MT´23 – Building Design and Transformation for Sustainability

Back to the Future

a climate adaptive rammed earth house design in Yunnan based on a data-driven approach

Student: Jieming Yan & Xingda Guo
Direction: Building Design and Transformation for Sustainability
Superviosr: Shea Hagy
Examiner: Walter Unterrainer

"What is the use of a house if you haven't got a tolerable planet to put it on?"

- Henry David Thoreau

Back to the Future

a climate adaptive rammed earth house design in Yunnan based on a data-driven approach

CHALMERS
UNIVERSITY OF TECHNOLOGY

JIEMING YAN 颜洁铭

XINGDA GUO 郭兴达

Direction: Building Design and Transformation for Sustainability
Superviosr: Shea Hagy / Examiner: Walter Unterrainer

Graduation and Publication Year: 2023

Acknowledgement

Sincere appreciation to our examiner and supervisor:

Walter Unterrainer & Shea Hagy

for your invaluable guidance, unwavering encouragement and insightful feedback

Heartfelt thanks to

Max Tillberg & EQUA Simulation AB
Alexander Hollberg & CAALA GmbH
Thomas Slater & Daniel Kiehlmann & Transsolar Energietechnik GmbH
Yichi Zhang
Shan Dai & Chan Cheung Mun Chung Charitable Fund
Lai Zhou
Jie Li & Habitat for Humanity

for your warm-hearted support and helpful advice

Great thanks to our

families and friends
all who gave suggestions and comments

for being supportive and going through the whole process together

Abstract

Abstract

Climate change, energy crisis, and housing shortage pose significant global challenges. In the rural context of Yunnan, a developing region in China, the extensive use of concrete-brick buildings raises sustainability concerns. This thesis aims to explore the potential of a climate-adaptive rammed earth building design based on a data-driven approach to enhance indoor comfort and reduce environment impact, particularly in social housing projects.

The research will begin with an investigation of the local climate, earth vernacular, local context, and modern rammed earth technology. To compare the energy performance and environment impact between brick and rammed earth constructions, a room-scale shoebox will be modeled for dynamic thermal simulations and a life cycle assessment (LCA).The daylight will also be studied with simulation on the room-scale.

Based on the findings, guidelines for rammed earth construction will be derived and synthesized. Subsequent to simulations, life cycle assessment, and data analysis, a climate-adaptive rammed earth house will be designed on a specific site, utilizing the established guidelines. The newly designed house will be simulated, discussed, and optimized, compared to a typical concrete-brick house. The outcomes of this research and design endeavor are expected to contribute as a sustainable housing prototype, not only in Yunnan but also as an inspiration for similar social and climatic regions.

Keywords

climate-adaptive, energy efficiency, house design, indoor climate, life cycle assessment, rammed earth, simulation, data-driven

Table of Content

Authors

JIEMING YAN

Architecture and Planning Beyond Sustainability

jieming@chalmers.se

EDUCATION

Chalmers University of Technology
[2020 - 2023, M.Sc.]

Sichuan University
[Architecture, B.Eng.]

VIA University College
[Exchange]

STUDIOS

Sustainable architectural design

Residential healthcare - Housing for seniors

Design and planning for social Inclusion

XINGDA GUO

Architecture and Urban Design

xingda@chalmers.se

EDUCATION

Chalmers University of Technology
[2021 - 2023, M.Sc.]

Tongji University
[Architecture, B.Arch.]

Iowa State University
[Exchange]

Delft University of Technology
[Exchange]

STUDIOS

Material and detail studio

Housing inventions studio

Architectrual design crossover studio [exchange]

Introduction

This Chapter gives an overall look for the thesis, including backgrounds, aims, research questions and method. It's a guide to understand the framework of the thesis.

Background

We human beings are facing the global challenge of energy crisis and climate change. However, the population has been rising to 8 billion recently. Most of it is in the poorest region of the world.

Adequate housing is one of the basic human rights, but how can we offer houses with basic comfort but with the least impact, from a life cycle perspective?

If we take a look at the developing region, people are building housing with concrete bricks around the world. There are complex reasons behind it, but what we need to keep in mind, is those materials lead to a large amount of greenhouse emissions. *(Figure 1)* As architects, can't we make something different?

The crisis of architects is obvious if we still keep the focus on the 1% richest in this world. When we look at 99%, we can see there is a huge market and gap to improve. It doesn't mean every house needs to be designed by architects, but some consensus can be input to improve the welfare of all human beings.

Yunnan is a southwest border province in China. It is close to many Southeast Asian countries such as Vietnam, Thailand, Laos, Myanmar, and India *(Figure 2)*.

On one hand, this leads to rich cultural and ethnic diversity. Besides, the mild climate, the variant altitude (76m - 6740m) and topography contribute to the abundant bio-diversity in Yunnan. The energy share in Yunnan is quite clean, 81% is hydropower and fossil fuels only share 11% *(Figure 3)*.

On the other hand, due to its geolocation, the economy is much less developed than in other regions of China. The population in Yunnan is 47 million, and 24 million are registered in the countryside. Some people move to cities to buy apartments but most of them still have the demand to build houses on their own for the family.

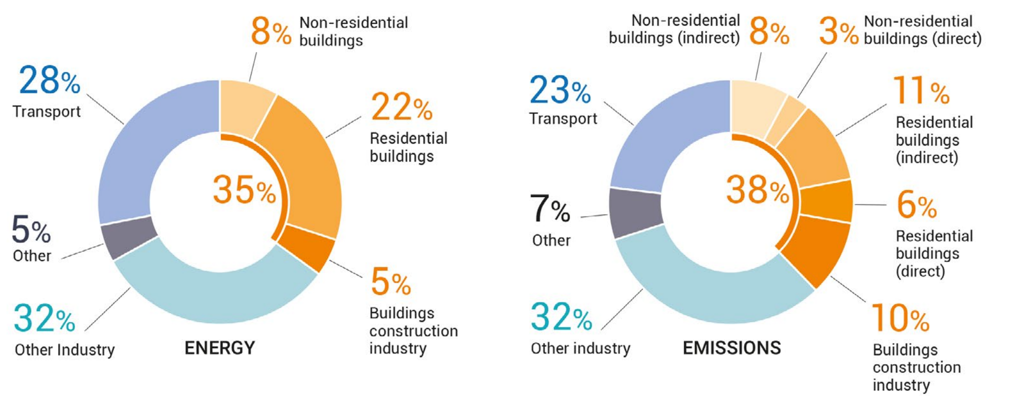


Figure 1. Global share of buildings and construction final energy and emissions,2019
United Nations Environment Programme, & Global Alliance for Buildings and Construction (2020). 2020 Global Status Report for Buildings and Construction: Towards a Zero-emissions, Efficient and Resilient Buildings and Construction Sector - Executive Summary. https://wedocs.unep.org/20.500.11822/34572.

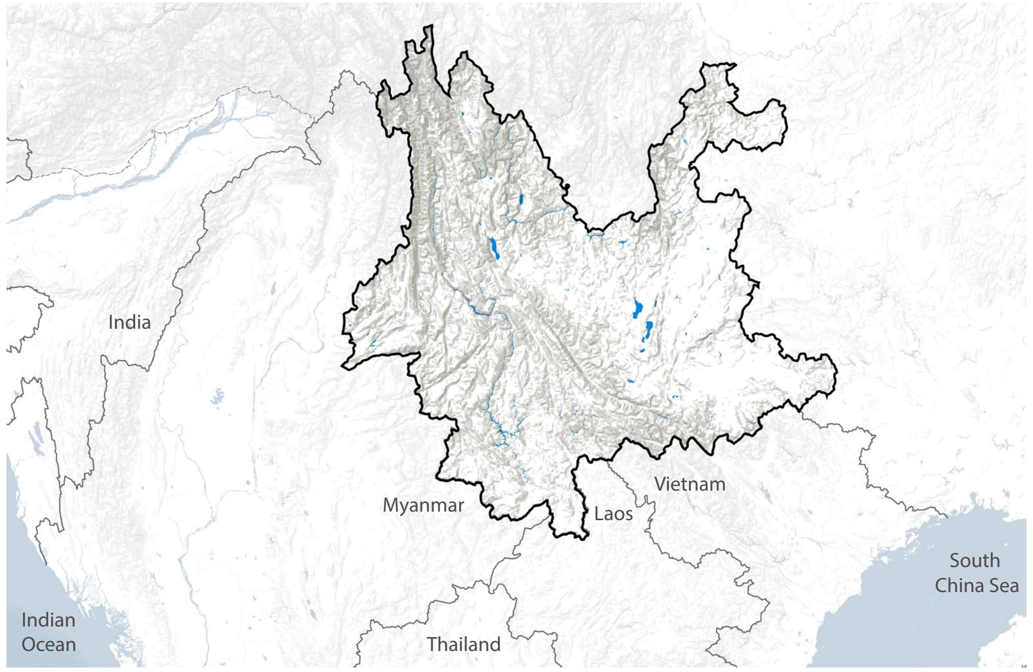


Figure 2. Yunnan province and its neighbouring countries, data source: Mapbox.

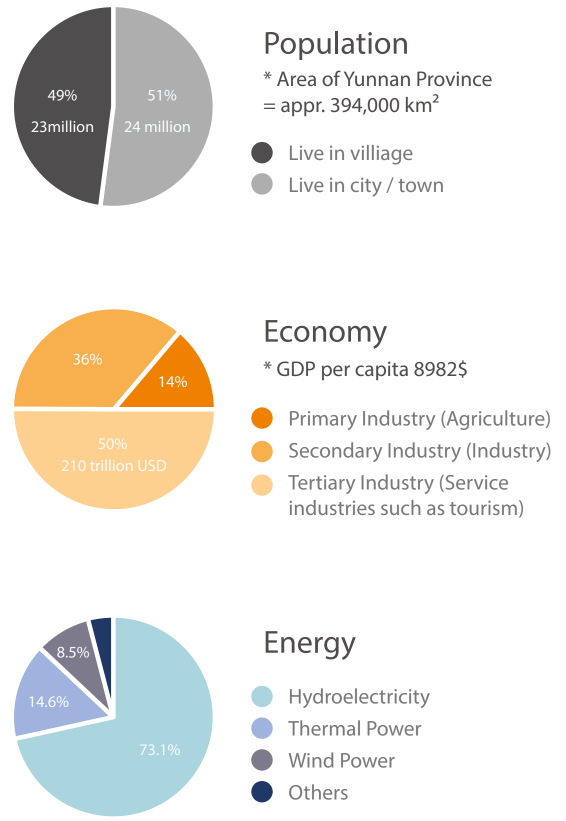


Figure 3. Population, energy and economy data of Yunnan,
data source: Bureau of Statistics, people's gonvernment of Yunnan Province, 2020 data.

Aim

The thesis aims to propose a housing project in Dashuijing village, Yunnan, China. People moved out from earth vernacular because it does not meet the demands nowadays. Brick houses become the choice due to their advantages such as affordability, better structure performance, easy-to-master skills, etc. However, these materials bring new challenges such as pollution and greenhouse gas emissions. Can modern rammed earth be a better choice than brick? We will compare these two choices in a computational and evidence-based approach and propose a design based on the research.

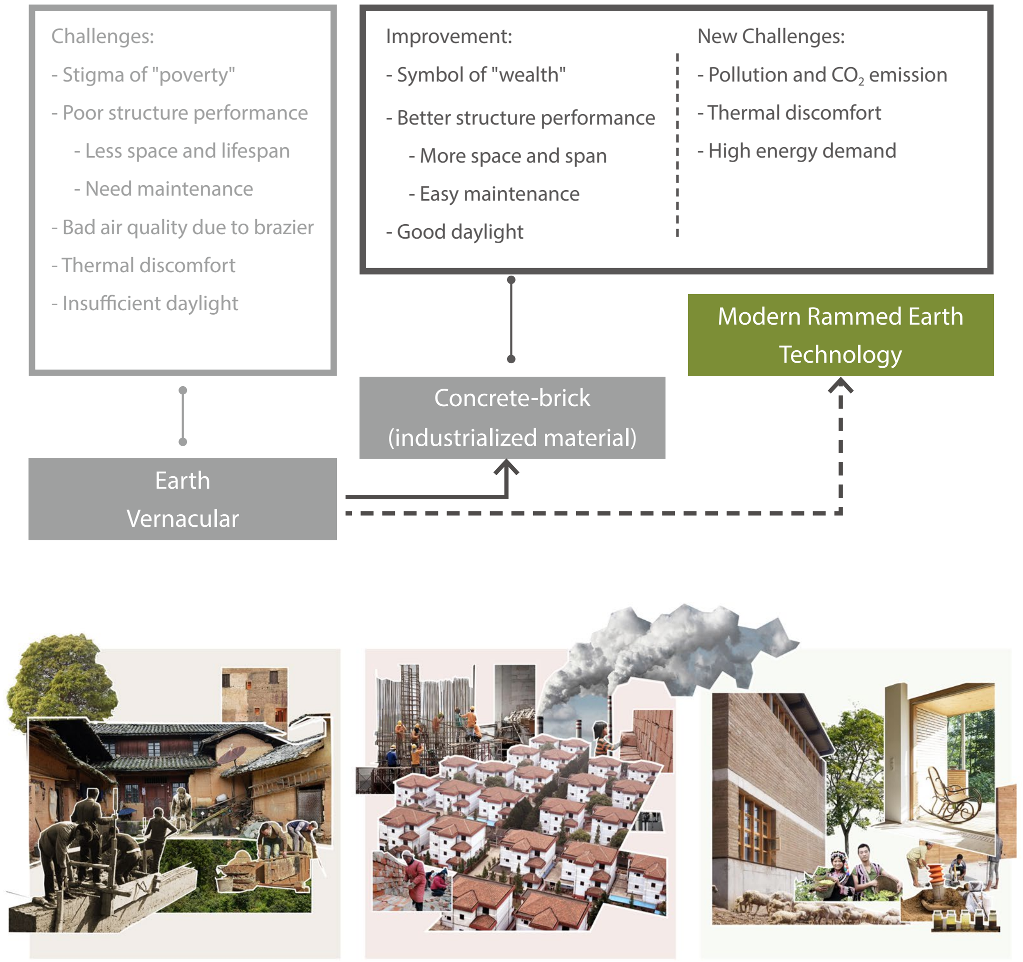


Figure 5. Concept diagram, the challenges of rural housing in Yunnan.

Delimitation

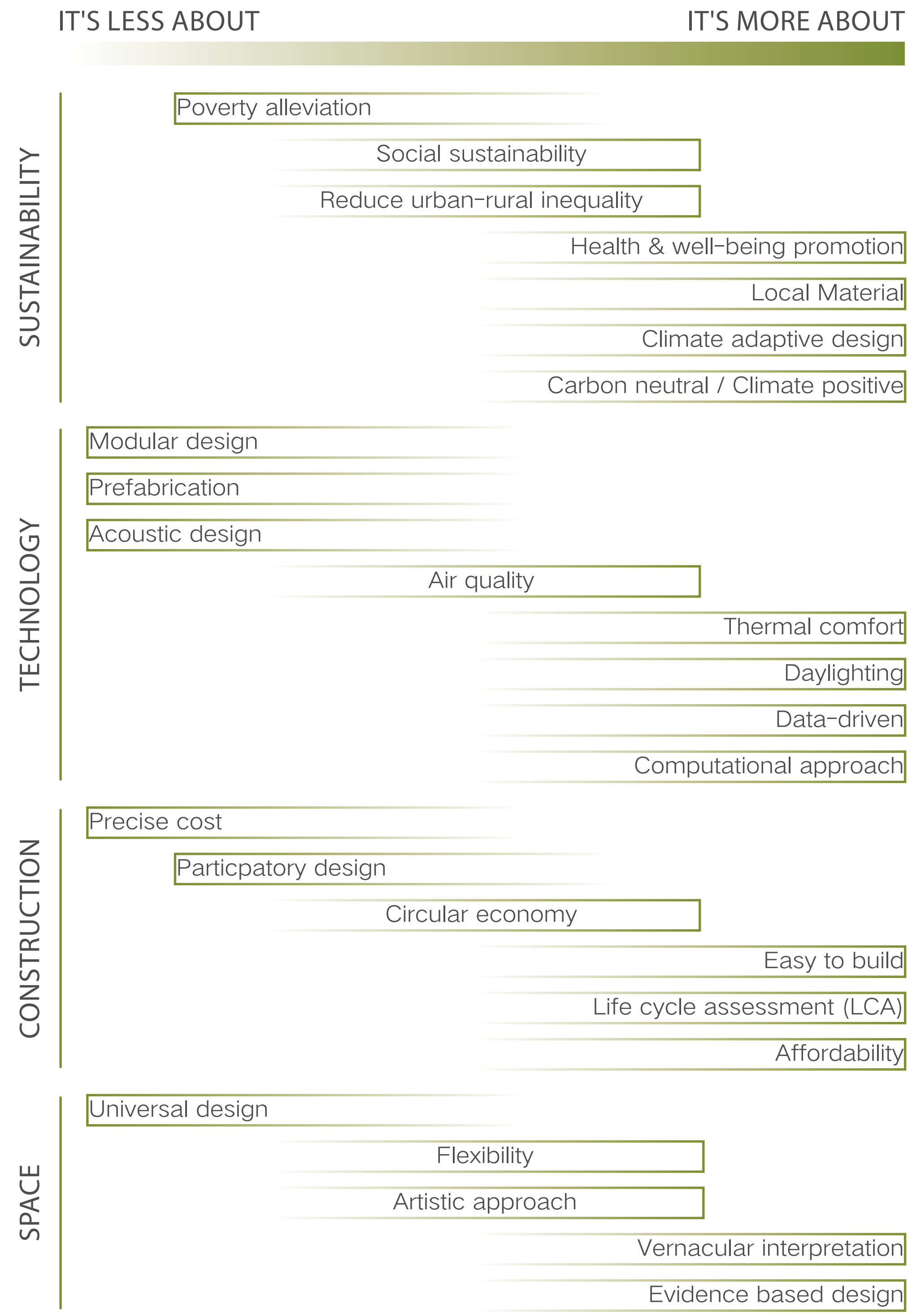


Figure 6. Delimitation diagram.

Research Question

Main Question

How to design a climate-adaptive house using modern rammed earth technology in rural Yunnan to achieve improved indoor climate and reduced environmental impact compared to conventional brick houses?

Sub Questions

1. What are the challenges and opportunities of utilizing modern rammed-earth technology for housing, in the rural context of Yunnan?

2. With a data-driven approach, how to assess the variables that influence the thermal and daylight performance of rammed earth houses?

3. With a data-driven approach, how to evaluate the rammed earth house design regarding energy demand, indoor climate, and environment impact?

Method

The thesis is based on two methods: research for/by design. It follows the structure of a "triple diamond"*(Figure 6)*.

The first phase is about background study. It provides both a theoretical and technical foundation for further work. Research and literature related to the modern rammed earth technique will be studied. The context will be also analyzed to provide basic information for the next phase.

The second phase is to set up a shoe box simulation for comparing different constructions (rammed earth and brick). Other constant values and variables will be set for daylight and thermal simulation. In the end, a design guideline will be the output with evaluation from the data.

The last phase is to apply the guidelines to designing the building. Other factors will be involved as well. The simulation at the building level will also be implemented to optimize the design.

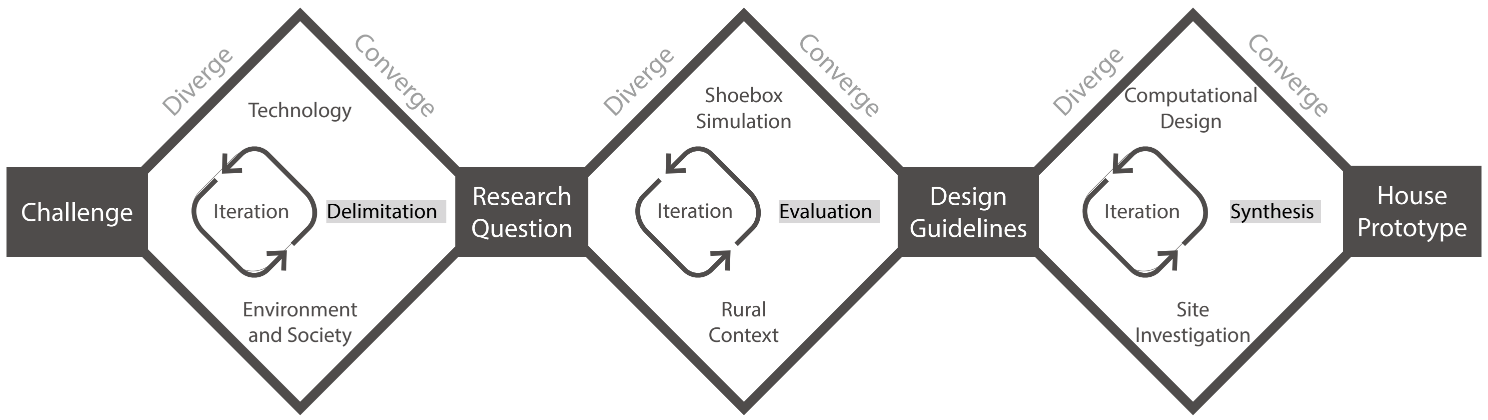


Figure 7. Thesis frame, the thesis follows the frame of "tripple diamond".

Chapter 1

Technology: Modern Rammed Earth

Throughout history, earth has been a key building material. In rural China, rammed earth, a prominent example, is commonly used for vernaculars. In this chapter, we aim to outline the modern technical aspects of rammed earth as a building enclosure. We'll explore the evolution of rammed earth techniques from ancient times to the present and introduce Life Cycle Assessment (LCA) to highlight the potential sustainability of rammed earth materials.

1.1 Earth as Material

Earth, a readily available building material, has been used in various forms across different architectural elements for a considerable time. Among these, rammed earth, compressed earth blocks, and cob stand out as the three primary load-bearing earth structures. *(Figure 8)*

The construction process of rammed earth can be simplified as follows: workers fill a mixture of earth into molds, compact it using tools, and move the molds upward after completing the lower layer. As the molds ascend, the walls are gradually built layer by layer. This construction method produces walls that are more cohesive and have better earthquake resistance compared to walls made from compressed earth blocks. In contrast to cob, rammed earth offers walls with improved water and insect resistance, along with faster construction and reduced manual labor. *(Miccoli et al., 2014)*

Moreover, in Yunnan, China, many traditional earth-built homes exist, fostering local familiarity and expertise with rammed earth. Taking these factors into account, we have chosen to concentrate our research on rammed earth as a primary type of load-bearing earth construction.

Rammed earth
(Photo by Green Building Advisor)

Rammed earth walls are crafted from soil particles, ranging from clay to gravel.

Their surface boasts a distinctive horizontal texture.

Rammed earth walls showcased a 40 % higher earthquake resistance compared to compressed earth blocks. (Miccoli et al., 2014)

Compressed earth blocks (CEB)
(Photo by EESC glossaries)

Compressed earth block masonry is composed of earth blocks and typically employs earth mortar.

Stabilizing additives like lime, cement, or gypsum are occasionally used in both mortars and blocks.

Earth blocks come in various shapes and sizes, with or without perforations.

Cob
(Photo by Rima Sabina Aouf, 2019)

Cob consists of a blend of earth and plant fibers. The earth's largest particle size is within the sand fraction.

Environmental factors can affect the original structural characteristics of cob buildings.

Higher water content not only weakens material strength but also triggers fiber decay.

Figure 8. Characteristics of three load-bearing earth structures.

1.2 Modern Rammed Earth Technology

Rammed earth stands as a distinctive construction method that employs formwork. The formwork's size and construction for rammed earth are influenced by local traditions. Historically, smaller wooden formworks were common due to better handling and lighter weight. Continuous formwork, prevalent nowadays, was less frequent. During wall construction, the formwork was lifted horizontally for one course, then lifted vertically and horizontally again for the next course. The compaction process gives rammed earth a distinct horizontal layering. *(Mu, 2014)*

Rammed earth exhibits two key material traits: a relatively low moisture content, often below the earth's plastic limit when placed into the formwork, and a broad, uneven distribution of particle sizes, ranging from clay to gravel-sized fractions (up to 64 mm). The wall made of rammed earth, on the other hand, has excellent thermal storage properties and acts as a thermal mass to reduce the heating energy consumption of the house. At the same time, by adjusting the granulometry of the earth, moisture content, compaction, fiber content and amount of additions, rammed earth walls can have better structural strength and seismic performance than CEB. *(Miccoli et al., 2014)*

Case Study

In the context of modern rammed earth technology in architecture, three key aspects require special attention: building materials, architectural performance, and architectural style. Architects must establish the right mix and sources for rammed earth components, maximize its remarkable heat retention and insulation properties, and then adapt rammed earth structures to contemporary architectural aesthetics and forms. Martin Rauch's Rauch House *(Figure 9 & Figure 10)* serves as an excellent example in this regard.

Figure 9. Rauch house,
(Photo by Beat Bühler, 2008)

Figure 10. Rauch house,
(Photo by Brutarchitekt, 2023)

Regarding the rammed earth material, this house is nestled on a hillside, crafted entirely from earth excavated on-site. From the foundation to the flat roof, everything - the floors, arched ceilings, plastered walls and ceilings, steps, tiles, and sinks - is fashioned from processed soil sourced from the location itself. Notably, all rammed earth remains unstabilized, maximizing the ecological and recyclable value of this material while significantly reducing the building's impact on the environment.

Concerning architectural performance, the house features thick rammed earth walls, ensuring substantial heat retention. Additionally, windows on the walls are positioned close to the exterior, harnessing more solar heat and maintaining room temperatures during colder seasons. On the external walls, horizontally arranged clay bricks, entirely handcrafted by Rauch, gently mitigate water flow, enhancing the building's protection. *(Boltshauser, 2008)*

Regarding architectural form, this rammed earth residence embodies Rauch's declaration of "building contemporary forms." The building's form is distinct and uncluttered, gradually refining from the exterior to the interior. The juxtaposition of the earth's raw texture and the house's warmth creates a pleasing equilibrium. The continuous horizontal arrangement of clay bricks on the external walls generates a delightful rhythm and soft texture, harmonizing with the character of the rammed earth walls they rest upon. This sensation extends indoors, where the tactile qualities of the earth are emphasized in the oval space encompassing the staircase. Progressing through the building involves ascending a dramatic vertical tunnel of clay.

Figure 11. Rauch house,
(Photos by Beat Bühler, 2008)

Clay Study

The mixture and proportion of traditional rammed earth are based on the artisan's experience, and some of the knowledge is lost. A scientific approach could standardize the material and bridge the knowledge gap. In modern rammed earth construction, to ensure excellent cohesion, structural integrity, and mechanical performance of the earth walls, it is common practice to sample and test the local earth composition before construction begins. This is done to ensure the appropriate proportion of particles with different diameters present in the earth mixture.

A good amount of clay and the right proportion of the different sizes of particles (clay, silt, sand, gravel) is important to improve the mechanics and durability of rammed earth. *(Figure 12)* If the soil is too gravelly, the gaps between the particles are not properly filled, and the soil lacks cohesion and is consequently very sensitive to erosion. If the soil is too clayey, it lacks the large grains that give it stability and is thus sensitive to swelling and shrinkage. An optimum grain size distribution is one in which the proportion of large and small grains is well balanced, leaving practically no gaps, and sufficient clay particles are present to facilitate proper cohesion. *(Martijn Schildkamp, 2009)*

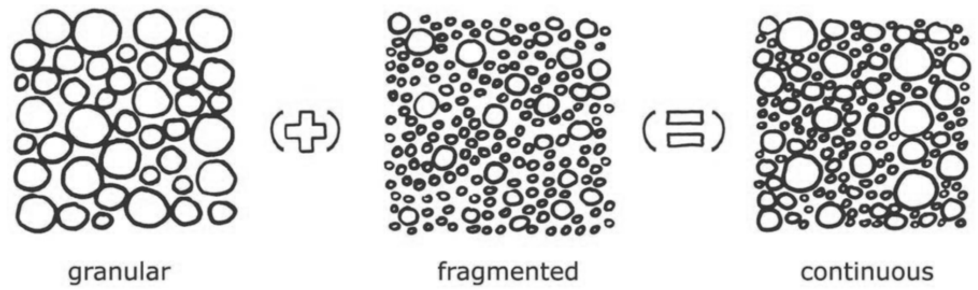


Figure 12. Clay study, mix extra sand and gravel with the soil, and clay sticks all together,
(Martijn Schildkamp, 2009)

Grain size distribution analysis is a method of evaluating the conformity of soil composition in modern rammed earth technology. The chart below shows an example of gravelly soil (G) and a clay soil type (C). The horizontally shaded area indicates the types of soils that are suitable for rammed earth construction, while the vertically shaded area shows appropriate soils for compressed block production. The overlapping area is thus good for most soil constructions so that a curve (I) running through the middle symbolizes a soil of ideal granulation. *(Figure 13)*

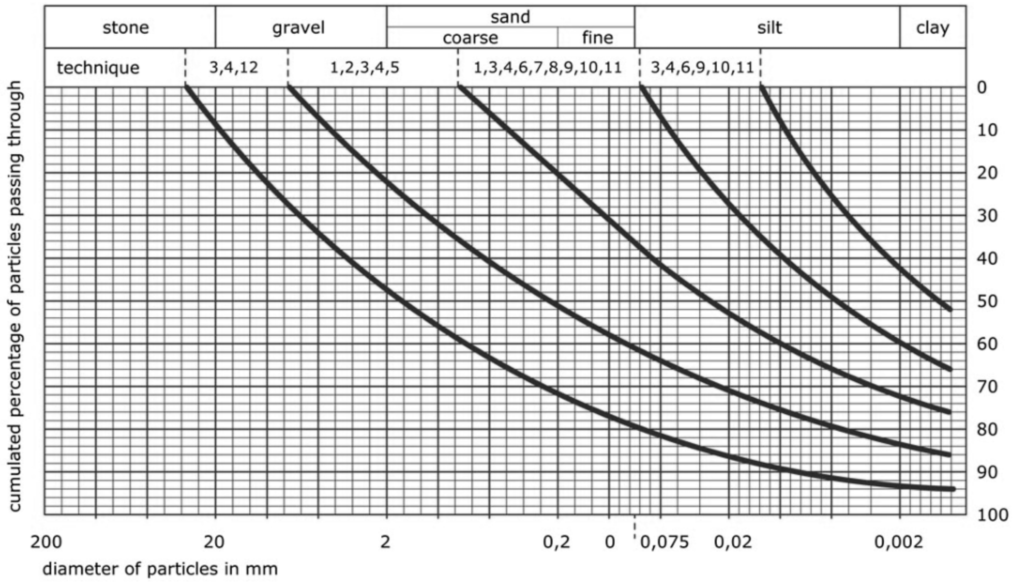


Figure 13. Clay study, grain size distribution, an ideal propotion makes a smooth curve in the horizontal hatch, (Martijn Schildkamp, 2009)

Durability and Water Resistance

Rammed earth is generally highly durable, with its fundamental techniques having existed for millennia, evidenced by centuries-old rammed earth structures still standing today. However， all types of rammed earth walls are naturally porous and must be safeguarded against heavy rain and prolonged moisture exposure. Therefore, it's crucial to ensure water protection at the upper and lower sections of walls. Prolonged moisture exposure can compromise the earth's internal structure, potentially reversing cement stabilization and allowing clays to expand. While new water-repellent additives can make rammed earth suitable for exposed conditions like retaining walls, they might hinder the material's breathability.

Thermal Proerties

Rammed earth functions as substantial masonry with substantial thermal mass. Thermal mass absorbs and gradually releases heat in response to temperature shifts.

When used appropriately and in suitable climates, rammed earth's thermal mass can delay heat transfer through the building for up to 10 to 12 hours, evening out daily temperature fluctuations. This effectiveness becomes evident when the outdoor temperature difference between day and night is at least 6 ℃ . *(Gupta,2020)*

However, rammed earth possesses limited insulation properties, comparable to an uninsulated fiber cement wall. Generally, indoor temperatures in an uninsulated rammed earth building closely mirror the 24-hour average of outdoor temperatures, potentially causing discomfort.

Fortunately, our project's location in Kunming boasts a relatively mild climate, and a rammed earth house could capitalize on a day-night temperature difference of over 10℃ in both summer and winter. This makes a high thermal mass a viable passive strategy. Following calculations and adherence to local regulations, our wall thickness must be at least 420mm.

Structural Capability

Rammed earth boasts robust compression strength, suitable for multi-story load-bearing structures. Studies in New Zealand demonstrate that solid earth walls exhibit superior earthquake resistance compared to walls composed of individual bricks or blocks. Rammed earth can be engineered to attain considerable strength and reinforced similarly to concrete. While horizontal reinforcement is discouraged, excessive vertical reinforcement can result in cracking issues. *(Chang Recavarren, 2013)*

Seismic Desgin

Earth vernacular architecture is often criticized for its perceived lack of seismic performance. Some instances of collapse during earthquakes have led to concerns about their safety. China's seismic design codes outlined specific seismic design requirements for it. *[Appendix page 002]* However, extensive research and practical experience have shown that rammed-earth buildings can meet safety and seismic requirements through optimized structural design and material selection. *(Wang, 2017)* Here are some essentials for the seismic design of rammed earth houses:

1. Foundation quality significantly impacts earth vernacular wall cracking and collapse during earthquakes, highlighting the importance of proper foundation design and construction.

2. Achieving desired compressive strength and durability relies on appropriate material ratios, mechanical ramming techniques, and formwork optimization.

3. Regular layout patterns contribute to overall structural robustness.

4. Employing ring beams on each floor enhances structural integrity. In high seismic areas, structural columns connected to walls, ring beams, and floor slabs help withstand lateral loads from earthquakes.

Construction Techniques

In addition to controlling soil composition, modern rammed earth techniques differ significantly from traditional methods mainly in terms of formwork and ramming tools. In the past, smaller wooden formwork and manual tamping were common, demanding substantial labor for rammed earth construction. Today, refined formwork systems and powered rammers have substantially reduced labor requirements, rendering rammed earth methods applicable even in industrialized nations. *(Mu, 2014)*

Typically, rammed earth involves compacting a mix of gravel, sand, silt, and clay (sometimes with cement) between formwork in layers. Modern rammed earth production is more mechanized and less labor-intensive, utilizing powered rammers. For ecological and sometimes economic reasons, mechanized rammed earth technology can be a feasible alternative to standard masonry, particularly in industrialized areas where rigorous thermal insulation standards are not necessary.

Figure 14. Traditional earth ramming, (Photo by Christine M. Fiori, 2013)

Figure 15 Modern earth ramming, (Photo by David Easton, n.d.)

	Tradtitional rammed earth	Modern rammed earth
Material	Local soil with poor mechanical properties and water resistance	A mixture of soil, sand, and gravel, which greatly improved the mechanical properties and water resistance, with no need for painting.
Rammer	Manual rammer, which has limited ramming power	Pneumatic/electric rammers, which have up to 5MPa ramming strength and high efficiency
Formwork	Made with wood or bamboo boards, which is simple to build but has poor impact resistance and flexibility	Made with aluminum alloy, which is a flexible and standardized formwork system with high impact strength and easier to assemble
Material mix	Manualmi mix, which has low efficiency and high labour costs	Electric mixer, which is more efficient and requires less labour.
Cost	Low	Cost is higher, but with adapted technology, equipment and local materials can cut the cost down.

Figure 16. New ramming techniques versus traditional ramming techniques, (Mu, 2014, pp.24)

1.3 Environmental Impact and LCA

Rammed earth as a building material is generally considered eco-friendly, with a relatively small environmental impact or carbon footprint. Based on the research questions proposed, two issues need to be addressed: first, the rammed earth house can be compared with the most common concrete-brick houses in terms of environmental impact, and second, we need to quantify its environmental impact by data.

For quantifying a rammed earth house's environmental impacts throughout its life cycle, the life cycle assessment (LCA) method is introduced.

LCA is a method for assessing the environmental impacts of products. According to EN15978, we will assess the production, construction, usage, and end-of-life stage of the building*(Figure 17)*. This method can be systematically applied to estimate each material and related processes. In Chapters 3 and 4, we will utilize the framework of LCA for our research. Following ISO14040, LCA primarily consists of four phases: goal and scope, life cycle inventory, life cycle impact assessment, and interpretation.

The goal and scope contain the functional unit, system boundaries, and impact categories. Life cycle inventory analysis involves inventory flows with data collection for energy and material within the life cycle. Life cycle impact assessment evaluates environmental impact with different categories based on the inventory. Interpretation is to assess the results by life cycle inventory and life cycle impact assessment.

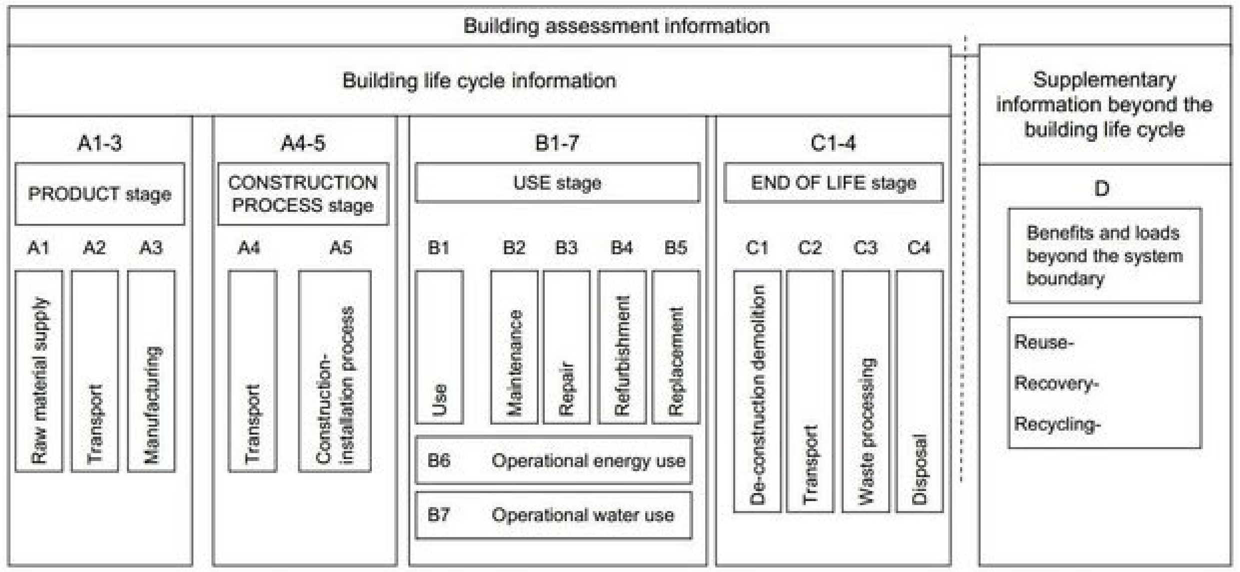


Figure 17. Building's LCA stages according to EN 15978.
Obrecht, T. P., Kunič, R., Jordan, S., & Legat, A. (2019, August). Roles of the reference service life (RSL) of buildings and the RSL of building components in the environmental impacts of buildings. In IOP Conference Series: Earth and Environmental Science (Vol. 323, No. 1, p. 012146). IOP Publishing.

Chapter 2

Environment and Society: Rural Area in Yunnan

In this chapter, we will focus on Yunnan's climate, earth vernacular, and the site at a larger scale. Through climate analysis, we can gain insights into the opportunities and challenges for building design in terms of energy efficiency and comfort. By doing case studies and drawing inspiration from villages and vernacular, we will attempt to understand how to effectively utilize resources to build suitable housing in the scarcity of resources and how to apply modern technology for improvement. Ultimately, we will analyze the site to understand the design's specific challenges.

2.1 Climate and Weather

2.1.1 Climate Diversity in Yunnan

Yunnan features a diverse range of climate types, with most areas falling under the subtropical plateau monsoon category. *(Figure 18)* This climate is characterized by minimal yearly temperature fluctuations, significant daily temperature variations, distinct wet and dry seasons, and noticeable temperature shifts according to elevation changes in the landscape. *(Gonvernment, 2022)*

Within Yunnan Province, a triad of climatic belts coexist: boreal, temperate, and tropical. Northwestern Yunnan experiences a boreal climate, marked by prolonged winters and truncated springs and autumns. Eastern and central regions embrace a temperate climate akin to perpetual spring, albeit temperatures dip during precipitation events. The southern and southwestern Yunnan, situated in valleys, extend into the tropical realm, characterized by protracted summers and the absence of a distinct winter. *(Gonvernment, 2022)*

Generally, with every 100 meter ascent in elevation, the temperature diminishes by approximately 0.6° C to 0.7° C. Yunnan's intricate topography and substantial elevation differentials accentuate its distinctive three-dimensional climatic traits. *(Figure 19)* *(Gonvernment, 2022)*

Yunnan's local building regulations categorize the province into five climatic zones: severe cold, Cold, Hot summer & cold winter, Hot summer & warm winter, and Mild. *(Figure 20)* The chosen site, Dashuijing Village, falls under the regulations suited for temperate climatic regions. *(Yang, 2009)*

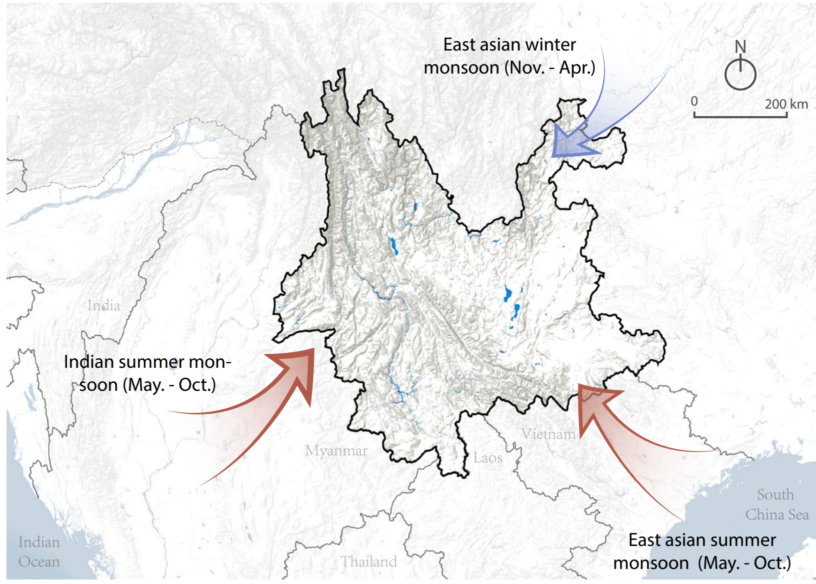


Figure 18. Monsoon affecting Yunnan. (Feng & Hua, 2022), adapted by authors

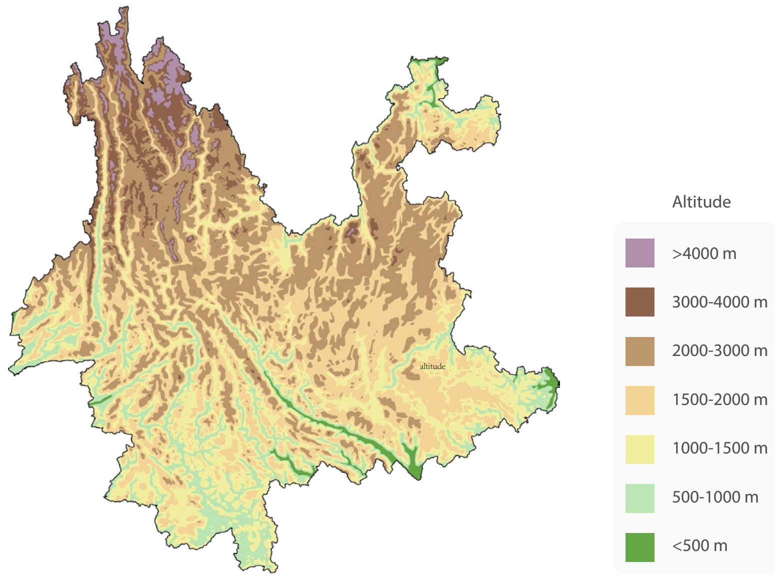


Figure 19. Terrain of Yunnan. Data source: Mapbox

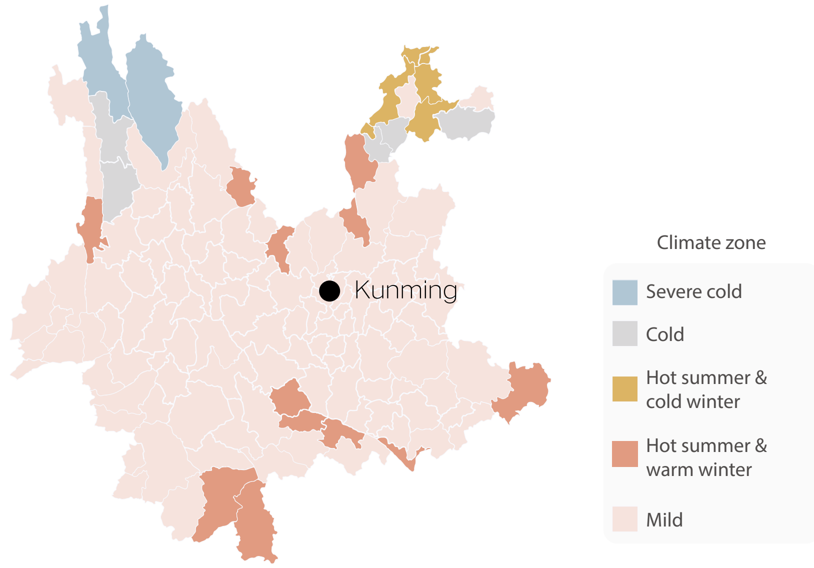


Figure 20. Climate zone according to local codes. Data source: DBJ 53/T-39-2020

2.1.2 Weather Analysis

Understanding the local climate and weather is the foundation for designing a climate-adaptive building. We adopted the following tools and data

CBE Clima Tool: a free and open-source web application for climate analysis.

Weather data: from Energy Plus, a free, open-source, and cross-platform.

- Temperature

According to Köppen – Geiger climate zone, Kunming belongs Cwb, which means temperate highland tropical climate with dry winters. In Kunming, the summer is cool and the hottest temperature is around 26℃ . The winter is cold but always above 0 ℃ . The coldest month is December and January, and the average monthly temperature is around 8℃ . Notably, the daily swing temperature is around 10℃ to 12℃ , which means a large thermal mass could be a good balance in the design.

In *Figure 21*, the band of Ashrae adaptive comfort is shown. The hours above 26℃ only take up 1% while below 18℃ takes up ℃ , which means there is no cooling demand but a heating demand, In *Figure 22*, the yearly temperature heatmap shows the hours between 12° C-28° C, taking up 73%, which means natural ventilation should be feasible, considering taking good advantage of solar energy.

- Humidity

In *Figure 23*, the humidity is higher than the comfort band(35%-70%) in many seasons. In summer due to the monsoon bringing the rainfall, the humidity rises significantly. However, in the winter, the chart still shows a high relative humidity, which is against our experience of a drying winter and the description of Köppen – Geiger climate zones. This can be attributed to two points, one is the swing of humidity day and night, and the other is relative humidity should be considered with temperature.

In *Figure 24*, taking January for instance, during the night, the humidity is high but it decreases rapidly in the daytime, which might be caused by the temperature swing. When people stay in the house, the indoor temperature is higher than outdoor in the winter, which leads to a decrease in relative humidity and people could feel dry in the daytime. Earth could be a good moisture to buffer the humidity, and it will be discussed in later chapters.

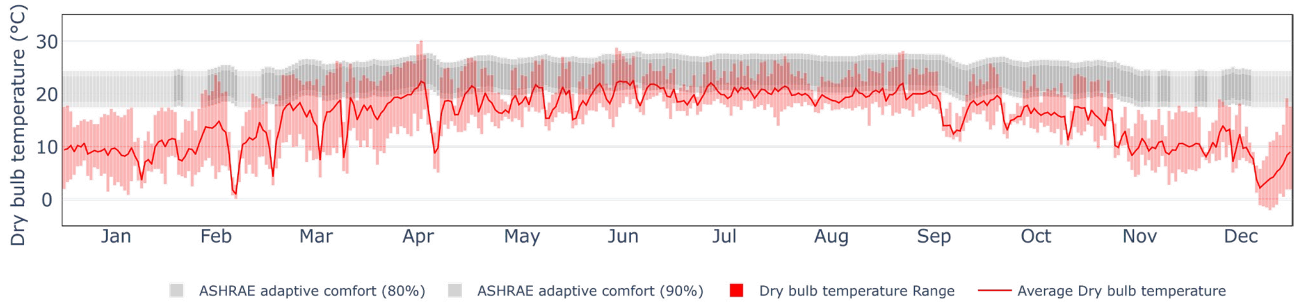


Figure 21. Annually dry bulb temperature, with the band for adaptive comfort, Kunming.
Data source: Kunming 567780 CSWD, Energy Plus
analysis tool: CBE clima tool, Betti G., Tartarini F., Nguyen C., Schiavon S. (2022)

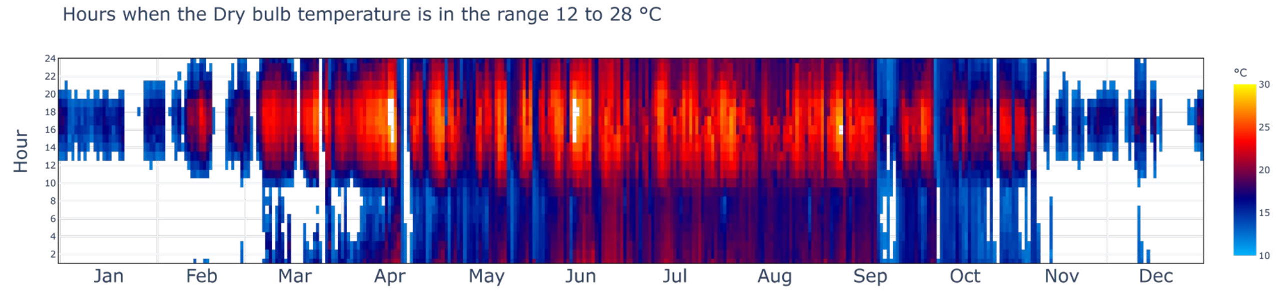


Figure 22. Hours when the dry bulb temperature in the range 12℃ to 28℃ , Kunming.
Data source: Kunming 567780 CSWD, Energy Plus, analysis tool: CBE clima tool

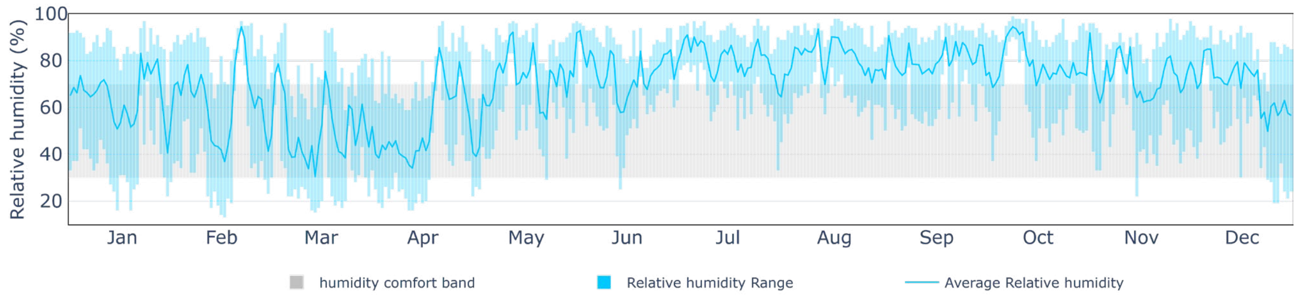


Figure 23. Annually relative humidity, with the bandwidth for comfort, Kunming.
Data source: Kunming 567780 CSWD, Energy Plus, analysis tool: CBE clima tool

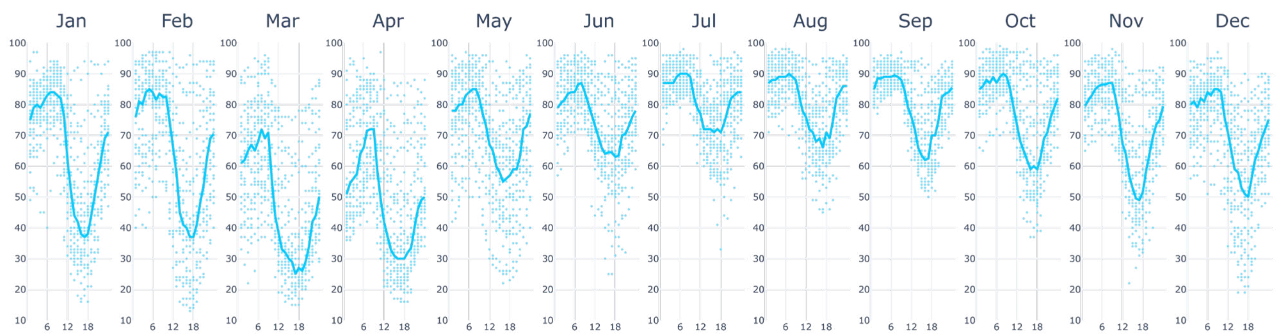


Figure 24. Monthly relative humidity, Kunming.
Data source: Kunming 567780 CSWD, Energy Plus, analysis tool: CBE clima tool

- Precipitation

In Kunming, the average annual precipitation has varied between 500 and 2000 mm from 1956 to 2012. The city's average annual precipitation is 962mm*(Li, 2016, pp182-189)*. In *Figure 25*, the wet season (May to October) contributes to 89% of the annual rainfall, while the dry season (November to April) accounts for only about 11%. This distribution is influenced by monsoons, leading to corresponding variations of humidity.

- Solar Radiation

The altitude of Kunming is 1892m, benefiting from abundant sunlight throughout the year, with annual insolation reaching 1806 kWh/m^2. *(Figure 26)* In the cold and clear winter, a large amount of solar direct radiation could be an ideal energy source to decrease the heating demand. In the rainy and cloudy summer seasons, the direct radiation decreases and becomes a part of the diffuse radiation. The rainfall evaporation also makes the summer cool.

- Conclusion

Generally, influenced by monsoons and topography, the winter in Kunming is clear, dry, and cold with a heating demand that can be compensated partially by abundant solar gain while the summer is cool and rainy. Natural ventilation holds significant potential in this mild climate.

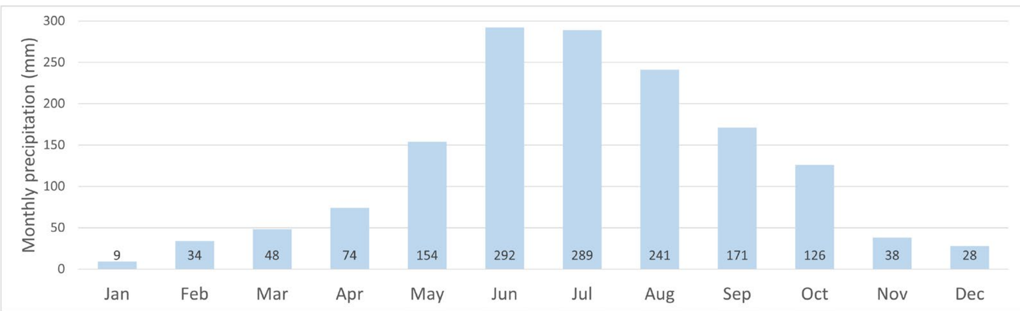


Figure 25. Monthly precipitation, Kunming. Data source: https://en.climate-data.org/

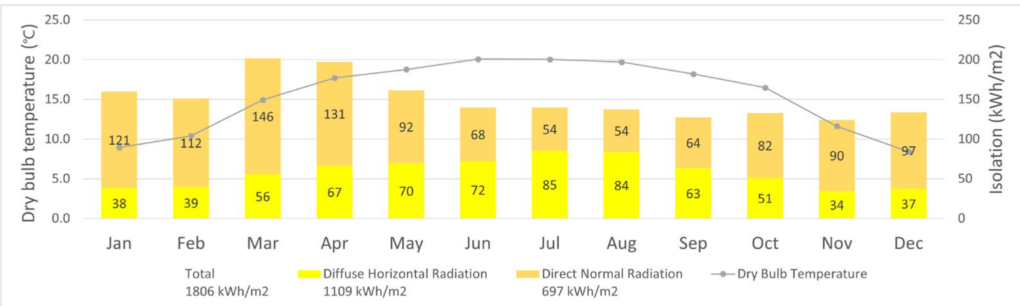


Figure 26. Monthly solar radiation, Kunming. Data source: Kunming 567780 CSWD, Energy Plus

2.2 Earth Vernacular in Yunnan

To comprehend the current state of traditional rammed earth dwellings in Yunnan, a preliminary understanding of the province's topography and ethnic culture is necessary.

Topographically, Yunnan mainly features a plateau landscape. *(Figure 27)* The province's terrain descends in three levels from northwest to southeast, with Kunming situated in the middle tier. The land undulates in a wave-like manner, and human settlements tend to occupy gently sloping mountain basins intertwined with rivers. This topography ensures that while village sizes remain modest, cultural interaction can thrive among these settlements.

In terms of ethnic distribution, there are many ethnic groups in Yunnan. *(Figure 28)* At the rural level, each ethnic group lives in its own small-scale villages, while coexisting on a larger scale. Each ethnic group possesses its unique dwelling customs and preferences, with their architectural styles independently evolving yet mutually influencing one another. This dynamic interaction has led to diverse traditional residential architecture in Yunnan, while certain shared characteristics endure. Representative examples, like the Yunnan rammed earth dwellings known as "The Tuzhang House" and "The Mushroom House," exemplify this diversity. *(Figure 29)* These structures, prominent in the Yi and Hani ethnic groups, embody distinct functional needs and aesthetic preferences. *(Yang, 2009)*

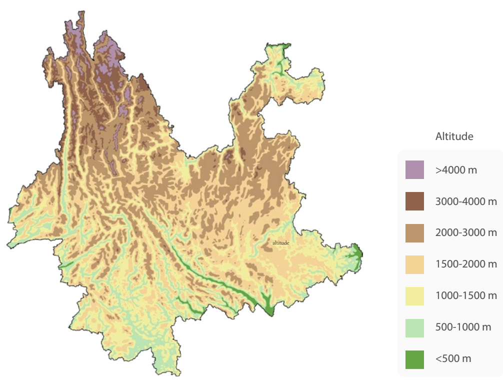


Figure 27. Terrain of Yunnan.
data source: Mapbox

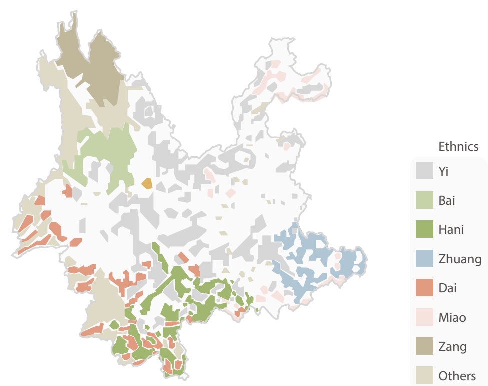


Figure 28. Ethnics distribution in Yunnan.
(中国少数民族社会历史调查资料丛刊 , 2009),
adapted by authors

Figure 29. photos of buildings in Xiaoshuijing and Baishuitang. ©archiposition, 2014

2.2.1 Case Study - Xiaoshuijing Village

Not far from Dashuijing village, Xiaoshuijing village shares remarkable similarities with it in terms of ethnic composition, lifestyle, architectural style, and economic sources. Taking Xiaoshuijing Village as a case study to analyze its settlement layout and the present state of residential buildings could provide insights into the environmental factors that impact the architectural design and construction in Dashuijing Village.

- Village Layout

Xiaoshuijing village exhibits a similar settlement pattern to Dashiujing Village. Houses are situated along the slopes of the mountains near gentle valleys, and their orientations depend on the direction of the slope. *(Figure 30)* The predominant ethnic group in the village is the Miao people, normally engaged in farming. The existing structures in the village are mainly constructed with wood and earth materials, with earth walls serving as the primary load-bearing structures. In contrast, newer constructions predominantly employ brick and concrete materials.

- Building Types

The traditional architecture in the area mainly utilized earth and wood as building materials, although there are variations in the structural systems employed. *(Figure 31)* Some structures were constructed with a wooden frame that supported an earth envelope, while others integrated wood beams and columns with load-bearing earth walls. Among the village buildings, approximately half were made of bricks. Most of the traditional structures followed a wall-load-bearing approach or integrated columns, beams, and walls. Moreover, it's observed that the openings in earth walls were generally smaller compared to brick buildings.

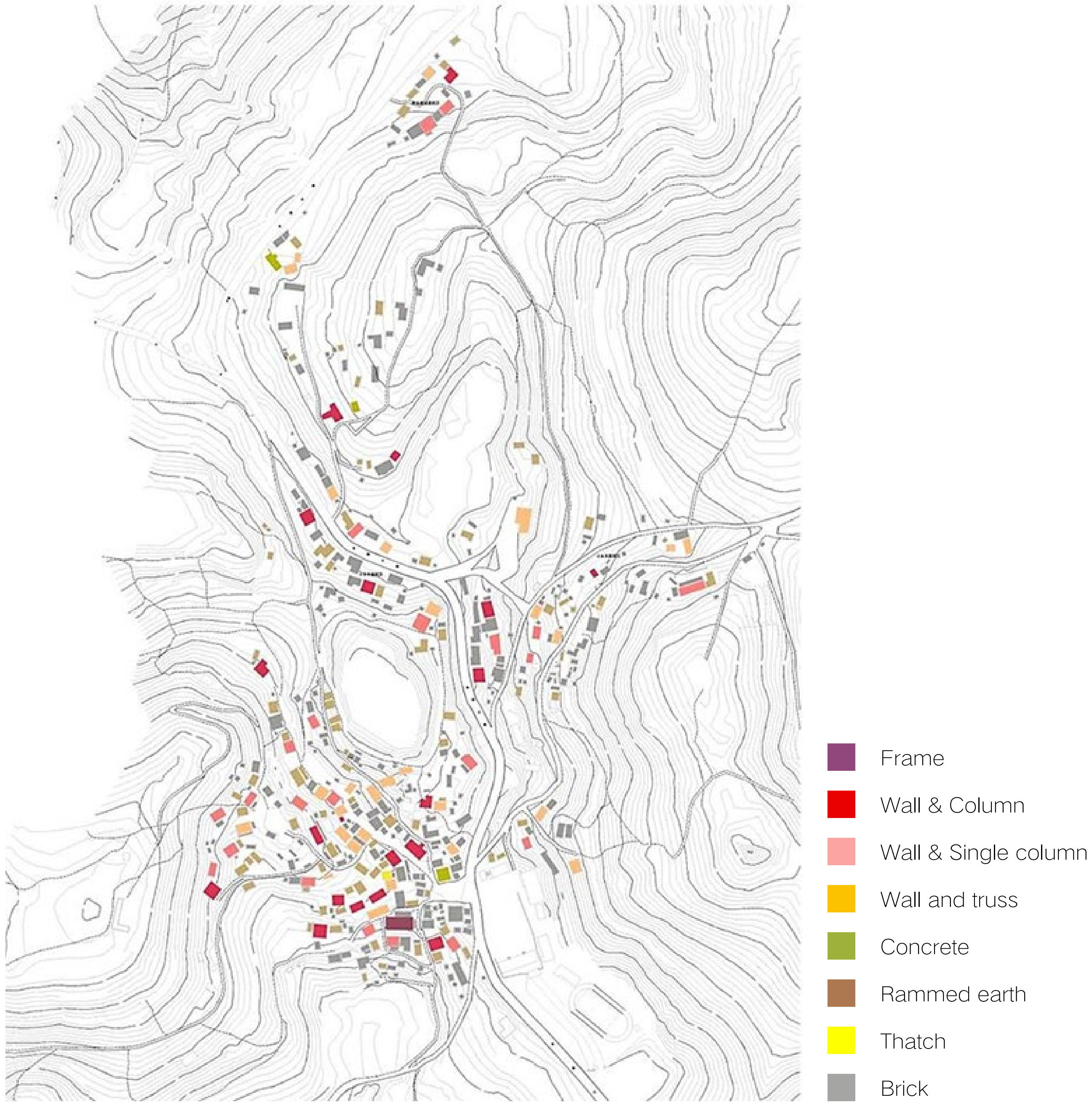


Figure 30. Layout of whole village and souroundings. ©archiposition, 2014

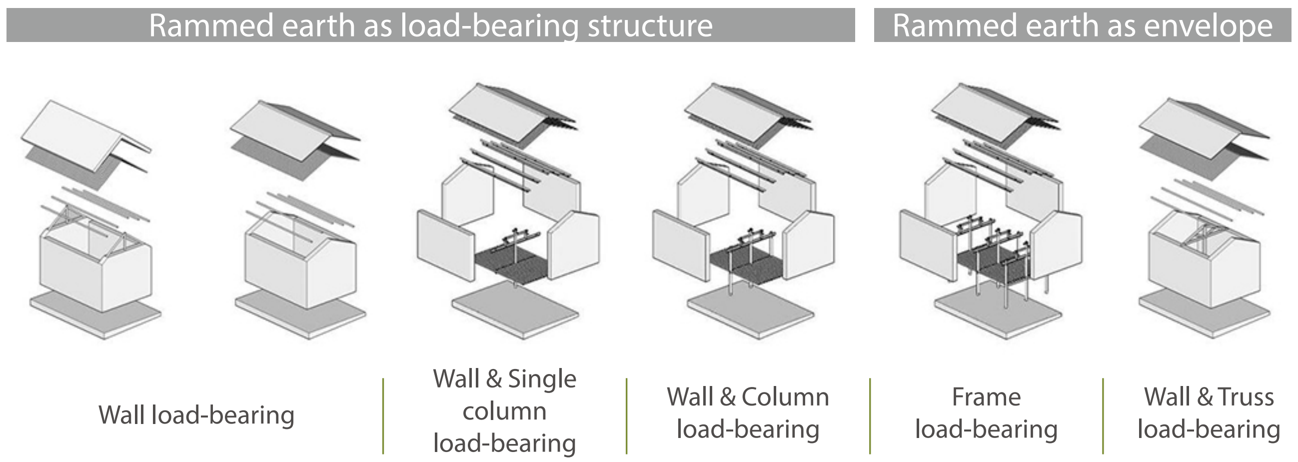


Figure 31. Load bearing typology of rammed earth, wood beam and column. ©archiposition, 2014

2.2.2 Case Study - Tuzhang House

The Tuzhang House represents a distinctive example of vernacular architecture associated with the Yi ethnic group. Predominantly found in areas of lower rainfall in Yunnan, this architectural type is well-suited for both warm and cold climates. Situated on sloping terrains, these houses are thoughtfully integrated with the mountainous landscape. The flat roof serves the dual purpose of grain drying and creating connections between neighboring houses. Due to limited space, the layout is designed for compactness. The use of earth as a construction material provides effective thermal mass for temperature regulation between day and night. The thickness of the walls is optimized to prevent excessive heat during warmer periods and to retain warmth in colder times. Earth, an affordable local material, can be harmoniously combined with other elements such as wood, lime, and straw.

2.2.3 Case Study - Mushroom House

The Mushroom House, a distinctive dwelling of the Hani ethnic group, is a modified version of the Tuzahng house. Its unique sloping roof design, adapted from the tuzhang, serves as a rain-resistant feature, rendering the house suitable for the warm, humid, and rainy climate of its region.

The house is organized with the ground floor for living spaces while the first floor is dedicated to grain storage. Adjacent to this is a small flat roof, strategically designed for grain drying and swift relocation indoors in case of rain. The straw roof, known for its excellent permeability, provides effective ventilation for the stored grains, preventing moisture-related spoilage. Compact layout design not only prevents heat loss but also optimizes the available limited land for construction. This integration of design elements not only ensures environmental suitability but also highlights the ingenious use of local materials and indigenous wisdom in architectural practices.

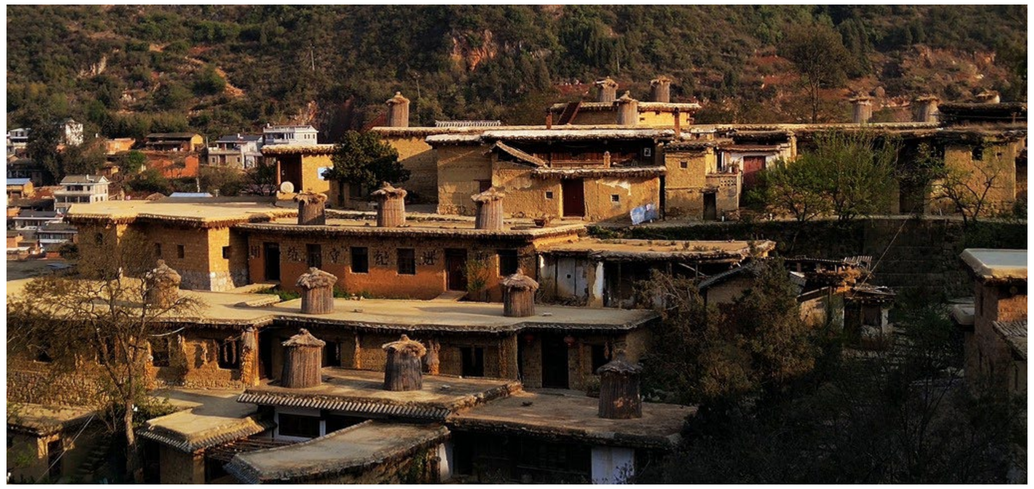


Figure 32. Photo of tuzhang house village. (Photo by Changhong Xu, 2021)

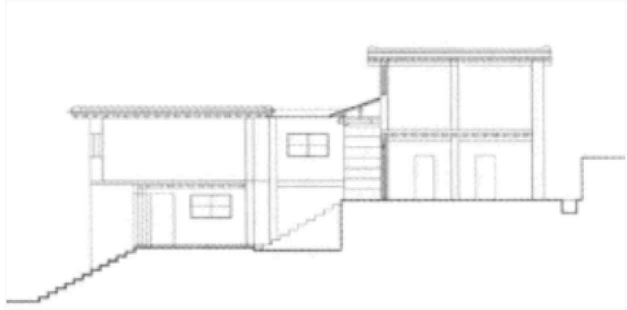


Figure 33. Section of Tuzhang house. (*Yang & Zhu, 2009, p.41)*

Figure 34. Photo of marshroom house village. ©Sohu, 2020

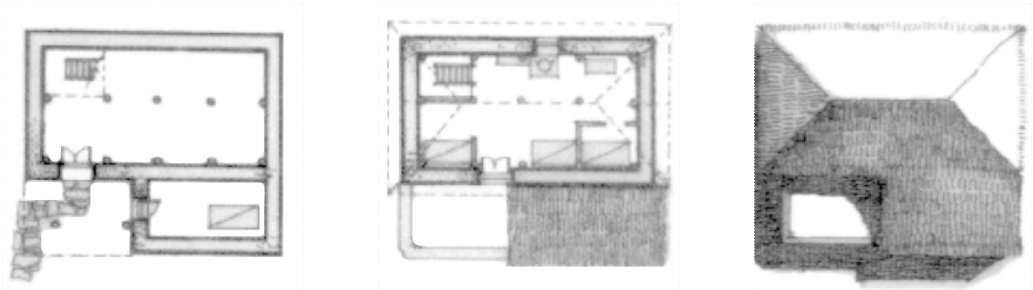


Figure 35. Plans of mushroom house. (*Yang & Zhu, 2009, p.103)*

2.3 Site Information

2.3.1 Brief

With interviews and site investigation, basic information about Dashuijing is collected below.

- Location

Dashuijing Village is located in the northern mountainous area of Kunming city, 15 kilometers from Sandan town and 66 kilometers from downtown Kunming. The village is located at the top of the mountain, and the traffic is inconvenient.

- Population

Around 250 people are registered, and 85 households are in the village.
The majority of the population belongs to Miao ethnic group.

- Economy

The primary economic source in Dashuijing is small-scale traditional agriculture.
Cash crops include Chinese peas and tobacco, while food crops consist of corn and potatoes. The annual income of villagers ranges between 7,000 and 12,000 CNY.

- Infrastructure

The main road in the village is concrete, while the branches are made of dirt. The village has access to power grid (around 0.4 CNY/ kWh) and the consumtion is from 500 to 1500 kWh/year for each household. People do not have access to tap water. The domestic water is from rainwater collection. There are no sewage and drainage pipes. Human waste is collected as fertilizer for the field. When the weather is cold, most people use braziers and stoves as heating equipment, and some use electric heaters.

- Topography

Dashuijing Village is situated on a gentle slope near the valley /in the mountain*(Figure 38)*. The village is surrounded by forests and terraced paddies cultivated by villagers, with a nearby brook. A valley separates the village into two parts. The project site is on the north facing slope, where most villagers reside.

Figure 36. The satelite map of Dashuijing, Kunming.
Data source: Google Map

Figure 37. Dashuijing village, Kunming.
(Photos by Lai Zhou, 2019)

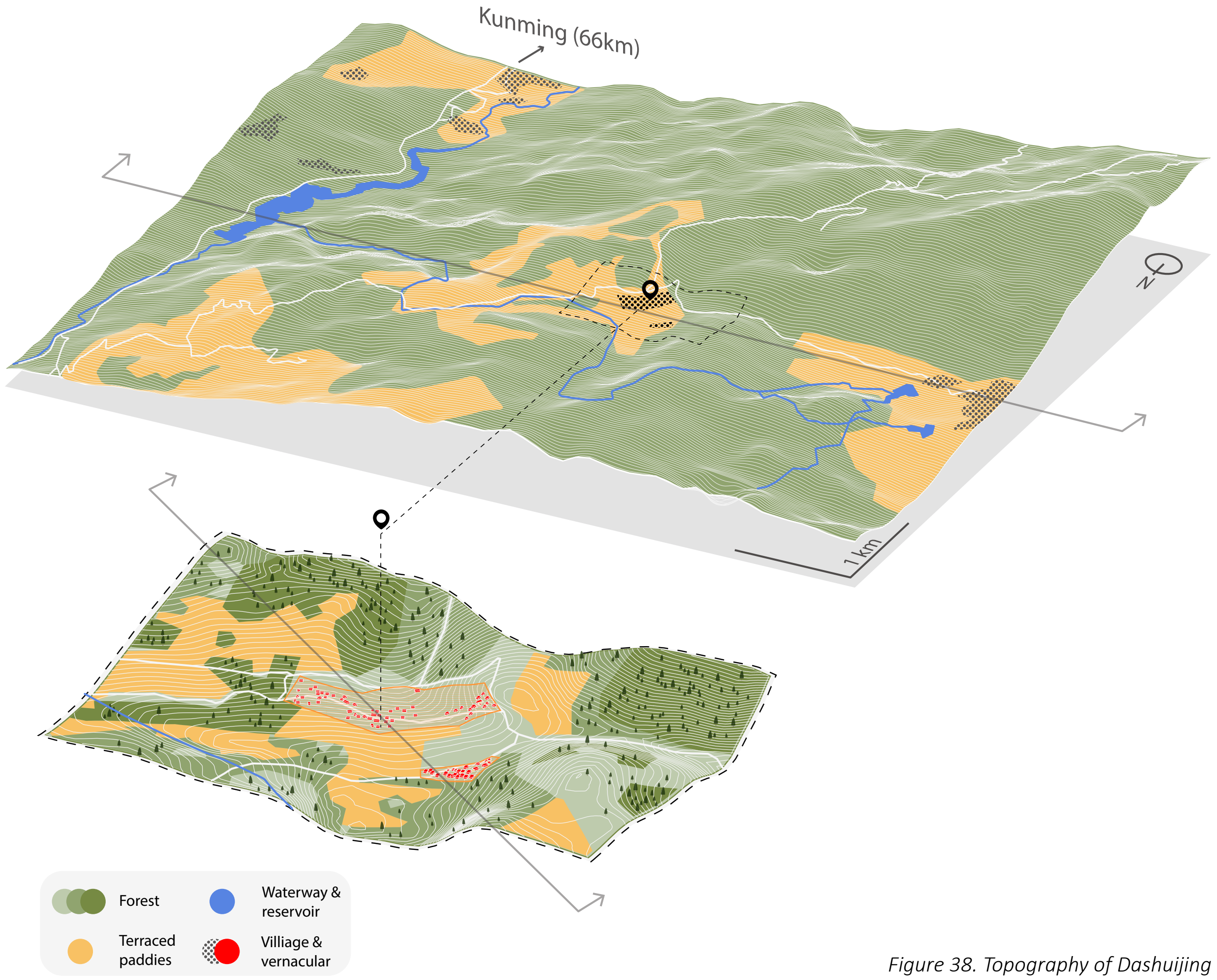


Figure 38. Topography of Dashuijing

2.3.2 Micro Climate Analysis

Due to the lack of weather data on this specific site, we did some preliminary and qualitative analyses based on the available information. The aim was to qualitatively supplement the missing info on wind patterns and water resources.

- Wind

The site is situated on a northwest-facing slope. During the rainy season, the prevailing wind direction is from the southeast.

On a yearly basis, the northwest slope acts as a natural wind barrier, lessening the impact of strong southeast winds. This orientation could also shield the site from excessive moisture carried by the prevailing winds, thus benefiting the preservation of rammed earth walls.

On a daily basis, due to differential temperature changes and air pressure between the hilltop and valley, a valley breeze blows from the valley to the hilltop during the daytime, and a mountain breeze blows from the hilltop to the valley at night. The mountain breeze during the night could slow down indoor cooling, potentially reducing the need for heating. The daytime valley breeze might provide opportunities for natural ventilation, thereby decreasing cooling requirements. *(Figure 40)*

- **Water**

In the mountainous terrain, a complex water cycle occurs among reservoirs, forests, farmlands, villages, and rivers. Rainwater falls on the slopes, forests, and farmlands. Some of it is absorbed by trees, undergoing transpiration to release water vapor into the atmosphere. Another portion is absorbed by the soil, eventually entering the groundwater system. Additionally, rainwater flows into rivers, forming flowing water bodies. *(Figure 41)*

Considering the arid conditions of a leeward slope with limited rainfall, incorporating rainwater harvesting systems for housing offers notable benefits. Firstly, the lower amount of rainfall can result in relatively pure rainwater, less susceptible to environmental pollutants. Secondly, these systems facilitate the gathering and storage of rainwater, serving as a vital water source for housing.

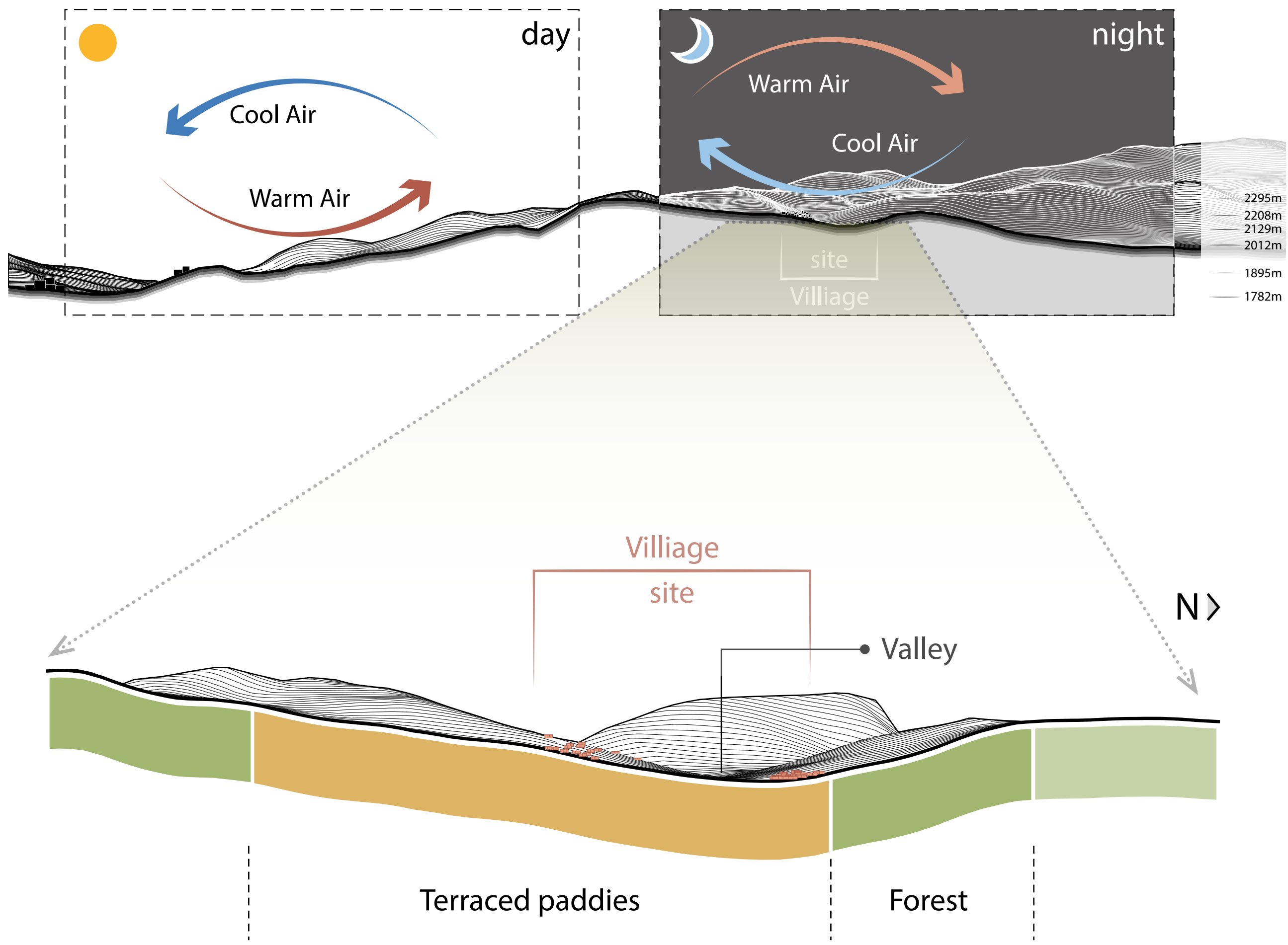


Figure 40. Site section showing the terrain and landscape around the village, with analysis of wind in day and night

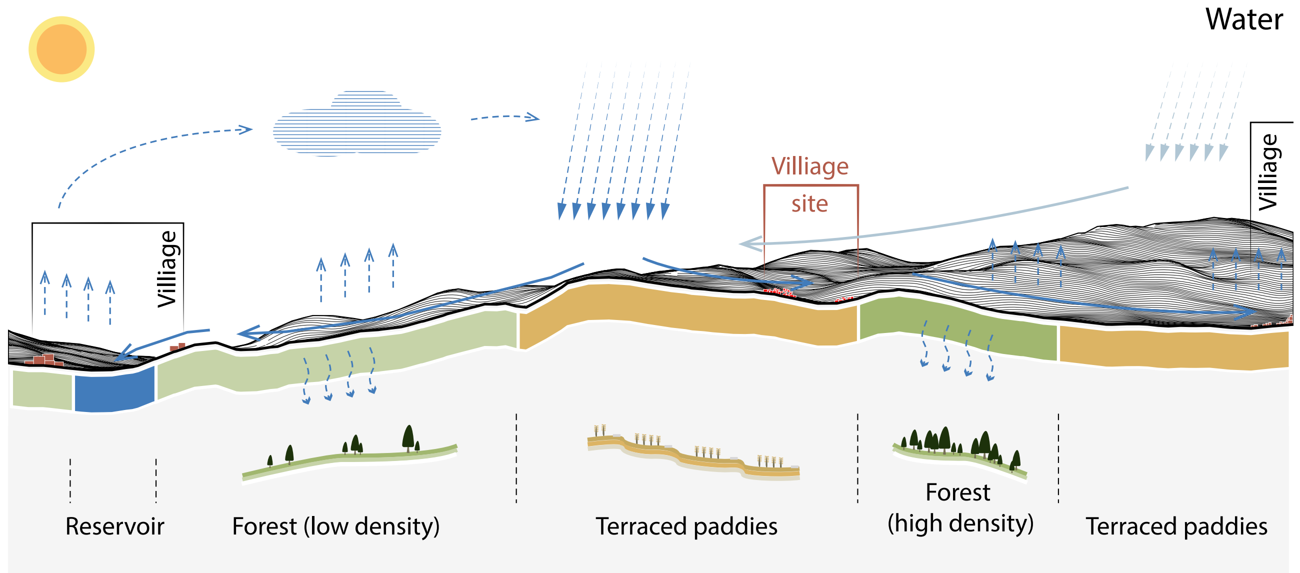


Figure 41. Site section in a large scale, showing the water cycle and landscape around the village.

Social Sustainablity

This section is outside the primary scope of the thesis, as we have already defined in the delimitation. However, social sustainability plays a significant role due to the nature of such aiding projects. In this part, we give a brief answer to the reason why this household and this village.

Similar aiding projects in Yunnan are often initiated by NGOs or charity foundations, which support villagers in building their houses and improving their lives. Before the designing and construction phase, much social work is required to build trust between the villagers and the outsiders. Usually, social workers are devoted to this part, while architects occasionally participate.

Based on interviews(appendix pp.003,004), some NGOs select economically impoverished villages in need of housing. Dashuijing is not a single case, as Yunnan has many similar villages. The selection of Dashuijing was based on the trust built by the NGOs and the willingness of the villagers to adopt modern rammed earth techniques. In Dashuijing, the household was selected after consultations between the NGO and the villagers. The household needs to have the willingness, motivation, a certain level of organizing skills, and a little economic, although most of the construction funds are provided from external sources.

During the construction, the organizations provide villagers with resources for building rammed earth houses. Modern rammed earth techniques are not too hard to learn, and both men and women can participate. Other villagers also make contributions in exchange for payments or mutual assistance. This mode motivates the villagers and creates employment opportunities.

Figure 42. the staff of NGO are organizing activitiy in village, (Photo by Shuqian Chen, 2023)

Chapter 3

Room Level: Simulation and LCA

Through research on Einfach Bauen, we attempted to apply the methodology to our study. We conducted extensive energy simulations and data analysis using a simplified shoebox model to comprehend how design elements will impact energy consumption under Yunnan's climate. Additionally, considering the construction features of modern rammed earth, we researched different window geometries in terms of daylighting. Finally, we did an LCA study comparing brick and rammed earth houses to understand and apply the LCA theory at the room level. This research aims to provide a guideline for building design in the early phase under this context.

3.1 Case Study: Einfach-Bauen

To understand the impact of different building design variables(geometry, orientation, wall thickness, etc.) on energy consumption and indoor comfort in the design process, we chose "Einfach Bauen" as our research case.

"Einfach Bauen" means "Build simply" in English and is a research initiated by a group of architects and engineers from the Technical University of Munich in 2012. This research aims to reduce the complexity of building and construction, which often leads to a high error rate in planning and execution, as well as placing excessive demands on builders and users*(Nagler, 2021)*.

In the early phase of the research, engineers and architects used computer simulations to investigate how reducing energy consumption can be accomplished with simple design variables and technologies while simultaneously achieving indoor comfort*(Figure 43)*.

This "shoebox simulation" methodology is applied in our thesis, and we will analyze the data obtained from simulations to provide a basis for decision-making in the architectural design phase.

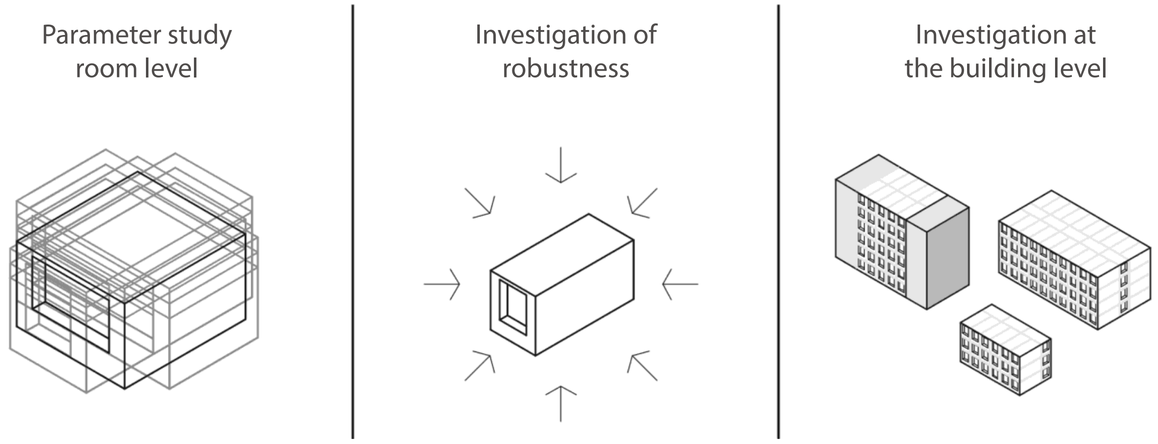


Figure 43. Sequence of work steps in the Einfach Bauen research project
Nagler, F. (Ed.). (2021). Building Simply: A Guideline. De Gruyter.

3.2 Shoebox Study

A "Shoebox" model is a simplified model of a building, typically a rectangular box with one opening, which captures the basic characteristics of the building in terms of lighting and energy performance*(Figure 44)*. Simulating the shoebox model allows an estimation of the whole building to assess energy demand and indoor climate before finalizing the building's geometry and site orientation during the design process. It effectively quantifies performance early and informs the design decisions*(Chhabra, n.d.)*.

In this part, the daylight and thermal simulation are done with the software IDA ICE 4.8, a whole-year detailed and dynamic multi-zone simulation application for the study of thermal indoor climate as well as the energy consumption of the entire building. IDA ICE is developed by EQUA Simulation AB.

Furthermore, LCA(life cycle assessment) will be conducted in this room-scale study. The purpose is to perform an initial exploration of environmental impacts (mainly GWP, Global Warming Potential) before entering the early design phase and clarify how to calculate each module. We will use CAALA, an LCA tool developed by Caala GmbH. This part will be explained in later chapters.

The main input data is attached in the *appendix p.005*

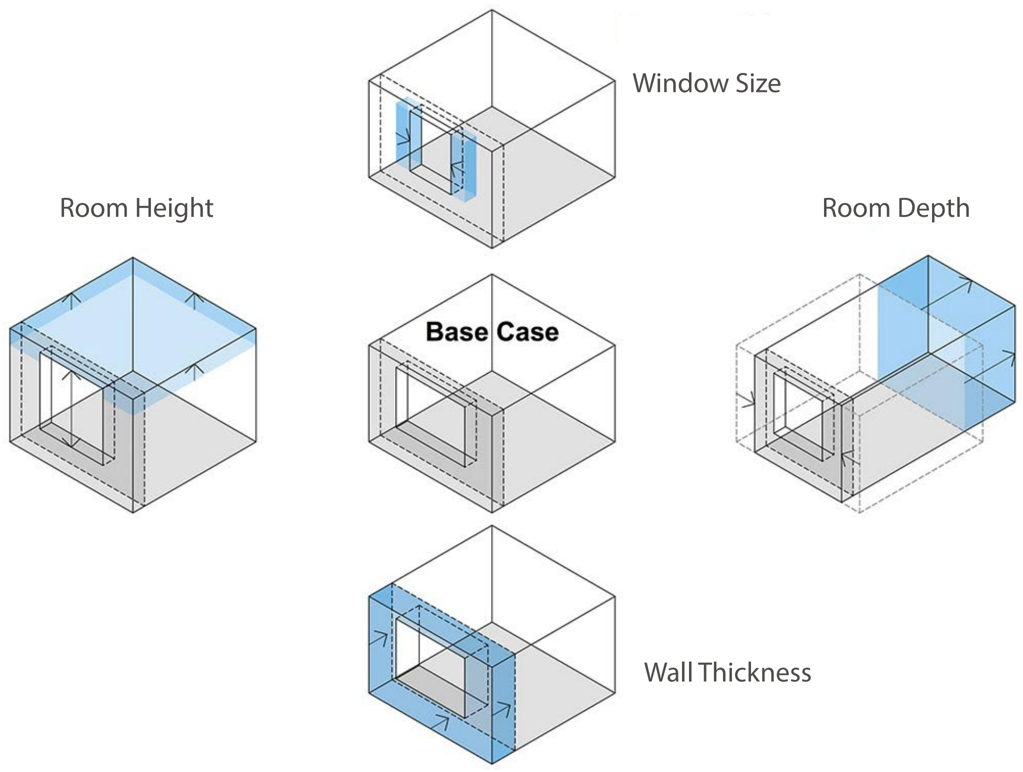


Figure 44. Shoebox variables of Einfach-bauen.
Nagler, F. (2019). Einfach Bauen. Ganzheitliche Strategien für energieeffizientes, einfaches Bauen-Untersuchung der Wechselwirkung von Raum, Technik, Material und Konstruktion.

3.2.1 Design of Experiments

This section aims to assess variables' impact on energy demand and indoor comfort through data obtained by simulating many cases.

- Variables and Boundary Conditions

Based on the weather analysis in Chapter 2, heating demand could be the main energy consumption. Therefore, as the dependent variable, **heating demand will be considered the primary indicator**. Numerous factors influence heating demand, but the purpose of the shoebox model study is to provide design guidelines for the early stages of building design. Therefore, we have selected variables more relevant to building design as independent variables. These variables are **orientation, width, height, wall thickness, wall-to-window ratio,** and **window glazing type**. Specific values of each variable are shown in the *appendix p. 005*. Among these six groups of variables, the orientation has four values (north, south, east, and west), while the other variables have three values each (high, medium, and low). Therefore, 972 cases will be simulated for analysis(*appendix pp.007,014)*.

However, heating demand is not the only indicator. The rooms need to be ensured to achieve a basic level of indoor comfort, and then we bring other indicators for a threshold.

PPD(predicted percentage of dissatisfied): ⩾ -1 and ⩽ 1

DF(daylight factor): ⩾ 2%

CO_2 concentration: ⩽ 1200 ppm

The meaning of the indicators and the relevant codes will be explained in the *appendix p.001*.

Variables

Orientation

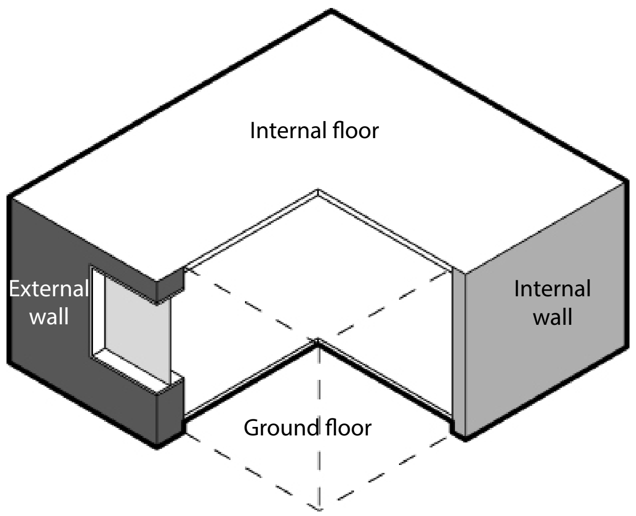
External wall width

External wall thickness

Height

Window-to-wall ratio

Window glazing type



Constants

Weather data

Floor area

Infiltration rate

Air velocity

Internal gains

Schedules

Ideal heater/cooler

......

Figure 45. Variables and constants to be defined

- Assessment Method

Quantitative assessment of the impact of variables across different dimensions is a challenge beyond architects' knowledge boundaries. For instance, it is complex to determine whether rotating the orientation by 1° has a larger impact on heating demand or to increase wall thickness by 1 millimeter.

Therefore, we bring up a statistical method, **standardized regression coefficient**, which are the estimates resulting from a regression analysis where the underlying data have been standardized so that the variances of dependent and independent variables are equal to 1*(Menard, 2004)*.

The steps are:

1. Prepare the dataset.

2. Calculate the mean (μ) and standard deviation (σ) of each variable.

$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}}$$

In this formula, σ is the standard deviation, x_i is each individual data point in the set, μ is the mean, and N is the total number of data points.

3. Converting the data to Z-score

$$Z = \frac{X - \mu}{\sigma}$$

In this formula, Z is the Z-score, x is the original score to be converted, μ is the mean, σ is the standard deviation.

4. Caculate the coefficient with linear regression.

In this way, the coefficients are between -1 and 1, eliminating the units of variables. The effect on dependent variables from independent variables can be measured.

3.2.2 Results

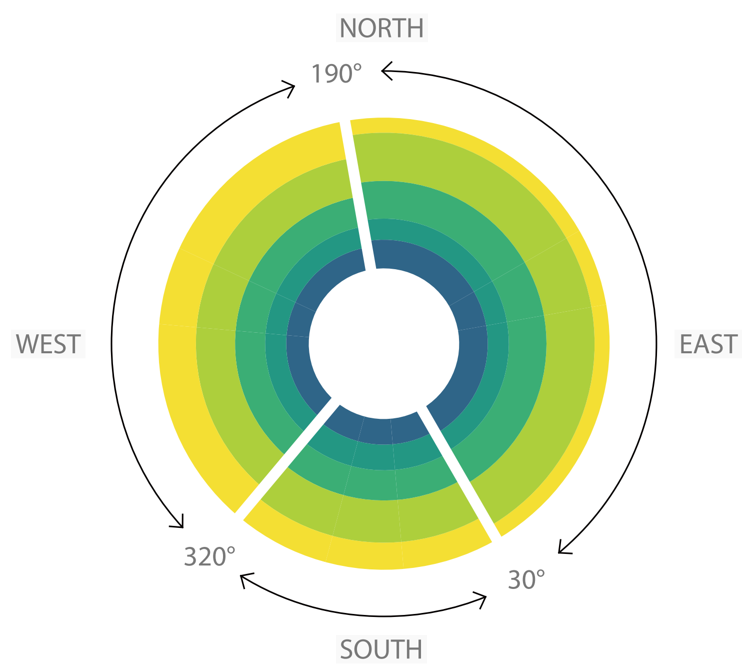
With standardized regression analysis, the data is visualized *(Figure 46)*.

Orientation has a significant impact on heating demand. Southwest is the most favorable, and as it rotates toward other directions, heating demand increases, surpassing most other variables in its influence. Although heating demand increases within the range from southeast to north, its impact is the smallest compared to all other variables.

Wall thickness and height have a relatively limited impact on heating demand. We noted that the variables with consistently significant effects are width and window-to-wall ratio. The reasons will be further discussed in the next section.

The variable "window glazing type" is excluded because, in this climate and context, the type of windows does not have a decisive impact on the results, especially when a favorable orientation(southwest) is selected *(Figure 47)*. This is mainly due to two reasons: first, Kunming experiences abundant solar radiation, and second, Kunming's winters are not too cold. Therefore, the solar heat gain through the glass is greater than the heat loss, implying that the g-value of the glass may be more important than the u-value.

Further research on other variables are included in the *appendix pp.014, 022*. Due to space limitations, detailed explanations are not provided in the main text.



	z-Orientation Angle	z-Width	z-WWR	z-Wall Thickness	z-Height
Southwest-Southeast (320°-360°, 360°-30°)	+0.39	+0.60	+0.44	−0.36	+0.37
Southeast-North (30°-190°)	−0.21	+0.66	+0.52	−0.29	+0.38
North-Southwest (190°-320°)	+0.53	+0.56	+0.42	−0.29	+0.33

Figure 46. visualization for standardized regression coefficients of the variables, in the different domains of orientation

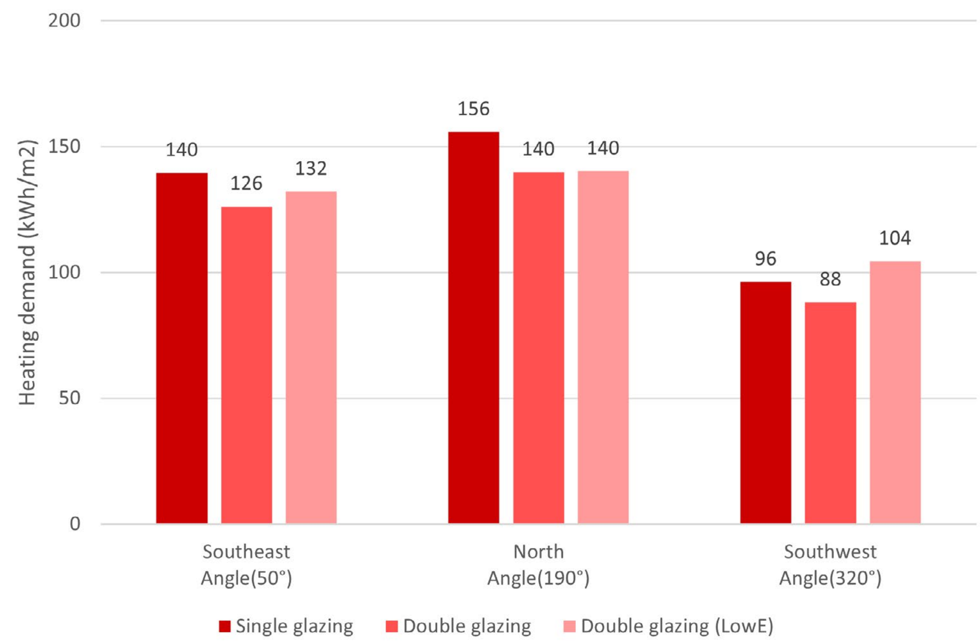


Figure 47. Heating demand by 3 types of glazings(single, double, double low-e), in 3 orientations (50°, 190°, 320°)

3.2.3 Discussion

- Thermal Simulation

With 972 cases and data, Pearson correlation analysis is applied to explore and uncover clues. A high correlation is noticed between daylight factor and heating demand. Consequently, we conducted linear regression analysis on these two variables*(Figure 48)*.

Regression can only reveal the correlation between the two variables and cannot establish a causal relationship. So, what causes this phenomenon? We assume that the windows as a "bridge" between these two variables: larger windows provide better daylighting but also lead to more heat loss.

Furthermore, with energy balance analysis, we discovered that natural ventilation through window openings is the main cause of heat loss*(Figure 49)*, while solar gain is an important supplementary in heating demand. To prove further, we found that windows with a high frequency of small openings can reduce heating demand while ensuring relatively fresh air*(Figure 50)*.

This discovery implies that, in a favorable orientation, windows should be as large as possible to increase solar gain. However, for ventilation, it is advisable to open windows frequently with a small opening.

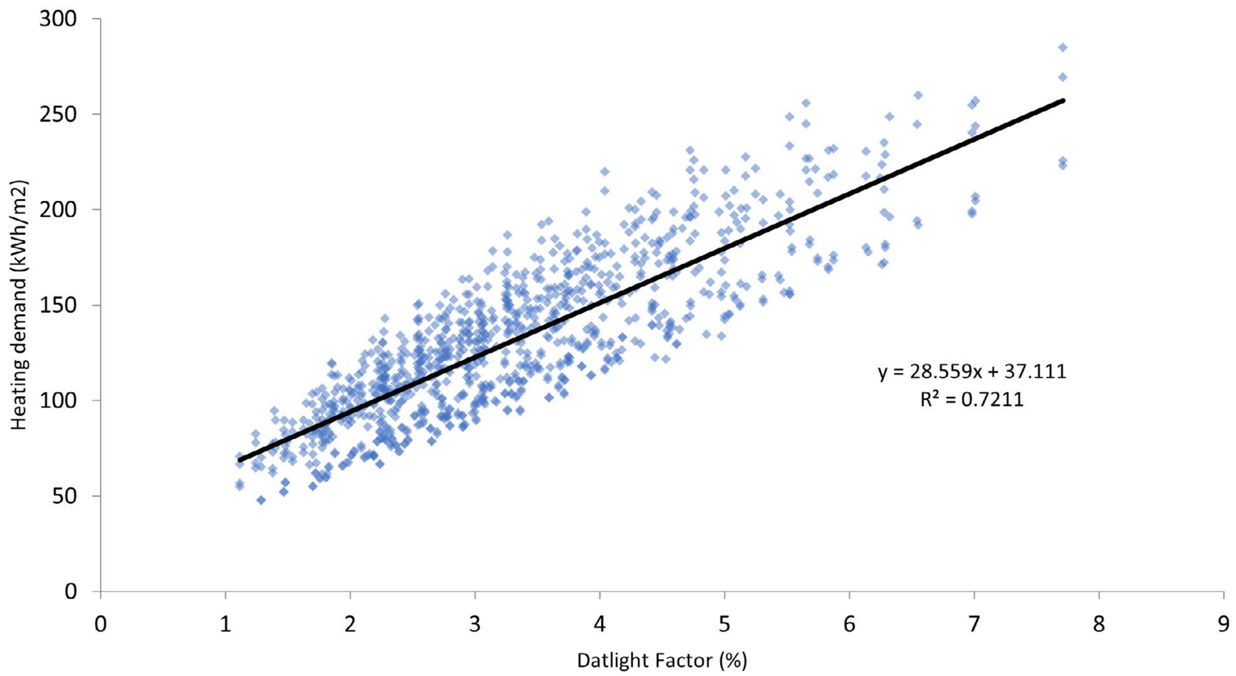


Figure 48. Simulation for the daylight factor and heating demand of 972 cases, with linear regression analysis.

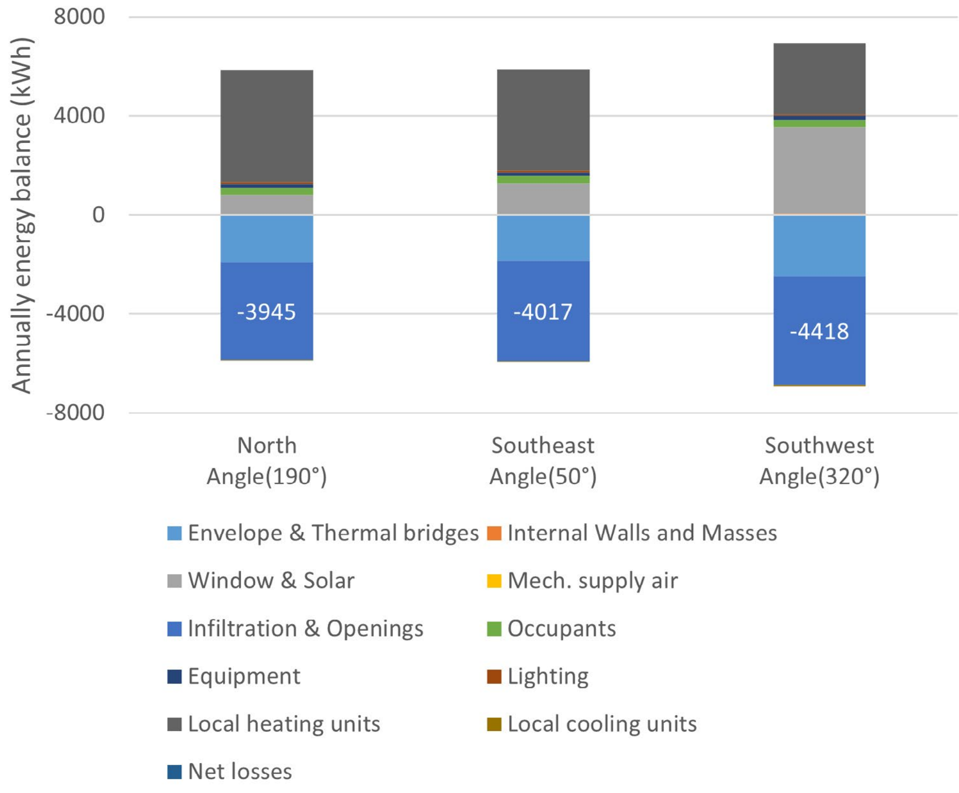


Figure 49. Annually energy balance of the room in 3 orientations.

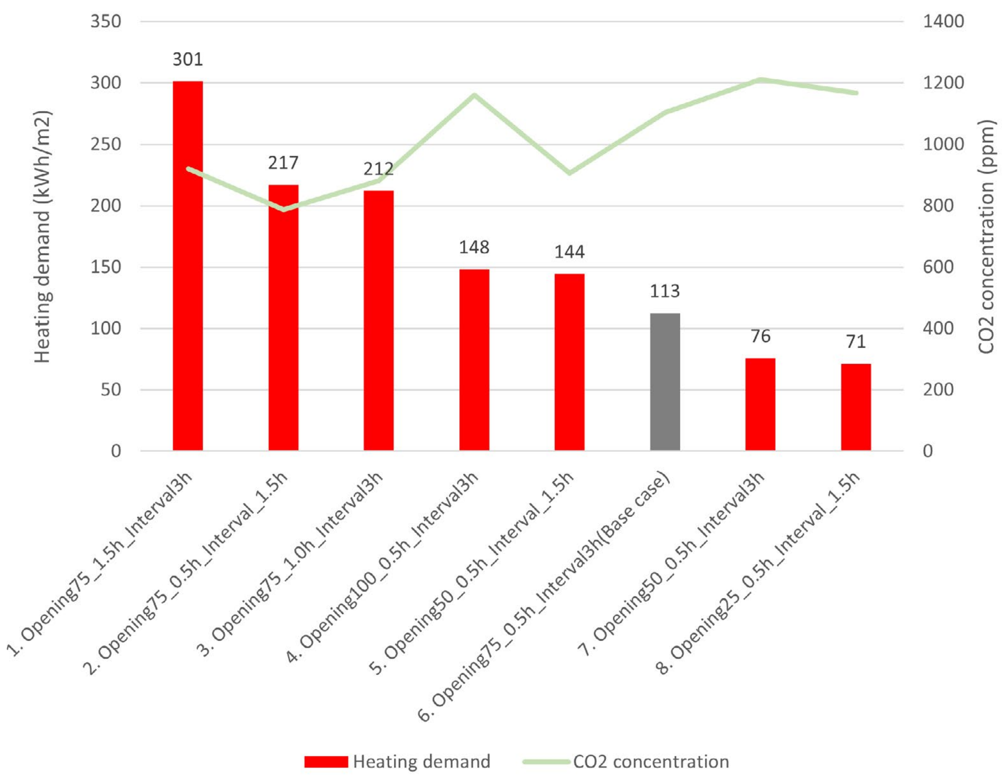


Figure 50. Heating demand and CO2 concentration by different window schedules.

- Daylight Simulation

Of the 972 cases, 129 had a daylight factor below 2%, but all values were above 1%. Additional simulations were done to further explore the relationship between window shape and daylight factor for design guidance*(Figure 51)*.

The window opening is determined by the characteristics of rammed earth construction, with the upper edge of the window opening aligned with the floor's ring beam. This design helps save on lintel and labor costs. Based on this, we found that for the same window area, the horizontal window has the lowest daylight factor, the vertical window is in the middle, and the window placed in the middle has the highest daylight factor. In terms of uniformity, horizontal windows have the best DF*(Figure 52)*.

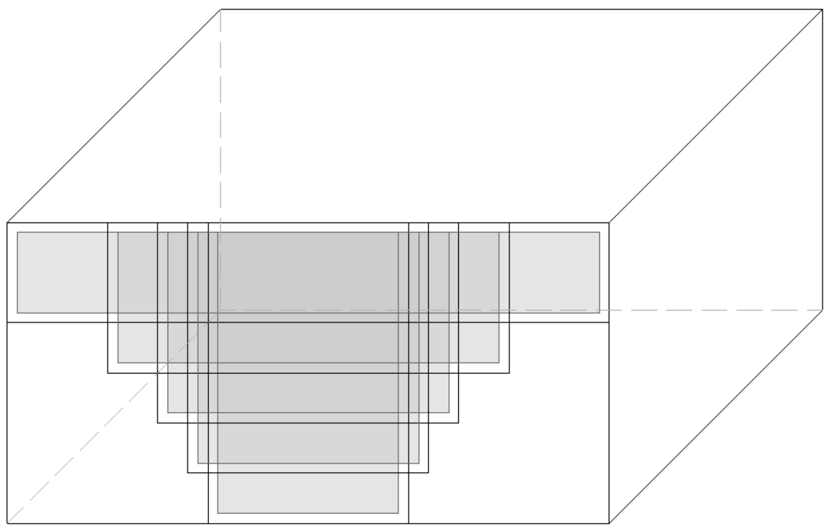


Figure 51, modeling different window geometries with same area for daylight factor study

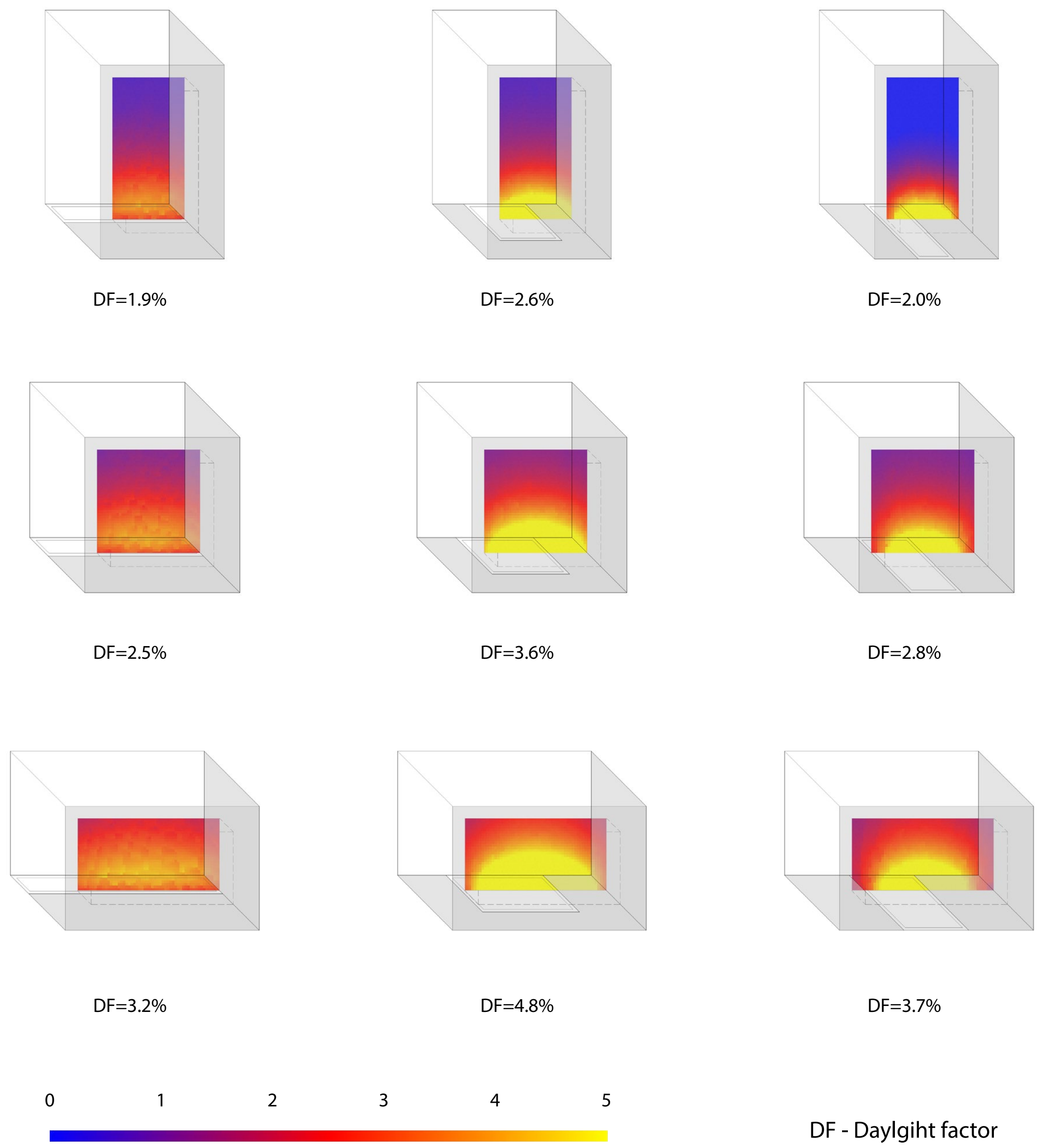


Figure 52. different window and room geometries for daylight factors and heatmap visualization

3.3 Life Cycle Assessment

3.3.1 Goal and Scope

The goal is to compare the carbon footprint of "rammed earth" and "brick" at the room scale. The research aims to explore the earth as an eco-friendly building material and assess how it differs in carbon footprint throughout the lifecycle compared to rural Yunnan's most common brick structure*(Figure 54, 55)*. Additionally, this research prepares for the building design in the next chapter by understanding the calculation methods for each module. The functional unit is defined as building a single-family house, considering 1 m2 area in a 50-year lifespan. The environmental impact is presented with global warming potential(GWP). The system boundary includes (A1-C4), from cradle to grave. In the use stage, B1-B5 will be considered as one module, and B6 will be calculated from energy simulation with relevant CO_2 emission factors.

3.3.2 Life Cycle Inventory

The data for modules A1-A3, B4, and C3-C4 is sourced from ÖKOBAUDAT. It is partly due to a lack of firsthand or secondhand data for local materials, and on the other hand, CAALA, the LCA software we use, draws data from ÖKOBAUDAT. The process involves creating a 3D model in Sketchup and then assigning materials to the model based on the design in CAALA. The software calculates the material quantities based on the model and integrates them with the data from the database to obtain the final results.

Data for B6 is obtained through energy simulations and then calculated by referring to the local power grid's carbon emission factors and relevant codes. However, we noticed that the fuel for heating and hot water is agricultural waste, such as corn cobs and branches*(Figure 53)*. It is not the same as the one-time biomass combustion as specified in the codes. If the fuels are sustainable and renewable sources, they are not considered to emit carbon emissions throughout the entire lifecycle.

Figure 53. Photos of heating resource(corncobs and braches) in village, Yunnan. (Photos by Lai Zhou, 2019)

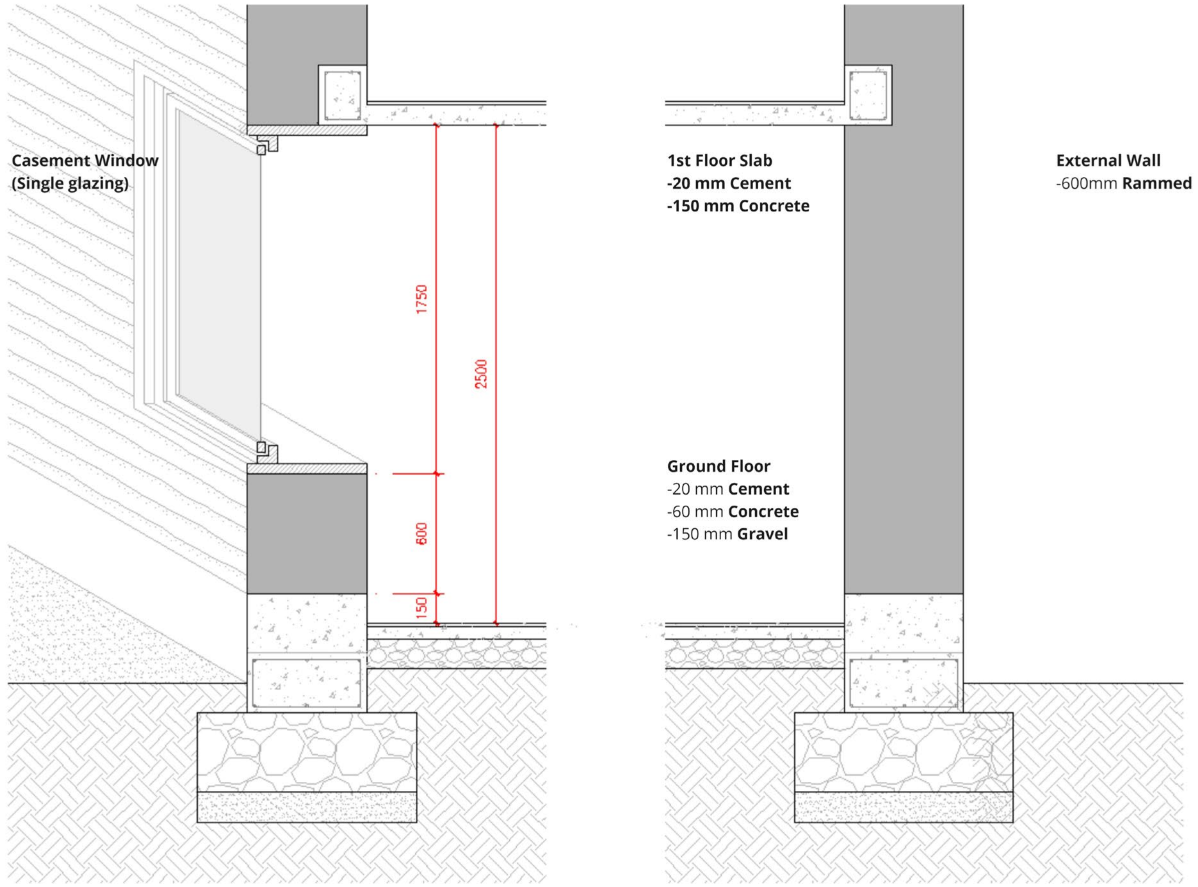


Figure 54. construction layers of the room - modern rammed earth

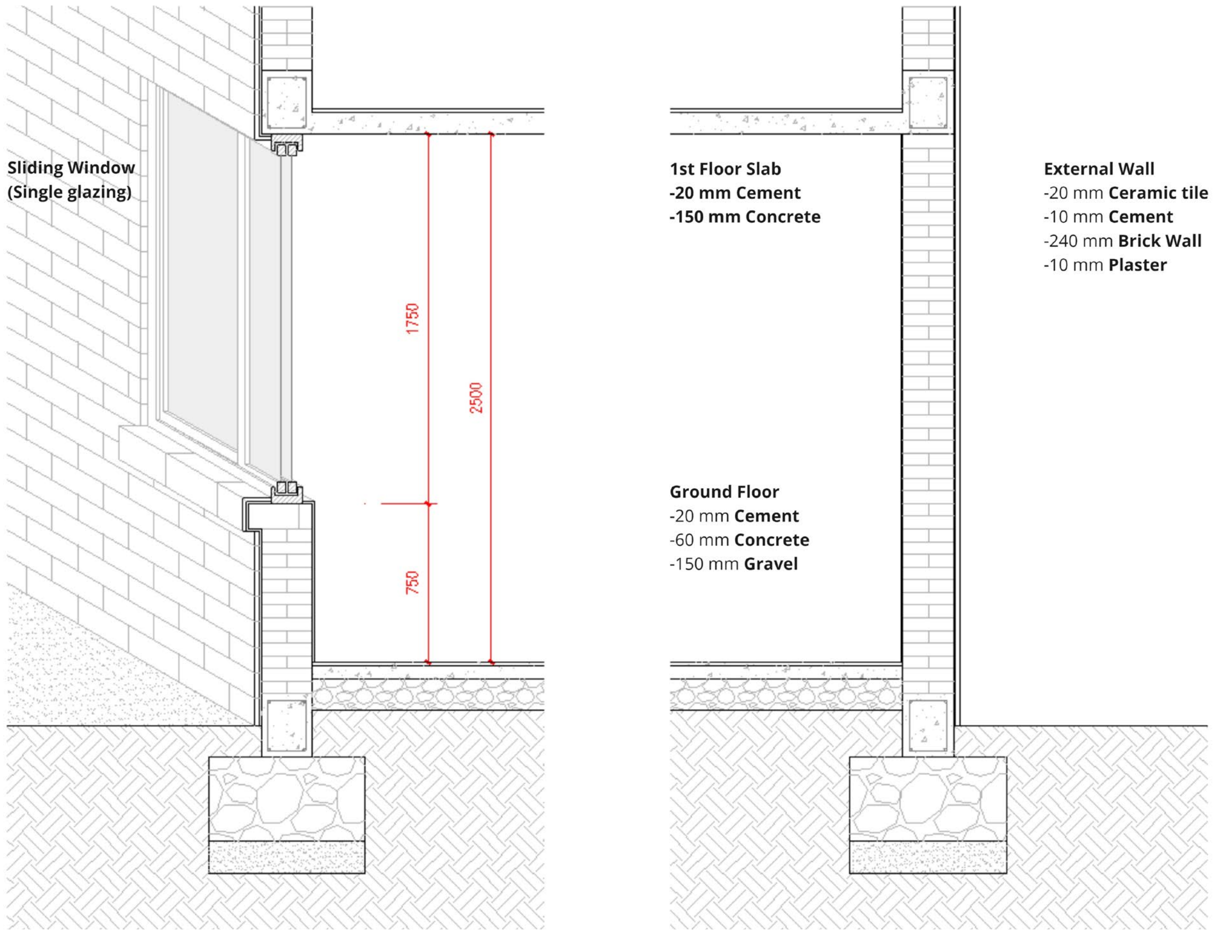


Figure 55. construction layers of the room - conventional brick and concrete structure in rural Yunnan

For A4 and C2, the local transportation modes and distance from the building material market are taken from the interviews. The emission factors are adopted from the local codes.

A5 and C1 usually take up a small portion, and data collection for these modules is complex. Because the study is carried out in the early design stage, we adopt the empirical formulas from local codes for assessment.

3.3.3 Results and Discussion

The results indicate that the CO_2 emissions for brick and rammed earth are respectively 7.61 CO_2 e/m^2・a and 6.12 CO_2 e/m^2・a , with earth being approximately 20% lower than brick. In the A1-A3 (production) stage, a reduction is about 40%*(Figure 56)*. Therefore, replacing brick with rammed earth plays a significant role in reducing GWP.

The energy includes three parts: heating demand, hot water demand, and electricity*(Figure 57)*. All CO_2 emissions in the B6 stage come from electricity use, accounting for approximately 42% and 52%. This differs from the CO_2 emission composition of buildings in developed regions. This is partly due to higher emission factors in the regional grid and partly vliiagers tend to simplify the construction layers and materials as much as possible due to economic and technical reasons.

3.4 Conclusion

The conclusion serves as the guidelines for the building design in the next phase, ensuring that designers can qualitatively apply the findings. Quantitative research has been discussed in the preceding sections and will not be reiterated in this part.

1. Earth has a better thermal performance and environmental impact than birck.
2. A favorable orientation has a significant impact on energy efficiency.
3. Single glazing is affordable, and the performance is acceptable in the context.
4. Enlarge the window on the south/west orientation for solar gain, compensating for the heating demand.
5. Ventilate frequently with a small amount of air inlet in winter.
6. Reduce the exterior wall/roof as much as possible.
7. Too thick walls do not help much with heating but could be a good shading strategy for cooling.
8. Different window geometry gives different daylight. It depends on the specific case.

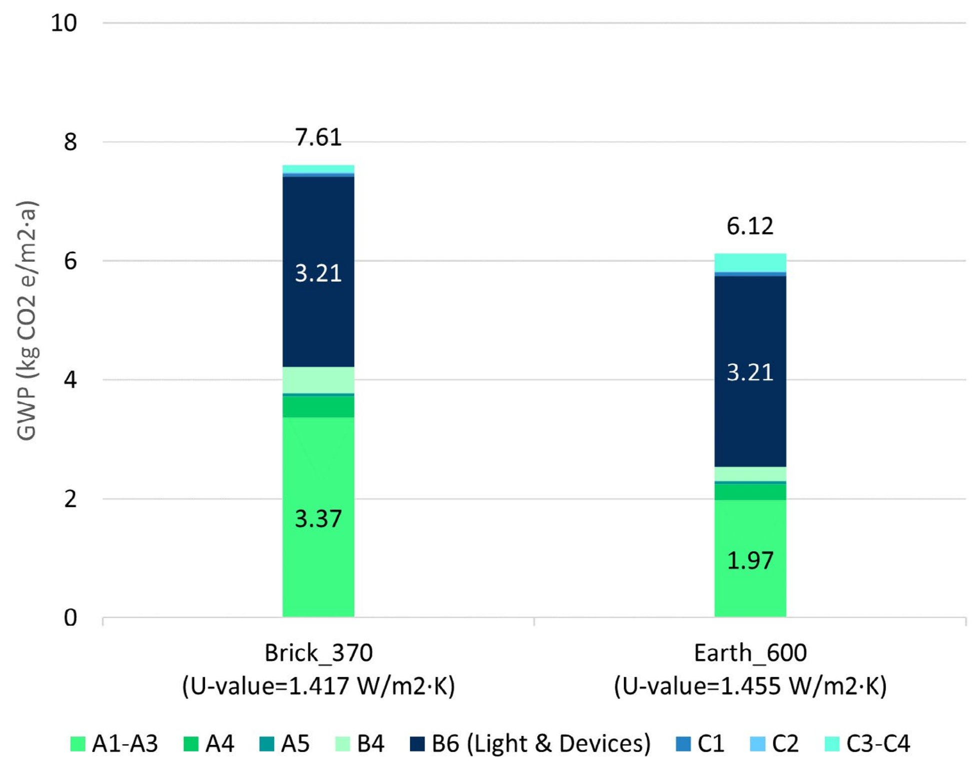


Figure 56. LCA for the room, by two different wall constructions(brick and rammed earth)

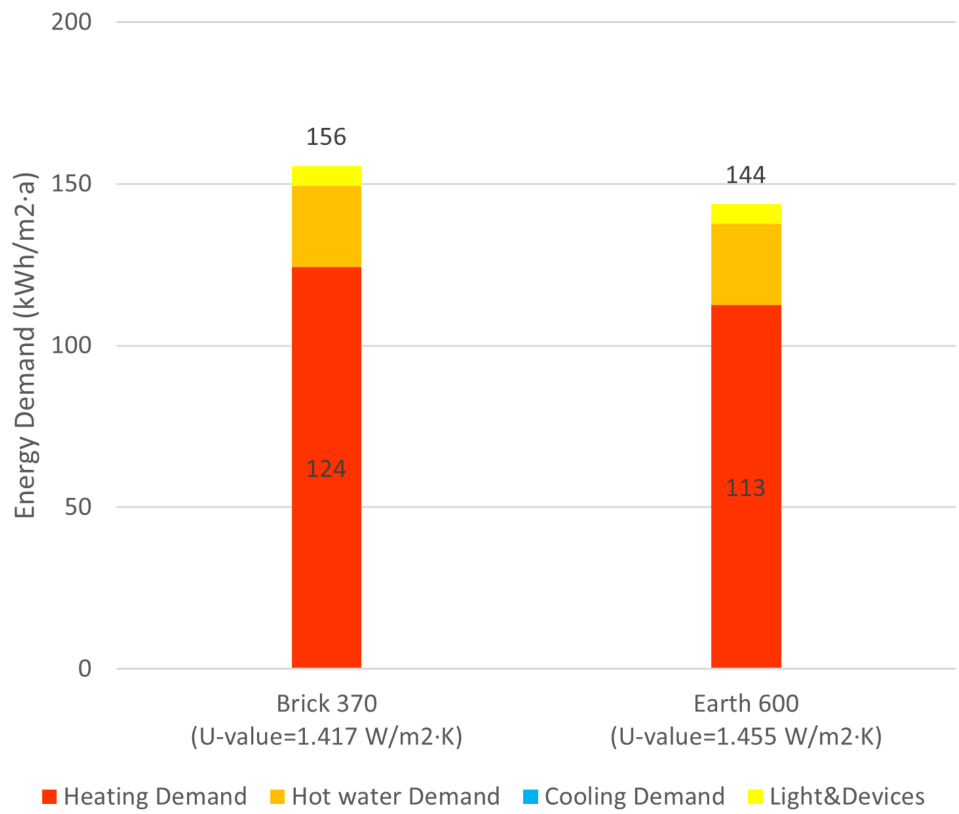


Figure 57. Energy demand for the room, by two different wall constructions (brick and rammed earth)

Chapter 4

Building Level: Design and Assessment

A site investigation of the neighborhood, the existing building, and the users will be done in depth. Based on research in the previous chapters, the findings will be applied to the building design. After studying and deciding the passive and active strategies as well as upcycling the resources, we offered three design proposals that align with the local lifestyle. These proposals will be assessed with the energy performance, environmental impact, and daylighting. Ultimately, we will take the conventional concrete-brick house as the baseline and one preferred proposal as the development direction to propose an exemplary optimization path

4.1 Site investigation

Chapter 2 analyzes the site on a regional and village scale. In this section, an investigation will be done on the neighborhood and building scale.

4.1.1 Neighborhood

- Buildings

Most houses nearby are built with rammed earth, adobe, and timber; many are old and lack maintenance. Some later additions are built with bricks and concrete blocks. Most houses have a yard used for drying clothes and grains. Due to the terrain, the majority of houses in the village face north. *Figure 58* shows the materials used for construction in the village.

- Infrastructure

The roads nearby are made of dirt and the main road is about 1.5 meters above the house. The village has access to the grid but lacks tap water. People rely on rainwater collection and a reservoir at the mountaintop, which supplies water to the villages below. Most houses do not have toilets, and villagers use public toilets. This is due to flushing water shortage, strong odors, and the need for septic tanks. Therefore, even for the newly-built brick houses, toilets are separate from the living spaces.

- Vegetation

A large amount of vegetation is around the houses, primarily bamboo, shrubs, and trees. To the north of the village, there are terraced paddies where the crops are corn and Chinese beans. Corn cobs and straws are often used as fuel sources.

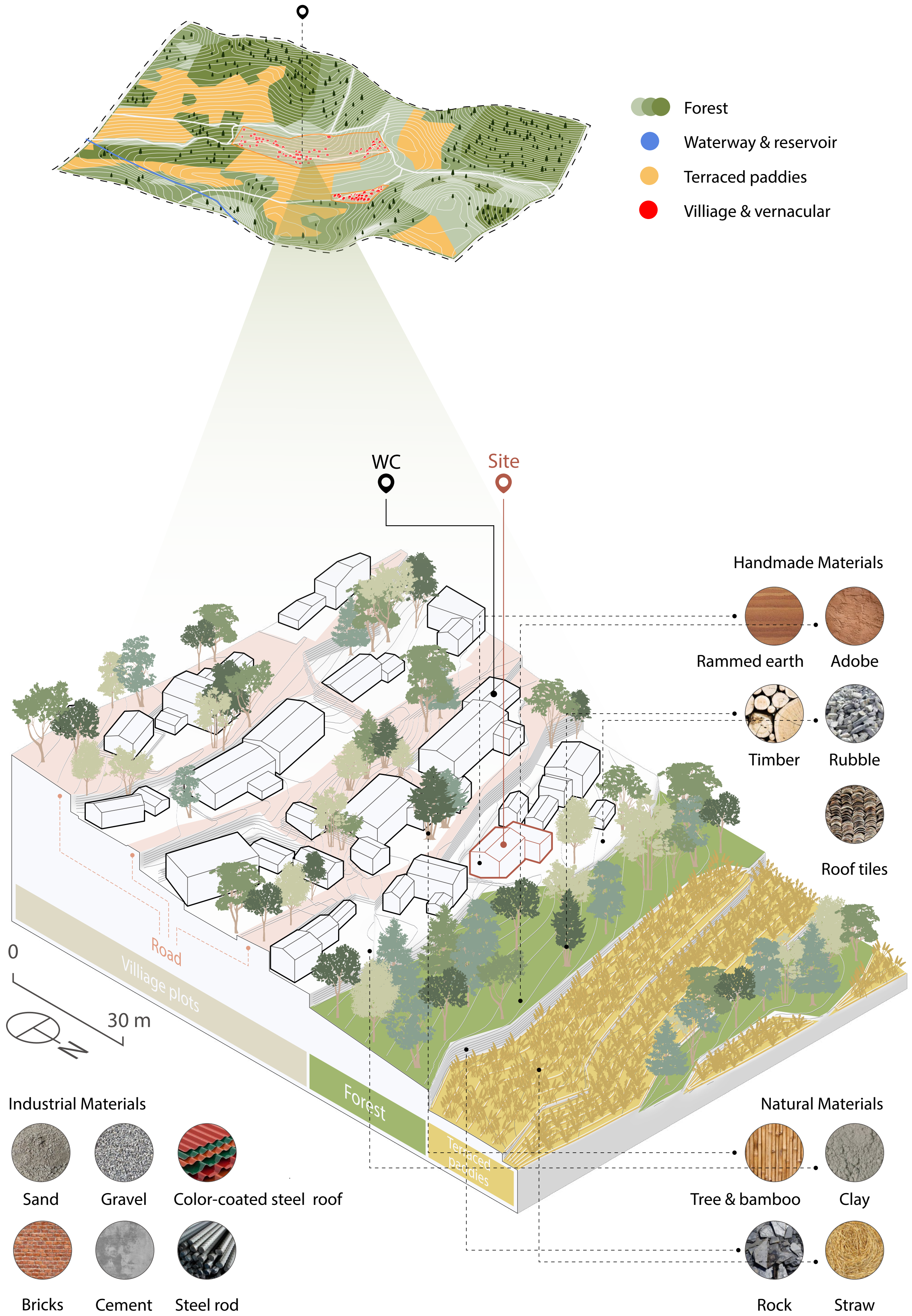


Figure 58. Site in the neighbourhood scale
This drawing includes information on terrain, roads, houses, vegetation, and farmland, as well as a classification of the widely used building materials in the village. The existing buildings on the design site and nearby public toilets are also marked in the drawing.

4.1.2 The Existing House on Site

The site consists of a house and a courtyard. The original house is approximately 95 square meters and can be roughly divided into two parts*(Figure 59, 60)*.

The eastern part, constructed earlier, features a combined living room and bedroom on the ground floor without partitions, and the first floor is for storage. It is a rammed earth and timber mixing structure. The envelope of the house is made of rammed earth, while the floors and roof are made of timber.

The western part was extended later by concrete blocks for the envelope and load-bearing structure. The roof was made of wooden rafters, with asbestos sheets directly laid on top as a covering.

Due to safety concerns about the structure and the renovation cost, we opted for demolishing and rebuilding rather than renovation.

4.1.3 User Needs and Background

The family consists of three members: a couple and their daughter. The husband and wife depend on traditional agriculture in this village, while their daughter attends school in the town during the week and returns home on weekends. Therefore, the owner wishes to have the basic functions of the existing building while making it as good as the newly-built concrete brick house in the village.

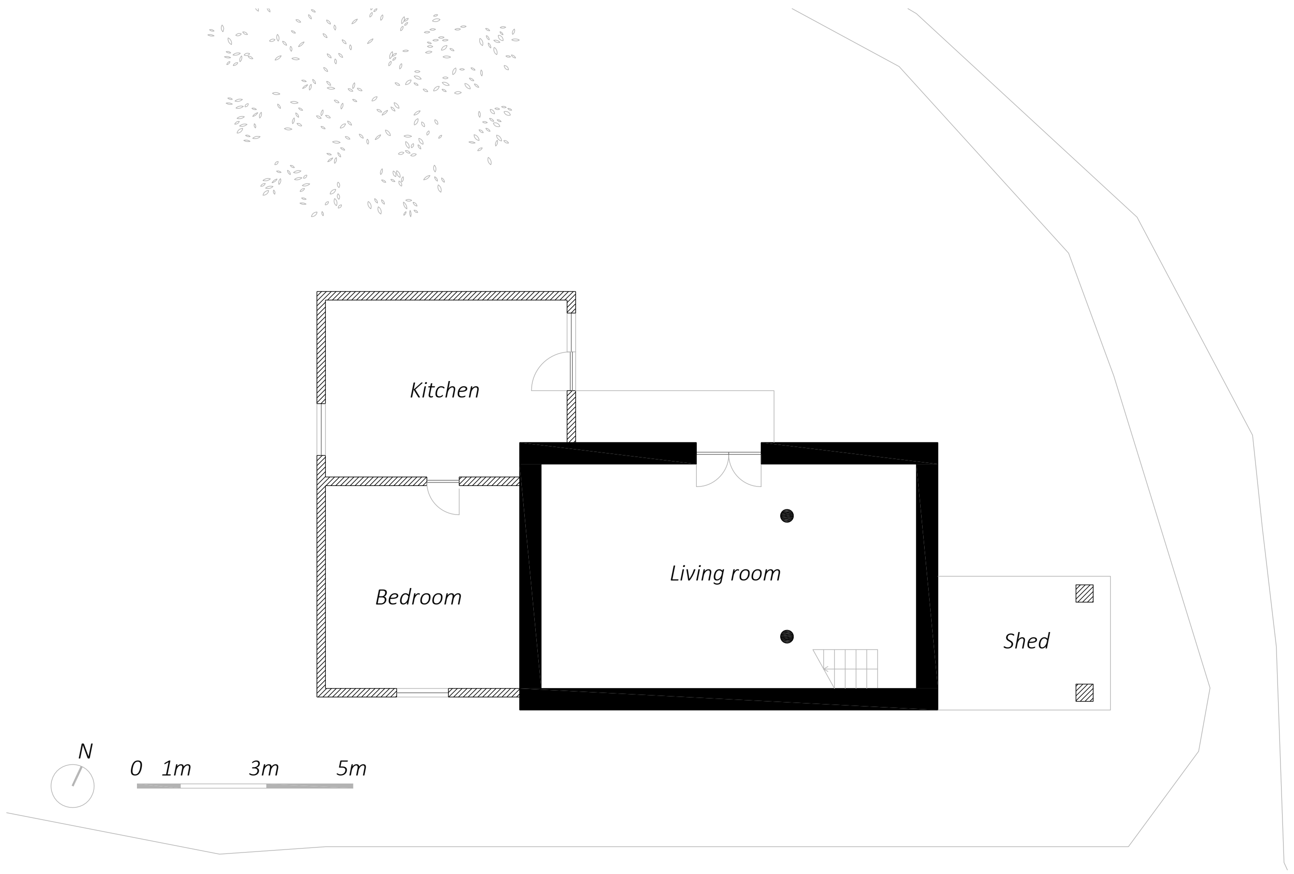


Figure 59. Plan of the exsiting house.

A

B

C

D

Figure 60. Exsiting house. A. house and surroundings B. Front door C. Kitchen D. Storage

4.2 Passive and Active Strategies

4.2.1 Givoni Bioclimatic Chart

We reviewed some literature on bioclimatic design strategies*(Figure 61)*, aiming to draw inspiration during the early design phase through the Givoni bioclimatic chart. We applied the same weather data and created the chart using an open-source web tool by Andrew Marsh.

It is found that approximately 19% (1672 hrs) of the total hours in the year fall within the comfort zone, with the majority leaning towards cold and humid and a very small portion being hot. According to the chart, the key strategies include internal gains, passive solar heating, active solar gain, and conventional heating.

Considering the local technology that may not achieve excellent airtightness and that rammed earth, as a monolithic material, does not have a good u-value, the strategy will mainly focus on thermal mass for heat storage, passive solar heating, and active heating.

4.2.2 Strategies

The strategies cover the utilization of "resources," not only focusing on energy efficiency and thermal comfort. The local lifestyle is also accounted for, ensuring the strategies align closely with the local circumstances.

- Passive Strategy

Based on the weather analysis in Chapter 2, the shoebox study in Chapter 3, and the Givoni bioclimatic chart, maximizing passive solar gain and minimizing external wall/roof areas are crucial to energy saving.

The main activity spaces of the house are the living room and the ground floor bedroom, which serve as the heating zones, while the other rooms act as thermal buffer zones*(Figure 62)*. Southwestern orientation with large windows is utilized to capture solar gain and reduce heating demand. The multi-functional room and guest bedroom on the first-floor act as "solar catchers." The clerestories on the first floor are installed with temperature openers, which is accessible and affordable. During cold days, the clerestories remain closed; during warm days, they automatically open to provide ventilation and cooling*(Figure 63)*.

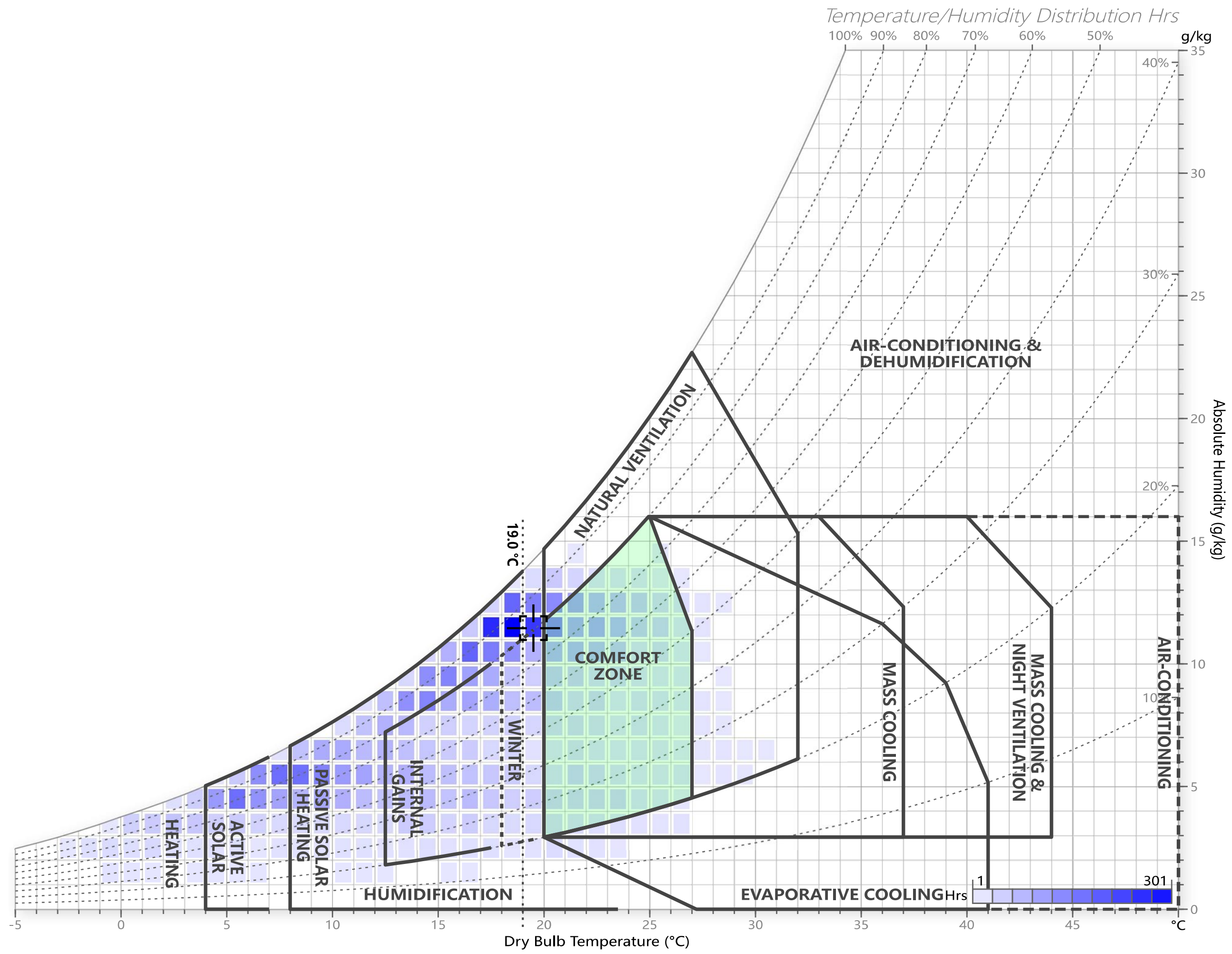


Figure 61. Givoni bioclimatic chart applied to Kunming
web tool by Andrew Marsh, data source: Energy Plus Kunming 567780 CSWD data.

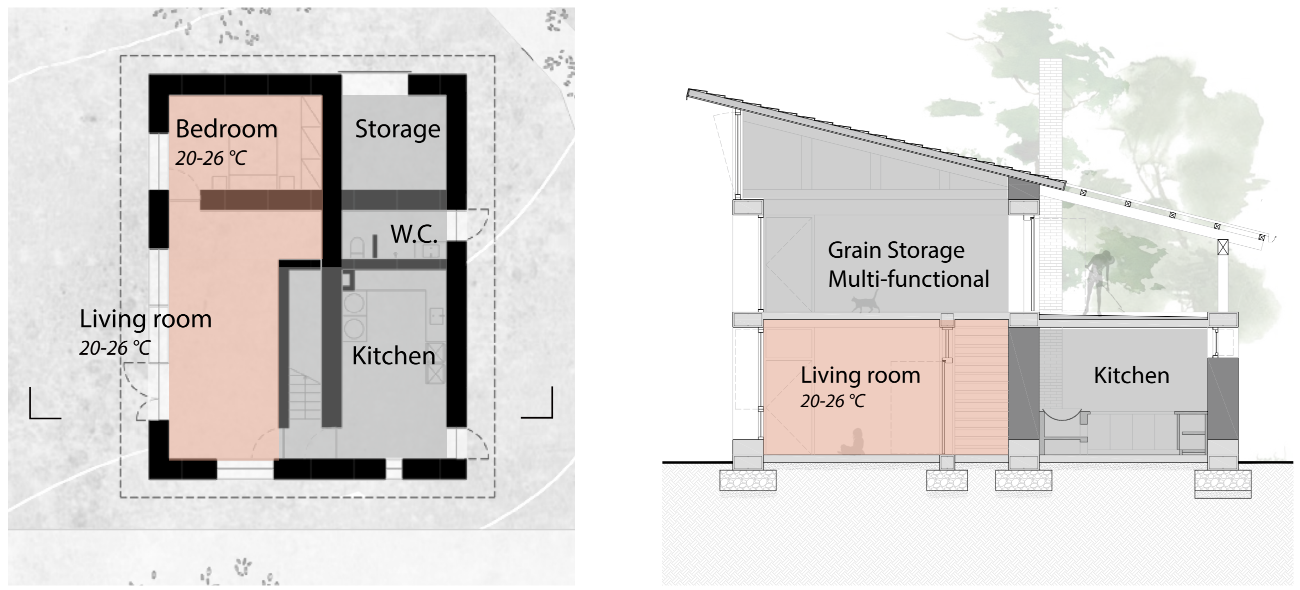


Figure 62. Thermal zoning
The living room and master bedroom is heated, while other rooms act as a thermal buffer zone.

- Active Strategy

In terms of heating technology, we studied the rocket mass heater*(Wisner &Wisner , 2016)*. This affordable heating technology is applied in developing regions. It involves efficient combustion, which reduces smoke and retains heat in thermal mass, significantly improving heating efficiency. At the same time, it can also be used for heating food and making tea during the combustion, which aligns well with local lifestyle*(Figure 64)*.

- Upcycle

Upcycling materials from the existing building comes with several advantages. Firstly, it helps save costs that would otherwise be spent on purchasing new materials. Secondly, it reduces environmental impact by reusing existing resources. Last but not least, due to the poor traffic, using materials available on-site is practical. However, there are challenges in reusing the materials, as they require careful dismantling, storage, design, and construction.

The rammed earth from the original house will be upcycled by adding sand and gravel to achieve a better mixture. The wooden roof beams, rafters, and tiles will be carefully stored and applied in the new construction.

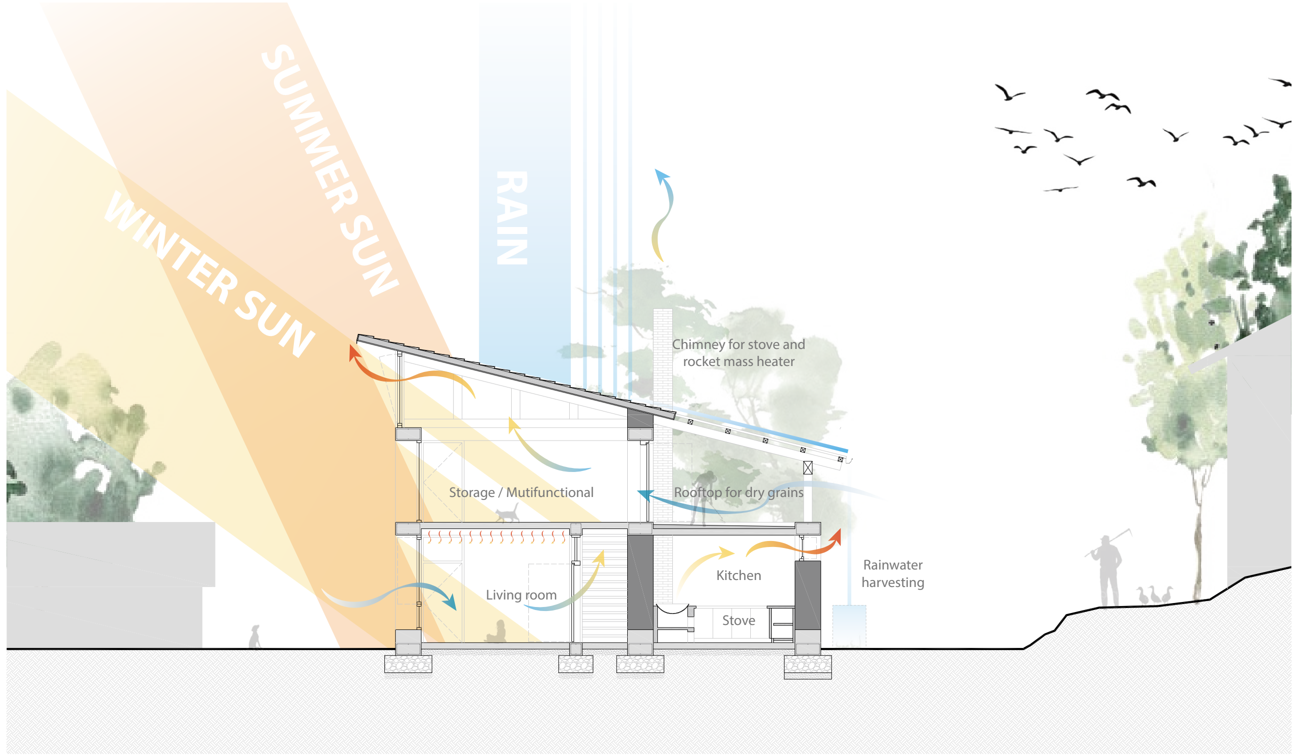


Figure 63. Energy and ventilation concept, section A-A

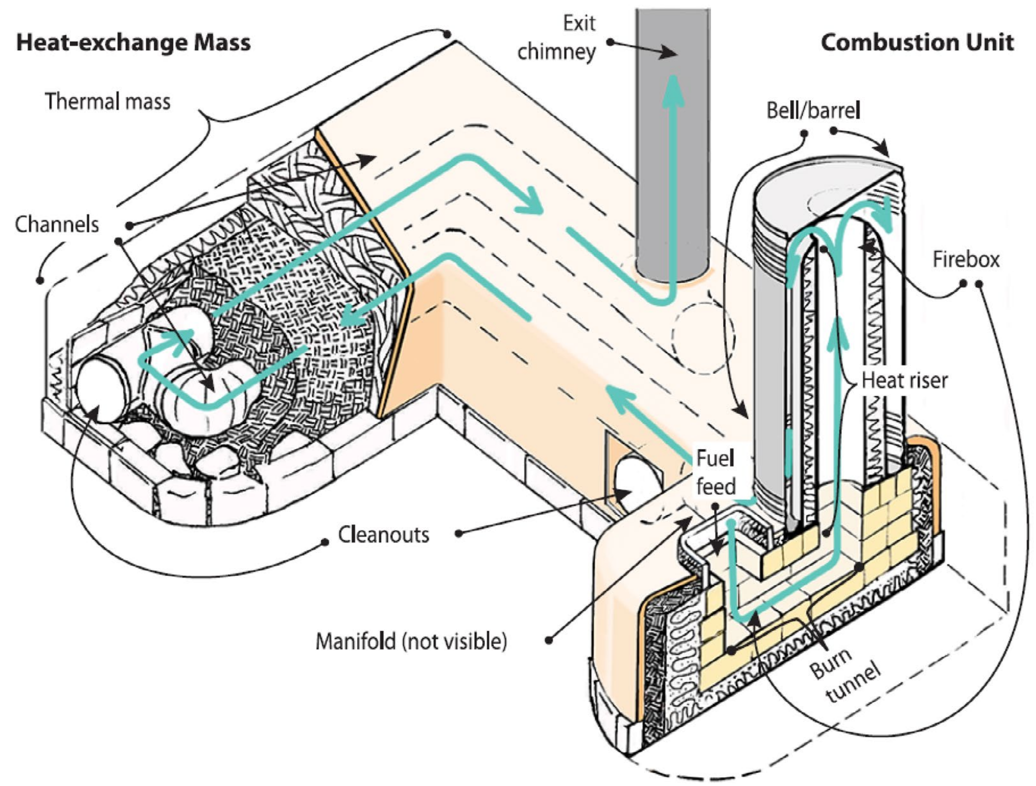


Figure 64. Rocket mass heater components,
Wisner, E., & Wisner, E. (2016). The rocket mass heater builder's guide: Complete step-by-step construction, maintenance and troubleshooting(p. 105). New Society Publishers.

4.3 Building Design

4.3.1 Layout

Based on the previous research, assessments, and analyses, the layout is developed as follows*(Figure 65,66)*:

The two-story house is near the main road and the slope, with a yard retained on the north in site. The living room, master bedroom, guest bedroom, and multi-functional room are oriented to the southwest, with large windows. The kitchen, bathroom, and storage are on the east and north. The flat roof is designed for drying grains, clothing, and other activities.

The exterior wall thickness is 600mm and 300mm for the interior. This is based on our shoebox study*(appendix p.017)*, which showed that increasing wall thickness initially improves insulation, but the effect diminishes as thickness continues to increase. Compared to 300mm, 600mm wall thickness provides shading during the summer, reducing overheating. Additionally, the construction of a 600mm wall does not require excessive labor.

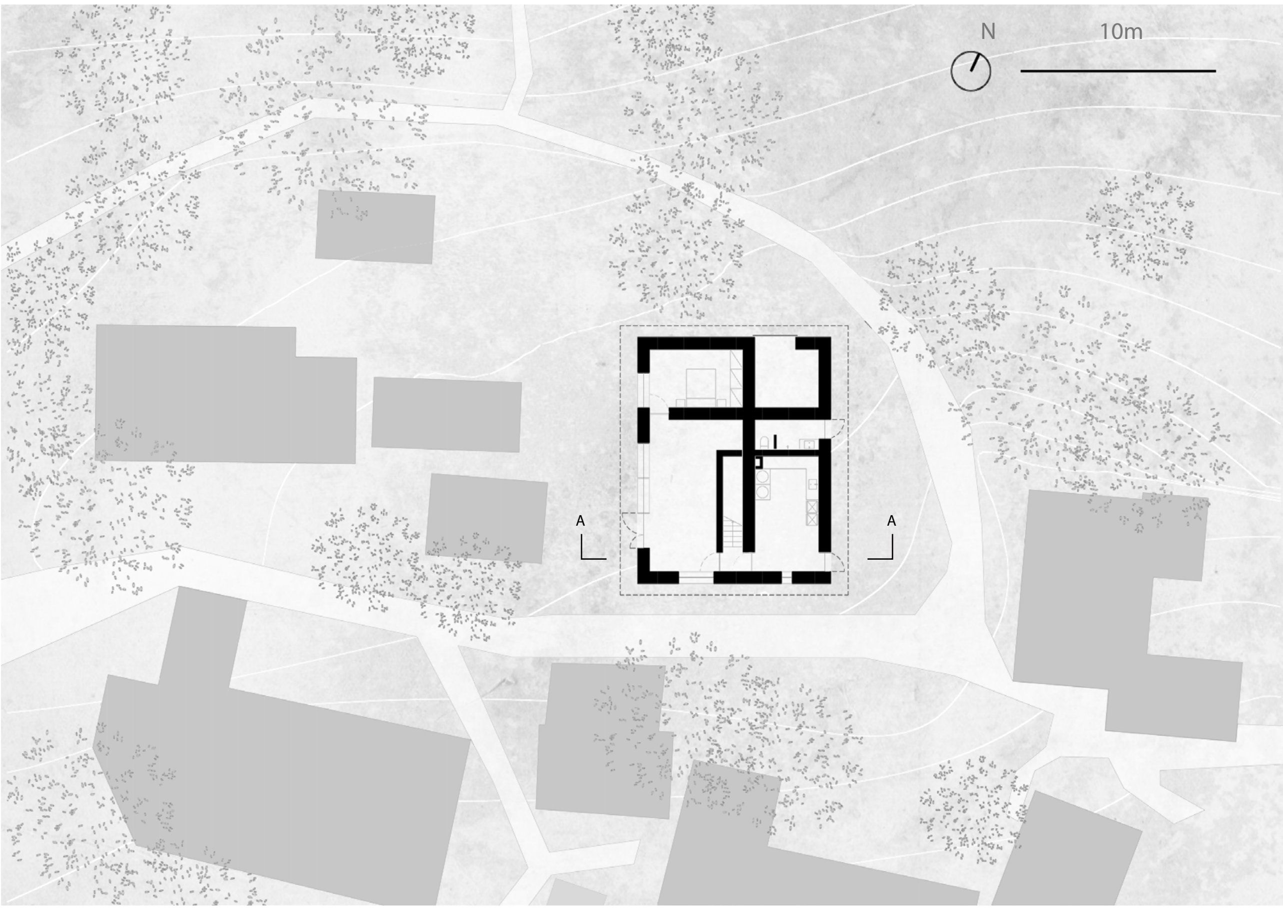


Figure 65. Situation plan of alternative 2.

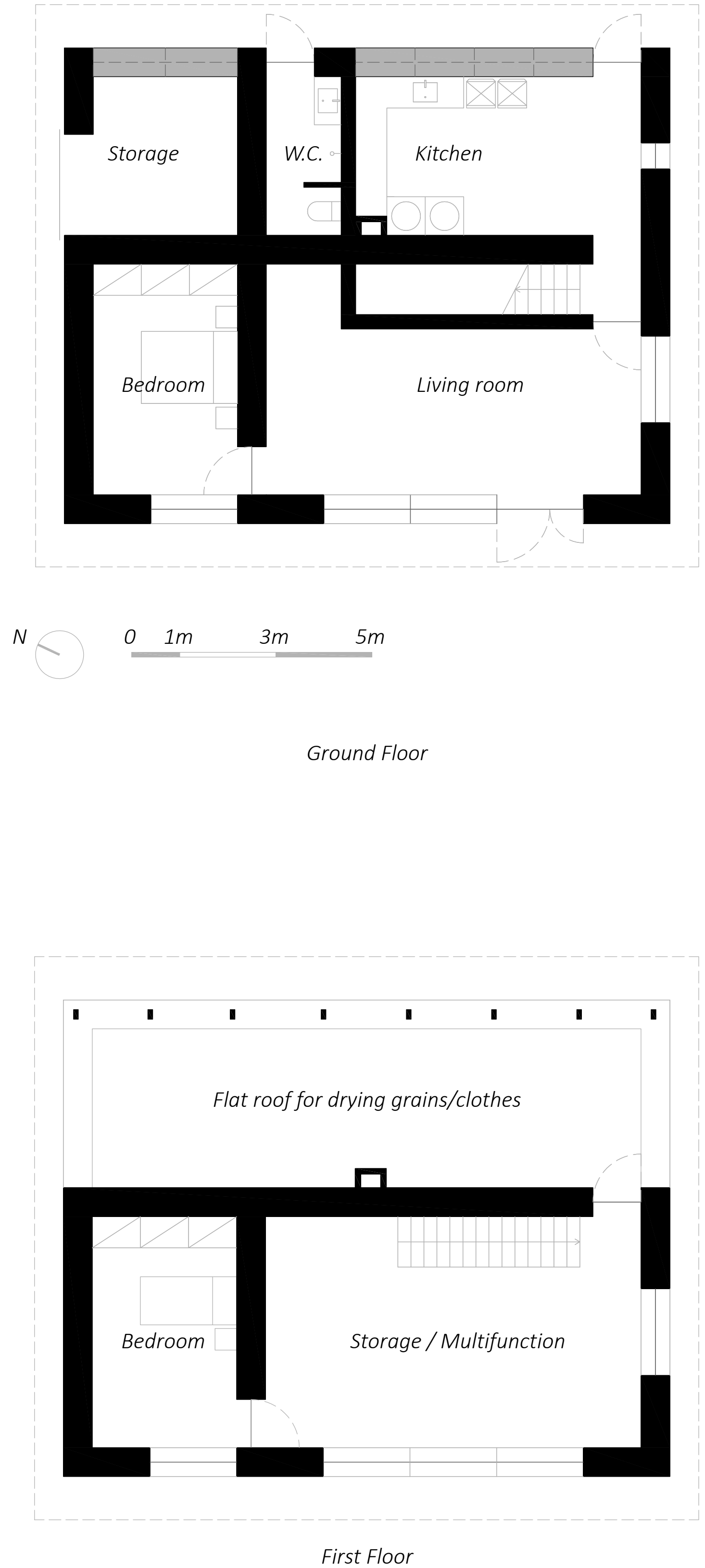


Figure 66. Plans of alternative 2.

4.3.2 Proposals

Based on the analysis above, we have proposed three alternatives *(Figure 68)*. There is no significant difference in the layout and area, but the main distinctions lie in the geometry, roof, and window size. Through these differences, and with the aid of simulations and LCA, the impact of these variations on energy consumption and the carbon footprint can be compared and assessed.

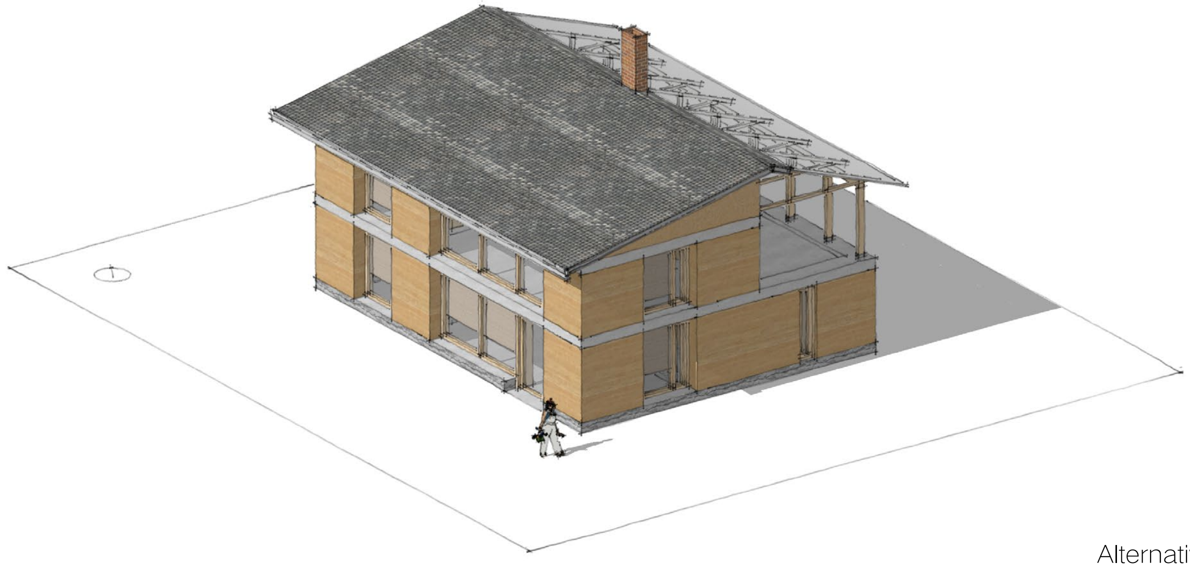
Alternative 1 features a gable roof with no clerestory on the first floor facing southwest. The first-floor rooms are placed above the heating zones on the ground floor(bedroom, living room).

Alternative 2 features a mono-pitch roof with clerestorys on the first floor facing southwest. The first-floor rooms are placed above the heating zones on the ground floor(bedroom, living room).

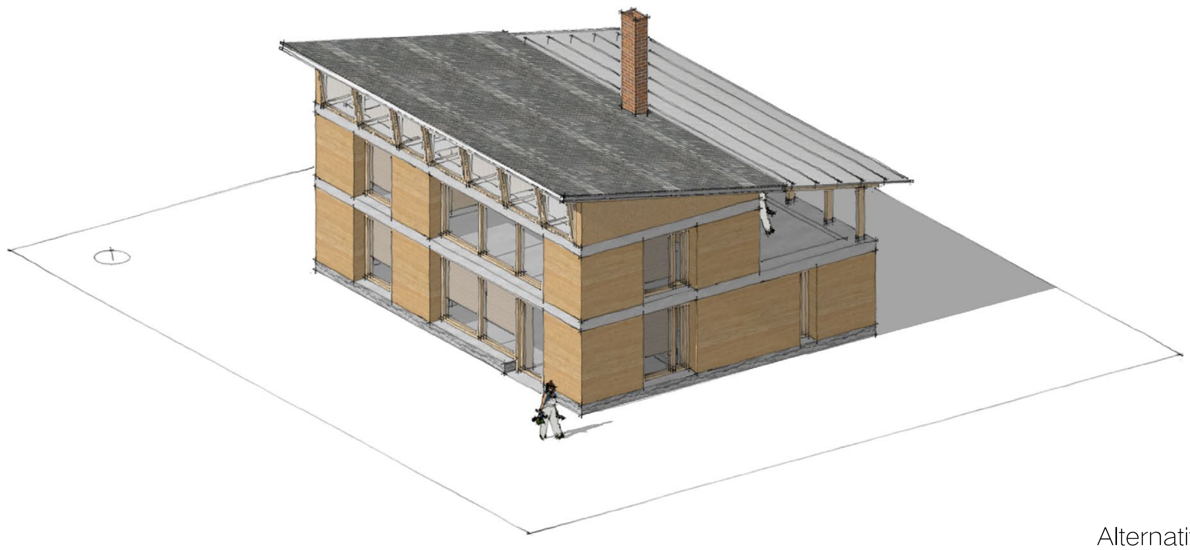
Alternative 3 features a mono-pitch roof with clerestorys on the first floor facing southwest. The first-floor rooms are placed above unheated rooms on the ground floor (storage, bathroom, kitchen). This allows more sunlight to reach the flat roof, which can be used for drying clothes, storing grains, and other activities.

Drawings for these three alternatives are in the *appendix pp.024 , 029*.

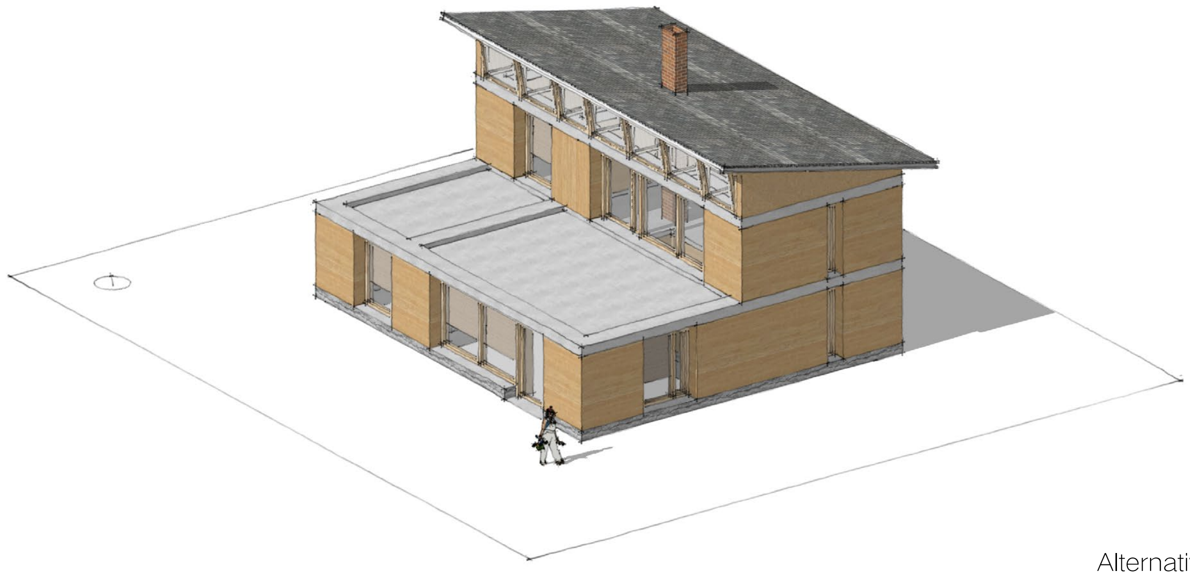
Figure 67. Alternative 2 in the neighborhood



Alternative_1



Alternative_2



Alternative_3

Figure 68. Three earth building design proposals

4.4 Assessment

4.4.1 Energy

Based on local household usage patterns, the energy can be divided into four parts: heating demand, cooling demand, electricity, and hot water. The heating/cooling demand is simulated with software, while electricity and hot water are calculated based on relevant regulations and interviews*(appendix pp.003, 005)*.

According to the chart*(Figure 69)*, the main energy consumption is the heating demand. The other parts are close due to similar and relatively low energy consumption patterns for electricity and hot water. The chart shows that alternative 2 has the lowest energy consumption, while alternative 3 has the highest.

To find the reasons behind this, we introduce an annual energy balance*(Figure 70)*:

Alternative 2 introduces more clerestory, which allows for more solar gain, thus reducing heating demand. This is evident in the "window and solar" category of the graph, where the bar is positioned above the x-axis, indicating that the solar gain from windows is greater than the heat loss.

The higher heating demand in Alternative 3 is due to envelope heat loss. The roof of the heating zone belongs to the external envelope. Since there is no accessible insulation material(EPS, XPS, etc.) for flat roofs, people do not insulate them. However, in Alternatives 1 and 2, the first-floor bedroom and multi-functional room act as a buffer zone, reducing the heat loss in the heating zone.

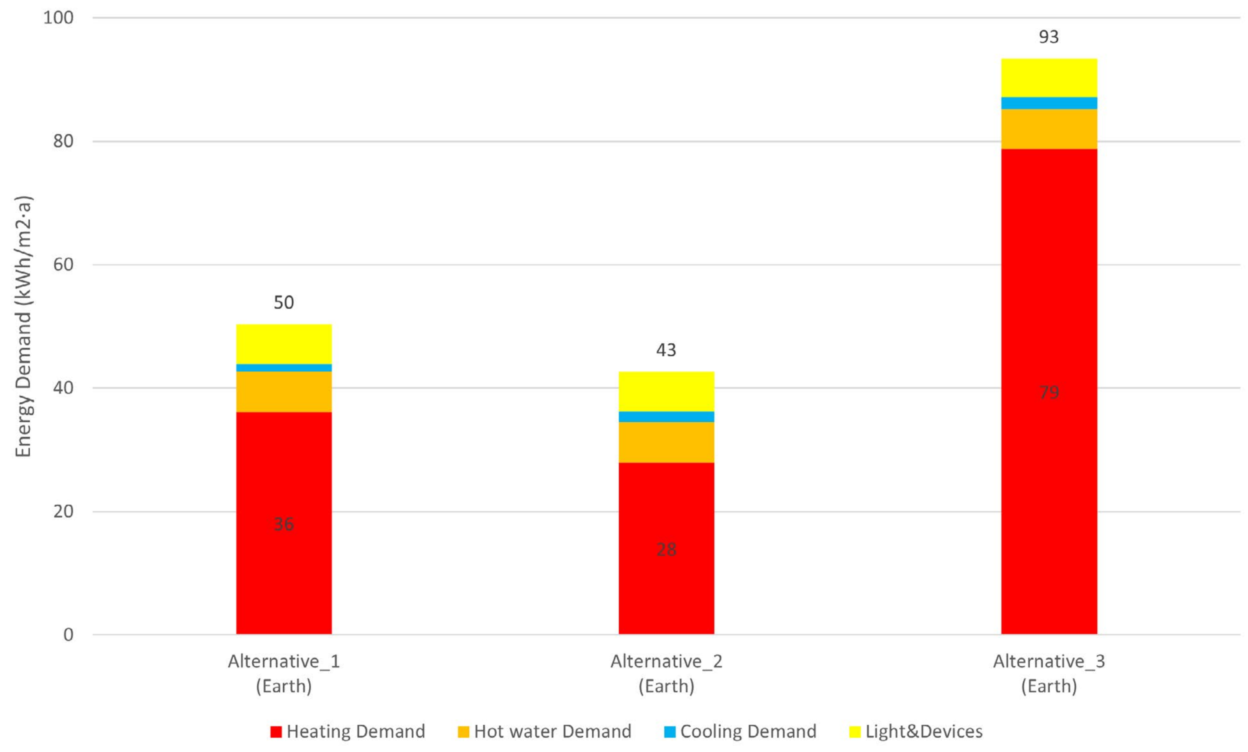


Figure 69. Energy demand of the 3 three earth building designs

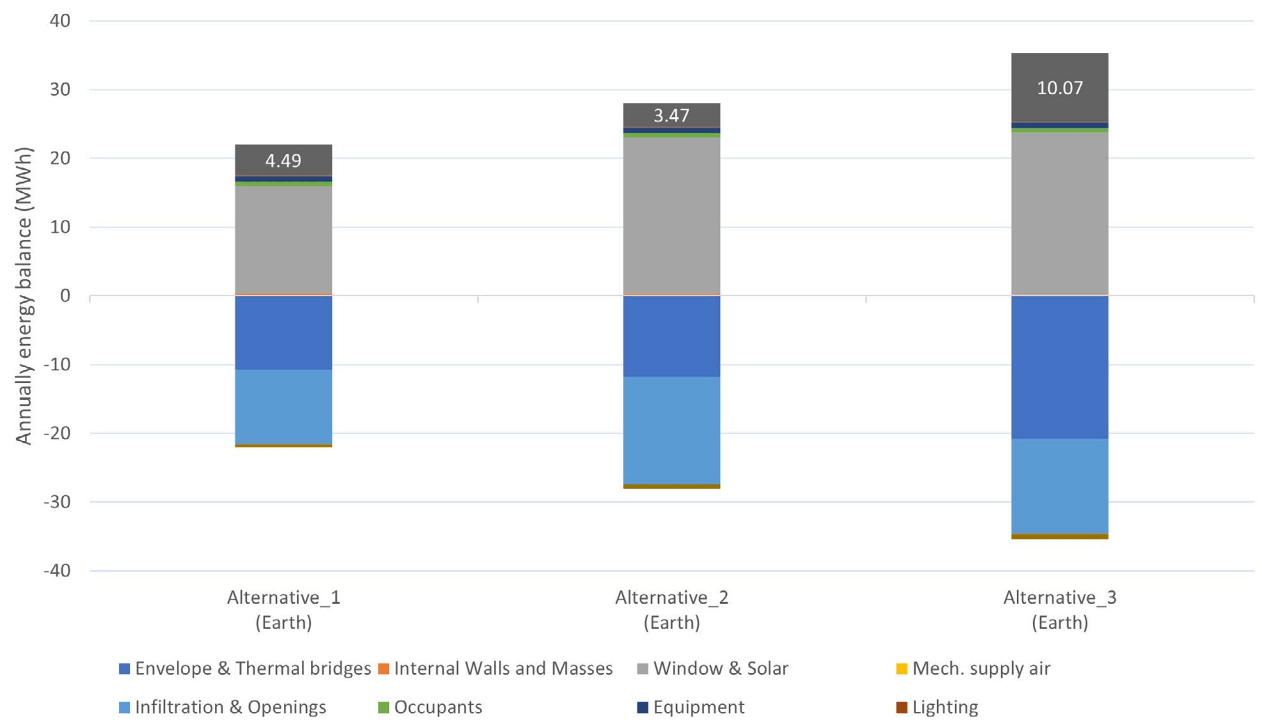


Figure 70. Annually energy balance of three earth building designs

4.4.2 LCA

- Goal and Scope

The goal is to compare the carbon footprint of 3 earth house alternatives and 1 brick house as the baseline*(Liu, et al. 2017)* and propose optimizations. The functional unit, environment impact indicator, system boundary, and tools are the same as the shoebox LCA study in Chapter 3.

- Result and Discussion

The chart*(Figure 71)* shows in a 50-year study period, considering A1-C4 and GWP as the indicator, the brick house is 12.90 CO_2 e/m2・a, and the three alternatives are 9.29 CO_2 e/m^2・a, 9.51 CO_2 e/m^2・a, 7.89 CO_2 e/m^2・a.

The major difference between the brick house and earth houses lies in the product stage(A1-A3). The brick house has a significantly higher value than the 3 rammed earth houses. Among the 3 alternatives, alternative 3 has a lower value than the other two and the difference lies in B4(replacement). Those differences are closely associated with the material. To look deep into the reasons, a further breakdown analysis of building components for A1-A3, B4, and C3-C4 is done*(Figure 72)*.

In the comparison between the brick house and earth houses, the walls and slope roof have a higher impact. This can be attributed to higher carbon emissions from fired clay bricks with ceramic tiles compared to rammed earth. Additionally, the concrete roof of the brick house contributes to higher emissions compared to the wooden sloped roof of the earthen houses. Notably, due to the passive solar gain strategy adopted in earthen house design, the window area in earthen houses is larger than that in brick building, leading to a moderate increase in carbon emissions.

Regarding the comparison among earthen houses, alternative 3 has lower emissions than alternative 1 and alternative 2. This can be attributed to the absence of polycarbonate shelter. In alternative 1 and alternative 2, polycarbonate accounts for 31% and 29%, respectively. It can be seen as a potential for further design optimization.

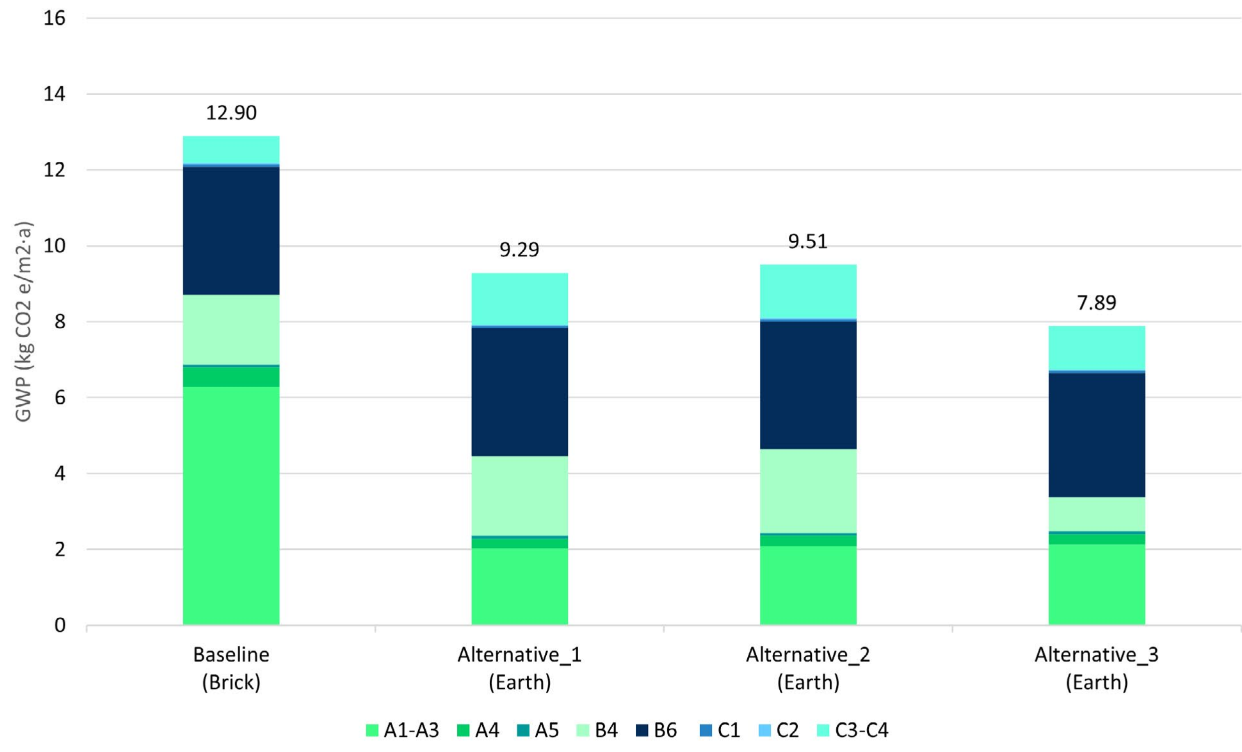


Figure 71. GWP for one brick house and three earth houses, from A1-C4

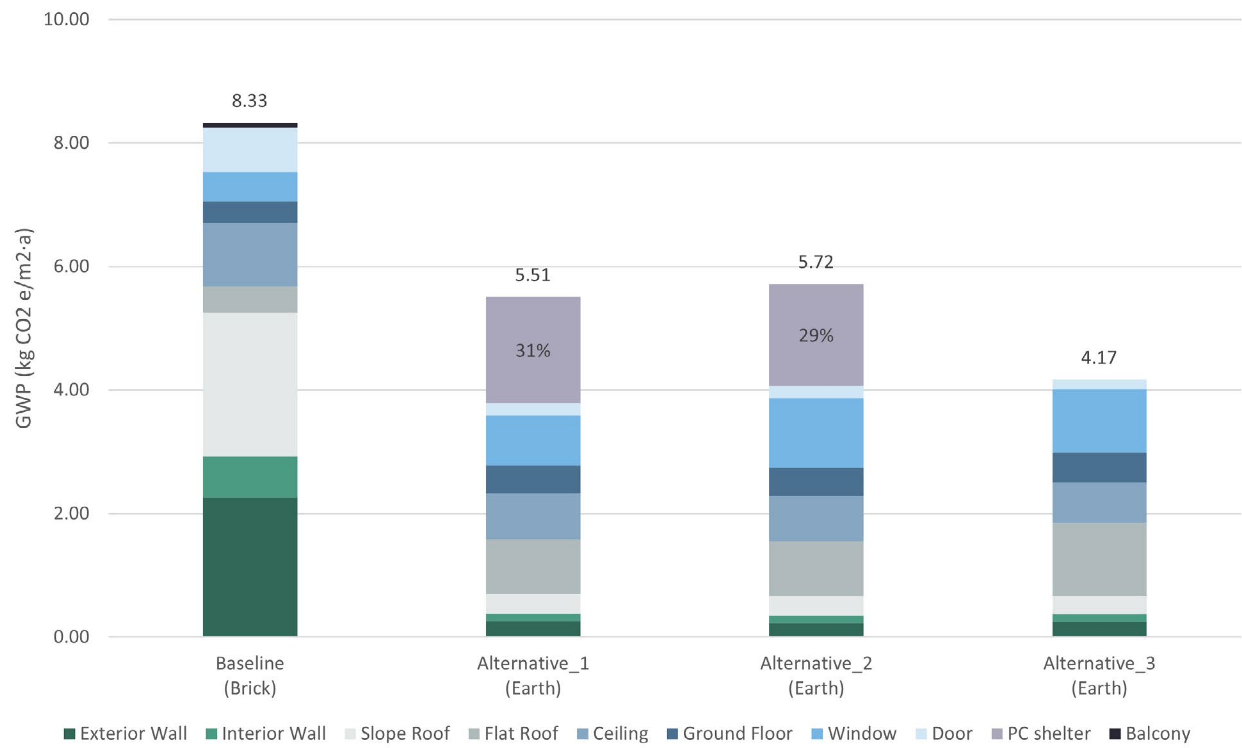


Figure 72. GWP of building components, for one brick house and three earth houses, from A1-C4

- Optimization

The brick house is the baseline, and alternative 2 is the direction, aiming to reduce GWP. We proposed a series of optimization steps*(Figure 73)*:

1. Setting the most common brick house as the baseline.

2. Taking rammed earth as the primary material to replace the fire clay brick.

3. Minimize the quantity of polycarbonate while ensuring sufficient sunlight penetrates the shelter for drying the grains.

4. Reuse the material from the demolished old house, such as the wood and tiles.

5. Minimize the concrete, such as the flat roof and slabs. In this step, the wood structure replaces the concrete ones, despite the unaffordability and inaccessibility of structural timber in this context, due to the strict law of deforestation in China.

6. Optimized the CO_2 intensity of the power grid. According to the IEA report *(IEA,2021)*, China's overall power grid's CO_2 intensity will decrease by 21% by 2035. This data is applied in the step.

- Discussion

In the optimization process, two issues should be noticed.

A. In step 5, where wood replaces concrete, a substantial reduction occurs in the product stage(A1-A3), reaching -0.42 kg CO_2 e/mv・a, while the C3-C4 significantly increases. Wood can be taken as a carbon sink, resulting the negative carbon emission in the product stage, which offsets the emission of other materials. However, in the C3-C4, wood is considered combusted and the CO2 is back in the atmosphere. The CO2 emission of C3-C4 in the step is 2.4 kg CO_2 e/m2・a, taking up 82% in the stage and 29% in all stages. Therefore, careful consideration is needed regarding waste processing and disposal when using wood as a material. Reusing and recycling can delay the release of CO_2.

B. In step 4, when using recycled materials instead of the new product, the reduction in the lifecycle is limited, only amounting to 0.02 kg CO_2 e/m^2・a. However, it triggers the shift in A1-A3 and C3-C4. The reason is that the recycled material is wood, and the wood itself doesn' t release much CO2 in its entire lifecycle, but it will change the distribution of the product and end-of-life stage. Hence, using recycled wood to replace the newly used wood does not help to reduce the CO_2 significantly in the system boundary of a new house. However, it helps reduce or delay the CO_2 emission for the demolished one, which should be evaluated holistically.

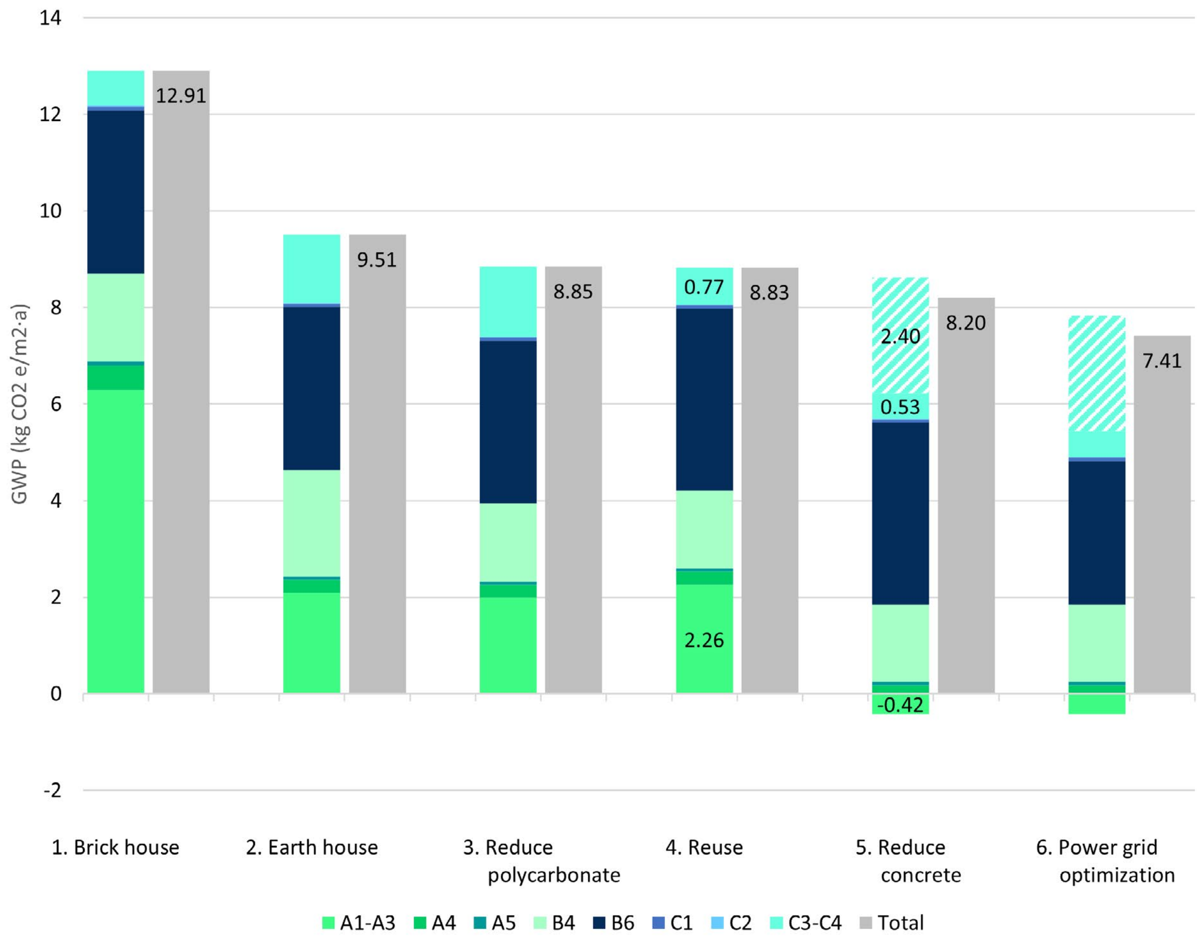


Figure 73. A step-by-step cut-down optimization for the housing in rural Yunnan.

Figure 74. The optimized design proposal, based on alternative 2

4.4.3 Daylight

Based on alternative 2, Daylight is simulated at the building level, ensuring that the primary rooms receive adequate natural lighting. The daylight factors for the bedroom, living room, and multifunctional room exceeded 2%, while the kitchen is approximately 1.3%, meeting the basic lighting requirements.

- Daylight Factor of the Rooms

Ground floor

Living room: 5.5% Master bedroom: 2.1% Kitchen:1.3%

First floor

Multi-functional room: 7.4% Guest bedroom: 4.2%

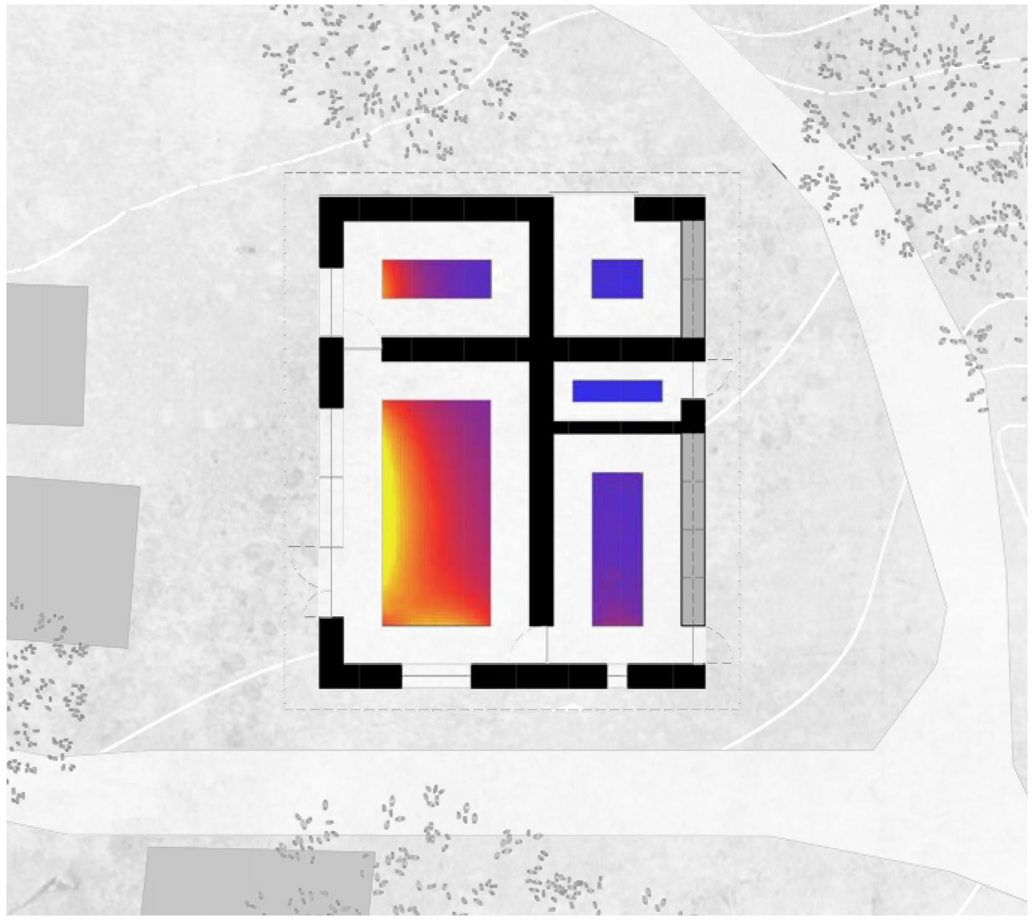


Figure 75. Daylight factor and heatmap one the ground floor, based on alternative 2

Chapter 5
Limitation and Discussion

In this chapter, we will discuss the limitations of the research, explaining the reasons behind these limitations, and proposing future research directions and improvement.

The thesis aims to research the design of a climate-adaptive rammed earth house in rural Yunnan through a data-driven approach. The intention is to build a framework to reveal the opportunities and challenges of self-built housing in rural Yunnan in the context of global energy crises, climate change, and housing shortages. However, within the limited time, the ambitions only allow us to research some aspects thoroughly. Several major limitations of the thesis are listed:

Timeliness of Weather Data:

The publication of the weather data traces back to 2005. Due to limited resources, we were unable to access more up-to-date data. Climate change has been influencing regions globally over the last 20 years, and we cannot tell how the climate changes in Yunnan may impact the results of our simulations. Future research could be taken to investigate the impact of climate change on energy consumption and thermal comfort.

Sample Size of Simulation:

We had six groups of variables and 972 cases for energy and daylight simulation, while each variable had only 3-4 values. Whether such values sufficiently represent their respective impacts on the dependent variable is uncertain. However, the methods taken in this study, such as simulation, data collection, and standardized regression, appear suitable for research using machine learning, with more cases.

Applicability of Life Cycle Inventory:

The data related to materials(A1-A3, B2, B6, C3-C4) is sourced from the ÖKOBAUDAT database. It is due to our inability to find a comprehensive, transparent, and accessible LCA database in Yunnan or China. Differences in energy shares and manufacturing processes between Germany and China may introduce biases for those modules. Finding more relevant data or correcting these biases could be a topic in the future.

Circular Economy:

In the LCA section, we touched on research and application in modules A, B, and C. Still, less in module D. The scarcity and reuse of materials are common challenges rural Yunnan and the global community face. Investigating module D's qualitative and quantitative impacts on the entire life cycle is an area for further in-depth exploration.

Although the delimitation of our research primarily focused on technology and environmental impacts, as a project aimed at assisting the vulnerable with specific materials, many other directions could be explored.

Sustainability in terms of the economy and society was less extensively research, and these aspects may be crucial, such as life cycle cost and participatory design/construction in the context. The different environmental impacts between stabilized and unstabilized rammed earth are not discussed. Sand, as an indispensable aggregate, becoming a scarce material in Yunnan and globally, needs to be studied in depth.

Due to the time limit and scope of the thesis, we could not delve into these topics, but these topics could be explored in future research.

References and Appendix

Reference

Journal Article / Book / Report

1. Chang Recavarren, G., Fiori, C. M., & Schexnayder, C. (2013). Rammed earth: Construction lessons from experience. *Practice Periodical on Structural Design and Construction*, *18*(3), 149-154.

2. Feng, L., & Hua, W. (2022, 12 15). 西风季风协同作用对云南春末 5 月降水的影响 . 高原山地气象研究 , 04, 42-48. CNKI:SUN:SCCX.0.2022-04-006.

3. Fernandes, J., Peixoto, M., Mateus, R., & Gervásio, H. (2019). Life cycle analysis of environmental impacts of earthen materials in the Portuguese context: Rammed earth and compressed earth blocks. Journal of Cleaner Production, 241, 118286. doi:10.1016/j.jclepro.2019.118286

4. Gupta, P., Cupkova, D., Ben-Alon, L., & Hameen, E. C. (2020). EVALUATION OF RAMMED EARTH ASSEMBLIES AS THERMAL MASS THROUGH WHOLE-BUILDING SIMULATION. In ASHRAE Topical Conference Proceedings (pp. 618-625). American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc..

5. Hopkins, R. G. (1963) Architectural Physics: Lighting, London: Her Majesty's Stationery Office.

6. IEA (2021), The Role of China's ETS in Power Sector Decarbonisation, IEA, Paris, p.43 https://www.iea.org/reports/the-role-of-chinas-ets-in-power-sector-decarbonisation, License: CC BY 4.0

7. Li, B., & He, F. (2016). Time-Space Distribution Features of Annual Precipitation in Kunming. Journal of Water Resources Research 水资源研究 , 5(2), 182-189.

8. Liu, Y., Wang, J., Ren, J., Xiao, Q., & Zhao, J. (2017). A preliminary study on the climate adaptive design of green rural houses in west China. Procedia engineering, 180, 735-740.

9. Miccoli, L., Müller, U., & Fontana, P. (2014). Mechanical behaviour of earthen materials: A comparison between earth block masonry, rammed earth and cob. Construction and building materials, 61, 327-339.

10. Mu, J. (2014). 新型夯土绿色民居 : 建造技术指导图册 . 中国建筑工业出版社 .

11. Nagler, F. (Ed.). (2021). Einfach Bauen: Ein Leitfaden. Birkhäuser.

12. Nagler, F., Jarmer, T., Niemann, A., Auer, T., Franke, L., Winter, S., ... & Kaufmann, H. (2018). Einfach Bauen. Lehrstuhl für Entwerfen und Konstruieren.

13. Potrc Obrecht, T., Kunič, R., Jordan, S., & Legat, A. (09 2019). Roles of the reference service life (RSL) of buildings and the RSL of building components in the environmental impacts of buildings. IOP Conference Series: Earth and Environmental Science, 323, 012146. doi:10.1088/1755-1315/323/1/012146

14. Ritchie, H., Roser, M., & Rosado, P. (2020, August). CO2 and Greenhouse Gas Emissions. Our World in Data. Retrieved May 16, 2023, from https://ourworldindata.org/co2-and-greenhouse-gas-emissions

15. Roser, M. (2021, March 15). How much economic growth is necessary to reduce global poverty substantially? Our World in Data. Retrieved May 16, 2023, from https://ourworldindata.org/poverty-minimum-growth-needed

16. Routledge, S. (2012, October 25). Rammed earth Construction. DAB810 Fictional Architecture. Retrieved May 16, 2023, from http://dab810fictionalarchitecture.blogspot.com/2012/10/rammed-earth-construction.html

17. Schildkamp, M. (2009). Suitability of Local Soil for Cost Saving Construction Techniques with test results of soil samples from Kaski District in Nepal (v.2 ed.). Architect and Founder of Smart Shelter Foundation. https://www.smartshelterfoundation.org/wp-content/uploads/2014/07/SSF-soil-testing-manual.pdf

18. Trabucco, D., Wood, A., Vassart, O., & Popa, N. (2016). A whole LCA of the sustainable aspects of structural systems in tall buildings. International Journal of High-Rise Buildings, 5(2), 71-86.

19. Wang, Y., Wang, M., Liu, K., Pan, W., & Yang, X. (2017). Shaking table tests on seismic retrofitting of rammed-earth structures. Bulletin of Earthquake Engineering, 15, 1037-1055.

20. Wisner, E., & Wisner, E. (2016). The rocket mass heater builder's guide: Complete step-by-step construction, maintenance and troubleshooting(p. 105). New Society Publishers.

21. Yang, D., & Zhu, I. (2009). 云南民居 . 中国建筑工业出版社 .

22. Menard, S. (2004), "Standardized regression coefficients", in Lewis-Beck, M.S.; Bryman, A.; Liao, T.F. (eds.), The Sage Encyclopedia of Social Science Research Methods, Thousand Oaks, CA, USA: Sage Publications, pp. 1069–1070,

Web Page

1. (n.d.). Einfach bauen | Technische Universität München. Retrieved May 16, 2023, from https://www.einfach-bauen.net/#einfach-bauen

2. 哈尼族蘑菇房：这个房子能吃吗？ _ 火塘 . (2020, April 6). Sohu. Retrieved March 17, 2023, from https://www.sohu.com/a/385876387_559116

3. 昆明小水井、白水塘村研究 | 中国空间研究计划 18 – 有方 . (2016, July 30). Archiposition. Retrieved March 17, 2023, from https://www.archiposition.com/items/20180525102717

4. Climate of Yunnan. (2022, November 2). People's gonvernment of Yunnan Province. Retrieved July 8, 2023, from https://www.yn.gov.cn/yngk/gk/201904/t20190403_96257.html

5. 营造 | 中式营造带您读懂 100 个传统建筑基因 - 土掌房 _ 民居 . (2020, October 31). Sohu. Retrieved March 17, 2023, from https://www.sohu.com/a/428507031_755852

6. Auroville Earth Institute. (2015). Auroville Earth Institute. Retrieved March 17, 2023, from https://www.earth-auroville.com/modern_rammed_earth_en.php

7. Boltshauser, R. (2008). Haus Rauch • Boltshauser Architekten AG. Boltshauser Architekten. Retrieved March 7, 2023, from https://boltshauser.info/projekt/haus-rauch/

8. Chhabra, J. (n.d.). Shoebox model. Cove.tool Help Center. Retrieved May 3, 2023, from https://help.covetool.com/en/articles/5790051-shoebox-model

9. Data publish platform. (n.d.). People's government of Yunnan province. Retrieved March 9, 2023, from https://www.yn.gov.cn/sjfb/

10. Discover how levels of daylight are calculated and measured. (n.d.). VELUX Group. Retrieved August 3, 2023, from https://www.velux.com/what-we-do/research-and-knowledge/deic-basic-book/daylight/daylight-calculations-and-measurements

11. Downton, P. (n.d.). Rammed earth | YourHome. | YourHome. Retrieved July 15, 2023, from https://www.yourhome.gov.au/materials/rammed-earth

12. Introduction to Whole Building Life Cycle Assessment: The Basics. (n.d.). WoodWorks. Retrieved August 28, 2023, from https://www.woodworks.org/resources/introduction-to-whole-building-life-cycle-assessment-the-basics/

13. Kong, B. (2016, July 6). 走近土掌房 | 文章 . 中国国家地理网 . Retrieved May 16, 2023, from http://www.dili360.com/article/p577cb4cf31f1d91.htm

14. Statisics 2020. (2021, February 1). Bureau of Statistics of Yunnan Province. Retrieved May 17, 2023, from http://stats.yn.gov.cn/tjsj/jjxx/202102/t20210201_1044039.html

15. Technical. (n.d.). Rammed Earth Enterprises. Retrieved August 28, 2023, from https://www.rammedearthenterprises.com.au/technical/

16. The Chinese University of Hong Kong & Kunming University of Science and Technology (2022). Post-Earthquake Reconstruction Project in Guangming Village / The Chinese University of Hong Kong & Kunming University of Science and Technology. ArchDaily. Accessed 27 Aug 2023. https://www.archdaily.com/985694/community-hall-of-dahei-new-village-one-university-one-village ISSN 0719-8884

17. Wohnhaus Rauch - Boltshauser Architekten. (n.d.). Arquitectura Viva. Retrieved May 10, 2023, from https://arquitecturaviva.com/works/wohnhaus-rauch

18. ÖKOBAUDAT (2022), German Federal Ministry for Housing, Urban Development and Building, https://oekobaudat.de/OEKOBAU.DAT/datasetdetail/process.xhtml?uuid=21500862-0dac-4cd2-b5bd-f6cb8d5b121b&version=20.23.050&stock=OBD_2023_I&lang=en, Acessed 25 Jul 2020

Appendix

Glossary

Term	Definition
Building Performance Simulation	Building performance simulation (BPS) is the replication of aspects of building performance using a computer-based, mathematical model created on the basis of fundamental physical principles and engineering practice.
PMV/PPD	PMV(predicted mean vote) is an index that aims to predict the mean value of votes of a group of occupants on a seven-point thermal sensation scale(from -3 to +3). PPD(predicted percentage of dissatisfaction), is an index that establishes a quantitative prediction of the percentage of thermally dissatisfied occupants. Once the PMV is calculated, PPD can be determined. PPD essentially gives the percentage of people predicted to experience local discomfort.
CO2 concentration	In indoor air, the concentration of CO_2 is used as an indicator of the level of air confinement since it is dependent on human occupation and air renewal in the building or room. It is measured in ppm (parts per million). Indoor CO_2 levels are generally higher than outdoor levels due to CO_2 exhaled by occupants.
Daylight factor	Daylight factor (DF) is a daylight availability metric that expresses as a percentage the amount of daylight available inside a room (on a work plane) compared to the amount of unobstructed daylight available outside under overcast sky conditions (Hopkins,1963).
Regression analysis	In statistical modeling, regression analysis is a set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables.
Linear regression	Linear regression analysis is used to predict the value of a variable based on the value of another variable. In linear regression, the relationships are modeled using linear predictor functions whose unknown model parameters are estimated from the data.
Standardized coefficient	Standardization of the coefficient is usually done to answer the question of which of the independent variables has a greater effect on the dependent variable in a multiple regression analysis where the variables are measured in different units of measurement.
LCA	Life cycle assessment is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service.

Yunnan Seismic Design Codes & China Seismic Intensity Scale

Yunnan, situated in the southwestern part of China, is prone to earthquakes due to its position on the eastern edge of the Qinghai-Tibet Plateau. The convergence of the Indian Plate and the Eurasian Plate further contributes to the region's seismic activity.

China's seismic design regulations emphasize the principle of withstanding minor earthquakes, being repairable after moderate ones, and resisting collapse during major ones. These principles lead to specific standards for different regions, as depicted in, which illustrates seismic design criteria for Yunnan Province according to national standards. To simplify the comprehension of the data presented in the illustration, we have created an abridged chart based on the code.

The selected site, Dashuijing village, falls within a seismic precautionary intensity of 7 and is subject to a design basic acceleration of ground motion at 0.15g.

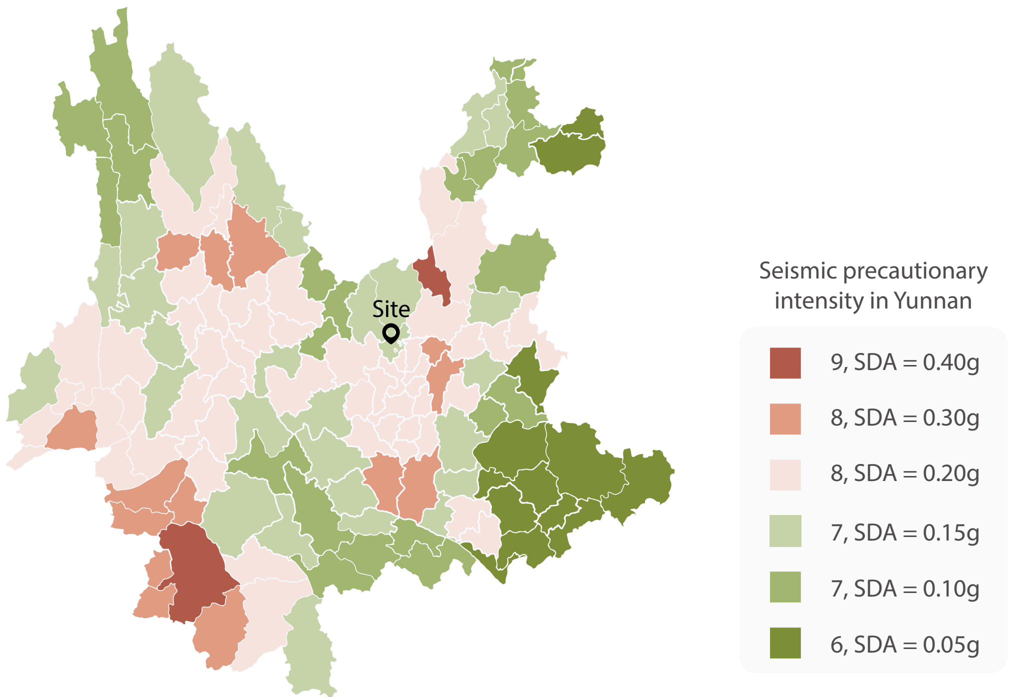


Figure. Seismic precautionary intensity in Yunnan according to local codes.
data source: GB 50011 2010(2016)

***Liedu* scale**[2]

Liedu (Intensity)	Senses by people on the ground	Degree of building damage: Damages	Degree of building damage: Mean damage index	Other damages	Horizontal motion on the ground: Peak acceleration m/s²	Horizontal motion on the ground: Peak speed m/s
I	Insensible					
II	Sensible by very few still indoor people					
III	Sensible by a few still indoor people	Slight rattle of doors and windows		Slight swing of suspended objects		
IV	Sensible by most people indoors, a few people outdoors; a few wake up from sleep	Rattle of doors and windows		Obvious swing of suspended objects; vessels rattle		
V	Commonly sensible by people indoors, sensible by most people outdoors; most wake up from sleep	Noise from vibration of doors, windows, and building frames; falling of dusts, small cracks in plasters, falling of some roof tiles, bricks falling from a few roof-top chimneys		Rocking or flipping of unstable objects	0.31 (0.22 - 0.44)	0.03 (0.02 - 0.04)
VI	Most unable to stand stably, a few scared to running outdoors	Damages - Cracks in the walls, falling of roof tiles, some roof-top chimneys crack or fall apart	0 - 0.10	Cracks in river banks and soft soil; occasional burst of sand and water from saturated sand layers; cracks on some standalone chimneys	0.63 (0.45 - 0.89)	0.06 (0.05 - 0.09)
VII	Majority scared to running outdoors, sensible by bicycle riders and people in moving motor vehicles	Slight destruction - localized destruction, crack, may continue to be used with small repairs or without repair	0.11 - 0.30	Collapse of river banks; frequent burst of sand and water from saturated sand layers; many cracks in soft soils; moderate destruction of most standalone chimneys	1.25 (0.90 - 1.77)	0.13 (0.10 - 0.18)
VIII	Most swing about, difficult to walk	Moderate destruction - structural destruction occurs, continued usage requires repair	0.31 - 0.50	Cracks appear in hard dry soils; severe destruction of most standalone chimneys; tree tops break; death of people and cattle caused by building destruction	2.50 (1.78 - 3.53)	0.25 (0.19 - 0.35)
IX	Moving people fall	Severe destruction - severe structural destruction, localized collapse, difficult to repair	0.51 - 0.70	Many cracks in hard dry soils; possible cracks and dislocations in bedrock; frequent landslides and collapses; collapse of many standalone chimneys	5.00 (3.54 - 7.07)	0.50 (0.36 - 0.71)
X	Bicycle riders may fall; people in unstable state may fall away; sense of being thrown up	Most collapse	0.71 - 0.90	Cracks in bedrock and earthquake fractures; destruction of bridge arches founded in bedrock; foundation damage or collapse of most standalone chimneys	10.00 (7.08 - 14.14)	1.00 (0.72 - 1.41)
XI		Widespread collapse	0.91 - 1.00	Earthquake fractures extend a long way; many bedrock cracks and landslides		
XII				Drastic change in landscape, mountains, and rivers		

Notes about qualifiers: "very few" - <10%; "few" - 10% - 50%; "most" - 50% - 70%; "majority" - 70% - 90%; "commonly" - >90%.

Figure. China Seismic Intensity Scale, datasource: GB/T 17742-2020

Interview with NGO Staffs

Interviewees:

Jie Li, former manager of Habitat for Humanity, Southwest China

Shan Dai, CEO of Chan Cheung Mun Chung Charitable Fund

Q: What is the criteria when you choose village to start a project?

A: There should be an acquaintance we know in this village, usually a guy from NGO or local municipality, who has already worked with village, and the trust is built.

The post-disaster villages always hold priority.

It doesn't matter wether the climate zone of the village is mild, cold or warm.

Q: What is the criteria when you choose family to start a project?

A: It's important that all the family members are registered and lived in the village regularly.

It's important that the families do have a demand to build the house, not because of the financial support from NGO.

It's important that they have the willingness to work together with NGO staffs on the sustainable concept and they can accept the rammed earth as main material to build.

It's important that they are self-motivated and self-organized during the whole construction phase. It will be good if they can help other families in the village in the future. Promoting social sustainability takes a large share of our work.

Q: About Dashuijing: How is the water supply and drainage system in Dashuijing?

A: It has two systems. One is local water supply. There are pools and wells for extracting and collecting the underground water and it is supplied with pipes to every family. The other is individual rainwater harvest pit.

The urine and waste is collected in the septic tank. The owner will collect them regularly for crops.

Biogas is not popular due to the maintenance cost. Besides, People need to stir the waste regularly, otherwise the biogas efficiency will decrease. The equipment (biogas lamp and biogas stove) is not easy to replace when it is out of lifespan.

Q: About Dashuijing: Do the villagers still use public toilets nowadays? How do they think about the individual toilet in their own house?

A: Yes, most people are still using public toilets. They are willing to include the toilet in their new house but not together with their living room and bedroom. They take the toilet as a “dirty space” in their mindset and should be separated from the “living space”.

Q: About Dashuijing: What is the economy and income of the villager in the village?

A: Traditional agriculture. Tabaco and Chinese peas are the cash crops. People also plant corn and potatoes for food crops. Wild mushroom (e.g., matsutake) is another source of income but not stable.

Q: About Dashuijing: How is the heating demand in the village?

A: People mostly use the brazier to warm up. Some people use stove heaters / Tibetan stove. Young people prefer to use electric heaters. Basically, it is localized heating rather than full-space heating. (eg. Warm face and cold back)

Softwares

IDA Indoor Climate and Energy (IDA ICE) is a new type of simulation tool that takes building performance to another level. It accurately models the building, its systems, and controllers - ensuring the lowest possible energy consumption and the best possible occupant comfort.

IDA ICE is an innovative and trusted whole-year detailed and dynamic multi-zone simulation application for study of thermal indoor climate as well as the energy consumption of the entire building. The physical models of IDA ICE reflect the latest research and best models available, and the computed results compare well with measured data. While serving a global market, IDA ICE is adapted to local requirements (climate data, standards, special systems, special reports, product and material data.

CAALA stands for a software for holistic energetic-ecological pre-dimensioning. CAALA facilitates to analyze the complete lifecycle of a building design in real time.

In this way, buildings are optimized sustainably in the initial planning phase. Besides, it can be measure at an initial phase whether guidelines like EnEV or KfW 55 are achieved or not. With CAALA, it is possible to measure the energy requirements throughout operation and the gray energy required to manufacture, substitute and eliminate them simultaneously. All applicable parameters like geometry, alignment, materiality and building technology are considered. No training is required due to the impulsive user interface. There are diverse design variants which can be easily analyzed and compared rapidly.

CAALA allows the users to directly calculate how ecological a design is throughout the design process and whether guidelines like the EnEV can be achieved. Numerous variations can be tallied instantly which facilitate superior optimization. If the decisions are taken in the initial phase of performance, it provides significant effect on both the cost and the energy and environmental performance of a building. CAALA is applied from performance phase 1 and support planning decisions with quantitative results. CAALA applies calculation algorithms on the basis of German standards. The energy assessment is accomplished as per DIN V 18599 and the gray energy and other ecological effects are set as per DIN EN 15978. So, the results are utilized for pre-dimensioning regarding EnEV or KfW Effizenzhaus or pre-certification as per BNB or DGNB.

Variable and Constant Value Table for Shoebox

Parameters for daylight and thermal simulation					
Weather Data					**Reference**
CHN_Yunnan.Kunming.567780_CSWD.epw					China Standard Weather Data for Analyzing Building Thermal Conditions, April 2005. Beijing: China Building Industry Publishing House, ISBN 7-112-07273-3 (13228). https://energyplus.net/weather-region/asia_wmo_region_2/CHN
Geometry					
Floor area (m²)	36				Interview
Width(m) x Depth(m)	7.5*4.8	6x6	4.8*7.5		
Height(m)	2.5	2.75	3		
Window					
Glazing type	Thickness (mm)	U-value (W/m²K)	g-value	Tvis	
Single	6	5.15	0.85	0.9	GB 50176-2016 Thermal design code for civil building(2016), Ministry of Housing and Urban-Rural Development of PRC, p.111
Double	6+12a+6	2.59	0.75	0.81	GB 50176-2016 Thermal design code for civil building(2016), Ministry of Housing and Urban-Rural Development of PRC, p.112
Double(Low-e)	6(Low-E)+12a+6	1.63	0.46	0.68	GB 50176-2016 Thermal design code for civil building(2016), Ministry of Housing and Urban-Rural Development of PRC, p.112
Material					
Construction	ρ Density (kg/m3)	λ Thermal conductivity (W/m·K)	c Heat capacity (J/kg·K)		
Rammed Earth	2000	1.16	1010		GB 50176-2016 Thermal design code for civil building(2016), Ministry of Housing and Urban-Rural Development of PRC, p.83
Brick	1700	0.76	1050		GB 50176-2016 Thermal design code for civil building(2016), Ministry of Housing and Urban-Rural Development of PRC, p.79
Concrete	2500	1.74	920		GB 50176-2016 Thermal design code for civil building(2016), Ministry of Housing and Urban-Rural Development of PRC, p.77
Wall thickness	300mm	600mm	900mm		
Orientation	South, East, North, South				
Electricity					
Artificial Light (W)	50 x 2(LED)				Interview
Devices (W)	100 (TV)				Interview
Internal gains					
People(W)	105W(1.0 MET)				
CO2 concentration (ppm)	<1500				
Infiltration rate (1/h)	1.0				GB/T 50785-2012, Evaluation standard for indoor thermal environment in civil buildings(2012), Ministry of Housing and Urban-Rural Development of PRC, p.6
Air velocity (m/s)	0.1				
PPD (Predicted Pecentage Dissatisfied)	PPD<25% (-1<PMV<1)				GB/T 50785-2012, Evaluation standard for indoor thermal environment in civil buildings(2012), Ministry of Housing and Urban-Rural Development of PRC, p.10
Operative Temperature	20℃-26℃				
Heating and cooling	Ideal heater and cooler				
Daylight Factor	Kitchen≥2% Corridor, Toilet, Staircase, Dining room≥1%				GB 50033-2013, Standard for Daylighting Design of Buildings(2013), Ministry of Housing and Urban-Rural Development of PRC, p.8

LCA Data Source

Parameters For LCA					
Module				Unit	Reference
A4		0.334		(kg CO2-eq/tkm)	GB/T 51366-2019, Standard for building carbon emission calculation(2019), Ministry of Housing and Urban-Rural Development of PRC, p.37
	Transport Distance	40		(km)	Interview
	CO2 intensity(Electricity)	0.53		(kg CO2-eq/kWh)	GB/T 51366-2019, Standard for building carbon emission calculation(2019), Ministry of Housing and Urban-Rural Development of PRC, p.48
B6		Biomass	Corncob		
		100		(t CO2-eq/TJ)	GB/T 51366-2019, Standard for building carbon emission calculation(2019), Ministry of Housing and Urban-Rural Development of PRC, p.22
	CO2 intensity(Heating)	0.36	0.43	(kg CO2-eq/kWh)	For biomass, 100t CO2-eq/TJ = 0.36 kg CO2-eq/kWh For corncob 1kg corncob contains 1kg * 48.31%= 0.4831 kg carbon. It will release 0.4831 * (44/12) =1.7713 kg CO2-eq. 1kg corncob contains 14.7 MJ thermal power, which is 4.08kWh Therefore, the CO2 intensity will be 1.7713/4.08=0.43 kg CO2-eq/kWh Unit convert Asonja, A., Desnica, E., & Radovanovic, L. (2017). Energy efficiency analysis of corn cob used as a fuel. Energy Sources, Part B: Economics, Planning, and Policy, 12(1), 1-7.
	Hot water demand			(L/pers/day)	Hot water energy demand: 4.2 kJ/(kg*K) * (2pers * 20L/pers/day * 1kg/L) * (60°C-7°C)= 8904 kJ = 2.48 kWh/day GB 50015-2019, Standard for design of building water supply and drainage(2019), Ministry of Housing and Urban-Rural Development of PRC, pp.104,110
A5		Room-scale	Building-scale		
	CO2 emission	2.99	3.49	(kg CO2-eq/m2)	Y=X+1.99 X means the floor level above the ground. Y is the CO2 emmission with the unit of (kg CO2-eq/m2) Building carbon emission calculaton guideline(for trial implemention) 建筑碳排放计算导则(试行)，广东省住房和城乡建设厅 (2021), Department of Housing and Urban-Rural Development of Guangdong
C1	CO2 emission	2.99	3.49	(kg CO2-eq/m2)	Y=X+1.99 X means the floor level above the ground. Y is the CO2 emmission with the unit of (kg CO2-eq/m2) Building carbon emission calculaton guideline(for trial implemention) 建筑碳排放计算导则(试行)，广东省住房和城乡建设厅 (2021), Department of Housing and Urban-Rural Development of Guangdong
C2	Mode-Truck(2t)	0.334		(kg CO2-eq/tkm)	GB/T 51366-2019, Standard for building carbon emission calculation(2019), Ministry of Housing and Urban-Rural Development of PRC, p.37
	Transport Distance	2	2	(km)	Interview

Raw Data: Thermal and Daylight Correlation Analysis

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10001	77.04	2.326	0	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.50	2993	2774	0	1514	23	460	19.79	24.95	19.79	24.63
run10002	89.83	2.588	0	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.75	3453	3234	0	1361	24	457	19.76	24.97	19.80	24.66
run10003	103.1	2.89	0	4.8	0.3	2.333	30%	5.15	0.85	0.90	3.00	3929	3710	0	1274	24	453	19.33	24.99	19.82	24.68
run10004	72.32	2.154	0	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.50	2823	2604	0	1553	24	461	19.79	24.84	19.81	24.56
run10005	84.51	2.324	0	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.75	3262	3042	0	1416	23	458	19.76	24.83	19.82	24.56
run10006	97.22	2.572	0	4.8	0.3	2.333	30%	2.59	0.75	0.81	3.00	3719	3500	0	1304	23	454	19.44	24.86	19.82	24.59
run10007	81.26	1.859	0	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.50	3145	2925	0	1302	24	497	19.79	24.31	19.81	24.02
run10008	94.28	1.941	0	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.75	3613	3394	0	1263	23	494	19.76	24.37	19.82	24.08
run10009	107.8	2.092	0	4.8	0.3	2.333	30%	1.63	0.46	0.68	3.00	4099	3880	0	1241	23	491	19.41	24.42	19.82	24.13
run10010	90.37	3.008	0	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.50	3472	3253	0	1354	23	429	19.60	25.37	19.84	25.05
run10011	106	3.371	0	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.75	4037	3817	0	1260	23	425	18.78	25.40	19.83	25.09
run10012	122.3	3.756	0	4.8	0.3	2.333	40%	5.15	0.85	0.90	3.00	4621	4401	0	1105	24	421	18.14	25.43	19.83	25.13
run10013	83.62	2.698	0	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.50	3230	3010	0	1346	23	428	19.67	25.26	19.86	24.94
run10014	98.48	2.997	0	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.75	3764	3545	0	1239	23	425	18.91	25.27	19.86	24.97
run10015	113.9	3.323	0	4.8	0.3	2.333	40%	2.59	0.75	0.81	3.00	4321	4101	0	1112	23	421	18.27	25.29	19.86	24.99
run10016	94.68	2.363	0	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.50	3628	3409	0	1164	23	471	19.66	24.52	19.86	24.24
run10017	110.6	2.53	0	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.75	4199	3980	0	1054	23	466	18.88	24.58	19.86	24.30
run10018	127	2.763	0	4.8	0.3	2.333	40%	1.63	0.46	0.68	3.00	4792	4573	0	1027	23	462	18.23	24.63	19.86	24.36
run10019	104.1	3.712	0	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.50	3966	3746	0	1249	23	404	18.62	25.80	19.85	25.46
run10020	122.4	4.064	0	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.75	4625	4406	0	1131	23	400	17.85	25.83	19.84	25.51
run10021	141.4	4.567	0	4.8	0.3	2.333	50%	5.15	0.85	0.90	3.00	5308	5089	0	1032	24	396	17.00	25.87	19.85	25.55
run10022	95.14	3.361	0	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.50	3644	3425	0	1295	23	402	18.75	25.66	19.88	25.34
run10023	112.5	3.583	0	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.75	4268	4048	0	1074	23	397	17.91	25.69	19.88	25.37
run10024	130.4	4.014	0	4.8	0.3	2.333	50%	2.59	0.75	0.81	3.00	4913	4693	0	1067	23	394	17.16	25.70	19.88	25.40
run10025	108.1	2.689	0	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.50	4110	3891	0	1394	23	447	18.74	24.72	19.88	24.44
run10026	126.6	3.031	0	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.75	4775	4556	0	1286	23	442	17.97	24.77	19.88	24.50
run10027	145.6	3.331	0	4.8	0.3	2.333	50%	1.63	0.46	0.68	3.00	5461	5242	0	1156	23	438	17.14	24.81	19.88	24.55
run10028	59.9	1.812	0	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.50	2376	2157	0	1491	22	436	19.80	24.95	19.89	24.64
run10029	70.8	2.114	0	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.75	2768	2549	0	1172	22	433	19.76	24.95	19.90	24.64
run10030	82.26	2.276	0	4.8	0.6	1.455	30%	5.15	0.85	0.90	3.00	3181	2961	0	1107	22	430	19.63	24.96	19.90	24.66
run10031	55.28	1.699	0	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.50	2209	1990	0	1459	22	436	19.80	24.89	19.90	24.60
run10032	65.63	1.829	0	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.75	2582	2363	0	1210	22	433	19.77	24.85	19.91	24.58
run10033	76.5	2.09	0	4.8	0.6	1.455	30%	2.59	0.75	0.81	3.00	2973	2754	0	1106	22	429	19.66	24.86	19.92	24.57
run10034	64.41	1.381	0	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.50	2538	2319	0	1318	22	477	19.80	24.06	19.90	23.75
run10035	75.61	1.625	0	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.75	2941	2722	0	1217	22	474	19.77	24.06	19.92	23.75
run10036	87.41	1.803	0	4.8	0.6	1.455	30%	1.63	0.46	0.68	3.00	3366	3147	0	1087	22	470	19.63	24.09	19.92	23.78
run10037	73.35	2.397	0	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.50	2860	2641	0	1351	22	407	19.71	25.43	19.93	25.10
run10038	87.17	2.797	0	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.75	3357	3138	0	1217	22	403	19.10	25.43	19.93	25.11
run10039	101.6	3.069	0	4.8	0.6	1.455	40%	5.15	0.85	0.90	3.00	3879	3659	0	1123	22	399	18.41	25.45	19.93	25.14
run10040	66.72	2.237	0	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.50	2621	2402	0	1479	22	404	19.74	25.35	19.96	25.07
run10041	79.74	2.464	0	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.75	3090	2871	0	1332	22	400	19.24	25.32	19.96	25.05
run10042	93.38	2.863	0	4.8	0.6	1.455	40%	2.59	0.75	0.81	3.00	3581	3362	0	1206	22	397	18.59	25.33	19.96	25.05
run10043	77.97	1.777	0	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.50	3026	2807	0	1290	22	451	19.74	24.34	19.95	24.02
run10044	92.06	2.009	0	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.75	3533	3314	0	1275	21	446	19.20	24.34	19.95	24.03
run10045	106.8	2.233	0	4.8	0.6	1.455	40%	1.63	0.46	0.68	3.00	4064	3845	0	1251	22	442	18.54	24.36	19.95	24.07
run10046	87.32	2.908	0	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.50	3363	3143	0	1161	22	384	18.90	25.86	19.93	25.53
run10047	103.9	3.289	0	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.75	3961	3742	0	1099	22	380	18.06	25.89	19.93	25.57
run10048	121.1	3.741	0	4.8	0.6	1.455	50%	5.15	0.85	0.90	3.00	4580	4361	0	1027	22	377	17.26	25.90	19.93	25.59
run10049	78.51	2.653	0	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.50	3046	2826	0	1147	21	379	19.06	25.77	19.97	25.49
run10050	94.03	3.002	0	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.75	3604	3385	0	1054	21	375	18.29	25.76	19.97	25.48
run10051	110.2	3.28	0	4.8	0.6	1.455	50%	2.59	0.75	0.81	3.00	4188	3968	0	1006	22	372	17.55	25.78	19.97	25.48
run10052	91.61	2.251	0	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.50	3517	3298	0	1206	21	428	19.01	24.61	19.96	24.29
run10053	108.4	2.453	0	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.75	4120	3901	0	1100	21	423	18.21	24.63	19.96	24.32
run10054	125.8	2.718	0	4.8	0.6	1.455	50%	1.63	0.46	0.68	3.00	4746	4527	0	1035	22	418	17.49	24.63	19.97	24.33
run10055	52.12	1.467	0	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.50	2096	1876	0	1406	22	424	19.80	25.03	19.98	24.75
run10056	62.15	1.722	0	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.75	2457	2238	0	1289	22	421	19.77	25.01	19.97	24.74
run10057	72.8	1.878	0	4.8	0.9	1.057	30%	5.15	0.85	0.90	3.00	2840	2621	0	1206	21	418	19.73	24.99	19.97	24.72
run10058	47.59	1.285	0	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.50	1933	1713	0	1409	21	422	19.80	25.02	20.00	24.74
run10059	57.09	1.482	0	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.75	2275	2055	0	1301	21	419	19.77	24.98	20.00	24.71
run10060	67.16	1.727	0	4.8	0.9	1.057	30%	2.59	0.75	0.81	3.00	2637	2418	0	1196	21	416	19.74	24.95	20.00	24.69
run10061	56.78	1.115	0	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.50	2263	2044	0	1320	21	467	19.80	24.06	19.99	23.77
run10062	67.23	1.244	0	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.75	2640	2420	0	1224	21	463	19.77	24.06	19.99	23.75
run10063	78.18	1.4	0	4.8	0.9	1.057	30%	1.63	0.46	0.68	3.00	3034	2814	0	1104	20	459	19.74	24.06	19.99	23.75
run10064	65.63	1.938	0	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.50	2582	2363	0	1347	21	396	19.74	25.49	19.98	25.20
run10065	78.63	2.218	0	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.75	3050	2831	0	1210	21	392	19.16	25.48	19.98	25.20
run10066	92.32	2.516	0	4.8	0.9	1.057	40%	5.15	0.85	0.90	3.00	3543	3324	0	1104	21	388	18.54	25.49	19.98	25.19
run10067	59.08	1.758	0	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.50	2346	2127	0	1426	21	391	19.74	25.48	20.01	25.20
run10068	71.25	2.009	0	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.75	2784	2565	0	1293	21	388	19.35	25.45	20.01	25.18
run10069	84.1	2.237	0	4.8	0.9	1.057	40%	2.59	0.75	0.81	3.00	3247	3028	0	1162	21	384	18.78	25.43	20.01	25.17
run10070	70.41	1.539	0	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.50	2754	2535	0	1454	20	441	19.74	24.35	20.00	24.05
run10071	83.71	1.697	0	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.75	3233	3013	0	1094	20	436	19.30	24.34	20.00	24.04
run10072	97.64	1.853	0	4.8	0.9	1.057	40%	1.63	0.46	0.68	3.00	3734	3515	0	1058	20	431	18.73	24.35	20.00	24.05
run10073	79.78	2.336	0	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.50	3091	2872	0	1139	21	374	18.92	25.92	19.99	25.62
run10074	95.57	2.791	0	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.75	3660	3441	0	1059	21	370	18.22	25.94	19.99	25.62
run10075	112.1	3.254	0	4.8	0.9	1.057	50%	5.15	0.85	0.90	3.00	4254	4035	0	991	21	367	17.48	25.95	19.99	25.64
run10076	71	2.186	0	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.50	2775	2556	0	1442	20	368	19.22	25.90	20.02	25.62
run10077	85.73	2.413	0	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.75	3306	3086	0	1056	20	364	18.38	25.87	20.02	25.61
run10078	101.2	2.738	0	4.8	0.9	1.057	50%	2.59	0.75	0.81	3.00	3862	3643	0	951	20	361	17.75	25.85	20.02	25.61
run10079	84.2	1.775	0	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.50	3251	3031	0	1375	20	418	19.16	24.63	20.02	24.33
run10080	100.2	2.059	0	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.75	3827	3608	0	1206	20	413	18.35	24.63	20.02	24.32
run10081	116.9	2.277	0	4.8	0.9	1.057	50%	1.63	0.46	0.68	3.00	4426	4207	0	1195	20	408	17.69	24.64	20.02	24.34
run10082	99.39	3.07	0	6	0.3	2.333	30%	5.15	0.85	0.90	2.50	3797	3578	0	1288	24	453	19.63	25.19	19.75	24.86
run10083	115.7	3.444	0	6	0.3	2.333	30%	5.15	0.85	0.90	2.75	4383	4164	0	1206	24	449	18.84	25.21	19.76	24.90
run10084	132.5	3.776	0	6	0.3	2.333	30%	5.15	0.85	0.90	3.00	4990	4771	0	1190	24	445	18.16	25.24	19.75	24.93
run10085	93.11	2.77	0	6	0.3	2.333	30%	2.59	0.75	0.81	2.50	3571	3352	0	1312	24	454	19.69	25.05	19.77	24.77
run10086	108.6	3.084	0	6	0.3	2.333	30%	2.59	0.75	0.81	2.75	4130	3910	0	1199	24	450	18.98	25.08	19.78	24.79
run10087	124.8	3.419	0	6	0.3	2.333	30%	2.59	0.75	0.81	3.00	4711	4492	0	1201	24	446	18.34	25.10	19.77	24.82
run10088	103.7	2.288	0	6	0.3	2.333	30%	1.63	0.46	0.68	2.50	3951	3732	0	1231	24	491	19.71	24.54	19.76	24.25
run10089	120.1	2.562	0	6	0.3	2.333	30%	1.63	0.46	0.68	2.75	4543	4323	0	1191	24	487	19.01	24.59	19.78	24.31
run10090	137.2	2.769	0	6	0.3	2.333	30%	1.63	0.46	0.68	3.00	5157	4938	0	1170	24	483	18.35	24.64	19.78	24.37
run10091	116.9	4.042	0	6	0.3	2.333	40%	5.15	0.85	0.90	2.50	4427	4208	0	1237	24	420	18.41	25.68	19.80	25.35
run10092	136.6	4.537	0	6	0.3	2.333	40%	5.15	0.85	0.90	2.75	5136	4917	0	1149	24	415	17.56	25.72	19.80	25.40
run10093	156.8	4.972	0	6	0.3	2.333	40%	5.15	0.85	0.90	3.00	5864	5645	0	1091	25	412	16.80	25.75	19.76	25.43
run10094	107.9	3.669	0	6	0.3	2.333	40%	2.59	0.75	0.81	2.50	4103	3883	0	1218	24	419	18.58	25.54	19.83	25.21
run10095	126.5	4.175	0	6	0.3	2.333	40%	2.59	0.75	0.81	2.75	4773	4554	0	1131	24	415	17.71	25.56	19.83	25.25
run10096	145.7	4.518	0	6	0.3	2.333	40%	2.59	0.75	0.81	3.00	5464	5244	0	1100	24	411	16.95	25.59	19.80	25.29
run10097	120.8	2.949	0	6	0.3	2.333	40%	1.63	0.46	0.68	2.50	4568	4349	0	1387	24	462	18.55	24.77	19.83	24.49
run10098	140.5	3.264	0	6	0.3	2.333	40%	1.63	0.46	0.68	2.75	5279	5059	0	1276	24	457	17.75	24.81	19.83	24.54
run10099	160.9	3.718	0	6	0.3	2.333	40%	1.63	0.46	0.68	3.00	6010	5791	0	1203	24	452	16.95	24.86	19.82	24.59
run10100	134.6	4.853	0	6	0.3	2.333	50%	5.15	0.85	0.90	2.50	5066	4847	0	1381	24	394	17.32	26.01	19.81	25.73
run10101	157.3	5.519	0	6	0.3	2.333	50%	5.15	0.85	0.90	2.75	5884	5664	0	1273	25	391	16.45	26.01	19.77	25.76
run10102	180.1	6.133	0	6	0.3	2.333	50%	5.15	0.85	0.90	3.00	6703	6484	0	1182	28	388	15.71	26.01	19.68	25.79
run10103	122.7	4.441	0	6	0.3	2.333	50%	2.59	0.75	0.81	2.50	4637	4417	0	1101	24	391	17.59	25.98	19.85	25.65
run10104	144.1	4.999	0	6	0.3	2.333	50%	2.59	0.75	0.81	2.75	5406	5187	0	992	24	387	16.71	26.00	19.83	25.70
run10105	165.6	5.43	0	6	0.3	2.333	50%	2.59	0.75	0.81	3.00	6182	5963	0	912	25	385	15.94	26.01	19.74	25.73
run10106	137.7	3.648	0	6	0.3	2.333	50%	1.63	0.46	0.68	2.50	5175	4956	0	1193	23	436	17.56	24.97	19.85	24.69
run10107	160.3	3.991	0	6	0.3	2.333	50%	1.63	0.46	0.68	2.75	5990	5771	0	1093	24	431	16.65	25.02	19.84	24.76
run10108	183	4.485	0	6	0.3	2.333	50%	1.63	0.46	0.68	3.00	6809	6590	0	995	25	428	15.94	25.11	19.75	24.81
run10109	77.49	2.435	0	6	0.6	1.455	30%	5.15	0.85	0.90	2.50	3009	2790	0	1602	22	427	19.75	25.17	19.85	24.84
run10110	91.38	2.753	0	6	0.6	1.455	30%	5.15	0.85	0.90	2.75	3509	3290	0	1489	22	423	19.26	25.19	19.87	24.87
run10111	106	3.069	0	6	0.6	1.455	30%	5.15	0.85	0.90	3.00	4035	3816	0	1344	23	419	18.58	25.21	19.87	24.90
run10112	71.32	2.19	0	6	0.6	1.455	30%	2.59	0.75	0.81	2.50	2787	2568	0	1364	22	426	19.75	25.07	19.87	24.78
run10113	84.52	2.456	0	6	0.6	1.455	30%	2.59	0.75	0.81	2.75	3262	3043	0	1240	22	422	19.32	25.07	19.89	24.76
run10114	98.36	2.734	0	6	0.6	1.455	30%	2.59	0.75	0.81	3.00	3760	3541	0	1059	22	419	18.66	25.07	19.89	24.77
run10115	82.19	1.833	0	6	0.6	1.455	30%	1.63	0.46	0.68	2.50	3178	2959	0	1457	22	469	19.75	24.20	19.88	23.88
run10116	96.4	2.066	0	6	0.6	1.455	30%	1.63	0.46	0.68	2.75	3690	3470	0	1309	22	465	19.31	24.24	19.89	23.94
run10117	111.2	2.274	0	6	0.6	1.455	30%	1.63	0.46	0.68	3.00	4224	4004	0	1024	22	460	18.64	24.30	19.90	24.00
run10118	95.1	3.259	0	6	0.6	1.455	40%	5.15	0.85	0.90	2.50	3643	3424	0	1264	22	396	18.72	25.72	19.90	25.38
run10119	112.6	3.696	0	6	0.6	1.455	40%	5.15	0.85	0.90	2.75	4271	4052	0	1104	22	392	17.93	25.73	19.91	25.41
run10120	130.6	4.087	0	6	0.6	1.455	40%	5.15	0.85	0.90	3.00	4921	4702	0	1033	23	388	17.11	25.77	19.90	25.45
run10121	86.28	2.904	0	6	0.6	1.455	40%	2.59	0.75	0.81	2.50	3326	3106	0	1249	22	393	18.84	25.60	19.93	25.30
run10122	102.6	3.334	0	6	0.6	1.455	40%	2.59	0.75	0.81	2.75	3914	3695	0	1161	22	389	18.09	25.61	19.94	25.30
run10123	119.6	3.684	0	6	0.6	1.455	40%	2.59	0.75	0.81	3.00	4527	4307	0	1074	23	385	17.28	25.62	19.94	25.31
run10124	99.48	2.409	0	6	0.6	1.455	40%	1.63	0.46	0.68	2.50	3800	3581	0	1156	22	440	18.81	24.53	19.93	24.21
run10125	117.1	2.705	0	6	0.6	1.455	40%	1.63	0.46	0.68	2.75	4433	4214	0	1080	22	434	17.97	24.53	19.93	24.24
run10126	135.2	3.016	0	6	0.6	1.455	40%	1.63	0.46	0.68	3.00	5088	4869	0	1096	22	430	17.24	24.60	19.94	24.30
run10127	113.3	3.936	0	6	0.6	1.455	50%	5.15	0.85	0.90	2.50	4297	4077	0	1116	22	373	17.67	26.01	19.91	25.76
run10128	133.9	4.541	0	6	0.6	1.455	50%	5.15	0.85	0.90	2.75	5039	4820	0	1055	23	369	16.79	26.01	19.91	25.79
run10129	154.7	5.075	0	6	0.6	1.455	50%	5.15	0.85	0.90	3.00	5790	5570	0	984	24	367	16.10	26.01	19.90	25.81
run10130	101.5	3.592	0	6	0.6	1.455	50%	2.59	0.75	0.81	2.50	3873	3654	0	1089	22	367	17.88	26.00	19.95	25.75
run10131	120.8	4.158	0	6	0.6	1.455	50%	2.59	0.75	0.81	2.75	4569	4349	0	1003	22	364	16.96	26.01	19.95	25.76
run10132	140.4	4.561	0	6	0.6	1.455	50%	2.59	0.75	0.81	3.00	5275	5056	0	965	23	361	16.32	26.01	19.95	25.77
run10133	116.7	2.953	0	6	0.6	1.455	50%	1.63	0.46	0.68	2.50	4421	4202	0	1512	22	415	17.78	24.85	19.95	24.53
run10134	137.3	3.383	0	6	0.6	1.455	50%	1.63	0.46	0.68	2.75	5164	4944	0	1335	22	410	16.95	24.87	19.95	24.55
run10135	158.2	3.818	0	6	0.6	1.455	50%	1.63	0.46	0.68	3.00	5916	5697	0	1208	23	406	16.25	25.02	19.95	24.58

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10136	67.56	1.971	0	6	0.9	1.057	30%	5.15	0.85	0.90	2.50	2651	2432	0	1641	22	414	19.75	25.23	19.96	24.94
run10137	80.44	2.247	0	6	0.9	1.057	30%	5.15	0.85	0.90	2.75	3115	2896	0	1483	22	410	19.36	25.21	19.95	24.93
run10138	94	2.563	0	6	0.9	1.057	30%	5.15	0.85	0.90	3.00	3603	3384	0	1349	22	406	18.73	25.23	19.95	24.92
run10139	61.57	1.817	0	6	0.9	1.057	30%	2.59	0.75	0.81	2.50	2436	2216	0	1346	21	411	19.76	25.19	19.98	24.91
run10140	73.67	2.029	0	6	0.9	1.057	30%	2.59	0.75	0.81	2.75	2871	2652	0	1252	21	407	19.54	25.17	19.98	24.90
run10141	86.48	2.286	0	6	0.9	1.057	30%	2.59	0.75	0.81	3.00	3332	3113	0	1139	21	403	18.91	25.13	19.98	24.87
run10142	72.5	1.471	0	6	0.9	1.057	30%	1.63	0.46	0.68	2.50	2829	2610	0	1209	21	457	19.75	24.19	19.97	23.87
run10143	85.7	1.73	0	6	0.9	1.057	30%	1.63	0.46	0.68	2.75	3304	3085	0	1154	21	453	19.45	24.19	19.97	23.88
run10144	99.53	1.867	0	6	0.9	1.057	30%	1.63	0.46	0.68	3.00	3802	3583	0	1047	21	448	18.76	24.20	19.98	23.89
run10145	85.28	2.644	0	6	0.9	1.057	40%	5.15	0.85	0.90	2.50	3289	3070	0	1213	21	384	18.84	25.77	19.96	25.45
run10146	101.7	3.057	0	6	0.9	1.057	40%	5.15	0.85	0.90	2.75	3881	3661	0	1129	21	380	18.07	25.79	19.96	25.47
run10147	118.8	3.401	0	6	0.9	1.057	40%	5.15	0.85	0.90	3.00	4496	4276	0	1058	22	376	17.34	25.80	19.96	25.49
run10148	76.54	2.365	0	6	0.9	1.057	40%	2.59	0.75	0.81	2.50	2975	2756	0	1171	21	379	19.10	25.73	20.00	25.45
run10149	91.92	2.726	0	6	0.9	1.057	40%	2.59	0.75	0.81	2.75	3528	3309	0	1092	21	375	18.30	25.70	20.00	25.44
run10150	108	3.054	0	6	0.9	1.057	40%	2.59	0.75	0.81	3.00	4106	3886	0	1045	21	371	17.57	25.68	20.00	25.43
run10151	89.88	1.992	0	6	0.9	1.057	40%	1.63	0.46	0.68	2.50	3455	3236	0	1344	20	428	18.97	24.54	19.99	24.22
run10152	106.5	2.259	0	6	0.9	1.057	40%	1.63	0.46	0.68	2.75	4054	3834	0	1274	20	423	18.23	24.54	19.99	24.23
run10153	123.8	2.573	0	6	0.9	1.057	40%	1.63	0.46	0.68	3.00	4675	4455	0	1028	21	418	17.55	24.54	20.00	24.24
run10154	103.7	3.237	0	6	0.9	1.057	50%	5.15	0.85	0.90	2.50	3951	3732	0	1265	22	362	17.82	26.01	19.97	25.81
run10155	123.3	3.75	0	6	0.9	1.057	50%	5.15	0.85	0.90	2.75	4660	4440	0	1272	22	359	16.95	26.01	19.97	25.82
run10156	143.4	4.286	0	6	0.9	1.057	50%	5.15	0.85	0.90	3.00	5381	5162	0	964	23	356	16.27	26.01	19.98	25.84
run10157	91.94	2.9	0	6	0.9	1.057	50%	2.59	0.75	0.81	2.50	3529	3310	0	1165	21	355	18.03	26.01	20.00	25.82
run10158	110.3	3.351	0	6	0.9	1.057	50%	2.59	0.75	0.81	2.75	4191	3971	0	1159	21	352	17.20	26.01	20.01	25.82
run10159	129.1	3.829	0	6	0.9	1.057	50%	2.59	0.75	0.81	3.00	4868	4649	0	1141	22	349	16.55	26.01	20.01	25.84
run10160	107.3	2.399	0	6	0.9	1.057	50%	1.63	0.46	0.68	2.50	4083	3864	0	1502	20	404	17.96	24.88	20.00	24.56
run10161	127	2.801	0	6	0.9	1.057	50%	1.63	0.46	0.68	2.75	4792	4573	0	1321	21	399	17.15	24.88	20.01	24.57
run10162	147.1	3.131	0	6	0.9	1.057	50%	1.63	0.46	0.68	3.00	5514	5295	0	1200	22	395	16.48	24.95	20.01	24.59
run10163	127.9	3.867	0	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.50	4825	4606	0	1257	25	446	18.47	25.43	19.69	25.11
run10164	148.3	4.419	0	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.75	5560	5340	0	1145	26	442	17.68	25.46	19.67	25.15
run10165	169.4	4.796	0	7.5	0.3	2.333	30%	5.15	0.85	0.90	3.00	6317	6098	0	1078	26	438	16.83	25.49	19.61	25.19
run10166	119.6	3.484	0	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.50	4523	4304	0	1271	25	447	18.63	25.27	19.71	24.97
run10167	139.1	3.928	0	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.75	5226	5007	0	1126	25	443	17.78	25.31	19.70	25.00
run10168	159	4.285	0	7.5	0.3	2.333	30%	2.59	0.75	0.81	3.00	5945	5725	0	1084	26	439	17.00	25.34	19.65	25.04
run10169	132	2.876	0	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.50	4972	4753	0	1208	25	485	18.61	24.75	19.72	24.47
run10170	152.6	3.256	0	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.75	5711	5492	0	1198	25	481	17.78	24.78	19.71	24.52
run10171	173.7	3.526	0	7.5	0.3	2.333	30%	1.63	0.46	0.68	3.00	6471	6252	0	1093	26	477	17.02	24.82	19.66	24.56
run10172	150.4	5.123	0	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.50	5635	5415	0	1136	25	412	17.11	25.98	19.69	25.64
run10173	174.6	5.743	0	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.75	6504	6284	0	1032	26	408	16.25	26.00	19.63	25.69
run10174	198.7	6.279	0	7.5	0.3	2.333	40%	5.15	0.85	0.90	3.00	7373	7154	0	986	32	407	15.47	26.01	19.44	25.72
run10175	138.5	4.584	0	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.50	5204	4985	0	1101	25	411	17.36	25.80	19.74	25.48
run10176	161.3	5.129	0	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.75	6028	5808	0	1015	26	407	16.41	25.84	19.69	25.53
run10177	184.2	5.682	0	7.5	0.3	2.333	40%	2.59	0.75	0.81	3.00	6850	6631	0	967	29	405	15.70	25.89	19.61	25.59
run10178	153.6	3.729	0	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.50	5747	5528	0	1189	25	453	17.40	24.97	19.78	24.69
run10179	177.6	4.353	0	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.75	6614	6395	0	1078	25	449	16.47	25.02	19.71	24.76
run10180	201.7	4.753	0	7.5	0.3	2.333	40%	1.63	0.46	0.68	3.00	7479	7260	0	1009	29	446	15.71	25.09	19.62	24.80
run10181	172.3	6.276	0	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.50	6422	6202	0	1202	26	387	15.98	26.02	19.67	25.89
run10182	199.2	6.981	0	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.75	7390	7171	0	1071	34	386	15.11	26.01	19.35	25.96
run10183	225.6	7.711	0	7.5	0.3	2.333	50%	5.15	0.85	0.90	3.00	8341	8122	0	976	44	386	14.31	26.02	18.59	26.02
run10184	156.6	5.477	0	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.50	5858	5638	0	1105	25	384	16.25	26.01	19.72	25.82
run10185	182	6.288	0	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.75	6773	6553	0	1106	30	381	15.36	26.01	19.59	25.86
run10186	207	7.011	0	7.5	0.3	2.333	50%	2.59	0.75	0.81	3.00	7672	7453	0	1033	39	381	14.56	26.01	18.94	25.89
run10187	173.8	4.591	0	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.50	6476	6257	0	1113	25	428	16.33	25.19	19.74	24.92
run10188	200.6	5.133	0	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.75	7442	7223	0	1022	29	424	15.42	25.32	19.63	24.98
run10189	226.9	5.651	0	7.5	0.3	2.333	50%	1.63	0.46	0.68	3.00	8389	8170	0	946	38	423	14.59	25.46	19.03	25.03
run10190	99.97	3.159	0	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.50	3818	3599	0	1395	23	418	18.83	25.40	19.82	25.07
run10191	117.5	3.602	0	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.75	4449	4230	0	1243	23	414	18.12	25.42	19.82	25.10
run10192	135.7	3.937	0	7.5	0.6	1.455	30%	5.15	0.85	0.90	3.00	5103	4884	0	1152	23	410	17.29	25.44	19.83	25.13
run10193	91.83	2.783	0	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.50	3525	3306	0	1514	23	417	18.95	25.26	19.84	24.95
run10194	108.4	3.128	0	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.75	4122	3903	0	1398	23	413	18.16	25.27	19.85	24.97
run10195	125.6	3.527	0	7.5	0.6	1.455	30%	2.59	0.75	0.81	3.00	4740	4521	0	1268	23	409	17.51	25.29	19.86	24.99
run10196	104.7	2.31	0	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.50	3987	3768	0	1221	23	461	18.92	24.36	19.84	24.07
run10197	122.5	2.631	0	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.75	4628	4409	0	1198	23	456	18.13	24.42	19.85	24.14
run10198	140.8	2.899	0	7.5	0.6	1.455	30%	1.63	0.46	0.68	3.00	5287	5068	0	1158	23	451	17.48	24.47	19.85	24.20
run10199	122.7	4.136	0	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.50	4636	4417	0	1080	23	386	17.56	26.00	19.87	25.66
run10200	144.2	4.722	0	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.75	5411	5192	0	1029	24	383	16.62	26.00	19.86	25.69
run10201	165.9	5.299	0	7.5	0.6	1.455	40%	5.15	0.85	0.90	3.00	6193	5974	0	959	24	380	15.96	26.00	19.82	25.72
run10202	111	3.717	0	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.50	4214	3995	0	1147	23	383	17.75	25.86	19.90	25.54
run10203	131.2	4.281	0	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.75	4942	4722	0	1053	23	379	16.88	25.88	19.90	25.57
run10204	151.7	4.726	0	7.5	0.6	1.455	40%	2.59	0.75	0.81	3.00	5679	5460	0	969	24	376	16.18	25.89	19.89	25.59
run10205	126.4	3.05	0	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.50	4771	4552	0	1135	23	429	17.71	24.73	19.91	24.41
run10206	148	3.491	0	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.75	5546	5327	0	1027	23	424	16.83	24.77	19.91	24.46
run10207	169.7	3.923	0	7.5	0.6	1.455	40%	1.63	0.46	0.68	3.00	6329	6110	0	970	24	420	16.11	24.94	19.90	24.52
run10208	145.4	5.041	0	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.50	5453	5234	0	1316	24	364	16.41	26.02	19.88	25.91
run10209	170	5.828	0	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.75	6340	6120	0	1115	27	362	15.56	26.02	19.80	25.98
run10210	194.2	6.543	0	7.5	0.6	1.455	50%	5.15	0.85	0.90	3.00	7213	6993	0	1008	34	362	14.78	26.02	19.35	26.03
run10211	129.9	4.616	0	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.50	4896	4677	0	1239	23	358	16.59	26.01	19.93	25.89
run10212	153	5.309	0	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.75	5728	5509	0	1229	24	356	15.79	26.02	19.88	25.90
run10213	176	5.871	0	7.5	0.6	1.455	50%	2.59	0.75	0.81	3.00	6554	6334	0	1046	31	355	15.01	26.02	19.66	25.92
run10214	147.4	3.636	0	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.50	5525	5306	0	1229	23	404	16.56	25.10	19.93	24.78
run10215	171.9	4.329	0	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.75	6407	6188	0	1111	24	400	15.76	25.21	19.91	24.81
run10216	196.2	4.724	0	7.5	0.6	1.455	50%	1.63	0.46	0.68	3.00	7282	7063	0	1045	30	398	14.98	25.37	19.76	24.84
run10217	87.32	2.561	0	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.50	3363	3143	0	1411	22	404	19.01	25.44	19.94	25.14
run10218	103.6	2.907	0	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.75	3949	3730	0	1279	22	399	18.25	25.44	19.93	25.13
run10219	120.5	3.238	0	7.5	0.9	1.057	30%	5.15	0.85	0.90	3.00	4557	4338	0	1166	22	396	17.57	25.46	19.94	25.15
run10220	79.3	2.283	0	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.50	3074	2855	0	1550	21	401	19.24	25.37	19.96	25.10
run10221	94.66	2.6	0	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.75	3627	3408	0	1369	22	397	18.44	25.35	19.96	25.09
run10222	110.6	2.956	0	7.5	0.9	1.057	30%	2.59	0.75	0.81	3.00	4200	3980	0	1302	22	393	17.68	25.32	19.97	25.08
run10223	92.36	1.93	0	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.50	3544	3325	0	1119	21	448	19.13	24.31	19.95	24.00
run10224	108.9	2.182	0	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.75	4140	3921	0	1077	21	443	18.34	24.32	19.96	24.01
run10225	126	2.552	0	7.5	0.9	1.057	30%	1.63	0.46	0.68	3.00	4754	4535	0	1037	21	438	17.68	24.34	19.96	24.04
run10226	110.3	3.389	0	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.50	4190	3970	0	1131	22	374	17.75	26.00	19.94	25.69
run10227	130.6	3.901	0	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.75	4919	4700	0	1099	22	370	16.88	26.01	19.95	25.72
run10228	151.2	4.421	0	7.5	0.9	1.057	40%	5.15	0.85	0.90	3.00	5662	5443	0	1033	23	367	16.16	26.01	19.95	25.74
run10229	98.62	3.03	0	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.50	3770	3551	0	1333	22	368	17.98	25.95	19.98	25.68
run10230	117.7	3.497	0	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.75	4455	4236	0	1053	22	364	17.06	25.94	19.98	25.67
run10231	137.1	3.963	0	7.5	0.9	1.057	40%	2.59	0.75	0.81	3.00	5154	4935	0	990	22	361	16.32	25.95	19.98	25.68
run10232	114.3	2.545	0	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.50	4334	4115	0	1242	21	416	17.91	24.72	19.98	24.41
run10233	134.7	2.953	0	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.75	5069	4850	0	1183	22	411	17.03	24.74	19.98	24.43
run10234	155.3	3.258	0	7.5	0.9	1.057	40%	1.63	0.46	0.68	3.00	5811	5592	0	1135	22	407	16.36	24.86	19.98	24.45
run10235	133.3	4.18	0	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.50	5019	4800	0	1111	23	353	16.61	26.02	19.95	25.95
run10236	156.9	4.834	0	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.75	5869	5650	0	1049	23	351	15.75	26.02	19.93	26.01
run10237	180.3	5.536	0	7.5	0.9	1.057	50%	5.15	0.85	0.90	3.00	6710	6491	0	1003	31	351	14.94	26.02	19.65	26.07
run10238	118	3.853	0	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.50	4466	4247	0	1101	22	345	16.80	26.02	19.99	25.96
run10239	140	4.418	0	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.75	5261	5042	0	1006	23	343	15.98	26.02	19.99	25.97
run10240	162	4.887	0	7.5	0.9	1.057	50%	2.59	0.75	0.81	3.00	6051	5831	0	948	27	342	15.25	26.02	19.94	25.98
run10241	135.6	3.069	0	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.50	5102	4883	0	1256	22	392	16.80	25.11	19.99	24.80
run10242	159.2	3.641	0	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.75	5949	5730	0	1152	22	388	15.98	25.15	19.99	24.82
run10243	182.5	4.038	0	7.5	0.9	1.057	50%	1.63	0.46	0.68	3.00	6789	6570	0	1026	26	385	15.18	25.31	19.96	24.85
run10244	93.82	2.326	90	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.50	3597	3378	0	1651	24	473	19.79	26.01	19.78	25.88
run10245	108.1	2.588	90	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.75	4113	3893	0	1293	24	470	19.75	26.01	19.79	25.90
run10246	122.9	2.862	90	4.8	0.3	2.333	30%	5.15	0.85	0.90	3.00	4644	4424	0	1074	24	468	19.17	26.01	19.81	25.93
run10247	86.31	2.142	90	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.50	3326	3107	0	1618	24	469	19.79	26.01	19.80	25.88
run10248	99.74	2.324	90	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.75	3810	3591	0	1303	23	467	19.75	26.01	19.81	25.91
run10249	113.7	2.572	90	4.8	0.3	2.333	30%	2.59	0.75	0.81	3.00	4313	4094	0	1138	24	464	19.32	26.01	19.81	25.94
run10250	87.41	1.804	90	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.50	3366	3147	0	1426	24	482	19.79	25.71	19.81	25.45
run10251	101	1.945	90	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.75	3854	3635	0	1293	23	480	19.75	25.75	19.81	25.50
run10252	115	2.092	90	4.8	0.3	2.333	30%	1.63	0.46	0.68	3.00	4359	4139	0	1227	23	477	19.31	25.81	19.82	25.56
run10253	112.7	3.008	90	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.50	4278	4059	1	1420	23	457	19.39	26.01	19.85	25.99
run10254	130.3	3.369	90	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.75	4912	4692	1	1437	23	453	18.64	26.01	19.86	26.02
run10255	148.5	3.756	90	4.8	0.3	2.333	40%	5.15	0.85	0.90	3.00	5566	5346	1	1309	24	450	17.97	26.01	19.86	26.04
run10256	102.3	2.698	90	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.50	3904	3684	1	1329	23	452	19.59	26.01	19.86	26.00
run10257	118.8	2.997	90	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.75	4499	4279	1	1288	23	448	18.81	26.01	19.88	26.03
run10258	135.9	3.33	90	4.8	0.3	2.333	40%	2.59	0.75	0.81	3.00	5111	4891	1	1277	23	445	18.10	26.01	19.89	26.05
run10259	103.7	2.363	90	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.50	3951	3732	0	1288	23	466	19.61	25.88	19.87	25.62
run10260	120.2	2.558	90	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.75	4547	4327	0	1166	23	462	18.86	25.94	19.89	25.69
run10261	137.3	2.763	90	4.8	0.3	2.333	40%	1.63	0.46	0.68	3.00	5164	4945	0	1082	23	459	18.13	25.97	19.89	25.73
run10262	131.5	3.712	90	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.50	4955	4735	1	1251	23	442	18.38	26.01	19.88	26.09
run10263	152.2	4.064	90	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.75	5700	5480	1	1177	23	438	17.63	26.01	19.88	26.11
run10264	173.3	4.567	90	4.8	0.3	2.333	50%	5.15	0.85	0.90	3.00	6460	6239	2	1125	24	435	16.82	26.01	19.87	26.14
run10265	118.2	3.361	90	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.50	4475	4254	1	1171	23	436	18.58	26.01	19.91	26.10
run10266	137.4	3.628	90	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.75	5167	4946	2	1102	23	432	17.79	26.01	19.91	26.13
run10267	157.1	4.008	90	4.8	0.3	2.333	50%	2.59	0.75	0.81	3.00	5877	5656	2	1082	23	428	16.98	26.01	19.91	26.15
run10268	119.6	2.689	90	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.50	4526	4306	0	1192	23	451	18.63	26.00	19.91	25.77
run10269	138.9	3.051	90	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.75	5219	5000	0	1078	23	447	17.86	26.00	19.91	25.81
run10270	158.8	3.331	90	4.8	0.3	2.333	50%	1.63	0.46	0.68	3.00	5934	5715	0	973	23	443	17.03	26.01	19.90	25.83

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10271	79.31	1.803	90	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.50	3074	2855	0	1484	23	462	19.80	25.97	19.87	25.72
run10272	91.96	2.112	90	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.75	3530	3311	0	1395	23	459	19.76	25.97	19.89	25.73
run10273	105.1	2.276	90	4.8	0.6	1.455	30%	5.15	0.85	0.90	3.00	4004	3785	0	1265	23	456	19.40	25.96	19.90	25.73
run10274	71.84	1.699	90	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.50	2806	2586	0	1690	22	457	19.80	25.99	19.89	25.74
run10275	83.62	1.829	90	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.75	3230	3010	0	1379	23	454	19.76	25.97	19.90	25.74
run10276	96.01	2.091	90	4.8	0.6	1.455	30%	2.59	0.75	0.81	3.00	3676	3457	0	1272	22	451	19.54	25.97	19.91	25.74
run10277	73.2	1.381	90	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.50	2854	2635	0	1386	23	473	19.80	25.32	19.90	25.04
run10278	85.13	1.625	90	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.75	3284	3065	0	1318	23	470	19.76	25.28	19.92	25.01
run10279	97.62	1.803	90	4.8	0.6	1.455	30%	1.63	0.46	0.68	3.00	3733	3514	0	1220	22	467	19.58	25.24	19.92	24.99
run10280	98.64	2.397	90	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.50	3770	3551	0	1488	22	446	19.62	26.01	19.92	25.87
run10281	114.7	2.797	90	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.75	4349	4129	0	1451	22	442	18.89	26.01	19.94	25.88
run10282	131.4	3.064	90	4.8	0.6	1.455	40%	5.15	0.85	0.90	3.00	4949	4730	0	1219	22	438	18.17	26.01	19.94	25.91
run10283	88.29	2.239	90	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.50	3398	3178	0	1413	22	439	19.70	26.01	19.95	25.90
run10284	103.2	2.483	90	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.75	3936	3716	0	1375	22	435	19.05	26.01	19.96	25.90
run10285	118.7	2.863	90	4.8	0.6	1.455	40%	2.59	0.75	0.81	3.00	4493	4273	0	1324	22	431	18.33	26.01	19.97	25.90
run10286	89.94	1.777	90	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.50	3457	3238	0	1271	22	457	19.72	25.48	19.96	25.19
run10287	105	2.002	90	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.75	3998	3779	0	1224	22	453	19.10	25.44	19.97	25.17
run10288	120.6	2.219	90	4.8	0.6	1.455	40%	1.63	0.46	0.68	3.00	4563	4343	0	1100	22	449	18.39	25.47	19.97	25.22
run10289	118.1	2.919	90	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.50	4470	4251	0	1332	22	432	18.61	26.01	19.95	25.99
run10290	137.3	3.281	90	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.75	5164	4945	1	1282	22	428	17.85	26.01	19.95	26.02
run10291	157.2	3.741	90	4.8	0.6	1.455	50%	5.15	0.85	0.90	3.00	5878	5659	1	1236	23	424	17.00	26.01	19.94	26.04
run10292	104.8	2.653	90	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.50	3992	3773	1	1230	22	424	18.77	26.01	19.98	26.02
run10293	122.6	3.002	90	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.75	4632	4412	1	1188	22	420	18.02	26.01	19.98	26.03
run10294	140.9	3.28	90	4.8	0.6	1.455	50%	2.59	0.75	0.81	3.00	5293	5073	1	1154	22	416	17.18	26.01	19.98	26.04
run10295	106.6	2.251	90	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.50	4056	3837	0	1321	21	442	18.81	25.70	19.98	25.40
run10296	124.5	2.453	90	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.75	4702	4483	0	1188	22	437	18.01	25.67	19.99	25.40
run10297	143.1	2.713	90	4.8	0.6	1.455	50%	1.63	0.46	0.68	3.00	5370	5151	0	1101	22	433	17.26	25.69	19.99	25.44
run10298	72.68	1.492	90	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.50	2836	2617	0	1594	22	457	19.80	25.87	19.96	25.59
run10299	84.61	1.722	90	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.75	3265	3046	0	1460	22	454	19.76	25.85	19.97	25.58
run10300	97.05	1.878	90	4.8	0.9	1.057	30%	5.15	0.85	0.90	3.00	3713	3494	0	1348	22	450	19.56	25.84	19.97	25.58
run10301	65.27	1.285	90	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.50	2569	2350	0	1686	22	451	19.80	25.88	19.97	25.61
run10302	76.35	1.482	90	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.75	2968	2749	0	1426	22	448	19.77	25.87	19.99	25.61
run10303	87.98	1.673	90	4.8	0.9	1.057	30%	2.59	0.75	0.81	3.00	3387	3167	0	1294	22	444	19.63	25.87	19.99	25.60
run10304	66.73	1.115	90	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.50	2622	2402	0	1432	22	470	19.80	25.06	19.96	24.78
run10305	77.96	1.244	90	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.75	3026	2807	0	1329	22	467	19.77	25.01	19.97	24.75
run10306	89.77	1.4	90	4.8	0.9	1.057	30%	1.63	0.46	0.68	3.00	3451	3232	0	1177	22	464	19.66	24.97	19.98	24.72
run10307	92.23	1.938	90	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.50	3540	3320	0	1523	22	441	19.68	26.00	19.98	25.81
run10308	107.6	2.218	90	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.75	4094	3875	0	1489	22	437	19.03	26.01	19.98	25.81
run10309	123.6	2.516	90	4.8	0.9	1.057	40%	5.15	0.85	0.90	3.00	4669	4449	0	1038	22	433	18.30	26.00	19.98	25.81
run10310	81.94	1.758	90	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.50	3169	2950	0	1417	21	434	19.74	26.00	20.01	25.83
run10311	96.18	2	90	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.75	3682	3463	0	1344	21	429	19.17	26.00	20.01	25.84
run10312	111	2.237	90	4.8	0.9	1.057	40%	2.59	0.75	0.81	3.00	4216	3997	0	1329	21	425	18.50	26.01	20.01	25.83
run10313	83.73	1.539	90	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.50	3233	3014	0	1339	21	453	19.74	25.23	20.01	24.96
run10314	98.14	1.697	90	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.75	3752	3533	0	1306	21	449	19.19	25.19	20.02	24.94
run10315	113.2	1.871	90	4.8	0.9	1.057	40%	1.63	0.46	0.68	3.00	4294	4075	0	1067	21	445	18.44	25.15	20.02	24.91
run10316	112	2.356	90	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.50	4252	4033	0	1338	21	428	18.72	26.01	19.98	25.94
run10317	130.6	2.791	90	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.75	4922	4702	0	1278	22	423	17.95	26.01	19.98	25.94
run10318	149.9	3.254	90	4.8	0.9	1.057	50%	5.15	0.85	0.90	3.00	5615	5396	0	1239	22	419	17.13	26.01	19.98	25.95
run10319	98.74	2.186	90	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.50	3774	3555	0	1208	21	419	18.85	26.01	20.01	25.97
run10320	115.9	2.413	90	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.75	4391	4171	0	1187	21	415	18.16	26.01	20.02	25.97
run10321	133.6	2.737	90	4.8	0.9	1.057	50%	2.59	0.75	0.81	3.00	5030	4810	0	1144	21	410	17.30	26.01	20.02	25.98
run10322	100.8	1.775	90	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.50	3847	3628	0	1430	21	439	19.00	25.43	20.02	25.14
run10323	118.2	2.12	90	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.75	4473	4254	0	1322	21	434	18.17	25.38	20.03	25.10
run10324	136.1	2.271	90	4.8	0.9	1.057	50%	1.63	0.46	0.68	3.00	5120	4901	0	1199	21	430	17.41	25.34	20.03	25.08
run10325	119.7	3.07	90	6	0.3	2.333	30%	5.15	0.85	0.90	2.50	4528	4308	1	1467	24	470	19.51	26.01	19.74	26.00
run10326	137.7	3.444	90	6	0.3	2.333	30%	5.15	0.85	0.90	2.75	5178	4958	1	1397	24	466	18.71	26.01	19.75	26.02
run10327	156.3	3.776	90	6	0.3	2.333	30%	5.15	0.85	0.90	3.00	5848	5628	1	1121	25	463	18.07	26.01	19.74	26.04
run10328	110	2.77	90	6	0.3	2.333	30%	2.59	0.75	0.81	2.50	4181	3962	1	1545	24	466	19.63	26.01	19.76	26.01
run10329	127	3.084	90	6	0.3	2.333	30%	2.59	0.75	0.81	2.75	4793	4573	1	1382	24	462	18.87	26.01	19.77	26.03
run10330	144.6	3.419	90	6	0.3	2.333	30%	2.59	0.75	0.81	3.00	5424	5204	1	1280	24	459	18.21	26.01	19.77	26.05
run10331	111.2	2.288	90	6	0.3	2.333	30%	1.63	0.46	0.68	2.50	4221	4002	0	1304	24	478	19.66	26.00	19.76	25.76
run10332	128.2	2.562	90	6	0.3	2.333	30%	1.63	0.46	0.68	2.75	4834	4614	0	1181	24	475	18.90	26.00	19.78	25.78
run10333	145.8	2.769	90	6	0.3	2.333	30%	1.63	0.46	0.68	3.00	5469	5249	0	1080	24	472	18.25	26.00	19.78	25.81
run10334	143.6	4.026	90	6	0.3	2.333	40%	5.15	0.85	0.90	2.50	5390	5169	2	1245	24	451	18.28	26.01	19.81	26.11
run10335	165.5	4.537	90	6	0.3	2.333	40%	5.15	0.85	0.90	2.75	6180	5959	2	1192	24	447	17.35	26.01	19.80	26.13
run10336	187.8	4.972	90	6	0.3	2.333	40%	5.15	0.85	0.90	3.00	6982	6761	2	1266	25	444	16.65	26.01	19.75	26.15
run10337	130.3	3.66	90	6	0.3	2.333	40%	2.59	0.75	0.81	2.50	4912	4691	2	1217	24	446	18.36	26.01	19.83	26.12
run10338	150.7	4.175	90	6	0.3	2.333	40%	2.59	0.75	0.81	2.75	5648	5427	2	1151	24	442	17.54	26.01	19.83	26.14
run10339	171.7	4.47	90	6	0.3	2.333	40%	2.59	0.75	0.81	3.00	6402	6180	2	1109	25	439	16.77	26.01	19.79	26.16
run10340	131.5	2.952	90	6	0.3	2.333	40%	1.63	0.46	0.68	2.50	4955	4736	0	1128	24	460	18.43	26.01	19.84	25.84
run10341	152.1	3.264	90	6	0.3	2.333	40%	1.63	0.46	0.68	2.75	5694	5475	0	1052	24	456	17.60	26.01	19.85	25.87
run10342	173.1	3.718	90	6	0.3	2.333	40%	1.63	0.46	0.68	3.00	6450	6231	0	968	24	452	16.81	26.01	19.81	25.88
run10343	167.1	4.976	90	6	0.3	2.333	50%	5.15	0.85	0.90	2.50	6239	6017	3	1367	24	436	17.14	26.01	19.82	26.20
run10344	192.4	5.519	90	6	0.3	2.333	50%	5.15	0.85	0.90	2.75	7148	6926	3	1284	25	433	16.34	26.02	19.75	26.22
run10345	217.5	6.133	90	6	0.3	2.333	50%	5.15	0.85	0.90	3.00	8055	7832	4	1017	29	430	15.55	26.02	19.68	26.23
run10346	150.1	4.441	90	6	0.3	2.333	50%	2.59	0.75	0.81	2.50	5625	5402	4	1256	24	430	17.42	26.02	19.87	26.21
run10347	173.5	4.999	90	6	0.3	2.333	50%	2.59	0.75	0.81	2.75	6470	6246	4	1220	24	426	16.55	26.02	19.82	26.23
run10348	197	5.43	90	6	0.3	2.333	50%	2.59	0.75	0.81	3.00	7318	7093	5	1167	25	423	15.77	26.02	19.73	26.24
run10349	151.4	3.579	90	6	0.3	2.333	50%	1.63	0.46	0.68	2.50	5669	5449	0	1019	24	444	17.48	26.01	19.88	25.93
run10350	174.9	3.998	90	6	0.3	2.333	50%	1.63	0.46	0.68	2.75	6515	6295	0	976	24	439	16.53	26.01	19.85	25.95
run10351	198.5	4.454	90	6	0.3	2.333	50%	1.63	0.46	0.68	3.00	7365	7145	0	893	25	436	15.85	26.01	19.75	25.97
run10352	101	2.435	90	6	0.6	1.455	30%	5.15	0.85	0.90	2.50	3856	3637	0	1611	23	456	19.71	26.01	19.84	25.84
run10353	117	2.753	90	6	0.6	1.455	30%	5.15	0.85	0.90	2.75	4431	4212	0	1370	23	453	19.04	26.01	19.86	25.85
run10354	133.6	3.06	90	6	0.6	1.455	30%	5.15	0.85	0.90	3.00	5029	4810	0	1229	23	449	18.36	26.01	19.86	25.88
run10355	91.39	2.19	90	6	0.6	1.455	30%	2.59	0.75	0.81	2.50	3510	3290	0	1475	23	451	19.74	26.01	19.86	25.86
run10356	106.3	2.456	90	6	0.6	1.455	30%	2.59	0.75	0.81	2.75	4047	3828	0	1454	23	447	19.18	26.01	19.88	25.86
run10357	121.9	2.734	90	6	0.6	1.455	30%	2.59	0.75	0.81	3.00	4607	4388	0	1243	23	444	18.52	26.01	19.89	25.88
run10358	92.85	1.838	90	6	0.6	1.455	30%	1.63	0.46	0.68	2.50	3562	3343	0	1532	22	467	19.75	25.53	19.87	25.23
run10359	107.9	2.066	90	6	0.6	1.455	30%	1.63	0.46	0.68	2.75	4104	3885	0	1415	23	463	19.22	25.49	19.89	25.21
run10360	123.5	2.274	90	6	0.6	1.455	30%	1.63	0.46	0.68	3.00	4667	4448	0	1277	23	460	18.56	25.53	19.90	25.27
run10361	125.5	3.247	90	6	0.6	1.455	40%	5.15	0.85	0.90	2.50	4739	4519	0	1354	23	439	18.44	26.01	19.90	25.99
run10362	145.6	3.649	90	6	0.6	1.455	40%	5.15	0.85	0.90	2.75	5461	5241	1	1291	23	434	17.67	26.01	19.91	26.02
run10363	166.1	4.078	90	6	0.6	1.455	40%	5.15	0.85	0.90	3.00	6199	5979	1	1261	23	430	16.87	26.01	19.91	26.04
run10364	112.2	2.934	90	6	0.6	1.455	40%	2.59	0.75	0.81	2.50	4259	4039	1	1275	22	432	18.67	26.01	19.93	26.01
run10365	130.8	3.334	90	6	0.6	1.455	40%	2.59	0.75	0.81	2.75	4928	4709	1	1215	22	427	17.87	26.01	19.94	26.02
run10366	149.9	3.684	90	6	0.6	1.455	40%	2.59	0.75	0.81	3.00	5615	5395	1	1195	23	423	17.06	26.01	19.95	26.04
run10367	113.9	2.409	90	6	0.6	1.455	40%	1.63	0.46	0.68	2.50	4321	4101	0	1403	22	448	18.71	25.75	19.94	25.44
run10368	132.6	2.705	90	6	0.6	1.455	40%	1.63	0.46	0.68	2.75	4994	4775	0	1292	22	444	17.93	25.74	19.95	25.48
run10369	151.9	3.016	90	6	0.6	1.455	40%	1.63	0.46	0.68	3.00	5686	5467	0	1173	23	440	17.11	25.78	19.95	25.52
run10370	150	3.936	90	6	0.6	1.455	50%	5.15	0.85	0.90	2.50	5620	5399	1	1178	23	424	17.44	26.01	19.92	26.13
run10371	173.6	4.537	90	6	0.6	1.455	50%	5.15	0.85	0.90	2.75	6471	6251	2	1152	23	420	16.58	26.02	19.92	26.15
run10372	197.3	5.075	90	6	0.6	1.455	50%	5.15	0.85	0.90	3.00	7325	7104	2	1094	24	417	15.82	26.02	19.88	26.17
run10373	132.9	3.592	90	6	0.6	1.455	50%	2.59	0.75	0.81	2.50	5005	4784	2	1288	22	416	17.64	26.02	19.96	26.15
run10374	154.7	4.158	90	6	0.6	1.455	50%	2.59	0.75	0.81	2.75	5789	5568	2	1244	23	412	16.71	26.02	19.96	26.16
run10375	176.6	4.583	90	6	0.6	1.455	50%	2.59	0.75	0.81	3.00	6580	6359	2	1020	23	408	16.03	26.02	19.95	26.18
run10376	134.6	2.953	90	6	0.6	1.455	50%	1.63	0.46	0.68	2.50	5067	4847	0	1271	22	432	17.71	25.99	19.97	25.68
run10377	156.6	3.383	90	6	0.6	1.455	50%	1.63	0.46	0.68	2.75	5857	5638	0	1169	22	428	16.83	26.00	19.97	25.71
run10378	178.8	3.818	90	6	0.6	1.455	50%	1.63	0.46	0.68	3.00	6655	6435	0	1118	23	424	16.08	26.00	19.97	25.75
run10379	92.49	1.971	90	6	0.9	1.057	30%	5.15	0.85	0.90	2.50	3549	3330	0	1623	22	450	19.75	26.00	19.95	25.75
run10380	107.5	2.276	90	6	0.9	1.057	30%	5.15	0.85	0.90	2.75	4091	3872	0	1142	22	446	19.21	25.99	19.95	25.75
run10381	123.3	2.563	90	6	0.9	1.057	30%	5.15	0.85	0.90	3.00	4658	4439	0	1074	22	443	18.56	25.98	19.96	25.75
run10382	82.96	1.777	90	6	0.9	1.057	30%	2.59	0.75	0.81	2.50	3206	2987	0	1504	22	444	19.75	26.00	19.96	25.78
run10383	96.96	1.999	90	6	0.9	1.057	30%	2.59	0.75	0.81	2.75	3710	3491	0	1449	22	440	19.31	26.00	19.97	25.77
run10384	111.6	2.259	90	6	0.9	1.057	30%	2.59	0.75	0.81	3.00	4237	4017	0	1384	22	436	18.65	25.99	19.98	25.78
run10385	84.6	1.466	90	6	0.9	1.057	30%	1.63	0.46	0.68	2.50	3265	3046	0	1357	22	463	19.75	25.23	19.95	24.96
run10386	98.79	1.647	90	6	0.9	1.057	30%	1.63	0.46	0.68	2.75	3776	3557	0	1247	22	459	19.33	25.18	19.96	24.92
run10387	113.6	1.849	90	6	0.9	1.057	30%	1.63	0.46	0.68	3.00	4309	4089	0	1134	21	455	18.72	25.15	19.97	24.90
run10388	117.4	2.644	90	6	0.9	1.057	40%	5.15	0.85	0.90	2.50	4444	4225	0	1338	22	433	18.57	26.01	19.96	25.92
run10389	136.6	3.057	90	6	0.9	1.057	40%	5.15	0.85	0.90	2.75	5135	4916	0	1303	22	428	17.87	26.01	19.96	25.92
run10390	156.3	3.401	90	6	0.9	1.057	40%	5.15	0.85	0.90	3.00	5846	5627	0	1256	22	424	17.02	26.01	19.96	25.93
run10391	104.1	2.365	90	6	0.9	1.057	40%	2.59	0.75	0.81	2.50	3966	3747	0	1267	22	425	18.79	26.01	19.99	25.95
run10392	121.8	2.727	90	6	0.9	1.057	40%	2.59	0.75	0.81	2.75	4604	4384	0	1208	22	420	18.05	26.01	19.99	25.95
run10393	140.1	3.063	90	6	0.9	1.057	40%	2.59	0.75	0.81	3.00	5263	5044	0	1176	22	416	17.21	26.01	20.00	25.95
run10394	106	1.992	90	6	0.9	1.057	40%	1.63	0.46	0.68	2.50	4037	3817	0	1439	21	444	18.83	25.46	20.00	25.16
run10395	123.9	2.259	90	6	0.9	1.057	40%	1.63	0.46	0.68	2.75	4681	4462	0	1373	21	439	18.11	25.42	20.00	25.13
run10396	142.4	2.538	90	6	0.9	1.057	40%	1.63	0.46	0.68	3.00	5347	5128	0	1303	22	435	17.27	25.37	20.00	25.10
run10397	142.3	3.244	90	6	0.9	1.057	50%	5.15	0.85	0.90	2.50	5341	5121	1	1393	22	419	17.56	26.01	19.96	26.06
run10398	165.1	3.75	90	6	0.9	1.057	50%	5.15	0.85	0.90	2.75	6165	5945	1	1124	22	415	16.65	26.01	19.97	26.07
run10399	188.2	4.233	90	6	0.9	1.057	50%	5.15	0.85	0.90	3.00	6994	6774	1	1059	23	411	15.97	26.02	19.94	26.08
run10400	125.2	2.88	90	6	0.9	1.057	50%	2.59	0.75	0.81	2.50	4726	4506	1	1275	22	410	17.78	26.02	20.00	26.10
run10401	146.2	3.351	90	6	0.9	1.057	50%	2.59	0.75	0.81	2.75	5482	5262	1	1226	22	405	16.92	26.02	20.01	26.10
run10402	167.4	3.809	90	6	0.9	1.057	50%	2.59	0.75	0.81	3.00	6248	6028	1	1004	22	401	16.12	26.02	19.99	26.11
run10403	127.3	2.413	90	6	0.9	1.057	50%	1.63	0.46	0.68	2.50	4801	4582	0	1387	21	428	17.86	25.75	20.01	25.44
run10404	148.5	2.801	90	6	0.9	1.057	50%	1.63	0.46	0.68	2.75	5566	5347	0	1287	21	423	16.97	25.71	20.02	25.42
run10405	170.1	3.141	90	6	0.9	1.057	50%	1.63	0.46	0.68	3.00	6343	6124	0	1173	22	419	16.28	25.67	20.02	25.39

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10406	152.3	3.867	90	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.50	5702	5482	2	1464	25	466	18.41	26.01	19.68	26.10
run10407	174.7	4.36	90	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.75	6510	6289	2	1280	26	463	17.56	26.01	19.65	26.11
run10408	197.5	4.764	90	7.5	0.3	2.333	30%	5.15	0.85	0.90	3.00	7332	7110	2	1209	26	460	16.76	26.01	19.59	26.14
run10409	139.9	3.484	90	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.50	5259	5038	2	1461	25	462	18.43	26.01	19.71	26.10
run10410	161.1	3.928	90	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.75	6021	5799	2	1256	25	459	17.61	26.01	19.69	26.12
run10411	182.6	4.285	90	7.5	0.3	2.333	30%	2.59	0.75	0.81	3.00	6795	6573	3	1181	26	456	16.96	26.01	19.64	26.13
run10412	141	2.876	90	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.50	5294	5075	0	1142	25	474	18.48	26.01	19.72	25.88
run10413	162.2	3.256	90	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.75	6058	5839	0	1024	25	470	17.65	26.01	19.71	25.90
run10414	183.8	3.532	90	7.5	0.3	2.333	30%	1.63	0.46	0.68	3.00	6835	6616	0	919	26	468	16.93	26.01	19.66	25.91
run10415	182.2	5.123	90	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.50	6781	6559	3	1146	25	447	16.93	26.02	19.69	26.20
run10416	208.7	5.743	90	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.75	7737	7514	4	1080	26	444	16.08	26.02	19.62	26.22
run10417	235.1	6.279	90	7.5	0.3	2.333	40%	5.15	0.85	0.90	3.00	8688	8465	4	1036	33	442	15.34	26.02	19.42	26.23
run10418	165.2	4.584	90	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.50	6169	5946	4	1127	25	442	17.11	26.02	19.74	26.20
run10419	190.1	5.129	90	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.75	7066	6842	5	1034	26	438	16.28	26.02	19.67	26.22
run10420	214.8	5.68	90	7.5	0.3	2.333	40%	2.59	0.75	0.81	3.00	7958	7733	5	1002	29	436	15.55	26.02	19.57	26.23
run10421	166.3	3.757	90	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.50	6205	5985	0	1059	25	454	17.17	26.01	19.76	25.96
run10422	191.2	4.283	90	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.75	7102	6882	0	993	25	451	16.35	26.01	19.70	25.98
run10423	216	4.753	90	7.5	0.3	2.333	40%	1.63	0.46	0.68	3.00	7997	7777	1	865	29	448	15.62	26.02	19.61	25.99
run10424	210.6	6.276	90	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.50	7806	7581	6	1086	26	433	15.88	26.02	19.63	26.29
run10425	240.3	6.981	90	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.75	8878	8652	7	1029	34	431	14.99	26.03	19.33	26.31
run10426	269.4	7.711	90	7.5	0.3	2.333	50%	5.15	0.85	0.90	3.00	9925	9698	8	967	44	431	14.19	26.03	18.57	26.32
run10427	188.9	5.525	90	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.50	7028	6801	7	1118	25	425	16.10	26.02	19.71	26.30
run10428	216.6	6.247	90	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.75	8025	7798	8	996	30	423	15.22	26.03	19.58	26.31
run10429	243.8	7.011	90	7.5	0.3	2.333	50%	2.59	0.75	0.81	3.00	9004	8775	9	938	40	422	14.42	26.03	18.92	26.32
run10430	189.9	4.591	90	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.50	7056	6836	1	1107	25	438	16.16	26.02	19.74	26.03
run10431	217.7	5.168	90	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.75	8056	7836	1	1022	29	435	15.30	26.02	19.62	26.05
run10432	244.9	5.651	90	7.5	0.3	2.333	50%	1.63	0.46	0.68	3.00	9038	8817	1	933	38	434	14.49	26.03	19.06	26.06
run10433	128.4	3.173	90	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.50	4842	4622	0	1503	23	451	18.60	26.01	19.81	25.95
run10434	148.3	3.518	90	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.75	5560	5340	0	1415	23	447	17.77	26.01	19.82	25.98
run10435	168.8	3.956	90	7.5	0.6	1.455	30%	5.15	0.85	0.90	3.00	6297	6077	0	1381	24	443	17.13	26.01	19.83	26.00
run10436	116	2.783	90	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.50	4397	4177	0	1384	23	446	18.78	26.01	19.83	25.96
run10437	134.7	3.128	90	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.75	5068	4849	0	1355	23	441	17.98	26.01	19.84	25.98
run10438	153.8	3.527	90	7.5	0.6	1.455	30%	2.59	0.75	0.81	3.00	5757	5537	0	1309	24	437	17.23	26.01	19.85	26.00
run10439	117.6	2.304	90	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.50	4454	4235	0	1221	23	461	18.82	25.74	19.84	25.43
run10440	136.4	2.629	90	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.75	5128	4909	0	1129	23	457	18.01	25.75	19.85	25.48
run10441	155.6	2.929	90	7.5	0.6	1.455	30%	1.63	0.46	0.68	3.00	5822	5603	0	1025	23	453	17.28	25.78	19.87	25.53
run10442	159.2	4.108	90	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.50	5950	5730	1	1220	23	432	17.29	26.02	19.86	26.11
run10443	183.6	4.722	90	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.75	6831	6611	1	1184	24	428	16.48	26.02	19.85	26.14
run10444	208.1	5.246	90	7.5	0.6	1.455	40%	5.15	0.85	0.90	3.00	7714	7493	2	1021	26	425	15.69	26.02	19.80	26.16
run10445	142.1	3.717	90	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.50	5337	5116	1	1167	23	425	17.52	26.01	19.89	26.12
run10446	164.8	4.326	90	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.75	6154	5933	1	1120	23	421	16.60	26.01	19.89	26.14
run10447	187.5	4.762	90	7.5	0.6	1.455	40%	2.59	0.75	0.81	3.00	6972	6751	2	1082	24	418	15.92	26.02	19.84	26.17
run10448	143.8	3.05	90	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.50	5397	5178	0	1234	23	441	17.58	26.00	19.90	25.70
run10449	166.6	3.491	90	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.75	6217	5997	0	1172	23	436	16.67	26.00	19.91	25.74
run10450	189.6	3.892	90	7.5	0.6	1.455	40%	1.63	0.46	0.68	3.00	7043	6824	0	1067	24	433	15.91	26.01	19.87	25.77
run10451	189.1	5.029	90	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.50	7028	6806	3	1164	24	418	16.13	26.02	19.86	26.25
run10452	217.1	5.828	90	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.75	8037	7814	4	1088	28	415	15.28	26.03	19.80	26.28
run10453	244.6	6.543	90	7.5	0.6	1.455	50%	5.15	0.85	0.90	3.00	9027	8804	4	1047	37	414	14.48	26.03	19.09	26.29
run10454	167.1	4.612	90	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.50	6239	6016	3	1084	23	410	16.44	26.02	19.92	26.26
run10455	193.1	5.309	90	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.75	7174	6951	4	1016	24	406	15.57	26.03	19.87	26.28
run10456	218.6	5.871	90	7.5	0.6	1.455	50%	2.59	0.75	0.81	3.00	8094	7871	4	975	33	405	14.74	26.03	19.43	26.31
run10457	168.9	3.636	90	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.50	6298	6079	0	1161	23	424	16.46	26.01	19.94	25.87
run10458	194.9	4.329	90	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.75	7236	7017	0	1038	24	421	15.62	26.01	19.87	25.90
run10459	220.7	4.724	90	7.5	0.6	1.455	50%	1.63	0.46	0.68	3.00	8164	7945	0	960	31	419	14.81	26.01	19.53	25.92
run10460	117.5	2.54	90	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.50	4451	4232	0	1466	22	444	18.79	26.01	19.93	25.85
run10461	136.4	2.907	90	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.75	5131	4912	0	1396	23	440	18.01	26.01	19.93	25.86
run10462	155.8	3.243	90	7.5	0.9	1.057	30%	5.15	0.85	0.90	3.00	5828	5609	0	1344	23	436	17.33	26.01	19.94	25.86
run10463	105.2	2.283	90	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.50	4008	3789	0	1395	22	437	18.94	26.01	19.95	25.88
run10464	122.8	2.599	90	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.75	4639	4420	0	1320	22	433	18.15	26.01	19.95	25.88
run10465	140.8	2.95	90	7.5	0.9	1.057	30%	2.59	0.75	0.81	3.00	5289	5070	0	1321	22	429	17.51	26.01	19.96	25.88
run10466	107.1	1.897	90	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.50	4074	3855	0	1311	22	456	18.99	25.40	19.93	25.11
run10467	124.8	2.166	90	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.75	4712	4493	0	1180	22	451	18.20	25.35	19.95	25.08
run10468	143	2.552	90	7.5	0.9	1.057	30%	1.63	0.46	0.68	3.00	5367	5148	0	1112	22	447	17.57	25.31	19.95	25.06
run10469	148.8	3.397	90	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.50	5576	5356	0	1224	23	426	17.49	26.01	19.94	26.03
run10470	172.3	3.901	90	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.75	6422	6202	1	1165	23	421	16.65	26.01	19.95	26.04
run10471	195.9	4.434	90	7.5	0.9	1.057	40%	5.15	0.85	0.90	3.00	7271	7051	1	964	24	418	15.86	26.02	19.89	26.04
run10472	131.8	3.03	90	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.50	4964	4744	1	1147	22	417	17.70	26.01	19.98	26.06
run10473	153.4	3.497	90	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.75	5741	5521	1	1094	23	413	16.77	26.01	19.98	26.07
run10474	175.3	3.963	90	7.5	0.9	1.057	40%	2.59	0.75	0.81	3.00	6529	6309	1	1050	23	409	16.09	26.02	19.95	26.06
run10475	133.8	2.536	90	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.50	5035	4816	0	1350	22	435	17.76	25.74	19.99	25.43
run10476	155.6	2.953	90	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.75	5822	5603	0	1211	22	430	16.89	25.67	19.99	25.38
run10477	177.8	3.258	90	7.5	0.9	1.057	40%	1.63	0.46	0.68	3.00	6618	6399	0	1096	23	427	16.11	25.65	19.97	25.37
run10478	179.3	4.192	90	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.50	6675	6454	2	1120	23	412	16.34	26.02	19.94	26.18
run10479	206.5	4.834	90	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.75	7654	7432	2	1064	25	409	15.46	26.02	19.89	26.19
run10480	233.4	5.521	90	7.5	0.9	1.057	50%	5.15	0.85	0.90	3.00	8623	8401	2	1019	34	408	14.60	26.03	19.32	26.20
run10481	157.4	3.853	90	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.50	5887	5666	2	1051	22	402	16.53	26.02	19.99	26.22
run10482	182.5	4.418	90	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.75	6792	6570	2	990	23	399	15.71	26.02	19.95	26.23
run10483	207.2	5.007	90	7.5	0.9	1.057	50%	2.59	0.75	0.81	3.00	7682	7461	2	942	30	397	14.92	26.03	19.68	26.23
run10484	159.6	3.102	90	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.50	5964	5744	0	1297	22	419	16.67	25.89	20.00	25.60
run10485	184.8	3.641	90	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.75	6873	6654	0	999	23	415	15.79	25.91	19.98	25.62
run10486	209.9	4.038	90	7.5	0.9	1.057	50%	1.63	0.46	0.68	3.00	7775	7555	0	898	29	413	15.00	25.95	19.78	25.66
run10487	100.2	2.326	180	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.50	3828	3609	0	1459	24	507	19.79	25.66	19.78	25.16
run10488	115.2	2.588	180	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.75	4368	4149	0	1338	24	504	19.75	25.67	19.79	25.25
run10489	130.7	2.89	180	4.8	0.3	2.333	30%	5.15	0.85	0.90	3.00	4925	4705	0	1200	24	501	19.20	25.69	19.81	25.29
run10490	91.95	2.154	180	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.50	3529	3310	0	1461	24	503	19.79	25.36	19.80	25.06
run10491	106	2.324	180	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.75	4037	3818	0	1348	24	500	19.76	25.42	19.81	25.12
run10492	120.6	2.578	180	4.8	0.3	2.333	30%	2.59	0.75	0.81	3.00	4561	4342	0	1238	24	497	19.32	25.45	19.81	25.17
run10493	92.16	1.859	180	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.50	3537	3318	0	1363	24	519	19.79	24.66	19.81	24.36
run10494	106.3	1.941	180	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.75	4044	3825	0	1289	23	516	19.76	24.71	19.81	24.42
run10495	120.8	2.099	180	4.8	0.3	2.333	30%	1.63	0.46	0.68	3.00	4569	4350	0	1083	23	513	19.36	24.74	19.82	24.46
run10496	120.3	3.021	180	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.50	4552	4333	0	1364	23	487	19.43	26.05	19.84	25.66
run10497	138.8	3.369	180	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.75	5215	4996	0	1190	23	483	18.66	26.07	19.83	25.71
run10498	157.8	3.756	180	4.8	0.3	2.333	40%	5.15	0.85	0.90	3.00	5899	5679	0	1095	24	479	18.00	26.07	19.83	25.75
run10499	108.9	2.698	180	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.50	4140	3921	0	1370	23	482	19.57	26.03	19.86	25.52
run10500	126.1	2.998	180	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.75	4760	4541	0	1202	23	478	18.86	26.04	19.86	25.58
run10501	143.9	3.33	180	4.8	0.3	2.333	40%	2.59	0.75	0.81	3.00	5400	5180	0	1090	23	474	18.15	26.04	19.86	25.63
run10502	109	2.363	180	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.50	4144	3925	0	1314	23	499	19.63	24.95	19.86	24.66
run10503	126.2	2.558	180	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.75	4763	4544	0	1153	23	495	18.93	25.01	19.86	24.72
run10504	144	2.763	180	4.8	0.3	2.333	40%	1.63	0.46	0.68	3.00	5402	5183	0	1097	23	491	18.20	25.05	19.86	24.78
run10505	140.3	3.692	180	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.50	5270	5051	0	1184	23	470	18.41	26.09	19.85	25.99
run10506	161.9	4.064	180	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.75	6048	5828	0	1104	23	466	17.66	26.10	19.85	26.00
run10507	184	4.475	180	4.8	0.3	2.333	50%	5.15	0.85	0.90	3.00	6843	6623	0	1079	24	462	16.90	26.11	19.85	26.01
run10508	125.7	3.361	180	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.50	4745	4526	0	1170	23	464	18.62	26.08	19.88	25.91
run10509	145.7	3.628	180	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.75	5466	5247	0	1146	23	459	17.86	26.07	19.88	25.92
run10510	166.2	4.014	180	4.8	0.3	2.333	50%	2.59	0.75	0.81	3.00	6204	5985	0	1114	23	455	17.03	26.08	19.88	25.90
run10511	125.6	2.689	180	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.50	4740	4521	0	1265	23	481	18.70	25.24	19.88	24.94
run10512	145.6	3.031	180	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.75	5459	5240	0	1163	23	476	17.91	25.32	19.88	25.01
run10513	166.1	3.331	180	4.8	0.3	2.333	50%	1.63	0.46	0.68	3.00	6198	5979	0	1071	23	472	17.07	25.33	19.88	25.06
run10514	85.3	1.803	180	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.50	3290	3071	0	1367	23	493	19.80	25.96	19.87	25.02
run10515	98.67	2.114	180	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.75	3771	3552	0	1195	23	490	19.76	25.99	19.88	25.09
run10516	112.5	2.276	180	4.8	0.6	1.455	30%	5.15	0.85	0.90	3.00	4269	4050	0	1171	23	487	19.42	25.99	19.89	25.14
run10517	77.04	1.699	180	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.50	2993	2773	0	1409	22	488	19.80	25.78	19.89	25.13
run10518	89.45	1.829	180	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.75	3439	3220	0	1219	22	485	19.76	25.76	19.90	25.01
run10519	102.5	2.09	180	4.8	0.6	1.455	30%	2.59	0.75	0.81	3.00	3908	3688	0	1140	22	482	19.56	25.78	19.91	25.00
run10520	77.45	1.381	180	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.50	3008	2788	0	1471	22	506	19.80	24.63	19.89	24.19
run10521	89.89	1.625	180	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.75	3455	3236	0	1209	22	503	19.76	24.49	19.89	24.12
run10522	102.9	1.803	180	4.8	0.6	1.455	30%	1.63	0.46	0.68	3.00	3923	3704	0	1133	22	499	19.62	24.51	19.90	24.18
run10523	106	2.387	180	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.50	4035	3815	0	1346	22	475	19.62	26.08	19.91	25.71
run10524	122.9	2.775	180	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.75	4644	4425	0	1227	22	470	18.89	26.07	19.91	25.77
run10525	140.4	3.069	180	4.8	0.6	1.455	40%	5.15	0.85	0.90	3.00	5273	5054	0	1179	22	466	18.18	26.08	19.91	25.73
run10526	94.59	2.239	180	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.50	3625	3405	0	1419	22	468	19.70	26.06	19.94	25.78
run10527	110.2	2.483	180	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.75	4188	3969	0	1290	22	464	19.07	26.05	19.94	25.72
run10528	126.5	2.771	180	4.8	0.6	1.455	40%	2.59	0.75	0.81	3.00	4774	4554	0	1166	22	459	18.35	26.06	19.94	25.81
run10529	94.93	1.777	180	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.50	3637	3418	0	1344	22	486	19.72	25.06	19.93	24.46
run10530	110.6	2.009	180	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.75	4201	3982	0	1197	22	482	19.11	25.03	19.94	24.50
run10531	126.8	2.219	180	4.8	0.6	1.455	40%	1.63	0.46	0.68	3.00	4785	4566	0	1118	22	477	18.42	25.06	19.94	24.56
run10532	126.7	2.908	180	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.50	4782	4563	0	1304	22	459	18.61	26.09	19.92	26.03
run10533	147	3.289	180	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.75	5510	5291	0	1188	22	454	17.85	26.09	19.92	26.09
run10534	167.7	3.741	180	4.8	0.6	1.455	50%	5.15	0.85	0.90	3.00	6257	6037	0	1116	23	450	17.00	26.11	19.93	26.15
run10535	112.1	2.653	180	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.50	4257	4037	0	1287	22	451	18.78	26.08	19.95	26.04
run10536	130.8	3.002	180	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.75	4927	4707	0	1202	22	446	18.03	26.09	19.96	26.09
run10537	150	3.28	180	4.8	0.6	1.455	50%	2.59	0.75	0.81	3.00	5619	5399	0	1071	22	442	17.19	26.10	19.96	26.11
run10538	112.3	2.251	180	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.50	4261	4042	0	1196	21	469	18.83	25.54	19.96	24.82
run10539	130.9	2.438	180	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.75	4932	4712	0	1179	22	464	18.03	25.56	19.96	24.85
run10540	150	2.718	180	4.8	0.6	1.455	50%	1.63	0.46	0.68	3.00	5621	5402	0	1040	22	460	17.28	25.56	19.97	24.90

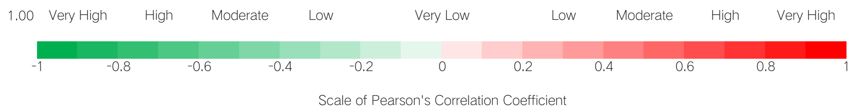
Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10541	78.54	1.492	180	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.50	3047	2828	0	1442	22	486	19.80	26.02	19.92	25.47
run10542	91.12	1.726	180	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.75	3499	3280	0	1309	22	483	19.76	26.00	19.93	25.10
run10543	104.3	1.878	180	4.8	0.9	1.057	30%	5.15	0.85	0.90	3.00	3973	3754	0	1293	22	479	19.55	26.01	19.94	25.08
run10544	70.28	1.285	180	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.50	2749	2530	0	1445	22	480	19.80	25.91	19.94	25.21
run10545	81.97	1.482	180	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.75	3170	2951	0	1309	22	477	19.77	25.85	19.95	25.03
run10546	94.21	1.727	180	4.8	0.9	1.057	30%	2.59	0.75	0.81	3.00	3611	3392	0	1351	21	473	19.67	25.86	19.96	25.02
run10547	70.76	1.115	180	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.50	2767	2547	0	1350	22	498	19.80	24.66	19.93	24.21
run10548	82.5	1.244	180	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.75	3189	2970	0	1323	22	495	19.77	24.65	19.94	24.21
run10549	94.78	1.393	180	4.8	0.9	1.057	30%	1.63	0.46	0.68	3.00	3631	3412	0	1207	22	491	19.66	24.52	19.95	24.02
run10550	99.52	1.937	180	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.50	3802	3583	0	1298	22	468	19.67	26.08	19.95	25.87
run10551	115.8	2.219	180	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.75	4387	4167	0	1184	22	464	19.01	26.08	19.96	25.83
run10552	132.5	2.538	180	4.8	0.9	1.057	40%	5.15	0.85	0.90	3.00	4990	4771	0	1139	22	459	18.29	26.08	19.96	25.98
run10553	88.15	1.758	180	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.50	3393	3173	0	1411	21	461	19.73	26.07	19.98	25.85
run10554	103.1	2.009	180	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.75	3932	3712	0	1276	21	456	19.16	26.07	19.98	25.81
run10555	118.7	2.237	180	4.8	0.9	1.057	40%	2.59	0.75	0.81	3.00	4493	4274	0	1163	21	452	18.49	26.06	19.99	25.89
run10556	88.58	1.539	180	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.50	3408	3189	0	1212	21	479	19.74	25.10	19.98	24.50
run10557	103.6	1.697	180	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.75	3947	3728	0	1212	21	475	19.17	25.07	19.99	24.43
run10558	119.2	1.853	180	4.8	0.9	1.057	40%	1.63	0.46	0.68	3.00	4510	4291	0	1174	21	470	18.44	25.12	20.00	24.49
run10559	120.7	2.336	180	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.50	4564	4345	0	1161	21	454	18.70	26.09	19.96	26.10
run10560	140.3	2.791	180	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.75	5270	5051	0	1055	22	449	17.93	26.10	19.96	26.12
run10561	160.4	3.254	180	4.8	0.9	1.057	50%	5.15	0.85	0.90	3.00	5994	5774	0	973	22	444	17.11	26.11	19.96	26.17
run10562	106.1	2.059	180	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.50	4039	3820	0	1234	21	445	18.84	26.07	19.99	26.03
run10563	124.1	2.412	180	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.75	4687	4468	0	1048	21	440	18.04	26.09	20.00	26.03
run10564	142.7	2.738	180	4.8	0.9	1.057	50%	2.59	0.75	0.81	3.00	5357	5137	0	987	21	435	17.38	26.08	20.00	26.09
run10565	106.4	1.775	180	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.50	4049	3830	0	1218	21	463	18.90	25.60	20.00	24.84
run10566	124.4	2.12	180	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.75	4697	4478	0	1141	21	458	18.15	25.58	20.00	24.70
run10567	143	2.277	180	4.8	0.9	1.057	50%	1.63	0.46	0.68	3.00	5367	5147	0	1097	21	453	17.39	25.68	20.01	24.96
run10568	127.5	3.07	180	6	0.3	2.333	30%	5.15	0.85	0.90	2.50	4809	4590	0	1345	24	503	19.57	26.02	19.74	25.47
run10569	146.4	3.444	180	6	0.3	2.333	30%	5.15	0.85	0.90	2.75	5488	5269	0	1281	24	499	18.74	26.03	19.75	25.53
run10570	165.8	3.746	180	6	0.3	2.333	30%	5.15	0.85	0.90	3.00	6188	5969	0	1096	25	495	18.12	26.02	19.74	25.60
run10571	116.9	2.727	180	6	0.3	2.333	30%	2.59	0.75	0.81	2.50	4427	4208	0	1313	24	499	19.66	25.81	19.76	25.37
run10572	134.6	3.084	180	6	0.3	2.333	30%	2.59	0.75	0.81	2.75	5066	4847	0	1279	24	495	18.91	25.86	19.77	25.42
run10573	152.9	3.419	180	6	0.3	2.333	30%	2.59	0.75	0.81	3.00	5724	5505	0	1088	24	492	18.25	25.88	19.76	25.49
run10574	116.9	2.288	180	6	0.3	2.333	30%	1.63	0.46	0.68	2.50	4429	4210	0	1286	24	514	19.68	24.94	19.76	24.64
run10575	134.6	2.553	180	6	0.3	2.333	30%	1.63	0.46	0.68	2.75	5066	4846	0	1214	24	511	18.98	24.98	19.78	24.69
run10576	152.9	2.829	180	6	0.3	2.333	30%	1.63	0.46	0.68	3.00	5725	5505	0	1082	24	507	18.30	25.02	19.78	24.74
run10577	152.9	4.042	180	6	0.3	2.333	40%	5.15	0.85	0.90	2.50	5724	5505	0	1283	24	481	18.31	26.08	19.80	25.85
run10578	175.8	4.555	180	6	0.3	2.333	40%	5.15	0.85	0.90	2.75	6548	6328	0	1209	25	477	17.41	26.09	19.79	25.93
run10579	199	4.958	180	6	0.3	2.333	40%	5.15	0.85	0.90	3.00	7385	7166	0	1025	25	473	16.71	26.10	19.74	25.97
run10580	138.3	3.66	180	6	0.3	2.333	40%	2.59	0.75	0.81	2.50	5198	4979	0	1222	24	475	18.42	26.07	19.83	25.78
run10581	159.6	4.131	180	6	0.3	2.333	40%	2.59	0.75	0.81	2.75	5967	5747	0	1201	24	471	17.57	26.06	19.83	25.82
run10582	181.4	4.47	180	6	0.3	2.333	40%	2.59	0.75	0.81	3.00	6751	6531	0	1122	25	467	16.83	26.08	19.79	25.86
run10583	138.1	2.952	180	6	0.3	2.333	40%	1.63	0.46	0.68	2.50	5190	4971	0	1221	24	492	18.52	25.25	19.83	24.95
run10584	159.4	3.271	180	6	0.3	2.333	40%	1.63	0.46	0.68	2.75	5956	5737	0	1099	24	488	17.69	25.29	19.83	25.01
run10585	181.1	3.68	180	6	0.3	2.333	40%	1.63	0.46	0.68	3.00	6740	6521	0	1083	24	484	16.88	25.33	19.81	25.07
run10586	177.8	4.976	180	6	0.3	2.333	50%	5.15	0.85	0.90	2.50	6623	6402	1	1303	24	463	17.17	26.12	19.82	26.16
run10587	204.2	5.519	180	6	0.3	2.333	50%	5.15	0.85	0.90	2.75	7571	7351	1	1196	25	459	16.35	26.13	19.76	26.25
run10588	230.5	6.133	180	6	0.3	2.333	50%	5.15	0.85	0.90	3.00	8519	8298	1	1097	29	456	15.55	26.16	19.66	26.20
run10589	159.2	4.441	180	6	0.3	2.333	50%	2.59	0.75	0.81	2.50	5951	5731	1	1137	24	456	17.46	26.10	19.85	26.04
run10590	183.7	4.999	180	6	0.3	2.333	50%	2.59	0.75	0.81	2.75	6832	6612	1	1019	24	452	16.58	26.12	19.82	26.09
run10591	208.2	5.445	180	6	0.3	2.333	50%	2.59	0.75	0.81	3.00	7714	7494	1	928	25	448	15.81	26.13	19.72	26.14
run10592	158.6	3.579	180	6	0.3	2.333	50%	1.63	0.46	0.68	2.50	5929	5710	0	1137	24	473	17.51	25.80	19.86	25.27
run10593	183	3.998	180	6	0.3	2.333	50%	1.63	0.46	0.68	2.75	6806	6587	0	1075	24	468	16.59	25.81	19.84	25.32
run10594	207.5	4.454	180	6	0.3	2.333	50%	1.63	0.46	0.68	3.00	7688	7468	0	1009	25	465	15.92	25.85	19.75	25.39
run10595	108.4	2.435	180	6	0.6	1.455	30%	5.15	0.85	0.90	2.50	4122	3903	0	1519	23	488	19.69	26.06	19.84	25.62
run10596	125.3	2.753	180	6	0.6	1.455	30%	5.15	0.85	0.90	2.75	4729	4510	0	1355	23	484	19.05	26.06	19.86	25.68
run10597	142.7	3.069	180	6	0.6	1.455	30%	5.15	0.85	0.90	3.00	5356	5137	0	1250	23	480	18.38	26.07	19.86	25.63
run10598	97.83	2.19	180	6	0.6	1.455	30%	2.59	0.75	0.81	2.50	3741	3522	0	1461	23	483	19.75	26.04	19.86	25.58
run10599	113.5	2.456	180	6	0.6	1.455	30%	2.59	0.75	0.81	2.75	4306	4086	0	1166	23	478	19.21	26.03	19.88	25.53
run10600	129.8	2.734	180	6	0.6	1.455	30%	2.59	0.75	0.81	3.00	4892	4673	0	1029	23	475	18.54	26.04	19.88	25.46
run10601	98.14	1.833	180	6	0.6	1.455	30%	1.63	0.46	0.68	2.50	3752	3533	0	1353	23	500	19.75	24.85	19.87	24.32
run10602	113.8	2.066	180	6	0.6	1.455	30%	1.63	0.46	0.68	2.75	4316	4097	0	1129	23	496	19.26	24.82	19.88	24.39
run10603	130.1	2.26	180	6	0.6	1.455	30%	1.63	0.46	0.68	3.00	4902	4683	0	1042	23	492	18.59	24.86	19.88	24.44
run10604	134.6	3.259	180	6	0.6	1.455	40%	5.15	0.85	0.90	2.50	5065	4845	0	1267	22	467	18.48	26.10	19.89	25.96
run10605	155.6	3.649	180	6	0.6	1.455	40%	5.15	0.85	0.90	2.75	5821	5602	0	1170	23	462	17.71	26.11	19.89	26.08
run10606	177.1	4.087	180	6	0.6	1.455	40%	5.15	0.85	0.90	3.00	6595	6375	0	1055	23	458	16.89	26.12	19.89	26.00
run10607	120	2.934	180	6	0.6	1.455	40%	2.59	0.75	0.81	2.50	4540	4320	0	1186	22	460	18.68	26.09	19.92	25.97
run10608	139.5	3.331	180	6	0.6	1.455	40%	2.59	0.75	0.81	2.75	5240	5020	0	1032	22	455	17.91	26.08	19.92	26.02
run10609	159.5	3.684	180	6	0.6	1.455	40%	2.59	0.75	0.81	3.00	5961	5741	0	1004	23	451	17.07	26.11	19.93	26.01
run10610	120.1	2.409	180	6	0.6	1.455	40%	1.63	0.46	0.68	2.50	4543	4324	0	1282	22	478	18.74	25.48	19.92	24.73
run10611	139.5	2.678	180	6	0.6	1.455	40%	1.63	0.46	0.68	2.75	5241	5022	0	1114	22	473	17.94	25.49	19.93	24.78
run10612	159.5	3.014	180	6	0.6	1.455	40%	1.63	0.46	0.68	3.00	5960	5741	0	1037	23	469	17.14	25.54	19.92	24.84
run10613	160.6	3.925	180	6	0.6	1.455	50%	5.15	0.85	0.90	2.50	6003	5783	1	1077	23	451	17.45	26.11	19.90	26.23
run10614	185.3	4.537	180	6	0.6	1.455	50%	5.15	0.85	0.90	2.75	6893	6673	1	982	23	446	16.59	26.13	19.90	26.40
run10615	210.1	5.075	180	6	0.6	1.455	50%	5.15	0.85	0.90	3.00	7784	7563	1	1011	24	443	15.80	26.14	19.89	26.31
run10616	141.9	3.592	180	6	0.6	1.455	50%	2.59	0.75	0.81	2.50	5330	5110	1	1119	22	442	17.66	26.10	19.94	26.27
run10617	164.8	4.158	180	6	0.6	1.455	50%	2.59	0.75	0.81	2.75	6152	5932	1	1036	23	437	16.77	26.11	19.94	26.32
run10618	187.7	4.583	180	6	0.6	1.455	50%	2.59	0.75	0.81	3.00	6976	6756	1	963	23	433	15.96	26.12	19.94	26.36
run10619	141.7	2.955	180	6	0.6	1.455	50%	1.63	0.46	0.68	2.50	5320	5101	0	1291	22	460	17.73	26.02	19.95	25.30
run10620	164.4	3.383	180	6	0.6	1.455	50%	1.63	0.46	0.68	2.75	6137	5918	0	1110	23	454	16.85	26.02	19.95	25.33
run10621	187.3	3.818	180	6	0.6	1.455	50%	1.63	0.46	0.68	3.00	6962	6743	0	1152	23	450	16.12	26.04	19.95	25.47
run10622	99.79	1.971	180	6	0.9	1.057	30%	5.15	0.85	0.90	2.50	3812	3592	0	1401	22	480	19.75	26.05	19.90	25.70
run10623	115.7	2.247	180	6	0.9	1.057	30%	5.15	0.85	0.90	2.75	4385	4166	0	1351	22	475	19.21	26.07	19.91	25.80
run10624	132.2	2.564	180	6	0.9	1.057	30%	5.15	0.85	0.90	3.00	4980	4761	0	1263	22	471	18.53	26.07	19.92	25.81
run10625	89.22	1.817	180	6	0.9	1.057	30%	2.59	0.75	0.81	2.50	3431	3212	0	1337	22	474	19.75	26.03	19.93	25.67
run10626	104	2.029	180	6	0.9	1.057	30%	2.59	0.75	0.81	2.75	3962	3743	0	1273	22	469	19.31	26.04	19.94	25.57
run10627	119.4	2.259	180	6	0.9	1.057	30%	2.59	0.75	0.81	3.00	4517	4297	0	1097	22	465	18.65	26.05	19.94	25.56
run10628	89.64	1.471	180	6	0.9	1.057	30%	1.63	0.46	0.68	2.50	3446	3227	0	1322	22	492	19.75	24.87	19.92	24.26
run10629	104.4	1.73	180	6	0.9	1.057	30%	1.63	0.46	0.68	2.75	3979	3760	0	1275	22	488	19.34	24.83	19.93	24.18
run10630	119.8	1.849	180	6	0.9	1.057	30%	1.63	0.46	0.68	3.00	4533	4314	0	1090	22	483	18.68	24.87	19.93	24.20
run10631	126.4	2.644	180	6	0.9	1.057	40%	5.15	0.85	0.90	2.50	4770	4550	0	1164	22	460	18.61	26.11	19.94	26.13
run10632	146.6	3.028	180	6	0.9	1.057	40%	5.15	0.85	0.90	2.75	5496	5277	0	1090	22	455	17.85	26.10	19.94	26.10
run10633	167.3	3.401	180	6	0.9	1.057	40%	5.15	0.85	0.90	3.00	6241	6022	0	1003	22	451	17.01	26.10	19.95	26.08
run10634	111.8	2.381	180	6	0.9	1.057	40%	2.59	0.75	0.81	2.50	4244	4025	0	1210	22	452	18.78	26.08	19.97	25.99
run10635	130.4	2.726	180	6	0.9	1.057	40%	2.59	0.75	0.81	2.75	4915	4696	0	1105	22	447	18.03	26.07	19.97	26.05
run10636	149.6	3.054	180	6	0.9	1.057	40%	2.59	0.75	0.81	3.00	5605	5386	0	1027	22	442	17.20	26.08	19.98	26.03
run10637	112	1.992	180	6	0.9	1.057	40%	1.63	0.46	0.68	2.50	4252	4033	0	1280	21	471	18.83	25.52	19.97	24.73
run10638	130.6	2.259	180	6	0.9	1.057	40%	1.63	0.46	0.68	2.75	4923	4703	0	1148	21	465	18.04	25.62	19.98	24.88
run10639	149.8	2.538	180	6	0.9	1.057	40%	1.63	0.46	0.68	3.00	5611	5392	0	1096	21	460	17.27	25.58	19.98	24.69
run10640	153	3.244	180	6	0.9	1.057	50%	5.15	0.85	0.90	2.50	5727	5506	1	1050	22	445	17.53	26.11	19.94	26.34
run10641	176.9	3.74	180	6	0.9	1.057	50%	5.15	0.85	0.90	2.75	6590	6370	1	963	22	440	16.68	26.13	19.95	26.39
run10642	200.9	4.233	180	6	0.9	1.057	50%	5.15	0.85	0.90	3.00	7454	7234	1	892	23	436	15.93	26.12	19.95	26.54
run10643	134.3	2.9	180	6	0.9	1.057	50%	2.59	0.75	0.81	2.50	5053	4834	1	1116	22	435	17.76	26.09	19.98	26.29
run10644	156.2	3.351	180	6	0.9	1.057	50%	2.59	0.75	0.81	2.75	5845	5625	1	983	22	430	16.86	26.11	19.98	26.33
run10645	178.5	3.809	180	6	0.9	1.057	50%	2.59	0.75	0.81	3.00	6647	6427	1	911	22	426	16.11	26.11	19.99	26.33
run10646	134.2	2.399	180	6	0.9	1.057	50%	1.63	0.46	0.68	2.50	5050	4831	0	1257	21	453	17.85	26.03	19.99	25.41
run10647	156.1	2.762	180	6	0.9	1.057	50%	1.63	0.46	0.68	2.75	5840	5621	0	1046	22	447	17.04	26.04	19.99	25.50
run10648	178.4	3.141	180	6	0.9	1.057	50%	1.63	0.46	0.68	3.00	6641	6422	0	1163	22	443	16.24	26.04	20.00	25.40
run10649	161.8	3.862	180	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.50	6044	5825	0	1239	25	499	18.46	26.06	19.68	25.73
run10650	185.3	4.36	180	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.75	6889	6670	0	1200	26	495	17.52	26.08	19.65	25.77
run10651	209.1	4.764	180	7.5	0.3	2.333	30%	5.15	0.85	0.90	3.00	7748	7529	0	1063	26	492	16.84	26.08	19.59	25.82
run10652	148.3	3.446	180	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.50	5558	5338	0	1259	25	495	18.49	26.04	19.70	25.65
run10653	170.3	3.894	180	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.75	6351	6132	0	1208	25	491	17.65	26.04	19.69	25.69
run10654	192.8	4.285	180	7.5	0.3	2.333	30%	2.59	0.75	0.81	3.00	7159	6939	0	1101	26	487	16.98	26.05	19.63	25.75
run10655	148	2.876	180	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.50	5548	5329	0	1203	25	510	18.54	25.14	19.71	24.86
run10656	170.1	3.256	180	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.75	6342	6123	0	1160	25	506	17.71	25.19	19.70	24.92
run10657	192.4	3.532	180	7.5	0.3	2.333	30%	1.63	0.46	0.68	3.00	7147	6928	0	1082	26	503	17.05	25.24	19.66	24.97
run10658	193.5	5.096	180	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.50	7185	6966	1	1168	25	476	16.96	26.13	19.69	26.06
run10659	221.3	5.727	180	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.75	8185	7965	1	1106	26	472	16.11	26.12	19.60	26.15
run10660	248.8	6.32	180	7.5	0.3	2.333	40%	5.15	0.85	0.90	3.00	9177	8957	1	1080	33	470	15.37	26.14	19.41	26.10
run10661	174.9	4.584	180	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.50	6517	6297	0	1219	25	470	17.20	26.11	19.73	25.93
run10662	200.8	5.176	180	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.75	7450	7230	0	1066	26	466	16.39	26.10	19.66	25.99
run10663	226.7	5.68	180	7.5	0.3	2.333	40%	2.59	0.75	0.81	3.00	8380	8160	1	1056	30	464	15.61	26.11	19.58	26.07
run10664	174.3	3.757	180	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.50	6493	6274	0	1191	25	486	17.33	25.61	19.77	25.22
run10665	200.1	4.283	180	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.75	7422	7203	0	1051	26	482	16.46	25.63	19.69	25.28
run10666	225.9	4.753	180	7.5	0.3	2.333	40%	1.63	0.46	0.68	3.00	8351	8131	0	982	29	479	15.69	25.71	19.61	25.34
run10667	223.6	6.262	180	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.50	8270	8050	2	1101	26	459	15.90	26.14	19.63	26.42
run10668	254.6	6.981	180	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.75	9388	9167	2	1019	34	456	15.02	26.16	19.33	26.50
run10669	285	7.711	180	7.5	0.3	2.333	50%	5.15	0.85	0.90	3.00	10481	10259	2	956	44	457	14.20	26.18	18.56	26.45
run10670	200	5.525	180	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.50	7419	7199	1	1199	25	450	16.13	26.13	19.69	26.32
run10671	228.8	6.288	180	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.75	8457	8237	2	1087	31	448	15.27	26.13	19.58	26.29
run10672	257.1	7.011	180	7.5	0.3	2.333	50%	2.59	0.75	0.81	3.00	9477	9256	2	993	40	447	14.47	26.15	18.91	26.44
run10673	198.8	4.591	180	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.50	7377	7157	0	1059	25	467	16.21	26.05	19.72	25.55
run10674	227.6	5.168	180	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.75	8412	8192	0	986	29	463	15.37	26.06	19.61	25.65
run10675	255.8	5.651	180	7.5	0.3	2.333	50%	1.63	0.46	0.68	3.00	9429	9209	0	961	38	462	14.56	26.06	19.04	25.71

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10676	137.5	3.173	180	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.50	5171	4952	0	1345	23	482	18.62	26.08	19.80	25.89
run10677	158.5	3.602	180	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.75	5926	5707	0	1248	23	478	17.82	26.10	19.81	25.94
run10678	180	3.937	180	7.5	0.6	1.455	30%	5.15	0.85	0.90	3.00	6700	6480	0	1092	24	474	17.15	26.10	19.81	25.91
run10679	124	2.776	180	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.50	4684	4464	0	1441	23	477	18.81	26.07	19.83	25.82
run10680	143.5	3.149	180	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.75	5386	5167	0	1268	23	472	17.99	26.08	19.84	25.86
run10681	163.6	3.527	180	7.5	0.6	1.455	30%	2.59	0.75	0.81	3.00	6109	5889	0	1211	24	468	17.26	26.07	19.85	25.83
run10682	124.1	2.304	180	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.50	4687	4467	0	1274	23	495	18.85	25.22	19.84	24.55
run10683	143.6	2.631	180	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.75	5389	5170	0	1157	23	490	18.05	25.19	19.85	24.61
run10684	163.6	2.899	180	7.5	0.6	1.455	30%	1.63	0.46	0.68	3.00	6109	5890	0	1017	23	486	17.33	25.25	19.86	24.67
run10685	170.3	4.136	180	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.50	6351	6131	1	1208	23	460	17.29	26.13	19.85	26.30
run10686	195.9	4.722	180	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.75	7274	7054	1	1127	24	456	16.48	26.13	19.85	26.22
run10687	221.5	5.246	180	7.5	0.6	1.455	40%	5.15	0.85	0.90	3.00	8196	7976	1	1018	26	453	15.65	26.15	19.79	26.37
run10688	151.7	3.717	180	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.50	5681	5461	0	1318	23	453	17.54	26.10	19.88	26.09
run10689	175.4	4.281	180	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.75	6534	6314	0	1140	23	448	16.62	26.10	19.88	26.10
run10690	199.2	4.726	180	7.5	0.6	1.455	40%	2.59	0.75	0.81	3.00	7392	7172	1	1068	24	445	15.86	26.13	19.87	26.12
run10691	151.4	3.05	180	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.50	5670	5451	0	1226	23	471	17.62	25.96	19.90	24.99
run10692	175.1	3.477	180	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.75	6521	6302	0	1076	23	466	16.68	25.99	19.90	25.05
run10693	198.8	3.892	180	7.5	0.6	1.455	40%	1.63	0.46	0.68	3.00	7377	7157	0	954	24	462	16.03	26.01	19.90	25.23
run10694	202	5.041	180	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.50	7492	7272	2	1081	24	444	16.12	26.14	19.86	26.45
run10695	231.2	5.834	180	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.75	8546	8324	2	1013	28	441	15.28	26.15	19.79	26.55
run10696	260	6.552	180	7.5	0.6	1.455	50%	5.15	0.85	0.90	3.00	9581	9359	2	921	37	440	14.47	26.16	19.08	26.73
run10697	178.2	4.612	180	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.50	6637	6416	1	1046	23	435	16.45	26.11	19.92	26.41
run10698	205.3	5.309	180	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.75	7610	7390	2	986	24	431	15.59	26.11	19.87	26.55
run10699	231.9	5.871	180	7.5	0.6	1.455	50%	2.59	0.75	0.81	3.00	8569	8348	2	924	32	429	14.75	26.14	19.45	26.62
run10700	177.5	3.628	180	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.50	6608	6389	0	1167	23	452	16.55	26.05	19.93	25.70
run10701	204.4	4.329	180	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.75	7579	7359	0	1109	24	447	15.65	26.06	19.89	25.74
run10702	231	4.724	180	7.5	0.6	1.455	50%	1.63	0.46	0.68	3.00	8536	8317	0	1016	31	445	14.84	26.08	19.57	25.75
run10703	126.6	2.54	180	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.50	4776	4557	0	1360	22	474	18.79	26.10	19.88	25.89
run10704	146.5	2.916	180	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.75	5492	5273	0	1225	23	469	18.00	26.11	19.89	25.91
run10705	166.9	3.238	180	7.5	0.9	1.057	30%	5.15	0.85	0.90	3.00	6227	6008	0	1103	23	464	17.25	26.11	19.90	25.93
run10706	113.1	2.283	180	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.50	4290	4071	0	1402	22	467	18.94	26.08	19.91	25.80
run10707	131.5	2.599	180	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.75	4953	4734	0	1348	22	462	18.24	26.09	19.92	25.90
run10708	150.4	2.95	180	7.5	0.9	1.057	30%	2.59	0.75	0.81	3.00	5635	5416	0	1177	22	458	17.51	26.08	19.93	25.95
run10709	113.3	1.897	180	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.50	4300	4081	0	1289	22	486	18.99	25.26	19.90	24.55
run10710	131.8	2.182	180	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.75	4963	4744	0	1206	22	481	18.20	25.22	19.91	24.41
run10711	150.7	2.552	180	7.5	0.9	1.057	30%	1.63	0.46	0.68	3.00	5643	5424	0	1032	22	476	17.57	25.25	19.92	24.43
run10712	160	3.389	180	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.50	5978	5758	1	1142	23	453	17.47	26.11	19.92	26.20
run10713	184.5	3.901	180	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.75	6864	6644	1	963	23	448	16.63	26.12	19.92	26.25
run10714	209.2	4.421	180	7.5	0.9	1.057	40%	5.15	0.85	0.90	3.00	7753	7533	1	887	24	444	15.85	26.15	19.88	26.45
run10715	141.3	3.03	180	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.50	5307	5087	0	1056	22	444	17.68	26.10	19.96	26.19
run10716	164	3.497	180	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.75	6125	5905	0	969	22	439	16.78	26.11	19.96	26.29
run10717	186.9	3.974	180	7.5	0.9	1.057	40%	2.59	0.75	0.81	3.00	6947	6727	1	899	23	435	16.12	26.12	19.95	26.17
run10718	141.2	2.545	180	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.50	5303	5084	0	1184	22	462	17.76	26.00	19.95	24.81
run10719	163.9	2.953	180	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.75	6119	5900	0	1112	22	457	16.88	26.01	19.96	25.27
run10720	186.7	3.258	180	7.5	0.9	1.057	40%	1.63	0.46	0.68	3.00	6941	6722	0	1063	23	453	16.16	26.02	19.97	25.28
run10721	192.4	4.192	180	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.50	7147	6926	2	1095	23	438	16.26	26.12	19.93	26.55
run10722	220.8	4.834	180	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.75	8168	7947	2	990	26	434	15.36	26.16	19.88	26.70
run10723	248.7	5.521	180	7.5	0.9	1.057	50%	5.15	0.85	0.90	3.00	9176	8955	2	912	34	432	14.61	26.15	19.27	26.65
run10724	168.6	3.853	180	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.50	6289	6068	1	1224	23	427	16.52	26.10	19.97	26.51
run10725	194.8	4.418	180	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.75	7232	7011	2	1008	23	423	15.70	26.12	19.96	26.57
run10726	220.7	5.007	180	7.5	0.9	1.057	50%	2.59	0.75	0.81	3.00	8165	7944	2	952	30	421	14.89	26.15	19.64	26.68
run10727	168	3.102	180	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.50	6267	6048	0	1245	22	444	16.67	26.07	19.98	25.74
run10728	194.1	3.59	180	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.75	7208	6989	0	1080	23	439	15.79	26.07	19.97	25.76
run10729	220	4.038	180	7.5	0.9	1.057	50%	1.63	0.46	0.68	3.00	8138	7919	0	970	29	437	14.99	26.08	19.77	25.78
run10730	75.89	2.326	270	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.50	2994	2732	43	1314	24	431	19.79	26.12	19.79	27.26
run10731	88.26	2.588	270	4.8	0.3	2.333	30%	5.15	0.85	0.90	2.75	3444	3178	47	1208	24	429	19.75	26.15	19.81	27.31
run10732	101.1	2.862	270	4.8	0.3	2.333	30%	5.15	0.85	0.90	3.00	3910	3640	51	1104	24	426	19.26	26.16	19.81	27.41
run10733	71	2.142	270	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.50	2811	2556	36	1372	24	431	19.79	26.14	19.81	26.98
run10734	82.83	2.324	270	4.8	0.3	2.333	30%	2.59	0.75	0.81	2.75	3240	2982	39	1293	23	429	19.76	26.14	19.82	27.01
run10735	95.13	2.578	270	4.8	0.3	2.333	30%	2.59	0.75	0.81	3.00	3686	3425	43	1190	23	426	19.35	26.16	19.82	27.09
run10736	78.22	1.804	270	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.50	3040	2816	5	1301	24	451	19.79	26.06	19.81	26.33
run10737	90.8	1.945	270	4.8	0.3	2.333	30%	1.63	0.46	0.68	2.75	3493	3269	5	1248	23	449	19.76	26.07	19.82	26.31
run10738	103.9	2.092	270	4.8	0.3	2.333	30%	1.63	0.46	0.68	3.00	3966	3741	6	1215	23	446	19.34	26.09	19.83	26.41
run10739	89.47	3.008	270	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.50	3519	3221	79	1203	23	414	19.47	26.13	19.86	27.83
run10740	104.6	3.371	270	4.8	0.3	2.333	40%	5.15	0.85	0.90	2.75	4072	3767	86	1116	23	411	18.74	26.15	19.87	27.94
run10741	120.4	3.756	270	4.8	0.3	2.333	40%	5.15	0.85	0.90	3.00	4648	4335	94	1048	23	408	18.04	26.18	19.87	28.00
run10742	82.59	2.698	270	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.50	3261	2973	68	1211	23	412	19.63	26.13	19.87	27.44
run10743	96.93	2.997	270	4.8	0.3	2.333	40%	2.59	0.75	0.81	2.75	3783	3489	74	1112	23	409	18.92	26.14	19.89	27.59
run10744	111.9	3.323	270	4.8	0.3	2.333	40%	2.59	0.75	0.81	3.00	4328	4027	81	1053	23	406	18.18	26.17	19.90	27.63
run10745	91.49	2.363	270	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.50	3524	3294	11	1258	23	432	19.63	26.12	19.88	26.57
run10746	106.8	2.53	270	4.8	0.3	2.333	40%	1.63	0.46	0.68	2.75	4077	3846	12	1131	23	428	18.91	26.13	19.90	26.68
run10747	122.8	2.763	270	4.8	0.3	2.333	40%	1.63	0.46	0.68	3.00	4653	4420	13	1050	23	424	18.16	26.14	19.91	26.64
run10748	103.3	3.712	270	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.50	4061	3720	121	1135	25	401	18.59	26.24	19.91	28.38
run10749	121.1	4.064	270	4.8	0.3	2.333	50%	5.15	0.85	0.90	2.75	4712	4360	132	1074	27	398	17.74	26.27	19.91	28.50
run10750	139.4	4.475	270	4.8	0.3	2.333	50%	5.15	0.85	0.90	3.00	5381	5018	144	1002	28	396	16.89	26.31	19.89	28.53
run10751	94.31	3.361	270	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.50	3722	3395	108	1164	23	398	18.69	26.14	19.93	28.02
run10752	111	3.583	270	4.8	0.3	2.333	50%	2.59	0.75	0.81	2.75	4334	3996	118	1079	23	394	17.91	26.16	19.94	28.13
run10753	128.3	4.014	270	4.8	0.3	2.333	50%	2.59	0.75	0.81	3.00	4967	4620	128	1022	23	391	17.08	26.20	19.93	28.19
run10754	104.6	2.689	270	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.50	4006	3767	20	1167	23	415	18.69	26.16	19.94	26.97
run10755	122.5	3.051	270	4.8	0.3	2.333	50%	1.63	0.46	0.68	2.75	4649	4408	22	1064	23	411	17.91	26.16	19.94	26.94
run10756	140.9	3.331	270	4.8	0.3	2.333	50%	1.63	0.46	0.68	3.00	5317	5073	24	1052	23	407	17.06	26.16	19.93	27.03
run10757	59.56	1.803	270	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.50	2411	2144	47	1301	22	413	19.80	26.11	19.89	27.40
run10758	70.01	2.114	270	4.8	0.6	1.455	30%	5.15	0.85	0.90	2.75	2791	2521	51	1191	22	410	19.76	26.12	19.90	27.47
run10759	80.97	2.276	270	4.8	0.6	1.455	30%	5.15	0.85	0.90	3.00	3189	2915	55	1117	22	408	19.50	26.14	19.91	27.50
run10760	54.87	1.699	270	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.50	2235	1975	41	1276	22	412	19.80	26.10	19.90	27.27
run10761	64.76	1.829	270	4.8	0.6	1.455	30%	2.59	0.75	0.81	2.75	2593	2331	43	1192	22	409	19.77	26.09	19.92	27.26
run10762	75.2	2.09	270	4.8	0.6	1.455	30%	2.59	0.75	0.81	3.00	2973	2707	46	1128	22	406	19.64	26.10	19.92	27.28
run10763	62.02	1.381	270	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.50	2456	2233	4	1377	22	433	19.80	26.06	19.91	26.43
run10764	72.81	1.625	270	4.8	0.6	1.455	30%	1.63	0.46	0.68	2.75	2845	2621	4	1245	22	430	19.76	26.06	19.92	26.47
run10765	84.13	1.718	270	4.8	0.6	1.455	30%	1.63	0.46	0.68	3.00	3252	3029	5	1129	22	427	19.64	26.08	19.93	26.48
run10766	73.22	2.387	270	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.50	2942	2636	87	1202	22	398	19.68	26.14	19.93	28.03
run10767	86.54	2.797	270	4.8	0.6	1.455	40%	5.15	0.85	0.90	2.75	3429	3115	94	1098	23	395	18.91	26.15	19.95	28.16
run10768	100.4	3.064	270	4.8	0.6	1.455	40%	5.15	0.85	0.90	3.00	3936	3616	101	1047	23	392	18.29	26.17	19.96	28.24
run10769	66.59	2.237	270	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.50	2694	2397	77	1204	22	395	19.73	26.10	19.96	27.73
run10770	79.13	2.464	270	4.8	0.6	1.455	40%	2.59	0.75	0.81	2.75	3150	2849	82	1108	22	391	19.14	26.12	19.97	27.78
run10771	92.21	2.863	270	4.8	0.6	1.455	40%	2.59	0.75	0.81	3.00	3627	3319	88	1058	22	388	18.47	26.14	19.99	27.87
run10772	75.33	1.777	270	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.50	2942	2712	10	1313	22	414	19.72	26.12	19.96	26.76
run10773	88.9	2.009	270	4.8	0.6	1.455	40%	1.63	0.46	0.68	2.75	3431	3201	11	1134	21	410	19.14	26.13	19.98	26.80
run10774	103.1	2.219	270	4.8	0.6	1.455	40%	1.63	0.46	0.68	3.00	3942	3711	12	1040	22	406	18.46	26.15	20.00	26.83
run10775	87.38	2.919	270	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.50	3498	3146	133	1134	26	388	18.73	26.22	19.98	28.47
run10776	103.4	3.289	270	4.8	0.6	1.455	50%	5.15	0.85	0.90	2.75	4085	3722	144	1073	27	385	17.96	26.25	19.99	28.53
run10777	119.9	3.741	270	4.8	0.6	1.455	50%	5.15	0.85	0.90	3.00	4693	4318	156	1028	30	383	17.13	26.29	20.00	28.75
run10778	78.68	2.653	270	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.50	3173	2832	121	1133	23	383	18.86	26.15	20.00	28.19
run10779	93.59	2.977	270	4.8	0.6	1.455	50%	2.59	0.75	0.81	2.75	3719	3369	130	1061	24	379	18.13	26.19	20.02	28.26
run10780	109.2	3.28	270	4.8	0.6	1.455	50%	2.59	0.75	0.81	3.00	4290	3930	140	1020	25	376	17.35	26.21	20.02	28.37
run10781	88.84	2.251	270	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.50	3438	3198	21	1212	21	398	18.95	26.13	20.01	27.13
run10782	104.9	2.453	270	4.8	0.6	1.455	50%	1.63	0.46	0.68	2.75	4019	3778	22	1055	21	394	18.16	26.16	20.03	27.11
run10783	121.7	2.713	270	4.8	0.6	1.455	50%	1.63	0.46	0.68	3.00	4623	4380	23	1019	22	390	17.34	26.17	20.03	27.20
run10784	52.42	1.467	270	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.50	2158	1887	52	1306	22	402	19.80	26.10	19.99	27.50
run10785	61.97	1.722	270	4.8	0.9	1.057	30%	5.15	0.85	0.90	2.75	2505	2231	55	1193	22	399	19.77	26.11	20.00	27.50
run10786	72.12	1.878	270	4.8	0.9	1.057	30%	5.15	0.85	0.90	3.00	2874	2596	58	1124	21	397	19.67	26.12	20.01	27.63
run10787	47.92	1.285	270	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.50	1989	1725	45	1302	21	399	19.80	26.08	20.01	27.30
run10788	56.93	1.482	270	4.8	0.9	1.057	30%	2.59	0.75	0.81	2.75	2316	2049	48	1192	21	397	19.77	26.11	20.02	27.32
run10789	66.49	1.673	270	4.8	0.9	1.057	30%	2.59	0.75	0.81	3.00	2662	2394	50	1119	21	394	19.73	26.11	20.04	27.34
run10790	54.84	1.115	270	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.50	2198	1974	4	1203	21	423	19.80	26.09	20.01	26.27
run10791	64.74	1.244	270	4.8	0.9	1.057	30%	1.63	0.46	0.68	2.75	2554	2331	4	1124	21	419	19.77	26.09	20.03	26.48
run10792	75.23	1.4	270	4.8	0.9	1.057	30%	1.63	0.46	0.68	3.00	2932	2708	4	1064	21	416	19.72	26.10	20.05	26.49
run10793	66.11	1.938	270	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.50	2692	2380	93	1199	21	389	19.72	26.13	20.03	28.06
run10794	78.56	2.218	270	4.8	0.9	1.057	40%	5.15	0.85	0.90	2.75	3147	2828	100	1114	23	386	19.14	26.14	20.04	28.21
run10795	91.66	2.516	270	4.8	0.9	1.057	40%	5.15	0.85	0.90	3.00	3626	3300	107	1064	24	383	18.35	26.18	20.05	28.29
run10796	59.65	1.758	270	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.50	2450	2147	84	1198	21	384	19.74	26.10	20.05	27.75
run10797	71.32	2.009	270	4.8	0.9	1.057	40%	2.59	0.75	0.81	2.75	2876	2567	89	1096	20	381	19.29	26.11	20.07	27.87
run10798	83.54	2.237	270	4.8	0.9	1.057	40%	2.59	0.75	0.81	3.00	3322	3007	95	1051	20	378	18.65	26.13	20.10	27.94
run10799	68.2	1.539	270	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.50	2686	2455	11	1259	20	404	19.74	26.13	20.06	26.83
run10800	80.94	1.697	270	4.8	0.9	1.057	40%	1.63	0.46	0.68	2.75	3145	2914	11	1126	20	400	19.23	26.14	20.10	26.84
run10801	94.29	1.871	270	4.8	0.9	1.057	40%	1.63	0.46	0.68	3.00	3626	3395	12	1047	20	396	18.65	26.15	20.13	26.86
run10802	80.35	2.336	270	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.50	3253	2893	141	1138	28	381	18.82	26.23	20.06	28.61
run10803	95.52	2.802	270	4.8	0.9	1.057	50%	5.15	0.85	0.90	2.75	3810	3439	152	1081	28	378	18.03	26.27	20.07	28.63
run10804	111.3	3.202	270	4.8	0.9	1.057	50%	5.15	0.85	0.90	3.00	4391	4009	163	1028	31	375	17.34	26.30	20.08	28.83
run10805	71.77	2.186	270	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.50	2932	2584	129	1127	22	375	19.09	26.15	20.10	28.13
run10806	85.89	2.413	270	4.8	0.9	1.057	50%	2.59	0.75	0.81	2.75	3450	3092	139	1078	25	371	18.30	26.16	20.13	28.36
run10807	100.6	2.737	270	4.8	0.9	1.057	50%	2.59	0.75	0.81	3.00	3991	3622	149	1020	26	368	17.61	26.20	20.16	28.46
run10808	81.76	1.775	270	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.50	3185	2944	22	1200	20	389	19.09	26.12	20.13	27.13
run10809	97.11	2.12	270	4.8	0.9	1.057	50%	1.63	0.46	0.68	2.75	3738	3496	23	1162	20	384	18.23	26.14	20.14	27.15
run10810	113	2.277	270	4.8	0.9	1.057	50%	1.63	0.46	0.68	3.00	4313	4070	24	1107	20	380	17.62	26.18	20.15	27.20

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10811	98.22	3.078	270	6	0.3	2.333	30%	5.15	0.85	0.90	2.50	3816	3536	61	1230	24	429	19.61	26.16	19.75	27.53
run10812	114	3.444	270	6	0.3	2.333	30%	5.15	0.85	0.90	2.75	4389	4103	66	1139	24	427	18.80	26.16	19.76	27.70
run10813	130.4	3.776	270	6	0.3	2.333	30%	5.15	0.85	0.90	3.00	4987	4696	73	1078	25	424	18.15	26.18	19.75	27.73
run10814	91.79	2.77	270	6	0.3	2.333	30%	2.59	0.75	0.81	2.50	3576	3304	52	1235	24	429	19.67	26.14	19.77	27.32
run10815	106.8	3.116	270	6	0.3	2.333	30%	2.59	0.75	0.81	2.75	4120	3844	57	1150	24	426	18.92	26.14	19.78	27.33
run10816	122.4	3.419	270	6	0.3	2.333	30%	2.59	0.75	0.81	3.00	4688	4407	62	1087	24	423	18.28	26.15	19.78	27.48
run10817	100.2	2.299	270	6	0.3	2.333	30%	1.63	0.46	0.68	2.50	3836	3608	9	1241	24	448	19.68	26.10	19.77	26.54
run10818	116.2	2.553	270	6	0.3	2.333	30%	1.63	0.46	0.68	2.75	4412	4183	10	1156	24	444	18.94	26.10	19.78	26.47
run10819	132.7	2.829	270	6	0.3	2.333	30%	1.63	0.46	0.68	3.00	5008	4778	11	1044	24	441	18.28	26.11	19.78	26.58
run10820	115.9	4.042	270	6	0.3	2.333	40%	5.15	0.85	0.90	2.50	4498	4171	108	1144	24	412	18.26	26.23	19.82	28.28
run10821	135	4.555	270	6	0.3	2.333	40%	5.15	0.85	0.90	2.75	5196	4859	118	1062	27	409	17.43	26.26	19.81	28.44
run10822	154.6	4.972	270	6	0.3	2.333	40%	5.15	0.85	0.90	3.00	5914	5567	128	1013	28	407	16.76	26.30	19.76	28.56
run10823	106.7	3.669	270	6	0.3	2.333	40%	2.59	0.75	0.81	2.50	4157	3842	95	1145	24	409	18.46	26.15	19.84	27.84
run10824	124.8	4.131	270	6	0.3	2.333	40%	2.59	0.75	0.81	2.75	4816	4493	104	1076	24	406	17.66	26.16	19.84	27.99
run10825	143.4	4.47	270	6	0.3	2.333	40%	2.59	0.75	0.81	3.00	5493	5161	113	1012	24	403	16.85	26.21	19.80	28.10
run10826	117.1	2.952	270	6	0.3	2.333	40%	1.63	0.46	0.68	2.50	4455	4217	19	1166	24	426	18.46	26.15	19.85	26.82
run10827	136.3	3.264	270	6	0.3	2.333	40%	1.63	0.46	0.68	2.75	5147	4907	21	1068	24	422	17.65	26.18	19.85	26.93
run10828	156	3.718	270	6	0.3	2.333	40%	1.63	0.46	0.68	3.00	5857	5615	23	1031	24	419	16.85	26.19	19.82	27.05
run10829	133.7	4.976	270	6	0.3	2.333	50%	5.15	0.85	0.90	2.50	5196	4815	162	1125	33	401	17.27	26.34	19.84	28.87
run10830	155.7	5.519	270	6	0.3	2.333	50%	5.15	0.85	0.90	2.75	6004	5607	178	1042	38	399	16.39	26.38	19.79	29.13
run10831	177.8	6.149	270	6	0.3	2.333	50%	5.15	0.85	0.90	3.00	6814	6401	194	981	41	399	15.62	26.42	19.69	29.29
run10832	121.8	4.528	270	6	0.3	2.333	50%	2.59	0.75	0.81	2.50	4750	4384	147	1095	27	395	17.49	26.25	19.89	28.45
run10833	142.5	4.999	270	6	0.3	2.333	50%	2.59	0.75	0.81	2.75	5507	5128	160	1044	29	393	16.56	26.30	19.84	28.60
run10834	163.2	5.445	270	6	0.3	2.333	50%	2.59	0.75	0.81	3.00	6270	5877	174	986	31	392	15.84	26.34	19.74	28.73
run10835	133.7	3.579	270	6	0.3	2.333	50%	1.63	0.46	0.68	2.50	5065	4813	33	1121	23	409	17.49	26.17	19.90	27.35
run10836	155.6	3.998	270	6	0.3	2.333	50%	1.63	0.46	0.68	2.75	5857	5601	37	1046	24	405	16.59	26.20	19.86	27.31
run10837	177.6	4.454	270	6	0.3	2.333	50%	1.63	0.46	0.68	3.00	6655	6395	40	972	25	402	15.90	26.18	19.76	27.36
run10838	76.97	2.435	270	6	0.6	1.455	30%	5.15	0.85	0.90	2.50	3056	2771	66	1221	22	410	19.75	26.12	19.85	27.81
run10839	90.38	2.753	270	6	0.6	1.455	30%	5.15	0.85	0.90	2.75	3544	3254	71	1117	23	407	19.14	26.14	19.87	27.93
run10840	104.4	3.06	270	6	0.6	1.455	30%	5.15	0.85	0.90	3.00	4055	3759	76	1075	23	404	18.47	26.14	19.87	28.06
run10841	70.75	2.189	270	6	0.6	1.455	30%	2.59	0.75	0.81	2.50	2823	2547	57	1228	22	408	19.75	26.11	19.87	27.53
run10842	83.45	2.456	270	6	0.6	1.455	30%	2.59	0.75	0.81	2.75	3284	3004	61	1134	22	405	19.26	26.13	19.89	27.58
run10843	96.74	2.734	270	6	0.6	1.455	30%	2.59	0.75	0.81	3.00	3767	3483	65	1076	22	401	18.60	26.13	19.90	27.73
run10844	79.34	1.833	270	6	0.6	1.455	30%	1.63	0.46	0.68	2.50	3083	2856	7	1297	23	428	19.75	26.11	19.88	26.66
run10845	92.98	2.066	270	6	0.6	1.455	30%	1.63	0.46	0.68	2.75	3574	3347	8	1223	22	424	19.26	26.10	19.90	26.71
run10846	107.2	2.26	270	6	0.6	1.455	30%	1.63	0.46	0.68	3.00	4089	3861	9	1118	22	420	18.60	26.11	19.90	26.77
run10847	94.76	3.259	270	6	0.6	1.455	40%	5.15	0.85	0.90	2.50	3748	3412	118	1141	25	395	18.58	26.22	19.91	28.42
run10848	111.6	3.696	270	6	0.6	1.455	40%	5.15	0.85	0.90	2.75	4365	4018	128	1073	27	392	17.83	26.24	19.92	28.55
run10849	129	4.078	270	6	0.6	1.455	40%	5.15	0.85	0.90	3.00	5000	4643	138	1020	28	389	16.98	26.27	19.92	28.60
run10850	85.95	2.904	270	6	0.6	1.455	40%	2.59	0.75	0.81	2.50	3420	3094	106	1129	23	391	18.76	26.16	19.94	28.18
run10851	101.7	3.331	270	6	0.6	1.455	40%	2.59	0.75	0.81	2.75	3995	3662	114	1073	23	387	18.00	26.15	19.95	28.25
run10852	118.1	3.684	270	6	0.6	1.455	40%	2.59	0.75	0.81	3.00	4593	4252	122	1020	25	384	17.17	26.17	19.95	28.37
run10853	96.32	2.376	270	6	0.6	1.455	40%	1.63	0.46	0.68	2.50	3705	3468	18	1162	22	407	18.77	26.16	19.94	27.07
run10854	113.3	2.678	270	6	0.6	1.455	40%	1.63	0.46	0.68	2.75	4317	4078	19	1070	22	402	18.00	26.17	19.95	27.11
run10855	130.7	3.016	270	6	0.6	1.455	40%	1.63	0.46	0.68	3.00	4947	4707	21	1025	22	398	17.17	26.16	19.96	27.12
run10856	113.1	3.925	270	6	0.6	1.455	50%	5.15	0.85	0.90	2.50	4468	4071	177	1125	37	387	17.56	26.33	19.94	29.18
run10857	132.9	4.541	270	6	0.6	1.455	50%	5.15	0.85	0.90	2.75	5197	4785	193	1014	39	385	16.62	26.37	19.95	29.28
run10858	153	5.086	270	6	0.6	1.455	50%	5.15	0.85	0.90	3.00	5935	5507	208	974	43	384	15.95	26.41	19.92	29.41
run10859	101.5	3.593	270	6	0.6	1.455	50%	2.59	0.75	0.81	2.50	4035	3652	163	1102	30	380	17.77	26.25	19.98	28.71
run10860	119.9	4.095	270	6	0.6	1.455	50%	2.59	0.75	0.81	2.75	4713	4318	176	1038	29	377	16.89	26.27	19.98	28.68
run10861	138.8	4.561	270	6	0.6	1.455	50%	2.59	0.75	0.81	3.00	5406	4997	190	997	32	375	16.11	26.32	19.98	28.85
run10862	113.3	2.953	270	6	0.6	1.455	50%	1.63	0.46	0.68	2.50	4330	4077	33	1168	22	391	17.78	26.16	19.99	27.54
run10863	133.1	3.383	270	6	0.6	1.455	50%	1.63	0.46	0.68	2.75	5047	4792	36	1105	22	387	16.90	26.20	19.99	27.61
run10864	153.2	3.818	270	6	0.6	1.455	50%	1.63	0.46	0.68	3.00	5773	5515	39	1004	23	383	16.15	26.20	20.00	27.70
run10865	67.62	1.988	270	6	0.9	1.057	30%	5.15	0.85	0.90	2.50	2725	2434	71	1219	22	398	19.75	26.11	19.97	27.96
run10866	79.88	2.247	270	6	0.9	1.057	30%	5.15	0.85	0.90	2.75	3172	2876	76	1117	22	395	19.30	26.14	19.99	27.97
run10867	92.91	2.563	270	6	0.9	1.057	30%	5.15	0.85	0.90	3.00	3646	3345	82	1075	22	392	18.63	26.16	20.00	28.06
run10868	61.62	1.777	270	6	0.9	1.057	30%	2.59	0.75	0.81	2.50	2500	2218	63	1228	21	395	19.75	26.10	20.00	27.59
run10869	73.2	2.029	270	6	0.9	1.057	30%	2.59	0.75	0.81	2.75	2921	2635	67	1133	21	392	19.40	26.11	20.02	27.63
run10870	85.46	2.286	270	6	0.9	1.057	30%	2.59	0.75	0.81	3.00	3366	3077	70	1062	21	388	18.76	26.12	20.02	27.75
run10871	69.99	1.466	270	6	0.9	1.057	30%	1.63	0.46	0.68	2.50	2746	2520	8	1351	21	416	19.75	26.10	20.00	26.68
run10872	82.62	1.647	270	6	0.9	1.057	30%	1.63	0.46	0.68	2.75	3202	2974	8	1090	21	412	19.39	26.11	20.02	26.75
run10873	95.87	1.867	270	6	0.9	1.057	30%	1.63	0.46	0.68	3.00	3679	3452	8	1016	21	408	18.75	26.12	20.03	26.73
run10874	85.49	2.645	270	6	0.9	1.057	40%	5.15	0.85	0.90	2.50	3423	3078	126	1135	28	386	18.75	26.22	20.01	28.62
run10875	101.2	3.028	270	6	0.9	1.057	40%	5.15	0.85	0.90	2.75	3998	3643	136	1074	30	383	17.99	26.27	20.03	28.73
run10876	117.6	3.401	270	6	0.9	1.057	40%	5.15	0.85	0.90	3.00	4597	4232	146	1027	31	380	17.15	26.28	20.05	28.81
run10877	76.91	2.365	270	6	0.9	1.057	40%	2.59	0.75	0.81	2.50	3102	2769	115	1140	23	380	18.99	26.14	20.05	28.25
run10878	91.56	2.726	270	6	0.9	1.057	40%	2.59	0.75	0.81	2.75	3639	3296	123	1063	23	377	18.15	26.19	20.07	28.22
run10879	106.9	3.063	270	6	0.9	1.057	40%	2.59	0.75	0.81	3.00	4199	3849	131	1021	26	373	17.38	26.21	20.08	28.40
run10880	87.1	1.982	270	6	0.9	1.057	40%	1.63	0.46	0.68	2.50	3373	3136	19	1309	21	396	18.89	26.13	20.06	27.17
run10881	103	2.201	270	6	0.9	1.057	40%	1.63	0.46	0.68	2.75	3948	3709	20	1182	20	391	18.16	26.15	20.09	27.15
run10882	119.5	2.538	270	6	0.9	1.057	40%	1.63	0.46	0.68	3.00	4544	4303	21	1000	21	387	17.38	26.15	20.11	27.19
run10883	104	3.244	270	6	0.9	1.057	50%	5.15	0.85	0.90	2.50	4150	3743	188	1119	38	380	17.70	26.34	20.04	29.23
run10884	122.8	3.75	270	6	0.9	1.057	50%	5.15	0.85	0.90	2.75	4844	4421	204	1014	39	378	16.80	26.38	20.05	29.23
run10885	142	4.233	270	6	0.9	1.057	50%	5.15	0.85	0.90	3.00	5551	5111	221	974	45	377	16.11	26.41	20.02	29.52
run10886	92.48	2.9	270	6	0.9	1.057	50%	2.59	0.75	0.81	2.50	3724	3329	175	1120	31	372	17.94	26.26	20.08	28.78
run10887	110.1	3.351	270	6	0.9	1.057	50%	2.59	0.75	0.81	2.75	4370	3962	189	1038	32	369	17.04	26.30	20.10	28.79
run10888	128	3.829	270	6	0.9	1.057	50%	2.59	0.75	0.81	3.00	5031	4609	202	968	33	367	16.38	26.34	20.11	28.93
run10889	104.2	2.413	270	6	0.9	1.057	50%	1.63	0.46	0.68	2.50	4006	3752	35	1231	20	381	17.94	26.15	20.13	27.57
run10890	123.1	2.801	270	6	0.9	1.057	50%	1.63	0.46	0.68	2.75	4687	4430	38	1124	21	376	17.05	26.14	20.13	27.63
run10891	142.3	3.141	270	6	0.9	1.057	50%	1.63	0.46	0.68	3.00	5384	5124	41	992	21	373	16.33	26.15	20.10	27.69
run10892	126.8	3.862	270	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.50	4868	4565	84	1166	25	429	18.42	26.17	19.69	27.94
run10893	146.8	4.419	270	7.5	0.3	2.333	30%	5.15	0.85	0.90	2.75	5595	5284	92	1092	26	426	17.53	26.22	19.67	28.06
run10894	167.2	4.764	270	7.5	0.3	2.333	30%	5.15	0.85	0.90	3.00	6338	6018	101	1047	26	424	16.85	26.24	19.60	28.25
run10895	118.3	3.446	270	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.50	4549	4257	72	1168	25	427	18.50	26.16	19.72	27.64
run10896	137.2	3.894	270	7.5	0.3	2.333	30%	2.59	0.75	0.81	2.75	5239	4940	79	1103	25	424	17.72	26.17	19.70	27.81
run10897	156.7	4.239	270	7.5	0.3	2.333	30%	2.59	0.75	0.81	3.00	5948	5642	87	1035	26	422	17.01	26.17	19.65	27.81
run10898	128.2	2.876	270	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.50	4849	4615	15	1219	25	445	18.51	26.12	19.72	26.74
run10899	148.2	3.256	270	7.5	0.3	2.333	30%	1.63	0.46	0.68	2.75	5571	5334	17	1106	25	441	17.69	26.15	19.71	26.81
run10900	168.6	3.526	270	7.5	0.3	2.333	30%	1.63	0.46	0.68	3.00	6310	6071	20	1005	26	438	17.02	26.17	19.66	26.87
run10901	149.4	5.123	270	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.50	5743	5380	144	1127	31	412	16.98	26.33	19.71	28.78
run10902	172.9	5.743	270	7.5	0.3	2.333	40%	5.15	0.85	0.90	2.75	6603	6225	159	1024	35	411	16.15	26.38	19.63	28.99
run10903	196.4	6.32	270	7.5	0.3	2.333	40%	5.15	0.85	0.90	3.00	7462	7071	172	978	38	411	15.41	26.41	19.46	29.12
run10904	137.3	4.637	270	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.50	5291	4943	128	1110	25	408	17.24	26.23	19.77	28.33
run10905	159.6	5.176	270	7.5	0.3	2.333	40%	2.59	0.75	0.81	2.75	6105	5744	141	1060	28	406	16.40	26.27	19.69	28.52
run10906	181.8	5.68	270	7.5	0.3	2.333	40%	2.59	0.75	0.81	3.00	6919	6546	154	979	29	405	15.62	26.32	19.61	28.62
run10907	149.4	3.729	270	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.50	5627	5377	30	1217	25	422	17.21	26.18	19.77	27.25
run10908	172.7	4.283	270	7.5	0.3	2.333	40%	1.63	0.46	0.68	2.75	6472	6219	34	1091	26	419	16.45	26.20	19.71	27.33
run10909	196.1	4.687	270	7.5	0.3	2.333	40%	1.63	0.46	0.68	3.00	7318	7061	38	983	28	417	15.65	26.22	19.61	27.44
run10910	171.3	6.262	270	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.50	6602	6168	215	1049	48	405	15.96	26.45	19.65	29.69
run10911	197.6	6.981	270	7.5	0.3	2.333	50%	5.15	0.85	0.90	2.75	7569	7113	236	1006	55	405	15.07	26.50	19.36	30.04
run10912	223.2	7.711	270	7.5	0.3	2.333	50%	5.15	0.85	0.90	3.00	8513	8037	257	942	57	408	14.31	26.54	18.62	30.13
run10913	155.6	5.525	270	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.50	6017	5602	196	1062	37	397	16.22	26.37	19.73	29.06
run10914	180.3	6.288	270	7.5	0.3	2.333	50%	2.59	0.75	0.81	2.75	6923	6489	215	1012	40	397	15.31	26.41	19.60	29.23
run10915	204.6	7.011	270	7.5	0.3	2.333	50%	2.59	0.75	0.81	3.00	7816	7364	232	957	44	398	14.49	26.45	18.97	29.45
run10916	169.3	4.592	270	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.50	6367	6096	51	1066	25	405	16.20	26.19	19.74	27.68
run10917	195.3	5.168	270	7.5	0.3	2.333	50%	1.63	0.46	0.68	2.75	7308	7032	57	1029	29	403	15.31	26.22	19.64	27.76
run10918	220.8	5.651	270	7.5	0.3	2.333	50%	1.63	0.46	0.68	3.00	8230	7947	63	969	38	403	14.53	26.24	19.07	27.83
run10919	99.34	3.173	270	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.50	3885	3576	90	1158	24	407	18.70	26.19	19.82	28.25
run10920	116.4	3.518	270	7.5	0.6	1.455	30%	5.15	0.85	0.90	2.75	4504	4189	96	1096	25	404	17.91	26.22	19.83	28.35
run10921	133.8	3.956	270	7.5	0.6	1.455	30%	5.15	0.85	0.90	3.00	5142	4818	105	1034	24	401	17.15	26.19	19.82	28.33
run10922	91.07	2.776	270	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.50	3576	3279	79	1156	23	405	18.86	26.13	19.84	27.89
run10923	107.1	3.128	270	7.5	0.6	1.455	30%	2.59	0.75	0.81	2.75	4158	3854	85	1095	23	401	18.06	26.16	19.85	27.96
run10924	123.6	3.527	270	7.5	0.6	1.455	30%	2.59	0.75	0.81	3.00	4761	4451	90	1016	23	398	17.39	26.17	19.86	28.13
run10925	101.3	2.304	270	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.50	3878	3646	12	1201	23	422	18.86	26.14	19.85	26.88
run10926	118.4	2.631	270	7.5	0.6	1.455	30%	1.63	0.46	0.68	2.75	4495	4262	13	1116	23	418	18.06	26.16	19.86	26.96
run10927	136.1	2.929	270	7.5	0.6	1.455	30%	1.63	0.46	0.68	3.00	5132	4899	15	1037	23	414	17.40	26.16	19.87	27.00
run10928	122.2	4.136	270	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.50	4776	4400	157	1116	32	394	17.40	26.32	19.87	28.92
run10929	143	4.694	270	7.5	0.6	1.455	40%	5.15	0.85	0.90	2.75	5537	5147	171	1040	35	392	16.57	26.37	19.87	29.06
run10930	163.9	5.299	270	7.5	0.6	1.455	40%	5.15	0.85	0.90	3.00	6303	5900	184	982	40	391	15.80	26.41	19.84	29.37
run10931	110.5	3.717	270	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.50	4338	3976	142	1108	28	388	17.63	26.23	19.90	28.62
run10932	129.9	4.326	270	7.5	0.6	1.455	40%	2.59	0.75	0.81	2.75	5051	4678	154	1038	29	385	16.69	26.25	19.90	28.66
run10933	149.7	4.726	270	7.5	0.6	1.455	40%	2.59	0.75	0.81	3.00	5772	5388	165	969	29	384	16.02	26.29	19.90	28.70
run10934	122.6	3.05	270	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.50	4663	4415	28	1215	23	401	17.63	26.16	19.91	27.46
run10935	143.4	3.477	270	7.5	0.6	1.455	40%	1.63	0.46	0.68	2.75	5411	5161	31	1144	23	397	16.74	26.19	19.91	27.49
run10936	164.3	3.892	270	7.5	0.6	1.455	40%	1.63	0.46	0.68	3.00	6168	5916	33	1031	24	393	16.05	26.19	19.89	27.65
run10937	144.9	5.029	270	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.50	5672	5217	235	1092	52	390	16.32	26.45	19.90	29.88
run10938	168.6	5.834	270	7.5	0.6	1.455	50%	5.15	0.85	0.90	2.75	6544	6068	257	999	55	390	15.35	26.49	19.84	30.05
run10939	192	6.552	270	7.5	0.6	1.455	50%	5.15	0.85	0.90	3.00	7408	6911	278	961	60	391	14.58	26.53	19.28	30.31
run10940	129.6	4.612	270	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.50	5101	4664	218	1054	38	381	16.52	26.37	19.94	29.22
run10941	151.7	5.309	270	7.5	0.6	1.455	50%	2.59	0.75	0.81	2.75	5917	5462	236	1000	43	380	15.67	26.41	19.91	29.39
run10942	173.6	5.871	270	7.5	0.6	1.455	50%	2.59	0.75	0.81	3.00	6723	6251	253	954	47	380	14.87	26.45	19.61	29.64
run10943	143.2	3.628	270	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.50	5426	5156	51	1074	23	386	16.57	26.18	19.95	27.92
run10944	166.8	4.329	270	7.5	0.6	1.455	50%	1.63	0.46	0.68	2.75	6280	6005	55	1017	23	383	15.68	26.20	19.92	28.02
run10945	190.2	4.662	270	7.5	0.6	1.455	50%	1.63	0.46	0.68	3.00	7126	6846	61	962	30	382	14.88	26.21	19.62	28.10

Name	Heating Demand (kWh/m2)	Average Daylight Factor(%)	Orientation Angle	Width (m)	Wall Thickness (m)	Wall (U-value) (W/m2·K)	WWR	Window (U-value) (W/m2·K)	Window (g-value)	Window (Tvis)	Height (m)	Total Demand (kWh)	Heating Demand (kWh)	Cooling Demand (kWh)	CO2 Concentration (ppm)	PPD(%)	PDH (hours)	TAIR MIN (°C)	TAIR MAX (°C)	TOP MIN (°C)	TOP MAX (°C)
run10946	87.16	2.54	270	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.50	3454	3138	97	1158	25	395	18.90	26.17	19.96	28.35
run10947	102.8	2.907	270	7.5	0.9	1.057	30%	5.15	0.85	0.90	2.75	4023	3700	104	1093	26	392	18.19	26.22	19.97	28.41
run10948	119	3.238	270	7.5	0.9	1.057	30%	5.15	0.85	0.90	3.00	4615	4284	112	1029	25	389	17.36	26.24	19.97	28.42
run10949	79.18	2.288	270	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.50	3156	2851	86	1155	22	391	19.07	26.12	19.98	28.06
run10950	93.87	2.6	270	7.5	0.9	1.057	30%	2.59	0.75	0.81	2.75	3690	3379	92	1095	22	388	18.31	26.16	20.00	28.11
run10951	109.1	2.956	270	7.5	0.9	1.057	30%	2.59	0.75	0.81	3.00	4245	3928	98	1027	23	384	17.62	26.15	20.01	28.20
run10952	89.28	1.93	270	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.50	3446	3214	13	1194	22	409	19.07	26.14	19.98	26.94
run10953	105.2	2.182	270	7.5	0.9	1.057	30%	1.63	0.46	0.68	2.75	4018	3786	13	1082	22	405	18.30	26.17	20.00	27.02
run10954	121.5	2.404	270	7.5	0.9	1.057	30%	1.63	0.46	0.68	3.00	4606	4373	14	985	22	400	17.64	26.17	20.01	27.01
run10955	110.1	3.389	270	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.50	4352	3965	168	1084	34	385	17.61	26.33	19.99	29.03
run10956	129.6	3.901	270	7.5	0.9	1.057	40%	5.15	0.85	0.90	2.75	5068	4666	182	1020	39	382	16.69	26.36	20.01	29.22
run10957	149.4	4.421	270	7.5	0.9	1.057	40%	5.15	0.85	0.90	3.00	5793	5378	196	980	41	381	16.03	26.40	19.96	29.31
run10958	98.72	3.007	270	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.50	3927	3554	154	1106	30	378	17.85	26.24	20.03	28.75
run10959	116.9	3.497	270	7.5	0.9	1.057	40%	2.59	0.75	0.81	2.75	4594	4209	166	1038	32	375	16.96	26.28	20.04	28.87
run10960	135.4	3.963	270	7.5	0.9	1.057	40%	2.59	0.75	0.81	3.00	5273	4875	178	995	32	373	16.28	26.31	20.03	28.86
run10961	110.8	2.545	270	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.50	4237	3989	29	1089	21	389	17.82	26.13	20.04	27.41
run10962	130.3	2.953	270	7.5	0.9	1.057	40%	1.63	0.46	0.68	2.75	4942	4691	32	1042	22	384	16.96	26.15	20.05	27.60
run10963	150.1	3.27	270	7.5	0.9	1.057	40%	1.63	0.46	0.68	3.00	5657	5403	34	984	22	381	16.28	26.15	20.01	27.65
run10964	133.2	4.18	270	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.50	5265	4795	251	1049	54	382	16.50	26.45	20.02	30.00
run10965	155.8	4.879	270	7.5	0.9	1.057	50%	5.15	0.85	0.90	2.75	6100	5608	273	1008	56	382	15.61	26.49	19.98	30.12
run10966	178.2	5.536	270	7.5	0.9	1.057	50%	5.15	0.85	0.90	3.00	6928	6414	295	959	61	384	14.82	26.53	19.55	30.37
run10967	118.1	3.855	270	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.50	4706	4253	234	1061	40	372	16.71	26.37	20.06	29.28
run10968	139.2	4.418	270	7.5	0.9	1.057	50%	2.59	0.75	0.81	2.75	5484	5012	253	1005	45	371	15.85	26.42	20.02	29.53
run10969	160.2	5.007	270	7.5	0.9	1.057	50%	2.59	0.75	0.81	3.00	6260	5768	273	958	50	372	15.06	26.44	19.89	29.77
run10970	131.7	3.102	270	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.50	5013	4740	54	1070	22	375	16.74	26.17	20.08	27.98
run10971	154.2	3.59	270	7.5	0.9	1.057	50%	1.63	0.46	0.68	2.75	5831	5553	59	1020	23	372	15.87	26.18	20.00	28.16
run10972	176.6	4.038	270	7.5	0.9	1.057	50%	1.63	0.46	0.68	3.00	6639	6357	64	967	27	371	15.07	26.19	19.90	28.17

Statistical Charts and Preliminary Conclusions: Thermal and Daylight Correlation Analysis



	Heating Demand	Average Daylight Factor	Orientation Angle	Width	Wall Thickness	Wall (U-value)	WWR	Window (U-value)	Window (g-value)	Window (Tvis)	Height
Heating Demand	1.00										
Average Daylight Factor	0.85	1.00									
Orientation Angle	0.01	0.00	1.00								
Width	0.61	0.58	0.00	1.00							
Wall Thickness	-0.31	-0.43	0.00	0.00	1.00						
Wall(U-value)	0.32	0.42	0.00	0.00	-0.98	1.00					
WWR	0.45	0.52	0.00	0.00	0.00	0.00	1.00				
Window(U-value)	0.09	0.30	0.00	0.00	0.00	0.00	0.00	1.00			
Window(g-value)	0.03	0.32	0.00	0.00	0.00	0.00	0.00	0.86	1.00		
Window(Tvis)	0.05	0.32	0.00	0.00	0.00	0.00	0.00	0.94	0.99	1.00	
Height	0.37	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Figure. correlation analysis for the shoebox variables

Simulation Process and Data Analysis

Correlation analysis requires abundant simulation data. In our study, we assigned multiple values to each variable and conducted extensive simulations using IDAICE's parameterization feature. We documented the values of variables alongside the corresponding simulated results for heating demand and DFAVG (Daylight Factor Average), thereby providing data for the examination of variable correlations.

Data Analysis (Thermal performance)

Most variables exhibit independence from each other, displaying no discernible linear correlation. A few variables may influence each other, but these relationships do not impact the research findings.

When organizing variables based on their correlation with heating demand, the following observations emerge:

a. The shoebox's geometry demonstrates a robust association with heating demand. Width exhibits a high level of correlation, while height shows a moderate degree of correlation.

b. The window-to-wall ratio of the shoebox exhibits a noticeable correlation with heating demand. Exterior wall thickness and U-value display relative correlations with heating demand, whereas window characteristics exhibit less pronounced correlations.

c. Statistical analysis reveals no linear correlation between building orientation angle and heating demand. However, based on empirical knowledge, in many regions of China, houses facing south or west tend to have heating advantages, often experiencing issues related to overheating and excessive cooling demand. Consequently, we posit a nonlinear correlation between building orientation angle and heating demand. Subsequent comprehensive research will focus on building orientation.

Data Analysis (Daylight)

a. In the case of the shoebox configuration, a robust positive correlation exists between the Daylight Factor and heating demand. This suggests that higher Daylight Factors do not necessarily translate to improved room conditions, as they may

contribute to increased heating demand.

b. Orientation exerts no influence on the Daylight Factor. Room width, window-to-wall ratio, and exterior wall thickness represent the factors exhibiting the highest linear correlations with daylighting performance.

c. The average Daylight Factor value falls short in reflecting the adequacy of internal light distribution. Additional experimental groups are essential for investigating the comfort of indoor lighting conditions.

Raw Data, Statistical Charts and Preliminary Conclusions: Individual Studies on Different Factors - Orientation

Orientation Angle	Width(4.8m)	Width(6m)	Width(7.5m)
-40	67.62	88.10	113.80
-35	67.75	88.31	114.20
-30	68.33	88.95	115.00
-25	69.32	90.15	116.40
-20	70.74	91.83	118.40
-15	72.54	93.97	120.90
-10	74.68	96.52	123.90
-5	77.08	99.45	127.40
0	79.74	102.60	131.20
5	82.44	105.90	135.10
10	85.29	109.30	139.20
15	88.11	112.70	143.20
20	90.75	116.00	147.10
25	93.01	118.70	150.40
30	94.87	120.90	153.10
35	96.34	122.60	155.20
40	97.54	124.10	156.90
45	98.51	125.20	158.30
50	99.34	126.20	159.40
55	100.00	127.00	160.40
60	100.60	127.80	161.20
65	101.10	128.30	161.90
70	101.60	128.90	162.60
75	102.10	129.40	163.10

Orientation Angle	Width(4.8m)	Width(6m)	Width(7.5m)
80	102.40	129.90	163.70
85	102.80	130.30	164.20
90	103.20	130.80	164.80
95	103.50	131.10	165.20
100	103.90	131.50	165.70
105	104.20	132.00	166.20
110	104.60	132.40	166.70
115	104.90	132.80	167.20
120	105.20	133.20	167.60
125	105.50	133.50	168.10
130	105.80	133.90	168.50
135	106.10	134.20	168.90
140	106.40	134.70	169.40
145	106.70	135.10	170.00
150	107.10	135.60	170.70
155	107.60	136.20	171.40
160	108.20	136.90	172.30
165	108.70	137.60	173.10
170	109.30	138.30	174.00
175	109.80	138.90	174.80
180	110.20	139.50	175.40
185	110.40	139.70	175.70
190	110.50	139.80	175.90
195	110.50	139.70	175.70

Orientation Angle	Width(4.8m)	Width(6m)	Width(7.5m)
200	110.20	139.40	175.30
205	109.60	138.60	174.30
210	108.60	137.30	172.70
215	107.00	135.50	170.50
220	105.10	133.10	167.70
225	102.80	130.40	164.30
230	100.20	127.20	160.60
235	97.41	123.90	156.60
240	94.55	120.40	152.40
245	91.67	117.00	148.20
250	88.88	113.50	144.00
255	86.20	110.20	140.10
260	83.67	107.20	136.50
265	81.29	104.30	133.00
270	79.13	101.70	129.90
275	77.11	99.29	127.00
280	75.30	97.10	124.40
285	73.70	95.20	122.00
290	72.31	93.51	120.00
295	71.04	91.94	118.20
300	69.93	90.65	116.70
305	69.02	89.61	115.40
310	68.31	88.80	114.50
315	67.80	88.25	114.00

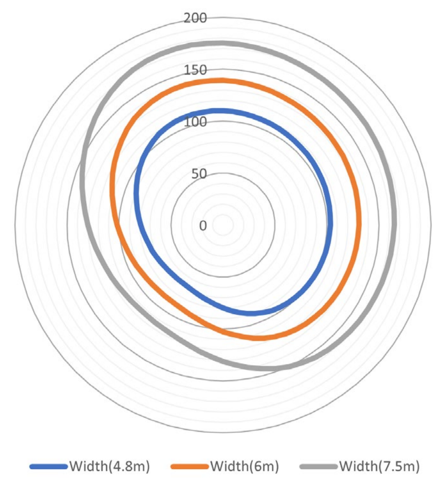


Figure. heating demand by different orientations, for 3 cases with room widths(4.8m, 6m, 7.5m)

Simulation Process

In the initial phase of simulations, our focus was on the orientation of the primary daylighting facade of the shoebox. In this segment, we assigned 72 values to the orientation of the daylighting facade, with a 5-degree increment, where 0° represented due south. To guarantee the consistency of the variation patterns in the simulation results, we carried out three sets of simulations, altering the width of the shoebox facade each time. Subsequently, we collected and analyzed the simulation data, generating variation curves to unveil the relationship between the orientation of the daylighting facade and the heating energy demand of the shoebox.

Data Analysis

Based on the curves, the optimal orientation for the shoebox daylighting facade is 320° (southwest), whereas the least favorable orientation is 190° (northwest). This mirrors the influence of solar radiation on the heating energy demand of the shoebox, consistent with our overall understanding. In the forthcoming simulations, we will concentrate on three values for the primary daylighting facade orientation: 190°, 320°, and 50°. The objective is to explore whether the associations between the remaining four factors and heating energy demand will vary with different primary daylighting facade orientations.

Statistical Charts and Preliminary Conclusions: Shoebox Geometry

Simulation Process

The second phase of simulations centered on the geometry of the shoebox. Concerning facade width, while maintaining the shoebox's area constant, we conducted three sets of simulations with various primary daylighting facade orientations. We assigned 15 values, ranging from 3 meters to 12 meters, with an increment of 0.6 meters. Similarly, for the height, we designated 9 values, ranging from 2.5 meters to 4.5 meters, with an increment of 0.25 meters, for three sets of simulations involving different primary daylighting facade orientations. Following the simulations, we obtained the relationship curves between width, height, and heating demand.

Data Analysis

Based on the Width-Heating Demand curve, as the width increases, heating demand exhibits a linear upward trend. This effect becomes more pronounced at less favorable solar angles (facing north), where an increase in width leads to a more significant rise in heating demand. Conversely, at more favorable angles, the increase in width has a relatively smaller impact on heating demand. Similar patterns are observed in the relationship between Height and Heating Demand. However, due to the relatively smaller magnitude of height variations, the influence of primary daylighting facade orientation on the rate of change is less evident for height.

Possible reasons for these observations are as follows:

a. An increase in width/height results in a larger exterior wall surface area for the shoebox, leading to increased heat dissipation and, consequently, higher heating energy demand.

b. Since the window-to-wall ratio remains constant, an increase in width or height results in a larger window area. This, in turn, enhances heat dissipation through the windows and increases ventilation when the windows are operational, ultimately contributing to higher heating demand.

c. A larger exterior wall surface area benefits from a more favorable primary daylighting facade orientation, resulting in greater solar heat gain. This can offset the increase in exterior wall heat dissipation. Consequently, the overall increase in heating energy demand is relatively smaller. This phenomenon is reflected in the slope of the curve.

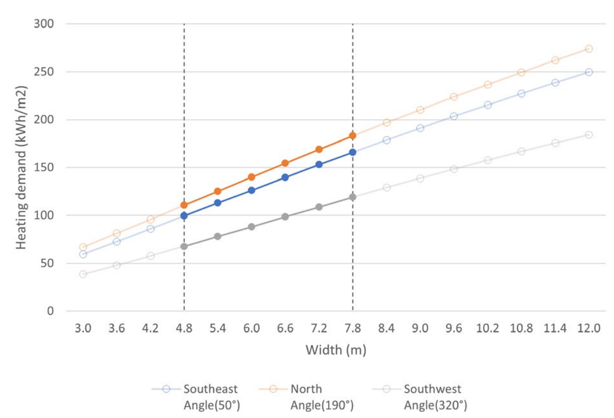


Figure. heating demand by different room widths, in 3 orientations (50°, 190°, 320°)

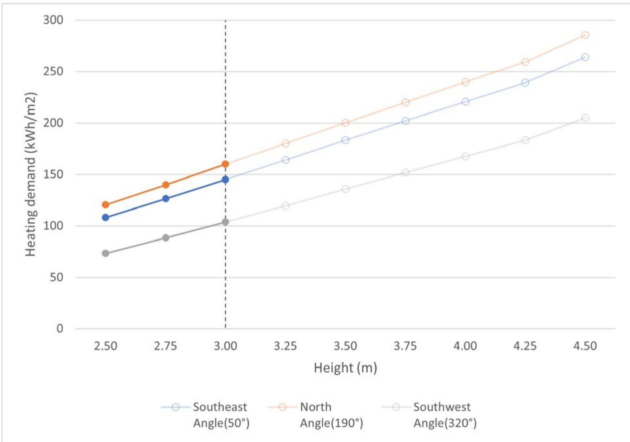


Figure. heating demand by different floor heights, in 3 orientations (50°, 190°, 320°)

Statistical Charts and Preliminary Conclusions: Wall Thickness

Simulation Process

The third phase of simulations centered on the exterior wall thickness of the shoebox. Maintaining all other conditions constant, we conducted three sets of simulations involving different primary daylighting facade orientations. We assigned 20 values, ranging from 0.1 meters to 2 meters, with an increment of 0.1 meters, to the exterior wall thickness. Following the simulations, we derived the relationship curve between exterior wall thickness and heating demand.

Data Analysis

According to the Thickness-Heating Demand curve, as wall thickness increases, heating demand exhibits a gradually decreasing trend with a slower rate of decline. The influence of the primary daylighting facade orientation on this

relationship is relatively minimal. From the chart, it is evident that the reduction in heating demand is significant when the wall thickness increases from 0.1 meters to 0.3 meters, whereas the reduction in heating demand resulting from changing the wall thickness from 0.9 meters to 2 meters is not substantial.

Possible reasons for these observations are as follows:

a. In the simulation principle, wall thickness is positively correlated with the exterior wall U-value, while heating demand is inversely proportional to the exterior wall U-value. As the wall thickness starts from a low initial value and increases by a fixed amount, the change in heating demand is initially rapid and then slows down.

b. When the wall thickness reaches a certain point, its impact on reducing the heating demand of the house reaches a saturation point. At this stage, other variables of the house (such as parameters related to windows on the exterior wall) become the primary factors influencing heating demand. As these variables remain constant, the curve tends to approach a specific value.

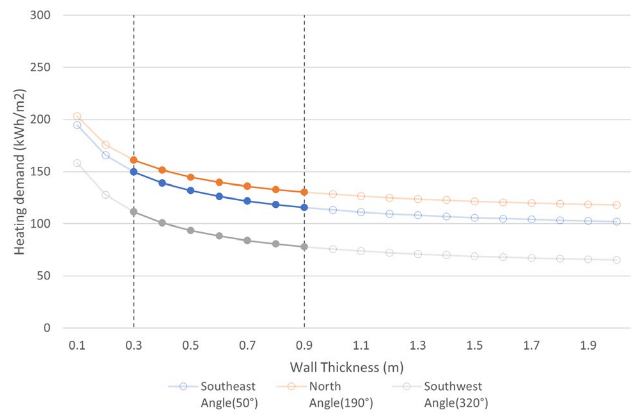


Figure. heating demand by different wall thickness, in 3 orientations (50°, 190°, 320°)

Statistical Charts and Preliminary Conclusions: Window-to-wall Ratio

Simulation Process

The fourth phase of simulations concentrated on the window-to-wall ratio (WWR) of the shoebox. Maintaining other conditions as constants, we conducted three sets of simulations involving different primary daylighting facade orientations. We assigned 6 values to the WWR, ranging from 10% to 70%, with an increment of 10%. Following the simulations, we derived the relationship curve between WWR and heating demand.

Data Analysis

According to the WWR-Heating Demand curve, as the window-to-wall ratio increases, heating demand exhibits a linear upward trend. The rise in heating demand is more pronounced at less favorable solar angles (north-facing) and less significant at more favorable angles. This characteristic closely resembles the patterns observed in the variations of width and height.

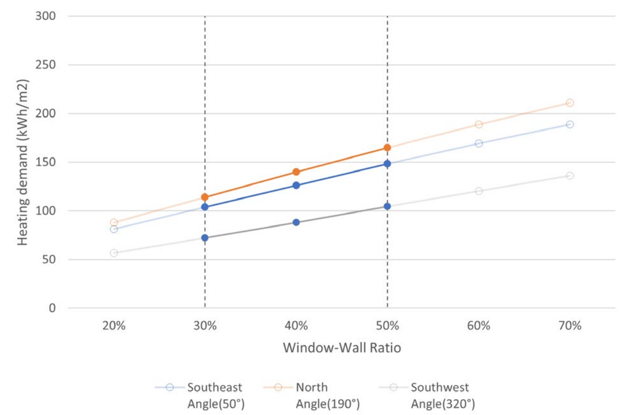


Figure. heating demand by different window-to-wall ratios, in 3 orientations (50°, 190°, 320°)

Statistical Charts and Preliminary Conclusions: Window Glazing Type

Simulation Process

The fifth phase of simulations concentrated on the window types of the shoebox. While keeping other conditions constant, we chose three distinct types of window glass and performed three sets of simulations for different orientations. Moreover, recognizing that windows act as conduits for direct sunlight into the interior, we also factored in the occurrence of indoor overheating stemming from various window types in our assessments. In this segment of simulations, we documented the correlation between window types and the heating and cooling energy demand of the shoebox. Following the simulations, we acquired the following statistical charts.

Data Analysis

Based on the simulation results, double glazing performs the best in reducing the heating demand of the "shoebox." Nevertheless, overall, the influence of glazing type on heating demand is not substantial, and the variations in heating energy consumption among different types are minimal. In the orientation most favorable for heating demand, overheating occurs, but the instances of cooling demand are relatively infrequent compared to heating demand. Low-e significantly improves cooling demand but does not have a positive impact on heating demand.

We speculate that this occurs because, in Yunnan's climate, the effect of solar gain through windows on heating energy consumption is greater than that of heat loss. The advantage of Low-E lies in its low G-value, which substantially reduces overheating in the summer. However, during the winter, this characteristic diminishes solar gain during the day, and the slightly higher U-value results in greater room heat loss. These effects are insufficient to offset this disadvantage, ultimately leading to an increase in the heating energy consumption of the shoebox.

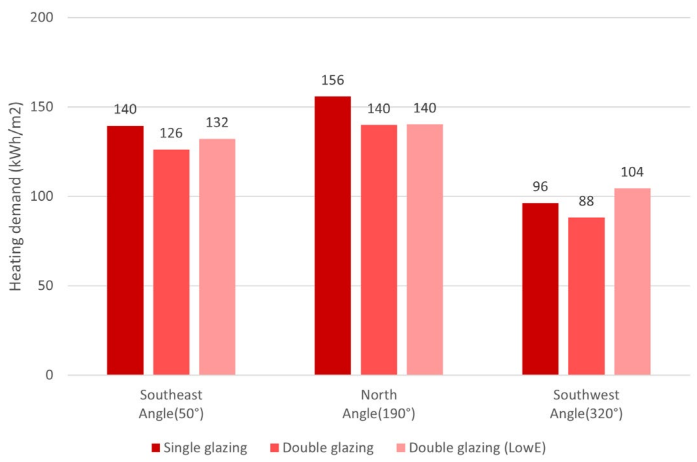


Figure. Heating demand by 3 types of glazings(single, double, double low-e), in 3 orientations (50°, 190°, 320°)

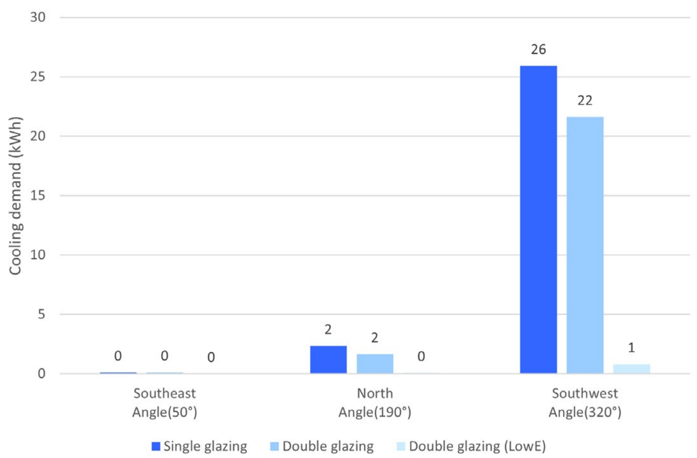


Figure. Total cooling demand by 3 types of glazings(single, double, double low-e), in 3 orientations (50°, 190°, 320°)

Raw Data: Standardization Regression Analysis in 3 Domains of Orientation

Orientation angle(0-30, 320-360), Single glazing

Name	Heating Demand (kWh/m2)	Orientation Angle	Width (m)	Wall Thickness (m)	WWR	Height (m)
run10001	91	390	4.8	0.3	30%	2.50
run10002	105	390	4.8	0.3	30%	2.75
run10003	119	390	4.8	0.3	30%	3.00
run10004	107	390	4.8	0.3	40%	2.50
run10005	124	390	4.8	0.3	40%	2.75
run10006	141	390	4.8	0.3	40%	3.00
run10007	123	390	4.8	0.3	50%	2.50
run10008	143	390	4.8	0.3	50%	2.75
run10009	163	390	4.8	0.3	50%	3.00
run10010	73	390	4.8	0.6	30%	2.50
run10011	85	390	4.8	0.6	30%	2.75
run10012	98	390	4.8	0.6	30%	3.00
run10013	89	390	4.8	0.6	40%	2.50
run10014	104	390	4.8	0.6	40%	2.75
run10015	120	390	4.8	0.6	40%	3.00
run10016	106	390	4.8	0.6	50%	2.50
run10017	124	390	4.8	0.6	50%	2.75
run10018	143	390	4.8	0.6	50%	3.00
run10019	65	390	4.8	0.9	30%	2.50
run10020	76	390	4.8	0.9	30%	2.75
run10021	88	390	4.8	0.9	30%	3.00
run10022	81	390	4.8	0.9	40%	2.50
run10023	95	390	4.8	0.9	40%	2.75
run10024	111	390	4.8	0.9	40%	3.00
run10025	98	390	4.8	0.9	50%	2.50
run10026	115	390	4.8	0.9	50%	2.75
run10027	133	390	4.8	0.9	50%	3.00
run10028	116	390	6.0	0.3	30%	2.50
run10029	134	390	6.0	0.3	30%	2.75
run10030	152	390	6.0	0.3	30%	3.00
run10031	136	390	6.0	0.3	40%	2.50
run10032	158	390	6.0	0.3	40%	2.75
run10033	180	390	6.0	0.3	40%	3.00
run10034	157	390	6.0	0.3	50%	2.50
run10035	181	390	6.0	0.3	50%	2.75
run10036	206	390	6.0	0.3	50%	3.00
run10037	93	390	6.0	0.6	30%	2.50
run10038	109	390	6.0	0.6	30%	2.75
run10039	125	390	6.0	0.6	30%	3.00
run10040	114	390	6.0	0.6	40%	2.50
run10041	133	390	6.0	0.6	40%	2.75
run10042	153	390	6.0	0.6	40%	3.00
run10043	135	390	6.0	0.6	50%	2.50
run10044	158	390	6.0	0.6	50%	2.75
run10045	180	390	6.0	0.6	50%	3.00
run10046	83	390	6.0	0.9	30%	2.50
run10047	97	390	6.0	0.9	30%	2.75
run10048	112	390	6.0	0.9	30%	3.00
run10049	104	390	6.0	0.9	40%	2.50
run10050	122	390	6.0	0.9	40%	2.75
run10051	141	390	6.0	0.9	40%	3.00
run10052	125	390	6.0	0.9	50%	2.50
run10053	147	390	6.0	0.9	50%	2.75
run10054	169	390	6.0	0.9	50%	3.00
run10055	148	390	7.5	0.3	30%	2.50
run10056	170	390	7.5	0.3	30%	2.75
run10057	193	390	7.5	0.3	30%	3.00
run10058	174	390	7.5	0.3	40%	2.50
run10059	200	390	7.5	0.3	40%	2.75
run10060	226	390	7.5	0.3	40%	3.00
run10061	199	390	7.5	0.3	50%	2.50
run10062	228	390	7.5	0.3	50%	2.75
run10063	256	390	7.5	0.3	50%	3.00
run10064	119	390	7.5	0.6	30%	2.50
run10065	139	390	7.5	0.6	30%	2.75
run10066	158	390	7.5	0.6	30%	3.00
run10067	146	390	7.5	0.6	40%	2.50
run10068	169	390	7.5	0.6	40%	2.75
run10069	193	390	7.5	0.6	40%	3.00
run10070	171	390	7.5	0.6	50%	2.50
run10071	198	390	7.5	0.6	50%	2.75
run10072	224	390	7.5	0.6	50%	3.00
run10073	106	390	7.5	0.9	30%	2.50
run10074	124	390	7.5	0.9	30%	2.75
run10075	142	390	7.5	0.9	30%	3.00
run10076	133	390	7.5	0.9	40%	2.50
run10077	155	390	7.5	0.9	40%	2.75
run10078	177	390	7.5	0.9	40%	3.00
run10079	159	390	7.5	0.9	50%	2.50
run10080	185	390	7.5	0.9	50%	2.75
run10081	210	390	7.5	0.9	50%	3.00
run10082	66	320	4.8	0.3	30%	2.50
run10083	77	320	4.8	0.3	30%	2.75
run10084	89	320	4.8	0.3	30%	3.00
run10085	77	320	4.8	0.3	40%	2.50
run10086	92	320	4.8	0.3	40%	2.75
run10087	107	320	4.8	0.3	40%	3.00
run10088	90	320	4.8	0.3	50%	2.50
run10089	106	320	4.8	0.3	50%	2.75
run10090	124	320	4.8	0.3	50%	3.00
run10091	50	320	4.8	0.6	30%	2.50
run10092	59	320	4.8	0.6	30%	2.75
run10093	69	320	4.8	0.6	30%	3.00
run10094	61	320	4.8	0.6	40%	2.50
run10095	74	320	4.8	0.6	40%	2.75
run10096	87	320	4.8	0.6	40%	3.00
run10097	73	320	4.8	0.6	50%	2.50
run10098	88	320	4.8	0.6	50%	2.75
run10099	104	320	4.8	0.6	50%	3.00
run10100	43	320	4.8	0.9	30%	2.50
run10101	51	320	4.8	0.9	30%	2.75
run10102	61	320	4.8	0.9	30%	3.00
run10103	54	320	4.8	0.9	40%	2.50
run10104	66	320	4.8	0.9	40%	2.75
run10105	78	320	4.8	0.9	40%	3.00
run10106	66	320	4.8	0.9	50%	2.50
run10107	80	320	4.8	0.9	50%	2.75
run10108	95	320	4.8	0.9	50%	3.00
run10109	86	320	6.0	0.3	30%	2.50
run10110	101	320	6.0	0.3	30%	2.75
run10111	117	320	6.0	0.3	30%	3.00
run10112	102	320	6.0	0.3	40%	2.50
run10113	120	320	6.0	0.3	40%	2.75
run10114	138	320	6.0	0.3	40%	3.00
run10115	118	320	6.0	0.3	50%	2.50
run10116	139	320	6.0	0.3	50%	2.75
run10117	160	320	6.0	0.3	50%	3.00
run10118	65	320	6.0	0.6	30%	2.50
run10119	78	320	6.0	0.6	30%	2.75
run10120	91	320	6.0	0.6	30%	3.00
run10121	80	320	6.0	0.6	40%	2.50
run10122	96	320	6.0	0.6	40%	2.75
run10123	113	320	6.0	0.6	40%	3.00
run10124	97	320	6.0	0.6	50%	2.50
run10125	115	320	6.0	0.6	50%	2.75
run10126	135	320	6.0	0.6	50%	3.00
run10127	56	320	6.0	0.9	30%	2.50

Orientation angle(30-190), Single glazing

Name	Heating Demand (kWh/m2)	Orientation Angle	Width (m)	Wall Thickness (m)	WWR	Height (m)
run10001	91	30	4.8	0.3	30%	2.50
run10002	105	30	4.8	0.3	30%	2.75
run10003	119	30	4.8	0.3	30%	3.00
run10004	107	30	4.8	0.3	40%	2.50
run10005	124	30	4.8	0.3	40%	2.75
run10006	141	30	4.8	0.3	40%	3.00
run10007	123	30	4.8	0.3	50%	2.50
run10008	143	30	4.8	0.3	50%	2.75
run10009	163	30	4.8	0.3	50%	3.00
run10010	73	30	4.8	0.6	30%	2.50
run10011	85	30	4.8	0.6	30%	2.75
run10012	98	30	4.8	0.6	30%	3.00
run10013	89	30	4.8	0.6	40%	2.50
run10014	104	30	4.8	0.6	40%	2.75
run10015	120	30	4.8	0.6	40%	3.00
run10016	106	30	4.8	0.6	50%	2.50
run10017	124	30	4.8	0.6	50%	2.75
run10018	143	30	4.8	0.6	50%	3.00
run10019	65	30	4.8	0.9	30%	2.50
run10020	76	30	4.8	0.9	30%	2.75
run10021	88	30	4.8	0.9	30%	3.00
run10022	81	30	4.8	0.9	40%	2.50
run10023	95	30	4.8	0.9	40%	2.75
run10024	111	30	4.8	0.9	40%	3.00
run10025	98	30	4.8	0.9	50%	2.50
run10026	115	30	4.8	0.9	50%	2.75
run10027	133	30	4.8	0.9	50%	3.00
run10028	116	30	6.0	0.3	30%	2.50
run10029	134	30	6.0	0.3	30%	2.75
run10030	152	30	6.0	0.3	30%	3.00
run10031	136	30	6.0	0.3	40%	2.50
run10032	158	30	6.0	0.3	40%	2.75
run10033	180	30	6.0	0.3	40%	3.00
run10034	157	30	6.0	0.3	50%	2.50
run10035	181	30	6.0	0.3	50%	2.75
run10036	206	30	6.0	0.3	50%	3.00
run10037	93	30	6.0	0.6	30%	2.50
run10038	109	30	6.0	0.6	30%	2.75
run10039	125	30	6.0	0.6	30%	3.00
run10040	114	30	6.0	0.6	40%	2.50
run10041	133	30	6.0	0.6	40%	2.75
run10042	153	30	6.0	0.6	40%	3.00
run10043	135	30	6.0	0.6	50%	2.50
run10044	158	30	6.0	0.6	50%	2.75
run10045	180	30	6.0	0.6	50%	3.00
run10046	83	30	6.0	0.9	30%	2.50
run10047	97	30	6.0	0.9	30%	2.75
run10048	112	30	6.0	0.9	30%	3.00
run10049	104	30	6.0	0.9	40%	2.50
run10050	122	30	6.0	0.9	40%	2.75
run10051	141	30	6.0	0.9	40%	3.00
run10052	125	30	6.0	0.9	50%	2.50
run10053	147	30	6.0	0.9	50%	2.75
run10054	169	30	6.0	0.9	50%	3.00
run10055	148	30	7.5	0.3	30%	2.50
run10056	170	30	7.5	0.3	30%	2.75
run10057	193	30	7.5	0.3	30%	3.00
run10058	174	30	7.5	0.3	40%	2.50
run10059	200	30	7.5	0.3	40%	2.75
run10060	226	30	7.5	0.3	40%	3.00
run10061	199	30	7.5	0.3	50%	2.50
run10062	228	30	7.5	0.3	50%	2.75
run10063	256	30	7.5	0.3	50%	3.00
run10064	119	30	7.5	0.6	30%	2.50
run10065	139	30	7.5	0.6	30%	2.75
run10066	158	30	7.5	0.6	30%	3.00
run10067	146	30	7.5	0.6	40%	2.50
run10068	169	30	7.5	0.6	40%	2.75
run10069	193	30	7.5	0.6	40%	3.00
run10070	171	30	7.5	0.6	50%	2.50
run10071	198	30	7.5	0.6	50%	2.75
run10072	224	30	7.5	0.6	50%	3.00
run10073	106	30	7.5	0.9	30%	2.50
run10074	124	30	7.5	0.9	30%	2.75
run10075	142	30	7.5	0.9	30%	3.00
run10076	133	30	7.5	0.9	40%	2.50
run10077	155	30	7.5	0.9	40%	2.75
run10078	177	30	7.5	0.9	40%	3.00
run10079	159	30	7.5	0.9	50%	2.50
run10080	185	30	7.5	0.9	50%	2.75
run10081	210	30	7.5	0.9	50%	3.00
run10082	94	110	4.8	0.3	30%	2.50
run10083	108	110	4.8	0.3	30%	2.75
run10084	123	110	4.8	0.3	30%	3.00
run10085	114	110	4.8	0.3	40%	2.50
run10086	131	110	4.8	0.3	40%	2.75
run10087	150	110	4.8	0.3	40%	3.00
run10088	133	110	4.8	0.3	50%	2.50
run10089	154	110	4.8	0.3	50%	2.75
run10090	175	110	4.8	0.3	50%	3.00
run10091	80	110	4.8	0.6	30%	2.50
run10092	93	110	4.8	0.6	30%	2.75
run10093	107	110	4.8	0.6	30%	3.00
run10094	101	110	4.8	0.6	40%	2.50
run10095	117	110	4.8	0.6	40%	2.75
run10096	134	110	4.8	0.6	40%	3.00
run10097	121	110	4.8	0.6	50%	2.50
run10098	140	110	4.8	0.6	50%	2.75
run10099	160	110	4.8	0.6	50%	3.00
run10100	74	110	4.8	0.9	30%	2.50
run10101	86	110	4.8	0.9	30%	2.75
run10102	99	110	4.8	0.9	30%	3.00
run10103	95	110	4.8	0.9	40%	2.50
run10104	110	110	4.8	0.9	40%	2.75
run10105	126	110	4.8	0.9	40%	3.00
run10106	115	110	4.8	0.9	50%	2.50
run10107	134	110	4.8	0.9	50%	2.75
run10108	154	110	4.8	0.9	50%	3.00
run10109	120	110	6.0	0.3	30%	2.50
run10110	138	110	6.0	0.3	30%	2.75
run10111	157	110	6.0	0.3	30%	3.00
run10112	145	110	6.0	0.3	40%	2.50
run10113	167	110	6.0	0.3	40%	2.75
run10114	189	110	6.0	0.3	40%	3.00
run10115	169	110	6.0	0.3	50%	2.50
run10116	194	110	6.0	0.3	50%	2.75
run10117	220	110	6.0	0.3	50%	3.00
run10118	102	110	6.0	0.6	30%	2.50
run10119	118	110	6.0	0.6	30%	2.75
run10120	135	110	6.0	0.6	30%	3.00
run10121	128	110	6.0	0.6	40%	2.50
run10122	148	110	6.0	0.6	40%	2.75
run10123	169	110	6.0	0.6	40%	3.00
run10124	153	110	6.0	0.6	50%	2.50
run10125	177	110	6.0	0.6	50%	2.75
run10126	201	110	6.0	0.6	50%	3.00
run10127	94	110	6.0	0.9	30%	2.50

Orientation angle(190-320), Single glazing

Name	Heating Demand (kWh/m2)	Orientation Angle	Width (m)	Wall Thickness (m)	WWR	Height (m)
run10001	101	190	4.8	0.3	30%	2.50
run10002	116	190	4.8	0.3	30%	2.75
run10003	132	190	4.8	0.3	30%	3.00
run10004	121	190	4.8	0.3	40%	2.50
run10005	140	190	4.8	0.3	40%	2.75
run10006	159	190	4.8	0.3	40%	3.00
run10007	141	190	4.8	0.3	50%	2.50
run10008	163	190	4.8	0.3	50%	2.75
run10009	185	190	4.8	0.3	50%	3.00
run10010	86	190	4.8	0.6	30%	2.50
run10011	99	190	4.8	0.6	30%	2.75
run10012	113	190	4.8	0.6	30%	3.00
run10013	106	190	4.8	0.6	40%	2.50
run10014	123	190	4.8	0.6	40%	2.75
run10015	141	190	4.8	0.6	40%	3.00
run10016	127	190	4.8	0.6	50%	2.50
run10017	147	190	4.8	0.6	50%	2.75
run10018	168	190	4.8	0.6	50%	3.00
run10019	79	190	4.8	0.9	30%	2.50
run10020	91	190	4.8	0.9	30%	2.75
run10021	104	190	4.8	0.9	30%	3.00
run10022	99	190	4.8	0.9	40%	2.50
run10023	116	190	4.8	0.9	40%	2.75
run10024	132	190	4.8	0.9	40%	3.00
run10025	120	190	4.8	0.9	50%	2.50
run10026	140	190	4.8	0.9	50%	2.75
run10027	160	190	4.8	0.9	50%	3.00
run10028	129	190	6.0	0.3	30%	2.50
run10029	148	190	6.0	0.3	30%	2.75
run10030	167	190	6.0	0.3	30%	3.00
run10031	154	190	6.0	0.3	40%	2.50
run10032	177	190	6.0	0.3	40%	2.75
run10033	200	190	6.0	0.3	40%	3.00
run10034	179	190	6.0	0.3	50%	2.50
run10035	205	190	6.0	0.3	50%	2.75
run10036	231	190	6.0	0.3	50%	3.00
run10037	109	190	6.0	0.6	30%	2.50
run10038	126	190	6.0	0.6	30%	2.75
run10039	143	190	6.0	0.6	30%	3.00
run10040	135	190	6.0	0.6	40%	2.50
run10041	156	190	6.0	0.6	40%	2.75
run10042	177	190	6.0	0.6	40%	3.00
run10043	161	190	6.0	0.6	50%	2.50
run10044	185	190	6.0	0.6	50%	2.75
run10045	210	190	6.0	0.6	50%	3.00
run10046	100	190	6.0	0.9	30%	2.50
run10047	116	190	6.0	0.9	30%	2.75
run10048	132	190	6.0	0.9	30%	3.00
run10049	126	190	6.0	0.9	40%	2.50
run10050	146	190	6.0	0.9	40%	2.75
run10051	167	190	6.0	0.9	40%	3.00
run10052	153	190	6.0	0.9	50%	2.50
run10053	176	190	6.0	0.9	50%	2.75
run10054	200	190	6.0	0.9	50%	3.00
run10055	164	190	7.5	0.3	30%	2.50
run10056	187	190	7.5	0.3	30%	2.75
run10057	211	190	7.5	0.3	30%	3.00
run10058	195	190	7.5	0.3	40%	2.50
run10059	223	190	7.5	0.3	40%	2.75
run10060	250	190	7.5	0.3	40%	3.00
run10061	225	190	7.5	0.3	50%	2.50
run10062	256	190	7.5	0.3	50%	2.75
run10063	286	190	7.5	0.3	50%	3.00
run10064	138	190	7.5	0.6	30%	2.50
run10065	159	190	7.5	0.6	30%	2.75
run10066	181	190	7.5	0.6	30%	3.00
run10067	171	190	7.5	0.6	40%	2.50
run10068	196	190	7.5	0.6	40%	2.75
run10069	222	190	7.5	0.6	40%	3.00
run10070	202	190	7.5	0.6	50%	2.50
run10071	231	190	7.5	0.6	50%	2.75
run10072	260	190	7.5	0.6	50%	3.00
run10073	127	190	7.5	0.9	30%	2.50
run10074	147	190	7.5	0.9	30%	2.75
run10075	167	190	7.5	0.9	30%	3.00
run10076	160	190	7.5	0.9	40%	2.50
run10077	184	190	7.5	0.9	40%	2.75
run10078	209	190	7.5	0.9	40%	3.00
run10079	192	190	7.5	0.9	50%	2.50
run10080	220	190	7.5	0.9	50%	2.75
run10081	248	190	7.5	0.9	50%	3.00
run10082	82	255	4.8	0.3	30%	2.50
run10083	95	255	4.8	0.3	30%	2.75
run10084	109	255	4.8	0.3	30%	3.00
run10085	97	255	4.8	0.3	40%	2.50
run10086	113	255	4.8	0.3	40%	2.75
run10087	130	255	4.8	0.3	40%	3.00
run10088	112	255	4.8	0.3	50%	2.50
run10089	131	255	4.8	0.3	50%	2.75
run10090	150	255	4.8	0.3	50%	3.00
run10091	66	255	4.8	0.6	30%	2.50
run10092	77	255	4.8	0.6	30%	2.75
run10093	88	255	4.8	0.6	30%	3.00
run10094	81	255	4.8	0.6	40%	2.50
run10095	95	255	4.8	0.6	40%	2.75
run10096	109	255	4.8	0.6	40%	3.00
run10097	96	255	4.8	0.6	50%	2.50
run10098	113	255	4.8	0.6	50%	2.75
run10099	130	255	4.8	0.6	50%	3.00
run10100	58	255	4.8	0.9	30%	2.50
run10101	68	255	4.8	0.9	30%	2.75
run10102	79	255	4.8	0.9	30%	3.00
run10103	73	255	4.8	0.9	40%	2.50
run10104	87	255	4.8	0.9	40%	2.75
run10105	100	255	4.8	0.9	40%	3.00
run10106	89	255	4.8	0.9	50%	2.50
run10107	105	255	4.8	0.9	50%	2.75
run10108	122	255	4.8	0.9	50%	3.00
run10109	106	255	6.0	0.3	30%	2.50
run10110	122	255	6.0	0.3	30%	2.75
run10111	140	255	6.0	0.3	30%	3.00
run10112	125	255	6.0	0.3	40%	2.50
run10113	145	255	6.0	0.3	40%	2.75
run10114	165	255	6.0	0.3	40%	3.00
run10115	144	255	6.0	0.3	50%	2.50
run10116	167	255	6.0	0.3	50%	2.75
run10117	190	255	6.0	0.3	50%	3.00
run10118	84	255	6.0	0.6	30%	2.50
run10119	98	255	6.0	0.6	30%	2.75
run10120	113	255	6.0	0.6	30%	3.00
run10121	104	255	6.0	0.6	40%	2.50
run10122	121	255	6.0	0.6	40%	2.75
run10123	140	255	6.0	0.6	40%	3.00
run10124	123	255	6.0	0.6	50%	2.50
run10125	144	255	6.0	0.6	50%	2.75
run10126	165	255	6.0	0.6	50%	3.00
run10127	75	255	6.0	0.9	30%	2.50

run10128	67	320	6.0	0.9	30%	2.75
run10129	79	320	6.0	0.9	30%	3.00
run10130	71	320	6.0	0.9	40%	2.50
run10131	86	320	6.0	0.9	40%	2.75
run10132	101	320	6.0	0.9	40%	3.00
run10133	87	320	6.0	0.9	50%	2.50
run10134	105	320	6.0	0.9	50%	2.75

Orientation angle(0-30, 320-360), Single glazing

Name	Heating Demand (kWh/m2)	Orientation Angle	Width (m)	Wall Thickness (m)	WWR	Height (m)
run10135	123	320	6.0	0.9	50%	3.00
run10136	112	320	7.5	0.3	30%	2.50
run10137	131	320	7.5	0.3	30%	2.75
run10138	150	320	7.5	0.3	30%	3.00
run10139	132	320	7.5	0.3	40%	2.50
run10140	155	320	7.5	0.3	40%	2.75
run10141	177	320	7.5	0.3	40%	3.00
run10142	152	320	7.5	0.3	50%	2.50
run10143	177	320	7.5	0.3	50%	2.75
run10144	202	320	7.5	0.3	50%	3.00
run10145	85	320	7.5	0.6	30%	2.50
run10146	101	320	7.5	0.6	30%	2.75
run10147	117	320	7.5	0.6	30%	3.00
run10148	105	320	7.5	0.6	40%	2.50
run10149	125	320	7.5	0.6	40%	2.75
run10150	145	320	7.5	0.6	40%	3.00
run10151	126	320	7.5	0.6	50%	2.50
run10152	148	320	7.5	0.6	50%	2.75
run10153	171	320	7.5	0.6	50%	3.00
run10154	73	320	7.5	0.9	30%	2.50
run10155	87	320	7.5	0.9	30%	2.75
run10156	103	320	7.5	0.9	30%	3.00
run10157	93	320	7.5	0.9	40%	2.50
run10158	111	320	7.5	0.9	40%	2.75
run10159	130	320	7.5	0.9	40%	3.00
run10160	114	320	7.5	0.9	50%	2.50
run10161	135	320	7.5	0.9	50%	2.75
run10162	157	320	7.5	0.9	50%	3.00
run10163	75	350	4.8	0.3	30%	2.50
run10164	87	350	4.8	0.3	30%	2.75
run10165	100	350	4.8	0.3	30%	3.00
run10166	88	350	4.8	0.3	40%	2.50
run10167	103	350	4.8	0.3	40%	2.75
run10168	119	350	4.8	0.3	40%	3.00
run10169	101	350	4.8	0.3	50%	2.50
run10170	119	350	4.8	0.3	50%	2.75
run10171	138	350	4.8	0.3	50%	3.00
run10172	58	350	4.8	0.6	30%	2.50
run10173	68	350	4.8	0.6	30%	2.75
run10174	80	350	4.8	0.6	30%	3.00
run10175	71	350	4.8	0.6	40%	2.50
run10176	84	350	4.8	0.6	40%	2.75
run10177	98	350	4.8	0.6	40%	3.00
run10178	84	350	4.8	0.6	50%	2.50
run10179	101	350	4.8	0.6	50%	2.75
run10180	118	350	4.8	0.6	50%	3.00
run10181	50	350	4.8	0.9	30%	2.50
run10182	60	350	4.8	0.9	30%	2.75
run10183	70	350	4.8	0.9	30%	3.00
run10184	63	350	4.8	0.9	40%	2.50
run10185	76	350	4.8	0.9	40%	2.75
run10186	89	350	4.8	0.9	40%	3.00
run10187	77	350	4.8	0.9	50%	2.50
run10188	92	350	4.8	0.9	50%	2.75
run10189	108	350	4.8	0.9	50%	3.00
run10190	97	350	6.0	0.3	30%	2.50
run10191	112	350	6.0	0.3	30%	2.75
run10192	129	350	6.0	0.3	30%	3.00
run10193	114	350	6.0	0.3	40%	2.50
run10194	133	350	6.0	0.3	40%	2.75
run10195	153	350	6.0	0.3	40%	3.00
run10196	131	350	6.0	0.3	50%	2.50
run10197	153	350	6.0	0.3	50%	2.75
run10198	176	350	6.0	0.3	50%	3.00
run10199	75	350	6.0	0.6	30%	2.50
run10200	88	350	6.0	0.6	30%	2.75
run10201	103	350	6.0	0.6	30%	3.00
run10202	92	350	6.0	0.6	40%	2.50
run10203	109	350	6.0	0.6	40%	2.75
run10204	127	350	6.0	0.6	40%	3.00
run10205	110	350	6.0	0.6	50%	2.50
run10206	130	350	6.0	0.6	50%	2.75
run10207	150	350	6.0	0.6	50%	3.00
run10208	65	350	6.0	0.9	30%	2.50
run10209	78	350	6.0	0.9	30%	2.75
run10210	91	350	6.0	0.9	30%	3.00
run10211	82	350	6.0	0.9	40%	2.50
run10212	98	350	6.0	0.9	40%	2.75
run10213	115	350	6.0	0.9	40%	3.00
run10214	100	350	6.0	0.9	50%	2.50
run10215	119	350	6.0	0.9	50%	2.75
run10216	139	350	6.0	0.9	50%	3.00
run10217	124	350	7.5	0.3	30%	2.50
run10218	145	350	7.5	0.3	30%	2.75
run10219	165	350	7.5	0.3	30%	3.00
run10220	146	350	7.5	0.3	40%	2.50
run10221	170	350	7.5	0.3	40%	2.75
run10222	194	350	7.5	0.3	40%	3.00
run10223	168	350	7.5	0.3	50%	2.50
run10224	194	350	7.5	0.3	50%	2.75
run10225	220	350	7.5	0.3	50%	3.00
run10226	97	350	7.5	0.6	30%	2.50
run10227	114	350	7.5	0.6	30%	2.75
run10228	132	350	7.5	0.6	30%	3.00
run10229	119	350	7.5	0.6	40%	2.50
run10230	140	350	7.5	0.6	40%	2.75
run10231	161	350	7.5	0.6	40%	3.00
run10232	141	350	7.5	0.6	50%	2.50
run10233	165	350	7.5	0.6	50%	2.75
run10234	189	350	7.5	0.6	50%	3.00
run10235	84	350	7.5	0.9	30%	2.50
run10236	100	350	7.5	0.9	30%	2.75
run10237	117	350	7.5	0.9	30%	3.00
run10238	107	350	7.5	0.9	40%	2.50
run10239	126	350	7.5	0.9	40%	2.75
run10240	147	350	7.5	0.9	40%	3.00
run10241	129	350	7.5	0.9	50%	2.50
run10242	152	350	7.5	0.9	50%	2.75
run10243	175	350	7.5	0.9	50%	3.00

run10128	110	110	6.0	0.9	30%	2.75
run10129	126	110	6.0	0.9	30%	3.00
run10130	120	110	6.0	0.9	40%	2.50
run10131	140	110	6.0	0.9	40%	2.75
run10132	160	110	6.0	0.9	40%	3.00
run10133	146	110	6.0	0.9	50%	2.50
run10134	169	110	6.0	0.9	50%	2.75

Orientation angle(30-190), Single glazing

Name	Heating Demand (kWh/m2)	Orientation Angle	Width (m)	Wall Thickness (m)	WWR	Height (m)
run10135	193	110	6.0	0.9	50%	3.00
run10136	152	110	7.5	0.3	30%	2.50
run10137	175	110	7.5	0.3	30%	2.75
run10138	198	110	7.5	0.3	30%	3.00
run10139	183	110	7.5	0.3	40%	2.50
run10140	210	110	7.5	0.3	40%	2.75
run10141	236	110	7.5	0.3	40%	3.00
run10142	213	110	7.5	0.3	50%	2.50
run10143	242	110	7.5	0.3	50%	2.75
run10144	272	110	7.5	0.3	50%	3.00
run10145	130	110	7.5	0.6	30%	2.50
run10146	150	110	7.5	0.6	30%	2.75
run10147	171	110	7.5	0.6	30%	3.00
run10148	162	110	7.5	0.6	40%	2.50
run10149	187	110	7.5	0.6	40%	2.75
run10150	211	110	7.5	0.6	40%	3.00
run10151	193	110	7.5	0.6	50%	2.50
run10152	221	110	7.5	0.6	50%	2.75
run10153	249	110	7.5	0.6	50%	3.00
run10154	120	110	7.5	0.9	30%	2.50
run10155	139	110	7.5	0.9	30%	2.75
run10156	159	110	7.5	0.9	30%	3.00
run10157	152	110	7.5	0.9	40%	2.50
run10158	176	110	7.5	0.9	40%	2.75
run10159	200	110	7.5	0.9	40%	3.00
run10160	184	110	7.5	0.9	50%	2.50
run10161	211	110	7.5	0.9	50%	2.75
run10162	239	110	7.5	0.9	50%	3.00
run10163	101	190	4.8	0.3	30%	2.50
run10164	116	190	4.8	0.3	30%	2.75
run10165	132	190	4.8	0.3	30%	3.00
run10166	121	190	4.8	0.3	40%	2.50
run10167	140	190	4.8	0.3	40%	2.75
run10168	159	190	4.8	0.3	40%	3.00
run10169	141	190	4.8	0.3	50%	2.50
run10170	163	190	4.8	0.3	50%	2.75
run10171	185	190	4.8	0.3	50%	3.00
run10172	86	190	4.8	0.6	30%	2.50
run10173	99	190	4.8	0.6	30%	2.75
run10174	113	190	4.8	0.6	30%	3.00
run10175	106	190	4.8	0.6	40%	2.50
run10176	123	190	4.8	0.6	40%	2.75
run10177	141	190	4.8	0.6	40%	3.00
run10178	127	190	4.8	0.6	50%	2.50
run10179	147	190	4.8	0.6	50%	2.75
run10180	168	190	4.8	0.6	50%	3.00
run10181	79	190	4.8	0.9	30%	2.50
run10182	91	190	4.8	0.9	30%	2.75
run10183	104	190	4.8	0.9	30%	3.00
run10184	99	190	4.8	0.9	40%	2.50
run10185	116	190	4.8	0.9	40%	2.75
run10186	132	190	4.8	0.9	40%	3.00
run10187	120	190	4.8	0.9	50%	2.50
run10188	140	190	4.8	0.9	50%	2.75
run10189	160	190	4.8	0.9	50%	3.00
run10190	129	190	6.0	0.3	30%	2.50
run10191	148	190	6.0	0.3	30%	2.75
run10192	167	190	6.0	0.3	30%	3.00
run10193	154	190	6.0	0.3	40%	2.50
run10194	177	190	6.0	0.3	40%	2.75
run10195	200	190	6.0	0.3	40%	3.00
run10196	179	190	6.0	0.3	50%	2.50
run10197	205	190	6.0	0.3	50%	2.75
run10198	231	190	6.0	0.3	50%	3.00
run10199	109	190	6.0	0.6	30%	2.50
run10200	126	190	6.0	0.6	30%	2.75
run10201	143	190	6.0	0.6	30%	3.00
run10202	135	190	6.0	0.6	40%	2.50
run10203	156	190	6.0	0.6	40%	2.75
run10204	177	190	6.0	0.6	40%	3.00
run10205	161	190	6.0	0.6	50%	2.50
run10206	185	190	6.0	0.6	50%	2.75
run10207	210	190	6.0	0.6	50%	3.00
run10208	100	190	6.0	0.9	30%	2.50
run10209	116	190	6.0	0.9	30%	2.75
run10210	132	190	6.0	0.9	30%	3.00
run10211	126	190	6.0	0.9	40%	2.50
run10212	146	190	6.0	0.9	40%	2.75
run10213	167	190	6.0	0.9	40%	3.00
run10214	153	190	6.0	0.9	50%	2.50
run10215	176	190	6.0	0.9	50%	2.75
run10216	200	190	6.0	0.9	50%	3.00
run10217	164	190	7.5	0.3	30%	2.50
run10218	187	190	7.5	0.3	30%	2.75
run10219	211	190	7.5	0.3	30%	3.00
run10220	195	190	7.5	0.3	40%	2.50
run10221	223	190	7.5	0.3	40%	2.75
run10222	250	190	7.5	0.3	40%	3.00
run10223	225	190	7.5	0.3	50%	2.50
run10224	256	190	7.5	0.3	50%	2.75
run10225	286	190	7.5	0.3	50%	3.00
run10226	138	190	7.5	0.6	30%	2.50
run10227	159	190	7.5	0.6	30%	2.75
run10228	181	190	7.5	0.6	30%	3.00
run10229	171	190	7.5	0.6	40%	2.50
run10230	196	190	7.5	0.6	40%	2.75
run10231	222	190	7.5	0.6	40%	3.00
run10232	202	190	7.5	0.6	50%	2.50
run10233	231	190	7.5	0.6	50%	2.75
run10234	260	190	7.5	0.6	50%	3.00
run10235	127	190	7.5	0.9	30%	2.50
run10236	147	190	7.5	0.9	30%	2.75
run10237	167	190	7.5	0.9	30%	3.00
run10238	160	190	7.5	0.9	40%	2.50
run10239	184	190	7.5	0.9	40%	2.75
run10240	209	190	7.5	0.9	40%	3.00
run10241	192	190	7.5	0.9	50%	2.50
run10242	220	190	7.5	0.9	50%	2.75
run10243	248	190	7.5	0.9	50%	3.00

run10128	88	255	6.0	0.9	30%	2.75
run10129	102	255	6.0	0.9	30%	3.00
run10130	94	255	6.0	0.9	40%	2.50
run10131	111	255	6.0	0.9	40%	2.75
run10132	128	255	6.0	0.9	40%	3.00
run10133	114	255	6.0	0.9	50%	2.50
run10134	134	255	6.0	0.9	50%	2.75

Orientation angle(190-320), Single glazing

Name	Heating Demand (kWh/m2)	Orientation Angle	Width (m)	Wall Thickness (m)	WWR	Height (m)
run10135	154	255	6.0	0.9	50%	3.00
run10136	136	255	7.5	0.3	30%	2.50
run10137	157	255	7.5	0.3	30%	2.75
run10138	178	255	7.5	0.3	30%	3.00
run10139	160	255	7.5	0.3	40%	2.50
run10140	185	255	7.5	0.3	40%	2.75
run10141	209	255	7.5	0.3	40%	3.00
run10142	183	255	7.5	0.3	50%	2.50
run10143	211	255	7.5	0.3	50%	2.75
run10144	237	255	7.5	0.3	50%	3.00
run10145	108	255	7.5	0.6	30%	2.50
run10146	126	255	7.5	0.6	30%	2.75
run10147	144	255	7.5	0.6	30%	3.00
run10148	133	255	7.5	0.6	40%	2.50
run10149	155	255	7.5	0.6	40%	2.75
run10150	176	255	7.5	0.6	40%	3.00
run10151	157	255	7.5	0.6	50%	2.50
run10152	182	255	7.5	0.6	50%	2.75
run10153	206	255	7.5	0.6	50%	3.00
run10154	96	255	7.5	0.9	30%	2.50
run10155	112	255	7.5	0.9	30%	2.75
run10156	129	255	7.5	0.9	30%	3.00
run10157	121	255	7.5	0.9	40%	2.50
run10158	141	255	7.5	0.9	40%	2.75
run10159	162	255	7.5	0.9	40%	3.00
run10160	145	255	7.5	0.9	50%	2.50
run10161	169	255	7.5	0.9	50%	2.75
run10162	192	255	7.5	0.9	50%	3.00
run10163	66	320	4.8	0.3	30%	2.50
run10164	77	320	4.8	0.3	30%	2.75
run10165	89	320	4.8	0.3	30%	3.00
run10166	77	320	4.8	0.3	40%	2.50
run10167	92	320	4.8	0.3	40%	2.75
run10168	107	320	4.8	0.3	40%	3.00
run10169	90	320	4.8	0.3	50%	2.50
run10170	106	320	4.8	0.3	50%	2.75
run10171	124	320	4.8	0.3	50%	3.00
run10172	50	320	4.8	0.6	30%	2.50
run10173	59	320	4.8	0.6	30%	2.75
run10174	69	320	4.8	0.6	30%	3.00
run10175	61	320	4.8	0.6	40%	2.50
run10176	74	320	4.8	0.6	40%	2.75
run10177	87	320	4.8	0.6	40%	3.00
run10178	73	320	4.8	0.6	50%	2.50
run10179	88	320	4.8	0.6	50%	2.75
run10180	104	320	4.8	0.6	50%	3.00
run10181	43	320	4.8	0.9	30%	2.50
run10182	51	320	4.8	0.9	30%	2.75
run10183	61	320	4.8	0.9	30%	3.00
run10184	54	320	4.8	0.9	40%	2.50
run10185	66	320	4.8	0.9	40%	2.75
run10186	78	320	4.8	0.9	40%	3.00
run10187	66	320	4.8	0.9	50%	2.50
run10188	80	320	4.8	0.9	50%	2.75
run10189	95	320	4.8	0.9	50%	3.00
run10190	86	320	6.0	0.3	30%	2.50
run10191	101	320	6.0	0.3	30%	2.75
run10192	117	320	6.0	0.3	30%	3.00
run10193	102	320	6.0	0.3	40%	2.50
run10194	120	320	6.0	0.3	40%	2.75
run10195	138	320	6.0	0.3	40%	3.00
run10196	118	320	6.0	0.3	50%	2.50
run10197	139	320	6.0	0.3	50%	2.75
run10198	160	320	6.0	0.3	50%	3.00
run10199	65	320	6.0	0.6	30%	2.50
run10200	78	320	6.0	0.6	30%	2.75
run10201	91	320	6.0	0.6	30%	3.00
run10202	80	320	6.0	0.6	40%	2.50
run10203	96	320	6.0	0.6	40%	2.75
run10204	113	320	6.0	0.6	40%	3.00
run10205	97	320	6.0	0.6	50%	2.50
run10206	115	320	6.0	0.6	50%	2.75
run10207	135	320	6.0	0.6	50%	3.00
run10208	56	320	6.0	0.9	30%	2.50
run10209	67	320	6.0	0.9	30%	2.75
run10210	79	320	6.0	0.9	30%	3.00
run10211	71	320	6.0	0.9	40%	2.50
run10212	86	320	6.0	0.9	40%	2.75
run10213	101	320	6.0	0.9	40%	3.00
run10214	87	320	6.0	0.9	50%	2.50
run10215	105	320	6.0	0.9	50%	2.75
run10216	123	320	6.0	0.9	50%	3.00
run10217	112	320	7.5	0.3	30%	2.50
run10218	131	320	7.5	0.3	30%	2.75
run10219	150	320	7.5	0.3	30%	3.00
run10220	132	320	7.5	0.3	40%	2.50
run10221	155	320	7.5	0.3	40%	2.75
run10222	177	320	7.5	0.3	40%	3.00
run10223	152	320	7.5	0.3	50%	2.50
run10224	177	320	7.5	0.3	50%	2.75
run10225	202	320	7.5	0.3	50%	3.00
run10226	85	320	7.5	0.6	30%	2.50
run10227	101	320	7.5	0.6	30%	2.75
run10228	117	320	7.5	0.6	30%	3.00
run10229	105	320	7.5	0.6	40%	2.50
run10230	125	320	7.5	0.6	40%	2.75
run10231	145	320	7.5	0.6	40%	3.00
run10232	126	320	7.5	0.6	50%	2.50
run10233	148	320	7.5	0.6	50%	2.75
run10234	171	320	7.5	0.6	50%	3.00
run10235	73	320	7.5	0.9	30%	2.50
run10236	87	320	7.5	0.9	30%	2.75
run10237	103	320	7.5	0.9	30%	3.00
run10238	93	320	7.5	0.9	40%	2.50
run10239	111	320	7.5	0.9	40%	2.75
run10240	130	320	7.5	0.9	40%	3.00
run10241	114	320	7.5	0.9	50%	2.50
run10242	135	320	7.5	0.9	50%	2.75
run10243	157	320	7.5	0.9	50%	3.00

Preliminary Conclusions: Standardization Regression Analysis in 3 Domains of Orientation

Upon completing simulations targeting individual variables, our objective was to examine the correlation between each variable and heating demand within the orientation ranges of 320°- 30°, 30°- 190°, and 190°- 320°. Consequently, we performed regression analyses on simulated data comprising variable values and heating demand for each orientation range. The results are presented in the correlation coefficient table below and visually illustrated in the circular stacked chart. Insights drawn from this chart lead to the following conclusions:

Across all three orientations, Width consistently exerts the most significant influence on Heating Demand. This effect likely stems from the interplay of three factors. Firstly, increased exterior wall width leads to a greater wall area, resulting in increased heat dissipation. Secondly, wider exterior walls correspond to larger windows (with the window-to-wall ratio remaining constant), improving heat dissipation during ventilation. Thirdly, wider exterior walls correlate with larger windows, enhancing solar gain. However, further experimentation is required to determine which factor has the most substantial impact.

Across all three orientations, Wall Thickness displays the weakest correlation with heating demand. This could be attributed to the inherent high thermal conductivity of rammed earth. Increasing wall thickness from 300mm to 900mm does not significantly improve the U-value. Consequently, compared to other variables, changes in wall thickness have a minimal influence on Heating Demand.

Window-to-Wall Ratio (WWR) consistently demonstrates a strong correlation in all cases. This is likely due to two factors: increased window area, which facilitates efficient heat dissipation during ventilation, and larger window areas contributing to more substantial solar gain.

In unfavorable orientations, prioritizing measures to reduce heat loss is recommended. Solar gain is limited under these conditions, and efforts to increase daylighting may inadvertently elevate heating demand.

	z-Orientation Angle	z-Width	z-WWR	z-Wall Thickness	z-Height
Southwest-Southeast (320°-360°, 360°-30°)	+0.39	+0.60	+0.44	−0.36	+0.37
Southeast-North (30°-190°)	−0.21	+0.66	+0.52	−0.29	+0.38
North-Southwest (190°-320°)	+0.53	+0.56	+0.42	−0.29	+0.33

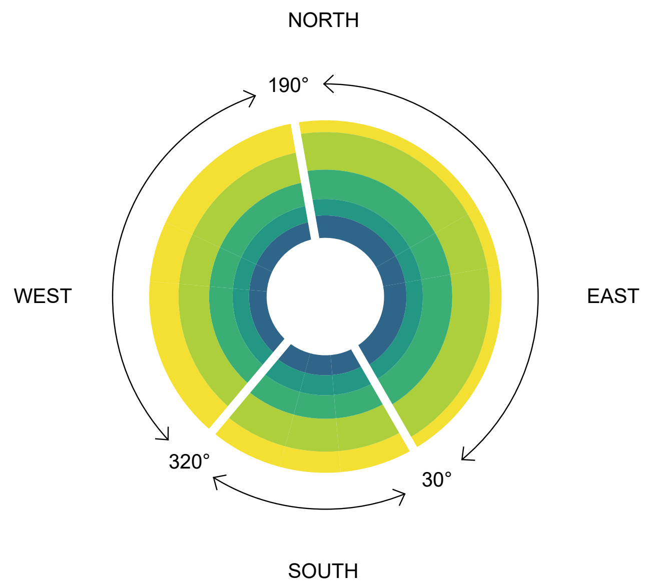


Figure. Visualization for standardized regression coefficients of the variables, in the different domains of orientation

Statistical Charts and Preliminary Conclusions: Window Thermal Study

To investigate the connection between window area, heat loss, and solar gain in various orientations, we chose three examples with different orientations and examined their energy balance statistics. Our observations revealed that under local climatic conditions when the building orientation falls within a relatively unfavorable range of 30° to 190°, heat loss surpasses solar gain. In contrast, in other scenarios, heat loss remains lower than solar gain. This suggests that larger window areas result in greater solar gain when the orientation is favorable.

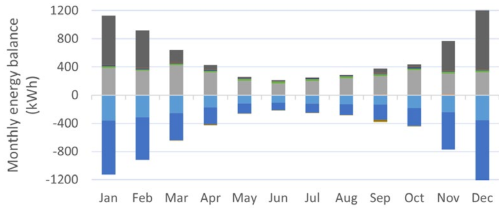


Figure. Monthly energy balance of the room in the orientation of 190° angle (southwest)

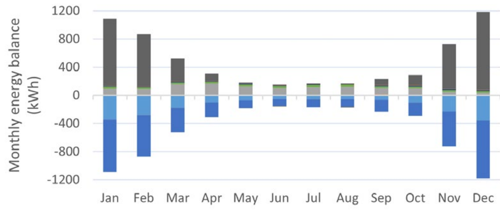


Figure. Monthly energy balance of the room in the orientation of 50° angle (east)

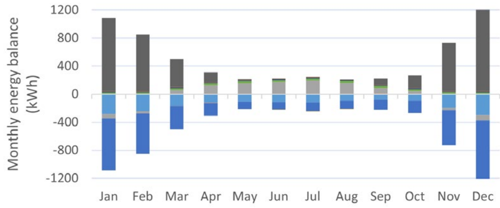
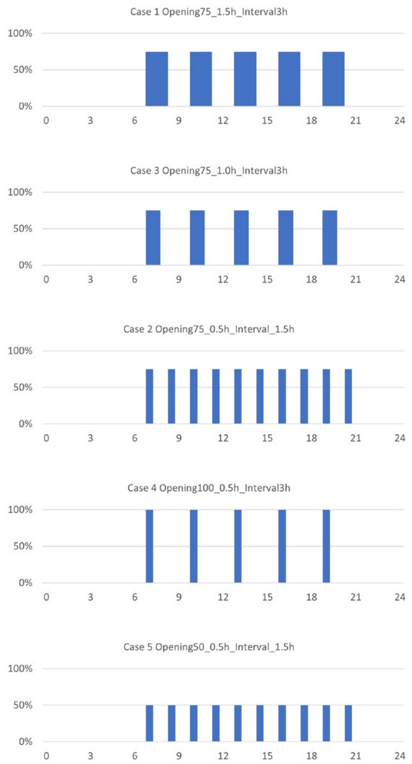


Figure. Monthly energy balance of the room in the orientation of 190° angle (north)

<u>Moving forward, our study delved into heat loss related to window ventilation.</u> We investigated eight distinct ventilation methods, each defined by varying window opening durations, sizes, and frequencies. Following thermal simulations, we recorded heating demand and carbon dioxide concentration, leading to the following conclusions: Strategies involving smaller window opening ratios, shorter ventilation times, but higher ventilation frequencies (e.g., Case 8), substantially decrease heating demand while keeping CO_2 concentrations within reasonable limits.



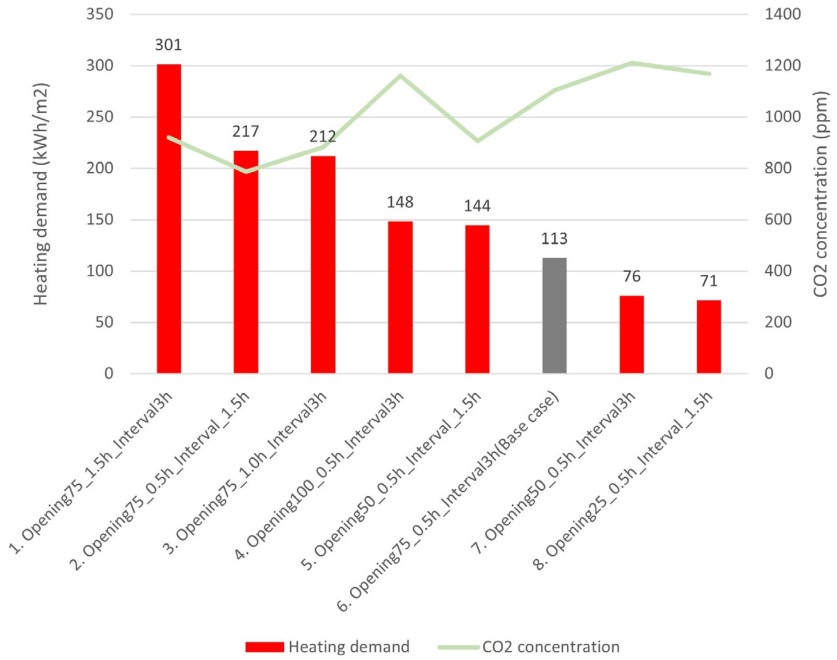
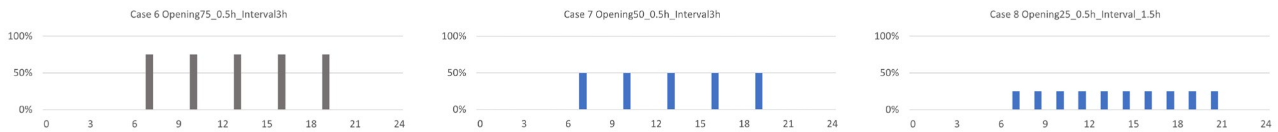
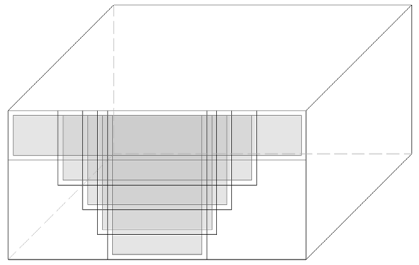


Figure. Heating demand and CO2 concentration by different window schedules.



Statistical Charts and Preliminary Conclusions: Window Daylight Study



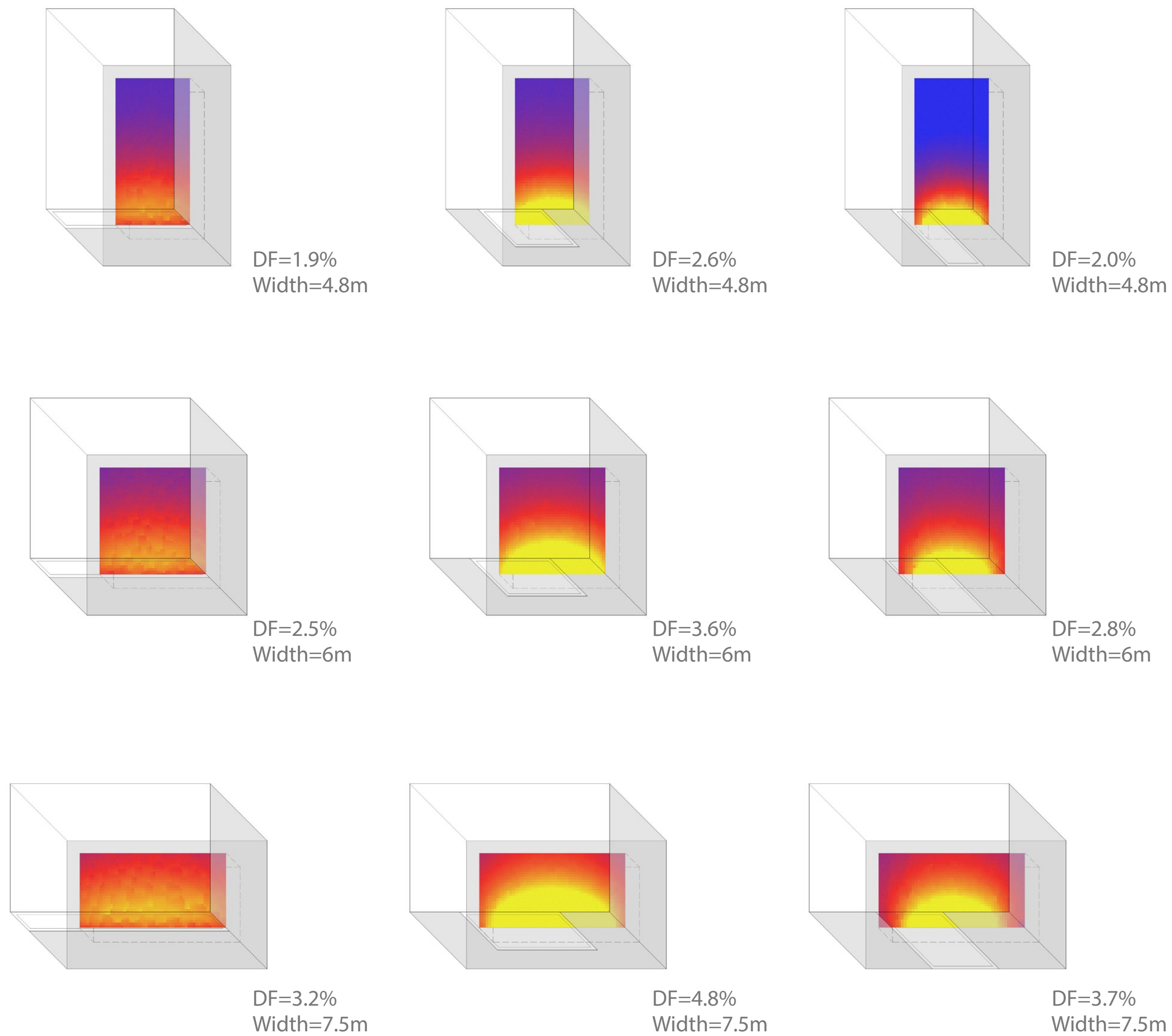
<u>Simulation Process and Data Analysis</u>

To explore the impact of window shapes on indoor daylighting, we conducted a series of daylight simulations for various window configurations. We generated DF heat maps for these window setups and documented their DFAVG (Daylight Factor Average). The simulations yielded several insights:

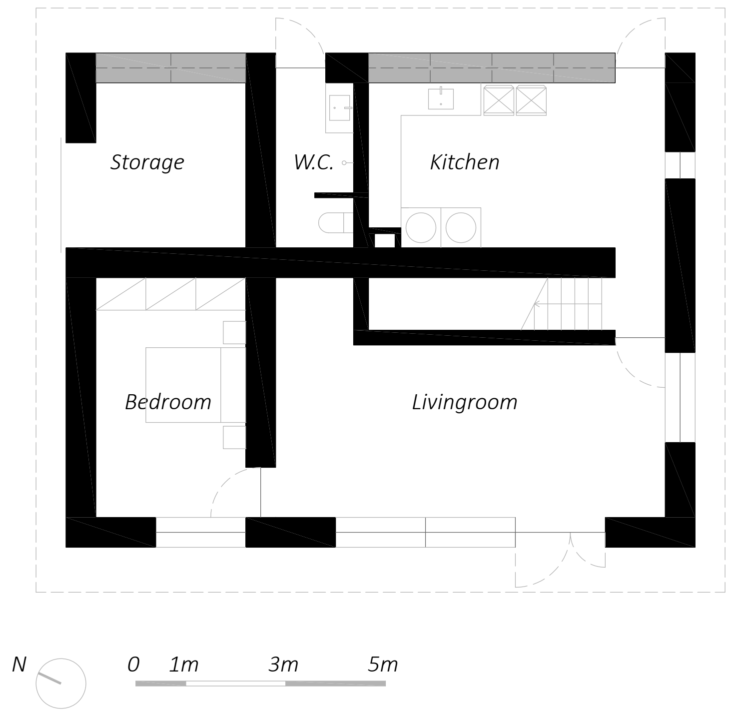
Central windows positioned at the center of the space exhibited the most favorable DF performance, effectively distributing daylight throughout the room. Horizontal high windows contributed to a more even distribution of light on the work plane, thereby enhancing the overall lighting quality. Vertical windows resulted in more concentrated light, which is advantageous for focused tasks.

In the design phase, it is advisable to flexibly select window shapes based on specific lighting requirements.

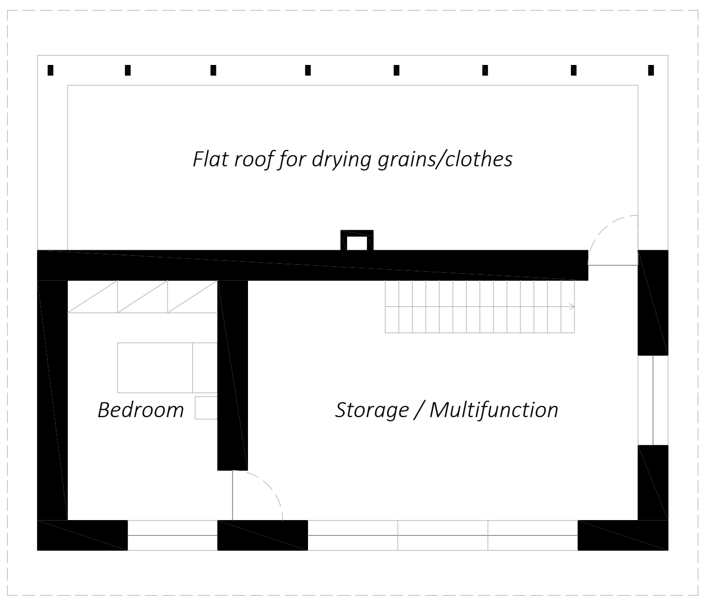
DF - Daylight factor
All pictures are top view



Drawings for Alternative 1

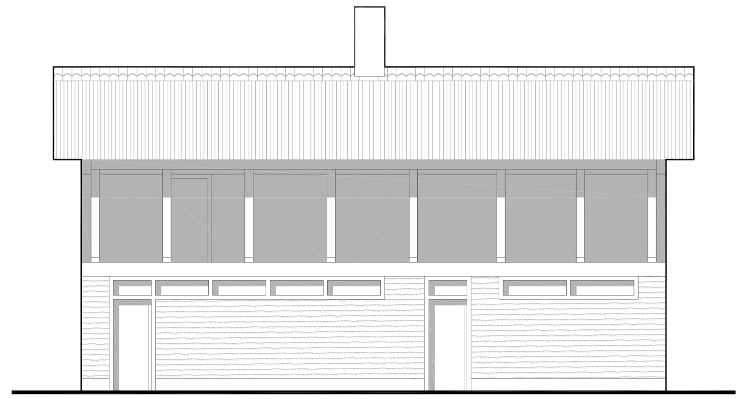


Ground Floor

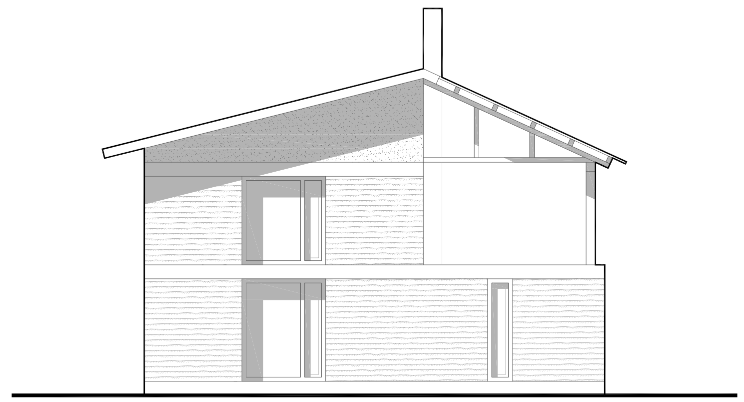


First Floor

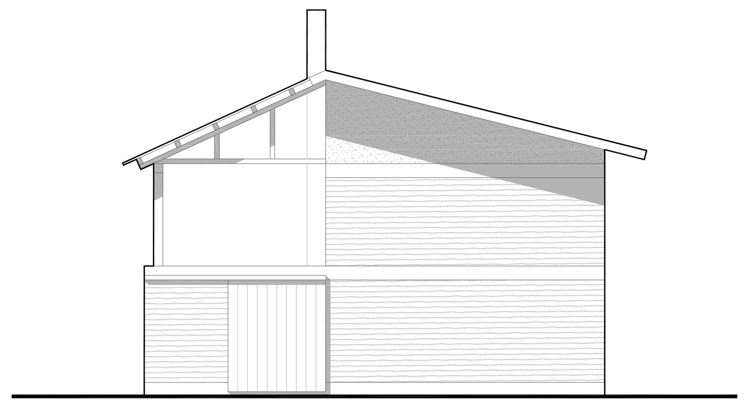
West Elevation



East Elevation

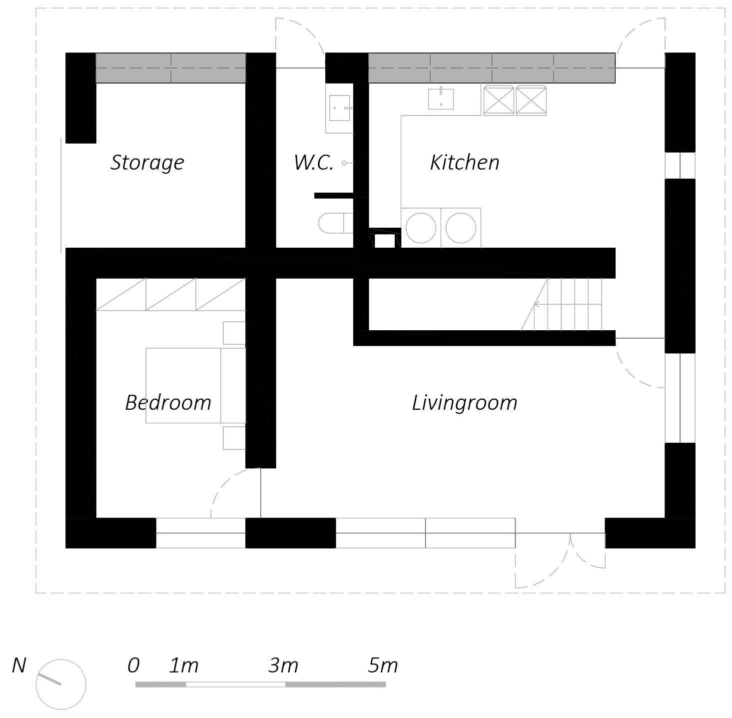


South Elevation

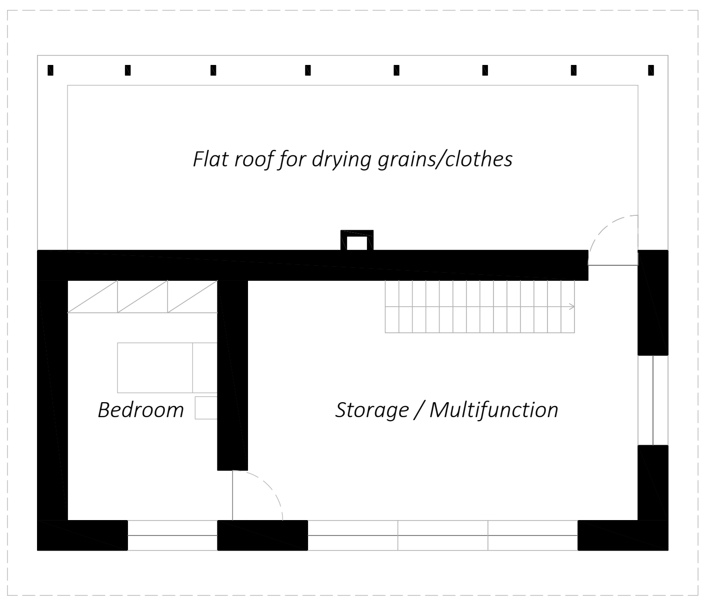


North Elevation

Alternative 2

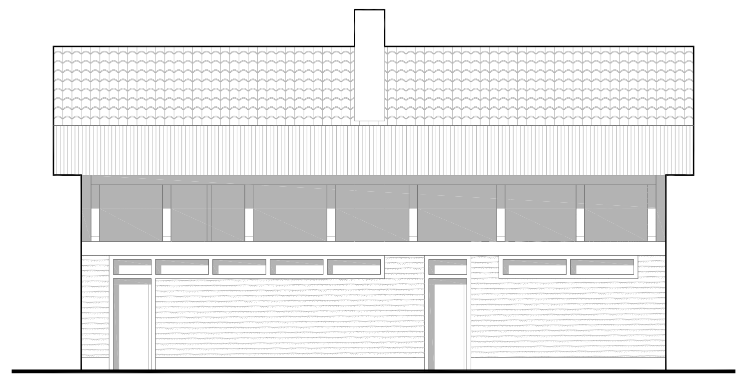


Ground Floor

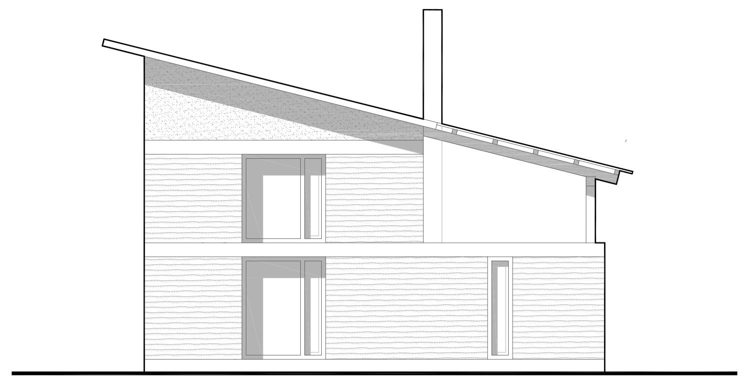


First Floor

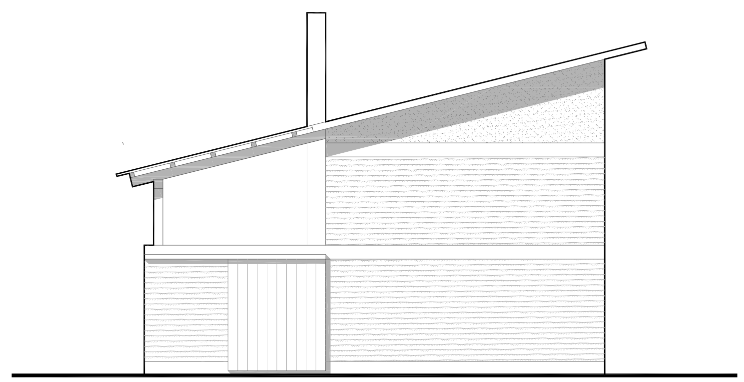
West Elevation



East Elevation

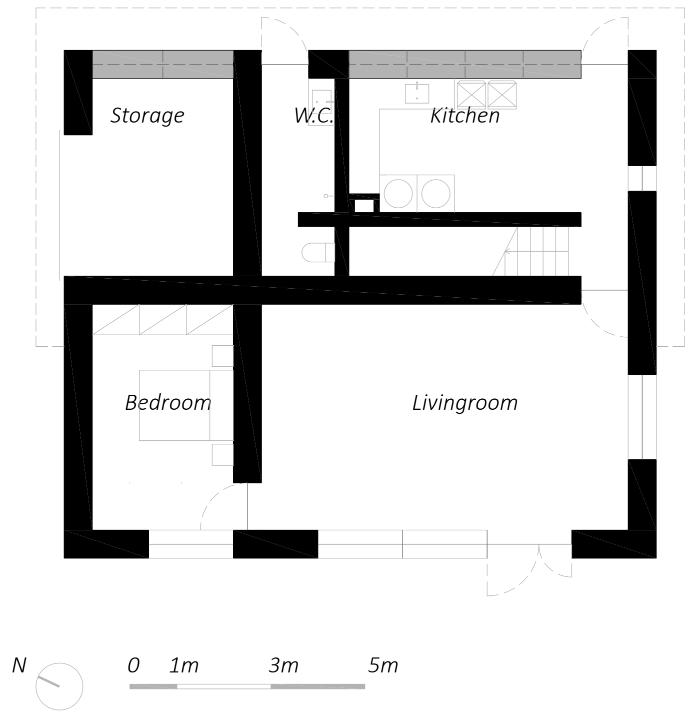


South Elevation

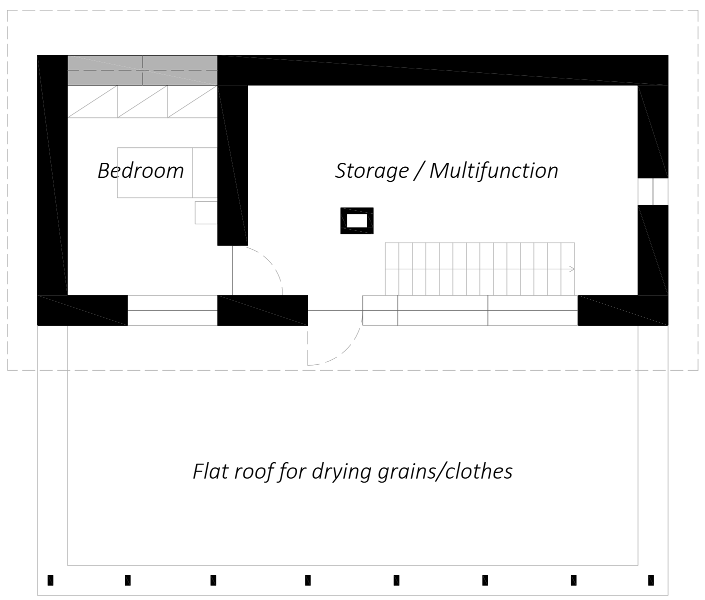


North Elevation

Drawings for Alternative 3

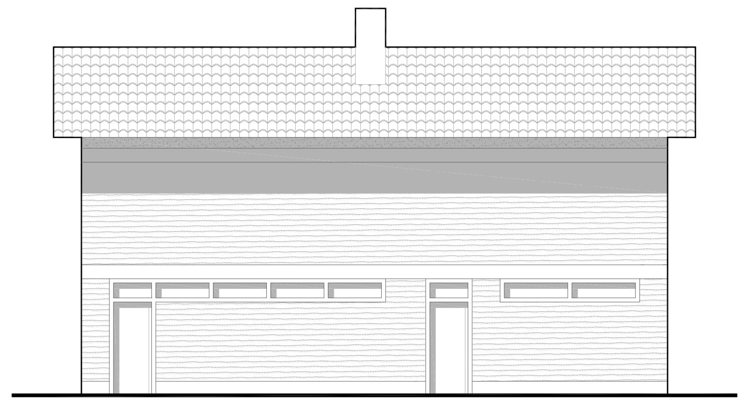


Ground Floor

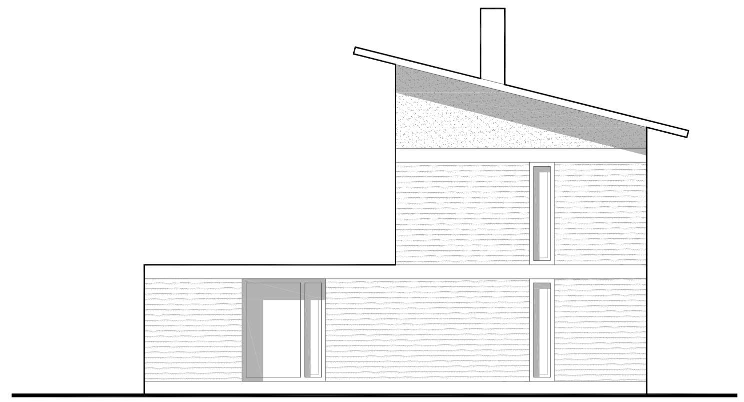


First Floor

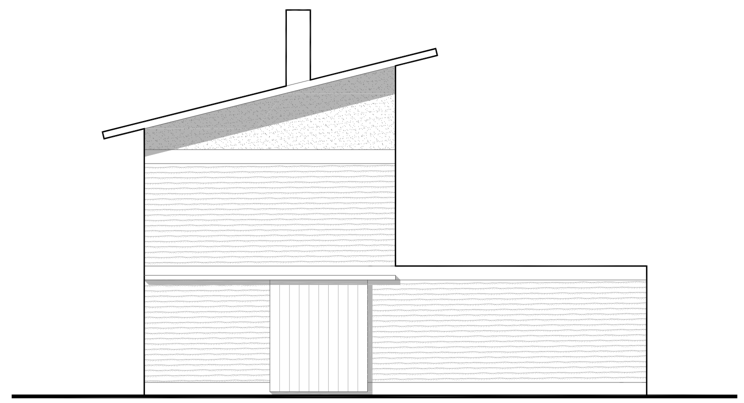
West Elevation



East Elevation



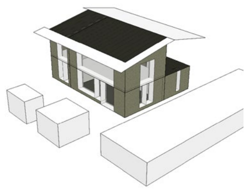
South Elevation



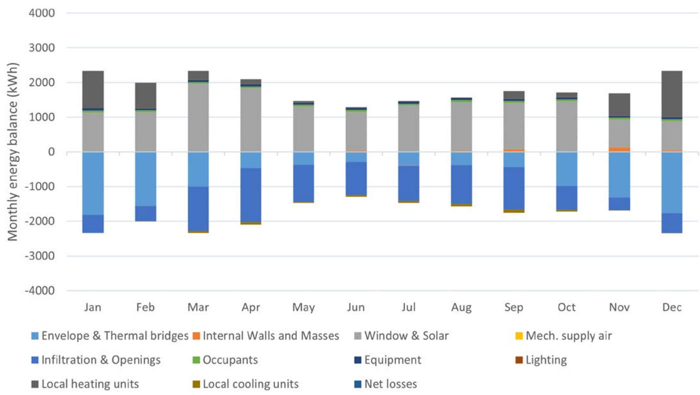
North Elevation

Statistical Charts and Preliminary Conclusions: Theraml Evaluation

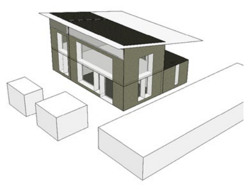
We conducted thermal simulations for three schemes and obtained energy balance diagrams. From the diagrams, it's evident that alternative 1 has significantly lower solar gain compared to alternative 2 and 3. On the other hand, alternative 3 exhibits notably higher heating demand than alternative 1 and 2. Overall, alternative 2 seems to offer the best performance.



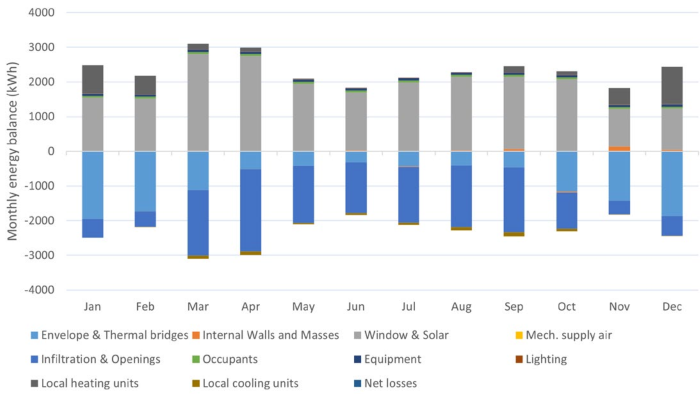
Alternative 1



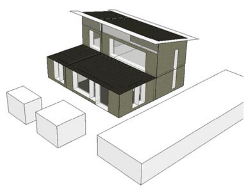
Energy balance



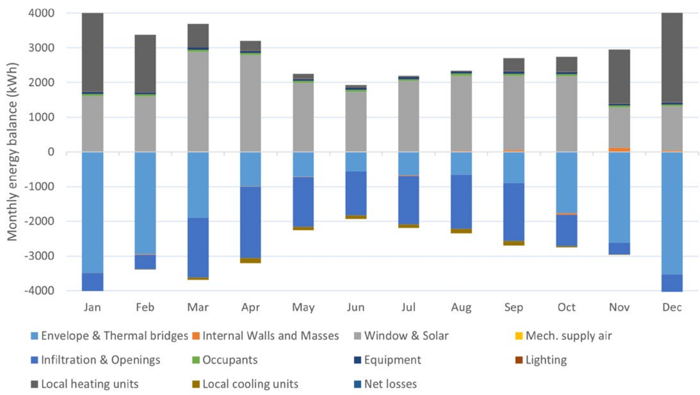
Alternative 2



Energy balance



Alternative 3



Energy balance

CHALMERS
UNIVERSITY OF TECHNOLOGY