peace

IZAC MYONGJI UNIVERSITY ZED Architects Co.,Ltd.

1st Asia-Pacific Housing Conference: Making Housing Affordable, Inclusive, and Resilient

08 November 2022 to 09 November 2022

1st Asia-Pacific Housing Conference

Net Zero Source Energy Project in Korea for Climate Change Adaptation & Mitigation

09. Nov. 2022
Prof. Ph.D. Architektin Myoungju Lee (Myongji University)

Why are poor countries more vulnerable to climate change?

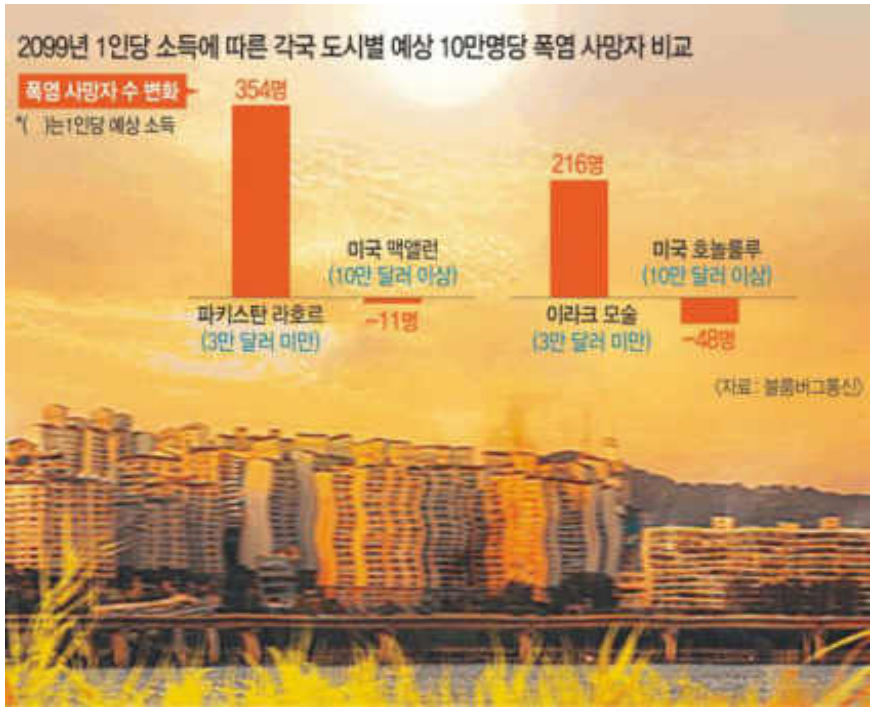
Summary for Policymakers Sixth Assessment Report-IPCC

[Premium Report]
Developing countries are more venerable to dimate change

※ Source: Dongascience,「[Premium Report] Why are poor countries more vulnerable to climate change? 2022.04.

The more severe climate change impact on poor individuals and nations

Even within the countries, the level of impact from heatwaves varies according to the gap between the rich and the poor



※ Source : Kukmin Ilbo,「'Abnormal Climate' impacts for the poor and poor countries」, 2021.08.

Adaptation & Mitigation

Climate Change Adaptation & **Greenhouse Gas Reduction**

Technology to adapt to climate change

Technology to mitigate climate change

Adaptation & Mitigation

in Korea Net Zero Source Energy Housing Complex & CITY

Urban area takes 3% of the entire surface of the earth.

80% of entire carbon footprint on earth is from the urban area.

Korea

Energy use by buildings

20%

Seoul

Electricity use by buildings

83%

※ Source: Worldwatch Institute

Comparison of Carbon-Neutral Cities with or without Practical Strategies

Before (existing) ← [Declaration of Carbon Neutrality by 2050] → **After** (planned)

Estimation of National Greenhouse Gas Inventory

00City Existing Plan for GHG Emission Sector

탄소배출 487,306 tCO_2 /년

건물(E) Building
450,037 tCO_2 /년
92%

기반시설(E)
3,242 tCO_2 /년
1%
Infrastructure

교통
34,027 tCO_2 /년
7%
Transportation

Prediction of carbon emissions by implementation strategy

00City GHG Reduction Sector

탄소감축 65%

건물(E) 60% ▼
183,766 tCO_2 /년
84%
Building

흡수
공원·녹지
+CCUS
19,498 tCO_2 /년
6%

기반시설(E)
96% ▼
115 tCO_2 /년
1%
Infrastructure

교통 90% ▼
3,571 tCO_2 /년
9%
Transportation

PUBLIC BUILDING:
(Certification of Zero Energy Building)
ZEB: 3rd Grade)

PRIVATE BUILDING:
(Certification of Zero Energy Building
ZEB: 5th Grade)

* Carbon emission in building and infrastructure are based on energy usage in Saemangeum Smart Waterfront City Energy Usage Plan (2021.12.)

Source: Korea Research Institute for Human Settlements, ZED Architects and Land Total Solution, Establishing Basic Carbon Neutral Plan for Saemangeum Smart Waterfront City, 2022.06, Saemangeum Development and Investment Agency

Net Zero Energy Building Definitions

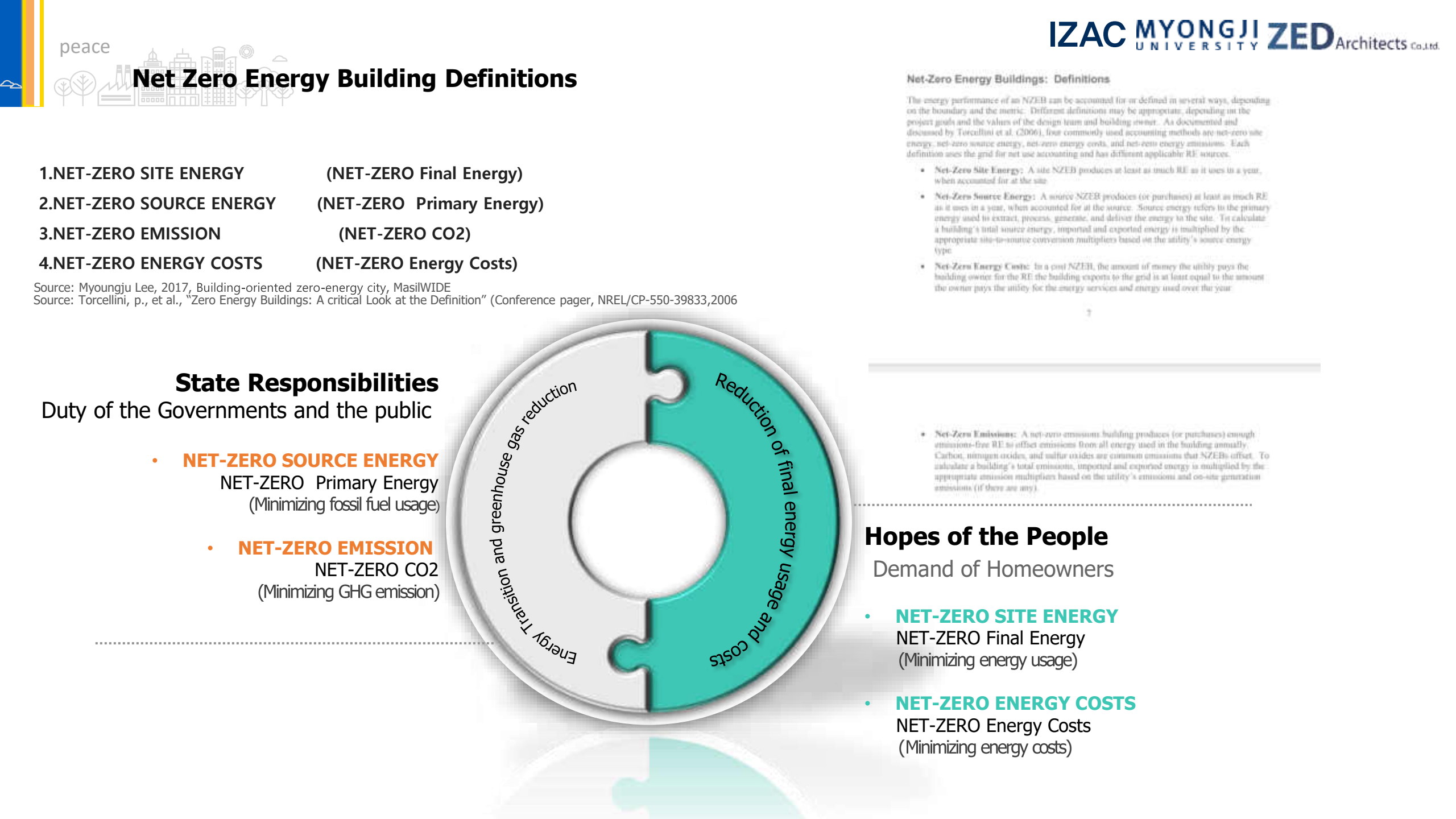
1.NET-ZERO SITE ENERGY (NET-ZERO Final Energy)

2.NET-ZERO SOURCE ENERGY (NET-ZERO Primary Energy)

3.NET-ZERO EMISSION (NET-ZERO CO2)

4.NET-ZERO ENERGY COSTS (NET-ZERO Energy Costs)

Source: Myoungju Lee, 2017, Building-oriented zero-energy city, MasilWIDE
Source: Torcellini, p., et al., "Zero Energy Buildings: A critical Look at the Definition" (Conference pager, NREL/CP-550-39833,2006



State Responsibilities

Duty of the Governments and the public

- **NET-ZERO SOURCE ENERGY**
  NET-ZERO Primary Energy
  (Minimizing fossil fuel usage)
- **NET-ZERO EMISSION**
  NET-ZERO CO2
  (Minimizing GHG emission)

Hopes of the People

Demand of Homeowners

- **NET-ZERO SITE ENERGY**
  NET-ZERO Final Energy
  (Minimizing energy usage)
- **NET-ZERO ENERGY COSTS**
  NET-ZERO Energy Costs
  (Minimizing energy costs)

R&D project in 2012 by Ministry of Land, Infrastructure and Transport in Korea

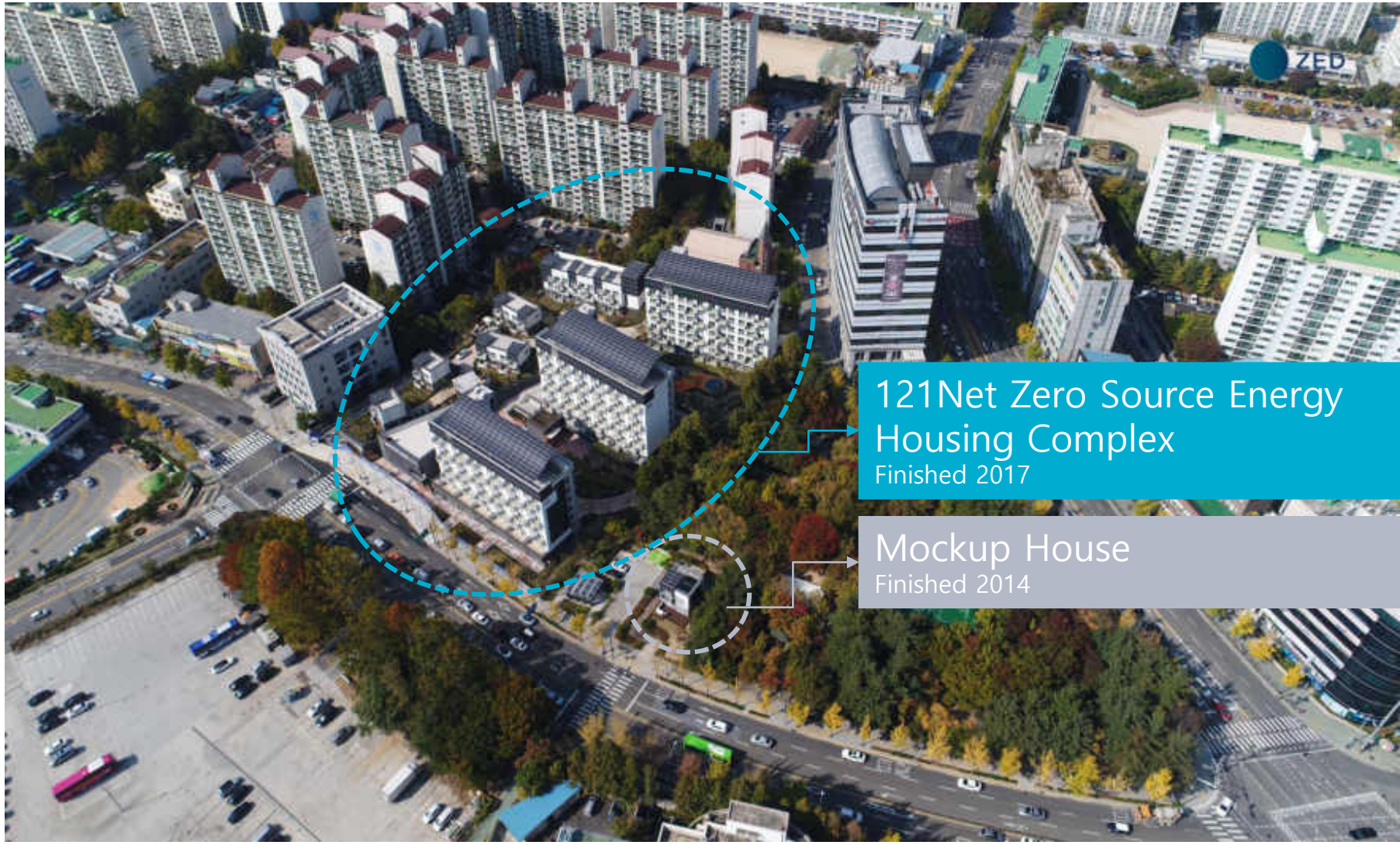
Ministry of Land, Infrastructure and Transport

Korea Agency for Infrastructure Technology Advancement ↔ **Research Agency**: MyoungJi University + Nowon District + Seoul City

1 Detailed Assignment	2 Detailed Assignment	3 Detailed Assignment
MyongJi University	(Inc.)KCC Construction	Seoul Housing and Communities Corporation Research
· MyongJi Zero Energy Center	· (Inc.)KCC Construction	· **ZED Architects (Inc.)**
· MyongJi Real Estate Department	· Primo K&S (Inc.)	· Nuri Telecom (Inc.)
· **ZED Architects (Inc.)**	· Korea Construction Research (Inc.)	

The 1st Zero Energy Housing Complex in Korea, Nowon EZ House

•Pre-planning 2012, Planning 2013.10~2015.10. Completed 2017.11



Source: IT & Zero Energy Architecture Center & ZED Architects (www.ized.co.kr)

Zero Energy Experience House (2014) – Mockup House

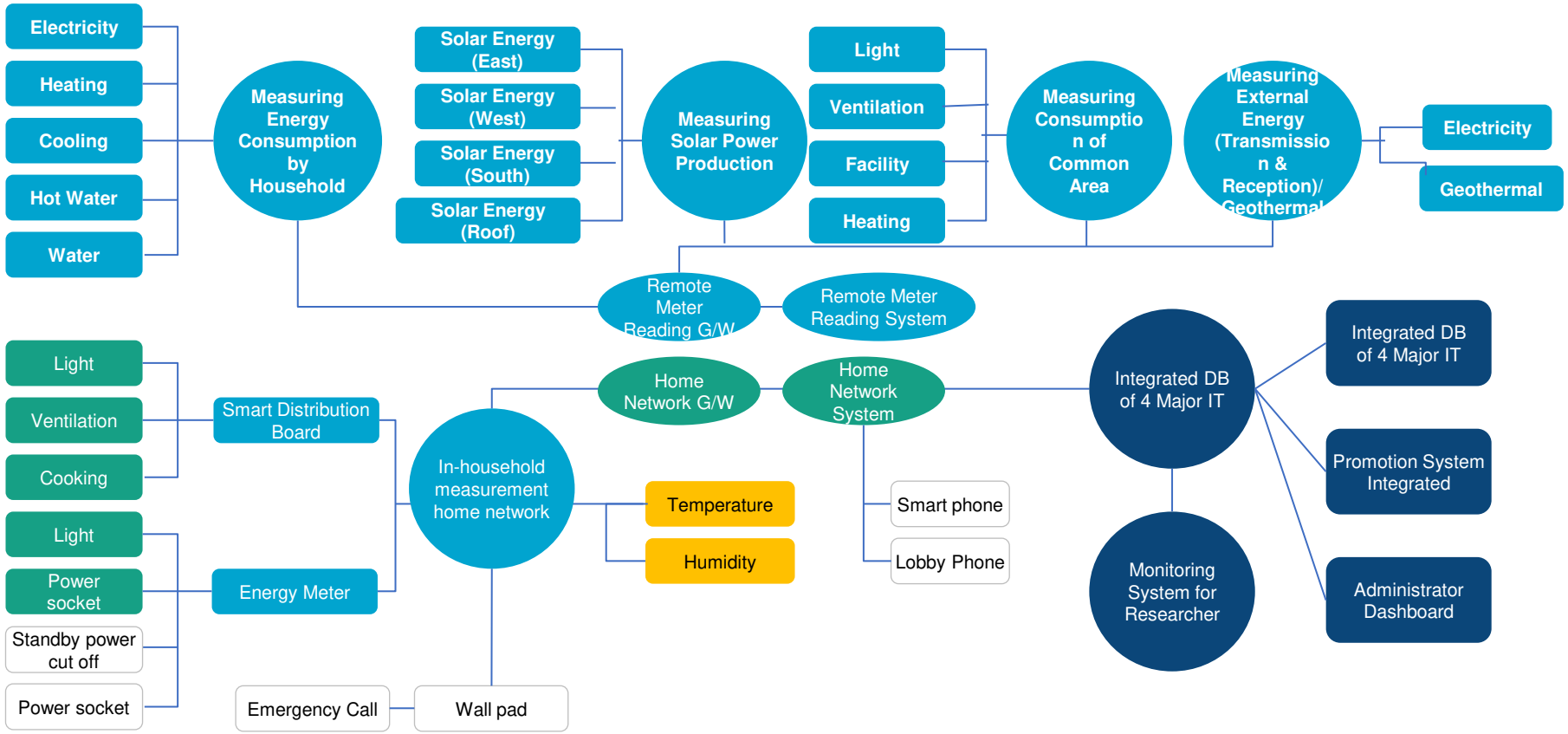
Location: **On the grounds of the park, 251-8 Hagye-dong, Nowon-gu, Seoul**
Building size: two floor above ground
Total FL Area: 82.03 ㎡ **Building Area:** 55.06㎡
Main Construction Materials: Triple glazing system window, Heat recovery ventilation system, Brick Tile
Solar Power Generation: 7.5kW installed

(C) 2017 NOWON ENERGY ZERO HOUSE, SEOUL KOREA

Monitoring System of EZ HOUSE

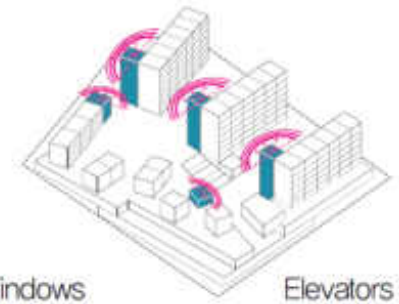
Monitored for 4 years (2018-2021)

•Energy independence rate of 93% (Heating, cooling, hot water, ventilation and lighting) (4 years average)

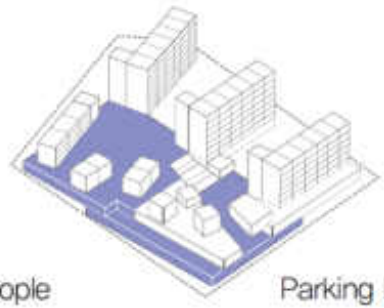


▶ Measurement of both household energy consumption and renewable energy production
▶ The application of AMI measuring equipment enables remote inspection,
so, the residential household management efficiency of the complex is high
▶ Measurement points are approximately 2,400 and large amounts of data are produced

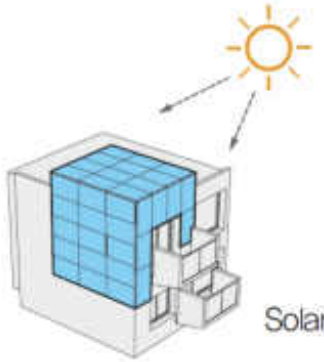
Southern Facing Windows



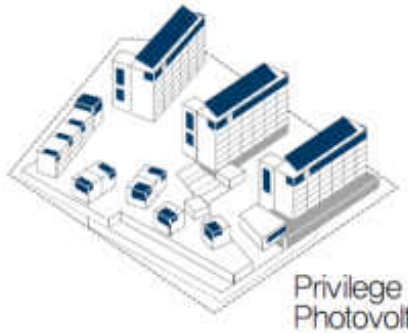
Elevators for People with Disabilities



Parking Lot



Solar Block



Privilege of Photovoltaic Panel Uses

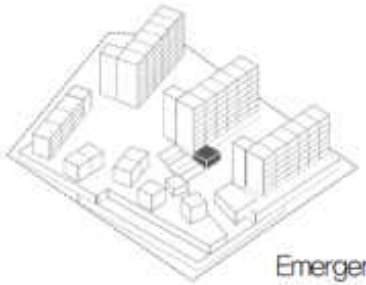
Residential Facilities

Neighborhood Unit (Shopping Area)

Residential Community Center

Nowon EZ Center

Senior Center



Emergency Room (Monitoring)

4 Major Philosophies of Zero Energy Housing Complex

"Realizing human, social, energy and environmental welfare"

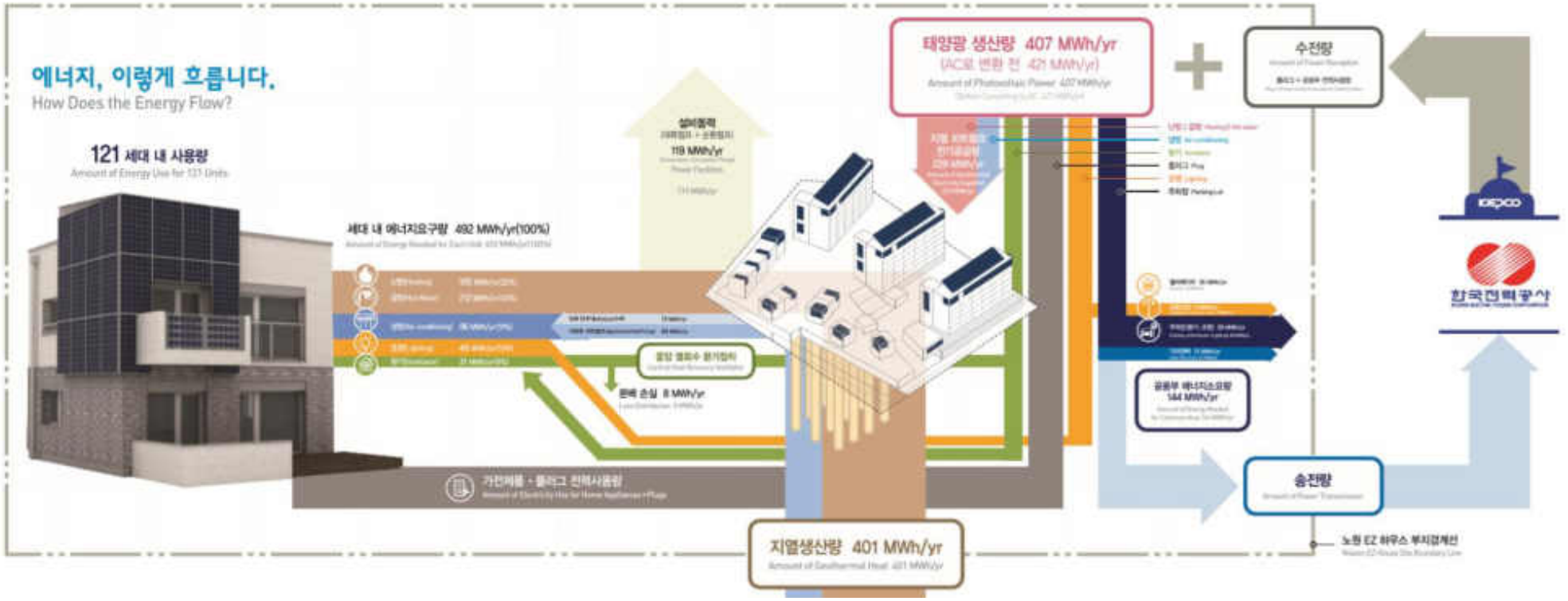
Happy People
- Long-duration houses that can be remodeled / Living room facing south
- Universal design for the people with disabilities and the elderly
- Prevention of crimes through a space design
- Provision of spaces and elevation that people could not experience in existing rental houses

Town for Getting Together
- Various types of residential buildings & roadside developments
- Local community inside the housing complex & securing education and promotion spaces
- Utilization of the common areas as community spaces

Warm Buildings
- Minimization of the required building energy through efficient design and construction methods
- Optimization of the use of renewable energy balanced with the energy consumption
- Minimization of the energy cost burden on economically vulnerable groups

Pleasant Environment
- Zero fossil energy responding to the issues of resource depletion and climate change
- Building a water-circulation system of the space outside the complex
- Using energy-saving and eco-friendly building materials

Nowon EZ House_ the 1st Zero Energy Housing Complex



Source: Myoungju Lee, 2017, Building-oriented zero-energy city, MasilWIDE

[Definition of Net-Zero primary Energy NOWON EZ HOUSE]

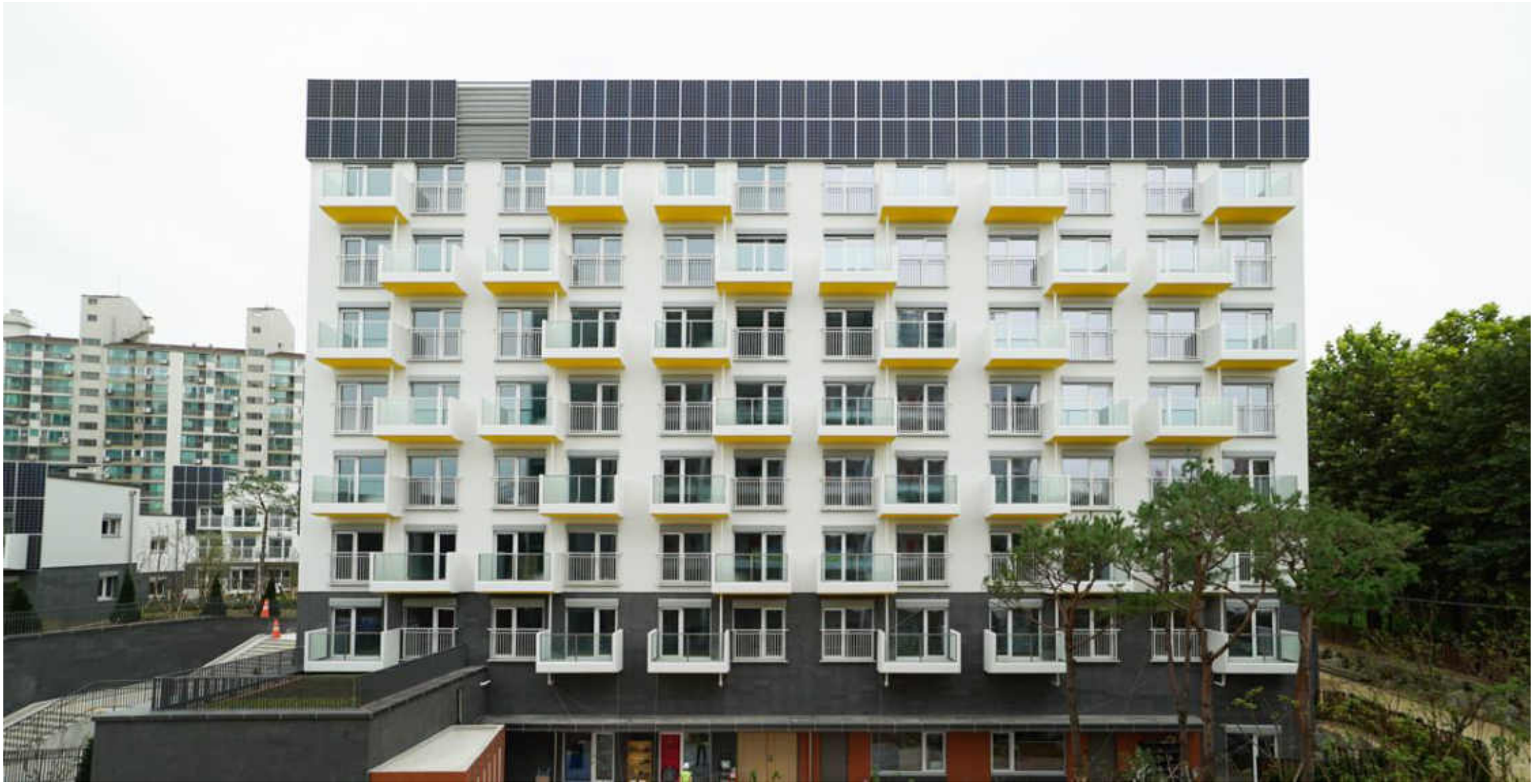
A more concrete definition of the Nowon Complex is that energy needs for heating, cooling, hot water, ventilation, and light, from the entire household in the Complex would be fulfilled by renewable energy, which also has produced within the complex.

If additional energy is needed, energy is received from the grid, and the leftover is returned. Net zero is calculated by offsetting the total annual energy consumption with the energy produced via renewable energy sources at a primary energy level. (Lee, 2017).

- R&D Project of the Ministry of Land, Infrastructure and Transport, 'Development of an Optimization Model for the Revitalization of Zero Energy Housing' (Nowon EZ House) 3rd Year Performance Report, defines the Net-Zero Energy housing complex as above


101
전 용


101
102



How to achieve ZERO?

research, design, technology management, construction, equipment, monitoring

Energy reduction technique

Passive design technology

Highly efficient equipment

Technology applying Highly efficient construction

Clean Energy technology

Renewable energy

Measuring production and consumption rates

IT techniques

"Energy ever follows Building envelope" Prof. Ph.D. Myoungju Lee 2018

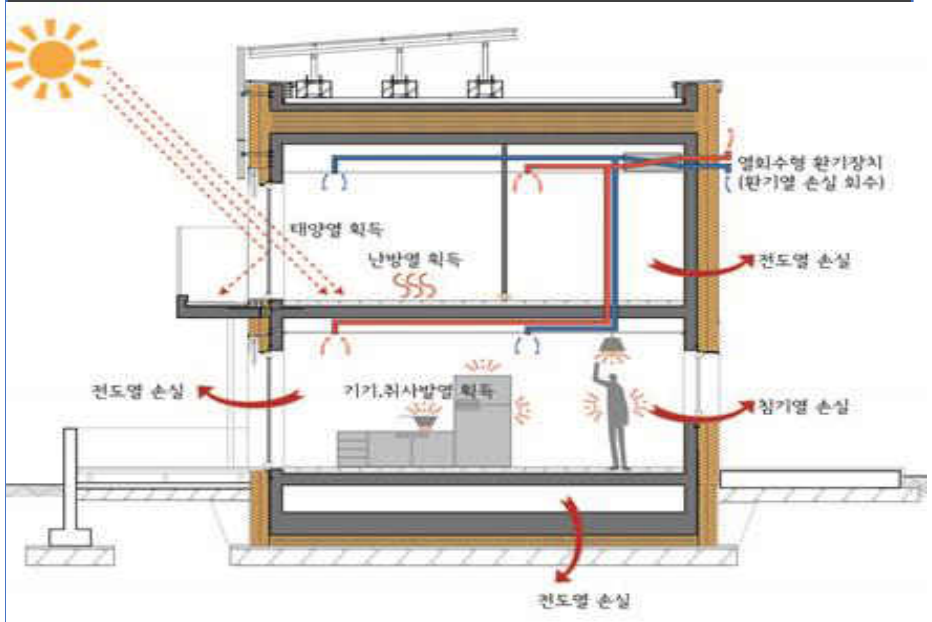
Total Energy Cost
(Mar.2018 ~ DEC.2021)

$ 1 /(unit.day) energy cost inc. cooking & Pubic

Korean housing complex completed with 100% Korean techniques and 98.3% of Korean products.

Zero Energy Housing Complex minimized the heat loss using passive elementary technologies in each physical phenomenon and maximized heat gain from Solar energy and internal heat gain

SOUTH KOREA



ZED IZAC
ZERO ENERGY DESIGN IT & Zero Energy Architecture Center

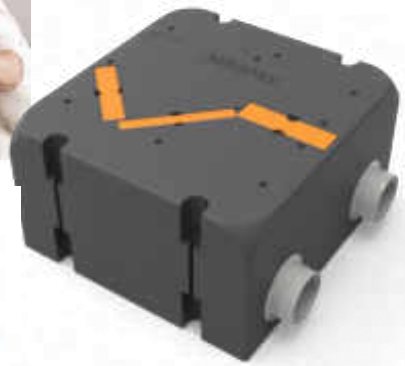
Purpose Of Design	Elementary Technologies	Techniques Contents	
Heat Loss Protection from Conductive Heat	Heat Insulation	Inside/Outside Insulation	
	Heat Insulation of Building Envelope (Thermal Transmittance)	Direct Outside Air	
		Indirect Outside Air	
		Floor (Indirect, Floor Heating)	
		Roof (Direct Outside Air)	
		Side Wall	
	Heat Bridge Cut-Off	Apply Heat Bridge Cut-Off in Each Part	
	Windows and Doors Insulation (Thermal Transmittance)	Window Glass	Insulation Door
		Window Frame	
Heat Loss Protection from Air Tightening	Airtight	Performance	
Ventilation Heat Recovery System	Waste Heat Recovery Ventilation	Equipment Efficiency, Distribution Loss	
Control the Solar Energy	Awning, outside Blinde (Cooling Load Reduction)	Application Status Of External Blind	

Source: Prof. Ph.D. Myoungju Lee, Application Techniques on the First Zero Energy Housing Complex in Nowon District, Korea, Passivhaus Conference 2018, München, Germany

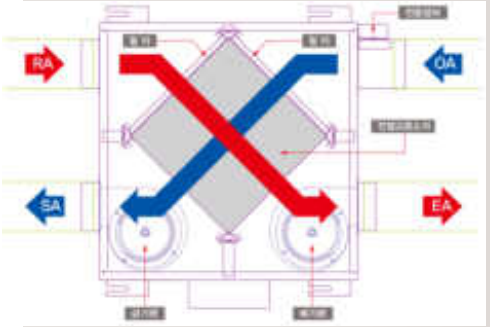
Indoor Air Quality

ECO

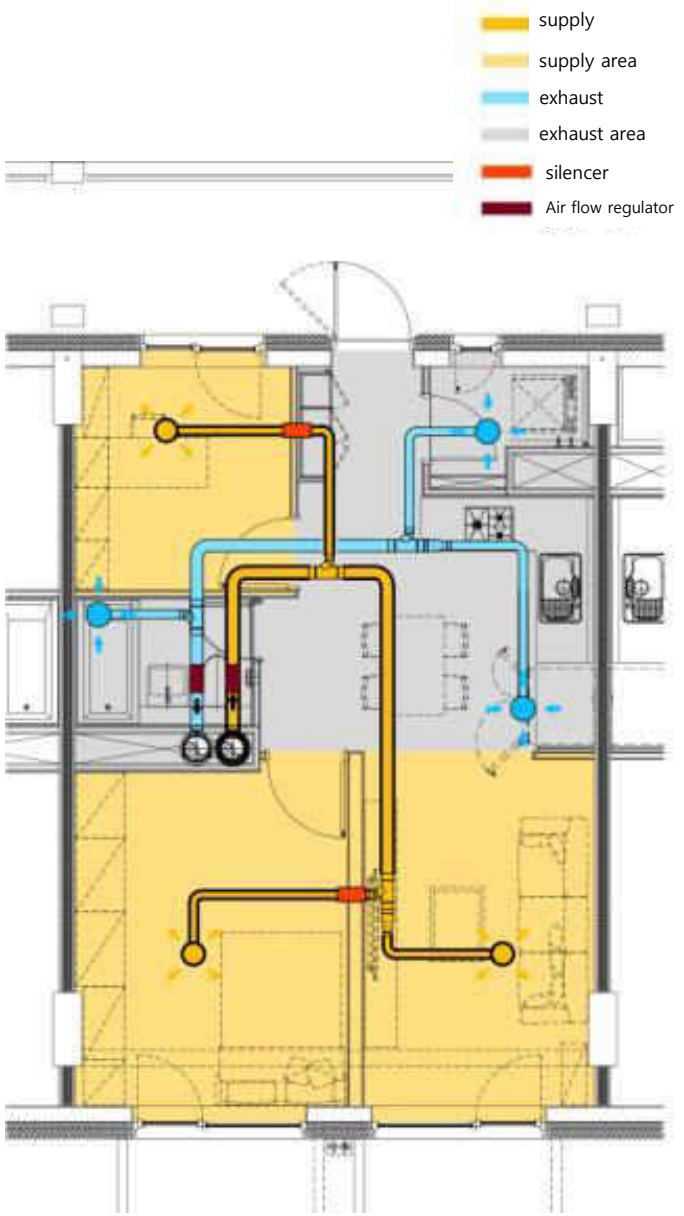
Strengthen the air tightness blocks the inflow of external polluted air but provides fresh air through the Heat Recovery Ventilation System with HEPA filter*



HEPA FILTER H13



Clean Indoor Air Quality



Real time energy monitoring

103동
Power Generation 256kWh
Consumption 1,131kWh

102동
Power Generation 268kWh
Consumption 1,160kWh

101동
Power Generation 258kWh
Consumption 1,308kWh

203동
Power Generation 140kWh
Consumption 200.4kWh

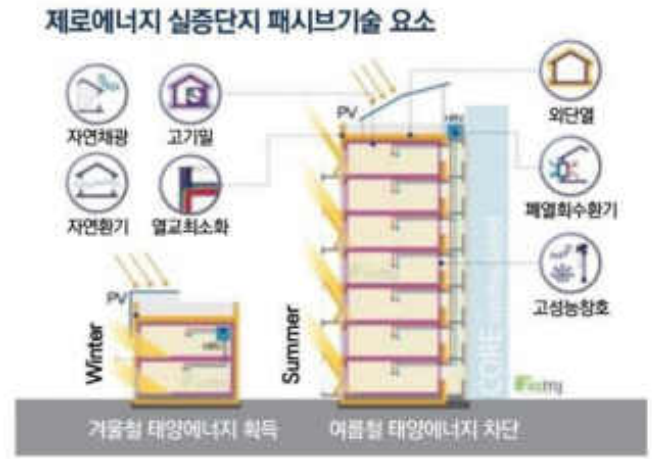
201동, 202동
Power Generation 70kWh
Consumption 101kWh

301동, 302동
Power Generation 70kWh
Consumption 51kWh

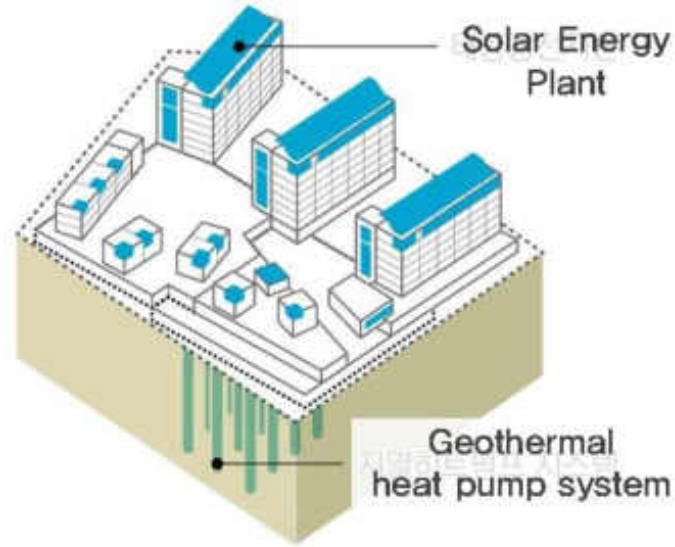
홍보관

The highest grade for Green building certification
1+++ grade for energy efficiency grade certification
Passive Housing Certification from Germany

Components of Passive design technology



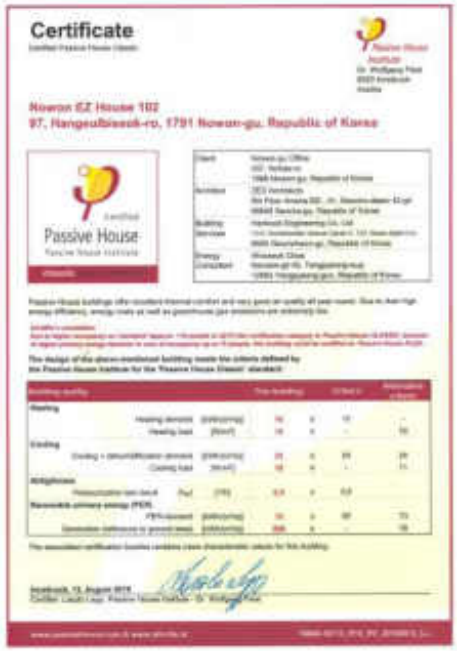
Components of Renewable energy technology



The Certificate acquisition on Nowon Energy Zero Housing Complex

Energy Efficiency Level
Certified 1+++

Green Building Certificate
The Highest Grade Certified



Nowon EZ house Building Unit 102
German Passive House Certificate

Living Environment without Any Obstacles
Superior Grade Pre-Certified

PUBLICATIONS

1. Effects of Mechanical ventilation on indoor air quality ....

2. Field-Based longitudinal study design for measuring ...

Ah-YoungLim[a] MiryoungYoon[a] Eun-HyeKim[a] Hyun-AhKim[b] Myoung JuLee[b] Hae-KwanCheong[a]

MethodsX

Field-based longitudinal study design for measuring the association between indoor air quality and occupant health status in residential buildings

Abstract

There has been a growing interest in the association between indoor air quality (IAQ) with an increase in the time spent at home. However, there is still a lack of evidence on the impact of IAQ on occupants' health and well-being in the long term. This study aimed to develop a field-based longitudinal study design to evaluate the IAQ level and daily symptoms of adults and children living in different types of buildings over one year. We proposed vital principles to be considered when recruiting the study participants so that potential confounders, such as age, underlying diseases, and the geographic area would be either removed in advance or matched between different building types. We suggested collecting exposure and outcome data in three categories: lifestyle and housing environment, IAQ measurement, and occupants' health. We presented web-based survey tools for collecting housing and health data, and the frequency of data collection varied from weekly to six-month intervals. We developed two different models using a generalized mixed model for modeling the association between housing environment, IAQ, and human health. The current study design could be applied for future studies on the association between built environment and health, regardless of the type of buildings.

Ah-Young Lim [a], Miryoung Yoon [a], Eun-Hye Kim [a], Hyun-Ah Kim [b], Myoung Ju Lee [b], Hae-Kwan Cheong [a]

Effects of mechanical ventilation on indoor air quality and occupant health status in energy-efficient home'

ScienceDirect

Science of The Total Environment

Effects of mechanical ventilation on indoor air quality and occupant health status in energy-efficient homes: A longitudinal field study

Highlights

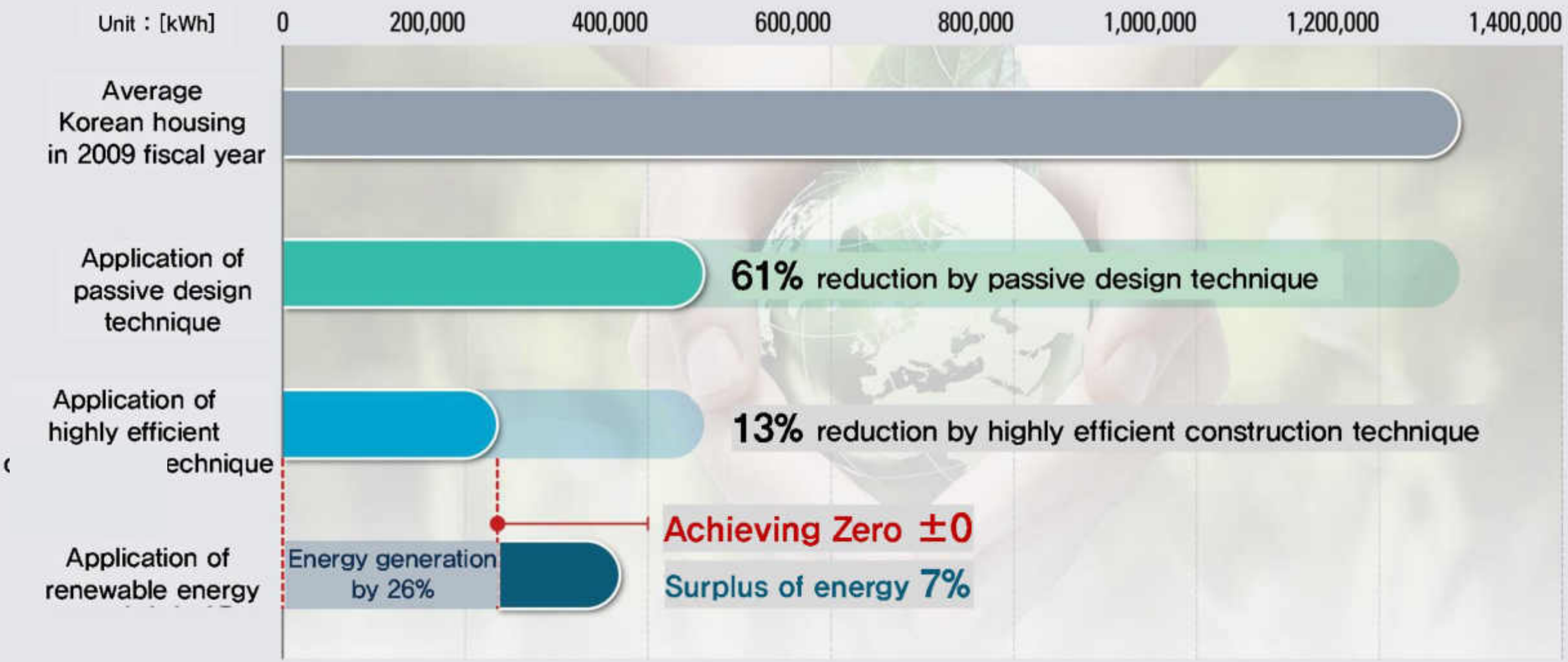
- Energy-efficient homes have better indoor air quality.
- Temperature and humidity remained constant year-round in energy-efficient houses.
- Children in energy-efficient homes showed lower risks of allergic symptoms.

The indoor temperature/humidity, which is related to the comfort perceived by residents, remained relatively constant throughout the year in the zero-energy house compared to the general house.

In particular, the zero-energy house maintained lower temperature/humidity in summer and higher temperature/humidity in winter than general houses.

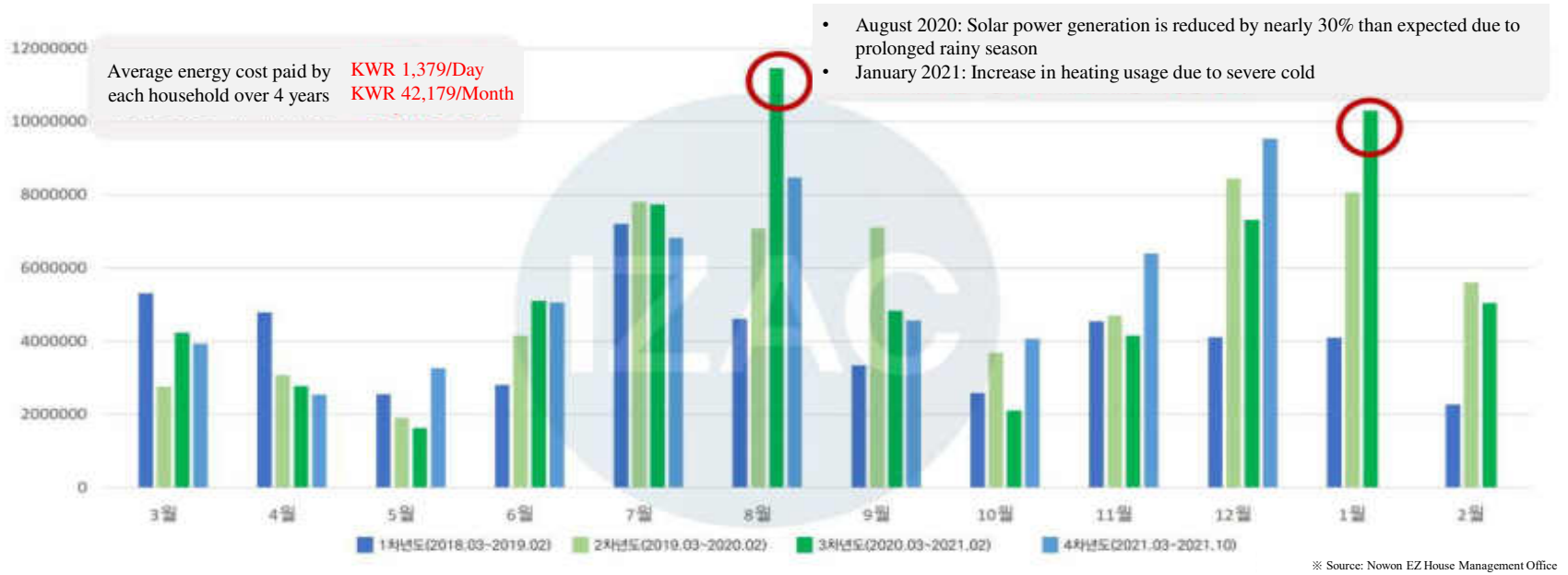
A high indoor ventilation rate is known to lower the risk of allergic symptoms. In this study, when gender, age, and medical history were adjusted, the incidence of allergic rhinitis and atopic dermatitis symptoms in children in zero-energy houses was lower than in general houses.

Nowon EZ House_ Net Zero Source Energy (Heating, Cooling, Lighting, Ventilation, Hot water)



Comparison of Monthly Average Energy Cost of Nowon EZ House(2018.3. VS. 2021.12)

Improving the Quality of Life at Minimal Cost

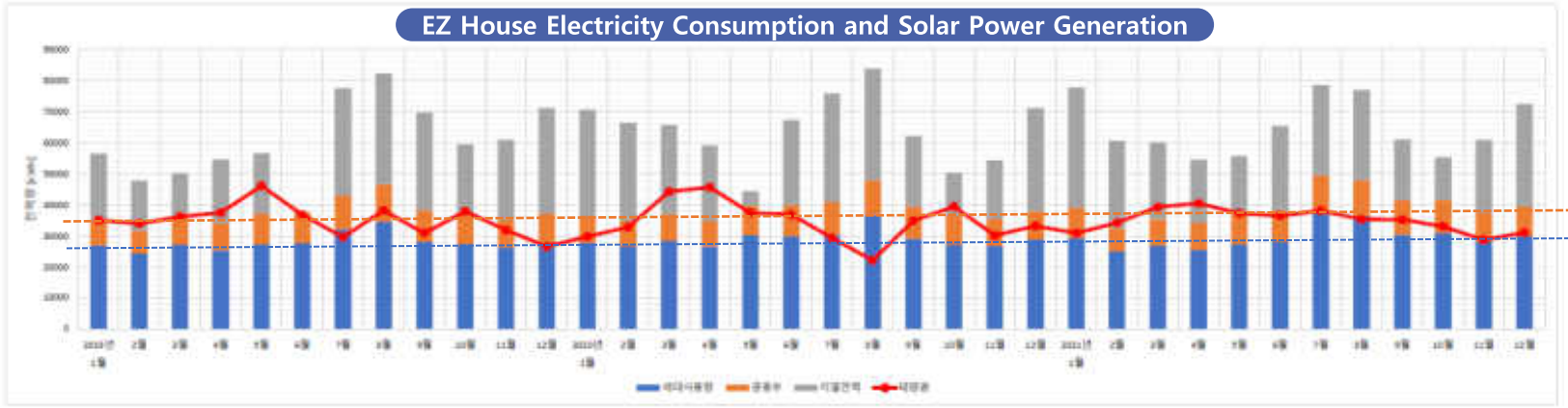


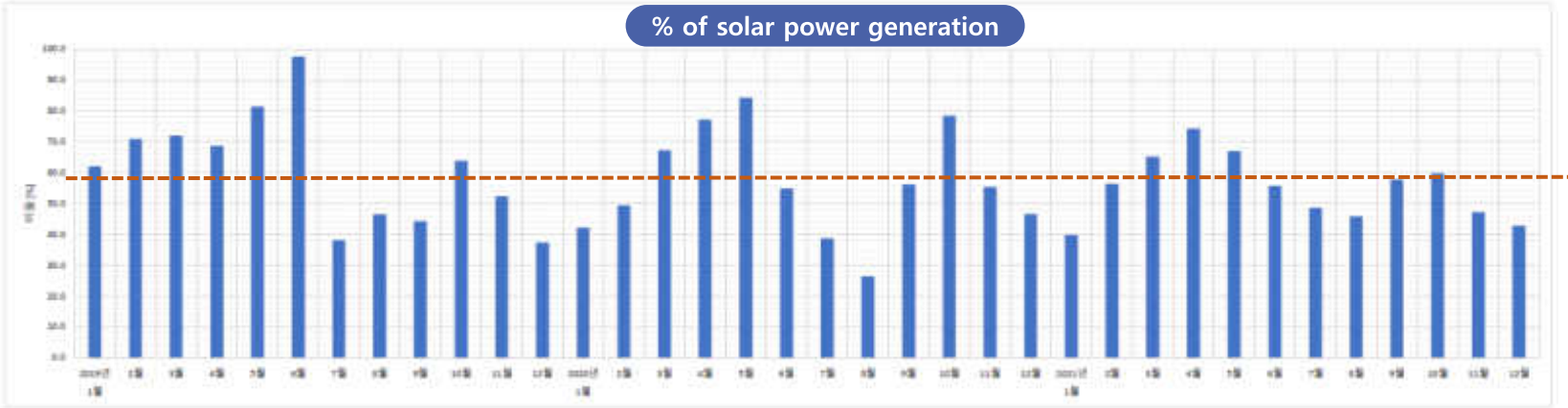
※ Source: Nowon EZ House Management Office

Period	Energy cost paid per household (KRW)		
	Annual Average	Monthly Average	Daily Average
Year 1 (2018.03~2019.02)	469,502	39,125	1,286
Year 2 (2019.03~2020.02)	532,193	44,349	1,458
Year 3 (2020.03~2021.02)	551,351	45,946	1,507
Year 4 (2021.03~2021.12	451,893	45,189	1,463

Each household only pays **Average $29.5**/(unit. Month) to cover energy use by the public electricity, cooking, and domestic appliance

Relationship between Electricity Usage and Solar Power Generation in EZ HOUSE





▶ At the time of design, solar modules were installed at an average capacity of 3 [kW/generation] per household (3 kW/generation with a 35-degree slope * 121 generations = 363 kW)
▶ Average monthly power usage per household for 3 years is 239 kWh/(monthly generation)
▶ Solar power is distributed per household at 288 kWh/month, slightly more than the generation's power consumption (power that can zero out five generations of energy)

Roadmap of Certification of Zero Energy Buildings in Korea

	2020	2023	2024	2025	2030	2050
MOLT	PUBLIC	More than 1,000㎡ (ZEB Grade 5)	500 ㎡ or more (ZEB Grade 5)	ZEB Grade 4	500 ㎡ or more (ZEB Grade 4)	500 ㎡ or more (ZEB Grade 3)	All buildings (ZEB Grade 1)
			Public Rental Housing (ZEB Grade 5)				
	PRIVATE	-	-	-	More than 1,000㎡ (ZEB Grade 5)	500 ㎡ or more (ZEB Grade 5)	All buildings (ZEB Grade 1)
				Private Flat/Apartment (ZEB Grade 5)			
Seoul		-	-	Mandatory zero-energy buildings for new private buildings			

Energy Efficiency Rating Certification of Building

- Pre-certification: approval of energy efficiency rating based on design document assessment
- Certification: Energy efficiency rating certified based on the pre-certification and on-site inspection

Grade	Primary energy consumption per unit area per year (kWh/㎡yr)	
	Residential building	Buildings other than residential
1+++	< 60	< 80
1++	60≤, >90	80≤, >140
1+	90≤, >120	140≤, >200
1	120≤, >150	200≤, >260
2	150≤, >190	260≤, >320
3	190≤, >230	320≤, >380
4	230≤, >270	380≤, >450
5	270≤, >320	450≤, >520
6	320≤, >370	520≤, > 610
7	370≤, >420	610≤, > 700

Certification of Zero Energy Building

- Building energy efficiency rating 1++ or higher
- Energy Independence Rate(%) = The amount of primary energy production (kWh/㎡yr) /the amount of consumption of primary energy (kWh/㎡yr)X 100(%)

ZEB Grade	Rate of Energy Independence
1 Grade	100% ≤
2 Grade	80 ≤, >100%
3 Grade	60 ≤, >80%
4 Grade	40 ≤, >60%
5 Grade	20 ≤, >40%

Current standard of existing public building's energy efficiency

Goal Setting and How to Do it Well by 2030?

https://www.archdaily.com/

[Zero-carbon-ready building]

In the 'Roadmap for the Global Energy Sector' published by the International Energy Agency in May 2021, By 2050, Net Zero means as 'a supply of energy that uses renewable energy directly with high energy efficiency or that can be completely decarbonized, such as electricity or district heating'.

https://www.designingbuildings.co.uk/wiki/Zero-carbon-ready_building

NET-ZERO ENERGY COSTS

CARBON NEUTRAL BUILDING: 8

ZERO CARBON READY BUILDING @IEA
(Including embedded GHG emissions)

NET-ZERO FINAL ENERGY 5->8

NET-ZERO EMISSION

NET-ZERO SOURCE ENERGY
(Net-Zero Primary Energy) : NOWON EZ HOUSE

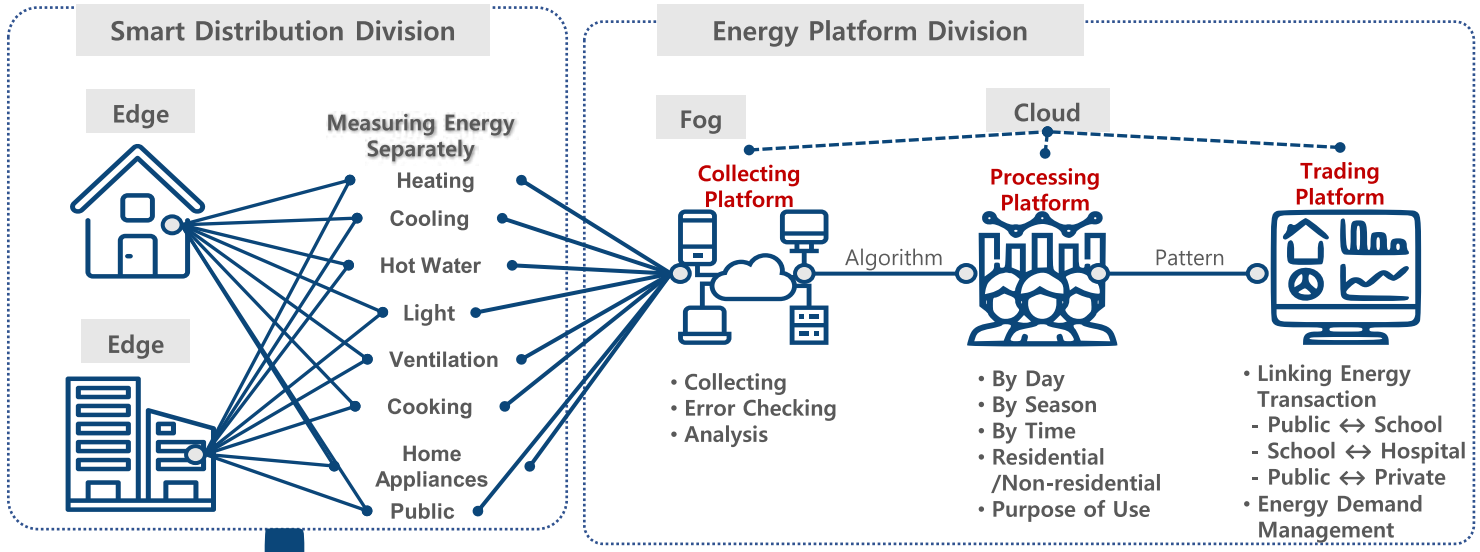
NEARLY-ZERO SOURCE ENERGY
(Quasi-Zero Primary Energy)- Certification System of Korea

8 Energy of the Building
(Heating, cooling, hot water, ventilation, lighting) + household appliances, cooking, and public electricity)
Energy Independence Rate 100%

5 Energy of the Building
(Heating, cooling, hot water, ventilation and lighting)
Energy Independence Rate 100%

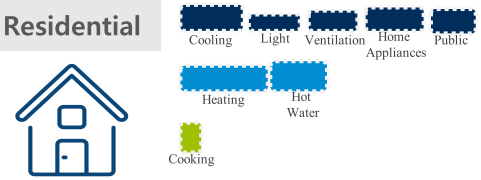
5 Energy of the Building
(Heating, cooling, hot water, ventilation and lighting)
Energy Independence Rate 20%

Buildings can serve as energy producers and consumers through energy platforms

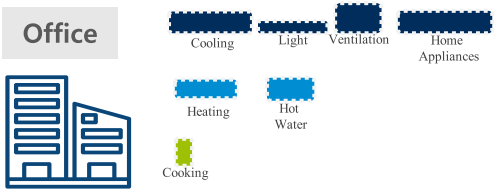


Source :Myoungju Lee, Building-oriented zero-energy city, MasilWIDE, 2017

Residential



Office



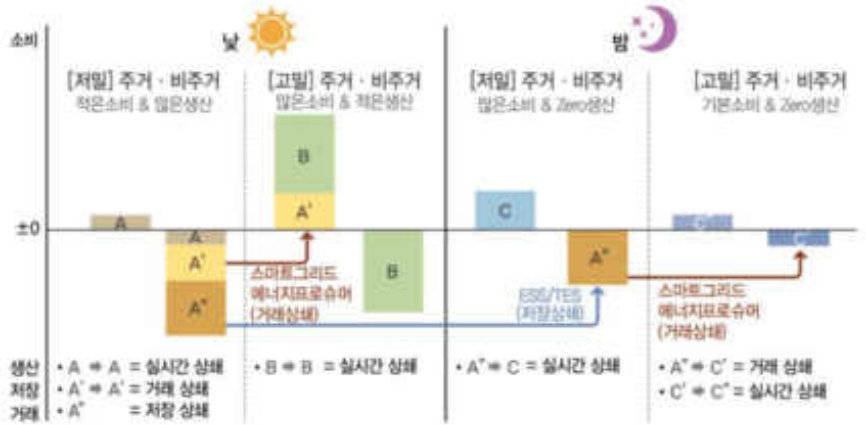
<Separate Real-Time Measurement>

- Measuring each energy consumption by time
- Smart energy saving according to individual priorities
- Energy bill savings are possible by adjusting energy consumption according to hourly and seasonal energy rates
- Energy transactions possible through the comparison of production and consumption through renewable energy facilities

Integrated Energy Operation Center

Example : Korea Energy Agency

Example : KT-MEG Center



Zero Energy City


ZED
Solar Arch (2019)
Design : ZED architects Co., Ltd.


ZED


ZED


ZED

Solar Arch (2019)

Design : ZED architects Co., Ltd.

Utilizing Off-Site policy & Energy Furniture

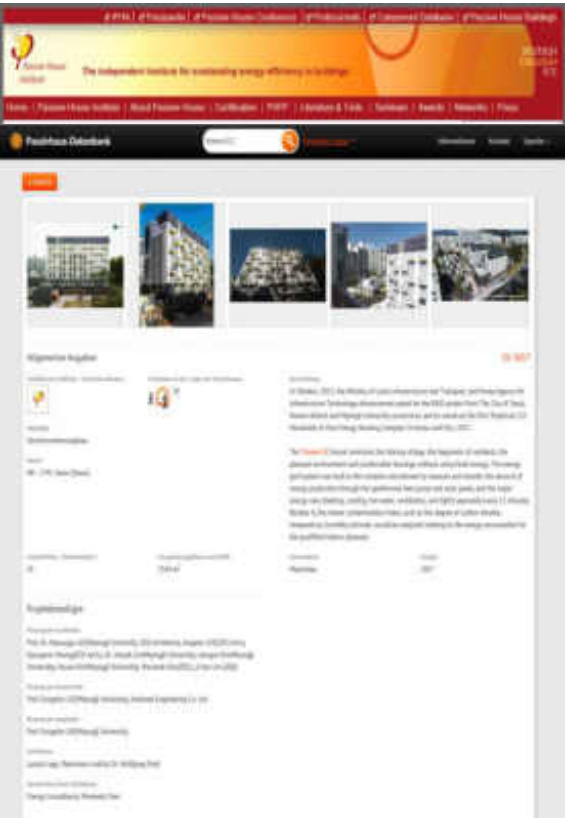

ZED
Design : ZED architects Co., Ltd.
Solar Bridge (2020)_Seoul Metropolitan Government, Climate & Environment Headquarters
Location: Upper part of truss, Imjingang(river) steel bridge
Scale: (Roof) Approx. 365kW
(Exterior) Approx. 230kW

PROMOTION of NOWON EZ HOUSE

MISSION INNOVATION

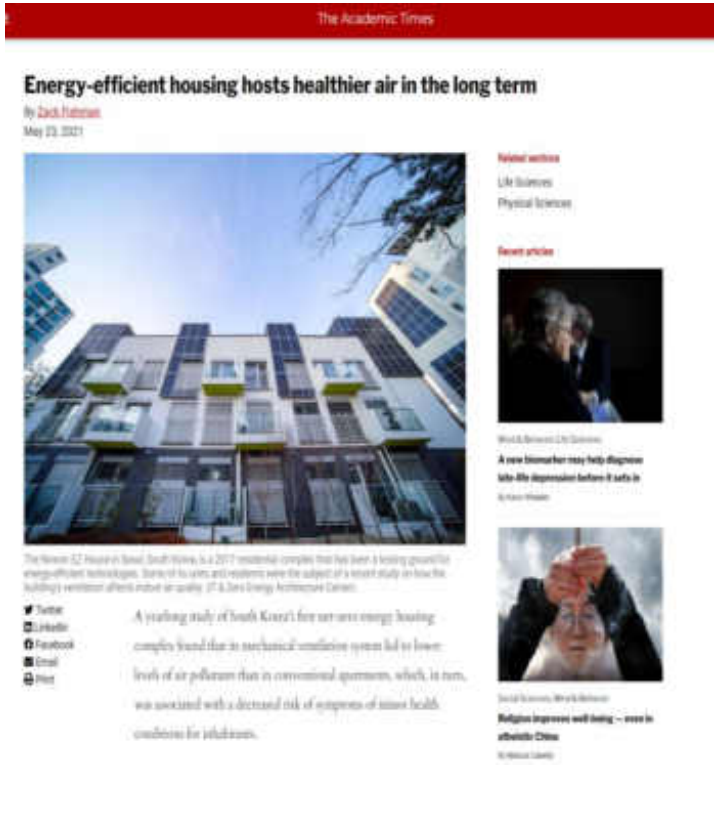
MISSION INNOVATION

Passive House Institute
https://passivehouse.com/



Climate Action – Korea and EU
http://climateaction-korea.eu

Academic times
https://academictimes.com



http://mission-innovation.net/2020/06/11/champions-corner-myoungju-lee-paving-the-way-for-zero-energy-buildings/

MI Champions

MI Champions is a program for recognizing and supporting the next wave of energy technology leaders.

Meet the Republic of Korea's Champions!

peace

IZAC MYONGJI UNIVERSITY ZED Architects Co.,Ltd.

MISSION INNOVATION CHAMPIONS

Thank you

Prof. Ph.D. Architektin. Myoungju LEE

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Founder & Partner Architect, ZED architects Co., Ltd.
The 1st Mission Innovation Champion

REPUBLIC OF KOREA

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FOCUS AREA: Passive Houses, Zero Energy Buildings and Cities

Myoungju Lee is a Professor at the College of Architecture at Myongji University. She is also the Director of the Zero Energy Architecture Center at Myongji University. Her work has focused on high efficiency building design and she has successfully launched the Zero Energy Housing Complex in South Korea.

"As a Mission Innovation Champion, I will introduce the importance of developing individual technologies globally and become an architect who works with experts in various fields from all over the world to build a zero energy."