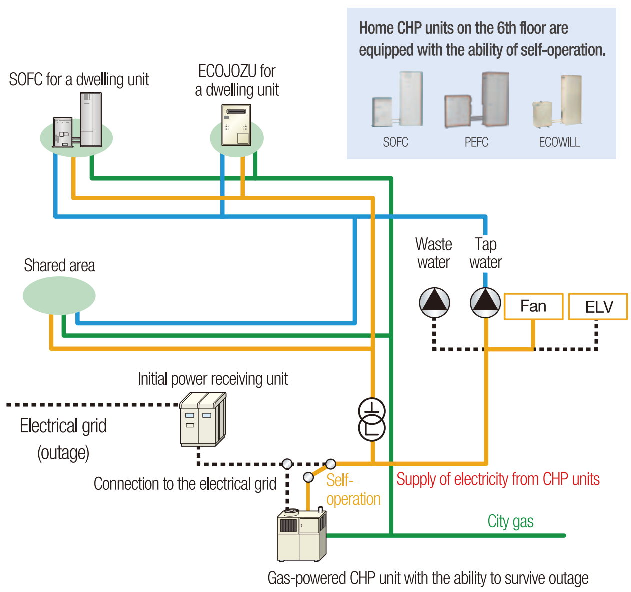
Gas-powered CHP units for shared areas in combination with SOFCs for individual dwelling units (from the basement to the 5th floor)

At the time of power outage, CHP units for shared zones (GENELITE 31 kW) will be turned on, to autonomously supply electricity to dwelling units.
This system makes it possible for SOFCs on 3rd to 5th floors (having no self-operation ability) to run to supply electricity (700 W), which will then enable other SOFCs to run too, ensuring energy security.

Home CHP units equipped with self-operation function will be installed for individual dwelling units (on the 6th floor).

These home CHP systems (for individual dwelling units on the 6th floor) with the ability of self-operation help survive power outage.

Dwelling unit	CHP unit (equipped with self-operation function)	Self-operation system	Maximum output in self-operation mode
Unit #601	ECOWILL PLUS	At the time of power outage, this unit can be turned on manually to run in self-operation mode.	980W
Unit #603	ENE-FARM type S (SOFC)	These units will be automatically severed from the electrical grid at the time of power outage, and will be automatically reconnected to the grid at the time of recovery from outage.	350W
Unit #605	ENE-FARM (PEFC)		



D Introduction of the HEMS (home energy management system)

Each dwelling unit is provided with an HEMS tablet terminal.

Visualizing energy

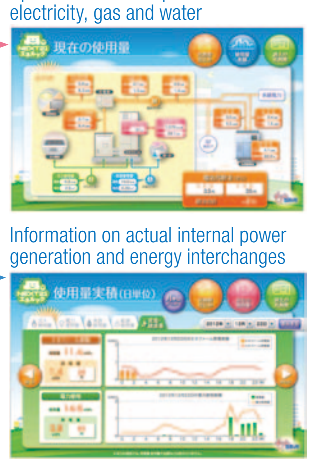
The HEMS enables dwellers to receive information visually on gas, water, energy interchanges, alert in the DR scheme and other data that prompts residents to promote energy-saving efforts. (*1)

(*1) This HEMS has been customized to meet the needs of the NEXT21, with its base features sourced from Osaka Gas' existing "ENELOOK PLUS," on which special functions such as the ability to measure and control energy consumption have been added as drawn from our "Motto-save" industrial product.

Access to diverse community services

The HEMS tablet terminal enables residents to use NEXT21 community services.(*2) This convenience encourages residents to use the HEMS frequently.

(*2) The HEMS uses "Co-Co-Kulu" and "Kurashifulu" platforms provided by NTT MEDIASUPPLY Co., Ltd. to enable NEXT21 residents to exchange information, receive information from the NEXT21 facility maintenance manager on experimental energy projects, make reservations with shared facilities in the premises, and also use diverse application software on the terminal including "customized calendar for family" and "kids security email." In addition, the HEMS has access to an internet supermarket operated by AEON Co., Ltd. as well as to the e-book service operated by Sharp Corporation.



Demonstrating next-generation HEMS (Unit #601)

Abilities of the next-generation HEMS are extensive—residents can remotely control the operation of home appliances, confirm energy consumption of respective appliances, and share understanding with other family members about energy-saving needs and achievements through the newly-developed wall or table display. This project is expected to enable us to find answers to the question "which functions are attractive and important to end users?"

Tablet
Handy and portable. Convenient for remote control of home appliances.
Access to detailed energy information

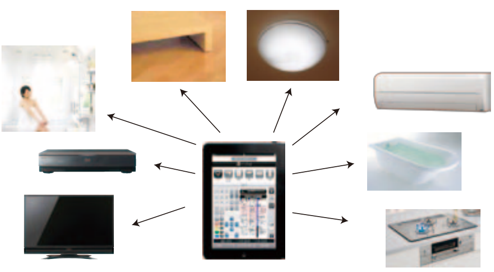
Wall display
Understanding on the status of energy consumption can be shared by family members who can see the wall display at any time.

Table display
The tablet terminal can promote family communications about the status of their energy consumption and saving needs.

Function to control the operation of home appliances

The tablet enables 10 kinds of operations

- Gas appliances: Shut off gas to the kitchen stove; Clean the bathtub; Fill the bath; Turn on/off the floor heater; Turn on/off the bath heater/dryer
- Electric appliances: Lighting, television, air conditioners, and recorders
- Other appliances: Intercom



Function to measure energy consumption of individual energy systems

Consumption of gas, electricity and water can be measured for each room and energy system, and measurement results can be shown on the screen in a variety of display modes.

New application software for visualizing energy use

Wall display

This wall-mounted digital clock tells not only time but also energy saving needs, which can be confirmed instantly through the appearance of numerals.

Table display

Top page

The display shows the image of the sky reflected on the water surface. An increase in energy consumption would result in increased clouds or decreased stars.

Energy Counter

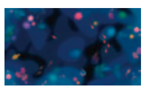
Users can select activities for which energy consumption can be measured or compared.

Energy Play

The display shows a bird's-eye view of energy consumption. The analog clock is interlinked with real-time energy consumption data. If you move a hand on the clock, you can confirm energy consumption at a specific time.

Energy-saving Assignments

Users are encouraged to carry out selected 80 types of energy-saving efforts. Achieving a goal will increase the number of fish in the aquarium on the display.



E Renewable energy in combination with conventional energy

The effective combination of gas systems designed for multifamily housing with renewable energy will make it possible to further promote energy saving.

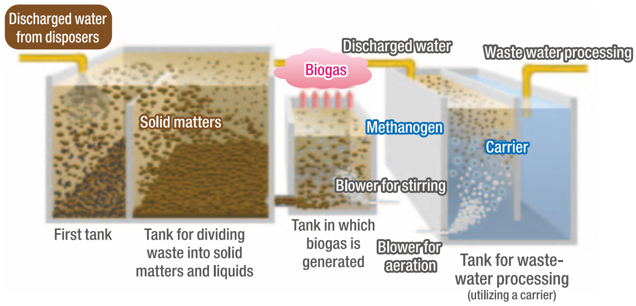
Solar thermal energy

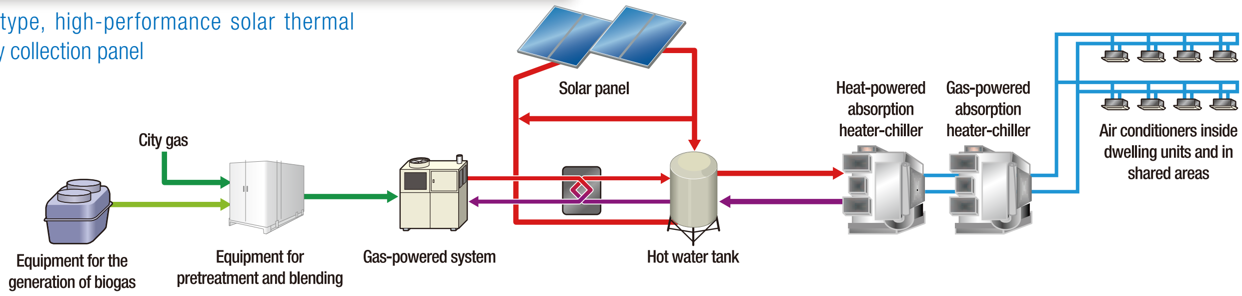
Through the utilization of solar thermal energy (collected by a tube-type panel of 30 square meters <24 square meters in winter>) together with recycling of waste heat discharged from CHP units, we seek to promote energy saving of the centralized air conditioning system for the residential building. (For air heating, hot water is used. For air cooling, cold water is used as generated by an absorption heater-chiller with the function to recover discharged heat.)

Tube-type, high-performance solar thermal energy collection panel

Biogas

Kitchen refuse is collected from dwelling units and goes into the disposer in underground. Such refuse generates biogas consisting mainly of methane. The biogas will be blended with city gas to be fed into CHP units as fuel.





Solar power generation

Next-generation HEMS for "energy visualization" (Unit #601)

The HEMS enables residents to see diverse energy information on the display, including real-time energy/cost-saving achievements through solar power generation and a resale of electricity to a power company, which helps promote the level of their interest in energy-saving efforts and cost reduction achievements.

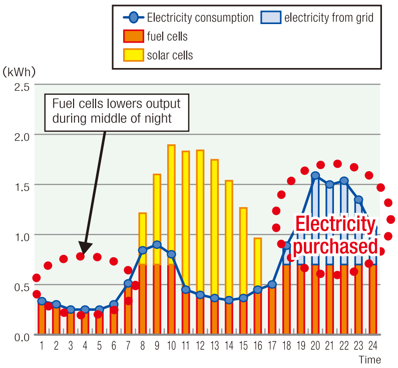
3-way power system consisting of SOFC, storage cells and solar cells (Unit #603)

This unit represents "Smart Energy House". This experimental project with multifamily housing, together with our previous experimental project with an independent house (located at Oji-cho in Nara Prefecture), contributes to the accumulation of important data for verifying and analyzing energy efficiency for housing.

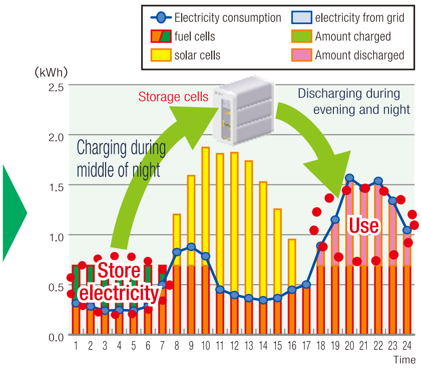
Optimum control of 3-way power system

Power generation from both fuel cells and solar cells in combination of the use of storage cells makes it possible to significantly increase energy-saving performance, where storage cells can be charged with electricity during middle of night when consumption is low and can discharge electricity during evening and night when consumption is high. This scheme effectively improves electric efficiency of fuel cells and helps promote the recovery of exhaust heat.

■Power generation from both fuel cells and solar cells



■3-way power system : fuel cells, solar cells and storage cells



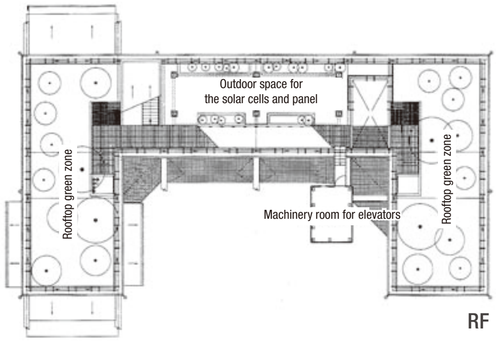
"Smart Energy House"
Live-in experimental house (Oji-cho in Nara Prefecture)

The owner started living in this experimental house on February 5, 2011.

Floor plan of each floor and elevation/cross-sectional views

PLAN

3F



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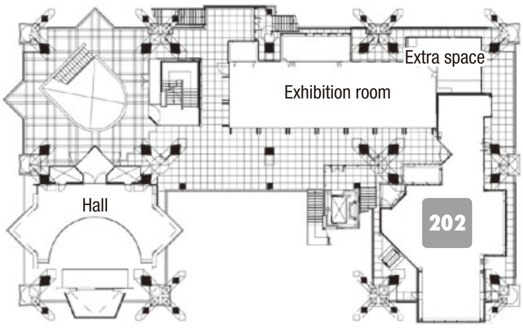

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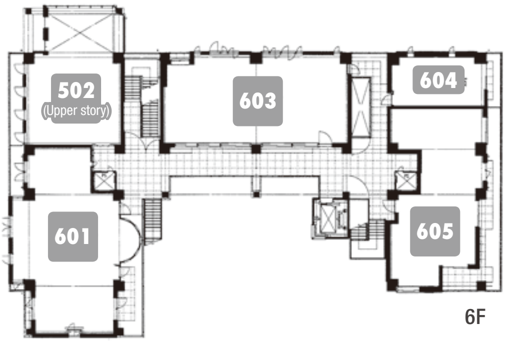

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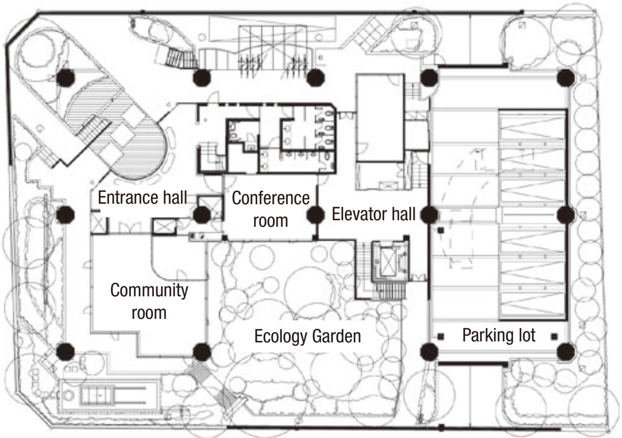

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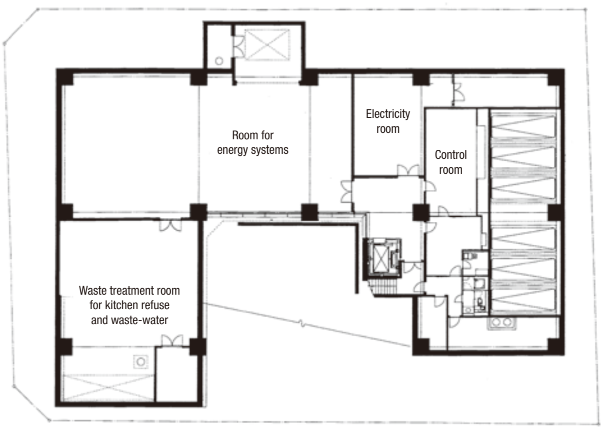

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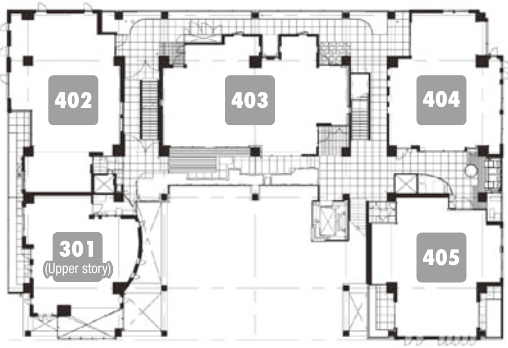
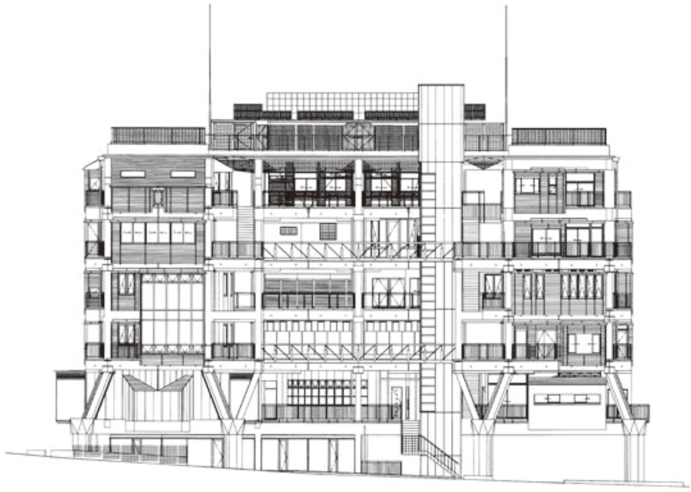


4F

1 : 600

ELEVATION

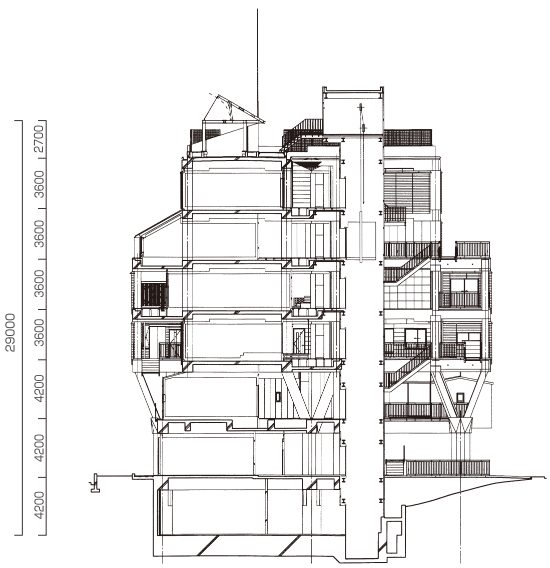
View from the West



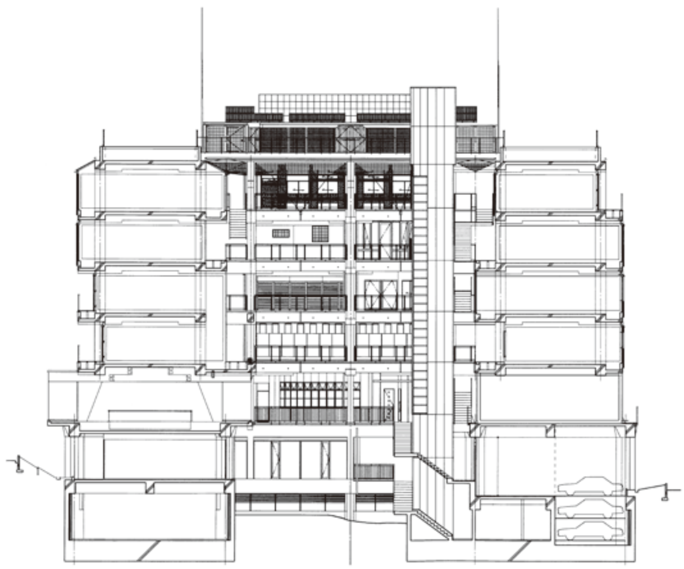
View from the South

1 : 600

SECTION



Cross-sectional view



Cross-sectional view

1 : 600

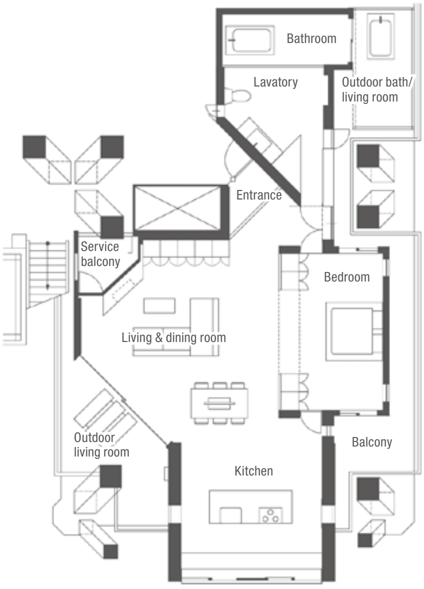
202 Dankai House

Floor area
190.15m²

Designed jointly by Shinji Kawamura of UR Support Co.,Ltd. and Takeo Endo & Takahisa Iwasaki of Endo Takeo Architect Office

Targeting middle-aged couples of the baby-boom generation (*Dankai* generation), this unit is designed to ensure residents' comfort and pleasure, with the employment of Osaka Gas With Gas Housing specifications. Major concepts are:

(1) Refreshing, comfortable living for all family members (comfortableness),
(2) User-friendly housing with energy-conscious features contributing to local and global environment. (Environment-friendliness),
(3) Housing that ensures safety and security (Safety), and
(4) Cost-conscious, sustainable housing (Economy).



1250

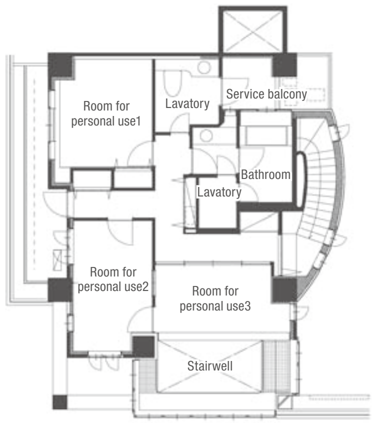
301 House of Factor 4

(Former "Garden House")

Floor area
115.00m²

Originally designed by Naomi Tachibana | Remodeled by Osaka Gas Co, Ltd. and KBI Planning & Designing Office

The original concept of this unit was "living with plants and breeze." This basic idea with the emphasis on nature-friendliness is preserved with the remodeled design, while additionally introducing energy-saving features that can function as countermeasures against global warming.
The term "Factor-4" implies the goal of achieving four-fold improvement in energy efficiency through two-fold improvement in comfort and the halving of energy consumption. In other words, the renovation seeks to achieve a four-fold reduction in environmental load (energy consumption), through the employment of solar thermal energy, diverse energy efficient facilities and appliances, and practicing an energy-saving lifestyle.



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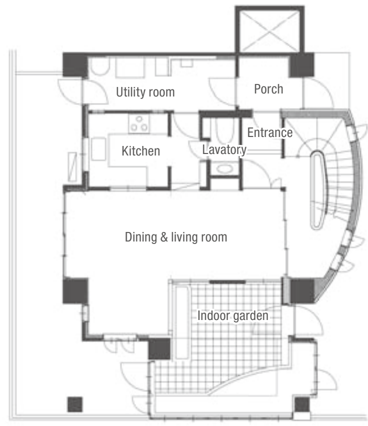


1F

1 : 250

302 Young Family House

Floor area
108.45m²

Designed by Keiko Sasaki of Atelier Trefoil

Today, many houses in Japan are of Western style with a partial use of traditional Japanese-style fittings. Through this unit, the designer sought to create a comfortable Japanese-style space, where residents can feel relaxed.

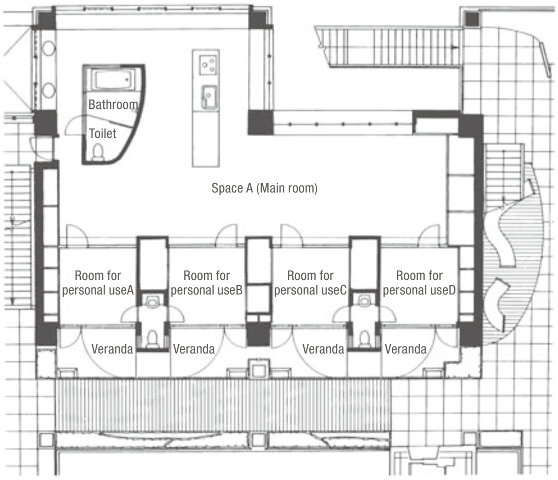
1 : 250

303 Independent Family House

Floor area
140.15m²

Designed by Coelacanth And Associates

Today, family relationships within the home differ from what used to be common in old-time Japanese society. More and more families tend to respect privacy of each member as an independent individual. At the same time, we see that many houses adopt similar floor plans convenient for a nuclear family, typically with a dining kitchen. This unit seeks to achieve two seemingly-incompatible goals at the same time–one is to “respect close relationship among family members” and the other is to “respect independence of each member.” To this end, the location of the main room (traditionally referred to as “living room”) as well as that of bedrooms of individuals has been reviewed carefully. This dwelling design ensures accessibility of individual bedrooms to the main (shared) room and also to the outside.



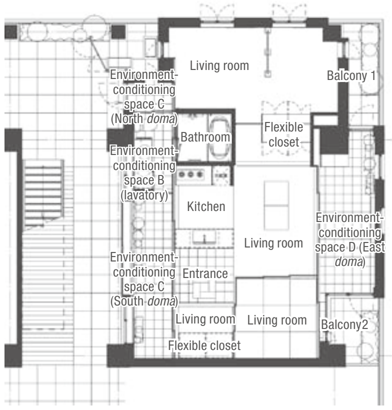
1 : 250

304 House for taking over
–adaptable housing for different families and different generations

Floor area
83.50m^2

Designed jointly by the subcommittee for the NEXT21 next-generation living environment, Atelier CK and Space Planning

This unit's infill solution is a reasonable choice in today's aging society, as it can accommodate the diverse lifestyles of different families and can be adjusted accordingly. The careful placement of door locks makes it possible for this house to secure privacy zones where visitors cannot enter–as shown by the "privacy line" on the floor plan of this unit. (see the figure, p. 11) Also, "environment-conditioning space" is introduced to further develop a traditional, long-cherished style of living, while ensuring environmental protection. *Domas*, like veranda, functionally connect an indoor space with the outside, enabling residents to enrich their activities in the quasi-outdoor space on the one hand, and helps optimize indoor thermal conditions, on the other.



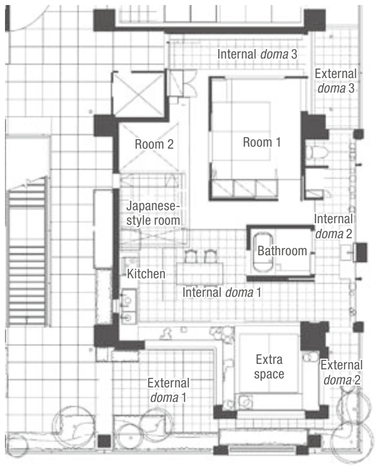
1 : 250

305 Home with "Blank" Spaces

Floor area
87.26m^2

Designed by Yoshiji Takehara of MOO Architect Workshop

Minimal rooms are scattered inside the dwelling unit, creating a string of "blank *doma* spaces" between rooms, giving the impression that an outdoor space exists inside this urban house. Such blank spaces enable residents to cohabit with sunlight, breeze and plants. Residents adapt loosely to capricious changes of these natural elements, and enjoy a simple, natural and beautiful life.



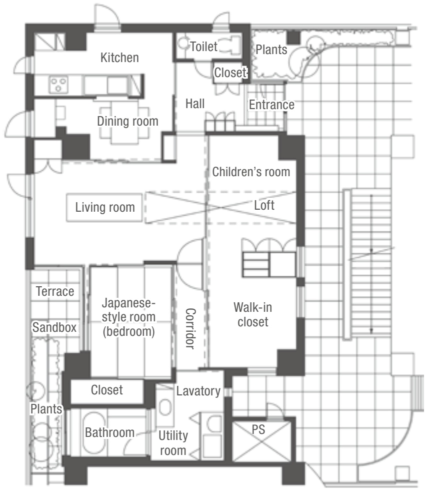
1 : 250

402 House of Wellness

Floor area
108.36m²

Designed by Tokuichi Yoshimura of the Institute for Architecture & Environment

Today, our society is full of chemical substances, and the issue of sick building syndrome draws much attention.
Besides chemical substances, there are other factors that add stress to people's living especially for families with young children, including small rooms and insufficient parks or playgrounds. This unit is designed to provide an ideal living environment for a family with a young child, and uses organic materials for interior painting and fittings as well as a partitioning system that enables residents to have both a spacious room and also to enjoy customized space creation to meet their needs, by moving sliding panels.



1 : 250

403 Resilient House

Floor area
117.81m²

Designed by Yoko Chikazumi of Yoko Chikazumi Architect Office

One target family of this unit is a middle-aged couple whose child has grown up and already left home. The multiple access routes to indoor spaces of this unit play the role of facilitating people's exchanges and gatherings. Such accessibility as well as the employment of movable walls allows this dwelling space to adapt to changing residents' lifestyles in the course of time, and to accommodate successive uses by different families.

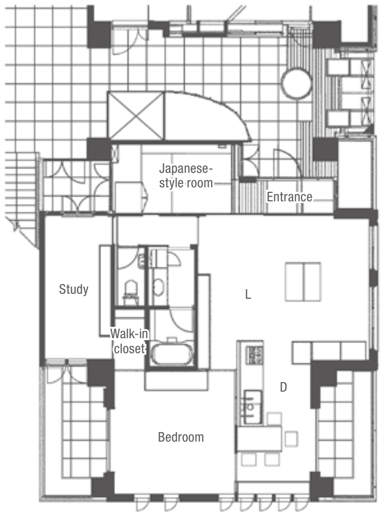
1 : 250

405 House of Next Generation Family

Floor area
91.98m²

Designed by Yoko Chikazumi of Yoko Chikazumi Architect Office

This dwelling satisfies the needs of an owner who often has guests and wants to secure both privacy and enjoyable times with guests. The spacious living room connected to the entrance hall can accommodate a large number of guests. The Japanese-style room with a sliding door can be used in various ways through opening or closing the door, and a walk-in closet can function as a passage. Thus, this unit can be characterized by its user-friendly versatility.



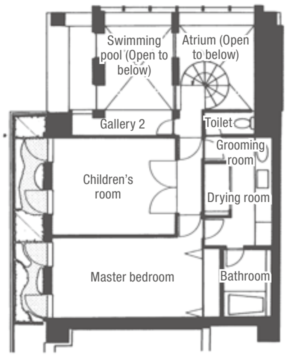
1 : 250

502 Home Party House

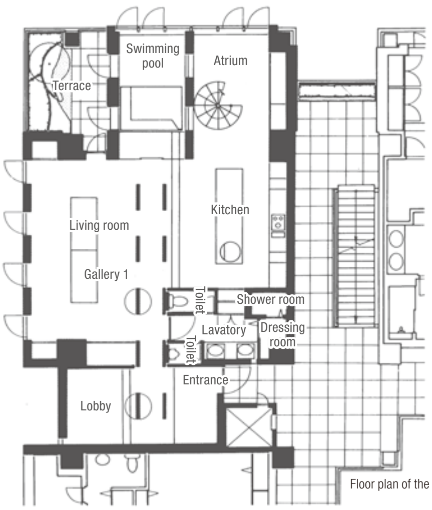
Floor area
166.89m²

Designed by Akihiro Tsukaguchi and Associates

Today, there are many double-income couples who share child-raising activities and housework. These couples often invite guests including friends and coworkers from their respective workplaces. The designer of this dwelling pays close attention to the growing population of these families who enjoy home parties.
This dwelling is designed on two levels, to ensure convenience for the owner when inviting guests.



Floor plan of the upper level



Floor plan of the lower level

1 : 250

503 Handmade Workshop

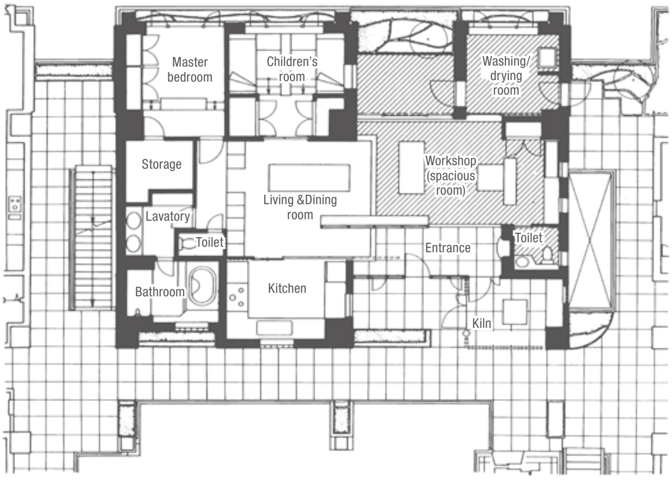
Floor area
131.33m^2

Designed by KBI Planning & Designing Office

In former times, citizens living in urban areas used to organize security teams with neighboring residents belonging to the same community, to prevent fires and crimes and share duties to manage and maintain shared facilities. These group activities were community-based, mandatory and inevitable activities. Today, citizens living in urban multi-unit housing do not have to organize such teams.

Instead, people often gather to enjoy hobbies together. This dwelling is designed to promote such hobby activities–"cooking" and "ceramic art" are assumed–through the creation of a workshop at home.

Carefully designed fittings and spaces help promote community activities suitable for today's society.



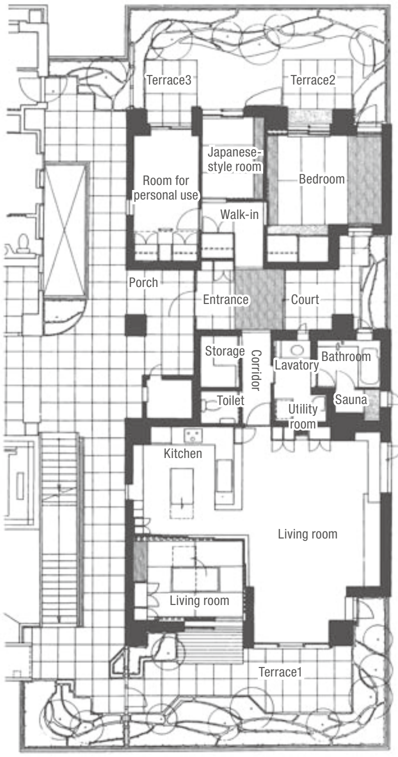
1 : 250

504 House for Relaxation

Floor area
134.64m^2

Designed by Tokuichi Yoshimura of the Institute for Architecture & Environment

Increasingly stressful factors of various kinds in today's urban society tend to discourage people from active exchanges with other people including even parents, siblings, friends and neighbors. This dwelling is designed to provide a solution to such a stressful society, through the creation of comfortable spaces where people can gather and also feel refreshed through exchanges with other people.



1 : 250

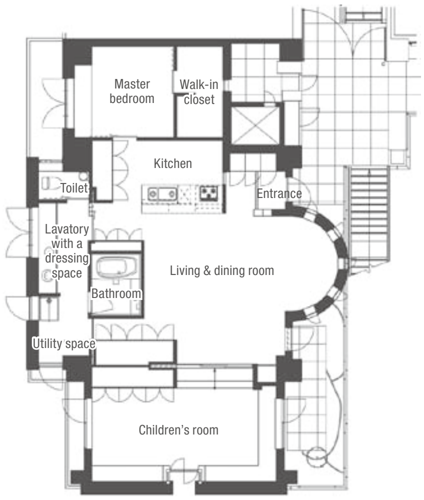
601 *Kizuki* House (House with 3Es)

"Electricity," "encouragement" and "envisioning"

Floor area
112.5m²

Originally designed by Osaka Gas Jutakusetsubi Co., Ltd. | Remodeled by KBI Planning & Designing Office

This dwelling employs the advanced HEMS (tablet terminal) and "smart" outlets interlinked with wall/table displays that visualize energy consumption and thereby prompt residents to promote energy-saving efforts. The original floor plan has been reorganized through major renovations of the living & dining rooms, kitchen and bathroom, under the assumption that this unit serves four family members at the maximum.



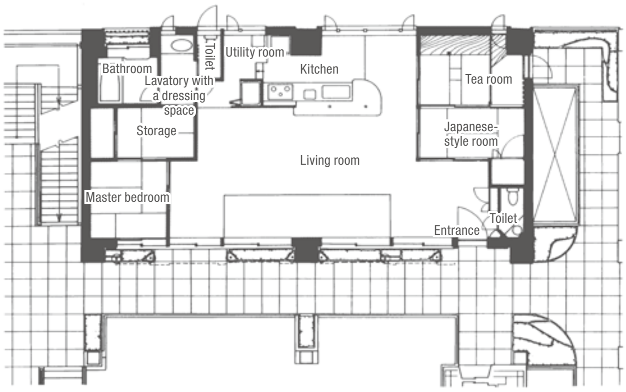
1 : 250

603 Changeable House

Floor area
106.56m²

Designed jointly by Yoshichika Uchida and Koda Architect Office

This dwelling can be reconfigured by use of panels to satisfy the changing needs of the owner or seasonal requirements. The owner will never get bored with this unit, as his/her new requirements can be always satisfied.



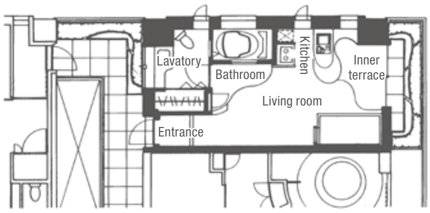
1 : 250

604 Urban Single House

Floor area
32.40m^2

Designed by Osaka Gas Jutakusetsubi Co., Ltd.

Being an urban resident means that you have the option of either depending fully on convenient outside facilities or making the maximum utilization of facilities at home. This dwelling is designed for singles, for whom wise selection of facilities is important to fully enjoy urban living in a smart way.



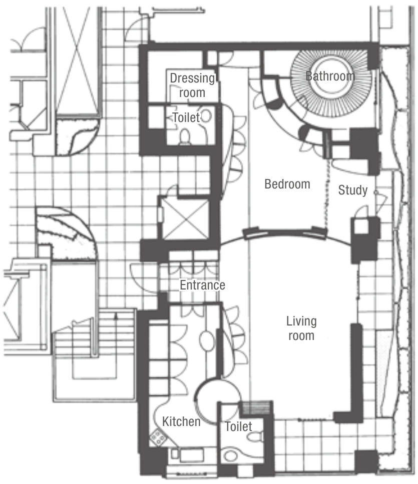
1 : 250

605 DINKS APARTMENT

Floor area
93.78m^2

Designed jointly by Mark Beaver, KBI and Kazuyuki Negishi

This dwelling is designed for a double-income couple without kids who wish to maintain their unrestricted style of living.



1 : 250

Architectural profile

Name	Experimental residential project NEXT21
Principal purpose	Multifamily housing (consisting of 18 dwelling units)
Address	6-16 Shimizudani-cho, Tennoji-ku, Osaka City, Osaka Prefecture
Ground area	1,542.92m^2
District category	Designated as "category 2 restricted residential district" and "quasi-fire prevention district" under the City Planning Act, where the building-to-land ratio must be 60% or lower and the floor area ratio must be 300% or lower.
Building size	Six stories above ground and one story underground
Building area	896.20m^2 (58.1%)
Total floor area	4,577.20 square meters, of which 4,152.90 square meters (269.2%) are counted for the calculation of a floor area ratio. 424.30 square meters for the parking lot.
Floor area by story	915.10 square meters on the first basement, 668.00 square meters on the 1st floor, 617.70 square meters on the 2nd floor, 693.00 square meters on the 3rd floor, 636.40 square meters on the 4th floor, 587.00 square meters on the 5th floor, 445.90 square meters on the 6th floor, and 14.00 square meters on the rooftop.
Height	Height: 24.42 meters (PH: 27.95 meters); eaves height: 22.66 meters
Parking capacity	20 vehicles (18 vehicles in the 3-story parking garage with a car elevator and 2 vehicles in the drive-in parking lot)
Structure	Foundation pillar: mat-slab spread foundation; steel-frame reinforced concrete structure on the first basement to the 2nd floor; and composite structure consisting of precast concrete and reinforced concrete on the 3rd to 6th floors.
Air conditioning systems	Heat source: Gas-powered double-effect absorption heater-chiller (refrigeration capacity of 105 kW) Heat-powered absorption heater-chiller (refrigeration capacity of 31.3 kW) Solar panel (tube-type thermal energy collection panel) 30 square meters (partially powered by hot water) Gas-powered micro-CHP system with the function to recover discharged heat Air conditioning systems: For dwelling units, a hot/cold fan coil system is used together with the all-heat exchange ventilation system. Decentralized air conditioning system (EHP)
Water facilities	Supply of cold water: Tap water and recycled water (pressure feed) Supply of hot water: Each dwelling unit is equipped with a water heater Drainage: Shared piping system (partially equipped with booster pumps) Sprinklers: Automatic spraying
Gas facilities	Medium-pressure supply system (1,500 mmAq)
Electricity facilities	Power source: Gas-powered micro-CHP system 31 kW Fuel cell-powered home CHP system ENE-FARM Type S 700 W ENE-FARM 700 W, ECOWILL 1.0 kW Solar cell 5.2 kW (single crystal silicon) Storage cell 5.5 kWh, 4.4 kWh Control: Central monitoring system
Special facilities	Kitchen refuse disposal: Equipment for the generation of biogas Treatment of domestic waste-water: Biological treatment (contact aeration method); treatment of waste water (fast filtering of suspended substances and activated carbon absorption)
Elevators	Capacity 1,000 kilograms or 15 persons (one unit)

Awards

February 24, 1994	Prize for excellent energy-saving facilities
December 21, 1994	Excellent greening performance
September 29, 1995	Good Design Award: Facilities Category
October 1, 1995	Osaka City award for excellent housing design: Special award
October 24, 1995	Osaka Machinami Award (15th award for excellent urban landscape creators in Osaka) Special award
February 29, 1996	Award for excellent energy-saving architecture: Incentive award
March 15, 1996	Annual Architectural Design Commendation of the Architectural Institute of Japan
July 1, 1996	27th award for excellent greening facilities of building
August 30, 1996	7th award for excellent greening facilities in Osaka: Prize for best performance
February 26, 1997	Award of the Architecture Association of Japan
June 10, 1998	25th award for excellent environmental contribution
September 10, 2003	16th Nikkei New Office Award, The Best of New Offices in Kinki Region, Special Award of Screening Committee (Unit #202 of the NEXT21)
August 3, 2004	2004 award for excellent technology contributing to the global environment
July 8, 2011	5th Kids Design Award: Social kids product category
December 10, 2011	Award of the Association of Urban Housing Sciences: Prize for Excellent Performance

Project Outline

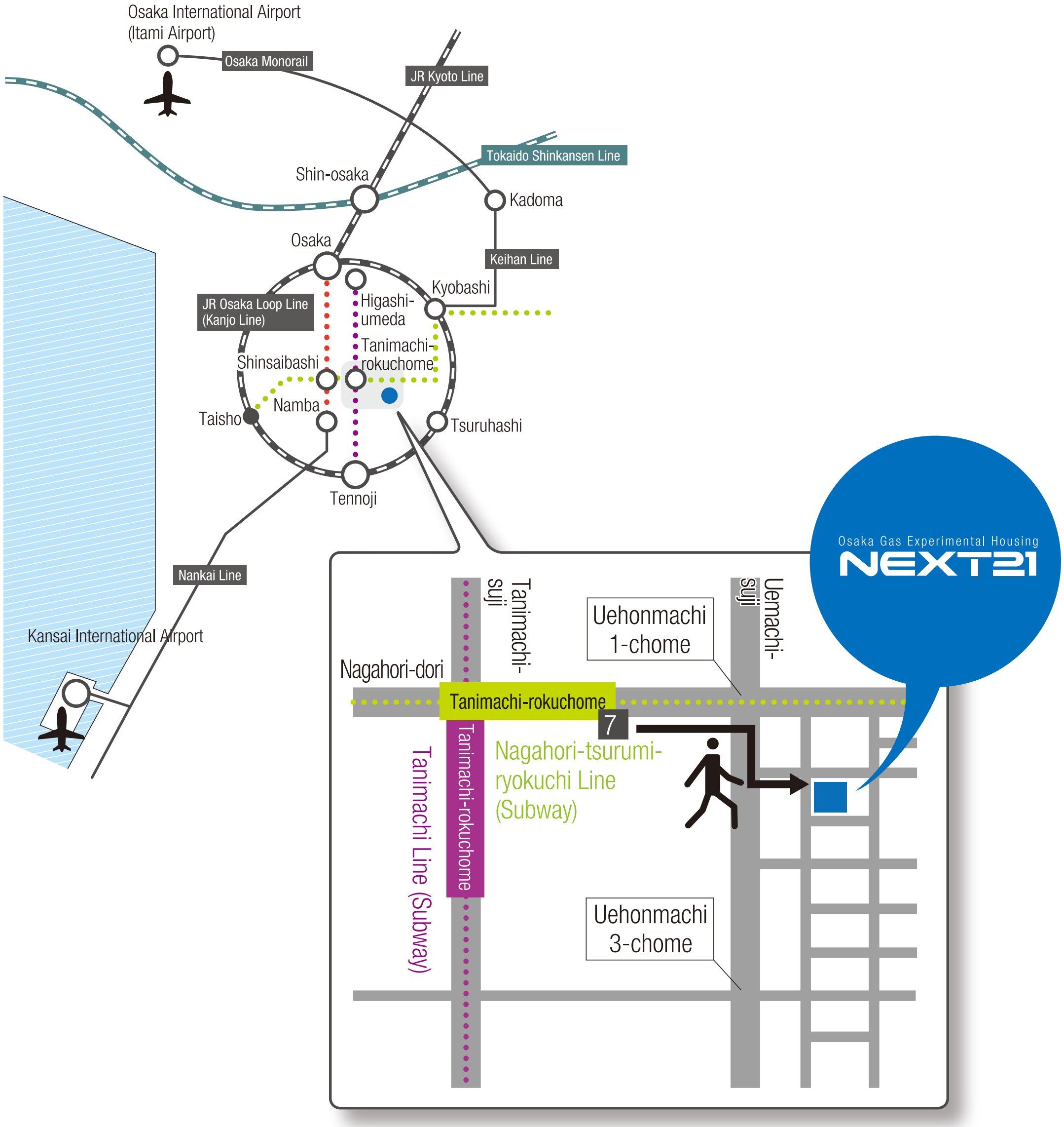
Initial Stage

Project planner	Osaka Gas Co., Ltd.
Members for the NEXT21 grand design	Osaka Gas NEXT21 Project Committee (Current titles in parentheses) Chairperson: Yoshichika Uchida (Professor Emeritus, The University of Tokyo) Vice-chairperson: Kazuo Tatsumi (Former Professor Emeritus, Kyoto University) (deceased) Member: Seiichi Fukao (Professor Emeritus, Tokyo Metropolitan University) Member: Mitsuo Takada (Professor, Kyoto University Graduate School) Member: Shinichi Chikazumi (Director, Shu-Koh-Sha Architectural & Urban Design Studio) Member: Saburo Takama (Director, Scientific Air-Conditioning Institute) Member: Shozo Endo (then-Executive Manager of Product/Technology Development, Osaka Gas Co., Ltd.) Member: Masahiro Sento (then-Marketing Director, Osaka Gas Co., Ltd.)
Designers	Osaka Gas NEXT21 Project Committee (Chief designer and supervisor: Yoshichika Uchida and Shu-Koh-Sha Architectural & Urban Design Studio)
Constructors	Obayashi Corporation and others

Phase 4 (Remodeling)

Project planner	Osaka Gas Co., Ltd.
Members for the NEXT21 grand design	NEXT21 Phase 4 Council Members: Osaka Gas Co., Ltd. Toshihide Tanaka (head), Takehiko Nishio, Hiroyuki Shinokura, Akemi Kubota, Midori Kamo, Masayuki Ushio, Tsuyoshi Takeda, Toru Shiba and Koji Watanabe Member for technical field: Mitsuo Takada (Professor, Kyoto University Graduate School) Member for technical field: Shinichi Chikazumi (Director, Shu-Koh-Sha Architectural & Urban Design Studio) Member for technical field: Saburo Takama (Director, Scientific Air-Conditioning Institute)
Designers	Placement of the residential building and facilities Shu-Koh-Sha Architectural & Urban Design Studio Dwelling units ◎Infill Unit #305: Yoshiji Takehara of MOO Architect Workshop Unit #403: Yoko Chikazumi of Yoko Chikazumi Architect Office Unit #601: KBI Planning & Designing Office ◎Cladding Shu-Koh-Sha Architectural & Urban Design Studio ◎Facilities Scientific Air-Conditioning Institute and Obayashi Corporation Energy systems Osaka Gas Co., Ltd. Green zones Atelier E2
Constructors	Obayashi Corporation and others

MAP



5 minutes on foot from Exit 7 of the Tanimachi-rokuchome Station of the Tanimachi Line (subway) or the Nagahori-tsurumi-ryokuchi Line (subway)

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