VOLUME 3: APPENDICES

APPENDIX 1: DESIGN GUIDELINES MATRIX

Design Guidelines Matrix Updated: Sept 2021			
AHO DESIGN GUIDELINES: Jefferson Park Federal			
SITE DESIGN			
1	**RESPONSE TO CONTEXT**		**COMMENTS**
	Objective: Design project site layouts to harmonize with the neighborhood context, including the surrounding urban patterns of streets and blocks, building setbacks, travel paths, and open spac-es. In existing neighborhoods with established patterns of development, responsive and con-text-sensitive site design will help preserve the character of the built environment. In evolving areas of the city, forward looking new develop-ments should help achieve the city's goals for urban character.		
Y	1.1	Locate and orient new buildings so that their front yard setbacks relate to those of neighboring and adjacent buildings to the maximum extent possible.	Meets setback requirement and reinforces edge along Rindge Avenue with strong edge parallel to Rindge.
Y	1.2	Locate open space in relation to adjacent yards, residential units, and public spaces that would benefit from natural light and views.	The large scale of the site and adjacency to rail and cemetary necessitates open space to be located away from these edges. Open space is designed to foster community of residents across buildings.
Y	1.3	Where site dimensions allow, consider creating entry courtyards, internal courtyards, and semi-enclosed courtyards open to the block interior.	Each building has adjacent open space or contains semi-private rear yards. Building 1 on Rindge includes connection directly across from Jackson Street that links Jackson Street and Rindge Ave to the playground in the courtyard of Building 1.
Y	1.4	Locate pedestrian and bicycle paths, vehicular routes; parking areas; and utility/service areas in response to neighboring buildings.	Pedestrian and bicycle paths, and vehicular routes create connections to existing neighborhood; Parking is located around outer perimeter of blocks and is contained within the site; Utility/service areas are located inside buildings. The project provide a Blue Bike docking station and an easement for the City for a future multi-use path, which the neighborhood can access via Main Street, a new tree-lined street.
Y	1.5	In large developments, consider creating through-block pedestrian or vehicular connections.	Through-block pedestrian connections created through courtyards and open space; Vehicular connections created by Main, North, South, East and West streets.
Y	1.6	Place buildings and design their landscapes to minimize impacts on nearby existing buildings, to respect the privacy of neighbors, and to maintain their access to natural light and air.	Building and landscape location and design respect existing neighbors privacy and access to light and air.
Y	1.7	In siting new buildings, consider public views to adjacent landmark buildings, public open spaces, public art areas, or other features of significant visual interest.	Buildings and street grid are organized to allow future connection to multi-use path along rail. In addition, a buffer is maintained to preserve the existing connection with the cemetery. A new seating area is planned along the cemetery edge, as well, to promote the peaceful relationship some residents value with the cemetery.
N/A	1.8	In existing well-developed areas, where urban patterns are relatively uniform and stable, match the prevailing pattern of front yard setbacks, building orientations, and the location of entrances as much as possible. Variation may be desirable, however, at certain locations, such as the corners of blocks.	Project is located in area where pattern of development is stable but more diverse -- see Site Design 1.9.
Y	1.9	In areas where the patterns of development are stable but more diverse, site buildings in relation to neighbors with the aim of creating a more coherent streetscape while meeting other citywide objectives articulated in these guidelines.	Buildings are located along improved street grid that improves circulation through site and creates connections to surounding neighborhood.

N/A	1.1	In evolving areas of the city, locate new buildings and site elements to support the planned patterns of development.	Project is located in area where pattern of development is stable but more diverse -- see Site Design 1.9.
N/A	1.11	In commercial districts, site new buildings to maintain the continuity of existing retail frontage while allowing for comfortable sidewalk width and creating opportunities for activation such as outdoor seating.	Project is located in residential area where pattern of development is stable but more diverse -- see Site Design 1.9.
Y	1.12	Locate and design parking, trash storage, and mechanical equipment to minimize their impacts on abutting residences and the public.	Trash storage is inside buildings; mechanical equipment is located on building roofs; parking is located at street level to match parking in adjacent neighborhood.
2	**OPEN SPACE AND LANDSCAPE DESIGN**		**COMMENTS**
	Objective: Design open space to enhance the lives of residents and the broader community by off ering aesthetic and environmental benefi ts through the inclusion of vegetation, trees, elements to provide shade. Off er useful amenities to resi-dents, provide opportunities to minimize the im-pact of the new development neighbors' privacy and quality of life, and contribute to the beauty of the city's streets, sidewalks, and open space.		
Y	2.1	Provide a range of types of open spaces as appropriate to the site, context, and building form: yards, entry courtyards, interior courtyards, porches, loggias, balconies, roof terraces, and upper-level decks.	The project includes front yards, semi-private rear yards, and open community spaces.
Y	2.2	Provide opportunities for enjoyment of nature, such as gathering places and play spaces for residents.	Each block contains semi-private rear yards and / or open space that can be enjoyed by residents.
Y	2.3	Provide seating to foster social connection. Consider locations at building entrances, courtyards, and along paths connecting different areas of the site.	Seating areas are located in semi-private rear yards; scattered seating areas are located throughout larger open spaces on site.
Y	2.4	Consider summer shading and winter solar access.	Preserving existing deciduous canpy trees with with a robust deciuous tree planting plan will provide summer shading and winter solar access
Y	2.5	Design open spaces to contribute positively to the public realm, maximizing vegetation—particularly canopy trees—to shade and enrich streets and other public open spaces.	A combination of existing and new trees will create shade and enrich streets and open spaces.
Y	2.6	In dense residential neighborhoods, design front yards to frame the street and sidewalk as civic spaces and to enhance the privacy of building interiors. Consider organizing front yard landscape elements—low walls, low planting or hedges, fences, trees, ground cover, foundation planting, etc.—as a series of layers parallel to the sidewalk to frame civic space and delineate thresholds of privacy as one moves from the sidewalk to the building entrance.	Front yards between streets, sidewalks, and residential entrances will have planting beds with ground cover and low plantings to icrease privacy of interior and create threshold between street and interior.
Y	2.7	Where possible in dense residential neighborhoods and on corridors, provide landscaped forecourts and inner courtyards to create transitional space between the public street and the building lobby, to provide light and air to unit interiors, and to enrich the site with plantings.	Landscaping strategy includes transitional spaces between residential entrances and sidewalk, as well as semi-private rear yard areas.
Y	2.8	Consider the location, dimension, and orientation of open spaces to best promote healthy trees and other vegetation.	Smaller and uniform trees are located along streets; Larger trees are located along edges of site and in larger open spaces and semi-private rear yards.
Y	2.9	Minimize the urban heat island effect by preserving existing mature canopy trees wherever possible and by planting new ones to shade buildings, open spaces, and paved surfaces.	51 existing trees will remain; roughly 220 new trees will be planted. There will be an approximate net addition of 69 trees onsite.

Y	2.1	Follow the recommendations of the Department of Public Works and the City's Urban Forest Master Plan for species, planting standards, and care.	Landscape design uses Cambridge UFMP guidelines for species selection, planting standards and care
Y	2.11	Select species for low plantings and ground cover that are appropriate for urban conditions.	We are selecting low shrub species that will withstand the urban conditions of the site, proposed site usage, and expected maintenance strategies. These conditions include drought, soil compaction, snow/salt build up, heavily used areas (community park) vs. low use areas (façade plantings/screen plantings).
Y	2.12	Minimize paved surfaces. Use permeable surfaces wherever possible for pedestrian pathways, parking areas, and other paved outdoor spaces.	We are using permeable surfaces where possible in courtyards, at building facades, and at street tree pits. Surfaces include lawn, planting beds, permeable play surface, and permeable pavers. Street widths have been reduced as much as Cambridge Fire will allow.
Y	2.13	Use landscaping to screen surface parking and vehicular driveways from residential units and open spaces on and adjoining the site.	Landscaping is used to buffer vehicular driveways and surface parking from residences and adjacent site.
N/A	2.14	Screen loading and trash areas, meters, mechanical units, and utility equipment with plant-ings or other appropriate landscape elements.	Trash and recylcing areas are inside buildings. Mechanical equipment is located on roof.
3	**CIRCULATION**		**COMMENTS**
	Objective: Promote non-motorized mobility by prioritiz-ing pedestrian-friendly and bike-accessible site design.		
Y	3.1	Create direct, functional, and beautiful paths for pedestrians and bicycles from the public sidewalk to building entrances. Pedestrian access to the building and site should be clearly articulated and accessible to people of all levels of ability, and should take precedence over other mobility modes.	Pedestrian access to buildings are clearly articulated by concrete and light colored pavers and landscaping.
Y	3.2	For large buildings, incorporate multiple entrances wherever possible.	All buildings have multiple entrances.
Y	3.3	Locate building entrances wherever possible to address public streets.	Building entrances are located at building corners and at mid-building in relation to street.
Y	3.4	Consider elevating residential first floors above sidewalk level to enhance privacy, consistent with accessibility needs and requirements.	No residential entrances along Rindge. Buildings 4, 5, and 6 have units that are slightly elevated above sidewalk level. All other units meet MAAB requirements.
Y	3.5	On corner lots with non-residential street level activities such as retail, consider locating entrances to ground floor functions at building corners.	Headstart entrance at ground floor of Building 1 is located at building corner.
Y	3.6	Establish pedestrian path widths and select their materials in accord with their uses and locations on the site.	Pedestrian pathways are 6' wide concrete and light colored pavers with high SRI that help reduce heat island effect. Major pedestrian crosswalks are highlighted through change in paving color and slight change in elevation
Y	3.7	Provide bicycle access to the site and building that is clearly legible, convenient, and reasonably direct. Locate short-term bicycle parking for visitors where it is visible and convenient to main building entrances. Locate long-term bicycle parking for residents in secure and screened locations.	Short-term and long-term bicycle parking is provided per AHO requirements. A bicycle parking plan is in progress.
Y	3.8	Create vehicular access and circulation routes that are distinct from paths of pedestrian travel.	Vehicular access is organized to connect with the existing street grid across Rindge Avenue. Pedestrian pathways creation connections between buildings and open spaces within the site.
Y	3.9	Minimize the number and widths of curb cuts and driveways.	Perpendicular and parallel parking minimizes curb cuts and individual driveways.
Y	3.1	Locate curb cuts on secondary streets where possible.	Curb cuts are located along Rindge Avenue. There are no other secondary streets to locate curb cuts.

4	PARKING		COMMENTS
	Objective: Minimize the impact of parking and driveways on residents, neighbors, and the general public.		
Y	4.1	Where possible, separate ground floor structured parking and/or bicycle storage from the street with residential units, common areas, retail, or other populated ground floor uses.	All parking is located at ground level along edges of blocks. Parking is separated from residential units by sidewalks and landscaping. Long-term bicycle storage is inside buildings.
Y	4.2	Develop the layout of parking and driveways to avoid conflicts with pedestrian and bicycle movement.	All parking is located at ground level along streets. Pedestrian and bicycle pathways creation connections between buildings and open spaces within the site.
Y	4.3	Minimize the site area dedicated to driveways and parking and maximize its distance from neighboring properties.	All parking is located at ground level along streets.
N/A	4.4	Use green walls, hedges, art work, metal stencils, fences, louvers, sun shading elements, or other means to visually screen parked cars.	Perpendicular and parallel parking matches parking types in surrounding neighborhood without green walls and screens.
Y	4.5	Shade parking lots with canopy trees or by other means where possible.	Combination of existing and new trees will create shaded parking where possible.
N	4.6	Utilize permeable pavement where possible.	Using permeable pavers where possible given maintenance requirements and construction costs. All walkways and paving in landscape areas will be permeable. Parking and private ways will not use permeable pavement.
5	**UTILITIES AND SERVICES**		**COMMENTS**
	Objective: Minimize the visual, acoustical, and environmental impacts of essential utilities and ser-vices on neighbors and on the public realm.		
Y	5.1	Locate utility functions such as gas, electric, and water meters, transformers, switchgear, and fire safety equipment where they will be least visible from the street. Where possible, conceal them within the building or in side or rear yard setbacks. They should be planned for early in the design process to minimize their impacts.	Transformers are located within a building in compliance with utility requirements. Switchgear, water meters, and fire safety equipment are located indoors, except code-required fire department connections, will be located as directed by the Fire Department. Gas meters will be screened by foundation plantings.
Y	5.2	Locate mechanical elements such as HVAC units, condensing units, ventilation outlets, mechanical exhausts, louvers, and similar ob-jects to minimize their visibility from the public realm and from neighboring sites and buildings. Screen these elements with plantings, fences or other materials that complement the site design and the building's architecture.	Mechanical elements are located on roof behind parapet to minimize their visibility from the public realm.
Y	5.3	Avoid locating air conditioning condensing units on the ground. They should be located on roofs wherever possible.	All condensing units are on roof.
Y	5.4	Locate roof mounted air conditioning equipment, and mechanical penthouses away from roof edges and/or provide parapets with adequate height to screen them from adjacent properties and public areas.	Roof mounted air conditioning equipment is located behind paraet to screen them from adjacent properties and public areas; See roof plans.
Y	5.5	Reduce the noise impact of rooftop mechanical equipment with sound damping materials and screens and proper acoustic and sound isolation methods.	42-inch high or taller parapet walls are provided at all buildings. These parapet walls provide both visual and acoustic screening at all rooftop mechanical equipment. All equipment will be specified with appropriate sound dampening options to meet the Cambridge Noise Ordinance.
Y	5.6	Screen trash and recycling areas with landscaping and/or fencing and ensure that noise and odor-generating functions are fully enclosed.	Trash and recylcing areas are inside buildings.

6	**OUTDOOR LIGHTING**		**COMMENTS**
	Objective: Provide lighting for safety and functionality while minimizing energy use, light pollution, and other negative impacts on neighbors, the public realm, and the larger environment.		
Y	6.1	Use lighting only for safety and functional purposes such as providing wayfi nding along access/egress routes, allowing open spaces to be usable in the evening, illuminating signage, or subtly accentuating key architectural elements of a building.	Site will be well-lit for safety.
Y	6.2	Outdoor lighting should provide a level of safety for residents while avoiding glare, light pollution, and light trespass onto adjacent properties.	Site lighting will be designed to meet IES standards for safety of exterior lighting of roadways, walkways, and other site areas. All fixtures will be appropriately shielded to limit or prevent light trespass on neighboring properties and minimize glare in residential units within the property. All fixtures will be dark-sky friendly to limit light pollution and harmful effects on nocturnal wildlife.
Y	6.3	Provide lighting that is fully shielded, downlit, has a warm color temperature, and is at or below typical neighborhood light levels.	Site lighting will be designed to meet these requirements. Lamp color temperature will be 3000K or at most 3500K, depending on fixture availability and efficiency (high color temperatures are more energy efficient).
Y	6.4	To further reduce light pollution, consider the provisions of Cambridge's draft Outdoor Lighting Ordinance.	We have reviewed the draft ordinance and believe the proposed site lighting will comply with its requirements.
Y	6.5	Select lighting fixtures that minimize energy consumption.	Chosen lighting fixtures minimize energy consumption.
Y	6.6	Employ timers, automatic dimming, motion sensors or other mechanisms to avoid excessive lighting, including in tuck-under parking.	General area site lighting will be on an astronomical time clock for energy conservation. Lighting at unit entries will be switched controlled by the resident, but equipped with photosensors so that it only operates when dark.
Y	6.7	Consider using photovoltaic panels to power lighting.	Photovoltaic systems will be integrated into project.
7	**PUBLIC ART**		
	Objective: Enrich the visual environment and strengthen the sense of place by incorporating art.		
Y	7.1	Incorporate public art as an integral component of the development's architectural and landscape design.	The project has designated a prominent Rindge Avenue façade that leads into rear yard passageway as a location for a future mural. The CHA is currently working with a group of interested residents and youth to select themes for the mural, along with street names for the new private ways onsite.
N/A	7.2	Where possible, integrate arts related uses such as artists' galleries, arts displays, or artists studios on the ground level of affordable housing developments that are located on business and commercial streets.	Ground level frontage along Rindge dedicated to educational space at Head Start. Rindge Avenue is residential street where ground level programming is reserved for early childhood education and residences.
BUILDING DESIGN			
1	**MASSING**		
	Objective: Confi gure building massing for compatibility with the prevailing or desired pattern of neighboring buildings and open spaces. In established neighborhoods, relate to the existing pattern of streets and other open spaces, and prioritize compatibility with existing buildings. In evolving areas, confi gure new developments to help realize the City's vision for urban form.		
Y	1.1	Relate new building height, massing, scale, and form to that of existing adjacent buildings.	New building height, massing, scale, and form relates to existing adjacent buildings.
Y	1.2	Incorporate stepbacks to relate to the heights of adjoining buildings and to the scale of the street; and to provide a transition between the height of taller buildings and lower surrounding buildings.	Massing of Building 1 along Rindge Avenue steps down to three stories to match adjacent two and three story residences. Four story buildings along western edge of site relate to three and four story buildings in adjacent Jefferson Park State Apartments and Brickworks Condominiums.

Y	1.3	Where a project's site adjoins a district with a different height and scale, as where a site along a commercial corridor adjoins a lower height residential district, adjust building massing to relate to those heights and scales.	Same as above.
Y	1.4	Where possible, divide large developments into separate buildings to reduce their scale.	Massing's of Buildings 1, 2, and 3 are separated at the street level to reduce their scale and allow for visual and physical openings.
Y	1.5	Articulate the facades of large buildings into smaller components by means such as vertical recesses or projections from the primary plane of the street facade.	Facades incorporate vertical recesses and projections from the primary plane.
Y	1.6	Reduce the visual bulk of taller buildings by using stepbacks, or mansard, gambrel, hipped, or gable roof profiles to enclose habitable upper stories.	Stepback in Building 1 massing along Rindge Avenue will match residential scale of abutting properties.
N/A	1.7	In high density areas, such as commercial corridors, frame streets and squares with street wall facades.	Façade along Rindge Avenue reinforces edge of project site.
Y	1.8	In smaller scaled residential areas, articulate the mass of large buildings to create a sense of scale compatible with smaller scaled neighbors.	Window and wall recesses and projections articulate building massings.
Y	1.9	Reinforce the existing or planned pattern of streets and blocks and minimize impacts on neighbors.	Street and block organization improves connection to Jefferson Park State Apartments and Rindge Avenue and creates a more intuitive street grid.
Y	1.1	Adjust building configuration and massing to maximize access to sunlight, air, and sky views from neighboring buildings and sites, and to maintain privacy.	Single-loaded corridors with access to light and air from front and rear yards are prioritized; Double-loaded corridors which provide less access to light and air are minimized.
Y	1.11	Where possible, provide courtyard spaces at building fronts or sides to reflect the character of preexisting development and to divide long frontages into smaller scaled facades.	Long facades are articulated with recesses and projections to break up massing into smaller scale.
Y	1.12	Where appropriate, reinforce important street corners or termini of view corridors with special elements.	The project's most prominent corner at Main St. and Rindge Avenue is articulated by a distinct material palette at the ground floor to indicate the entrance to Headstart.
N/A	1.13	Consider both symmetrical and asymmetrical arrangements of building massing to best relate new buildings to their existing neighbors.	No distinct patterns of symmetry are exhibited by existing neighbors. New building massings similarly do not highlight patterns of symmetry. Site plan was designed to match neighborhood block configuration.
Y	1.14	For buildings fronting onto more than one street, such as buildings on corner lots, respond to the relative significance of the streets with orientation and massing strategies that reinforce their distinct characters. If possible, incorporate multiple building entries.	Stepback in Building 1 massing along Rindge Avenue and the distinct material palette at the ground floor entrance of Head Start reinforces distinct character. Project prioritizes providing multiple building entries where possible; Ground floor units are given individual entries.
N/A	1.15	Where an existing neighboring residential building is located very close to the lot line, consider adjusting the new building’s footprint to create a wider side yard than the minimum required.	We are proposing significantly wider yard setbacks than the minimum required at all buildings except the accessory maintenance building at the southeast corner of the lot. The neighboring building at that location is not very close to the lot line.
N/A	1.16	Where new buildings are constructed in the rear yards of existing buildings, or on large lots with large setbacks, adjust their massing to reduce impacts on neighboring buildings and yards by careful siting, articulate massing, and by reducing the visual bulk of top floors.	No construction in rear yards of existing buildings.

2	FACADES		
	Objective: Design building facades to enhance and enliven the public realm. In established areas, emphasize compatibility and reinforce the sense of place. In evolving residential and commercial districts of the city, contribute to the transformation of urban form by setting precedents for design excellence. Where appropriate, incorporate ground level retail spaces and common areas to foster a lively enliven the urban environment. Provide daylight to interior spaces, avoid excessive energy use, and protect the privacy of the residents of neighboring buildings. Design facades to relate to the residential scales and patterns of Cambridge's diverse and historic neighborhoods. Design street facades to off er a sense of civic presence and human scale, incorporating architectural details to provide visual interest as appropriate to their role in defining public space.		
Y	2.1	Consider Cambridge’s architectural history, heritage, culture and regional signifi cance as well as the established pattern of residential neighborhoods and conservation districts.	Exterior materials for the project take inspiration from the existing context and have been selected for their durability and maintenance-free qualities. Masonry will be used at ground floors to provide durability, and will be paired with fiber cement panels and GFRC planks at upper floors. This combination of materials will be similar to those found at the adjacent Jefferson Park State, and will reference clapboard siding which is a common residential typology in Cambridge that exists in the adjacent neighborhood.
Y	2.2	Relate to architectural styles of the immediate neighborhood context, and the street's urban qualities.	From an urban design perspective, the project will reinforce existing street qualities in the surrounding neighborhood. The street grid will be reoriented to create more intuitive connections to the site’s context and to allow block sizes that are comparable to those across Rindge Avenue. In order to create a strong residential neighborhood character with a vibrant street experience, entrances to individual apartments and community spaces will be located at the ground level to face the front doors of surrounding residential buildings.
N	2.3	Provide architectural elements such as balconies, bay windows, dormers, roof gardens, and terraces where appropriate.	Recesses and projections from building facades are the main elements of architectural articulation. Semi-private courtyard spaceswith private decks have been provided in lieu of private balconies.
Y	2.4	Enrich facades with changes in plane, projecting bay windows, balconies, and articulated entrances, sun shades, and high quality materials.	Facades are articulated by recesses and projections, as well as changes in material palettes to indicate entrances.
Y	2.5	Relate to the window-to-wall ratios and the proportion and rhythm of doors and windows prevalent in the district.	Low window-to-wall ratio and rhythm of doors and windows relates to residential character and triple decker's in surrounding neighborhood.
Y	2.6	Relate to the scale of materials and joint patterns prevalent in the surrounding neighborhood.	Pattern of corrugated and panelized façade materials relate to scale of existing residential facades in surrounding neighborhood.
Y	2.7	Enrich and refine facades with details such as lintels, sills, and other window trim, railings, string courses, cornices, and rake and eave details.	The proposed design features secondary details such as window trim, cast stone banding and the like to provide a residential scale.
Y	2.8	Provide shelter and shade at building entrances.	Nearly all building entrances are protected by being located in entry recesses (under the second floor), under canopies, or by building overhangs and projecting bays.
Y	2.9	Where buildings present long facades to the street, give the facade visual interest and create an intermediate sense of scale by incorporating elements such as recesses, projections, balconies, bay windows, porticoes, columns, pilasters, piers, or expressed structural bays.	Recesses and projections are incorporated into façade designs.
Y	2.1	Consider providing emphasis at the corners of blocks by facade treatment and by providing functional entries to ground floor retail spaces.	Facades at corners of Building 1 and Building 6 emphasize transition into the project site from the public.
Y	2.11	Avoid incorporating extravagant or exaggerated building elements or features such as out-of-scale cornices on building parapets.	Project avoids extravagant and exaggerated façade treatments.
Y	2.12	For buildings on lots with significant side and rear setbacks, consider articulating all four sides of the building.	All building facades incorporate articulation.

Y	2.13	Use building massing, form, color, and materials, and architectural details to diff erentiate the building's base, middle, and upper level facades; and add special design emphasis on the ground floor facade.	Massing, color, and materials of facades highlight distinction between ground floor and upper floors.
Y	2.14	Enrich public streets with identifiable and functional building entrances. Where possible on residential streets, provide multiple entrances to individual first-floor units.	Nearly all ground floor apartments have private street entrances; private entrances are generally also located in recesses with stained wood paneling to make them warm and inviting. Most public entrances are marked by canopies or by building overhangs and projecting bays.
Y	2.15	For large buildings on business and commercial streets, emphasize the distinct character of the ground floor facade, particularly where retail space or community spaces are provided.	Location of Headstart on ground floor of Building 1 along Rindge Avenue is indicated through distinct façade materials.
Y	2.16	Where ground floors accommodate retail space, common spaces, or community spaces, maximize views of interior spaces on public streets by using clear glass in windows and storefronts.	Façade of Headstart on ground floor of Building 1 balances clear and opaque materials to provide privacy to classrooms spaces; Community Room located on ground floor of Building 6 uses clear glass to indicate community use.
Y	2.17	Enhance building entrances and spaces around them with features such as stoops, porches, recesses, canopies, awnings, low walls, arcades, landscaping, and seating areas.	Recesses and canopies are provided throughout. Stoops are provided at ground floor elevator building units, where there is also an internal accessible path of travel. Foundation planting provides separation and privacy at private entrances.
Y	2.18	On business and commercial corridors, clearly differentiate ground floor facades from those of upper floors. Provide ceiling heights and facades to accommodate retail or other active uses.	Façade of Headstart on ground floor of Building 1 uses distinct material palette that differentiates it from upper floors.
N/A	2.19	Wherever possible, screen parking with programed spaces to enliven the street facades.	Perpendicular and parallel parking matches parking types in surrounding neighborhood without screened parking.
N/A	2.2	Where parking spaces immediately behind the ground floor street facade or facing neighboring properties, screen the parking with architectural elements that provide depth and visual interest, including decorative louvers, green wall or other decorative treatment including art work, grilles or louvers. Avoid using metal wire mesh screen-ing that does not provide depth to the wall.	Perpendicular and parallel parking matches parking types in surrounding neighborhood without screened parking.
Y	2.21	Avoid blank walls on ground floor facades. Where spaces such as utility rooms, fire control centers, etc. require windowless walls, other means of creating visual interest should be provided, including changes in plane, materials, details, and provision for planting.	Changes in plane and materials are provided in the few locations where windowless spaces exist on the ground floor. Windows are provided in others, such as bicycle rooms.
Y	2.22	Give special consideration to the design of top floor facades, particularly in residential neighborhoods, where buildings in Cambridge often have intricate massing, roof lines, or parapet walls.	Several buildings feature different detailing at the top floor than at other floors. Many have setbacks, recesses, and material changes at the third floor. All buildings also include parapet walls.
N	2.23	Rooftop terraces and gardens can add visual interest to the tops of buildings and provide needed open space for residents.	Rooftop terraces and gardens are not included; Green space is located at ground level in front and rear yards as well as larger open spaces throughout site. Rooftops are reserved for photovoltaic solar installations.
Y	2.24	Design roofs and top floors as natural extensions of the building massing.	Project avoids extravagant and exaggerated changes in massing of top floors and roof design.
Y	2.24	Size and locate fenestration to balance urban design goals and architectural qualities such as transparency and a pedestrian-friendly appearance with building energy performance and neighbors' privacy.	Size and location of fenestration balances transparency, privacy, and building energy performance.

Y	2.25	Visually enrich glazed areas with carefully considered mullion and muntin patterns and profiles, operable windows, window trim, and sun-shading devices.	Windows mullion patterns at larger windows have been designed to provide maximum light in a visually pleasing proportion (golden section). All rooms with windows have at least one operable window. Exterior metal trim is provided around windows, which will be set in relative to the siding to provide a shadow profile on the glass. Sunshades are provided at some not all south facing windows.
N/A	2.26	Use best practices in restoration and maintaining historic structures. Consultation with the Cambridge Historical Commission is recommended, especially for developments in Historic and Neighborhood Conservation Districts.	There are no historical structures on site and the project is not located in a historic district.
N/A	2.27	In renovating or adding to an existing architecturally or historically signifi cant building, or where original materials or components need to be replaced, use traditional building elements with the same architectural features, material quality and craftsmanship. If not feasible, substitute with style-neutral high-quality components and materials compatible with the architecture and historic character of the building and district.	There are no historical structures on site.
N/A	2.28	Where new units are proposed on an existing lot shared with a historic structure, the new building should, if possible, be detached from the historic structure and distinguish itself as new construction through materials, architecture-al details, and form.	There are no historical structures on site.
3	**ARCHITECTURAL DETAILS, MATERIALS, COLOR, AND FINISHES**		
	Objective: Use materials that are warm, inviting, and compatible with surrounding existing buildings and the neighborhood context. Develop building facades of high-quality, durable materials and with colors, fi knishes, and textures appropriate to building contexts.		
Y	3.1	While is it not required that materials match those of adjacent buildings, select their general color and scale in response to the neighbor-hood character.	Color palette of buildings relates to existing neutral palette of nearby residential neighborhood.
Y	3.2	Use high-quality and durable construction materials with proven records of long life-cycle and low environmental impacts.	Durability and limiting need for exterior maintenance are both high priorities for CHA. Accordingly, exterior cladding materials are selected for these features. Masonry is typically used at the ground floor and cast stone trim is used below first floor windows close to grade. At a minimum, all exterior materials are expected to require only minimal mantenace for at least 25 years. After that, some maintenance and repairs are to be expected as is required with all building materials, including masory.
Y	3.3	Natural and durable materials such as brick, concrete masonry, and stone are preferred. Other optional materials include pre-manufactured panels of cementitious, concrete, or composite materials.	Pre-manufactured cementitious materials, concrete masonry, stone are used throughout project.
Y	3.4	Use materials with colors appropriate to the immediate context and that are commonly used in the area. Avoid the use of garish colors that are not relevant to the architectural vocabulary found in the neighborhood context.	Color palette of buildings relates to existing neutral palette of nearby residential neighborhood.
Y	3.5	Avoid reflective facade materials.	Buildings materials are non-reflective.
Y	3.6	Glass should be transparent, untinted, and have low reflectivity.	Glass is transparent, untinted, and has low reflectivity.
Y	3.7	For residential units, strive for divided light or multiple pane windows. Avoid plate glass and single light windows.	Residential units have multiple pane and divided light windows.
N	3.8	Consider vegetated facade systems.	Vegetated façade systems were considered but will not be included because cost and maintenance concerns.

4	**BUILDING INTERIORS**		
	Objective: Affordable housing, like all housing, should serve the needs of its residents while contributing to the residential character and sense of neighborhood within the area at large.		
Y	4.1	Provide a mix of unit types and sizes that will support and contribute to the diversity of housing in the neighborhood. The inclusion of a significant number of units that are suitable for families with children is preferred except in special cases where housing will serve populations with diff erent housing needs, such as housing for seniors.	Majority of unit types will be 2 and 3 bedrooms. Unit types will rang from 1 to 5 bedrooms.
Y	4.2	Design interior living spaces to be attractive and comfortable. Include adequate interior living space, common storage, and access to natural light and air. Interior living spaces should be designed to be comfortable. Size bedrooms to accommodate standard bedroom furniture and include access to natural light. Provide ample counter space and storage in kitchens. Provide access to laundry facilities in residential units or elsewhere in the development.	Interior living spaces are designed with visual and physical comfort in mind. Units in Buildings 1, 2, and 3 have in-unit laundry machines; Units in Buildings 4, 5, and 6 have shared laundry in each respective building.
Y	4.3	Utilize interior finishes and fixtures that are high quality, durable, sustainable, and energy-efficient.	Interior finishes are high quality, durable, sustainable, and energy-efficient to comply with Enterprise Green Communities standards.
Y	4.4	In larger projects, provide interior common spaces for shared amenities, services and facilities such as storage, recreation and gathering space, or in larger buildings areas that can serve residents in the event of extreme weather or power outages. Consider providing amenities that serve the broader community.	The project's open space, Community Room, and Headstart provide amenities and resources to residents and the broader community. Buildings include common-use spaces such as storage and laundry. The community room will be connected to emergency power to provide light, heat, cooling and wifi to residents of Jefferson Park and Jefferson Park State during emergencies.
Y	4.5	Consider providing common spaces at ground level, visually connected to outdoor space, whether on building frontages or addressing the interior of the block.	Community Room is located at ground floor of Building 6. Is it articulated by a glass façade that connects to adjacent outdoor space.
Y	4.6	Use operable windows for residential units and common spaces to provide passive ventilation and improve indoor air quality.	Operable windows are used for residential units and common spaces.
SUSTAINABILITY			
1	**SUSTAINABLE DESIGN**		
	Objective: Achieve resilience measures to the maximum extent possible, including energy efficiency and measures to promote the health and wellness of residents.		
Y	1.1	Use the City's most up-to-date projections for anticipated future flood elevations, including the City's Floodviewer information and dashboard, Seek guidance from the City of Cambridge Department of Public Works (DPW) regarding peak stormwater runoff and on measures to build and protect to the 2070 10% flood level and recover from the 2070 1% flood level.	All residential units will be built above 2070 100-year and 500-year flood plains.
Y	1.2	Avoid locating sensitive uses such as critical building functions, emergency equipment, or residential bedrooms in areas that are at risk of future flooding.	All residential units will be built above 2070 100-year and 500-year flood plains. Mechanical equipment will be located on roofs to protect against outages. Transformers will be located within buildings.
Y	1.3	If seeking a Sustainable Building certification, strive for the highest possible credential.	CHA is designing to Passive House standards and Enterprise Green Communities at a minimum.

Y	1.4	In site design, orientation, and facade arrangement, minimize the demand for heating and cooling by considering the effects of solar gain on different sides of the building. Design interior spaces for passive heating, cooling, and ventilation. This approach is intended to conserve energy while also improving resilience in the event of power outages or other mechanical failures.	The buildings are designed for passive house certification (PHIUS); PHIUS requires state-of-the-art and best-practice energy conserving features. Windows are specified to be triple-glazed high-performance, low solar heat gain units for energy efficiency. Roofs are designed with R-50 insulation; walls are about R-30; both are significantly higher values than required by the Massachusetts Energy Code.
Y	1.5	Incorporate passive cooling and ventilation with operable windows, including operable upper sashes or transoms.	High efficiency operable awning windows are required for Passive House.
Y	1.6	Incorporate sun shading devices or shutters with positive ventilation, solar screens, canopies, porches, or brise-soleils to shade strongly sunlit facades.	Sunshades are provided at some not all south facing windows. Triple-glazed windows will feature glazing with low solar heat gain.
Y	1.7	On roofs, exterior walls, and paved surfaces, use materials with high solar refl ectivity to minimize heat absorption and localized heat island eff ect. As an alternative, employ vegetated coverings such as green roofs or green walls.	Roofs will be white to have high solar reflectivity in order to minimize heat absorption.
Y	1.8	While trees are preferred, where they are not feasible consider the use of shading devices such as canopies, awnings, or pergolas to provide shade on exterior paved areas and/or to reduce solar heat gain on building facades.	Project will preserve existing trees and plant new trees to maximize shading.
Y	1.9	On large projects, consider providing common spaces that are protected from flooding and extreme heat and are suitable as shelter during emergencies.	Community Room is located above the 500-year flood plain and will be connected to a back-up generator for emergency heating and cooling.
Y	1.1	Employ renewable and low-carbon energy features where feasible, such as solar photovoltaic systems, solar heating systems, or geothermal heating and cooling systems.	Photovoltaic systems will be integrated into project.
Y	1.11	Consider operational and embodied energy in material selection.	High performance Passive House envelope minimizes operational carbon.
Y	1.12	Select and design building systems and equipment within units to facilitate future conversion to all-renewable energy systems.	Heating and cooling will be all electric; Hot water is being designed for future conversion to all electric.
Y	1.13	Use materials with no volatile organic compound emissions in all walls, floorings, ceilings, furniture, acoustic and thermal insulation, and facades exterior applied products.	The project is designed to meet VOC and acoustic standards in Enterprise Green Communities.
Y	1.14	Integrate cool roof or green roof systems on building roofs where possible to contribute to strategies for stormwater management and green infrastructure.	Roofs will be white to have high solar reflectivity in order to minimize heat absorption.
Y	1.15	Where possible, use and integrate recycled content materials without compromising durability and material quality.	Recycled content will be prioritized as per Enterprise Green Communities.

APPENDIX 2: UNIT LAYOUTS

UNIT MATRIX

Unit Type	Building						Unit Totals	Target Count
	1	2	3	4	5	6		
1BR Flat	0	5	9	6	10	6	**36**	
1BR ADA	0	0	0	1	0	0	**1**	2
1BR Subtotal	**0**	**5**	**9**	**7**	**10**	**6**	**37**	43
2BR Flat	18	15	12	29	13	20	**107**	
2BR Duplex	0	0	0	0	0	0	**0**	
2BR ADA	1	0	0	3	0	0	**4**	6
2BR Subtotal	**19**	**15**	**12**	**32**	**13**	**20**	**111**	118
3BR Flat	2	8	6	8	14	9	**47**	
3BR Duplex	7	17	20	5	0	10	**59**	
3BR ADA	0	1	1	0	3	0	**5**	4
3BR Subtotal	**9**	**26**	**27**	**13**	**17**	**19**	**111**	103
4BR Flat	0	1	1	0	0	2	**4**	
4BR Duplex	4	2	2	1	0	0	**9**	
4BR Triplex	1	0	0	0	0	0	**1**	
4BR ADA	0	0	0	4	0	0	**4**	3
4BR Subtotal	**5**	**3**	**3**	**5**	**0**	**2**	**18**	16
5BR Duplex	0	0	0	1	0	0	**1**	
5BR Subtotal	**0**	**0**	**0**	**1**	**0**	**0**	**1**	1
TOTAL	**33**	**49**	**51**	**58**	**40**	**47**	**278**	281

Gross Floor Area

GFA per Unit

Approved Conceptual Design (ex VESS):	**341,696**		**1,216**
As of 7/23/21 (ex VESS):	**404,058**	**18.3%**	**1,453**

BWA ARCHITECTURE

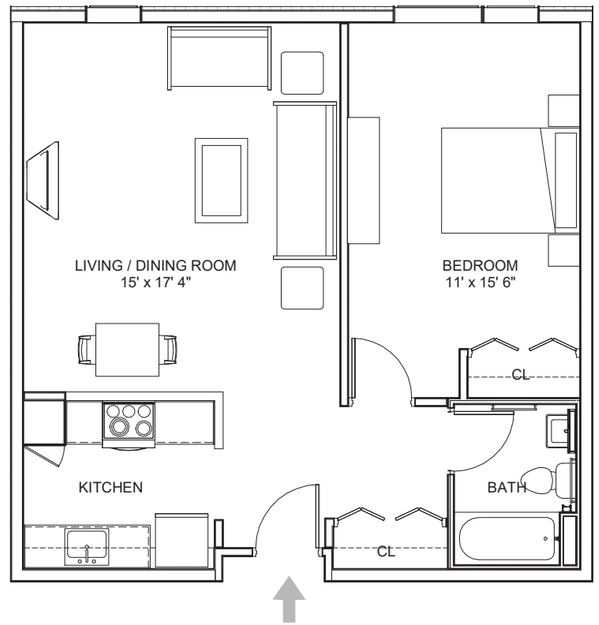
CHA

U101

1 BR FLAT

612 - 680 SF

BLDG 4, 5, 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

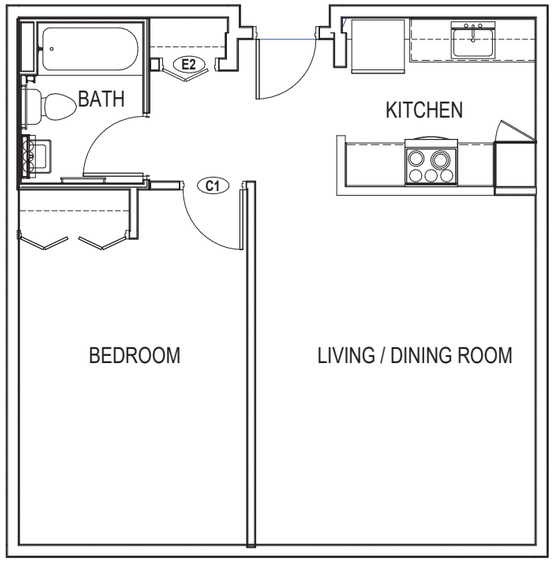
CHA

U101A

1 BR ADAPTABLE

599 - 895 SF

BLDG 5



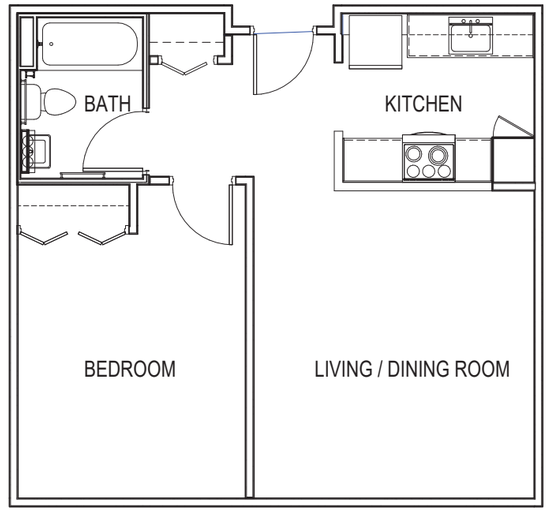
LEVEL 1

U101B

1 BR ADAPTABLE

568 - 762 SF

BLDG 6



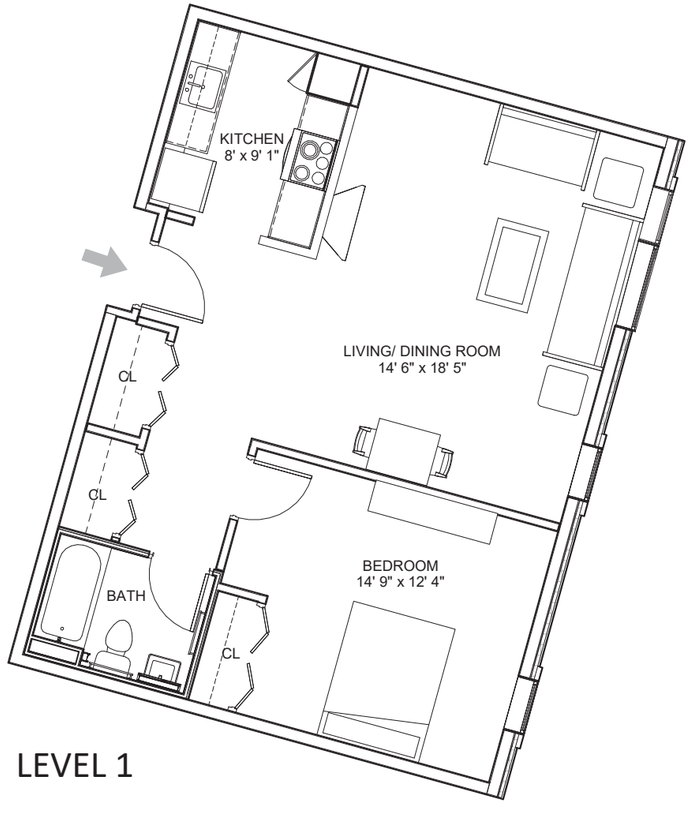
LEVEL 1

U101C

1 BR ADAPTABLE

777 SF

BLDG 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

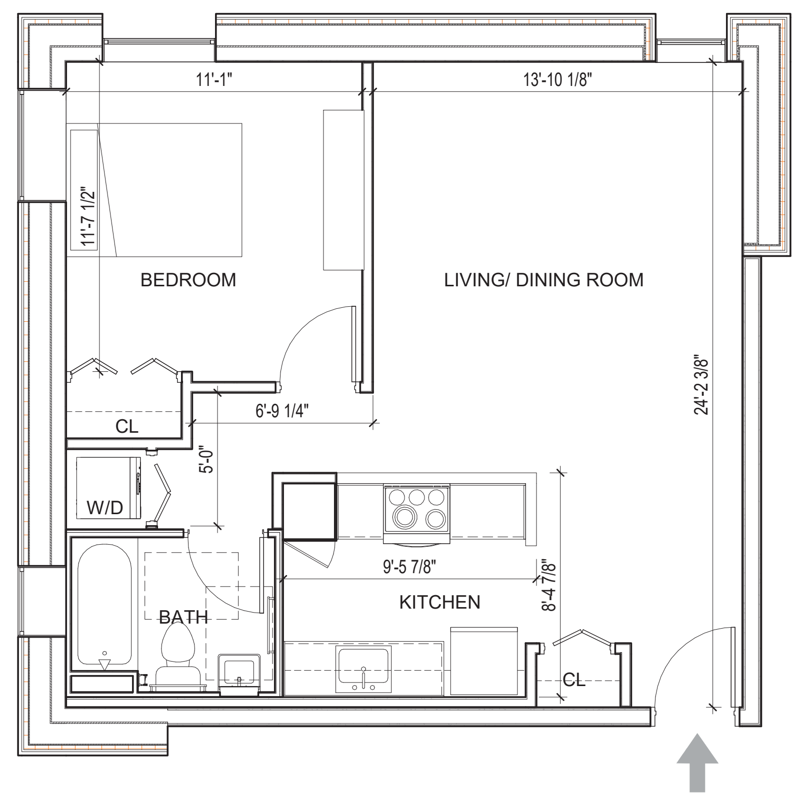
CHA

U102

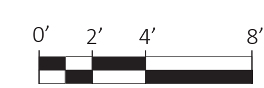
1 BR ADAPTABLE

404 - 924 SF

BLDG 2, 3



LEVEL 1



BWA ARCHITECTURE

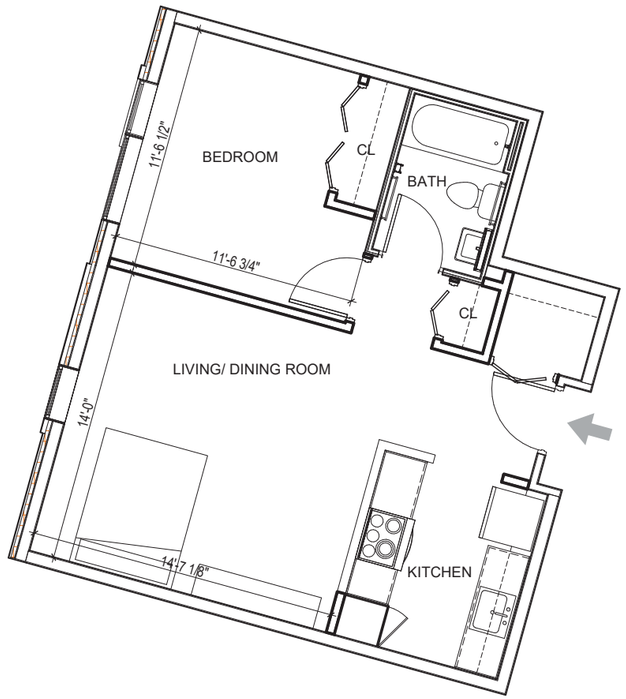
CHA

U103

1 BR ADAPTABLE

562 SF

BLDG 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

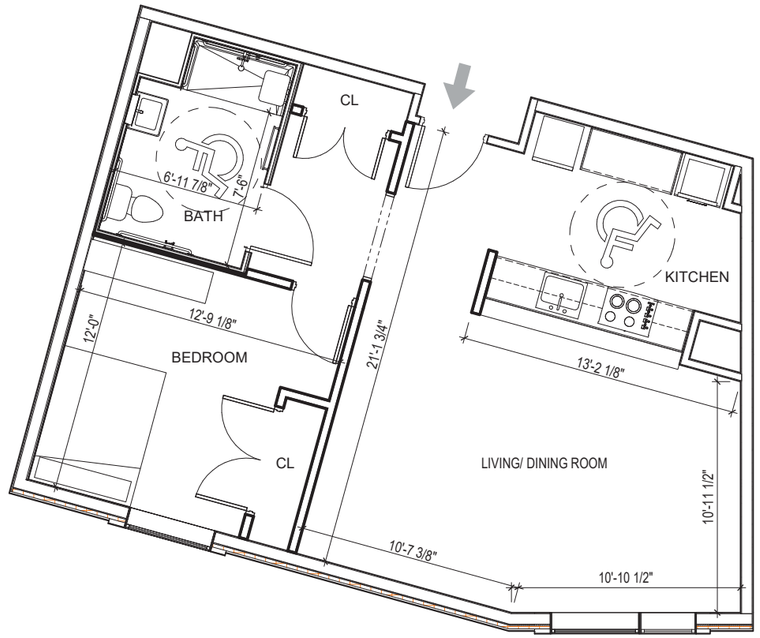
CHA

U104

1 BR ADAPTABLE

704 SF

BLDG 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

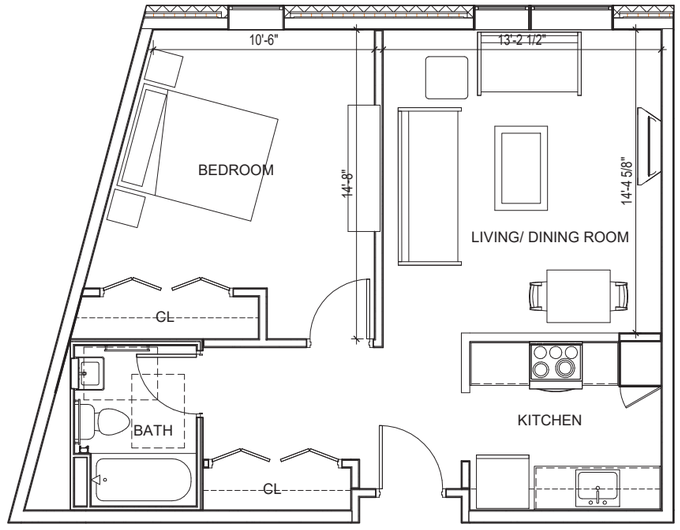
CHA

U105

1 BR ADAPTABLE

557 SF

BLDG 4



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

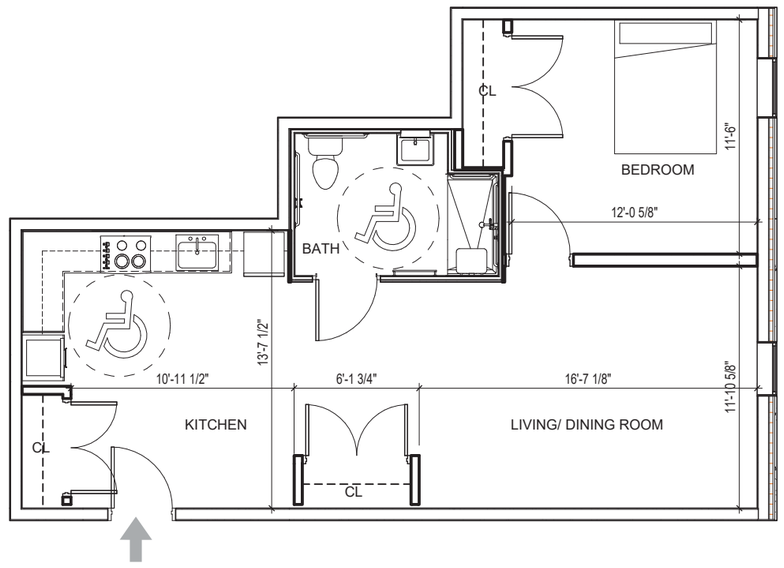
CHA

U106

1 BR ADA FLAT

674 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

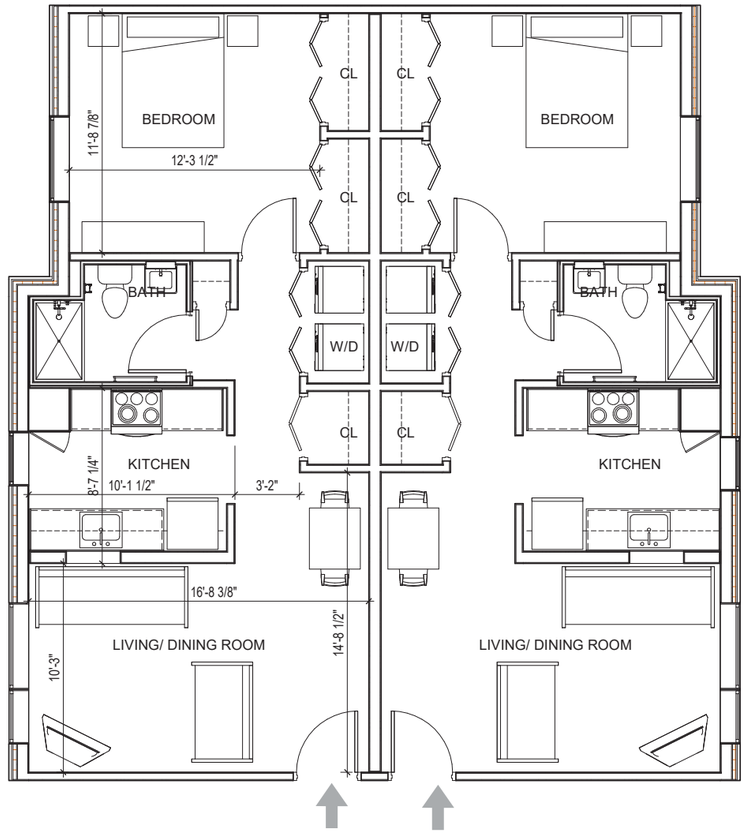
CHA

U107

1 BR FLAT

592 - 610 SF

BLDG 2, 3



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

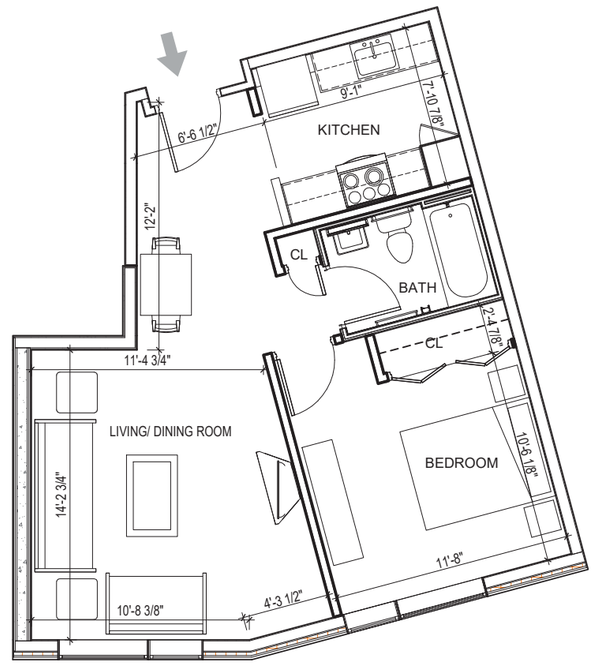
CHA

U108

1 BR FLAT

564 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

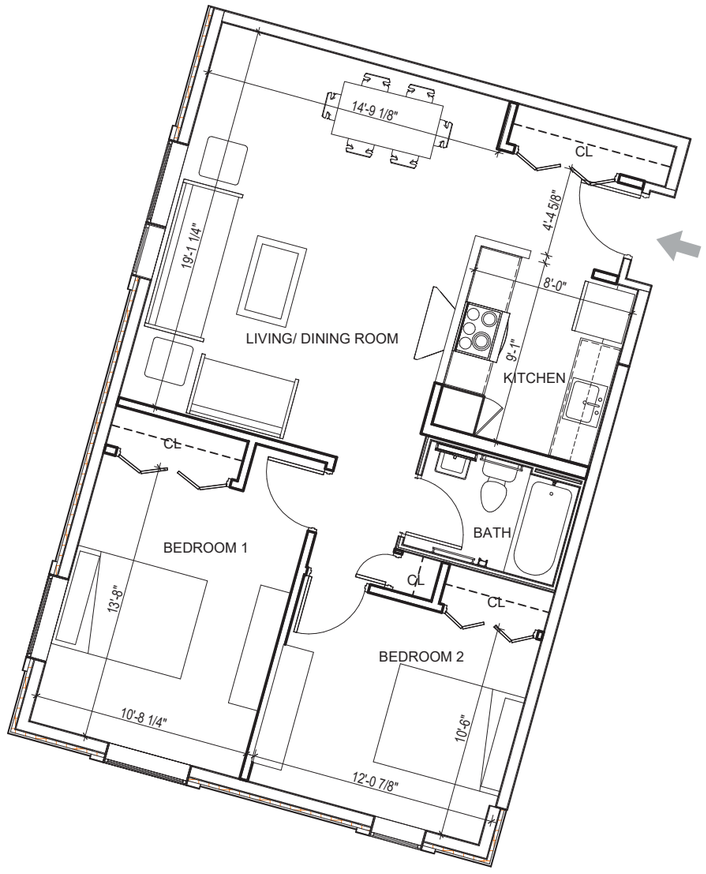
CHA

U201

1 BR FLAT

812 SF

BLDG 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

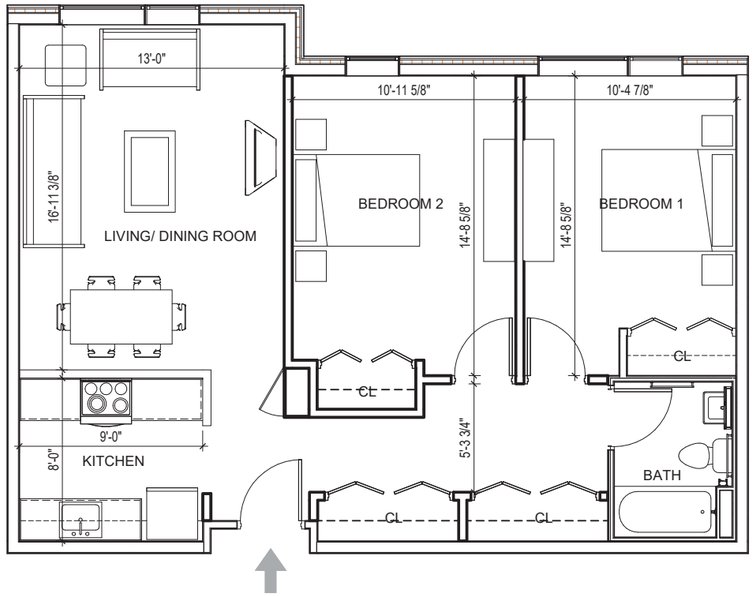
CHA

U202

2 BR FLAT

830 SF

BLDG 4, 5, 6



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

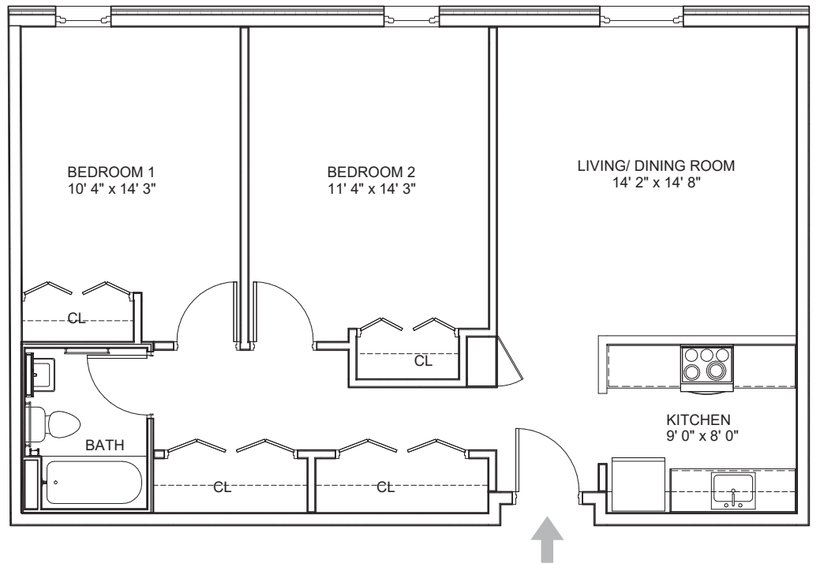
CHA

U202A

2 BR ADAPTABLE

842 - 915 SF

BLDG 6



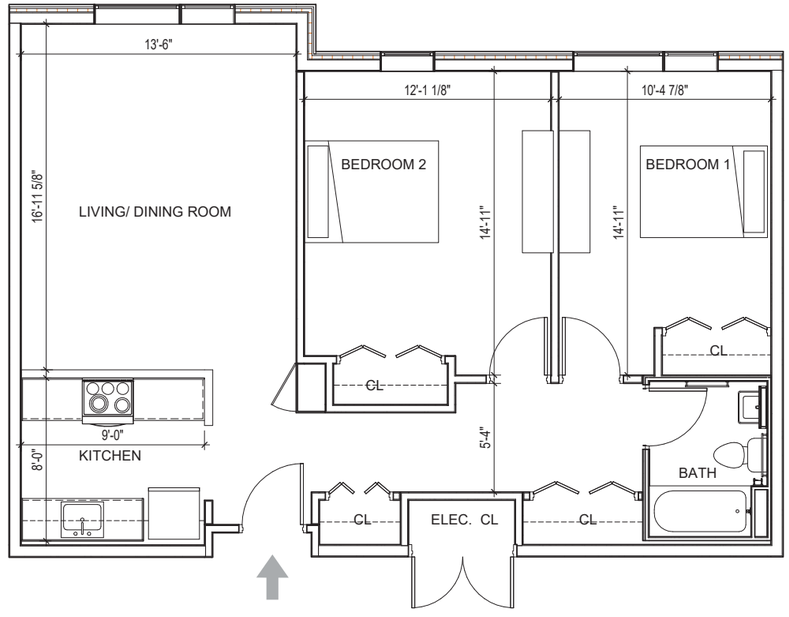
LEVEL 1

U202B

2 BR ADAPTABLE

893 SF

BLDG 6



LEVEL 1

0′ 2′ 4′ 8′

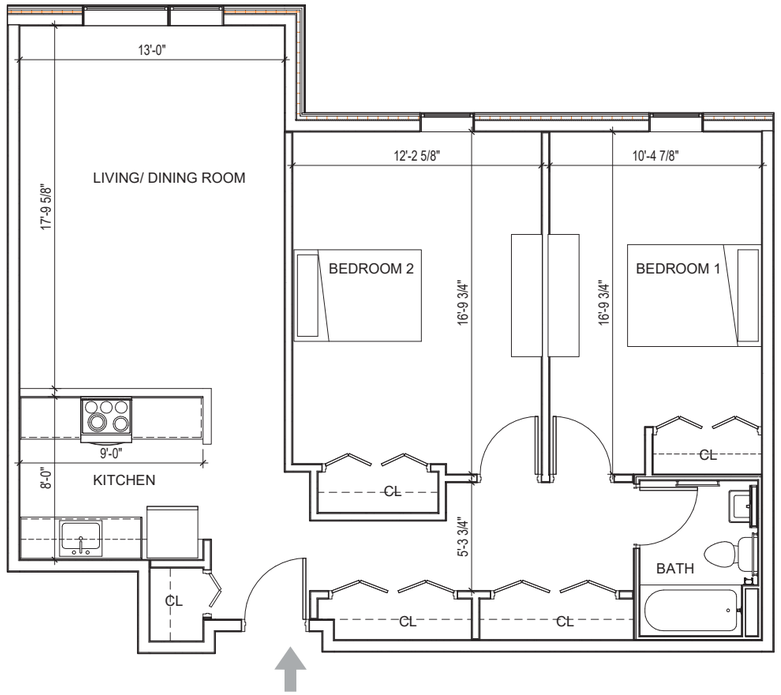
BWA ARCHITECTURE

U202C

2 BR ADAPTABLE

933 SF

BLDG 5



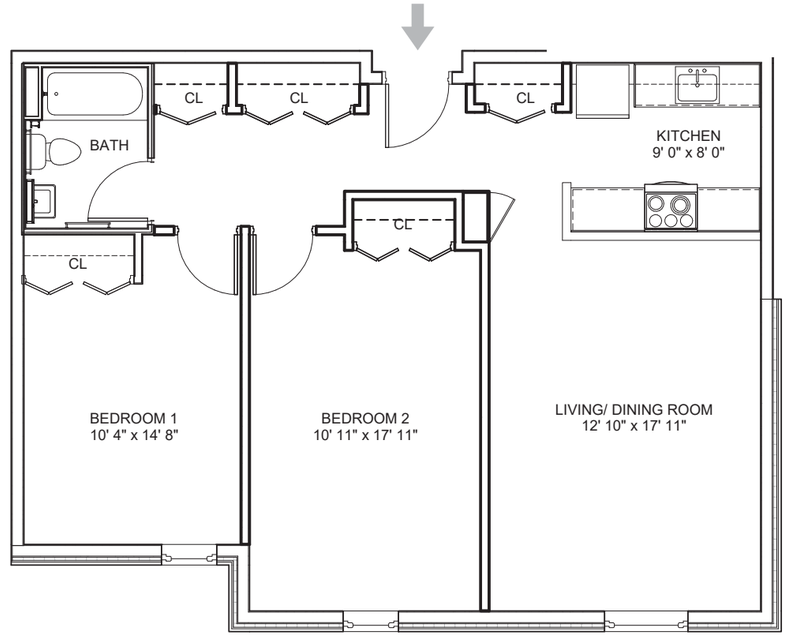
LEVEL 1

U202D

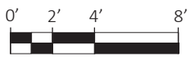
2 BR ADAPTABLE

874 SF

BLDG 4



LEVEL 1



BWA ARCHITECTURE

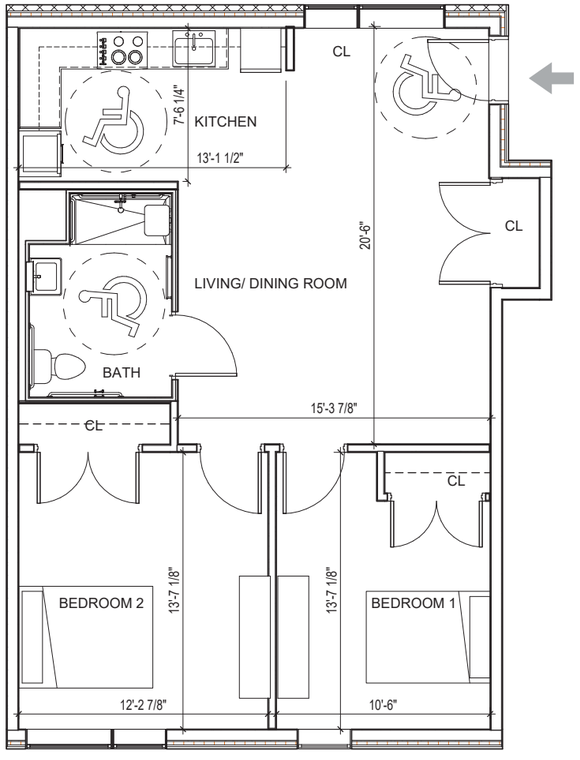
CHA

U203

2 BR ADA FLAT

810 SF

BLDG 1



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

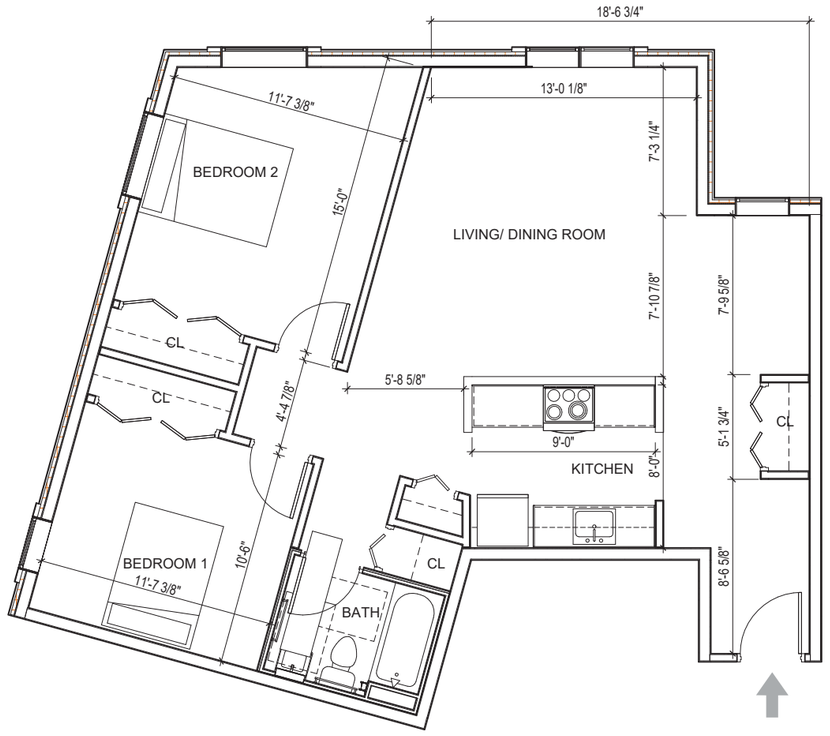
CHA

U204

2 BR ADAPTABLE

788 SF

BLDG 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

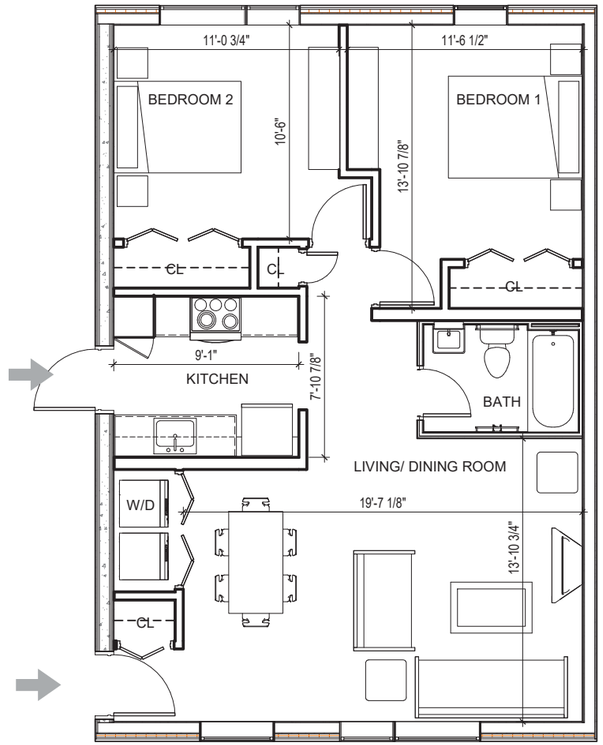
CHA

U205

2 BR FLAT

796 - 807 SF

BLDG 1



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

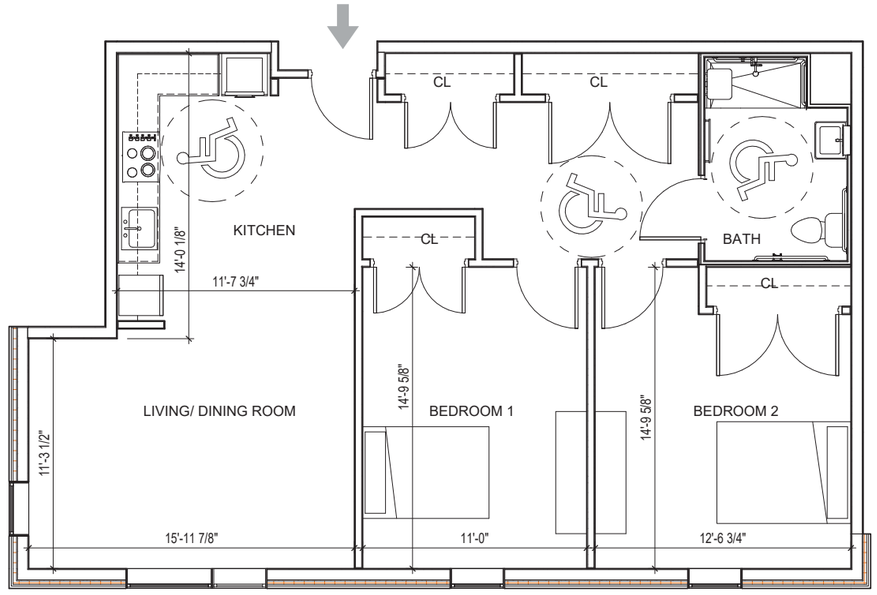
CHA

U206

2 BR ADA FLAT

1068 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

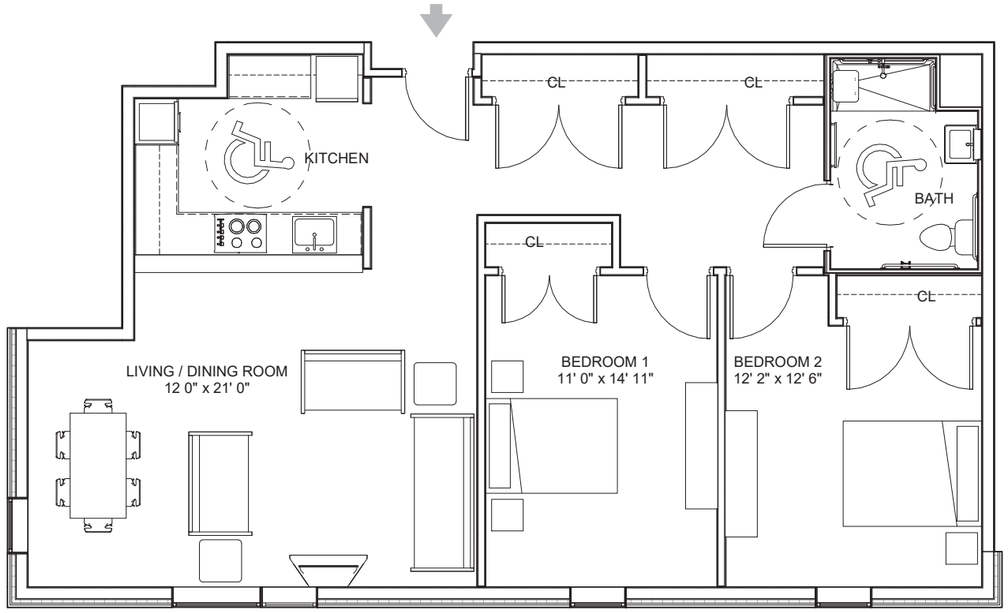
TCHA

U206A

2 BR ADA FLAT

1,068 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

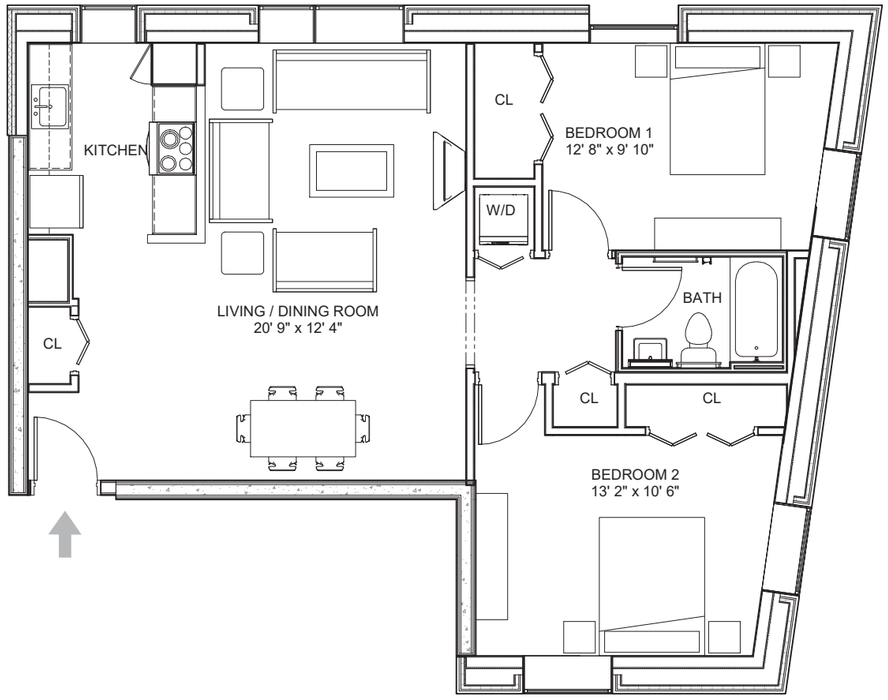
CHA

U207

2 BR FLAT

833 SF

BLDG 2



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

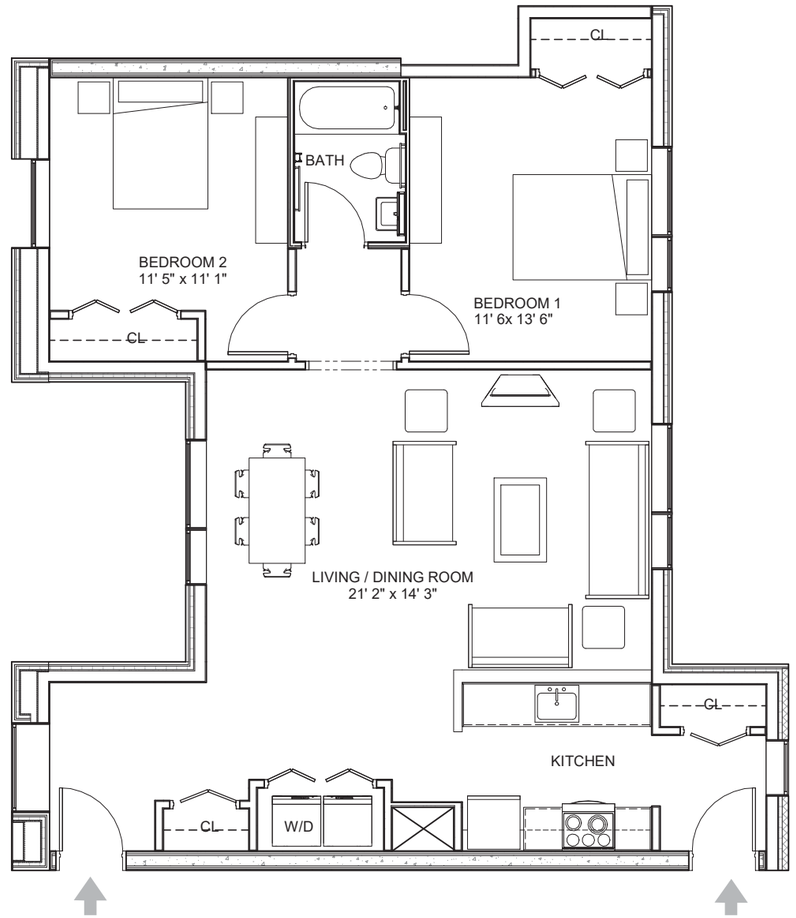
TCHA

U208

2 BR FLAT

1,012 SF

BLDG 2, 3



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

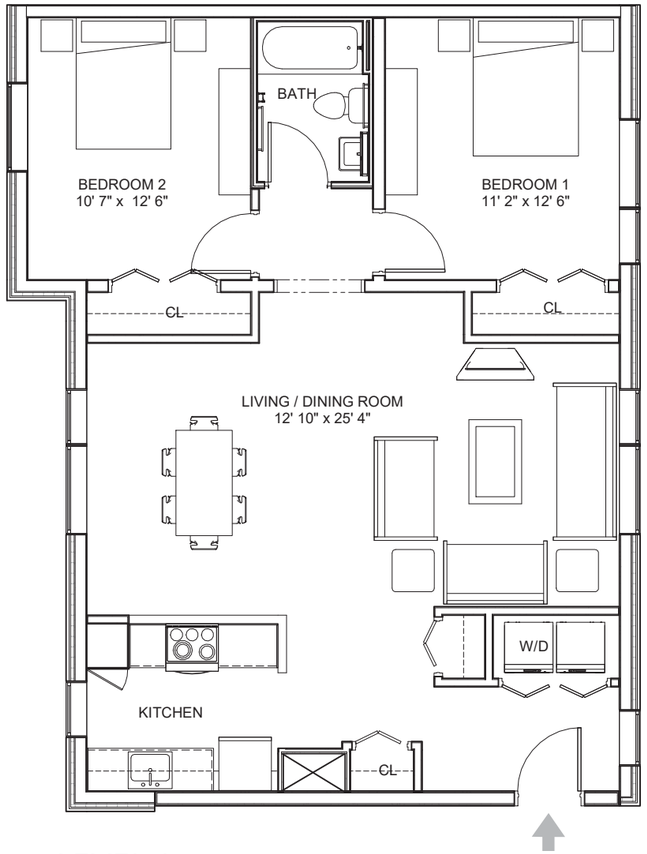
CHA

U209

2 BR FLAT

934 -964 SF

BLDG 2, 3



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

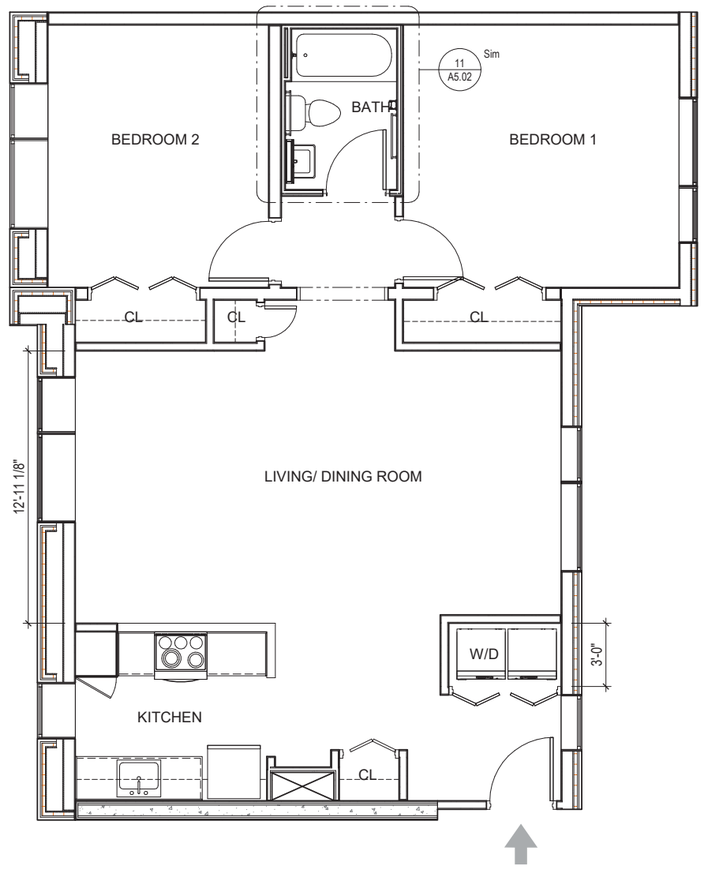
CHA

U209A

2 BR FLAT

707 -924 SF

BLDG 2, 3



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

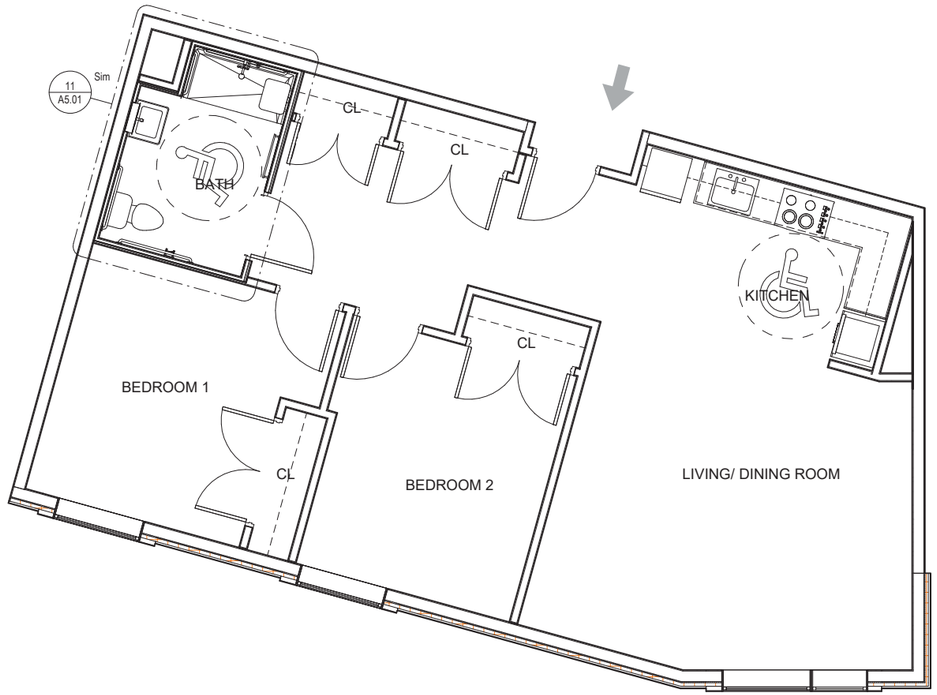
TCHA

U210

2 BR ADA FLAT

985 SF

BLDG 6



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

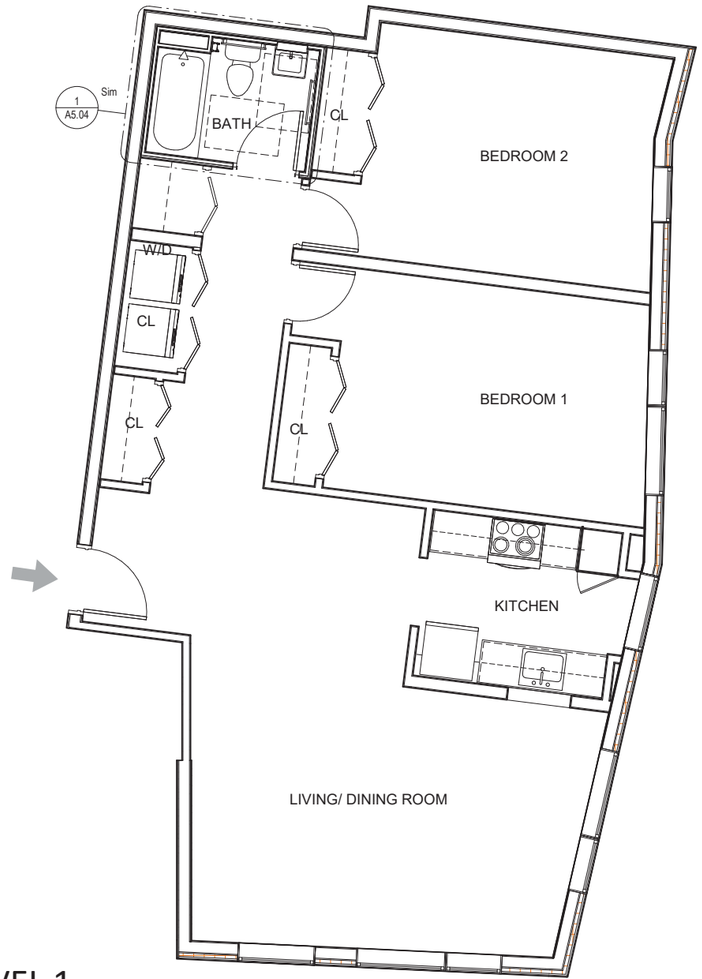
TCHA

U211

2 BR FLAT

900 SF

BLDG 1



LEVEL 1

0′ 2′ 4′ 8′

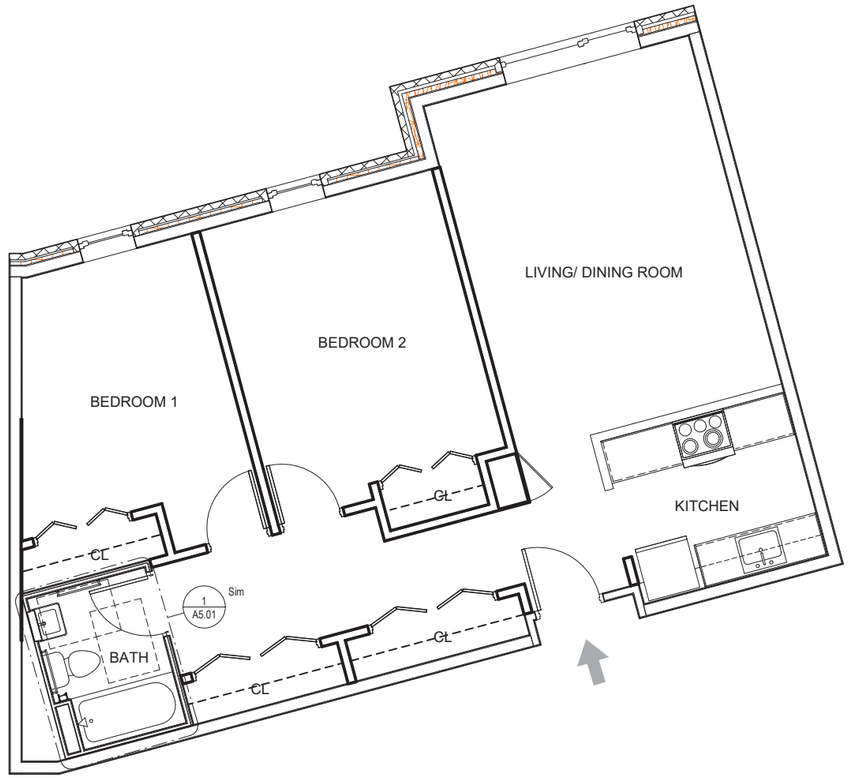
BWA ARCHITECTURE

U212

2 BR ADAPTABLE

856 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

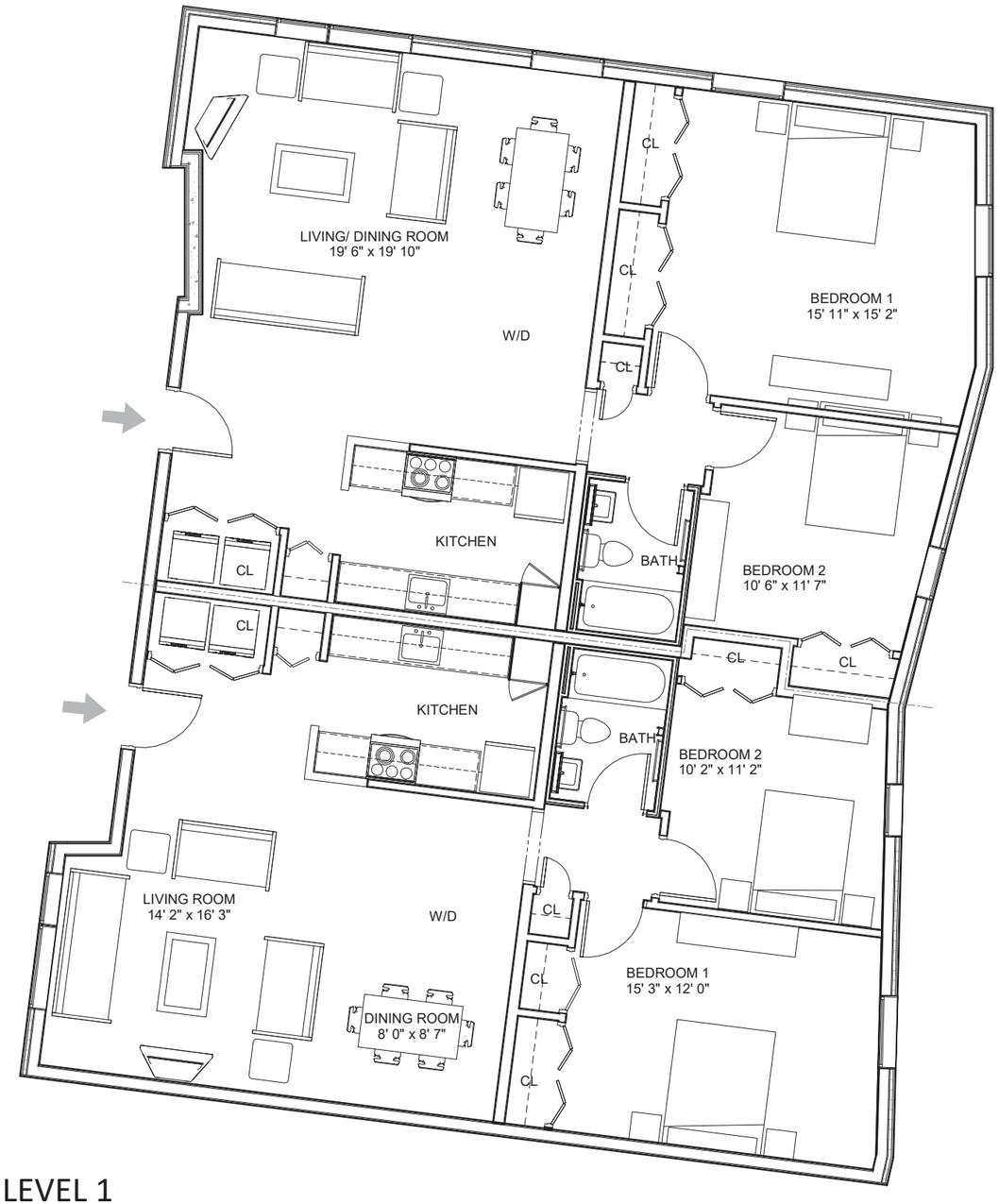
CHA

U213

2 BR FLAT

903 - 1067 SF

BLDG 1



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

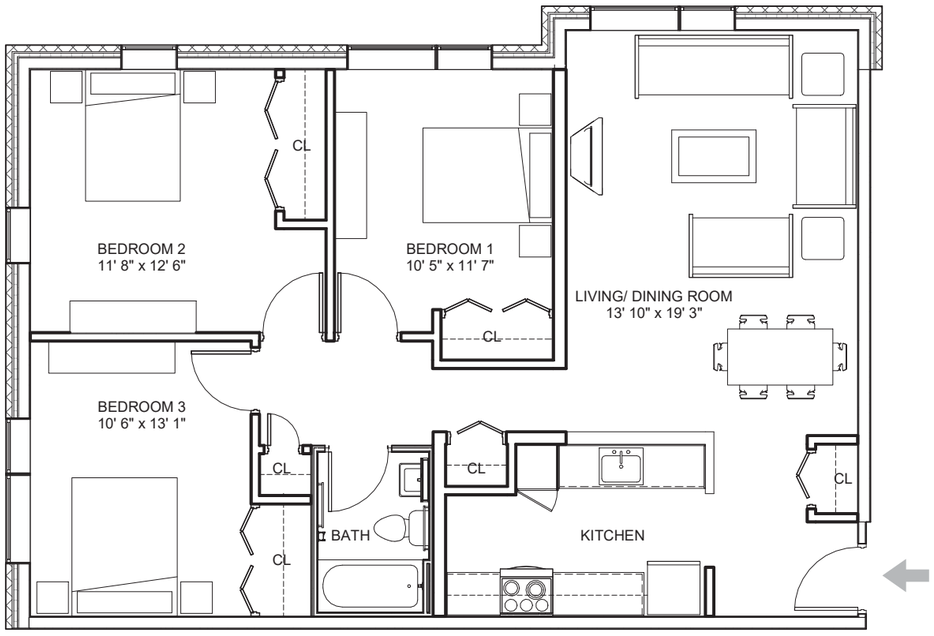
CHA

U301

3 BR ADAPTABLE

1,047 - 1,102 SF

BLDG 5



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

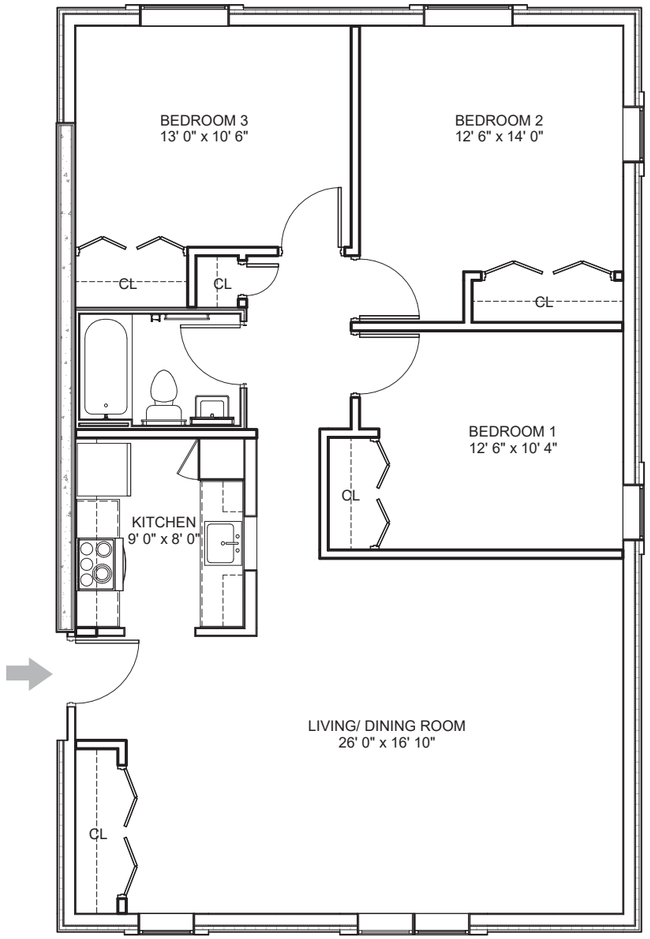
CHA

U301A

3 BR ADAPTABLE

1,138 SF

BLDG 6



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

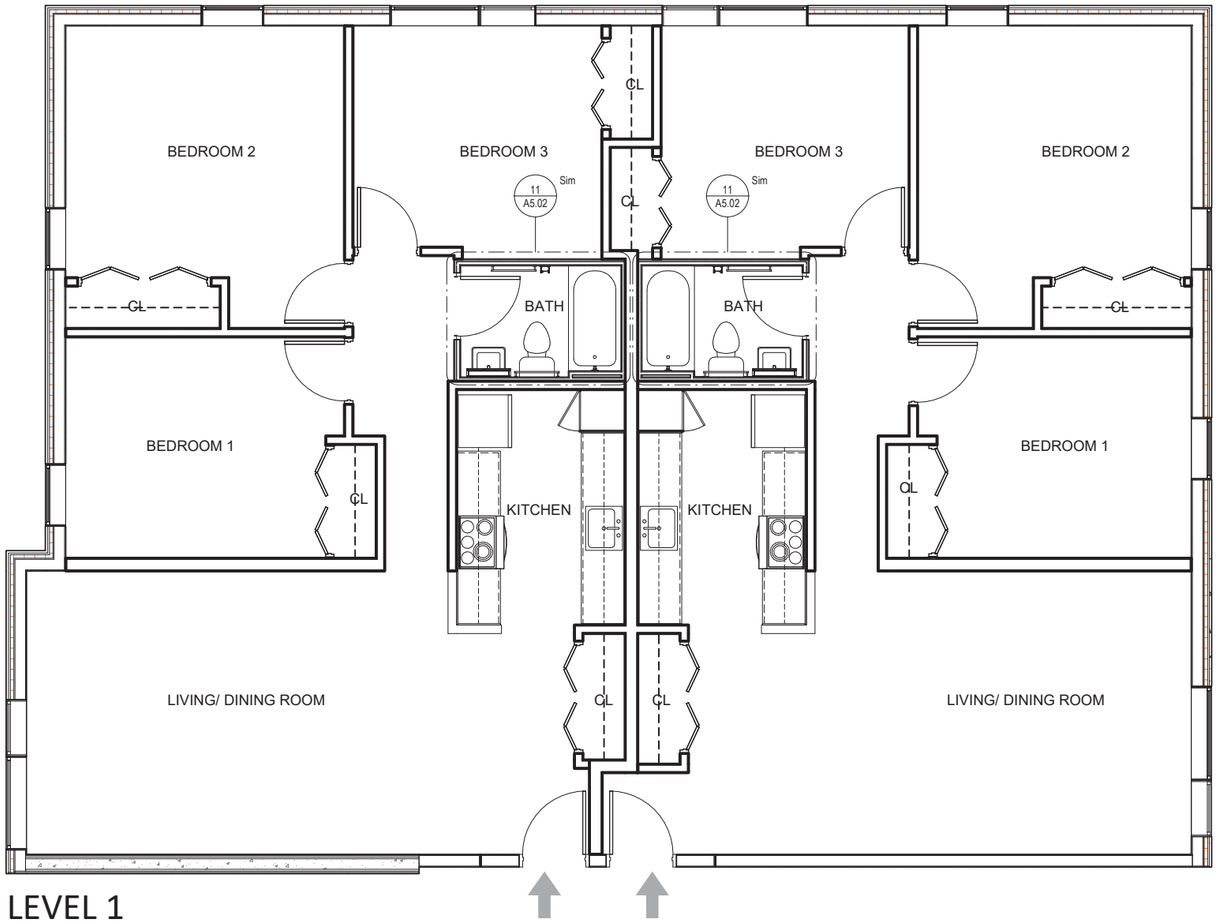
CHA

U302

3 BR ADAPTABLE

1,062 - 1,090 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

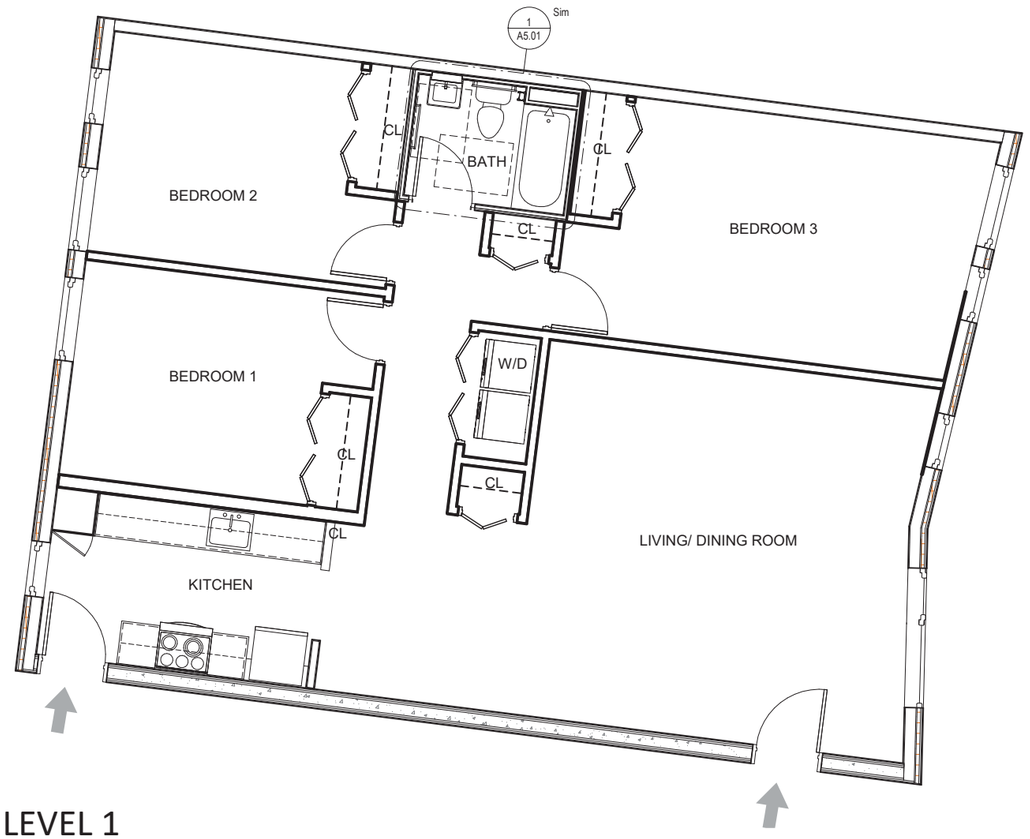
CHA

U303

3 BR FLAT

1,190 SF

BLDG 1



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

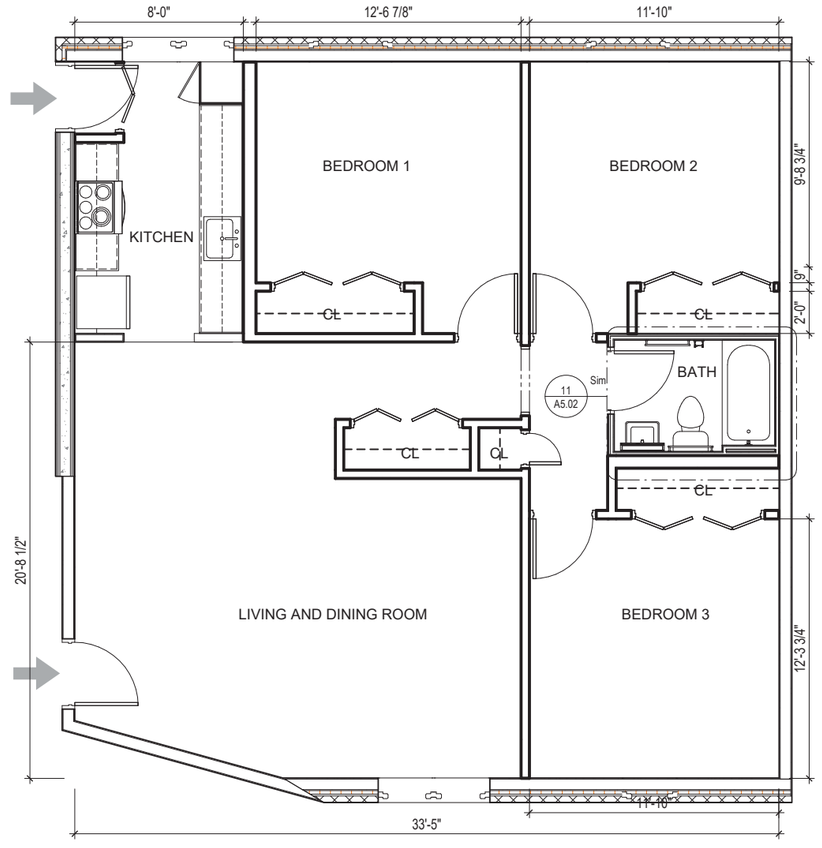
CHA

U304

3 BR ADAPTABLE

568 - 1,108 SF

BLDG 6



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

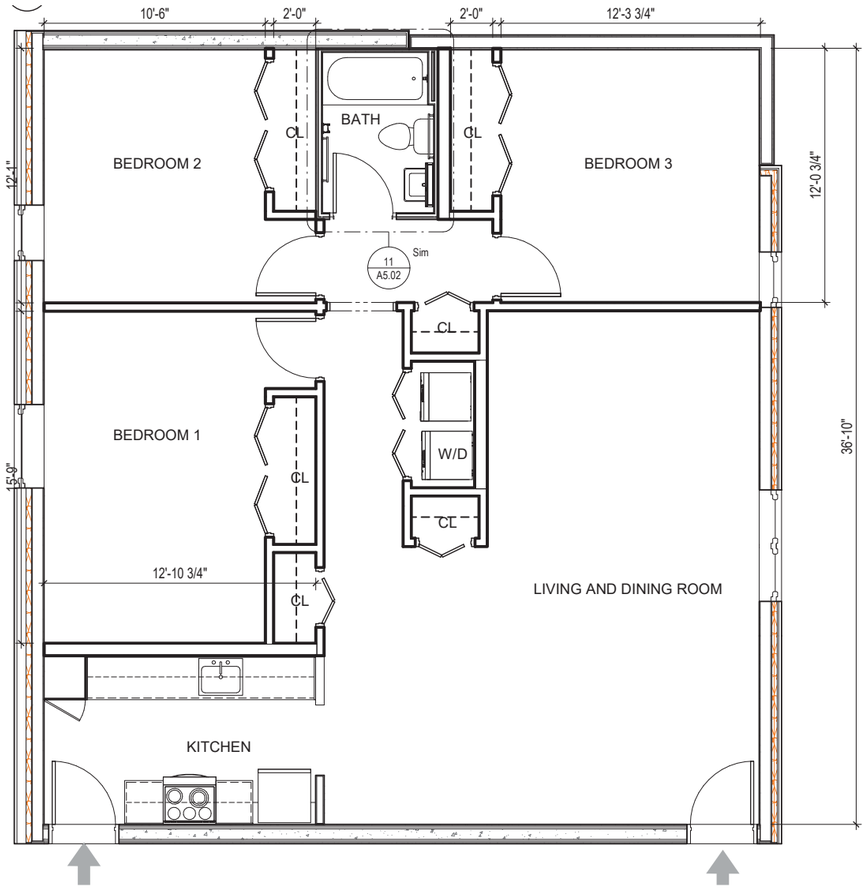
CHA

U304A

3 BR FLAT

1,252 SF

BLDG 2, 3



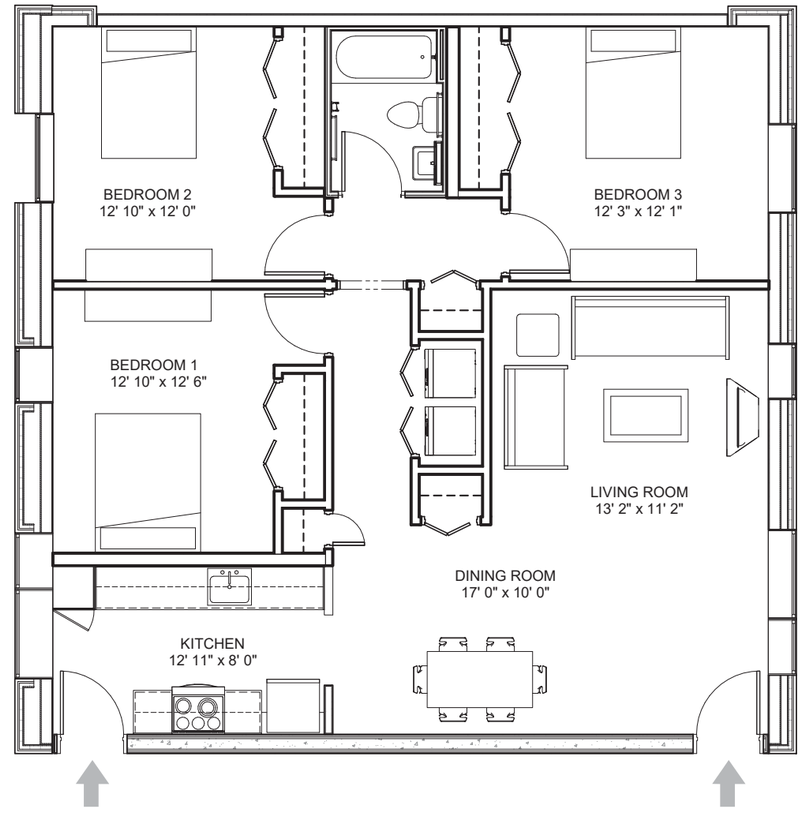
LEVEL 1

U304B

3 BR FLAT

1,138 SF

BLDG 2, 3



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

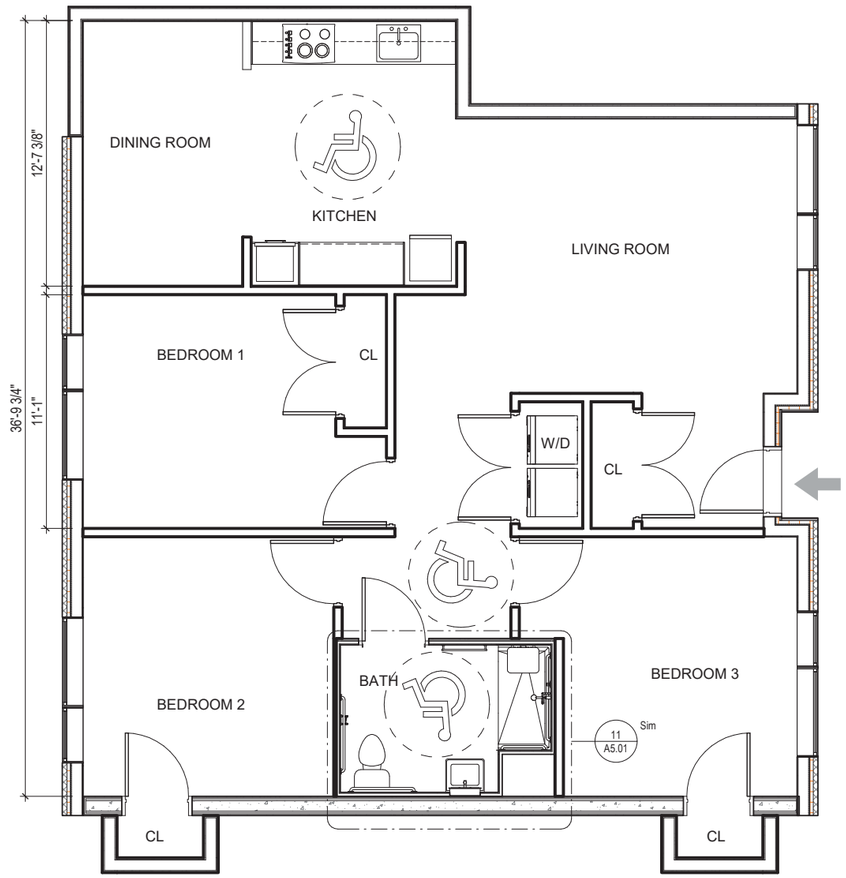
CHA

U305

3 BR ADA FLAT

1,163 SF

BLDG 2, 3



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

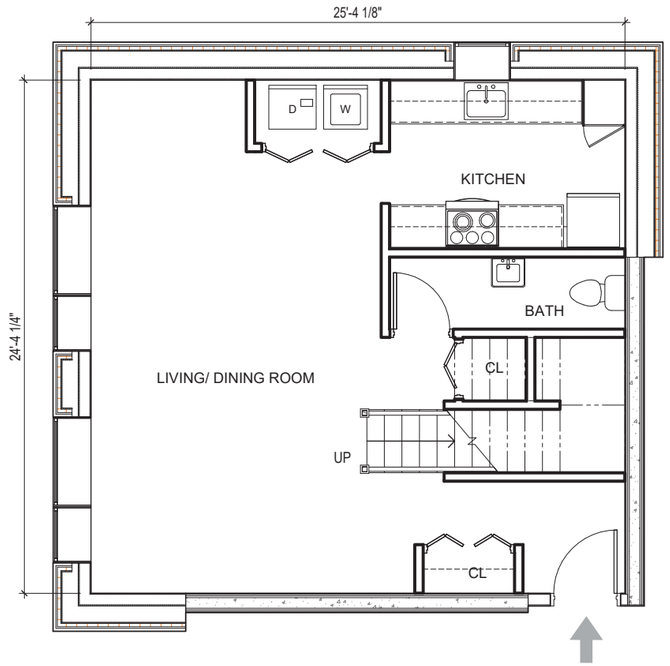
CHA

U306

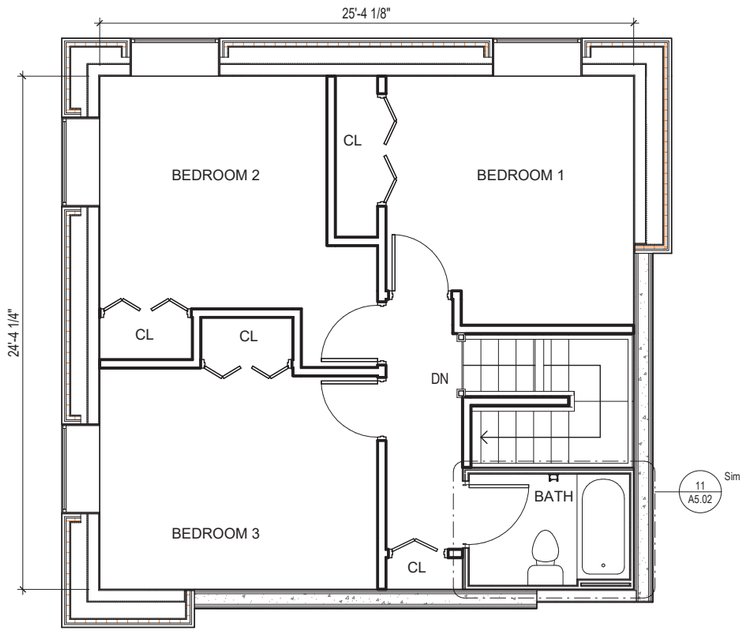
3 BR DUPLEX

808 SF

BLDG 2



LEVEL 1



LEVEL 2

0' 2' 4' 8'

BWA ARCHITECTURE

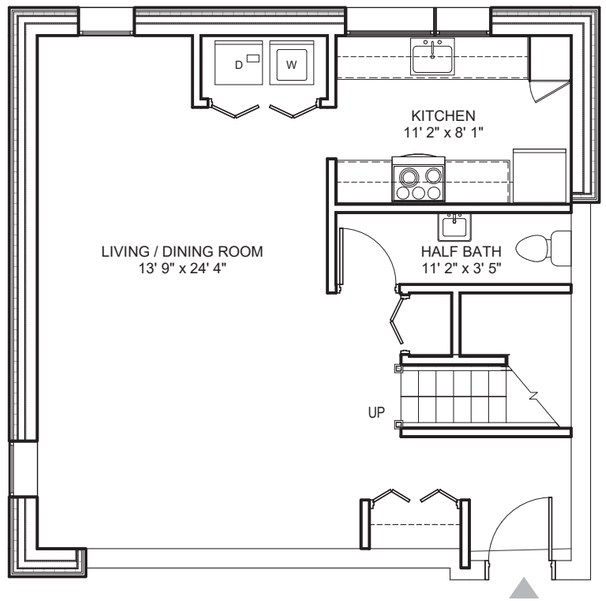
CHA

U306A

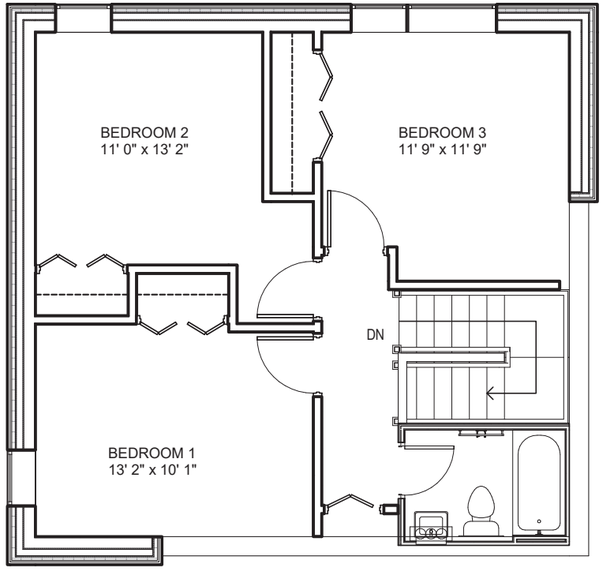
3 BR DUPLEX

808 - 1,690 SF

BLDG 3



LEVEL 1



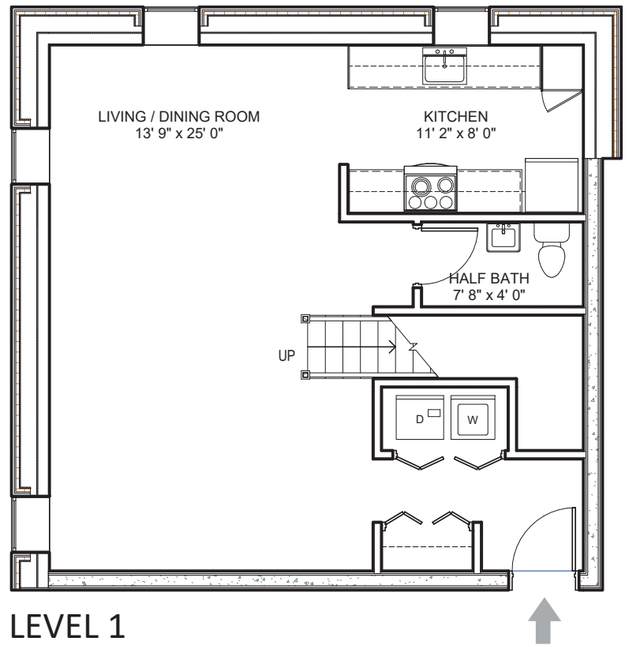
LEVEL 2

U306B

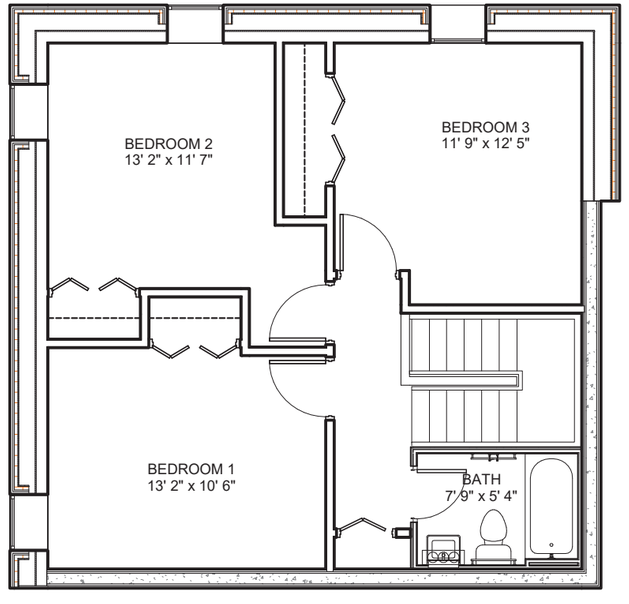
3 BR DUPLEX

1,240 SF

BLDG 3



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

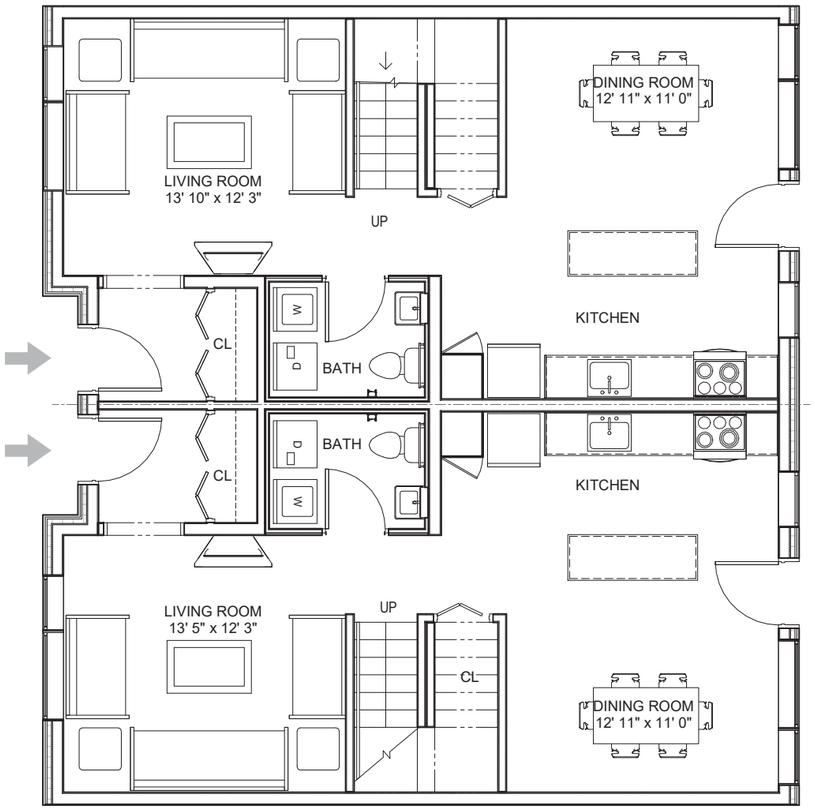
CHA

U307

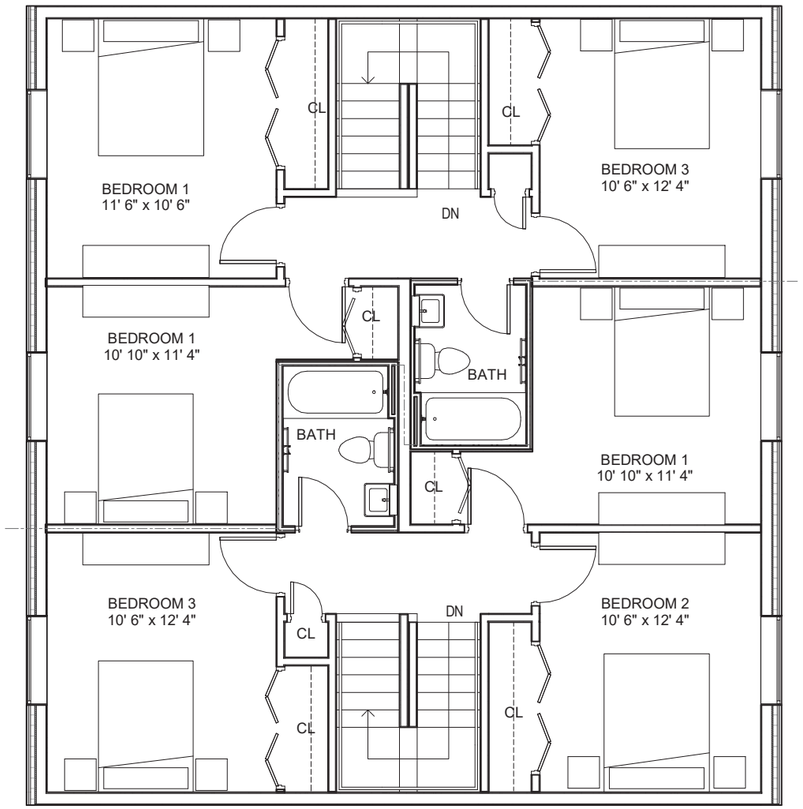
3 BR DUPLEX

1,202 - 1,212 SF

BLDG 1, 2, 3, 6



LEVEL 1



LEVEL 2

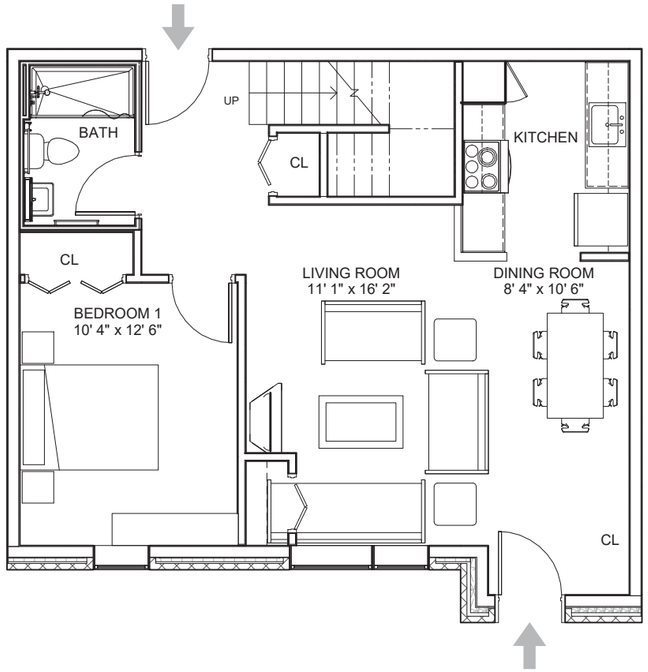
0' 2' 4' 8'

U308

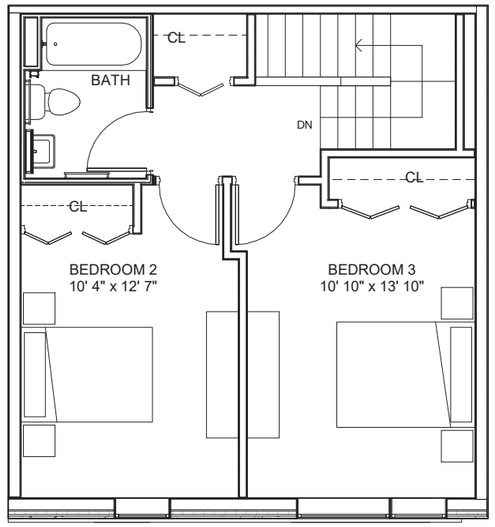
3 BR DUPLEX

1,175 - 1,190 SF

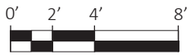
BLDG 4



LEVEL 1



LEVEL 2



BWA ARCHITECTURE

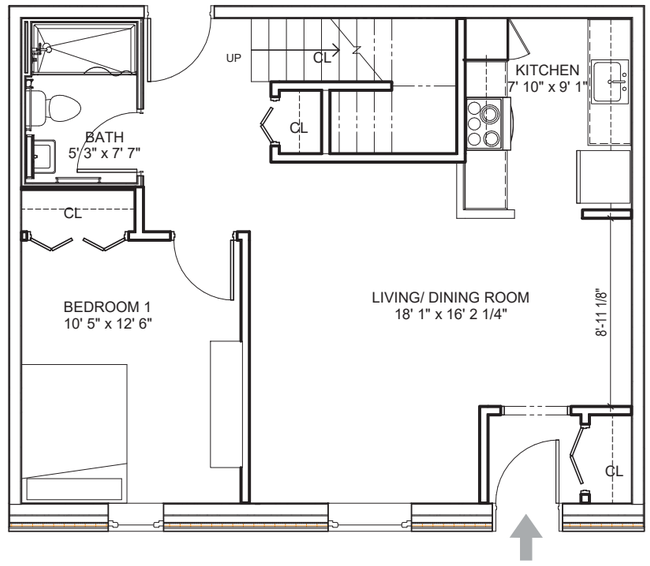
CHA

U308A

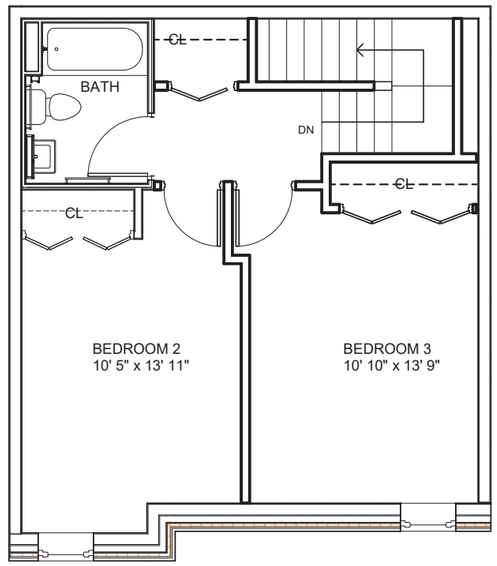
3 BR DUPLEX

1,129 SF

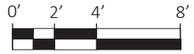
BLDG 6



LEVEL 1



LEVEL 2



BWA ARCHITECTURE

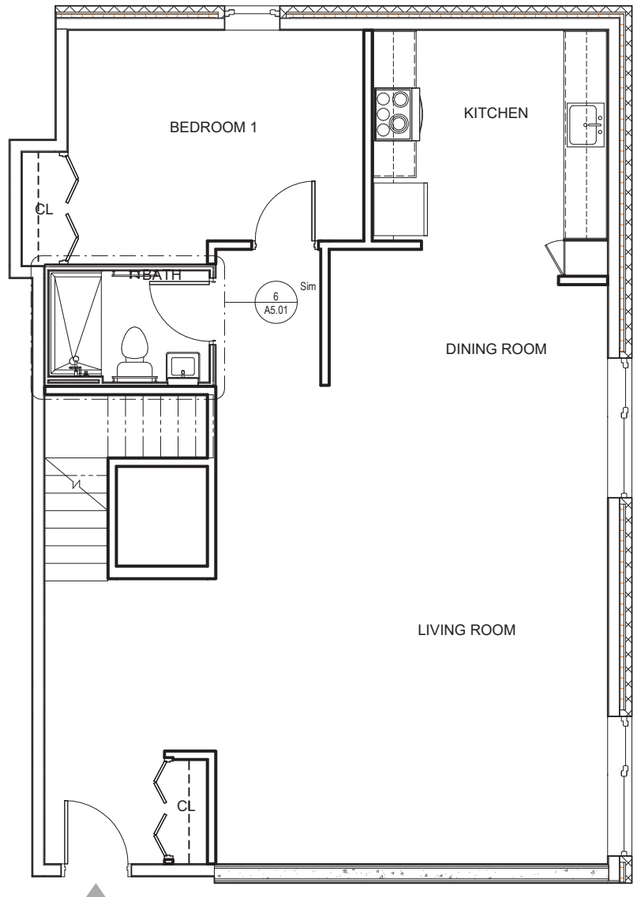
TCHA

U309

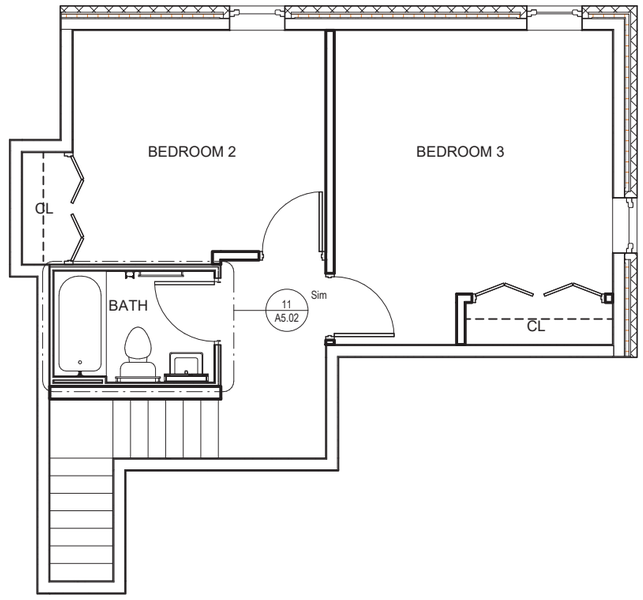
3 BR DUPLEX

1,507 SF

BLDG 4



LEVEL 1



LEVEL 2

0' 2' 4' 8'

BWA ARCHITECTURE

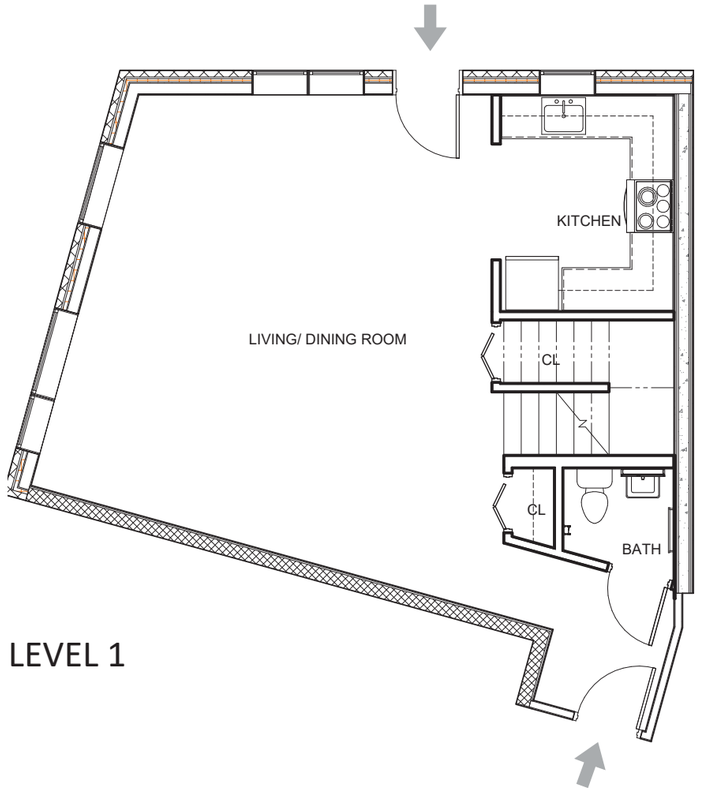
CHA

U310

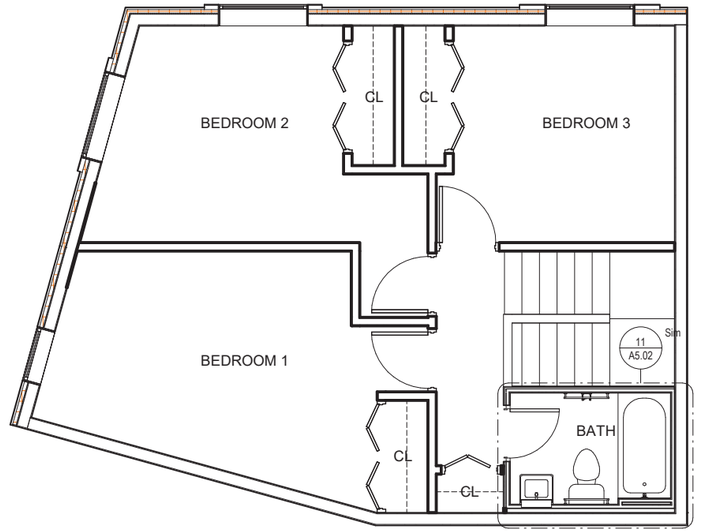
3 BR DUPLEX

1,060 SF

BLDG 6



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

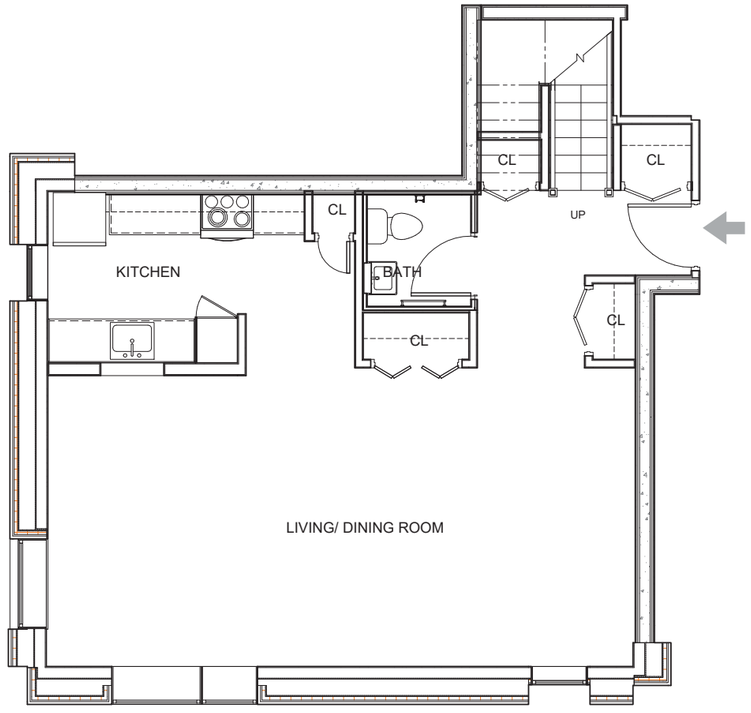
BWA ARCHITECTURE

U311

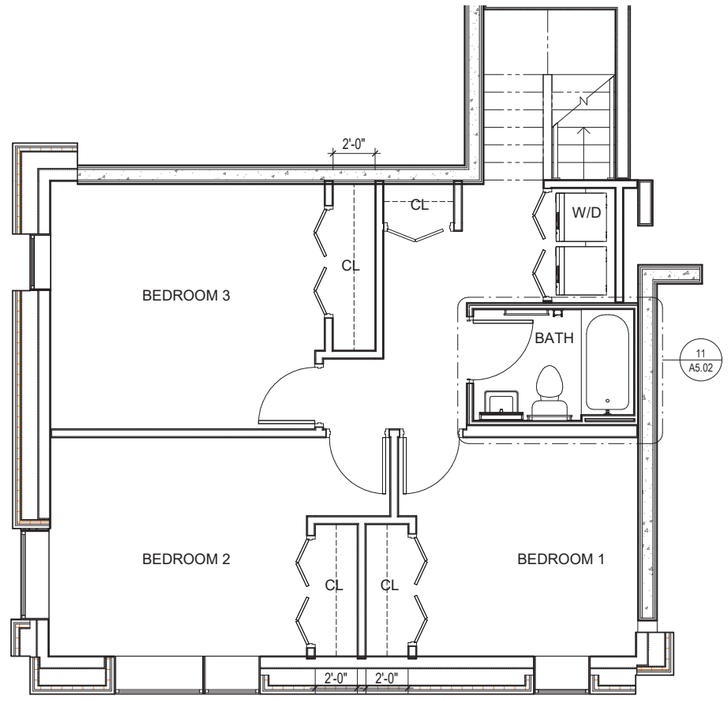
3 BR DUPLEX

1,388 SF

BLDG 2, 3



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

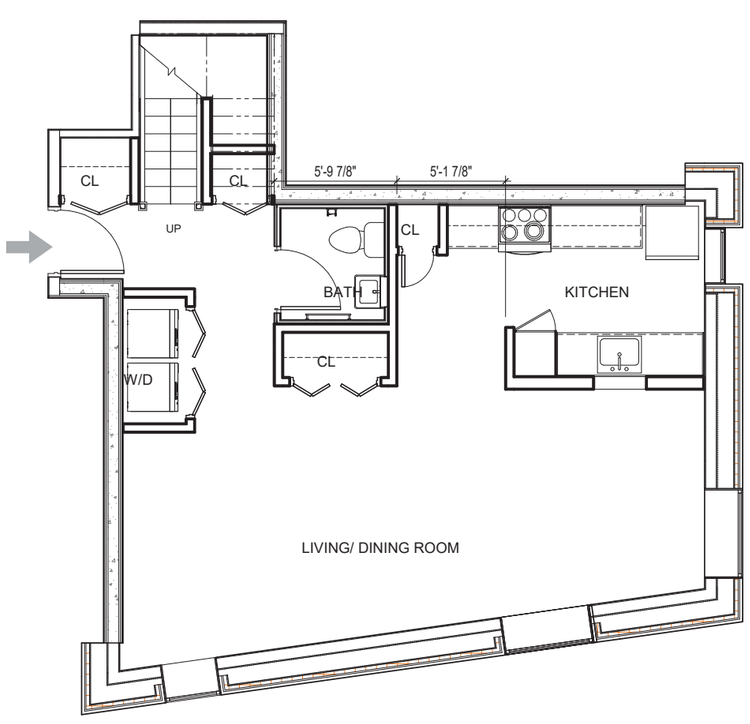
CHA

U311A

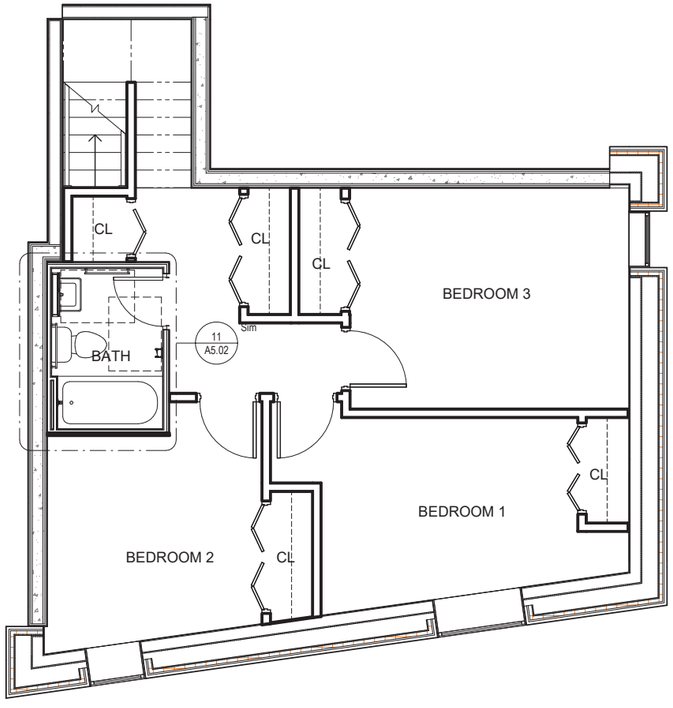
3 BR DUPLEX

1,262 SF

BLDG 2



LEVEL 1



LEVEL 2

0' 2' 4' 8'

BWA ARCHITECTURE

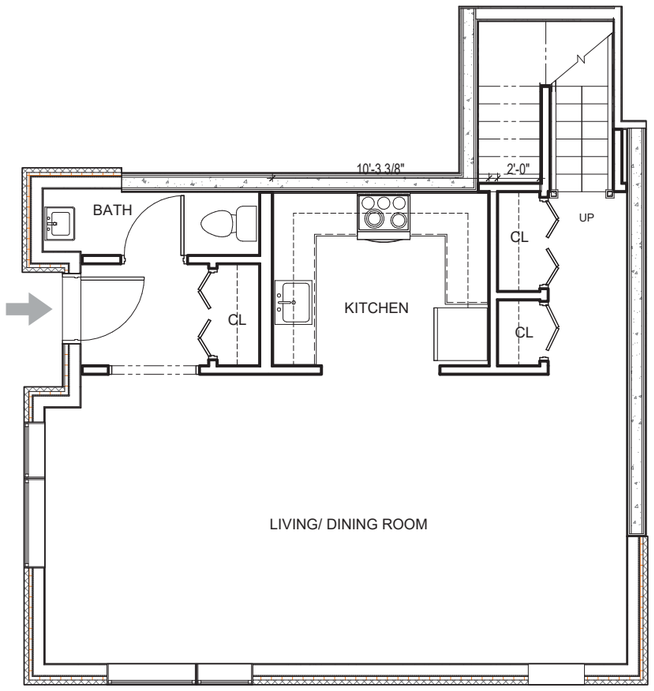
CHA

U312

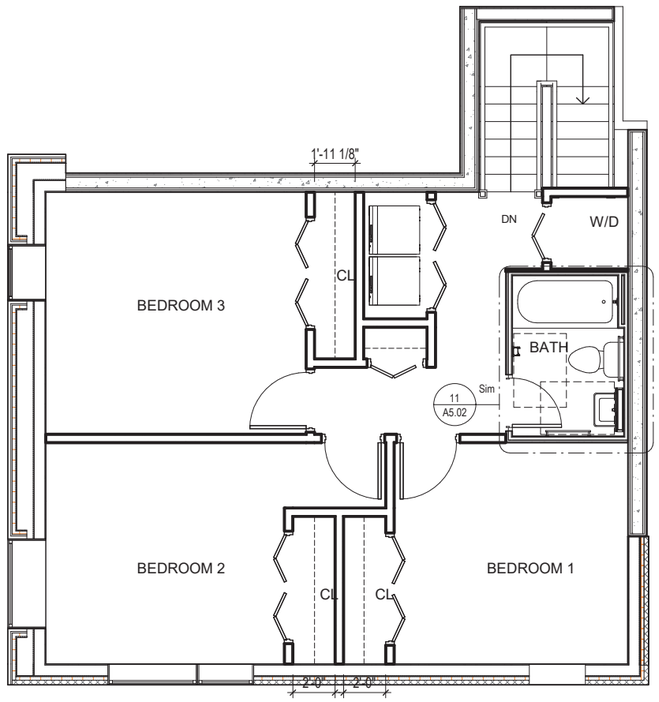
3 BR DUPLEX

1,229 - 1,353 SF

BLDG 2, 3



LEVEL 1



LEVEL 2

0' 2' 4' 8'

BWA ARCHITECTURE

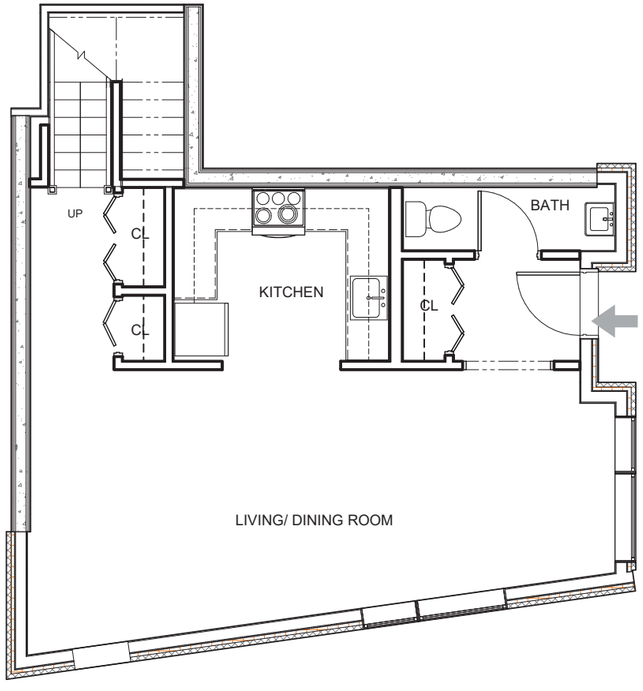
CHA

U312A

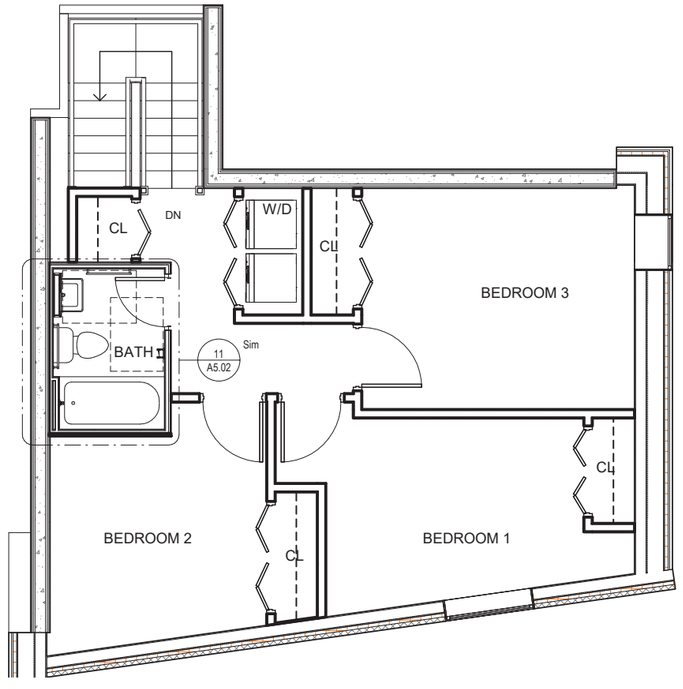
3 BR DUPLEX

1,230 SF

BLDG 2



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

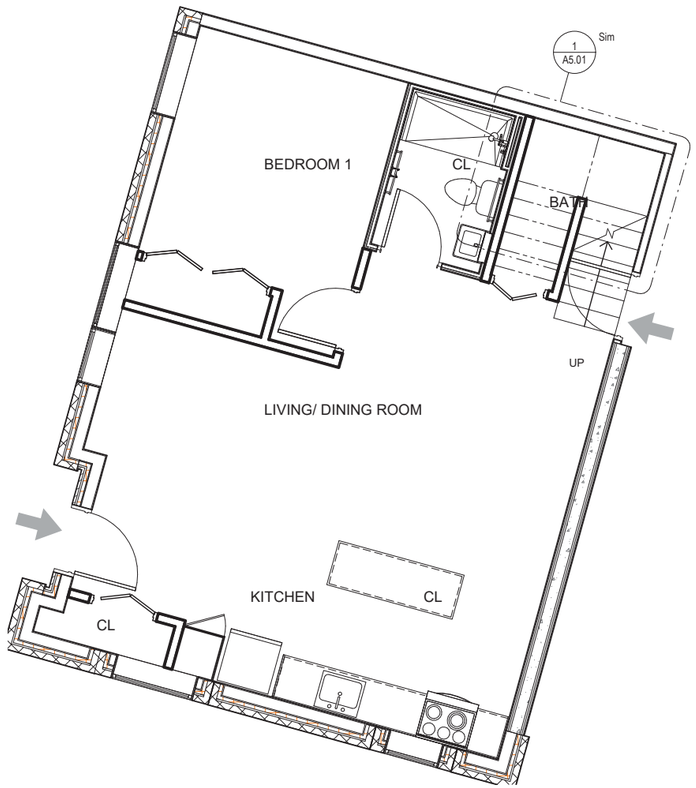
CHA

U313

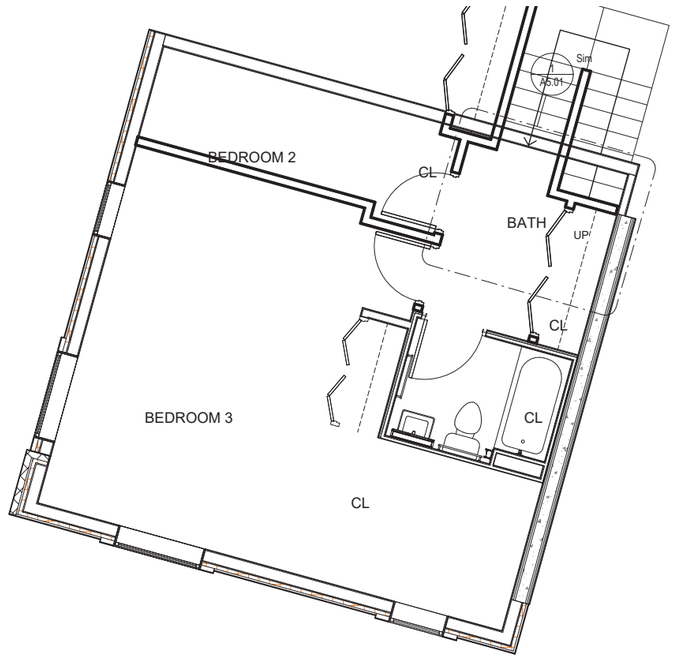
3 BR DUPLEX

1,158 SF

BLDG 6



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

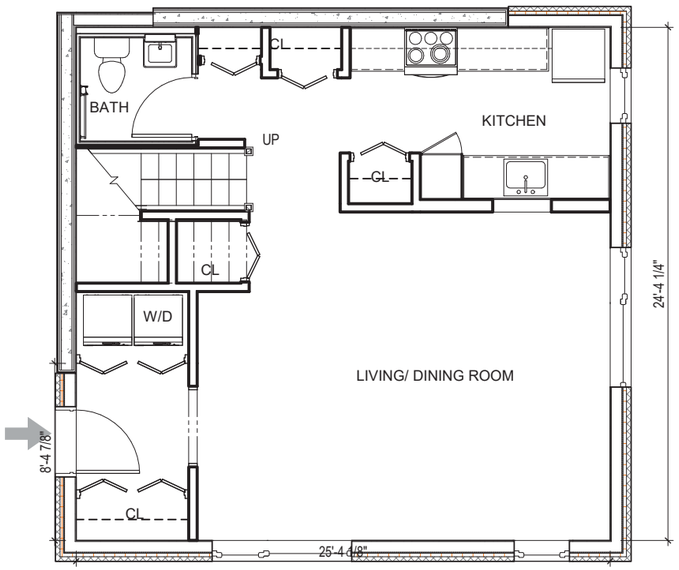
CHA

U314

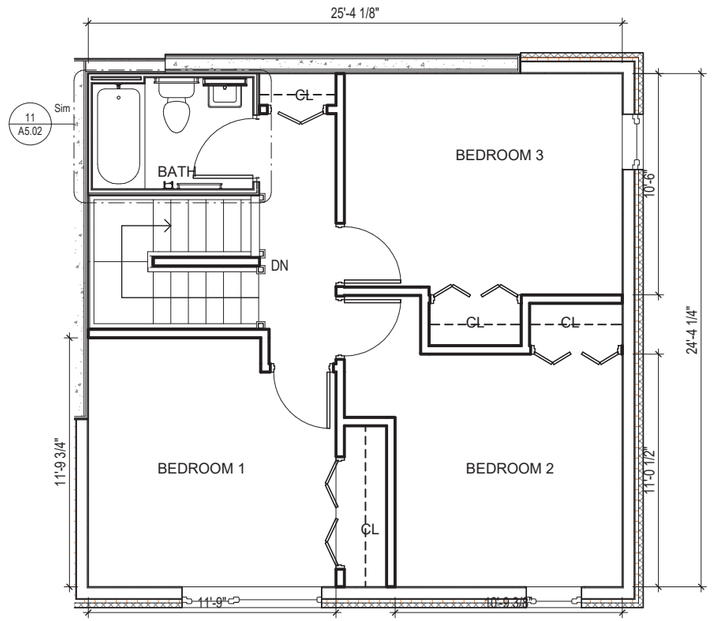
3 BR DUPLEX

808 - 1,690 SF

BLDG 3



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

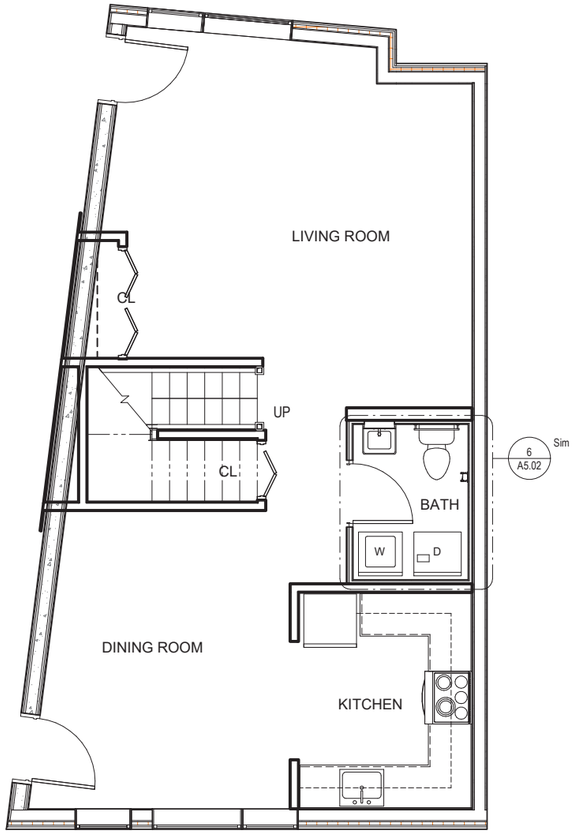
CHA

U315

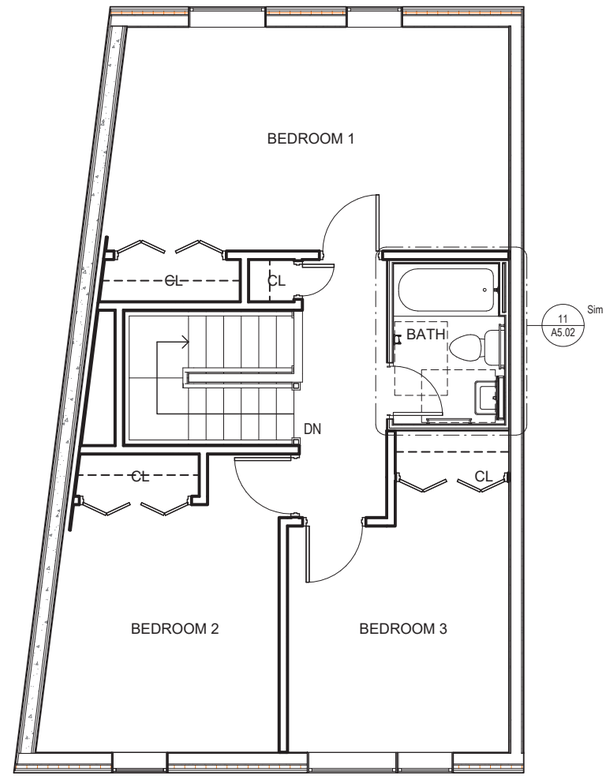
3 BR DUPLEX

1,321 SF

BLDG 1



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

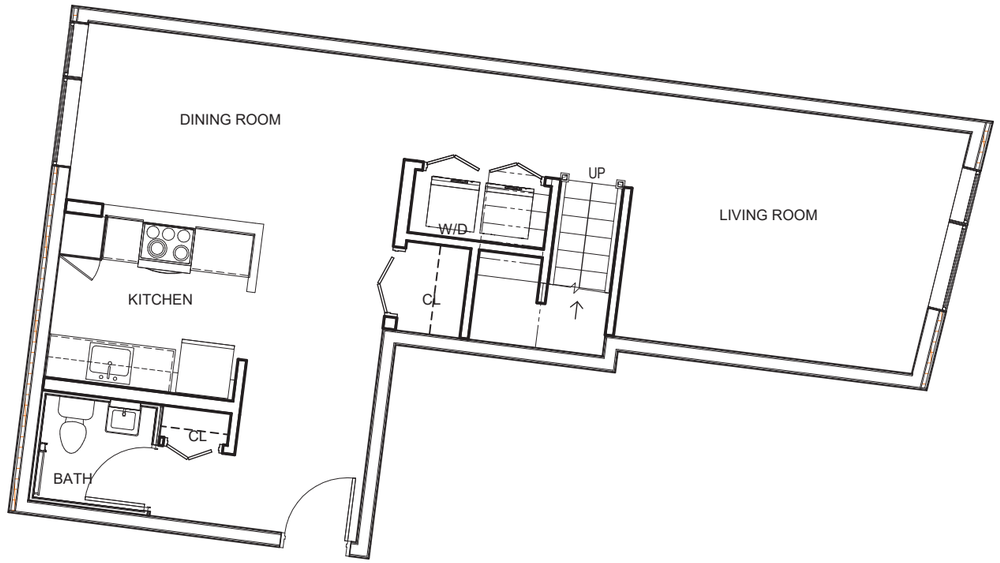
CHA

U316

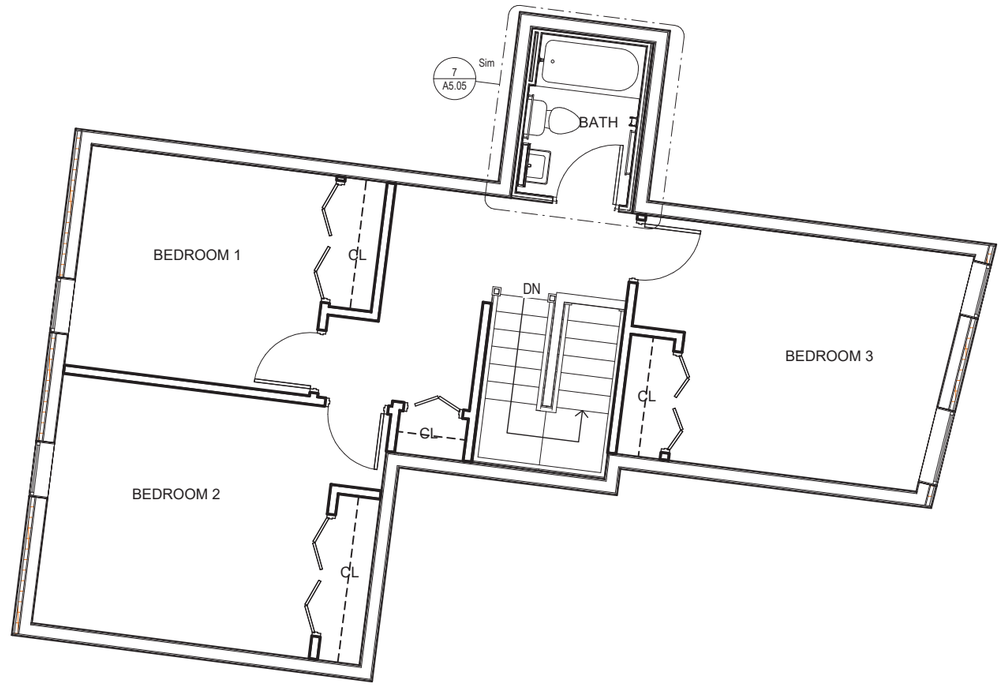
3 BR DUPLEX

1,800 SF

BLDG 1



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

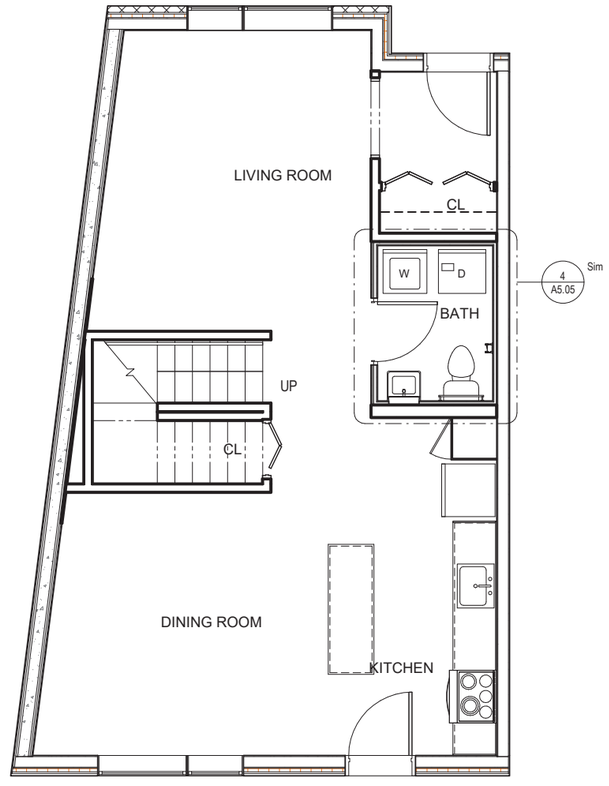
CHA

U317

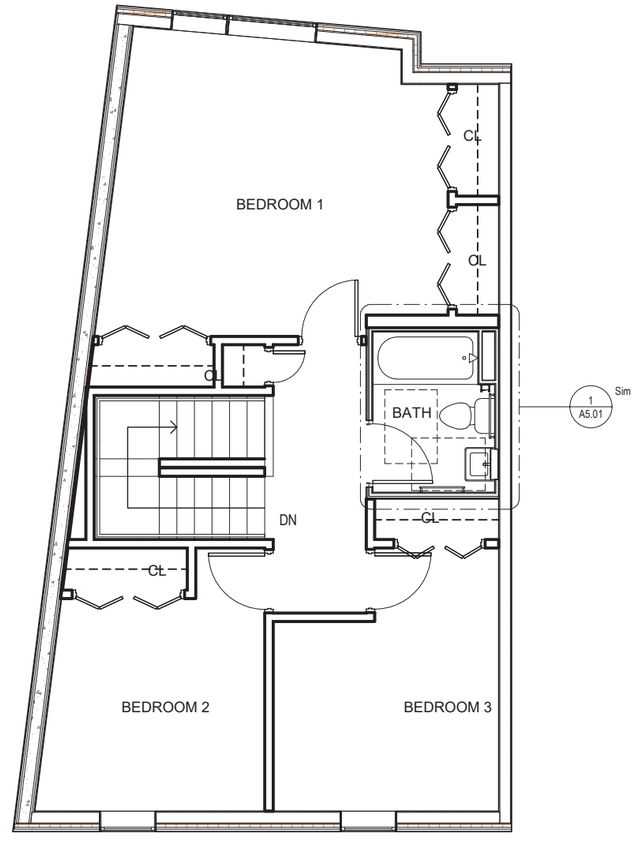
3 BR DUPLEX

1,383 SF

BLDG 1



LEVEL 1



LEVEL 2

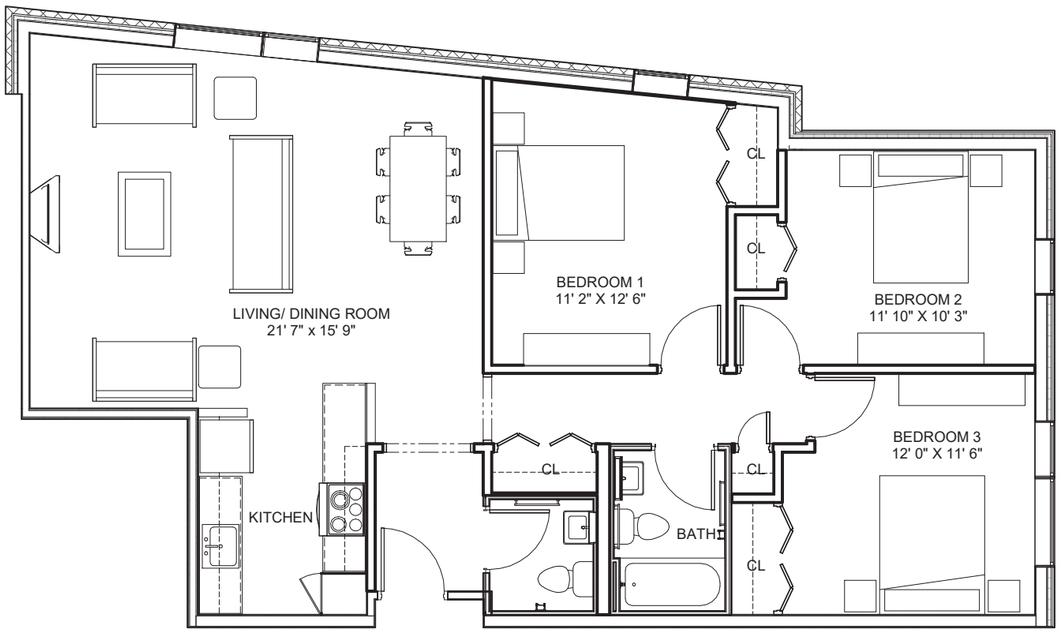
0′ 2′ 4′ 8′

U318

3 BR ADAPTABLE

1,015 SF

BLDG 5



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

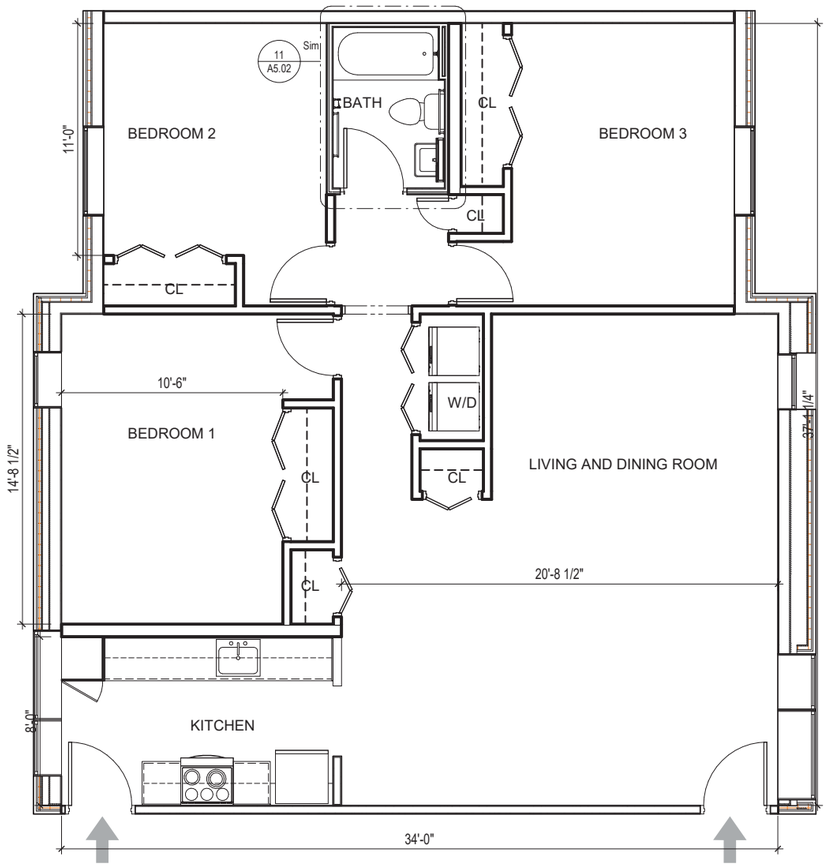
CHA

U319

3 BR FLAT

1,229 SF

BLDG 2



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

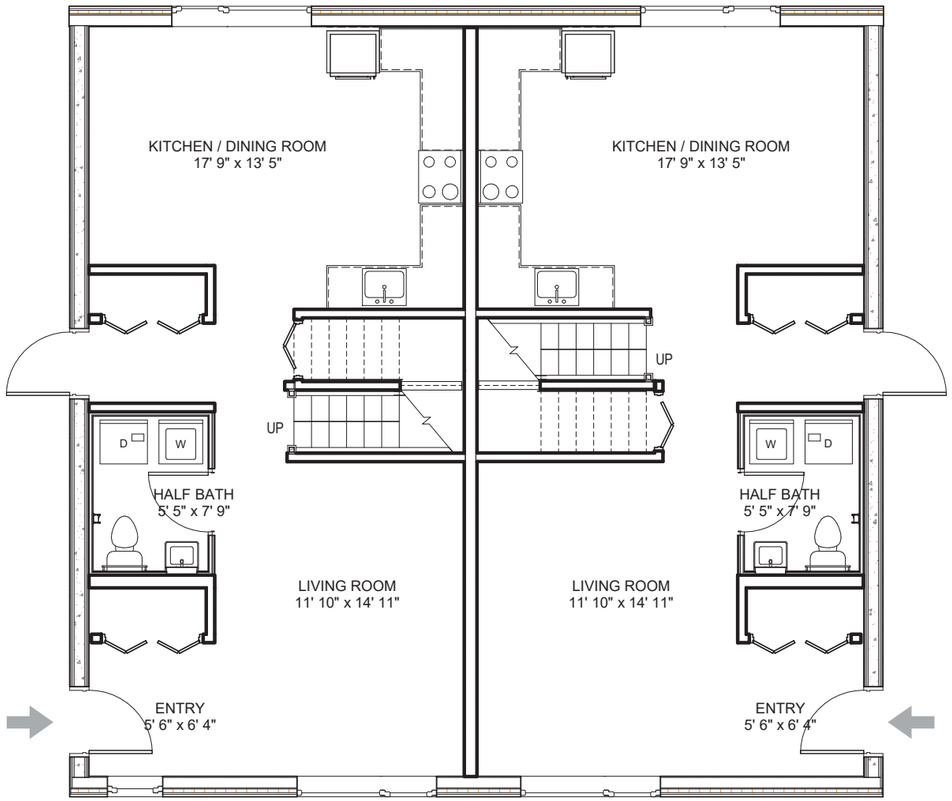
TCHA

U320

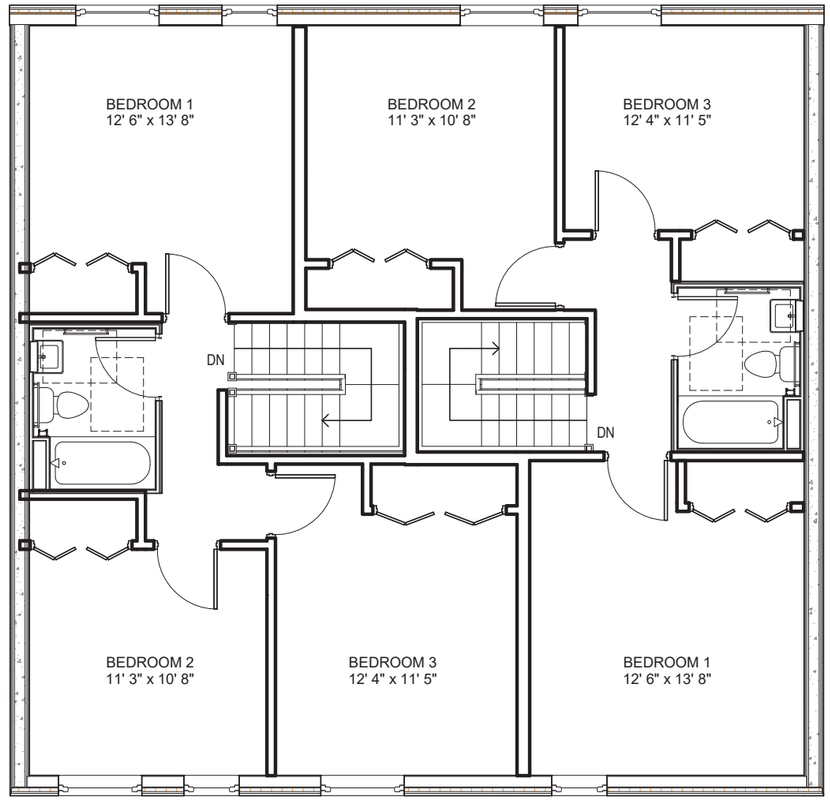
3 BR DUPLEX

1,234 - 1,252 SF

BLDG 1



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

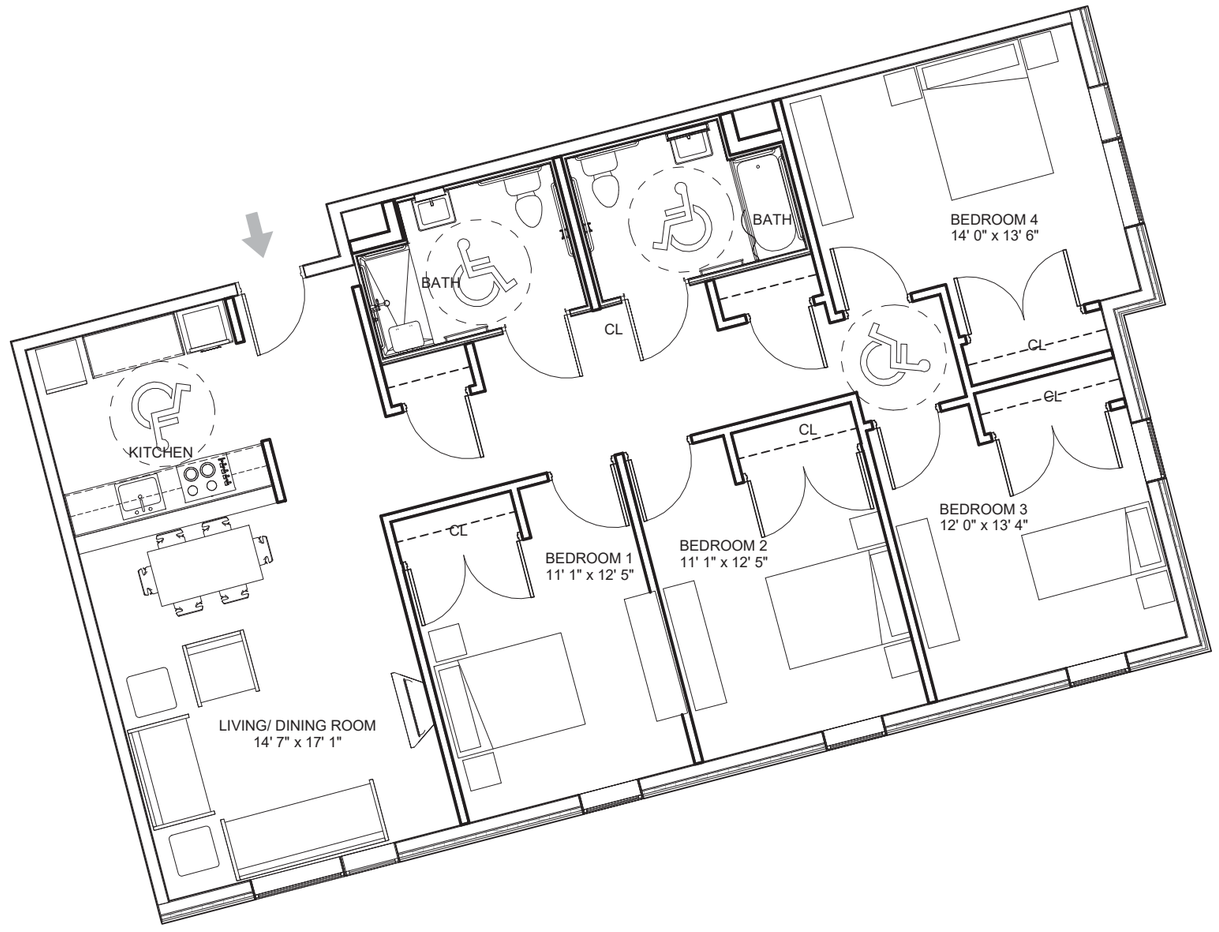
CHA

U401

4 BR ADA FLAT

1,461 - 1,680 SF

BLDG 4



LEVEL 1

0′ 2′ 4′ 8′

BWA ARCHITECTURE

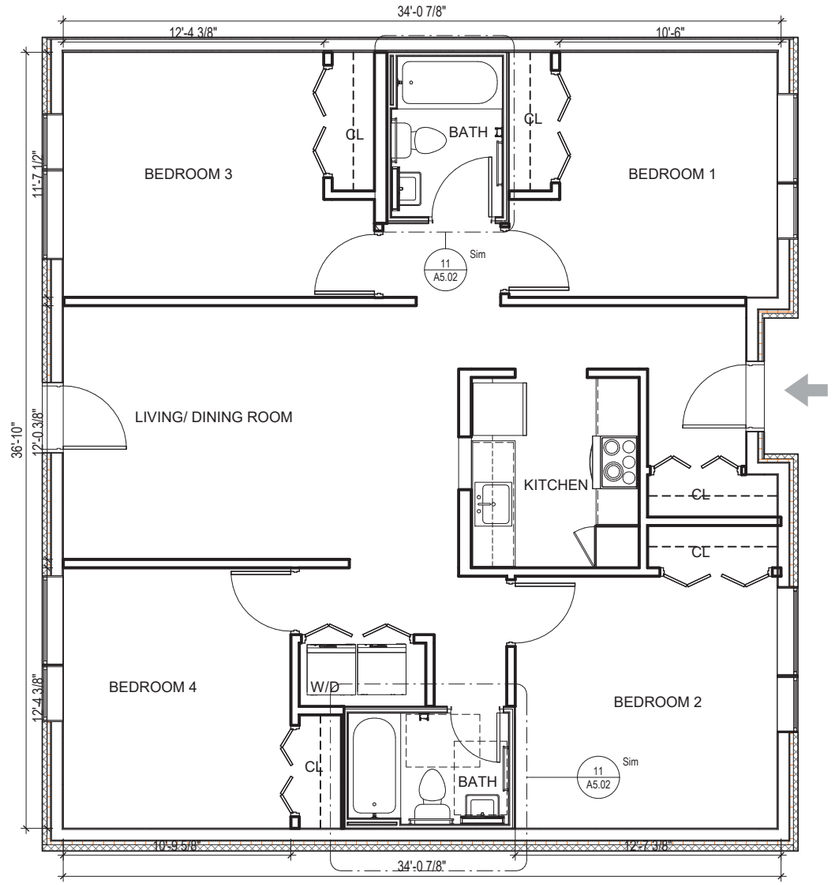
CHA

U402

4 BR ADAPTABLE

1,239 SF

BLDG 2, 3



LEVEL 1

0' 2' 4' 8'

BWA ARCHITECTURE

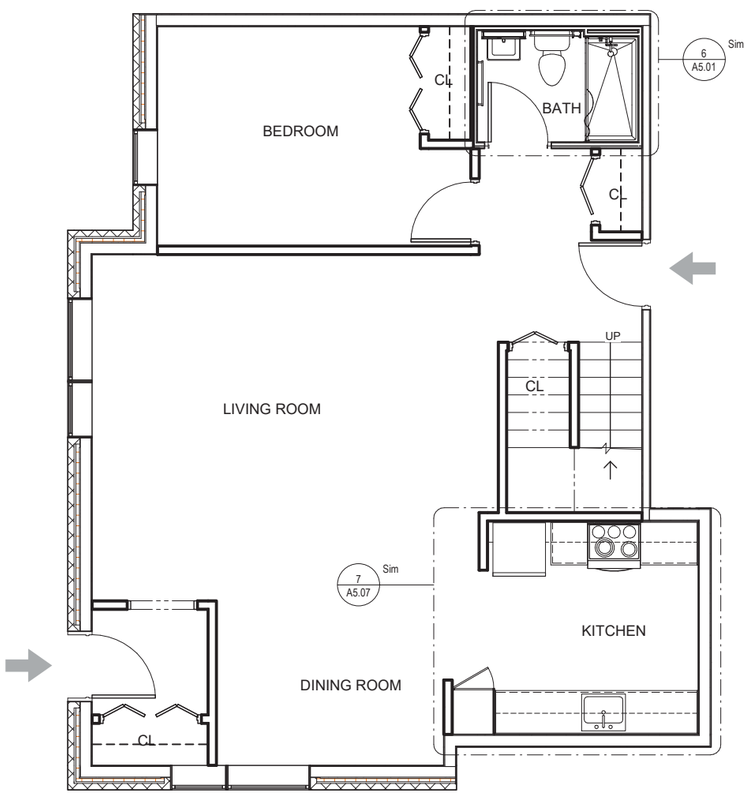
TCHA

U403

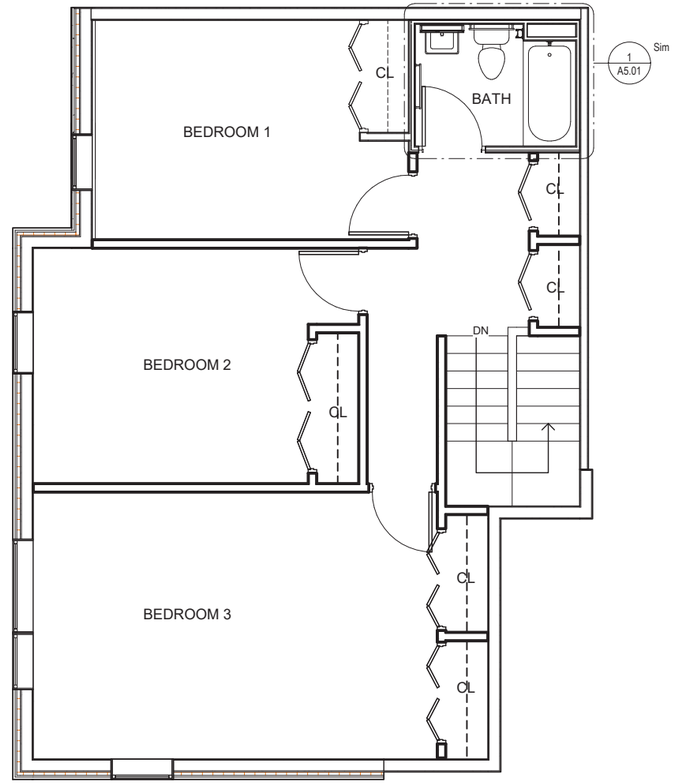
4 BR DUPLEX

1,665 SF

BLDG 4



LEVEL 1



LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

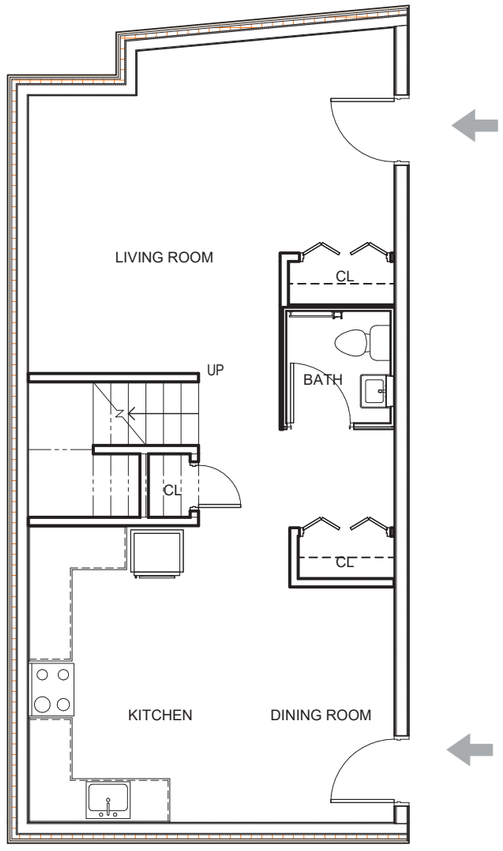
CHA

U404

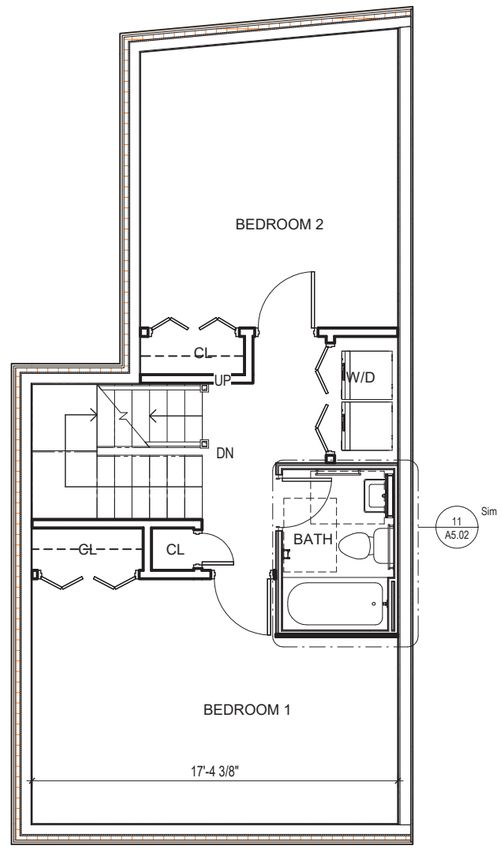
4 BR TRIPLEX

1,782 SF

BLDG 1



LEVEL 1



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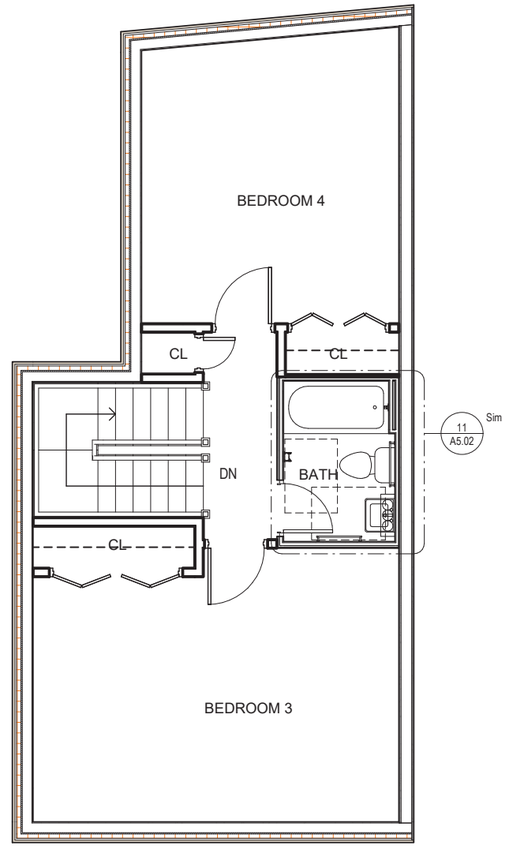


LEVEL 3

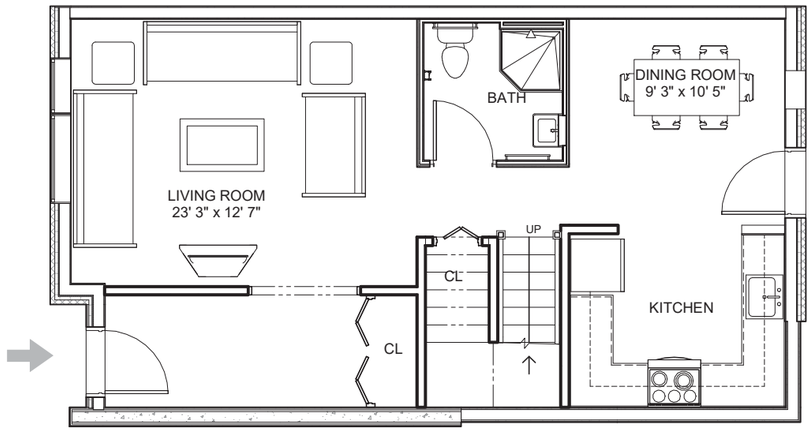
0′ 2′ 4′ 8′

U405

4 BR DUPLEX

1,635 SF

BLDG 2, 3



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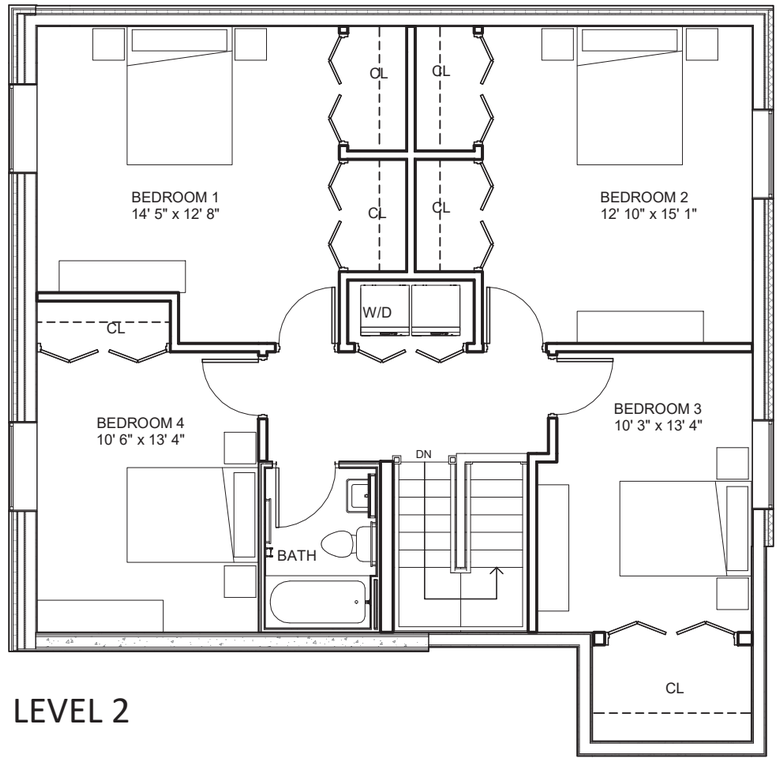


LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

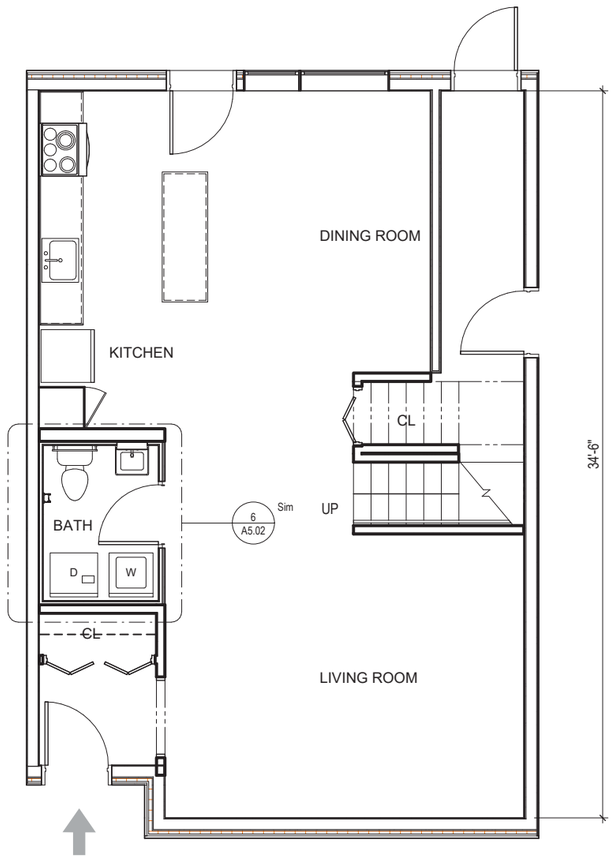
CHA

U406

4 BR DUPLEX

1,506 - 1,601 SF

BLDG 1



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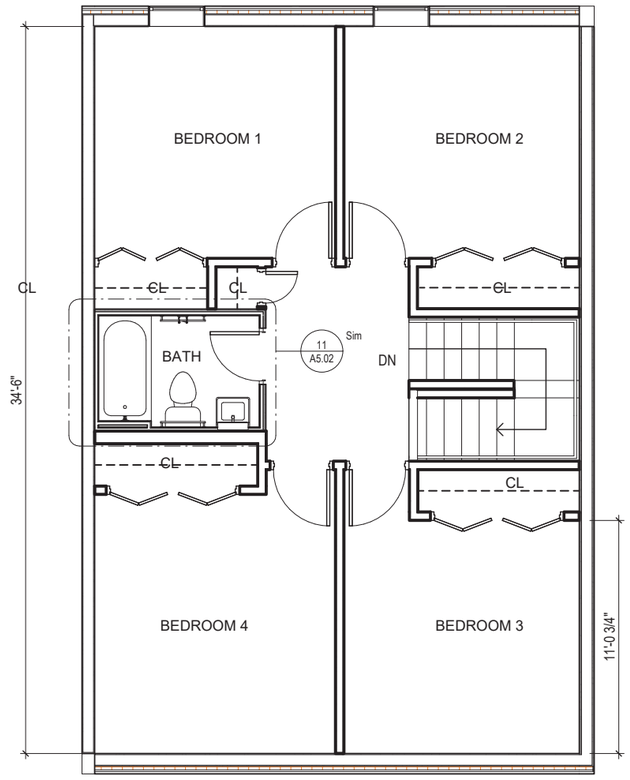


LEVEL 2

0' 2' 4' 8'

BWA ARCHITECTURE

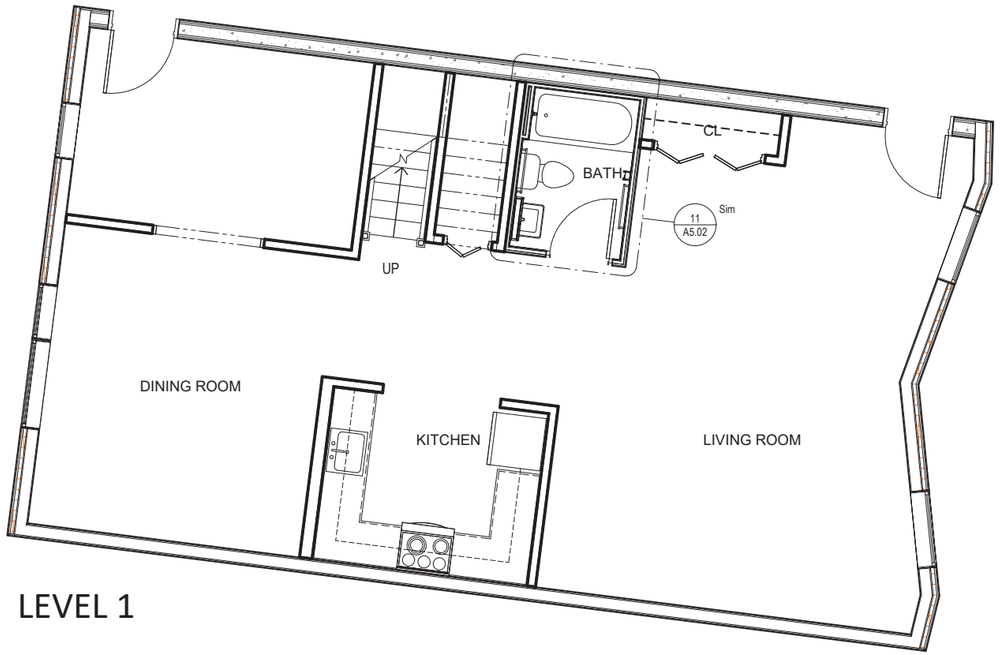
TCHA

U407

4 BR DUPLEX

1,387 SF

BLDG 1



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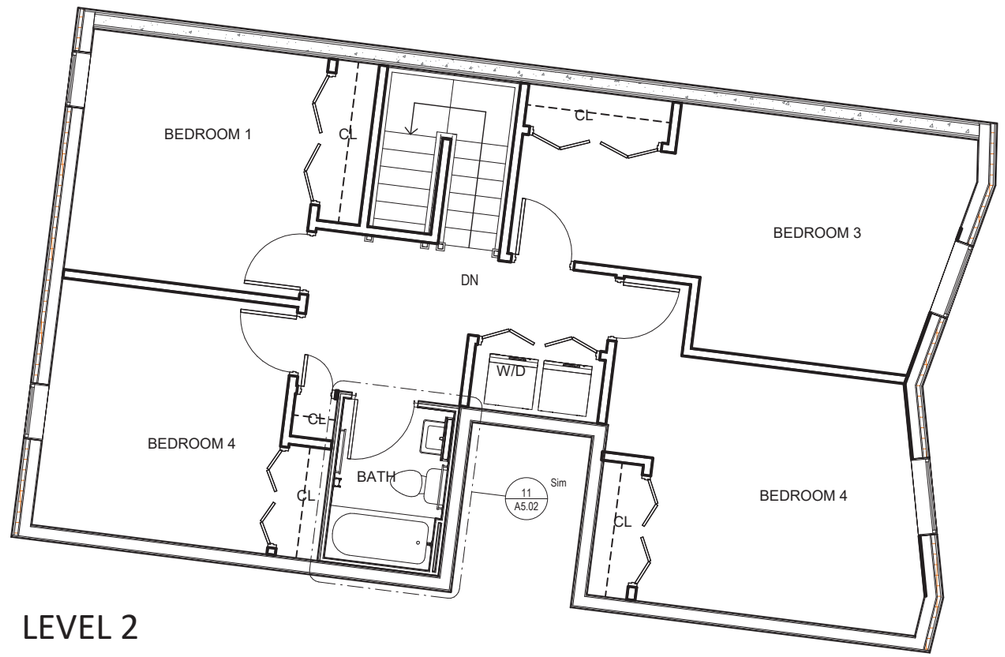

LEVEL 2

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BWA ARCHITECTURE

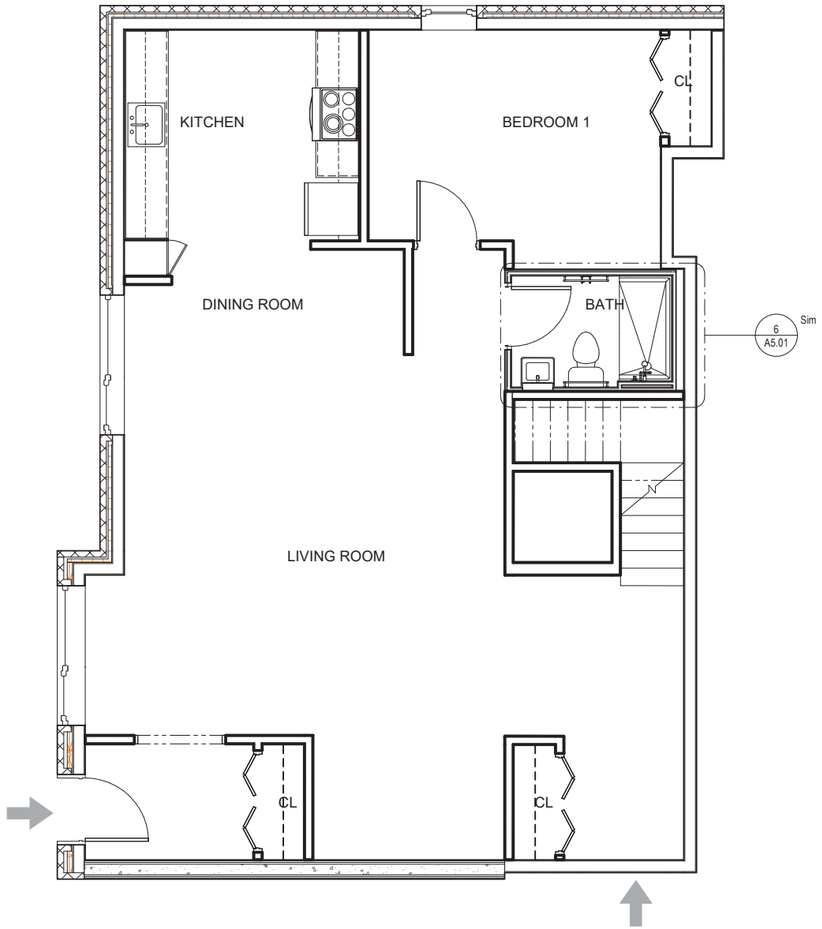
CHA

U501

4 BR DUPLEX

2,079 SF

BLDG 4



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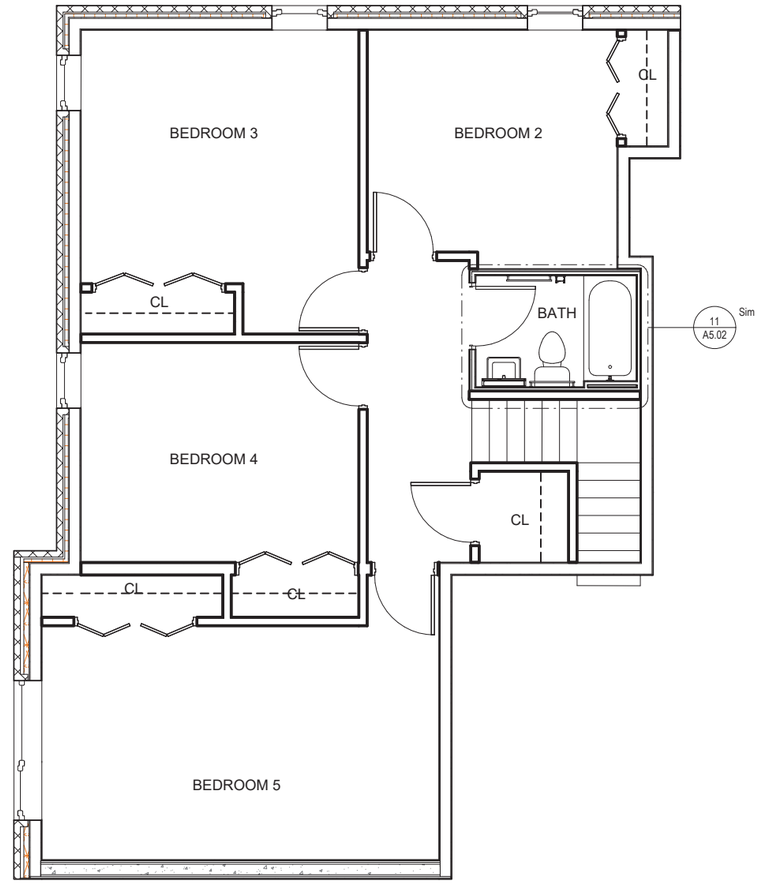


LEVEL 2

0′ 2′ 4′ 8′

BWA ARCHITECTURE

CHA

APPENDIX 3: GREEN BUILDING REPORT

Green Building Requirements

278 Rindge Avenue Green Building Report – Comments on AHO Review Stage

Status: Pursuant to Section 22.25.1 of the Zoning Ordinance, the Community Development Department (CDD) received the GBR for the Special Permit stage of 278 Rindge Avenue (also known as Jackson Place (JP) Federal Redevelopment) on 8/16/2021. The proposed multi-family residential project encompassed eight (8) buildings on a previously developed site for the Cambridge Housing Authority (CHA).

CDD staff have reviewed the project's GBR and offer the following Determination, Summary of Compliance and Advisory Comments on the project's sustainability.

CDD Determination: The documentation provided by the Applicant sufficiently demonstrates compliance with the Green Building Requirements applicable to the AHO review stage. However, a revised submission with additional documentation or clarification maybe required at the building permit and Certificate of Occupancy stage.

Project Summary: 278 Rindge Avenue is subject to the City's Green Building Requirements (Section 22.20, Zoning Ordinance). The project is currently meeting the minimum requirements for PHIUS+ Core rating system and pursuing Passive House certification. The Green Building Report for this project is complete and meets Article 22 requirements. The project is seeking PHIUS certification.

Summary of Compliance

Green Building Professional Certification

Henry Harvey of New Ecology, Inc. has been identified as the Green Building Professional for the project with a copy of the professional's credential from Green Building Rating Program. The affidavit states that this professional has reviewed all relevant documents for this project and confirm to the best of his/her knowledge that those documents indicate that the project is being designed to meet the requirements of Section 22.24 under Article 22.20 of the Cambridge Zoning Ordinance.

Rating System

The proposed project will demonstrate compliance to meet the requirements of Section 22.24 under Article 22.20 and adopting the following rating, testing, modeling, and performance standards:

- Rating System: PHIUS+ Core Residential (2018).
- Air Infiltration Testing including per RESNET procedures.
- Air Infiltration Inspection Thermal Bridging testing including using thermal imaging inspection.
- EPA Indoor air PLUS checklist.
- HVAC and building envelop inspections by site visits to observe the required testing and HVAC system balancing per PHIUS.

Advisory Comments:

Staff appreciate the Project team in using the Enterprise Green Communities (EGC) Certification Plus (in addition to using PHIUS certification). With regards to EGC, staff also encourage continuing to pursue optional points that include resilient communities (i.e., cultural resilience), active and healing centered-design approaches for the project (design development) as well as maximizing energy-efficient design metrics as the project moves through design development and construction documents phase.

Embodied carbon is important to the city's climate action plan and net zero goals. The Planning Board looks at the sustainability merits and qualities of all building types/uses (residentials and non-residential, affordable or market-rate). Currently, although 'Emissions Accounting' petition is not a zoning requirement for either residential or commercial, staff do provide comments and advisory recommendations to the Planning Board on embodied carbon attributes of all projects. For that reason, staff recommend using construction materials life cycle open-source LCA assessment tools including Tally, EC3 and other appropriate tools to demonstrate the Project team's commitment to reducing embodied carbon in the process of selecting alternatives in materials, products, or systems.

Information about selected materials' attributes and relevant environmental qualities i.e., Environmental Product Declarations (EPDs) will also be requested from the Architect in the next phases regardless of the rating system used.

Staff recommend the Project team continues to explore building/site areas for potential additional solar arrays that could overhang over roof-top mechanical equipment or as free-standing canopies where feasible.

The project will be subject to review prior to receiving Building Permit and Certificate of Occupancy. CDD Staff look forward to receiving updates including on the annual expected CO2 emissions, annual energy consumption as well as information on building materials and resources.

JP FEDERAL REDEVELOPMENT
Article 22 Special Permit Submission

278 Rindge Avenue
Cambridge, MA
June 9, 2021

Submitted to
Cambridge Community Development Department
344 Broadway
Cambridge, MA 02139

Prepared by
New Ecology, Inc.
15 Court Square Suite 420
Boston, MA 02108

City of Cambridge
Community Development Department
344 Broadway
Cambridge, MA 02139

To the members of Cambridge CDD,

The Revitalization of Jackson Place (the Project) team is excited to share the current building sustainability and resilience features for the highly efficient, 100% affordable multifamily development. Currently in schematic design, the project is targeting Passive House certification following PHIUS+ 2018 Core guidelines. Jackson Place is designed for resilience and incorporates a number of sustainable features including all-electric heating and cooling systems.

Included in this Special Permit submission package are the Rating System Narrative, Net Zero Narrative, Green Building Checklist, Green Building Professional Affidavit, and WUFI modeling summary reports and detailed results. The Net Zero Narrative provides detailed information on the Project's building envelope and mechanical systems performance, as well as current WUFI energy model outputs and an outlined pathway to a Net Zero building. Included in the Net Zero Narrative is also a Lifecycle Cost Analysis (LCCA) of both the proposed and net zero designs. The Rating System Narrative outlines the building performance requirements to achieve PHIUS+ 2018 Core certification.

As part of the PHIUS requirements, the project will also earn the EPA Indoor airPLUS, ENERGY STAR Multifamily New Construction, and DOE Zero Energy Ready Homes (ZERH) certifications. The EPA Indoor airPLUS certification program focuses on high quality indoor air and low or no emissions from building materials (low/no VOCs). The project will include MERV 13 filters to maintain indoor air quality. In addition to these certification requirements, this project will follow all Massachusetts Department of Housing and Community Development (DHCD) design requirements. The project team expects Jackson Place to earn full certification with the PHIUS+ 2018 Core program. Construction is expected to begin in the spring of 2022.

The final project will result in an exceptionally high-performance structures demonstrating a careful focus on envelope performance, including low air infiltration rates, a well-insulated envelope, and high indoor air quality with continuous energy recovery ventilation.

The project team looks forward to creating an affordable, resilient and high-performance building with a focus on occupant comfort and high indoor air quality.

Sincerely,

Kelsey Powers
New Ecology, Inc.

Table of Contents

NET ZERO NARRATIVE

Project Profile

Table 1: Development Characteristics			
Lot area (sf)	330,505		
Existing land use(s) and GFA by use	Residential, GFA = 263,231 sf		
Proposed land use(s)	Residential, GFA = 379,925 sf		
Proposed building height(s) (ft and stories)	4 stories/42'-4" (Bldgs. 1,2,3,4,5,6,8) 4 stories/45'-0" (Bldg. 7)		
Proposed dwelling units	277		
Proposed open space (sf)	110,194 sf		
Proposed parking spaces	125		
Proposed bicycle parking (long- and short-term spaces)	286 long-term, 30 short-term		
Rating system & version	PHIUS+ 2018	Seeking certification?	Yes

Proposed Project Design Characteristics

Table 3: Building Envelope Assembly Descriptions	
Roof	PVC roofing membrane 5/8” coverboard Tapered polyisocyanurate insulation (slope to drain), R-52 average 4” base layer rigid insulation Vapor barrier GWB Steel deck roof sheathing
Foundation	5” concrete slab 2” XPS insulation, R-10 below entire slab 9” crushed stone capillary break below vapor barrier
Exterior walls	Fiber cement, metal panel, etc. on fiberglass Z-furring 2” polyisocyanurate insulation, c.i. Sheet-applied AWB 5/8” sheathing 2x6 metal framing with fiberglass batt insulation in cavity Interior finish
Windows	Fiberglass composite casement, awning, fixed, U-0.15, SHGC 0.30
Window-to-wall ratio	19.25% (*average across all buildings*)

Table 4: Building Envelope Performance							
		Window		Wall		Roof	
		Area (sf)	*U-value*	*Area (sf)*	*U-value*	*Area (sf)*	*U-value*
Building 1	*Baseline*	8,388.8	0.38	27,310	R-20+ R-3.8 c.i.	15,756	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 2	*Baseline*	3,056	0.38	16,437	R-20+ R-3.8 c.i.	7,604	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 3	*Baseline*	6,169	0.38	22,791	R-20+ R-3.8 c.i.	11,399	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 4	*Baseline*	6,169	0.38	22,791	R-20+ R-3.8 c.i.	11,399	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 5	*Baseline*	3,056	0.38	16,437	R-20+ R-3.8 c.i.	7,604	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 6	*Baseline*	6,372	0.38	30,988	R-20+ R-3.8 c.i.	18,167	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 7	*Baseline*	5,741	0.38	25,016	R-20+ R-3.8 c.i.	13,761	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019
Building 8	*Baseline*	6,444	0.38	28,073	R-20+ R-3.8 c.i.	16,076	0.032
	Proposed		0.15		R-25+ R-12 c.i.		0.019

Envelope Commissioning Process

The Project team plans to test and verify the envelope air barrier and air infiltration rates using bi-directional blower door testing both at construction midpoint and again after construction completion. Two (2) inspections will be performed after framing and air-sealing are complete but before insulation is installed, in order to identify any potential areas of thermal bridging and/or air infiltration. These inspections will be documented with site photos. Once installed, the air barrier will be tested with a bi-directional whole building blower door test conducted to PHIUS+ CORE standards. At the end of construction, the whole building blower door test will be repeated to confirm air-tightness, and 54 units will be blower door tested for air infiltration rates per RESNET sampling protocols. In addition, a two-hour inspection using a thermal imaging camera will be conducted to show compliance with thermal bridging and air sealing protocols.

Building Mechanical Systems

Table 5: Building Mechanical Systems Description	
Space heating & cooling	Air-source heat pump VRF system
Heat rejection	*See above system*
Pumps & auxiliary	*See above system*
Ventilation	Central ERVs
Domestic hot water	Gas-fired DHW tanks
Interior lighting	LEDs in-unit; LEDs in common area with occupancy sensors
Exterior lighting	LEDs with photocell controls

Mechanical Systems Commissioning Process

The project will retain a licensed commissioning agent (CxA) who will develop a detailed commissioning plan based on the building specifications and systems. The CxA will develop a functional performance test sheet for each system to be commissioned, and will commission the following systems: Mechanical systems and equipment including Energy Recovery Ventilation (ERV) systems, air source heat pumps VRF systems, and all direct digital controls. For lighting systems, all common space lighting control systems including occupancy sensors will be commissioned and sampled at the appropriate rate. For plumbing systems, the domestic hot water heating system including central boiler plant, storage tanks, circulating pumps, thermostatic mixing valves, and controls will be sampled at the appropriate rate.

Building Energy Performance Measures

Table 6: Building Energy Performance Measures	
Land uses	Housing development promoting walking and bicycling, located near multiple public transit modes (e.g., bus, subway), grocery stores, schools, daycare centers, and parks. Bicycle storage and parking provided on site.
Building orientation and massing	Majority floor-through units to allow passive ventilation.
Envelope systems	Continuous exterior insulation, high performance glazing, sun shading, and white roofs.
Mechanical systems	ERVs for ventilation and ASHP VRF for space heating and cooling.
Renewable energy systems	The project team is currently exploring potential PV system options.
District-wide energy systems	NA

Integrative Design Process

As part of the integrative design process, the developer, architect, and mechanical engineer will participate in an early-stage MEP- and envelope-focused green charrette, led by New Ecology. The charrette will be an early stage integrated design meeting with the design/development team to review preliminary design concepts and to define a comprehensive greening strategy that meets City of Cambridge Article 22, Stretch Energy Code, and PHIUS+ 2018 requirements. Several preliminary integrative design meetings have taken place with the project team to discuss the design and construction process and to develop consensus on building systems and design that is consistent with PHIUS Passive House requirements.

Green Building Incentive Program Assistance

The project plans to offset the costs of an energy efficient building envelope and electric heating and cooling system cost by utilizing all available rebate programs. The project will enroll in the MassSave Passive House incentive program, and expects to use the Passive House Feasibility incentives from this program to offset the costs of energy modeling to meet Passive House standards. The project team plans to fully certify the building in order to be eligible for the full incentive package offered by MassSave.

Net Zero Scenario Transition

Table 7: Net Zero Scenario Transition		
	Net Zero Condition	Transition Process
Building envelope	The building envelope will be built to PHIUS Passive House standards, making it an ideal structure to achieve Net Zero. The envelope will be well-insulated and have a low level of air infiltration which will be tested and verified at construction.	This system will be a zero (site) emissions system at installation.
HVAC Systems	An ASHP VRF centralized system will be included at construction. Central energy recovery ventilation will be used to capture energy from the ventilation system and will be installed at construction.	ERVs and ASHP VRF in current design will be a zero emissions system at installation.
Domestic Hot Water	Lochnivar Shield gas-fired water heaters will be included at construction. Mechanical rooms will be electric-ready with electric panels upsized for future heat pump installation and conduits to the roof for future lines between condensers and tanks.	At the end of the system lifetime, the project team expects the all-electric DHW system technology to have advanced sufficiently to allow for conversion of this system to all-electric.

Lighting	The project will use LED lighting throughout at construction. The building energy model for this project, to be completed using WUFI modeling software for use in Passive House projects, will factor in and measure Lighting Power Density as a calculation in overall building energy consumption. Fixtures will be modeled and will be specified in project documents to meet or exceed the energy requirement of the WUFI model.	The building and management team will include updated technology as it is available and will update systems at the end of service life of the lighting systems.
Renewable Energy Systems	The project will be solar-ready at construction.	The project will be solar-ready per ZERH requirements and will include PV panels as necessary to meet PH requirements at time of construction.
Other Strategies	The project is actively considering and modeling the use of window shading to reduce building energy consumption during summer months, while also allowing solar thermal gains during winter months.	

Energy Systems Comparison

New Ecology, Inc. (NEI) performed a lifecycle cost analysis (LCCA) to evaluate the financial feasibility of a net zero design option for the eight (8) buildings of the Jackson Place Federal Redevelopment project. Operational and performance costs were estimated using the results of previous WUFI modeling completed on an earlier design. Using a per-square-foot cost estimate and typical maintenance costs provided by Norian/Siani Engineering (NSE) and NEI, the NEI team completed the following analysis using the updated gross floor area of the current proposed design.

The LCCA demonstrates the following results:

- The NZ scenario achieves significantly reduced energy consumption and greenhouse gas emissions via all-electric systems with Passive House envelope.
- The NZ scenario achieves those reductions at cost increases of 5.94% over the proposed design cost.
- The initial capital cost has the most significant impact on the overall total lifecycle net present value over a 25-year term.

Table 8: Total LCCA (NPV) of Propose and NZ Scenario

Scenario	Description	Total Lifecycle (NPV)	Increase in Total Lifecycle (NPV) from Proposed	% Increase of Total Lifecycle (NPV) from Proposed
Proposed	ASHP VRF Gas fired water heater Central ERV Passive House envelope	$178,154,710	-	-
NZ Scenario	Ground-source heat pump Ground-source high-performance water heater High-performance ERV Passive House envelope	$188,728,375	$10,573,665	5.94%

Assumptions

Table 9: Energy Systems Included/Excluded in Analysis			
	Included in Analysis?		Describe systems analyzed or explain why it was excluded from analysis
	Yes	No	
Solar photovoltaics		X	PV is assumed to be included in design, but will be PPA.
Solar hot water heater		X	In combination with potential PV solar panels, there is not enough space on the roofs to justify both technologies.
Ground-source heat pumps	X		High-efficiency geothermal well and closed loop.
Water-source heat pumps		X	Focus was on GSHP as more efficient option.
Air-source heat pumps		X	High-efficiency ASHP VRF to be included in design.
Non-carbon fuel district energy		X	Not feasible with systems to be included in design.
Other non-carbon fuel systems	X		Purchase of carbon offsets included.

NEI used the global assumptions shown in the table below when performing the LCCA.

Table 10: LCCA Global Assumptions	
Variable	Assumption
Lifecycle term	25 years
Inflation rate	3%
Nominal discount rate	4.5%
Effective discount rate	4%
Nominal utility escalation rate	4%
Effective utility escalation rate	1%
Project gross floor area (GFA)	379,925
Residential unit count	277
Electricity rate ($/kWh)	$ 0.18/kWh
Natural gas rate ($/therm)	$ 0.89/therm

Methodology

NEI completed the LCCA using the following information, and in accordance with ASTM Standard E917-17 "Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems" methodology.

- Costs have been updated to reflect 2021 costs
- Maintenance cost estimates based on:
    - Input from engineers outlining maintenance costs for associated systems
    - NEI project experience and ASHRAE guidelines
- Expected Useful Life (EUL) for each system type is based on ASHRAE Handbook of Fundamentals: Comparison of Service Life Estimates.
- Annual utility cost and consumption estimates were derived from current utility rates and WUFI energy modeling software.
- Residential High-Rise New Construction for Multifamily Buildings incentives are based on program guidelines supplied by MassSave program[1].
- Passive House incentives are based on program guidelines supplied by MassSave Program[2].
- Alternative Energy Credit values are based on information supplied by Massachusetts Department of Energy Resources for air source heat pumps[3] and ground source heat pumps[4].

Non-Carbon Fuel Scenario

A non-carbon, all-electric scenario was examined through the LCCA. The table below provides descriptions of the Proposed and NZ scenarios.

Table 11: LCCA Scenario Description by Key Components *(All Buildings)*

Scenario	Proposed	NZ Scenario
Heating & cooling	ASHP VRF	GSHP
Ventilation	Central ERV	High-performance ERV
DHW	Central gas	GSHP
Envelope	PH (2.5")	Baseline (2.5")
Window	PH (U-0.15)	PH (U-0.15)
Carbon offsets	No	Yes
Co-gen	No	No

[1] https://www.masssave.com/en/saving/residential-rebates/multi-family-high-rise-new-construction/
[2] https://www.masssave.com/en/saving/residential-rebates/passive-house-incentives
[3] https://www.mass.gov/service-details/qualifying-air-source-heat-pump-in-the-aps
[4] https://www.mass.gov/service-details/qualifying-ground-source-heat-pump-in-the-aps

Solar-Ready Roof Assessment

Table 12: Solar-Ready Roof Assessment	
Total roof area (sf)	95,450 sf
Total PV surface area (sf)	32,420 sf
Usable space ratio	34%
Structural support	Self-ballasted
Electrical infrastructure	(6) SolarEdge SE55K, 55 kW + (3) SolarEdge SE 100K, 100 kW inverters
Other roof appurtenances	Mechanical equipment, stair and elevator overheads
Capacity of solar array	630 kW AC
Annual production	862.8
Financial incentives	US Federal Tax Credit of 26% initial cost issued in year 1 + MA SMART incentive of $0.099 per kWh produced until year 20
Cost feasibility	Estimated $2.50/W; installed cost = $1.53M

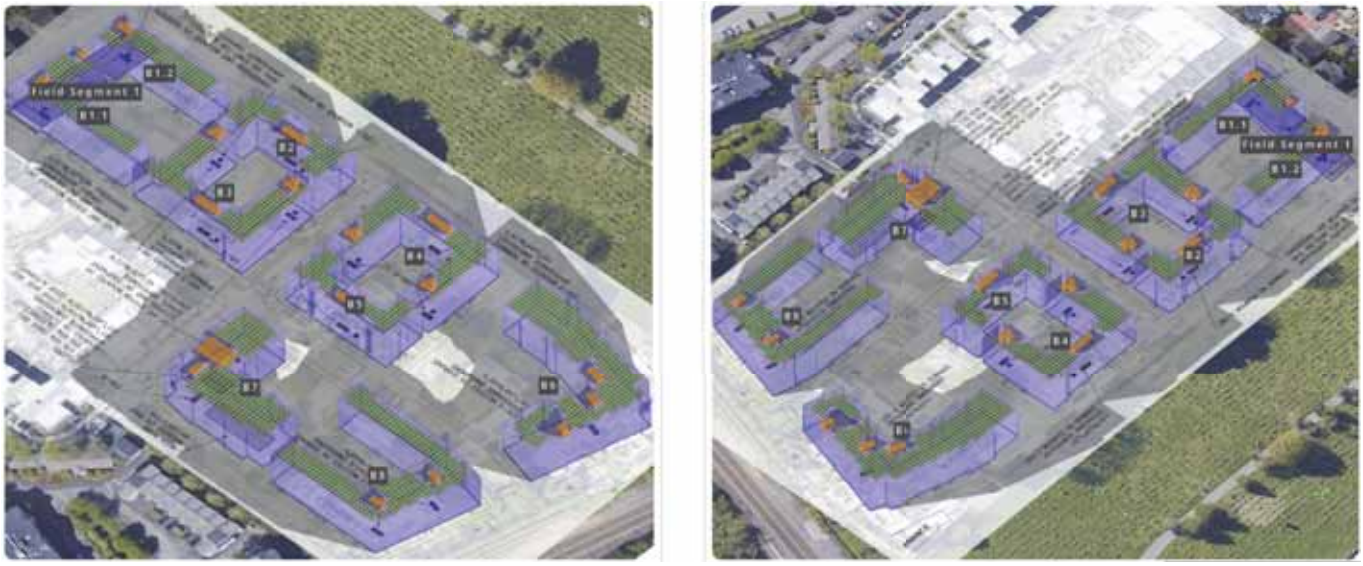


Figure 1: Detailed layout generated using Helioscope PV system planning tool. PV arrays were designed to maximize available solar-ready roof spaces.

Anticipated Energy Loads and GHG Emissions

Assumptions

The project will pursue Passive House certification and utilize WUFI energy modeling to demonstrate energy loads and energy use. The anticipated baseline building (ASHRAE 90.1-2013) energy use is indicated in the table below. Building heating and cooling loads, hot water heating load, lighting in units and common spaces, appliance and plug loads as well as miscellaneous system loads were included in this preliminary energy model.

Table 13: Anticipated Proposed and Baseline Building Energy Use

		Site EUI (kBtu/yr./sf)	Source EUI (kBtu/yr./sf)
Building 1	*Baseline*	30.7	41.2
	Proposed	18.1	28.91
	Net Zero	14.4	-
Building 2	*Baseline*	32.5	45.6
	Proposed	19.15	29.92
	Net Zero	14.6	-
Building 3	*Baseline*	32.2	44.3
	Proposed	18.95	29.89
	Net Zero	14.7	-
Building 4	*Baseline*	32.2	44.3
	Proposed	18.95	29.89
	Net Zero	14.7	-
Building 5	*Baseline*	32.5	45.6
	Proposed	19.15	29.89
	Net Zero	14.6	-
Building 6	*Baseline*	31.3	43.3
	Proposed	18.52	29.21
	Net Zero	14.4	-
Building 7	*Baseline*	32.2	43.8
	Proposed	19.02	30.25
	Net Zero	15.0	-
Building 8	*Baseline*	35	48.0
	Proposed	20.67	32.71
	Net Zero	16.1	-

Annual Projected GHG Emissions

The annual expected CO_2 emissions for the proposed building based on the preliminary WUFI energy model are provided in the table below.

Table 16: Annual Expected CO_2 Emissions for Proposed Building			
		CO_2 Emissions in metric tons/year	
		Electricity	Natural Gas
Building 1	*Baseline*	59.6	53.5
	Proposed	62.7	15.9
Building 2	*Baseline*	25.6	29.2
	Proposed	26.9	8.7
Building 3	*Baseline*	40.7	41.9
	Proposed	42.8	12.5
Building 4	*Baseline*	40.7	41.9
	Proposed	42.8	12.5
Building 5	*Baseline*	25.6	29.2
	Proposed	26.9	8.7
Building 6	*Baseline*	74.1	76.5
	Proposed	77.9	22.9
Building 7	*Baseline*	59.2	56.0
	Proposed	62.2	16.8
Building 8	*Baseline*	68.3	68.1
	Proposed	71.8	20.4
TOTAL	Baseline	393.8	396.3
	Proposed	414	118.4

Annual Projected Energy Consumption

WUFI modeling has been completed on all buildings within the Jackson Place project. Summary results and complete model output reports in can be found in *Appendix A* and *Appendix B*, respectively. Due to Buildings 2 and 5, and Buildings 3 and 4 being nearly identical in design, the reports from Building 2 also reflect Building 5 results and Building 3 reports also reflect Building 4 results.

RATING SYSTEM NARRATIVE

Project Description

The Jackson Place Redevelopment project (the Project) complies with the Special Permit application requirements, as defined in Article 22: Sustainable Design and Development ordinance in the City of Cambridge. The Project will be designed and constructed under the guidelines of Passive House Institute U.S. (PHIUS). Each building in the development will meet the design, construction, and testing requirements of the certification program and will be certified as Passive House. All buildings will be certified using PHIUS+ CORE.

The Project is comprised of eight (8) multifamily residential buildings on the Federal portion of a previously developed site located in the Jackson Place Cambridge Housing Authority site in Cambridge.

Integral to PHIUS certification is compliance with Indoor airPLUS certifications. In combination with third-party, RESNET-approved quality assurance and control testing, the building will exceed the Cambridge Green Building Requirements as outlined in Article 22.20. New Ecology will serve at the Project's Passive House Verifier.

PHIUS+ 2018 Rating System Requirements

PHIUS+ CORE OVERVIEW

The Project team will pursue Passive House certification to the standards set by the Passive House Institute US (PHIUS) for their PHIUS+ CORE rating system as well as certifying through the EPA Indoor airPLUS program. The PHIUS+ CORE rating system includes stringent and verified building performance metrics as well as professional testing of the building envelope and air sealing at two stages during building construction. EPA Indoor airPLUS certification includes verification of indoor air quality (IAQ) quality control measures including but not limited to: moisture control, HVAC venting and sealing, and use of low VOC materials in construction. The project team believes that these two ratings systems will result in a highly efficient building which protects occupant health through excellent indoor air quality.

While there is no rating system checklist for PHIUS+ CORE, there is a PHIUS Verifier workbook that will be completed as part of the field verification process as well as an EPA Indoor airPLUS checklist. The metrics measured and inspected by the PHIUS Verifier include:

- Building Envelope Air Infiltration & Compartmentalization
- Ventilation Air Flow Rates
- Heating and Cooling Equipment & Air Filtration Verification
- Domestic Hot Water System Specification Verification
- Appliance Energy Consumption Verification
- Indoor Air Quality Verification using the EPA Indoor airPLUS Verification Checklist

The PHIUS+ CORE rating system includes feasibility modeling to reach specified building performance metrics which are presented below in table format. The PHIUS verification process for the building energy model includes review and comments by a model evaluator from the PHIUS organization. This review of the model examines building assumptions for the envelope and mechanical systems, and is known to be a thorough and rigorous examination of building systems. The project team expects that

the outcome of this modeling and review process, combined with envelope and air infiltration testing, will lead to a very high-performance building with greatly reduced heating and cooling needs as compared with a baseline building.

TECHNICAL AND DESIGN APPROACHES

JP Federal design will follow a performance pathway using WUFI Passive modeling software to guide the material, assemblies, and equipment selection, as required to meet the certification metrics. The information below is an accurate estimation of the design and assumptions made by the design team at this early stage of the process and is likely to change based on the design development. Once complete, the success of the design, construction, and compliance with City of Cambridge Article 22 will be measured by:

- Results of the WUFI Pass energy model during design
- Registration with and precertification by PHIUS (acceptance of the design)
- Performance testing by a PHIUS verifier (New Ecology) and update to energy model based on results
- Certification by PHIUS (acceptance of design and construction)

The Project has implemented the following approaches to comply with Article 22 and PHIUS requirements.

Envelope

- Exterior continuous insulation will be installed with 2" polyiso and dense-pack cellulose cavity insulation to reduce heating and cooling loads of the building
- Sheet applied weather resistive barrier to help meet rigorous infiltration criteria of 0.08 CFM_{50}/ft^2 and to control bulk water and vapor drive
- Roof insulation will be above deck and will have R-value of 52
- Slab-on-grade will be fully-insulated with an R-value of 10
- Windows will be casement-type to further reduce infiltration and will achieve U-value of 0.15, while SHGC and shading devices will be dictated by the modeling requirements
- Solar exposure will be controlled using shading devices, as necessary, and solar gain controlled through glazing
- Project team will review opportunities to eliminate thermal bridging throughout

Heating, Cooling, and Ventilation

- Heating and cooling will be designed to meet efficiency requirements dictated by the energy model and will be provided via and air-source heat pump VRF system
- Domestic hot water will be generated via a central gas-fired system and will be distributed throughout the buildings
- Ventilation will be provided using centralized energy recovery ventilators (ERVs) meeting ASHRAE 62.2-2016 and 62.1-2016 in residential and common/commercial areas, respectively

PHIUS+ CORE-CERTIFIED BUILDINGS REQUIREMENTS

PHIUS sets strict standards for building certification under its PHIUS+ CORE rating system. PHIUS+ CORE sets requirements for building metrics in five areas: heating demand, cooling demand, heating load, cooling load and source energy consumption based on the expected number of residents. These 5 metrics are modeled, measured and verified by PHIUS using WUFI Passive modeling. The Project will be designed to pass in all categories and as the design progresses, the Project team will be sure that the design continues to meet all requirements.

Field-Tested Air-Tightness Standard

A rigorous and field-tested air-tightness standard is also applied to buildings seeking certification. The building envelope is tested twice using blower door testing. The first test is conducted after the installation of the air barrier, and the second at the completion of construction.

The PHIUS Passive House Air Tightness Standard is as follows:

- Residential Units air leakage: 0.30 CFM50 per sq. ft. of unit enclosure area, or less, demonstrated through blower door testing performed by the PHIUS+ Verifier following PHIUS sampling protocols.
- Whole Building air leakage: 0.08 CFM50 per sq. ft. of building enclosure area, or less, demonstrated through a blower door test performed by the PHIUS+ Verifier.

Field Inspections During Construction

A credentialed PHIUS+ Verifier will inspect, document and confirm the following features of the building envelope and building performance:

- Air Infiltration Testing: Blower door testing will be done at project mid-point for the whole building and at project completion for both the units (sampled per RESNET protocols) and the whole building in order to ensure compliance with the requirements outlined above.
- Thermal Bridging and Air Infiltration Inspection: The project will be inspected after framing, but before insulation installation to inspect construction and identify potential areas of thermal bridging and air infiltration.
- Thermal Bridging Inspection: Thermal imaging inspection with an infrared camera to review and show compliance with thermal bridging and air sealing protocols.
- EPA Indoor airPLUS Review: Review of compliance and documentation.
- HVAC Review: Review of the HVAC functional test checklist, and four (4) site visits to observe testing and balancing of the HVAC systems as required by PHIUS.

EPA INDOOR airPLUS-CERTIFIED BUILDINGS REQUIREMENTS

The EPA Indoor airPLUS certification is a checklist-based set of requirements focusing on building techniques that improve indoor air quality both through the construction process and throughout the lifetime of the building. Requirements are mainly focused on using low VOC materials, using proper procedures when building ductwork and systems, and following building procedures to prevent future water damage and/or mold growth. The EPA Indoor airPLUS certification is integral to the PHIUS+ CORE certification, and it will be independently reviewed and verified by a qualified reviewer.

The EPA Indoor airPLUS checklist requirements are assembled into the following categories: moisture control, radon, pests, HVAC systems, combustion pollutants, materials and final (inspection). The program requirements are outlined in the EPA Indoor airPLUS Construction Specifications Version 1 (Rev 04) and are summarized below. All requirements will be verified and confirmed by the qualified verifier and/or builder.

- Moisture Control
    - Drain or sump pump installed in basements and crawlspaces. In EPA Radon Zone 1, check valve also installed.
    - Layer of aggregate or sand (4 in.) with geotextile matting installed below slabs AND radon techniques used in EPA Radon Zone 1.
    - Basements/crawlspaces insulated, sealed and conditioned.
    - Protection from water splash damage if no gutters.

    - Supply piping in exterior walls insulated with pipe wrap.
    - Hard-surface flooring in kitchens, baths, entry, laundry, and utility rooms
- Radon
    - Radon-resistant features installed in Radon Zone 1 homes in accordance with Construction Specification 2.1.
- Pests
    - Corrosion-proof rodent/bird screens installed at all openings that cannot be fully sealed. (Not required for clothes dryer vents.)
- HVAC Systems
    - Duct systems protected from construction debris AND no building cavities used as air supplies or returns
    - No air-handling equipment or ductwork installed in garage.
    - Clothes dryers vented to the outdoors or plumbed to a drain according to manufacturer's instructions.
    - Central forced-air HVAC system(s) have minimum MERV 8 filter AND no ozone generators in home. Temporary filter installed to protect unit from construction dust.
- Combustion Pollutants
    - Emissions standards met for fuel-burning and space-heating appliances.
    - CO alarms installed in each sleeping zone (e.g., common hallway) according to NFPA 720.
    - Multifamily buildings: Smoking restrictions implemented AND ETS transfer pathways minimized.
    - Attached garages: Door closer installed on all connecting doors
    - Attached garages: In homes with exhaust-only whole-house ventilation EITHER
        - 70 cfm exhaust fan installed in garage OR
        - Pressure test conducted to verify the effectiveness of the garage-to-house air barrier.
- Materials
    - All composite wood products certified low-emission.
    - Interior paints and finishes certified low-emission.
    - Carpet, carpet adhesives, and carpet cushion certified low-emission.
- Final (Inspection)
    - HVAC system and ductwork verified to be dry and clean AND new filter installed.
    - Home ventilated before occupancy.
    - Equipment manuals, Indoor airPLUS label, and certificate provided for owner/occupant.

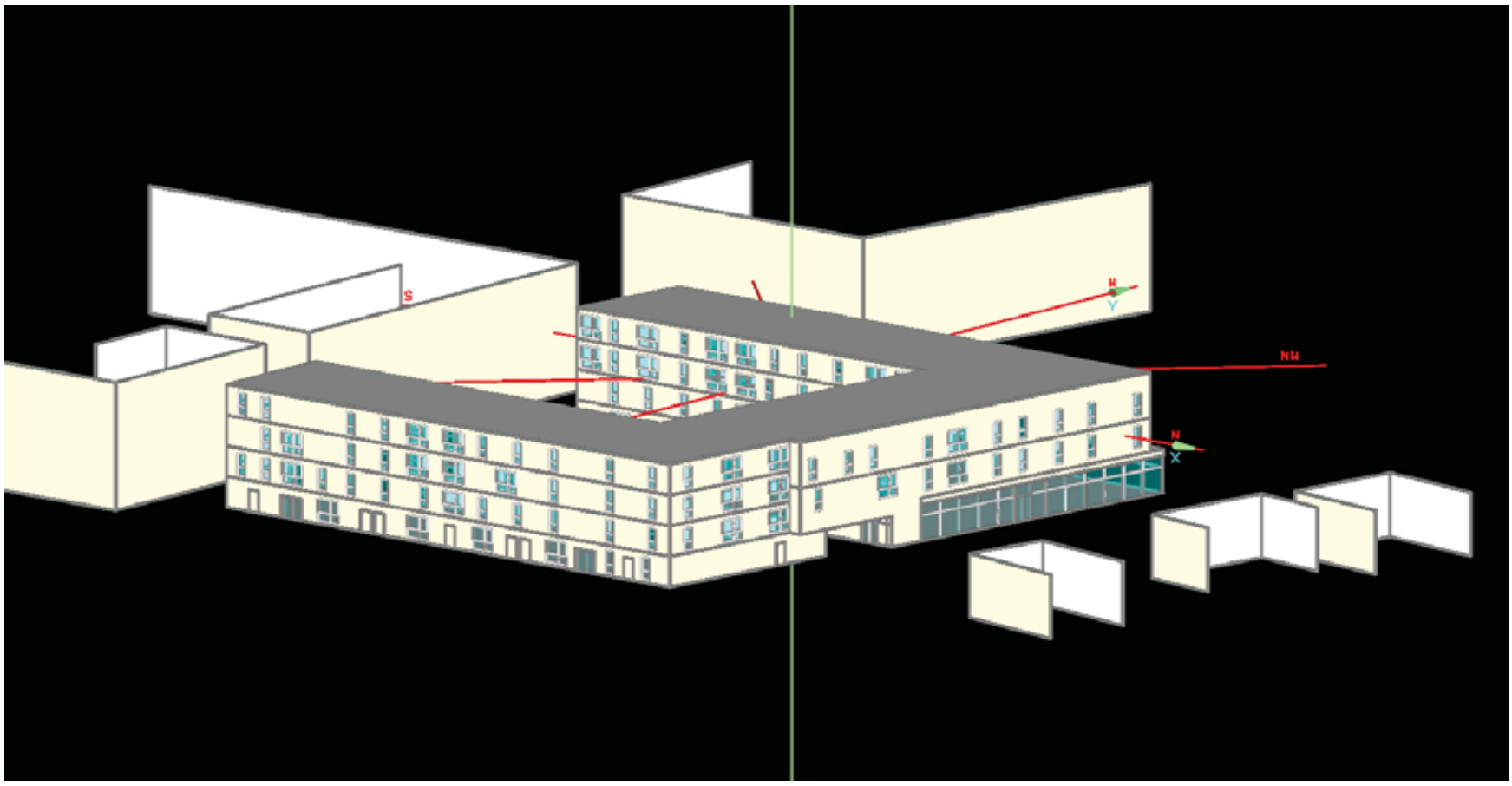
The Project team looks forward to the construction of a highly efficient building with a focus placed on reducing energy consumption and protecting resident health. The Project team believes that in following the aforementioned requirements of both PHIUS+ CORE and EPA Indoor airPLUS, the project will accomplish these goals and create a high-quality living environment well into the future at the JP Federal Redevelopment project.

APPENDIX A: WUFI MODEL SUMMARY REPORTS

NEW ECOLOGY Community-Based Sustainable Development	Project Name:		**JP Federal - Building 1**	
	Climate		Boston Logan International Airport	
	Case		Case 1 - PHIUS+ 2021	Case 2 - Net Zero
Direct Change From Previous Case	Notes		Geometry and inputs based on the provided Revit models, 20210401_JP Federal NZ Narrative.pdf, and JP Mechanical System Narrative 031921.pdf	Case 1 updated to all-electric in order to meet PHIUS Net Zero requirements
Meets PHIUS Target				
Misses PHIUS Target				
WUFI PASSIVE RESULTS				
PHIUS+ Core Criteria	**Units**	**Target**		
Heating Demand	kBtu/ft2.yr	4.30	**3.90**	**3.90**
Cooling Demand	kBtu/ft2.yr	6.20	**3.17**	**3.17**
Heating Load	Btu/hr.ft2	3.70	**3.37**	**3.37**
Cooling Load	Btu/hr.ft2	2.80	**2.66**	**2.66**
Total Site Energy	**Units**	**Target**		
Source Energy	kWh/person.yr	4,496	**4,054**	**0**
Site Energy Use Index	kBtu/ft2.yr	-	**18.1**	**14.4**
Site Energy Consumption	kWh/yr	-	**307,122**	**244,240**
Annual Gas Consumption	Therms/yr	-	**3,018**	**0**
Annual Electric Consumption	kWh/yr	-	**218,339**	**0**
WUFI PASSIVE INPUTS				
Geometry	**Units**			
Interior Conditioned Floor Area (iCFA)	ft2		57,899	57,899
Net Volume	ft3		448,729	448,729
Envelope Area	ft2		66,333	66,333
Average Window-to-Wall Ratio	%		24%	24%
Exterior Envelope	**Units**			
Roof	R		52	52
Exterior Wall	R (effective)		23	23
Slab	R		10	10
Exterior Floor	R		30	30
Window	U (Whole Window)		0.15	0.15
	SHGC (Center-of-Glass)		0.36	0.36
Storefront	U (Whole Window)		0.30	0.30
	SHGC (Center-of-Glass)		0.30	0.30
Glass Doors	U (Whole Window)		0.50	0.50
	SHGC (Center-of-Glass)		0.30	0.30
Opaque Door	R		2	2
Airtightness	**Units**			
Air changes per hour at 50 Pa	ACH50		**0.53**	**0.53**
Lighting Assumptions	**Units**			
Lighting	kWh/yr		60,347	60,347
Plug Loads	**Units**			
Miscellaneous Electric Loads	kWh/yr		53,391	53,391
Occupancy	**Units**			
Units	#		37	37
Bedrooms	#		84	84
Average Occupancy	# Bedrooms + 1		121	121
Appliances	**Units**			
Refrigerator	kWh/year/unit		440	440
Clothes Washer	kWh/year/unit		116	116
Clothes Dryer	Energy Factor		6.00	6.00
Electric Cooktop	kWh/use		0.2	0.2
Ventilation	**Units**			
ERV Ventilation	cfm		3,700	3,700
ERV Power	W/cfm		0.70	0.70
ERV Recovery Efficiency	%		87%	87%
ERV Location			Roof	Roof
Mechanical Systems	**Units**			
Heat Pumps	Heating COP		3.5	3.5
	Cooling COP		4.0	4.0
Domestic Hot Water	**Units**			
Water Heater Efficiency	%		88%	300%
Auxiliary Energy	**Units**			
DHW Pump	W		70	70
Recirculation Pump	W		360	360
Renewable Generation	**Units**			
Solar PV (capacity)	kW		0	208
Solar PV (annual generation)	kWh/yr		0	250,000

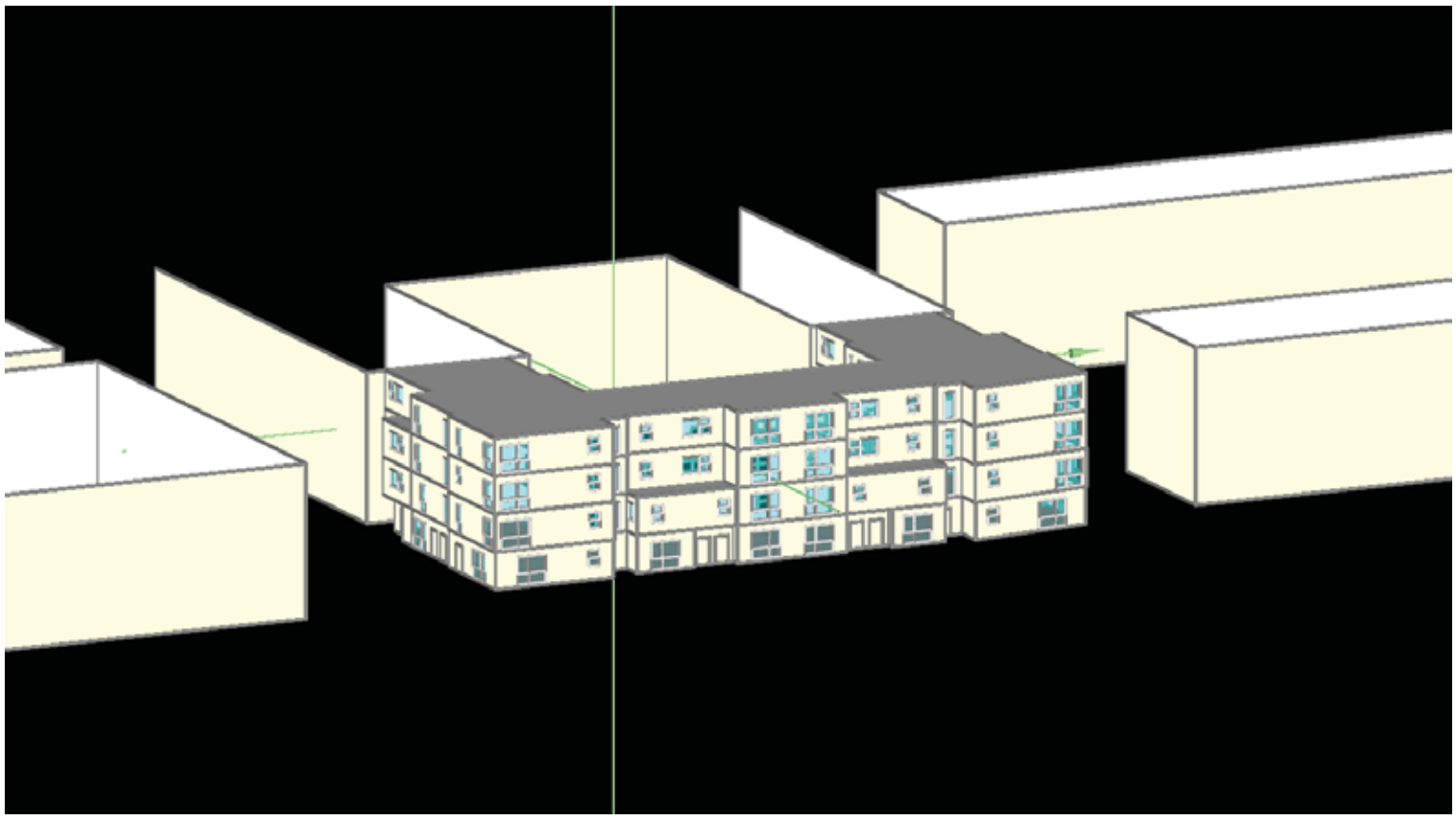
Solar PV (coincident generation)	kWh/yr	0	250,000

*Results from the feasibility study are preliminary and are subject to change during the PH certification process.



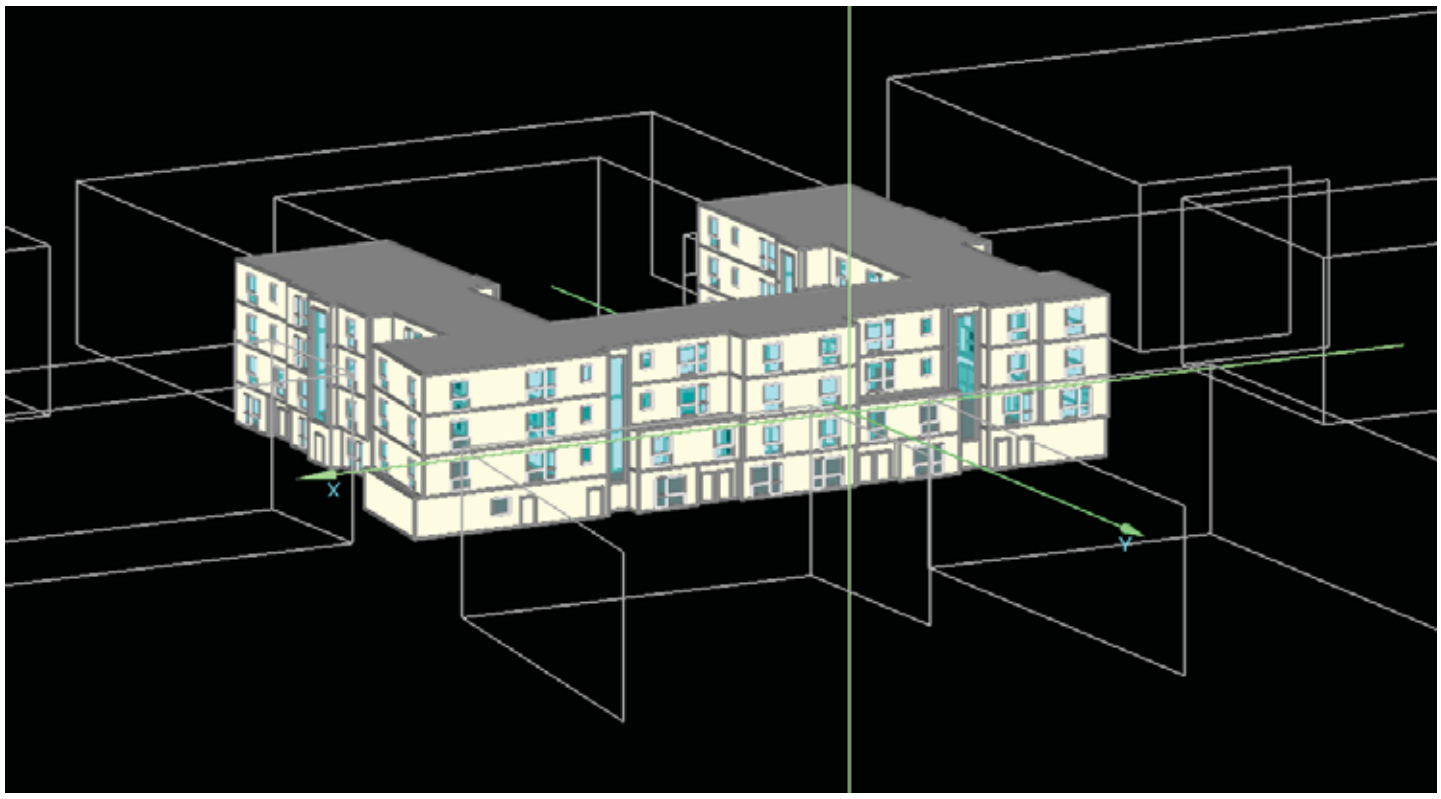
NEW ECOLOGY Community-Based Sustainable Development	Project Name:		JP Federal - Building 2 & 5	
	Climate		Boston Logan International Airport	
	Case		Case 1 - PHIUS+ 2021	Case 2 - Net Zero
Direct Change From Previous Case	Notes		Geometry and inputs based on the provided Revit models, 20210401_JP Federal NZ Narrative.pdf, and JP Mechanical System Narrative 031921.pdf	Case 1 updated to all-electric in order to meet PHIUS Net Zero requirements
Meets PHIUS Target				
Misses PHIUS Target				
WUFI PASSIVE RESULTS				
PHIUS+ Core Criteria	**Units**	**Target**		
Heating Demand	kBtu/ft2.yr	4.40	**4.04**	**4.04**
Cooling Demand	kBtu/ft2.yr	5.70	**3.31**	**3.31**
Heating Load	Btu/hr.ft2	3.80	**3.46**	**3.46**
Cooling Load	Btu/hr.ft2	2.80	**2.64**	**2.64**
Total Site Energy	**Units**	**Target**		
Source Energy	kWh/person.yr	4,037	**3,365**	**0**
Site Energy Use Index	kBtu/ft2.yr	-	**19.2**	**14.6**
Site Energy Consumption	kWh/yr	-	**141,997**	**107,962**
Annual Gas Consumption	Therms/yr	-	**1,647**	**0**
Annual Electric Consumption	kWh/yr	-	**93,880**	**0**
WUFI PASSIVE INPUTS				
Geometry	**Units**			
Interior Conditioned Floor Area (iCFA)	ft2		25,330	25,330
Net Volume	ft3		204,955	204,955
Envelope Area	ft2		33,963	33,963
Average Window-to-Wall Ratio	%		16%	16%
Exterior Envelope	**Units**			
Roof	R		52	52
Exterior Wall	R (effective)		23	23
Slab	R		10	10
Exterior Floor	R		30	30
Window	U (Whole Window)		0.15	0.15
	SHGC (Center-of-Glass)		0.46	0.46
Opaque Door	R		2	2
Airtightness	**Units**			
Air changes per hour at 50 Pa	ACH50		**0.60**	**0.60**
Lighting Assumptions	**Units**			
Lighting	kWh/yr		21,002	21,002
Plug Loads	**Units**			
Miscellaneous Electric Loads	kWh/yr		24,903	24,903
Occupancy	**Units**			
Units	#		18	18
Bedrooms	#		48	48
Average Occupancy	# Bedrooms + 1		66	66
Appliances	**Units**			
Refrigerator	kWh/year/unit		440	440
Clothes Washer	kWh/year/unit		116	116
Clothes Dryer	Energy Factor		6.00	6.00
Electric Cooktop	kWh/use		0.2	0.2
Ventilation	**Units**			
ERV Ventilation	cfm		1,400	1,400
ERV Power	W/cfm		0.70	0.70
ERV Recovery Efficiency	%		87%	87%
ERV Location			Roof	Roof
Mechanical Systems	**Units**			
Heat Pumps	Heating COP		3.5	3.5
	Cooling COP		4.0	4.0
Domestic Hot Water	**Units**			
Water Heater Efficiency	%		88%	300%
Auxiliary Energy	**Units**			
DHW Pump	W		47	47
Recirculation Pump	W		188	188
Renewable Generation	**Units**			
Solar PV (capacity)	kW		0	83
Solar PV (annual generation)	kWh/yr		0	100,000
Solar PV (coincident generation)	kWh/yr		0	100,000

*Results from the feasibility study are preliminary and are subject to change during the PH certification process.



NEW ECOLOGY Community-Based Sustainable Development	Project Name:		**JP Federal - Building 3 & 4**	
	Climate		Boston Logan International Airport	
	Case		Case 1 - PHIUS+ 2021	Case 2 - Net Zero
Direct Change From Previous Case	Notes		Geometry and inputs based on the provided Revit models, 20210401_JP Federal NZ Narrative.pdf, and JP Mechanical System Narrative 031921.pdf	Case 1 updated to all-electric in order to meet PHIUS Net Zero requirements
Meets PHIUS Target				
Misses PHIUS Target				
WUFI PASSIVE RESULTS				
PHIUS+ Core Criteria	**Units**	**Target**		
Heating Demand	kBtu/ft2.yr	4.50	**3.70**	**3.70**
Cooling Demand	kBtu/ft2.yr	5.80	**3.06**	**3.06**
Heating Load	Btu/hr.ft2	3.90	**3.40**	**3.40**
Cooling Load	Btu/hr.ft2	2.80	**2.54**	**2.54**
Total Site Energy	**Units**	**Target**		
Source Energy	kWh/person.yr	4,246	**3,378**	**0**
Site Energy Use Index	kBtu/ft2.yr	-	**19.0**	**14.7**
Site Energy Consumption	kWh/yr	-	**218,187**	**169,369**
Annual Gas Consumption	Therms/yr	-	**2,365**	**0**
Annual Electric Consumption	kWh/yr	-	**149,074**	**0**
WUFI PASSIVE INPUTS				
Geometry	**Units**			
Interior Conditioned Floor Area (iCFA)	ft2		39,331	39,331
Net Volume	ft3		273,613	273,613
Envelope Area	ft2		51,557	51,557
Average Window-to-Wall Ratio	%		21%	21%
Exterior Envelope	**Units**			
Roof	R		52	52
Exterior Wall	R (effective)		23	23
Slab	R		10	10
Exterior Floor	R		30	30
Window	U (Whole Window)		0.15	0.15
	SHGC (Center-of-Glass)		0.36	0.36
Opaque Door	R		2	2
Airtightness	**Units**			
Air changes per hour at 50 Pa	ACH50		**0.68**	**0.68**
Lighting Assumptions	**Units**			
Lighting	kWh/yr		35,218	35,218
Plug Loads	**Units**			
Miscellaneous Electric Loads	kWh/yr		37,272	37,272
Occupancy	**Units**			
Units	#		32	32
Bedrooms	#		70	70
Average Occupancy	# Bedrooms + 1		102	102
Appliances	**Units**			
Refrigerator	kWh/year/unit		440	440
Clothes Washer	kWh/year/unit		116	116
Clothes Dryer	Energy Factor		6.00	6.00
Electric Cooktop	kWh/use		0.2	0.2
Ventilation	**Units**			
ERV Ventilation	cfm		2,500	2,500
ERV Power	W/cfm		0.70	0.70
ERV Recovery Efficiency	%		87%	87%
ERV Location			Roof	Roof
Mechanical Systems	**Units**			
Heat Pumps	Heating COP		3.5	3.5
	Cooling COP		4.0	4.0
Domestic Hot Water	**Units**			
Water Heater Efficiency	%		88%	300%
Auxiliary Energy	**Units**			
DHW Pump	W		53	53
Recirculation Pump	W		237	237
Renewable Generation	**Units**			
Solar PV (capacity)	kW		0	142
Solar PV (annual generation)	kWh/yr		0	170,000
Solar PV (coincident generation)	kWh/yr		0	170,000

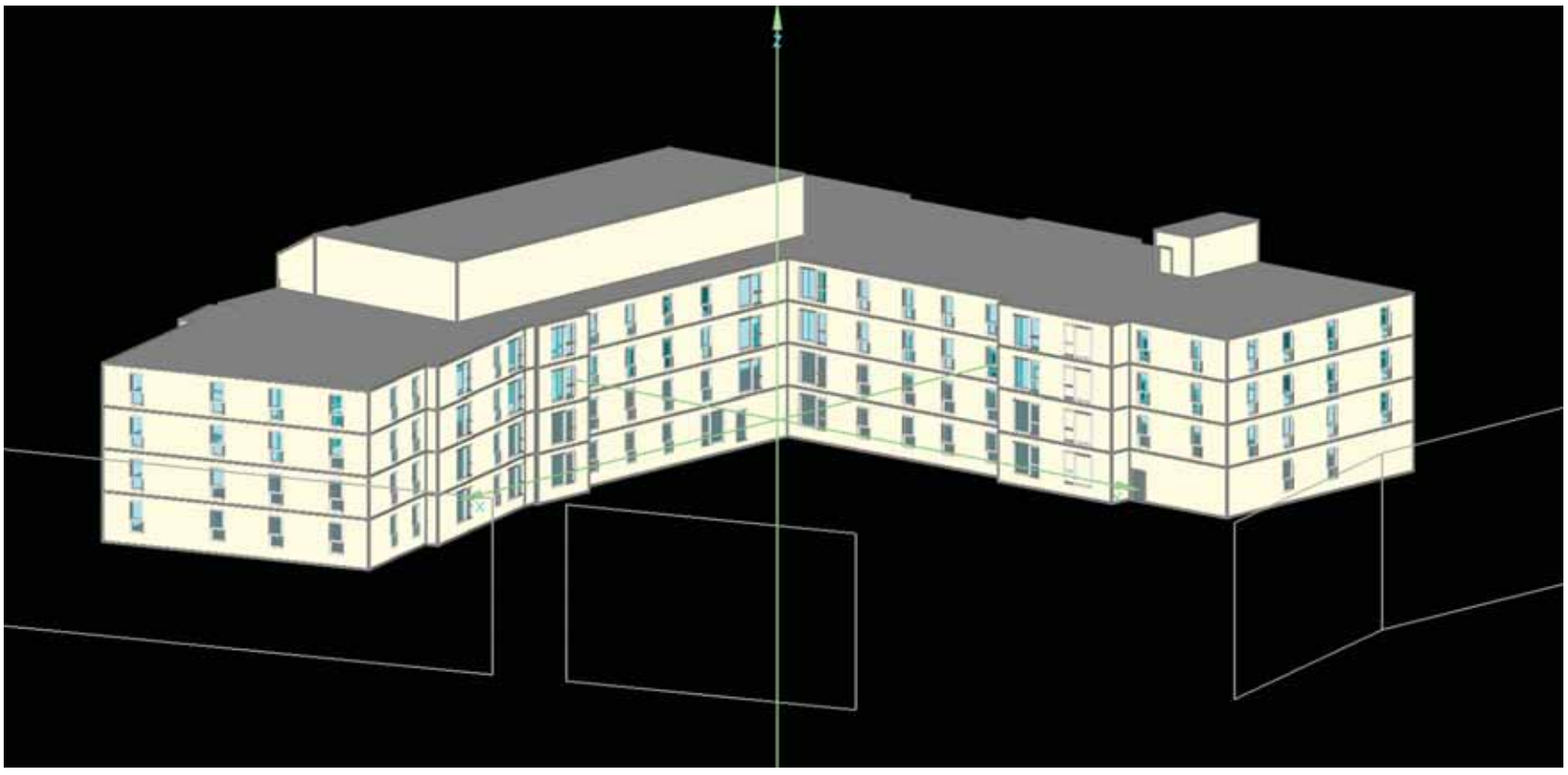
*Results from the feasibility study are preliminary and are subject to change during the PH certification process.



NEW ECOLOGY Community-Based Sustainable Development	Project Name:	JP Federal - Building 6	
	Climate	Boston Logan International Airport	
	Case	Case 1 - PHIUS+ 2021	Case 2 - Net Zero
Direct Change From Previous Case **Meets PHIUS Target** **Misses PHIUS Target**	Notes	Geometry and inputs based on the provided Revit models, 20210401_JP Federal NZ Narrative.pdf, and JP Mechanical System Narrative 031921.pdf	Case 1 updated to all-electric in order to meet PHIUS Net Zero requirements
WUFI PASSIVE RESULTS			
PHIUS+ Core Criteria	**Units**	**Target**	
Heating Demand	kBtu/ft2.yr	4.40	**2.62**	**2.62**
Cooling Demand	kBtu/ft2.yr	6.70	**2.05**	**2.05**
Heating Load	Btu/hr.ft2	4.00	**2.47**	**2.47**
Cooling Load	Btu/hr.ft2	3.00	**1.93**	**1.93**
Total Site Energy	**Units**	**Target**		
Source Energy	kWh/person.yr	4,264	**3,374**	**0**
Site Energy Use Index	kBtu/ft2.yr	-	**18.5**	**14.4**
Site Energy Consumption	kWh/yr	-	**397,472**	**308,406**
Annual Gas Consumption	Therms/yr	-	**4,318**	**0**
Annual Electric Consumption	kWh/yr	-	**271,353**	**0**
WUFI PASSIVE INPUTS			
Geometry	**Units**		
Interior Conditioned Floor Area (iCFA)	ft2		73,313	73,313
Net Volume	ft3		556,972	556,972
Envelope Area	ft2		73,530	73,530
Average Window-to-Wall Ratio	%		18%	18%
Exterior Envelope	**Units**			
Roof	R		52	52
Exterior Wall	R (effective)		23	23
Slab	R		10	10
Exterior Floor	R		30	30
Window	U (Whole Window)		0.15	0.15
	SHGC (Center-of-Glass)		0.36	0.36
Glass Doors	U (Whole Window)		0.50	0.50
	SHGC (Center-of-Glass)		0.30	0.30
Opaque Door	R		2	2
Airtightness	**Units**			
Air changes per hour at 50 Pa	ACH50		**0.47**	**0.47**
Lighting Assumptions	**Units**			
Lighting	kWh/yr		57,458	57,458
Plug Loads	**Units**			
Miscellaneous Electric Loads	kWh/yr		70,151	70,151
Occupancy	**Units**			
Units	#		58	58
Bedrooms	#		128	128
Average Occupancy	# Bedrooms + 1		186	186
Appliances	**Units**			
Refrigerator	kWh/year/unit		440	440
Clothes Washer	kWh/year/unit		116	116
Clothes Dryer	Energy Factor		3.14	3.14
Electric Cooktop	kWh/use		0.2	0.2
Ventilation	**Units**			
Dryer Exhaust	cfm		125	125
ERV Ventilation	cfm		5,000	5,000
ERV Power	W/cfm		0.70	0.70
ERV Recovery Efficiency	%		87%	87%
ERV Location			Roof	Roof
Mechanical Systems	**Units**			
Heat Pumps	Heating COP		3.5	3.5
	Cooling COP		4.0	4.0
Domestic Hot Water	**Units**			
Water Heater Efficiency	%		88%	300%

Auxiliary Energy	**Units**		
DHW Pump	W	461	461
Recirculation Pump	W	84	84
Renewable Generation	**Units**		
Solar PV (capacity)	kW	0	250
Solar PV (annual generation)	kWh/yr	0	300,000
Solar PV (coincident generation)	kWh/yr	0	300,000

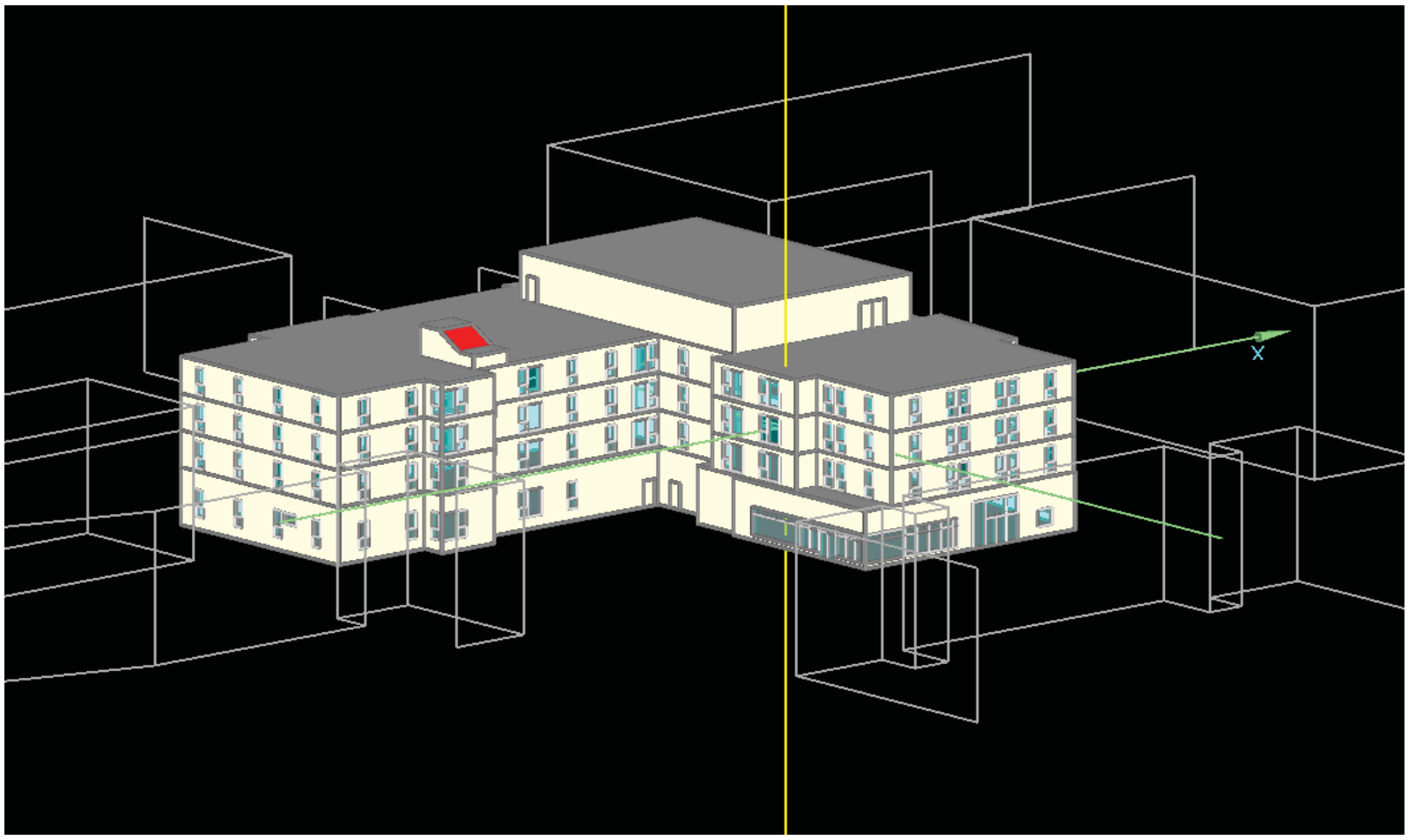
*Results from the feasibility study are preliminary and are subject to change during the PH certification process.



NEW ECOLOGY Community-Based Sustainable Development	Project Name:	JP Federal - Building 7	
	Climate	Boston Logan International Airport	
	Case	Case 1 - PHIUS+ 2021	Case 2 - Net Zero
Direct Change From Previous Case **Meets PHIUS Target** **Misses PHIUS Target**	Notes	Geometry and inputs based on the provided Revit models, 20210401_JP Federal NZ Narrative.pdf, and JP Mechanical System Narrative 031921.pdf	Case 1 updated to all-electric in order to meet PHIUS Net Zero requirements
WUFI PASSIVE RESULTS			
PHIUS+ Core Criteria	**Units**	**Target**	
Heating Demand	kBtu/ft2.yr	4.40	**3.29**	**3.29**
Cooling Demand	kBtu/ft2.yr	6.50	**2.29**	**2.29**
Heating Load	Btu/hr.ft2	3.90	**2.85**	**2.85**
Cooling Load	Btu/hr.ft2	3.00	**2.14**	**2.14**
Total Site Energy	**Units**	**Target**		
Source Energy	kWh/person.yr	4,407	**3,814**	**0**
Site Energy Use Index	kBtu/ft2.yr	-	**19.0**	**15.0**
Site Energy Consumption	kWh/yr	-	**308,970**	**243,667**
Annual Gas Consumption	Therms/yr	-	**3,162**	**0**
Annual Electric Consumption	kWh/yr	-	**216,678**	**0**
WUFI PASSIVE INPUTS			
Geometry	**Units**		
Interior Conditioned Floor Area (iCFA)	ft2		55,491	55,491
Net Volume	ft3		481,397	481,397
Envelope Area	ft2		57,964	57,964
Average Window-to-Wall Ratio	%		19%	19%
Exterior Envelope	**Units**			
Roof	R		52	52
Exterior Wall	R (effective)		23	23
Slab	R		10	10
Exterior Floor	R		30	30
Window	U (Whole Window)		0.15	0.15
	SHGC (Center-of-Glass)		0.36	0.36
Glass Doors	U (Whole Window)		0.50	0.50
	SHGC (Center-of-Glass)		0.30	0.30
Opaque Door	R		2	2
Airtightness	**Units**			
Air changes per hour at 50 Pa	ACH50		**0.43**	**0.43**
Lighting Assumptions	**Units**			
Lighting	kWh/yr		53,013	53,013
Plug Loads	**Units**			
Miscellaneous Electric Loads	kWh/yr		53,981	53,981
Occupancy	**Units**			
Units	#		41	41
Bedrooms	#		88	88
Average Occupancy	# Bedrooms + 1		129	129
Appliances	**Units**			
Refrigerator	kWh/year/unit		440	440
Clothes Washer	kWh/year/unit		116	116
Clothes Dryer	Energy Factor		3.14	3.14
Electric Cooktop	kWh/use		0.2	0.2
Ventilation	**Units**			
Dryer Exhaust	cfm		125	125
ERV Ventilation	cfm		3,900	3,900
ERV Power	W/cfm		0.70	0.70
ERV Recovery Efficiency	%		87%	87%
ERV Location			Roof	Roof
Mechanical Systems	**Units**			
Heat Pumps	Heating COP		3.5	3.5
	Cooling COP		4.0	4.0
Domestic Hot Water	**Units**			
Water Heater Efficiency	%		88%	300%

Auxiliary Energy	Units		
DHW Pump	W	365	365
Recirculation Pump	W	73	73
Renewable Generation	**Units**		
Solar PV (capacity)	kW	0	208
Solar PV (annual generation)	kWh/yr	0	250,000
Solar PV (coincident generation)	kWh/yr	0	250,000

*Results from the feasibility study are preliminary and are subject to change during the PH certification process.



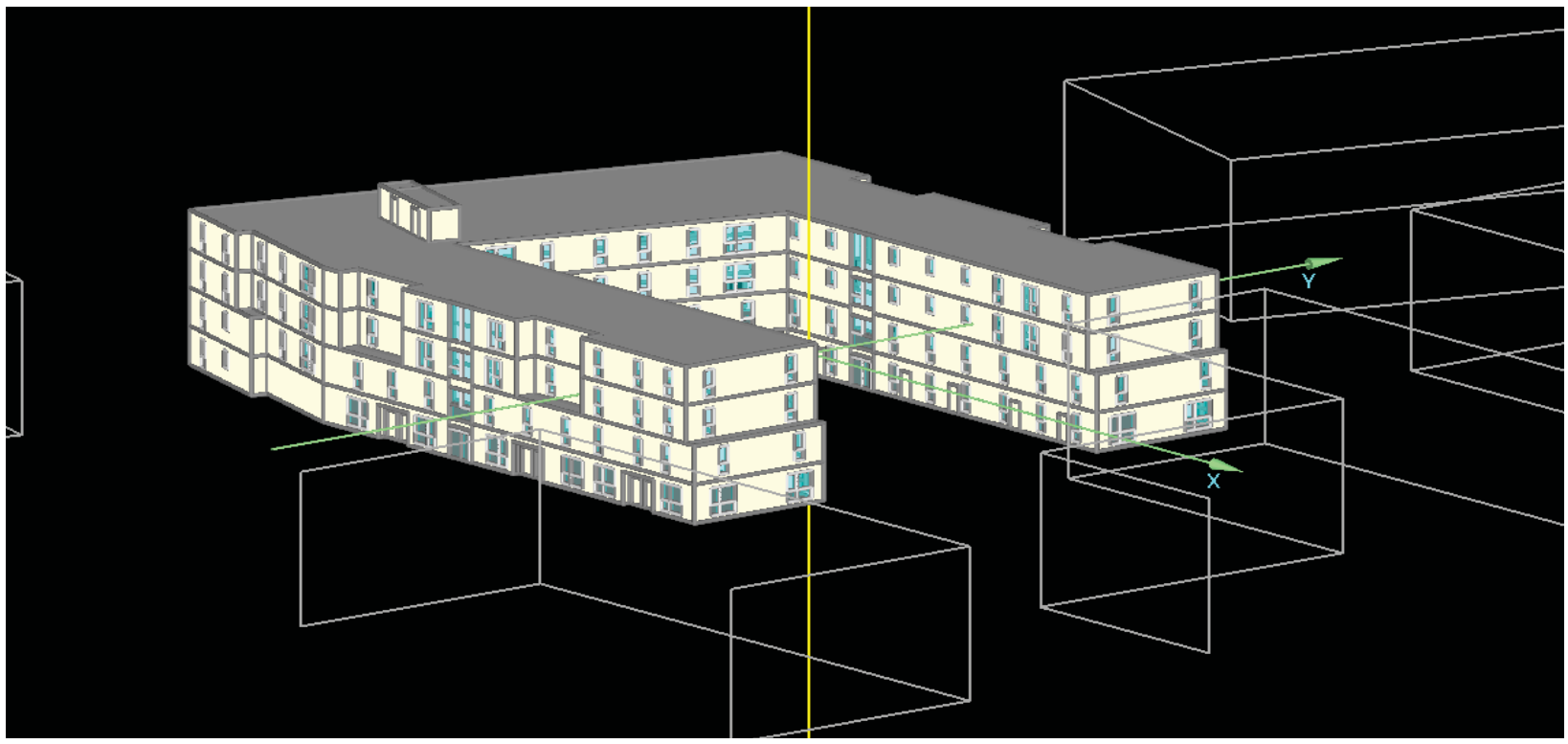
NEW ECOLOGY Community-Based Sustainable Development	Project Name:	JP Federal - Building 8	
	Climate	Boston Logan International Airport	
	Case	Case 1 - PHIUS+ 2021	Case 2 - Net Zero
Direct Change From Previous Case Meets PHIUS Target Misses PHIUS Target	Notes	Geometry and inputs based on the provided Revit models, 20210401_JP Federal NZ Narrative.pdf, and JP Mechanical System Narrative 031921.pdf	Case 1 updated to all-electric in order to meet PHIUS Net Zero requirements

WUFI PASSIVE RESULTS				
PHIUS+ Core Criteria	**Units**	**Target**		
Heating Demand	kBtu/ft2.yr	4.40	**2.90**	**2.90**
Cooling Demand	kBtu/ft2.yr	6.30	**2.99**	**2.99**
Heating Load	Btu/hr.ft2	3.90	**3.01**	**3.01**
Cooling Load	Btu/hr.ft2	3.00	**2.42**	**2.42**
Total Site Energy	**Units**	**Target**		
Source Energy	kWh/person.yr	4,109	**3,545**	**0**
Site Energy Use Index	kBtu/ft2.yr	-	**20.7**	**16.1**
Site Energy Consumption	kWh/yr	-	**362,490**	**283,047**
Annual Gas Consumption	Therms/yr	-	**3,846**	**0**
Annual Electric Consumption	kWh/yr	-	**250,196**	**0**

WUFI PASSIVE INPUTS			
Geometry	**Units**		
Interior Conditioned Floor Area (iCFA)	ft2	59,906	59,906
Net Volume	ft3	460,231	460,231
Envelope Area	ft2	59,906	59,906
Average Window-to-Wall Ratio	%	19%	19%
Exterior Envelope	**Units**		
Roof	R	52	52
Exterior Wall	R (effective)	23	23
Slab	R	10	10
Exterior Floor	R	30	30
Window	U (Whole Window)	0.15	0.15
	SHGC (Center-of-Glass)	0.36	0.36
Glass Doors	U (Whole Window)	0.50	0.50
	SHGC (Center-of-Glass)	0.30	0.30
Opaque Door	R	2	2
Airtightness	**Units**		
Air changes per hour at 50 Pa	ACH50	**0.52**	**0.52**
Lighting Assumptions	**Units**		
Lighting	kWh/yr	56,436	56,436
Plug Loads	**Units**		
Miscellaneous Electric Loads	kWh/yr	59,121	59,121
Occupancy	**Units**		
Units	#	48	48
Bedrooms	#	114	114
Average Occupancy	# Bedrooms + 1	162	162
Appliances	**Units**		
Refrigerator	kWh/year/unit	440	440
Clothes Washer	kWh/year/unit	116	116
Clothes Dryer, In-Unit	Energy Factor	3.14	3.14
Clothes Dryer, Central	Energy Factor	6.00	6.00
Electric Cooktop	kWh/use	0.2	0.2
Ventilation	**Units**		
Dryer Exhaust	cfm	125	125
ERV Ventilation	cfm	3,800	3,800
ERV Power	W/cfm	0.70	0.70
ERV Recovery Efficiency	%	87%	87%
ERV Location		Roof	Roof
Mechanical Systems	**Units**		
Heat Pumps	Heating COP	3.5	3.5
	Cooling COP	4.0	4.0
Domestic Hot Water	**Units**		
Water Heater Efficiency	%	88%	300%

Auxiliary Energy	Units		
DHW Pump	W	278	278
Recirculation Pump	W	71	71
Renewable Generation	**Units**		
Solar PV (capacity)	kW	0	233
Solar PV (annual generation)	kWh/yr	0	280,000
Solar PV (coincident generation)	kWh/yr	0	280,000

*Results from the feasibility study are preliminary and are subject to change during the PH certification process.



APPENDIX B: WUFI MODEL OUTPUT REPORTS

BUILDING INFORMATION

Category:	**Residential**
Status:	**In planning**
Building type:	**New construction**
Year of construction:	
Units:	**37**
Number of occupants:	**121 (Design)**
Occupant density:	**478.5** ft²/Person

Boundary conditions

Climate:	**MA - BOSTON LOGAN INT ARPT (cold year)**
Internal heat gains:	**1.1** Btu/hr ft²
Interior temperature:	**68** °F
Overheat temperature:	**77** °F

Building geometry

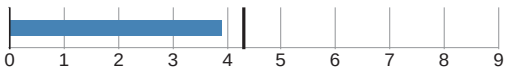
Enclosed volume:	**590,433.5** ft³
Net-volume:	**448,729.5** ft³
Total area envelope:	**66,332.7** ft²
Area/Volume Ratio:	**0.1** 1/ft
Floor area:	**57,899** ft²
Envelope area/iCFA:	**1.146**

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ 2018

Heating demand

specific:	**3.9** kBtu/ft²yr
target:	**4.3** kBtu/ft²yr
total:	225,863.58 kBtu/yr

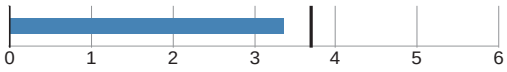


Cooling demand

sensible:	**2.8** kBtu/ft²yr
latent:	**0.38** kBtu/ft²yr
specific:	**3.17** kBtu/ft²yr
target:	**6.2** kBtu/ft²yr
total:	183,781.41 kBtu/yr

Heating load

specific:	**3.37** Btu/hr ft²
target:	**3.7** Btu/hr ft²
total:	194,990.81 Btu/hr



Cooling load

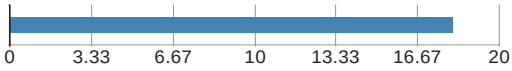
specific:	**2.66** Btu/hr ft²
target:	**2.8** Btu/hr ft²
total:	154,003.6 Btu/hr

Source energy

total:	**490,508.52**	kWh/yr
specific:	**4,054**	kWh/Person yr
target:	**3,840**	kWh/Person yr
total:	**1,673,519.35**	kBtu/yr
specific:	28.91	kBtu/ft²yr

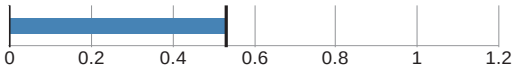
Site energy

total:	1,047,334.58	kBtu/yr
specific:	18.09	kBtu/ft²yr
total:	306,973.77	kWh/yr
specific:	5.3	kWh/ft²



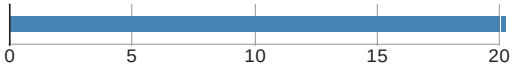
Air tightness

ACH50:	**0.53**	1/hr
CFM50 per envelope area:	**0.06**	cfm/ft²
target:	**0.53**	1/hr
target CFM50:	**0.06**	cfm/ft²



PASSIVEHOUSE RECOMMENDATIONS

Sensible recovery efficiency:	**86.5**	%
Frequency of overheating: Cooling system is required	**29.9**	%



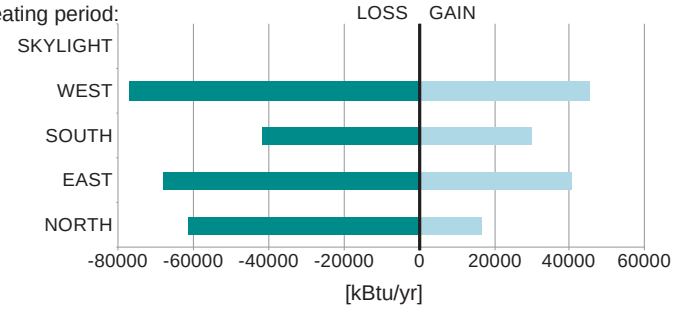
Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

BUILDING ELEMENTS

Windows

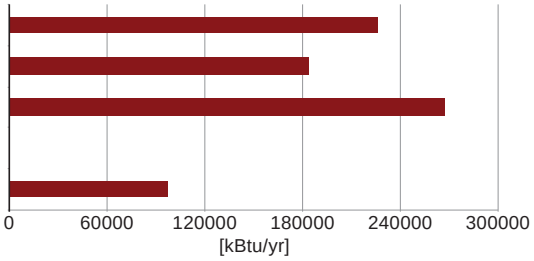
Average SHGC:	**0.34**	
Average solar reduction factor heating:	**0.42**	
Average solar reduction factor cooling:	**0.38**	
Average U-value:	**0.21**	Btu/hr ft² °F
Total glazing area:	**5,486**	ft²
Total window area:	**8,388.8**	ft²

Heat gain/loss heating period:



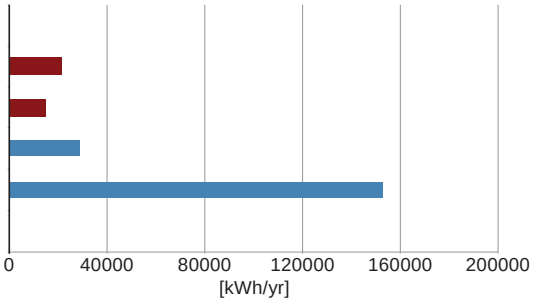
HVAC

Total heating demand:	**225,864**	kBtu/yr
Total cooling demand:	**183,781**	kBtu/yr
Total DHW energy demand:	**267,614**	kBtu/yr
Solar DHW contribution:	**0**	kBtu/yr
Auxiliary electricity:	**96,854**	kBtu/yr



Electricity

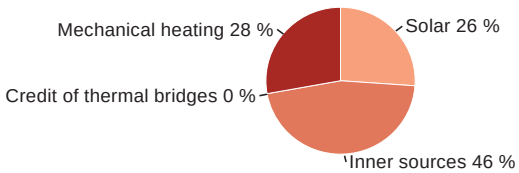
Direct heating / DHW:	**0**	kWh/yr
Heatpump heating:	**21,763**	kWh/yr
Cooling:	**15,070**	kWh/yr
HVAC auxiliary energy:	**28,388**	kWh/yr
Appliances:	**153,118**	kWh/yr
Renewable generation, coincident production and use:	**0**	kWh/yr
Total electricity demand:	**218,339**	kWh/yr



HEAT FLOW - HEATING PERIOD

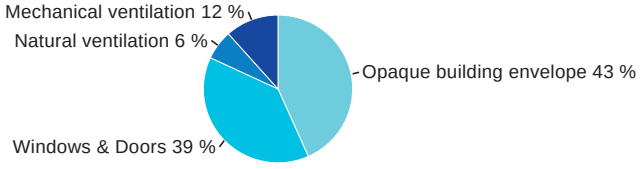
Heat gains

Solar:	**180,716**	kBtu/yr
Inner sources:	**318,987**	kBtu/yr
Credit of thermal bridges:	**0**	kBtu/yr
Mechanical heating:	**225,864**	kBtu/yr



Heat losses

Opaque building envelope:	**314,517**	kBtu/yr
Windows & Doors:	**280,059**	kBtu/yr
Natural ventilation:	**46,971**	kBtu/yr
Mechanical ventilation:	**84,020**	kBtu/yr

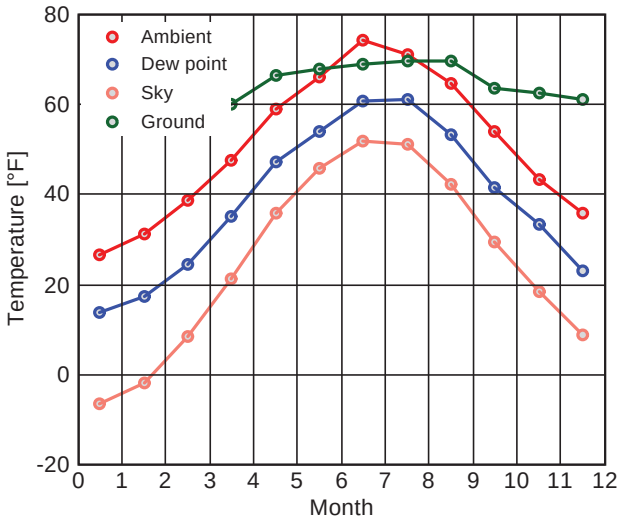


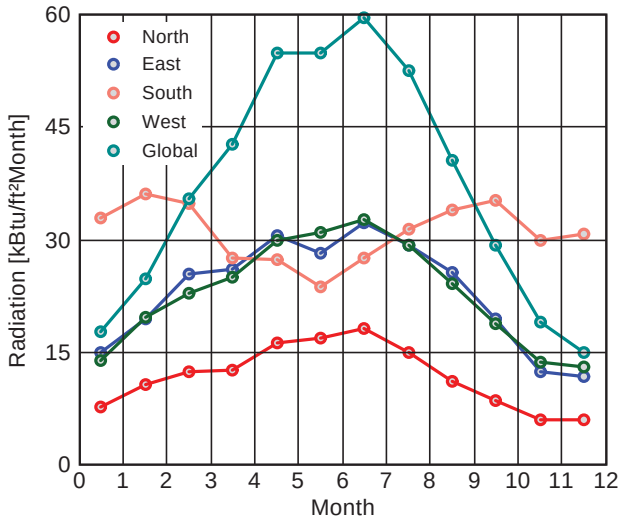
CLIMATE

Latitude:	**42.4**	°
Longitude:	**-71**	°
Elevation of weather station:	**19.7**	ft
Elevation of building site:	**6**	ft
Heat capacity air:	**0.018**	Btu/ft³F
Daily temperature swing summer:	**14.8**	°F
Average wind speed:	**13.1**	ft/s

Ground

Average ground surface temperature:	**52.8**	°F
Amplitude ground surface temperature:	**55.8**	°F
Ground thermal conductivity:	**1.2**	Btu/hr ft °F
Ground heat capacity:	**29.8**	Btu/ft³F
Depth below grade of groundwater:	**9.8**	ft
Flow rate groundwater:	**0.2**	ft/d





Calculation parameters

Length of heating period	**243**	days/yr
Heating degree hours	**140.9**	kFh/a
Phase shift months	**1.3**	mths
Time constant heating demand	**115.2**	hr
Time constant cooling demand	**0**	hr
Time constant cooling demand with night ventilation	**0**	hr

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	16.9	31.6	83.5
Solar radiation North [Btu/hr ft²]	12	7.9	27.6
Solar radiation East [Btu/hr ft²]	22.8	13.3	61.5
Solar radiation South [Btu/hr ft²]	49.5	27.3	41.8
Solar radiation West [Btu/hr ft²]	22.2	11.4	53.3
Solar radiation Global [Btu/hr ft²]	26.9	16.5	101.4

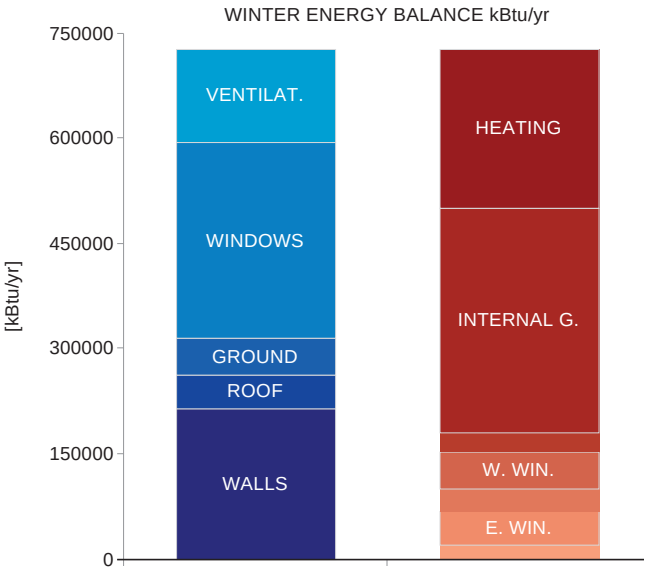
Relevant boundary conditions for heating load calculation: Heating load 1

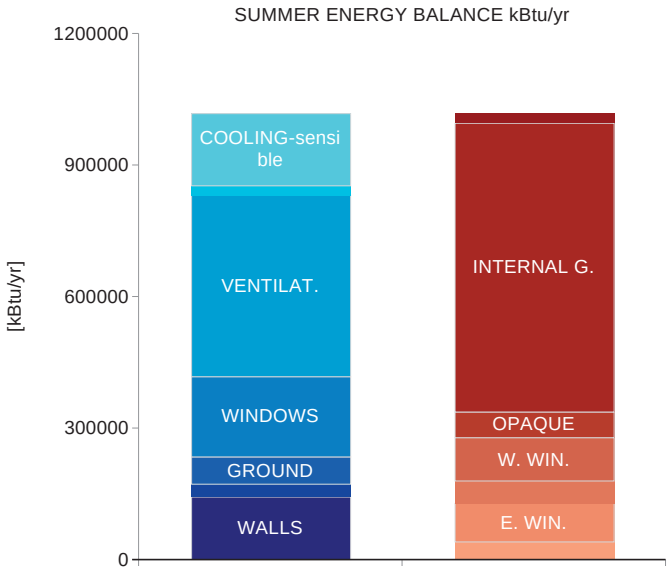
ANNUAL HEAT DEMAND

Transmission losses :	**594,576**	kBtu/yr
Ventilation losses:	**130,991**	kBtu/yr
Total heat losses:	**725,567**	kBtu/yr
Solar heat gains:	**211,924**	kBtu/yr
Internal heat gains:	**374,074**	kBtu/yr
Total heat gains:	**585,998**	kBtu/yr
Utilization factor:	**85.3**	%
Useful heat gains:	**499,703**	kBtu/yr
Annual heat demand:	**225,864**	kBtu/yr
Specific annual heat demand:	**3,901.4**	Btu/ft²yr

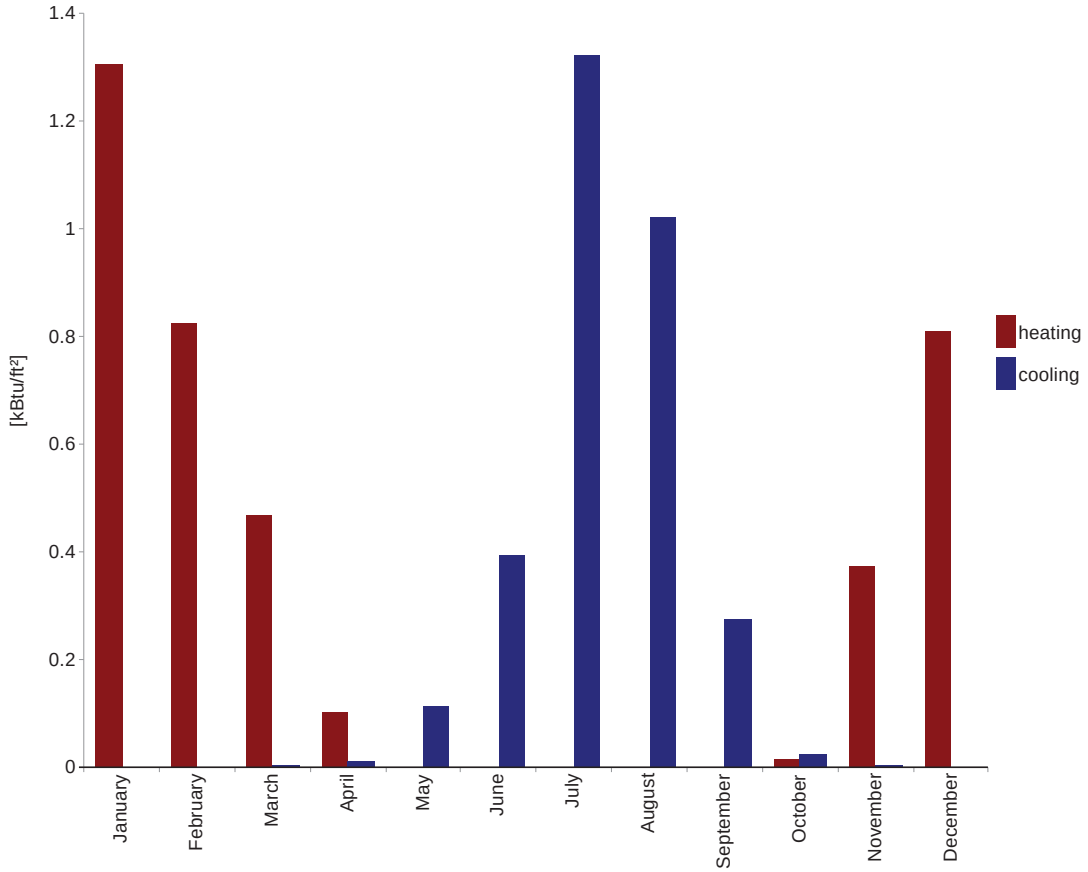
ANNUAL COOLING DEMAND

Solar heat gains:	**334,935**	kBtu/yr
Internal heat gains:	**657,300**	kBtu/yr
Total heat gains:	**992,235**	kBtu/yr
Transmission losses :	**965,971**	kBtu/yr
Ventilation losses:	**958,513**	kBtu/yr
Total heat losses:	**1,924,483**	kBtu/yr
Utilization factor:	**43.1**	%
Useful heat losses:	**830,342**	kBtu/yr
Cooling demand - sensible:	**161,893**	kBtu/yr
Cooling demand - latent:	**21,889**	kBtu/yr
Annual cooling demand:	**183,781**	kBtu/yr
Specific annual cooling demand:	**3.2**	kBtu/ft²yr





SPECIFIC HEAT/COOLING DEMAND MONTHLY



Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1.3	0
February	0.8	0
March	0.5	0
April	0.1	0
May	0	0.1
June	0	0.4
July	0	1.3
August	0	1
September	0	0.3
October	0	0
November	0.4	0
December	0.8	0

HEATING LOAD

	First climate	Second climate
Transmission heat losses:	**185,354.5** Btu/hr	**135,058.4** Btu/hr
Ventilation heat losses:	**64,814.1** Btu/hr	**46,083.6** Btu/hr
Total heat loss:	**250,168.6** Btu/hr	**181,142.1** Btu/hr
Solar heat gain:	**25,811.6** Btu/hr	**14,573.2** Btu/hr
Internal heat gain:	**29,366.2** Btu/hr	**29,366.2** Btu/hr
Total heat gains heating:	**55,177.8** Btu/hr	**43,939.4** Btu/hr
Heating load:	**194,990.8** Btu/hr	**137,202.7** Btu/hr

Relevant heating load: **194,990.8** Btu/hr

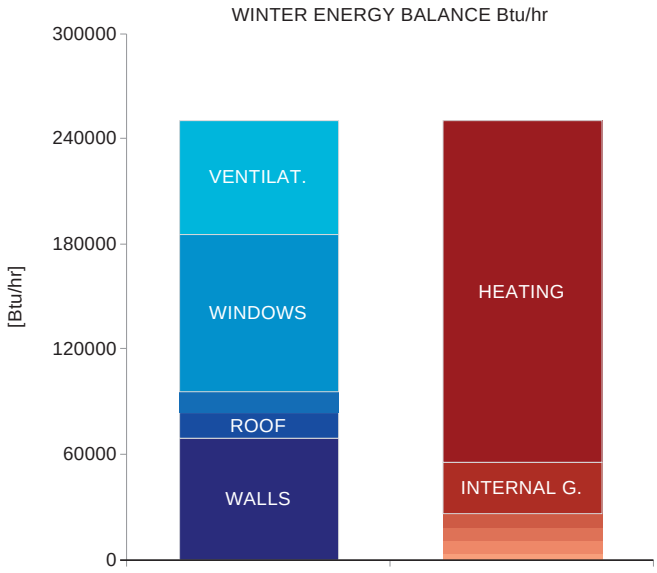
Specific heating load: **3.4** Btu/hr ft²

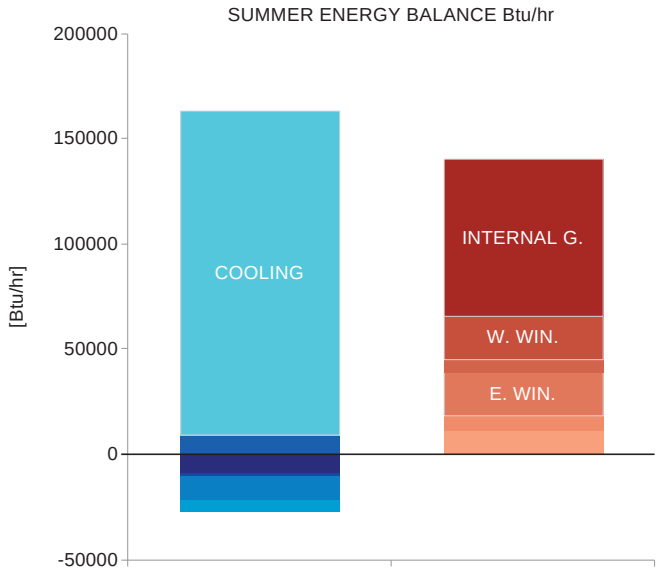
COOLING LOAD

Solar heat gain:	**65,384.1** Btu/hr
Internal heat gain:	**75,041.6** Btu/hr
Total heat gains cooling:	**140,425.7** Btu/hr
Transmission heat losses:	**-8,193.6** Btu/hr
Ventilation heat losses:	**-5,384.2** Btu/hr
Total heat loss:	**-13,577.9** Btu/hr
Cooling load - sensible:	**154,003.6** Btu/hr
Cooling load - latent:	**0** Btu/hr

Relevant cooling load: **154,003.6** Btu/hr

Specific maximum cooling load: **2.7** Btu/hr ft²





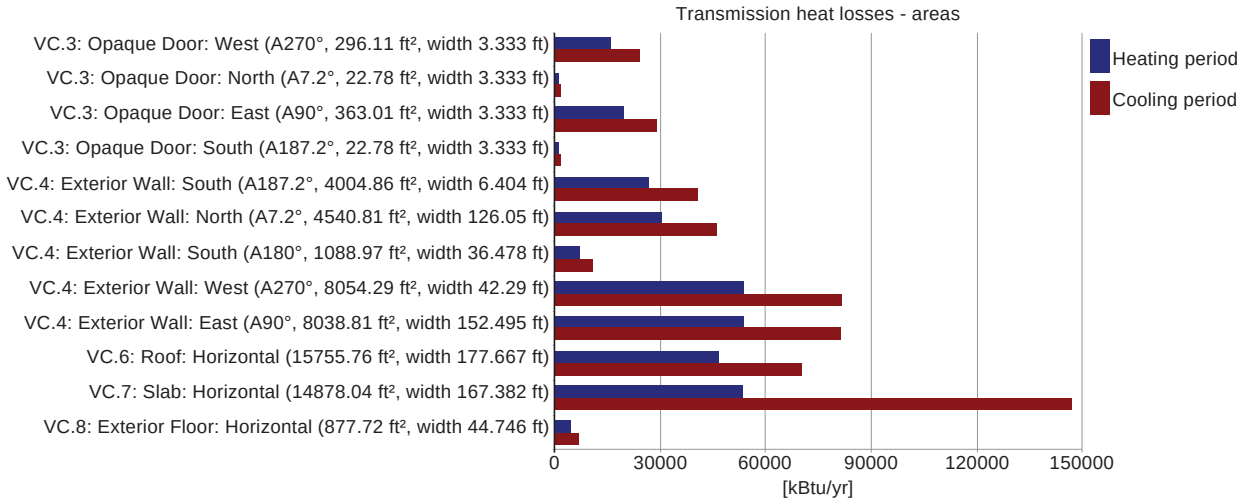
AREAS

Transmission heat losses - areas

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.3: Opaque Door: West (A270°, 296.11 ft², width 3.333 ft)	296.1	0.337	0.4	0.9	100	15852.1	23991.4
VC.3: Opaque Door: North (A7.2°, 22.78 ft², width 3.333 ft)	22.8	0.337	0.4	0.9	100	1219.4	1845.5
VC.3: Opaque Door: East (A90°, 363.01 ft², width 3.333 ft)	363	0.337	0.4	0.9	100	19433.3	29411.4
VC.3: Opaque Door: South (A187.2°, 22.78 ft², width 3.333 ft)	22.8	0.337	0.4	0.9	100	1219.4	1845.5
VC.4: Exterior Wall: South (A187.2°, 4004.86 ft², width 6.404 ft)	4004.9	0.042	0.4	0.9	100	26804.3	40567
VC.4: Exterior Wall: North (A7.2°, 4540.81 ft², width 126.05 ft)	4540.8	0.042	0.4	0.9	100	30391.3	45995.9
VC.4: Exterior Wall: South (A180°, 1088.97 ft², width 36.478 ft)	1089	0.042	0.4	0.9	100	7288.4	11030.7
VC.4: Exterior Wall: West (A270°, 8054.29 ft², width 42.29 ft)	8054.3	0.042	0.4	0.9	100	53906.8	81585.4
VC.4: Exterior Wall: East (A90°, 8038.81 ft², width 152.495 ft)	8038.8	0.042	0.4	0.9	100	53803.2	81428.6
VC.6: Roof: Horizontal (15755.76 ft², width 177.667 ft)	15755.8	0.019	0.4	0.9	100	46616.7	70552.3
VC.7: Slab: Horizontal (14878.04 ft², width 167.382 ft)	14878	0.088	0	0	0	53634.8	147281.9
VC.8: Exterior Floor: Horizontal (877.72 ft², width 44.746 ft)	877.7	0.031	0.4	0.9	100	4347.3	6579.4

Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	88.2	133.5
Ground heating	22.8	62.6



THERMAL BRIDGES

Transmission heat losses - thermal bridges

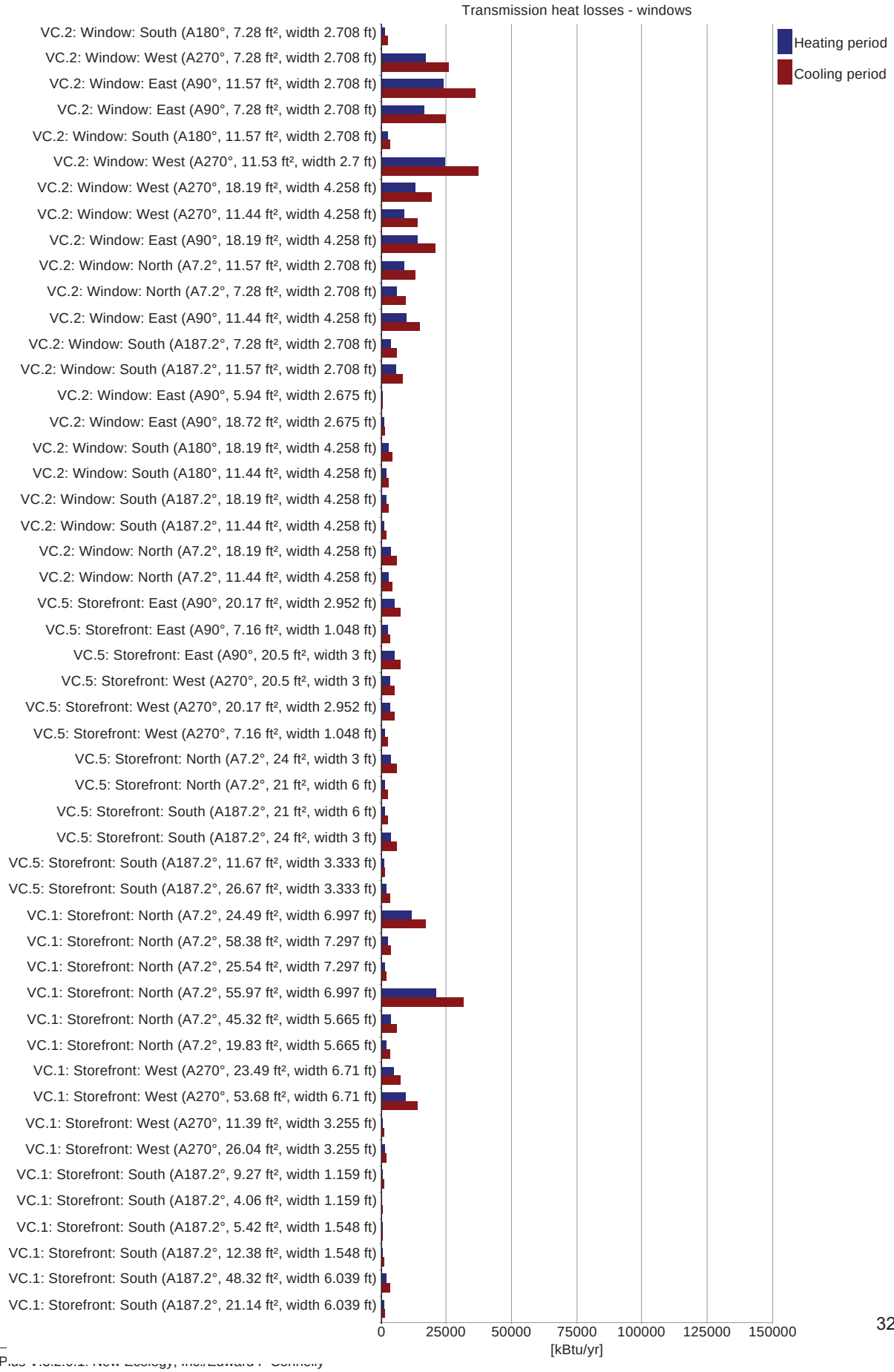
Name	Length [ft]	Psi-value [Btu/hr ft °F]	Transmission losses [kBtu/yr]	Transmission losses cooling [kBtu/yr]

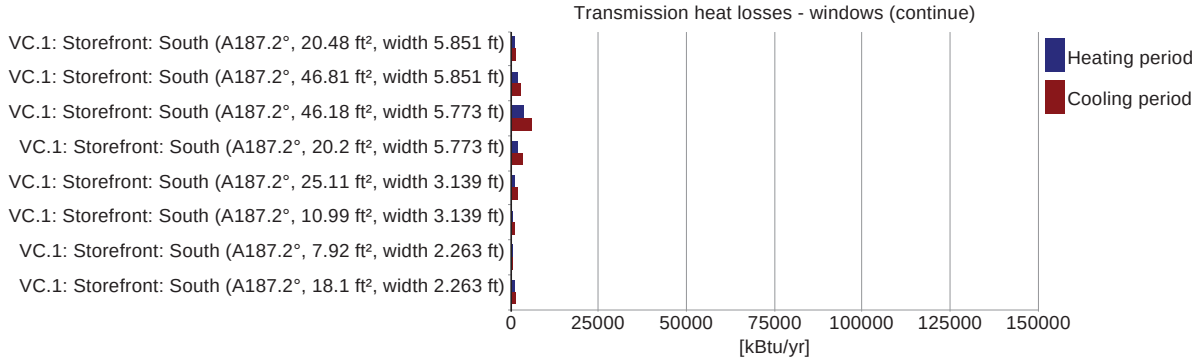
WINDOWS

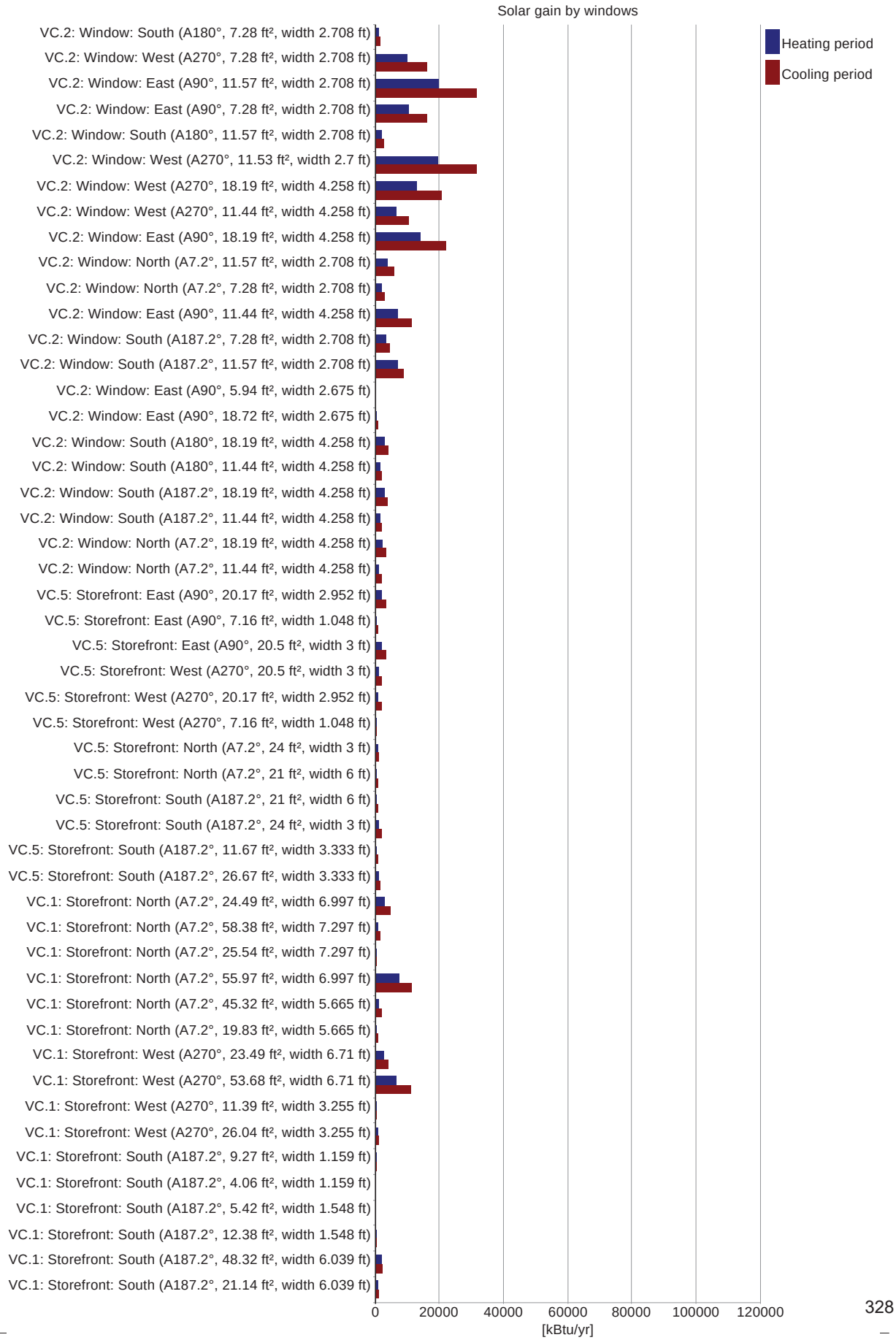
Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.2: Window: South (A180°, 7.28 ft², width 2.708 ft)	7	90	0.185	0.4	58.1	52.7	1,059.5	1,426.8	1,498.7	2,268.3
VC.2: Window: West (A270°, 7.28 ft², width 2.708 ft)	79	90	0.185	0.4	79.8	70.8	10,049.4	16,312.7	16,914.4	25,599.2
VC.2: Window: East (A90°, 11.57 ft², width 2.708 ft)	77	90	0.169	0.4	82.9	72.8	19,793.1	31,436.8	23,832.6	36,069.5
VC.2: Window: East (A90°, 7.28 ft², width 2.708 ft)	77	90	0.185	0.4	81.2	70.9	10,278.9	16,253.5	16,486.2	24,951.1
VC.2: Window: South (A180°, 11.57 ft², width 2.708 ft)	7	90	0.169	0.4	60.1	55.5	2,053.9	2,792	2,166.6	3,279
VC.2: Window: West (A270°, 11.53 ft², width 2.7 ft)	79	90	0.169	0.4	81.6	72.8	19,296.5	31,468.4	24,395.9	36,922
VC.2: Window: West (A270°, 18.19 ft², width 4.258 ft)	29	90	0.152	0.4	82.5	72.8	12,744.1	20,617.8	12,757.6	19,308
VC.2: Window: West (A270°, 11.44 ft², width 4.258 ft)	29	90	0.171	0.4	79.6	70	6,508.7	10,501.3	9,019.1	13,650
VC.2: Window: East (A90°, 18.19 ft², width 4.258 ft)	31	90	0.152	0.4	82.5	71.8	14,028.5	22,139.4	13,637.4	20,639.6
VC.2: Window: North (A7.2°, 11.57 ft², width 2.708 ft)	28	90	0.169	0.4	80.9	66.9	3,738.1	5,772.2	8,666.4	13,116.2
VC.2: Window: North (A7.2°, 7.28 ft², width 2.708 ft)	28	90	0.185	0.4	80.5	66.8	1,954.2	3,029.1	5,995	9,073.1
VC.2: Window: East (A90°, 11.44 ft², width 4.258 ft)	31	90	0.171	0.4	79.6	69.2	7,161.4	11,284.3	9,641.1	14,591.4
VC.2: Window: South (A187.2°, 7.28 ft², width 2.708 ft)	18	90	0.185	0.4	71.9	58	3,535.9	4,538.8	3,853.9	5,832.7
VC.2: Window: South (A187.2°, 11.57 ft², width 2.708 ft)	18	90	0.169	0.4	74.2	60.7	6,865	8,866.9	5,571.2	8,431.8
VC.2: Window: East (A90°, 5.94 ft², width 2.675 ft)	2	90	0.195	0.4	48.4	41.3	117.2	182.2	368	556.9
VC.2: Window: East (A90°, 18.72 ft², width 2.675 ft)	2	90	0.158	0.4	38.2	33.7	418.5	671.5	939.8	1,422.4
VC.2: Window: South (A180°, 18.19 ft², width 4.258 ft)	6	90	0.152	0.4	56.9	54.3	2,894.9	3,991	2,639.5	3,994.8
VC.2: Window: South (A180°, 11.44 ft², width 4.258 ft)	6	90	0.171	0.4	54.3	49.8	1,488.1	2,011.3	1,866	2,824.1
VC.2: Window: South (A187.2°, 18.19 ft², width 4.258 ft)	4	90	0.152	0.4	79.1	64.8	2,860	3,695.3	1,759.7	2,663.2
VC.2: Window: South (A187.2°, 11.44 ft², width 4.258 ft)	4	90	0.171	0.4	74.8	59.5	1,445.6	1,844.8	1,244	1,882.8
VC.2: Window: North (A7.2°, 18.19 ft², width 4.258 ft)	9	90	0.152	0.4	83.6	69.5	2,173.2	3,373.1	3,959.3	5,992.1
VC.2: Window: North (A7.2°, 11.44 ft², width 4.258 ft)	9	90	0.171	0.4	82.1	68.5	1,123.2	1,747.9	2,799	4,236.2
VC.5: Storefront: East (A90°, 20.17 ft², width 2.952 ft)	3	90	0.511	0.3	96	100	1,836.1	3,455.4	4,913.2	7,435.9
VC.5: Storefront: East (A90°, 7.16 ft², width 1.048 ft)	3	90	0.651	0.3	97.1	100	511.4	953.8	2,218.9	3,358.2
VC.5: Storefront: East (A90°, 20.5 ft², width 3 ft)	3	90	0.51	0.3	95.8	100	1,862.5	3,510.9	4,980.8	7,538.2
VC.5: Storefront: West (A270°, 20.5 ft², width 3 ft)	2	90	0.51	0.3	82.4	92.4	999.2	2,003.4	3,320.5	5,025.5
VC.5: Storefront: West (A270°, 20.17 ft², width 2.952 ft)	2	90	0.511	0.3	82.3	92.4	980.8	1,966.8	3,275.5	4,957.3
VC.5: Storefront: West (A270°, 7.16 ft², width 1.048 ft)	2	90	0.651	0.3	90.1	100	291.3	587	1,479.3	2,238.8
VC.5: Storefront: North (A7.2°, 24 ft², width 3 ft)	2	90	0.506	0.3	85.3	86	675.2	1,272.2	3,852.9	5,831.2
VC.5: Storefront: North (A7.2°, 21 ft², width 6 ft)	1	90	0.504	0.3	99.3	98.9	347.2	649.5	1,679.5	2,541.8
VC.5: Storefront: South (A187.2°, 21 ft², width 6 ft)	1	90	0.504	0.3	52.8	53.3	578.2	900.1	1,679.5	2,541.8
VC.5: Storefront: South (A187.2°, 24 ft², width 3 ft)	2	90	0.506	0.3	52.4	52.8	1,311.5	2,036.9	3,852.9	5,831.2
VC.5: Storefront: South (A187.2°, 11.67 ft², width 3.333 ft)	1	90	0.533	0.3	80.7	86	457.7	728.9	986.3	1,492.8
VC.5: Storefront: South (A187.2°, 26.67 ft², width 3.333 ft)	1	90	0.498	0.3	75.3	79.3	1,036.7	1,645.7	2,108.4	3,190.9
VC.1: Storefront: North (A7.2°, 24.49 ft², width 6.997 ft)	9	90	0.325	0.3	84.2	70.6	3,134.1	4,913.4	11,359.1	17,191.5
VC.1: Storefront: North (A7.2°, 58.38 ft², width 7.297 ft)	1	90	0.262	0.3	82.1	69.2	867.6	1,366.9	2,428.1	3,674.8
VC.1: Storefront: North (A7.2°, 25.54 ft², width 7.297 ft)	1	90	0.323	0.3	84.7	71	366.2	573.5	1,310.9	1,984.1
VC.1: Storefront: North (A7.2°, 55.97 ft², width 6.997 ft)	9	90	0.263	0.3	79.9	67.6	7,258	11,475.8	21,065.8	31,882.1
VC.1: Storefront: North (A7.2°, 45.32 ft², width 5.665 ft)	2	90	0.271	0.3	77.5	65.6	1,256.9	1,987.5	3,905.9	5,911.4
VC.1: Storefront: North (A7.2°, 19.83 ft², width 5.665 ft)	2	90	0.332	0.3	82.9	69.5	551.5	864	2,091.4	3,165.2
VC.1: Storefront: West (A270°, 23.49 ft², width 6.71 ft)	4	90	0.326	0.3	85.9	75.3	2,553.8	4,110.2	4,862.3	7,358.9
VC.1: Storefront: West (A270°, 53.68 ft², width 6.71 ft)	4	90	0.265	0.3	93.1	84	6,674.1	10,951.2	9,029.1	13,665.1
VC.1: Storefront: West (A270°, 11.39 ft², width 3.255 ft)	1	90	0.362	0.3	83.6	74.7	286.7	468.4	654.1	990
VC.1: Storefront: West (A270°, 26.04 ft², width 3.255 ft)	1	90	0.303	0.3	85.3	77.1	712.8	1,175.8	1,251.6	1,894.2
VC.1: Storefront: South (A187.2°, 9.27 ft², width 1.159 ft)	1	90	0.436	0.3	77.2	63.6	346.5	449.6	641.3	970.5
VC.1: Storefront: South (A187.2°, 4.06 ft², width 1.159 ft)	1	90	0.487	0.3	78.7	64.9	143.7	186.4	313.4	474.3
VC.1: Storefront: South (A187.2°, 5.42 ft², width 1.548 ft)	1	90	0.438	0.3	75.8	62	195.6	252.8	376.6	570
VC.1: Storefront: South (A187.2°, 12.38 ft², width 1.548 ft)	1	90	0.384	0.3	74.1	61	469.4	608.5	754.5	1,141.9
VC.1: Storefront: South (A187.2°, 48.32 ft², width 6.039 ft)	1	90	0.269	0.3	67.9	58.7	1,833	2,427.8	2,062	3,120.8
VC.1: Storefront: South (A187.2°, 21.14 ft², width 6.039 ft)	1	90	0.33	0.3	70.4	57.1	794.3	1,022.2	1,106.6	1,674.8

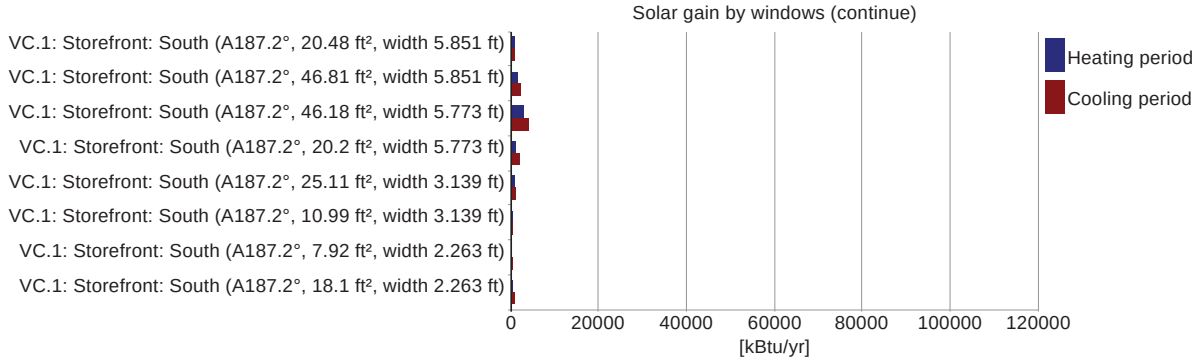
Transmission heat losses - windows (continue)

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Storefront: South (A187.2°, 20.48 ft², width 5.851 ft)	1	90	0.331	0.3	67.7	55.7	735.9	952.4	1,076	1,628.4
VC.1: Storefront: South (A187.2°, 46.81 ft², width 5.851 ft)	1	90	0.27	0.3	65.1	56.9	1,693.7	2,251.7	2,007.2	3,037.8
VC.1: Storefront: South (A187.2°, 46.18 ft², width 5.773 ft)	2	90	0.271	0.3	61.2	51.6	3,187.9	4,175.4	3,968.7	6,006.5
VC.1: Storefront: South (A187.2°, 20.2 ft², width 5.773 ft)	2	90	0.332	0.3	63.2	52.1	1,354.8	1,752.8	2,126.5	3,218.3
VC.1: Storefront: South (A187.2°, 25.11 ft², width 3.139 ft)	1	90	0.305	0.3	57.8	48.4	795	1,038.3	1,217.7	1,842.9
VC.1: Storefront: South (A187.2°, 10.99 ft², width 3.139 ft)	1	90	0.364	0.3	62.3	50.8	352.2	454.5	635.2	961.4
VC.1: Storefront: South (A187.2°, 7.92 ft², width 2.263 ft)	1	90	0.392	0.3	57.9	47.3	229.9	296.6	492.8	745.9
VC.1: Storefront: South (A187.2°, 18.1 ft², width 2.263 ft)	1	90	0.335	0.3	55.1	45.2	536.8	694	962.7	1,456.9


Transmission heat losses - windows
Heating period
Cooling period
VC.2: Window: South (A180°, 7.28 ft², width 2.708 ft)
VC.2: Window: West (A270°, 7.28 ft², width 2.708 ft)
VC.2: Window: East (A90°, 11.57 ft², width 2.708 ft)
VC.2: Window: East (A90°, 7.28 ft², width 2.708 ft)
VC.2: Window: South (A180°, 11.57 ft², width 2.708 ft)
VC.2: Window: West (A270°, 11.53 ft², width 2.7 ft)
VC.2: Window: West (A270°, 18.19 ft², width 4.258 ft)
VC.2: Window: West (A270°, 11.44 ft², width 4.258 ft)
VC.2: Window: East (A90°, 18.19 ft², width 4.258 ft)
VC.2: Window: North (A7.2°, 11.57 ft², width 2.708 ft)
VC.2: Window: North (A7.2°, 7.28 ft², width 2.708 ft)
VC.2: Window: East (A90°, 11.44 ft², width 4.258 ft)
VC.2: Window: South (A187.2°, 7.28 ft², width 2.708 ft)
VC.2: Window: South (A187.2°, 11.57 ft², width 2.708 ft)
VC.2: Window: East (A90°, 5.94 ft², width 2.675 ft)
VC.2: Window: East (A90°, 18.72 ft², width 2.675 ft)
VC.2: Window: South (A180°, 18.19 ft², width 4.258 ft)
VC.2: Window: South (A180°, 11.44 ft², width 4.258 ft)
VC.2: Window: South (A187.2°, 18.19 ft², width 4.258 ft)
VC.2: Window: South (A187.2°, 11.44 ft², width 4.258 ft)
VC.2: Window: North (A7.2°, 18.19 ft², width 4.258 ft)
VC.2: Window: North (A7.2°, 11.44 ft², width 4.258 ft)
VC.5: Storefront: East (A90°, 20.17 ft², width 2.952 ft)
VC.5: Storefront: East (A90°, 7.16 ft², width 1.048 ft)
VC.5: Storefront: East (A90°, 20.5 ft², width 3 ft)
VC.5: Storefront: West (A270°, 20.5 ft², width 3 ft)
VC.5: Storefront: West (A270°, 20.17 ft², width 2.952 ft)
VC.5: Storefront: West (A270°, 7.16 ft², width 1.048 ft)
VC.5: Storefront: North (A7.2°, 24 ft², width 3 ft)
VC.5: Storefront: North (A7.2°, 21 ft², width 6 ft)
VC.5: Storefront: South (A187.2°, 21 ft², width 6 ft)
VC.5: Storefront: South (A187.2°, 24 ft², width 3 ft)
VC.5: Storefront: South (A187.2°, 11.67 ft², width 3.333 ft)
VC.5: Storefront: South (A187.2°, 26.67 ft², width 3.333 ft)
VC.1: Storefront: North (A7.2°, 24.49 ft², width 6.997 ft)
VC.1: Storefront: North (A7.2°, 58.38 ft², width 7.297 ft)
VC.1: Storefront: North (A7.2°, 25.54 ft², width 7.297 ft)
VC.1: Storefront: North (A7.2°, 55.97 ft², width 6.997 ft)
VC.1: Storefront: North (A7.2°, 45.32 ft², width 5.665 ft)
VC.1: Storefront: North (A7.2°, 19.83 ft², width 5.665 ft)
VC.1: Storefront: West (A270°, 23.49 ft², width 6.71 ft)
VC.1: Storefront: West (A270°, 53.68 ft², width 6.71 ft)
VC.1: Storefront: West (A270°, 11.39 ft², width 3.255 ft)
VC.1: Storefront: West (A270°, 26.04 ft², width 3.255 ft)
VC.1: Storefront: South (A187.2°, 9.27 ft², width 1.159 ft)
VC.1: Storefront: South (A187.2°, 4.06 ft², width 1.159 ft)
VC.1: Storefront: South (A187.2°, 5.42 ft², width 1.548 ft)
VC.1: Storefront: South (A187.2°, 12.38 ft², width 1.548 ft)
VC.1: Storefront: South (A187.2°, 48.32 ft², width 6.039 ft)
VC.1: Storefront: South (A187.2°, 21.14 ft², width 6.039 ft)
0
25000
50000
75000
100000
125000
150000
[kBtu/yr]


Transmission heat losses - windows (continue)
VC.1: Storefront: South (A187.2°, 20.48 ft², width 5.851 ft)
VC.1: Storefront: South (A187.2°, 46.81 ft², width 5.851 ft)
VC.1: Storefront: South (A187.2°, 46.18 ft², width 5.773 ft)
VC.1: Storefront: South (A187.2°, 20.2 ft², width 5.773 ft)
VC.1: Storefront: South (A187.2°, 25.11 ft², width 3.139 ft)
VC.1: Storefront: South (A187.2°, 10.99 ft², width 3.139 ft)
VC.1: Storefront: South (A187.2°, 7.92 ft², width 2.263 ft)
VC.1: Storefront: South (A187.2°, 18.1 ft², width 2.263 ft)
Heating period
Cooling period
0
25000
50000
75000
100000
125000
150000
[kBtu/yr]


Solar gain by windows
Heating period
Cooling period
VC.2: Window: South (A180°, 7.28 ft², width 2.708 ft)
VC.2: Window: West (A270°, 7.28 ft², width 2.708 ft)
VC.2: Window: East (A90°, 11.57 ft², width 2.708 ft)
VC.2: Window: East (A90°, 7.28 ft², width 2.708 ft)
VC.2: Window: South (A180°, 11.57 ft², width 2.708 ft)
VC.2: Window: West (A270°, 11.53 ft², width 2.7 ft)
VC.2: Window: West (A270°, 18.19 ft², width 4.258 ft)
VC.2: Window: West (A270°, 11.44 ft², width 4.258 ft)
VC.2: Window: East (A90°, 18.19 ft², width 4.258 ft)
VC.2: Window: North (A7.2°, 11.57 ft², width 2.708 ft)
VC.2: Window: North (A7.2°, 7.28 ft², width 2.708 ft)
VC.2: Window: East (A90°, 11.44 ft², width 4.258 ft)
VC.2: Window: South (A187.2°, 7.28 ft², width 2.708 ft)
VC.2: Window: South (A187.2°, 11.57 ft², width 2.708 ft)
VC.2: Window: East (A90°, 5.94 ft², width 2.675 ft)
VC.2: Window: East (A90°, 18.72 ft², width 2.675 ft)
VC.2: Window: South (A180°, 18.19 ft², width 4.258 ft)
VC.2: Window: South (A180°, 11.44 ft², width 4.258 ft)
VC.2: Window: South (A187.2°, 18.19 ft², width 4.258 ft)
VC.2: Window: South (A187.2°, 11.44 ft², width 4.258 ft)
VC.2: Window: North (A7.2°, 18.19 ft², width 4.258 ft)
VC.2: Window: North (A7.2°, 11.44 ft², width 4.258 ft)
VC.5: Storefront: East (A90°, 20.17 ft², width 2.952 ft)
VC.5: Storefront: East (A90°, 7.16 ft², width 1.048 ft)
VC.5: Storefront: East (A90°, 20.5 ft², width 3 ft)
VC.5: Storefront: West (A270°, 20.5 ft², width 3 ft)
VC.5: Storefront: West (A270°, 20.17 ft², width 2.952 ft)
VC.5: Storefront: West (A270°, 7.16 ft², width 1.048 ft)
VC.5: Storefront: North (A7.2°, 24 ft², width 3 ft)
VC.5: Storefront: North (A7.2°, 21 ft², width 6 ft)
VC.5: Storefront: South (A187.2°, 21 ft², width 6 ft)
VC.5: Storefront: South (A187.2°, 24 ft², width 3 ft)
VC.5: Storefront: South (A187.2°, 11.67 ft², width 3.333 ft)
VC.5: Storefront: South (A187.2°, 26.67 ft², width 3.333 ft)
VC.1: Storefront: North (A7.2°, 24.49 ft², width 6.997 ft)
VC.1: Storefront: North (A7.2°, 58.38 ft², width 7.297 ft)
VC.1: Storefront: North (A7.2°, 25.54 ft², width 7.297 ft)
VC.1: Storefront: North (A7.2°, 55.97 ft², width 6.997 ft)
VC.1: Storefront: North (A7.2°, 45.32 ft², width 5.665 ft)
VC.1: Storefront: North (A7.2°, 19.83 ft², width 5.665 ft)
VC.1: Storefront: West (A270°, 23.49 ft², width 6.71 ft)
VC.1: Storefront: West (A270°, 53.68 ft², width 6.71 ft)
VC.1: Storefront: West (A270°, 11.39 ft², width 3.255 ft)
VC.1: Storefront: West (A270°, 26.04 ft², width 3.255 ft)
VC.1: Storefront: South (A187.2°, 9.27 ft², width 1.159 ft)
VC.1: Storefront: South (A187.2°, 4.06 ft², width 1.159 ft)
VC.1: Storefront: South (A187.2°, 5.42 ft², width 1.548 ft)
VC.1: Storefront: South (A187.2°, 12.38 ft², width 1.548 ft)
VC.1: Storefront: South (A187.2°, 48.32 ft², width 6.039 ft)
VC.1: Storefront: South (A187.2°, 21.14 ft², width 6.039 ft)
0
20000
40000
60000
80000
100000
120000
[kBtu/yr]



Summary building envelope

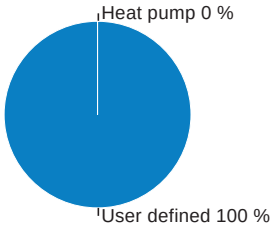
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	**27,310.1** ft²	**0.049** Btu/hr ft² °F	**214,265.5** kBtu/yr
Exterior wall ground:	**0** ft²	**0** Btu/hr ft² °F	**0** kBtu/yr
Basement:	**14,878** ft²	**0.088** Btu/hr ft² °F	**53,634.8** kBtu/yr
Roof:	**15,755.8** ft²	**0.019** Btu/hr ft² °F	**46,616.7** kBtu/yr
Windows:	**8,388.8** ft²	**0.21** Btu/hr ft² °F	**280,058.8** kBtu/yr
Doors:	**0** ft²	**0** Btu/hr ft² °F	**0** kBtu/yr
Thermal bridge ambient:	**0** ft	**0** Btu/hr ft °F	**0** kBtu/yr
Thermal bridge perimeter:	**0** ft	**0** Btu/hr ft °F	**0** kBtu/yr
Thermal bridge floor slab:	**0** ft	**0** Btu/hr ft °F	**0** kBtu/yr

Shading

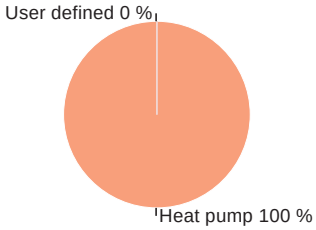
	Heating	Cooling
Reduction factor North:	**81.6** %	**69** %
Reduction factor East:	**82.1** %	**72.8** %
Reduction factor South:	**65.8** %	**57** %
Reduction factor West:	**82.7** %	**74.2** %
Reduction factor Horizontal:	**100** %	**100** %

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Source energy demand [kBtu/yr]
Heat pump, VRF	0	0	0	100	0	74,251.1	0	32,626,195.6	133,652
User defined, Condensing Gas-Fired Boilers	100	0	302,404.1	0	0	0	1.1	18,188,671.8	332,644.6
Σ	100	0	302,404.1	100	0	74,251.1		50,814,867.4	466,296.6

DHW - final energy



Heating - final energy



COOLING UNITS

	sensible	latent
Air cooling:	**0** kBtu/ft²yr	**0** kBtu/ft²yr
Recirculation cooling:	**2.8** kBtu/ft²yr	**0** kBtu/ft²yr
Additional dehumidification:		**0.4** kBtu/ft²yr
Panel cooling:	**0** kBtu/ft²yr	
Sum:	**2.8** kBtu/ft²yr	**0.4** kBtu/ft²yr

VENTILATION

Energy transportable by supply air

Heating energy

transportable: **1.28** W/ft²

load: **0.99** W/ft²

Cooling energy

transportable: **0.81** W/ft²

load: **0.78** W/ft²

Infiltration pressure test ACH50:	**0.53** 1/hr
Total extract air demand:	**3,700** cfm
Supply air per person:	**18** cfm
Occupancy:	**121**

Average air flow rate:	**3,700** cfm
Average air change rate:	**0.49** 1/hr
Effective ACH ambient:	**0.1** 1/hr
Effective ACH ground:	**0** 1/hr
Energetically effective air exchange:	**0.1** 1/hr
Infiltration air change rate:	**0.04** 1/hr
Infiltration air change rate (heating load):	**0.09** 1/hr

Type of ventilation system:	**Balanced PH ventilation**
Wind screening coefficient (e):	**0.07**
Wind exposure factor:	**15**
Wind shield factor:	**0.05**

Ventilation heat losses: **116,223.96** kBtu/yr

Devices

Name	Sensible recovery efficiency [-]	Electric efficiency [W/cfm]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Basic Central ERV	0.9	0.04	0	0.9
Altogether	0.9	0.04	0	0.9

Ducts

Name	Length (total) [ft]	Clear cross-section [ft²]	U-value [Btu/hr ft² °F]	Assigned ventilation units
ERV-1	10	2.25	14.33	Basic Central ERV
ERV-1	10	2.25	14.33	Basic Central ERV
Σ	20			

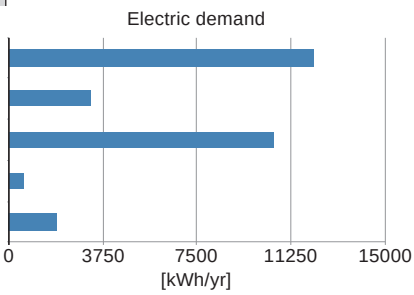
*length * quantity ** thermal conductivity / thickness

SUMMER VENTILATION

ACH night ventilation:	**0** 1/hr
ACH natural summer:	**0** 1/hr
Mechanical ventilation summer:	**0.5** 1/hr
Mechanical ventilation summer with HR:	**no**

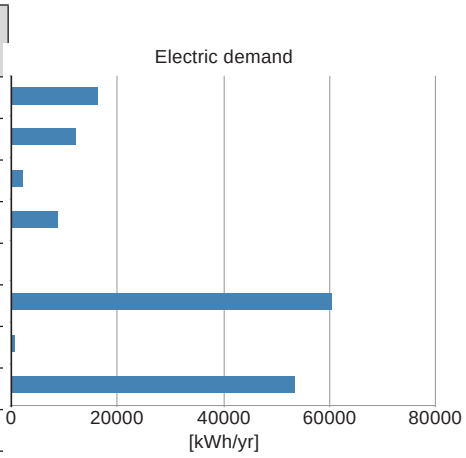
ELECTRICITY DEMAND - AUXILIARY ELECTRICITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Source energy [kBtu/yr]
Ventilation winter	1	no	0.7 W/cfm	12116	74407.1
Ventilation Defrost	1	no	17,359 W	3243	19916
Ventilation summer	1	no	0.7 W/cfm	10572.4	64928
DHW circulating pump	1	yes	69.8 W	575.9	3536.6
DHW storage load pump	1	yes	359.7 W	1880.7	11550
Σ				28388	174337.7



ELECTRICITY DEMAND RESIDENTIAL BUILDING

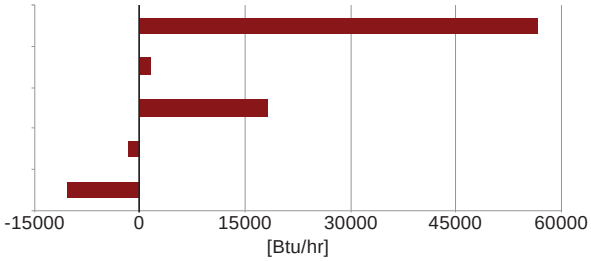
Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Non-electric demand [kWh/yr]	Source energy [kBtu/yr]
Kitchen refrigerator	1	yes	1.2	16280	0	99979.5
Kitchen cooking	1	yes	0.2	12100	0	74309.1
Laundry - washer	1	yes	0.3	1886.3	0	11584
Laundry - dryer	1	yes	6	8553.4	0	52528.3
Energy consumed by evaporation	0	yes	3.1	0	1238.8	5232.5
User defined lighting	1	yes	60,347	60347	0	370605.9
User defined lighting	1	no	560	560	0	3439.1
User defined MELs	1	yes	53,391	53391	0	327887.4
Σ	7			153117.6	1238.8	945566



INTERNAL HEAT GAINS

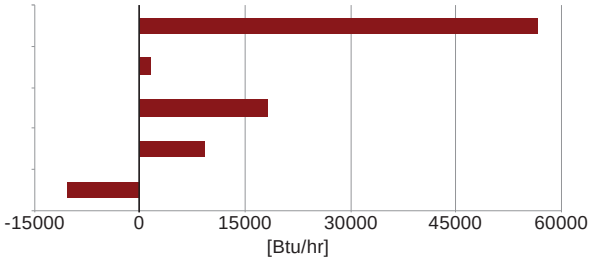
Heating season

Electricity total:	**56,552.4**	Btu/hr
Auxiliary electricity:	**1,491.6**	Btu/hr
People:	**18,166.2**	Btu/hr
Cold water:	**-1,681.2**	Btu/hr
Evaporation:	**-10,321.7**	Btu/hr
Σ:	**64,147.9**	Btu/hr
Specific internal heat gains:	**1.1**	Btu/hr ft²



Cooling season

Electricity total:	**56,552.4**	Btu/hr
Auxiliary electricity:	**1,491.6**	Btu/hr
People:	**18,166.2**	Btu/hr
Cold and hot water:	**9,212.5**	Btu/hr
Evaporation:	**-10,321.7**	Btu/hr
Σ:	**64,147.9**	Btu/hr
Specific internal heat gains:	**1.1**	Btu/hr ft²



DHW AND DISTRIBUTION

DHW consumption per person per day:	**6.6**	gal/Person/day
Average cold water temperature supply:	**52.8**	°F
Useful heat DHW:	**211,468.4**	kBtu/yr
Specific useful heat DHW:	**3,652.7**	Btu/ft²yr
Total heat losses of the DHW system:	**56,145.9**	kBtu/yr
Specific losses of the DHW system:	**969.8**	Btu/ft²yr
Performance ratio DHW distribution system and storage:	**1.3**	
Utilization ratio DHW distribution system and storage:	**0.8**	
Total heat demand of DHW system:	**267,614.3**	kBtu/yr
Total specific heat demand of DHW system:	**4,622.5**	Btu/ft²yr
Total heat losses of the hydronic heating distribution:	**0**	kBtu/yr
Specific losses of the hydronic heating distribution:	**0**	Btu/ft²yr
Performance ratio of heat distribution:	**100**	%

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
In conditioned space	1880	40688.3
Σ	1880	40688.3
Individual pipes		
In conditioned space	925	8488.7
Σ	925	8488.7
Water storage		
Device 4 (Water storage: DHW)		1742.2
Σ		1742.2

BUILDING INFORMATION

Category:	**Residential**
Status:	**In planning**
Building type:	**New construction**
Year of construction:	
Units:	**37**
Number of occupants:	**11 2Design(**
Occupant density:	**) 7) 47** ft²/Person

Boundar8 conditions

Climate:	**MA . BO5TON LOGAN INT ARyT 2cold 8ear(**	
Internal heat gains:	**348**	Btu/hr ft²
Interior temperature:	**17**	°F
Overheat temperature:	**- -**	°F

Building geoS etr8

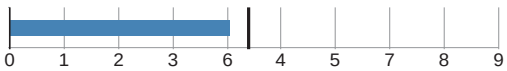
Enclosed volume:	**P16n1- 7**	ft³
Net-volume:	**P90n6, , 4)**	ft³
Total area envelope:	**)) n61P4-**	ft²
Area/Volume Ratio:	**943**	1/ft
Floor area:	**P, n) 9**	ft²
Envelope area/iCFA:	**34) 03**	

yA55IVEHOU5E REQUIREMENT5

Certificate criteria: yHIU5+ P937

Heating deS and

specific:	**0490**	kBtu/ft²yr
target:	**040**	kBtu/ft²yr
total:	102,256.38	kBtu/yr

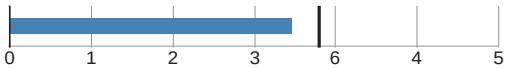


Cooling deS and

sensible:	**P46**	kBtu/ft²yr
latent:	**9403**	kBtu/ft²yr
specific:	**) 4) 3**	kBtu/ft²yr
target:	**, 4**	kBtu/ft²yr
total:	83,796.62	kBtu/yr

Heating load

specific:	**) 401**	Btu/hr ft²
target:	**) 47**	Btu/hr ft²
total:	87,596.93	Btu/hr



Cooling load

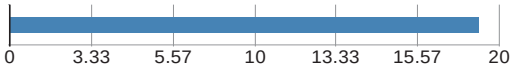
specific:	**P410**	Btu/hr ft²
target:	**P47**	Btu/hr ft²
total:	55,841.97	Btu/hr

5ource energ8

total:	PPPn970406	kWh/yr
specific:	) n1,	kWh/Person yr
target:	) m709	kWh/Person yr
total:	- , - m9745P	kBtu/yr
specific:	29.92	kBtu/ft²yr

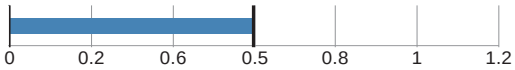
5ite energ8

total:	686,998.78	kBtu/yr
specific:	19.14	kBtu/ft²yr
total:	162,143.16	kWh/yr
specific:	4.51	kWh/ft²



Air tightness

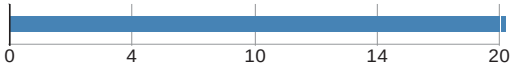
ACH40:	941	1/hr
CFM40 per envelope area:	9491	cfm/ft²
target:	941	1/hr
target CFM40:	9491	cfm/ft²



y A55IVEHOU5E RECOMMENDATION5

Sensible recovery efficiency:	7, 43	%
Frequency of overheating: Cooling system is required	) 34	%

Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

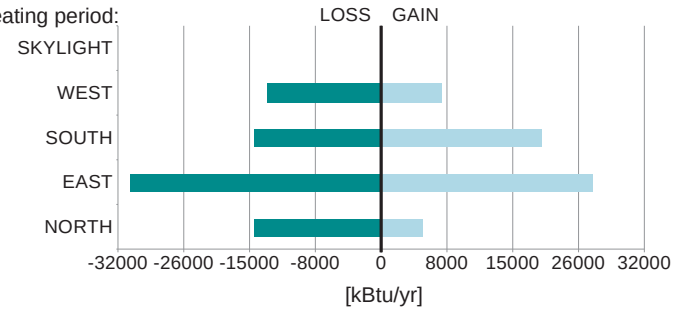


BUILDING ELEMENT5

Windows

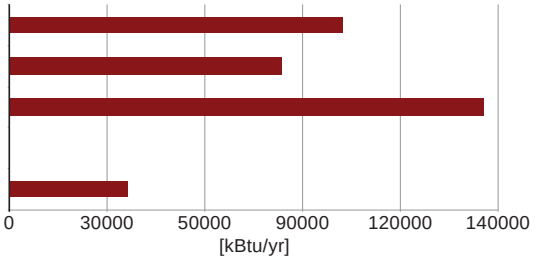
Average SHGC:	94 01	
Average solar reduction factor heating:	94) 0	
Average solar reduction factor cooling:	94) 3	
Average U-value:	94 3- ,	Btu/hr ft² °F
Total glazing area:	3m 1734 3	ft²
Total window area:	) m 9 , , 47	ft²

Heat gain/loss heating period:



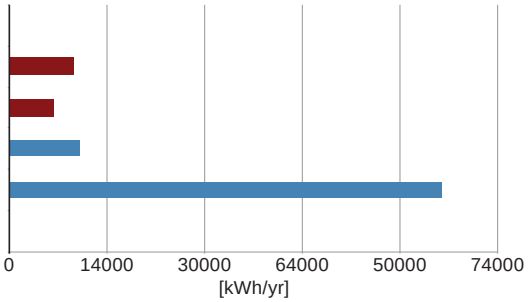
HVAC

Total heating demand:	39Pm R10	kBtu/yr
Total cooling demand:	7) m 60	kBtu/yr
Total DHW energy demand:	30, m, 3	kBtu/yr
Solar DHW contribution:	9	kBtu/yr
Auxiliary electricity:	) 1m P,	kBtu/yr



Electricit8

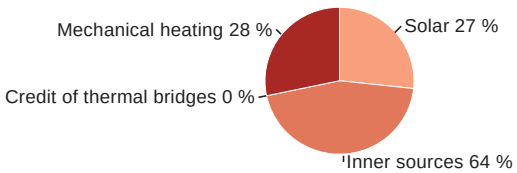
Direct heating / DHW:	9	kWh/yr
Heatpump heating:	6m 7) -	kWh/yr
Cooling:	1m 69)	kWh/yr
HVAC auxiliary energy:	39m 91	kWh/yr
Appliances:	11m 0) ,	kWh/yr
Renewable generation, coincident production and use:	9	kWh/yr
Total electricity demand:	6) m 79	kWh/yr



HEAT FLOW . HEATING y ERIOD

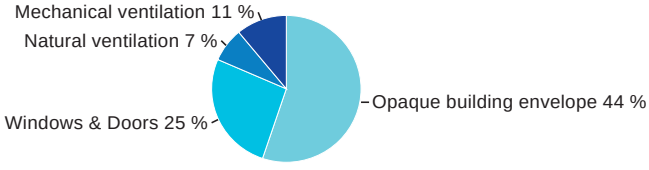
Heat gains

Solar:	7) m R13	kBtu/yr
Inner sources:	309m)1-	kBtu/yr
Credit of thermal bridges:	9	kBtu/yr
Mechanical heating:	39Pm R10	kBtu/yr



Heat losses

Opaque building envelope:	3- 6m 17	kBtu/yr
Windows & Doors:	7, m 60P	kBtu/yr
Natural ventilation:	P0m)7,	kBtu/yr
Mechanical ventilation:	) , m 6-	kBtu/yr

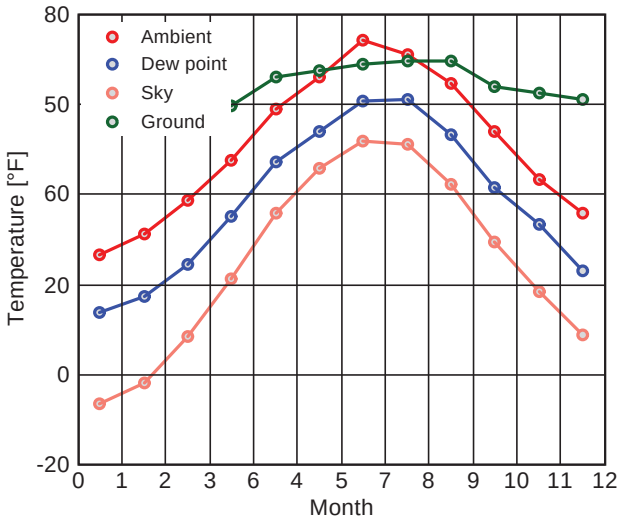


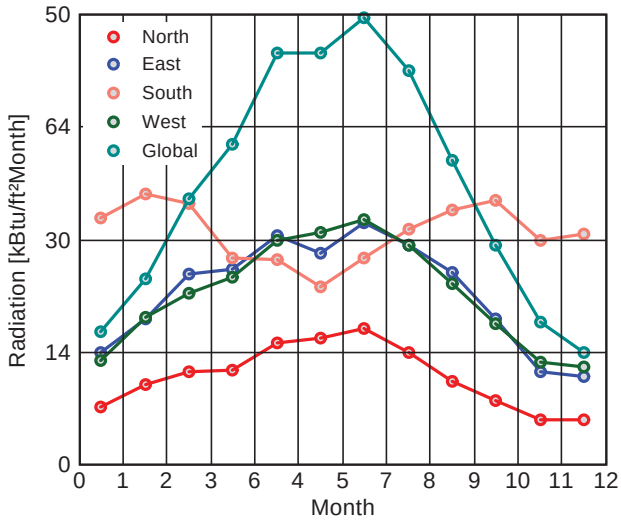
CLIMATE

Latitude:	0P40 °
Longitude:	.-3 °
Elevation of weather station:	364 ft
Elevation of building site:	1 ft
Heat capacity air:	94937 Btu/ft³F
Daily temperature swing summer:	3047 °F
Average wind speed:	3)43 ft/s

Ground

Average ground surface temperature:	,P47 °F
Amplitude ground surface temperature:	,,47 °F
Ground thermal conductivity:	34P Btu/hr ft °F
Ground heat capacity:	P647 Btu/ft³F
Depth below grade of groundwater:	647 ft
Flow rate groundwater:	94P ft/d





Calculation paraS eters

Length of heating period	P0) days/yr
Heating degree hours	30946 kFh/a
Phase shift months	34) mths
Time constant heating demand	33)4P hr
Time constant cooling demand	9 hr
Time constant cooling demand with night ventilation	9 hr

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	15.9	31.5	83.4
Solar radiation North [Btu/hr ft²]	12	7.9	27.5
Solar radiation East [Btu/hr ft²]	22.8	13.3	51.4
Solar radiation South [Btu/hr ft²]	69.4	27.3	61.8
Solar radiation West [Btu/hr ft²]	22.2	11.6	43.3
Solar radiation Global [Btu/hr ft²]	25.9	15.4	101.6

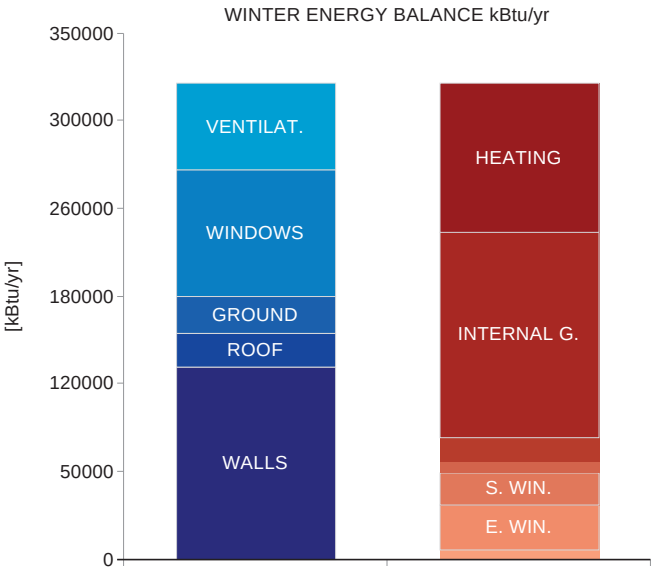
Relevant boundary conditions for heating load calculation: Heating load 1

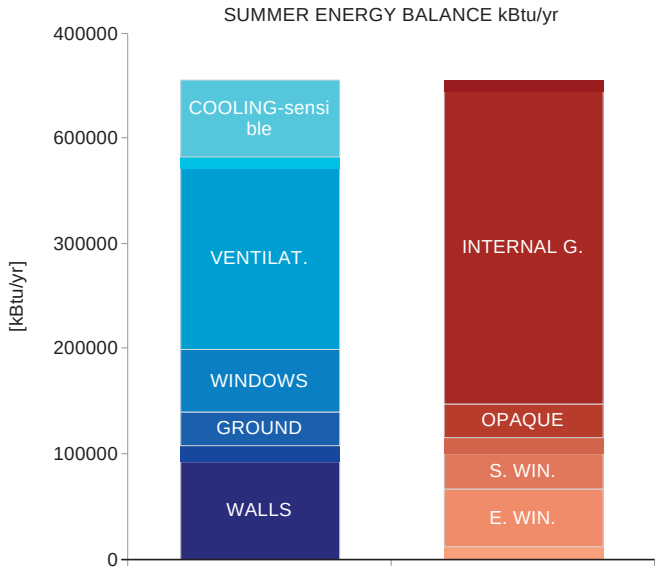
ANNUAL HEAT DEMAND

Transmission losses :	P1, m96	kBtu/yr
Ventilation losses:	19m87)	kBtu/yr
Total heat losses:	) P, m76P	kBtu/yr
Solar heat gains:	61m) ,	kBtu/yr
Internal heat gains:	31Pm0,	kBtu/yr
Total heat gains:	P, 6m79	kBtu/yr
Utilization factor:	714P	%
Useful heat gains:	PP) m1P7	kBtu/yr
Annual heat demand:	39Pm10	kBtu/yr
Specific annual heat demand:	0m) - 4	Btu/ft²yr

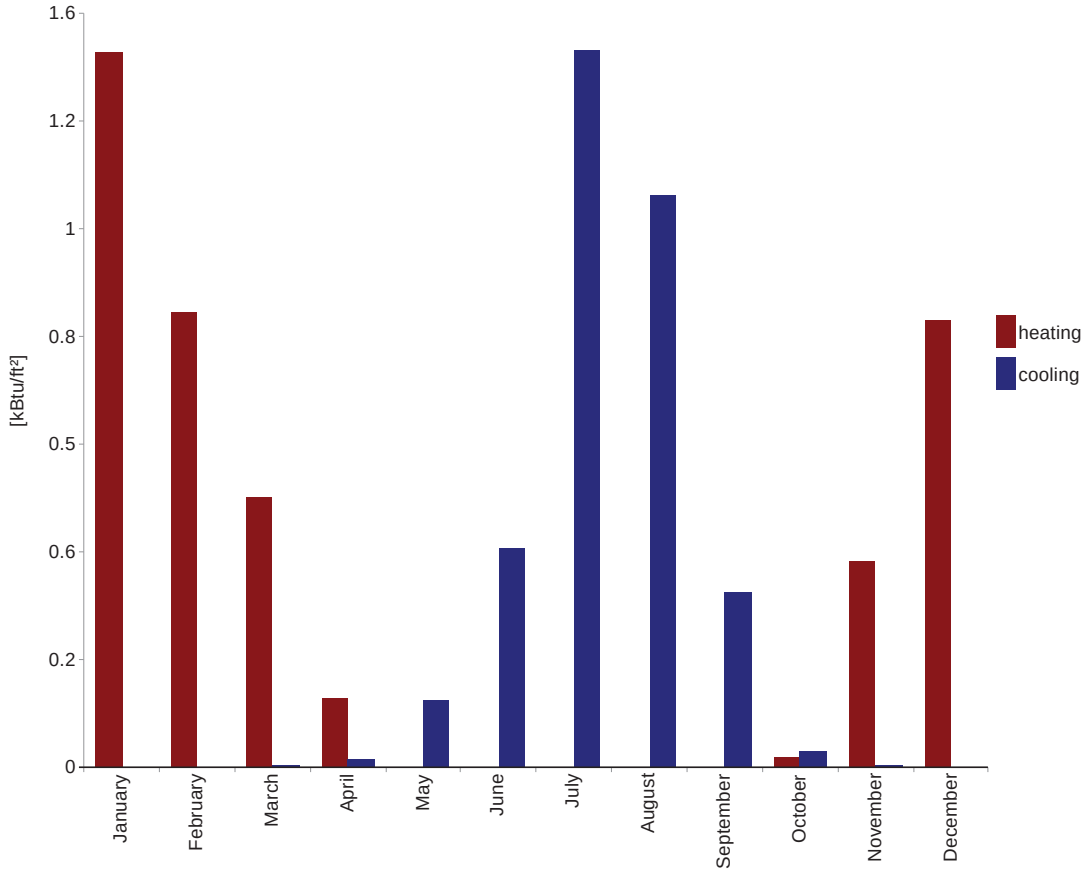
ANNUAL COOLING DEMAND

Solar heat gains:	30- m79	kBtu/yr
Internal heat gains:	P61m69	kBtu/yr
Total heat gains:	000m- 9	kBtu/yr
Transmission losses :	0) Pm67	kBtu/yr
Ventilation losses:	) - 3m1P,	kBtu/yr
Total heat losses:	790m1P0	kBtu/yr
Utilization factor:	0143	%
Useful heat losses:	) - 9m70	kBtu/yr
Cooling demand - sensible:	-) m71	kBtu/yr
Cooling demand - latent:	39m097	kBtu/yr
Annual cooling demand:	7) m60	kBtu/yr
Specific annual cooling demand:	) 4	kBtu/ft²yr





5y ECIFIC HEAT/COOLING DEMAND MONTHLY



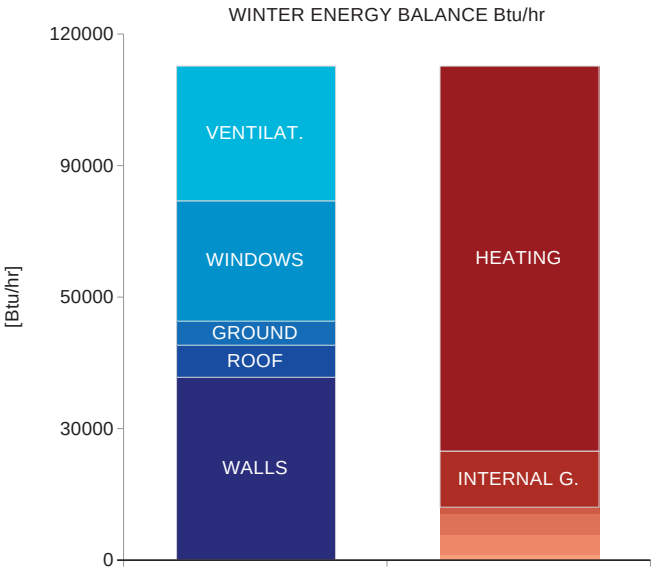
Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1.3	0
February	0.8	0
March	0.4	0
April	0.1	0
May	0	0.1
June	0	0.6
July	0	1.3
August	0	1.1
September	0	0.3
October	0	0
November	0.6	0
December	0.8	0

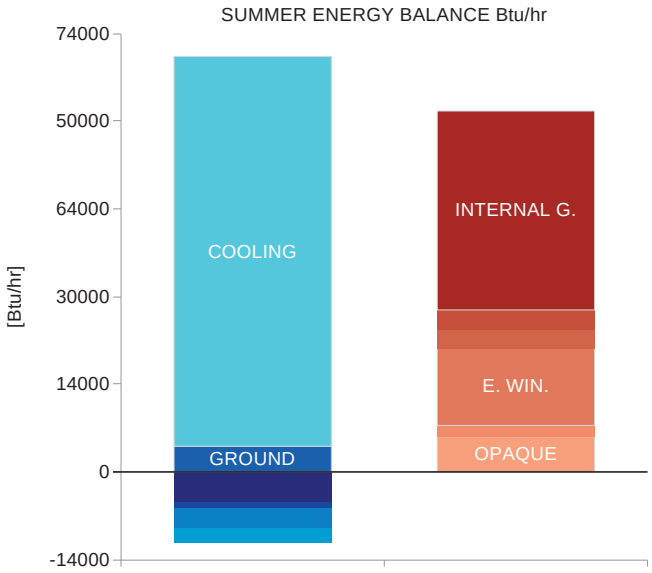
HEATING LOAD

	First climate	Second climate
Transmission heat losses:	73m119 Btu/hr	,6m1040 Btu/hr
Ventilation heat losses:	)9m9)4P Btu/hr	P3m7)940 Btu/hr
Total heat loss:	33Pm1)4P Btu/hr	73m0647 Btu/hr
Solar heat gain:	33m7P3 Btu/hr	1m004 Btu/hr
Internal heat gain:	3Pm70-4) Btu/hr	3Pm70-4) Btu/hr
Total heat gains heating:	P0m1174) Btu/hr	36m6P Btu/hr
Heating load:	7-m1646 Btu/hr	13m69P47 Btu/hr
Relevant heating load:	7-m1646 Btu/hr	
Specific heating load:	)4 Btu/hr ft²	

COOLING LOAD

Solar heat gain:	P-m9041 Btu/hr
Internal heat gain:	))m7)4 Btu/hr
Total heat gains cooling:	13m7743 Btu/hr
Transmission heat losses:	.Pm7P04P Btu/hr
Ventilation heat losses:	.Pm0)64 Btu/hr
Total heat loss:	.,m71)46 Btu/hr
Cooling load - sensible:	11m7,P Btu/hr
Cooling load - latent:	9 Btu/hr
Relevant cooling load:	11m7,P Btu/hr
Specific maximum cooling load:	P41 Btu/hr ft²





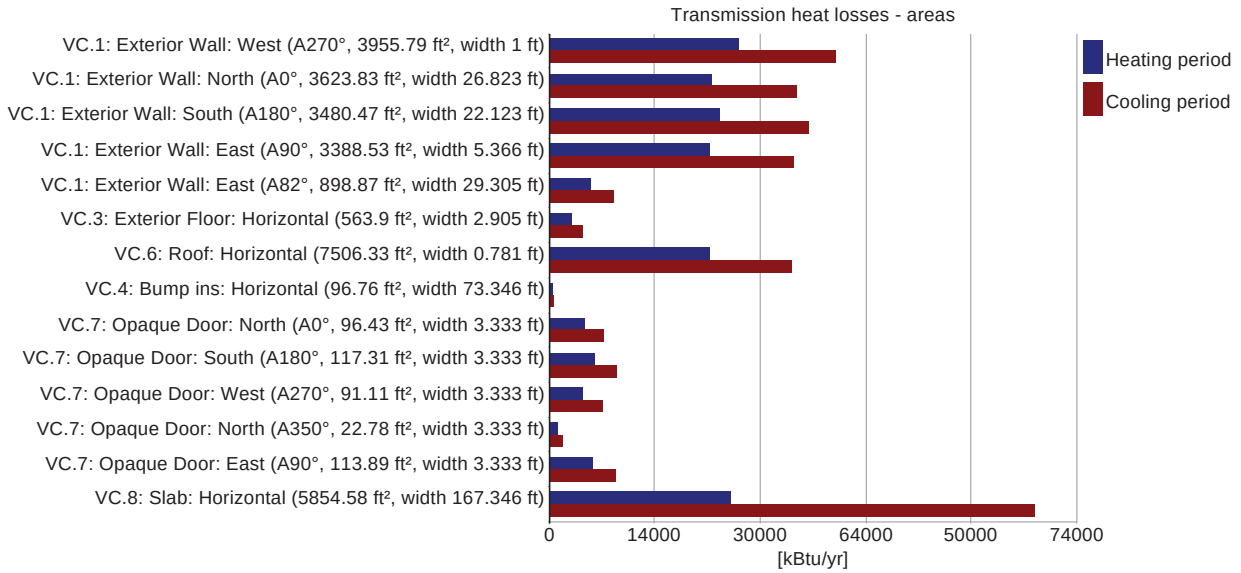
AREA5

TransS ission heat losses . areas

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Exterior Wall: West (A270°, 3955.79 ft², width 1 ft)	3955.8	0.062	0.6	0.9	100	25920.1	60834.6
VC.1: Exterior Wall: North (A0°, 3623.83 ft², width 26.823 ft)	3623.8	0.062	0.6	0.9	100	23234.6	34265
VC.1: Exterior Wall: South (A180°, 3480.47 ft², width 22.123 ft)	3480.5	0.062	0.6	0.9	100	26299	35849.4
VC.1: Exterior Wall: East (A90°, 3388.53 ft², width 5.366 ft)	3388.5	0.062	0.6	0.9	100	22995.6	36883.5
VC.1: Exterior Wall: East (A82°, 898.87 ft², width 29.305 ft)	898.9	0.062	0.6	0.9	100	5100	9243.2
VC.3: Exterior Floor: Horizontal (563.9 ft², width 2.905 ft)	563.9	0.031	0.6	0.9	100	3233.7	6904.2
VC.6: Roof: Horizontal (7506.33 ft², width 0.781 ft)	7506.3	0.019	0.6	0.9	100	22813.1	36504.4
VC.4: Bump ins: Horizontal (96.76 ft², width 73.346 ft)	96.7	0.031	0.6	0.9	100	654.8	705.5
VC.7: Opaque Door: North (A0°, 96.43 ft², width 3.333 ft)	96.4	0.337	0.6	0.9	100	4131.1	7783.6
VC.7: Opaque Door: South (A180°, 117.31 ft², width 3.333 ft)	117.3	0.337	0.6	0.9	100	5357.4	9549
VC.7: Opaque Door: West (A270°, 91.11 ft², width 3.333 ft)	91.1	0.337	0.6	0.9	100	6964.5	7402.1
VC.7: Opaque Door: North (A350°, 22.78 ft², width 3.333 ft)	22.8	0.337	0.6	0.9	100	1235.6	1874.4
VC.7: Opaque Door: East (A90°, 113.89 ft², width 3.333 ft)	113.9	0.337	0.6	0.9	100	5182	9377.5
VC.8: Slab: Horizontal (5854.58 ft², width 167.346 ft)	5854.7	0.088	0	0	0	24861.3	59139.3

Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	89.6	134.7
Ground heating	23.8	53.7



THERMAL BRIDGE5

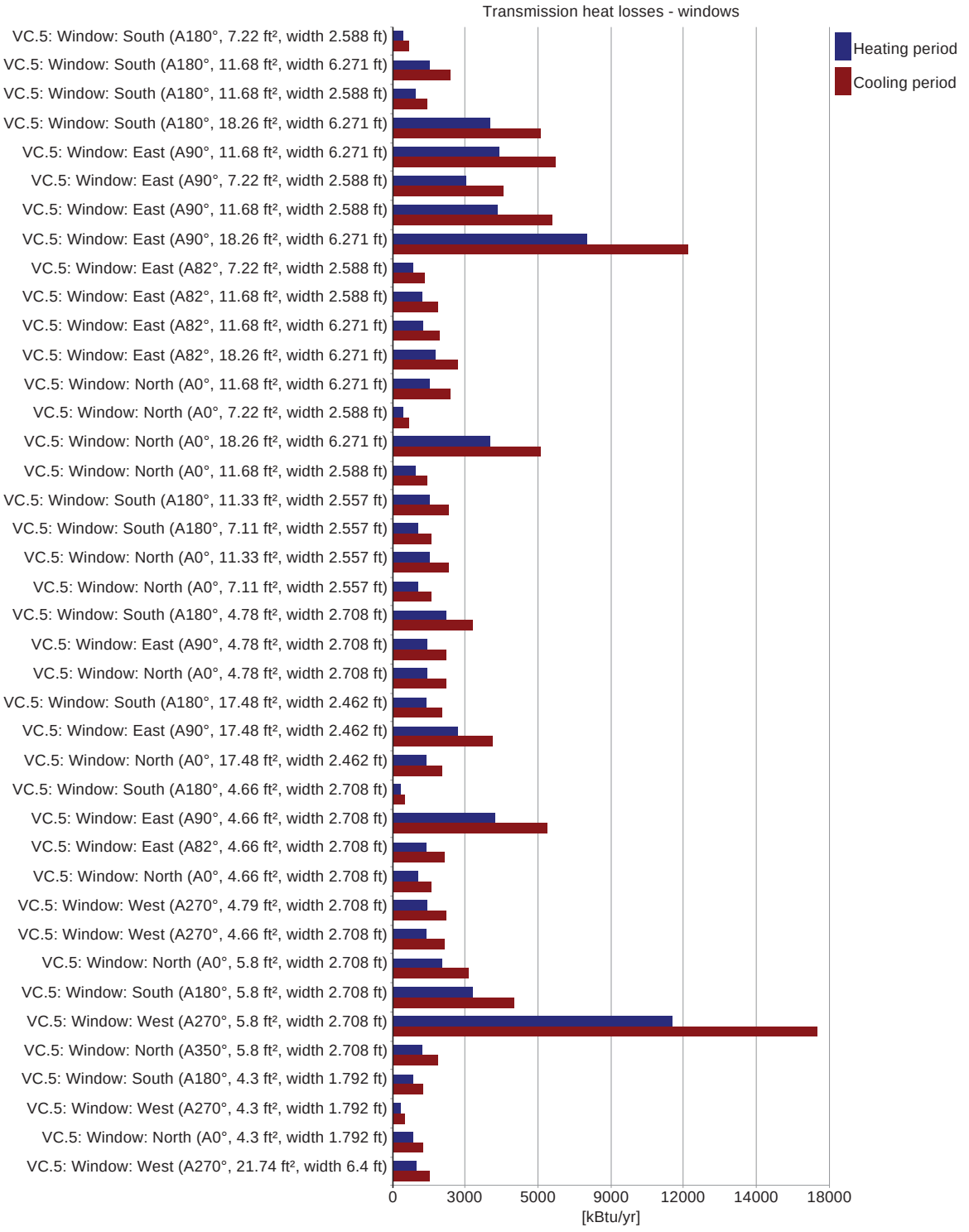
TransS ission heat losses . therS al bridges

Name	Length [ft]	Psi-value [Btu/hr ft °F]	Transmission losses [kBtu/yr]	Transmission losses cooling [kBtu/yr]

WINDOW5

TransS ission heat losses . windows

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.5: Window: South (A180°, 7.22 ft², width 2.588 ft)	2	90	0.185	0.4	58.3	48.7	650.6	505.4	631.4	546.5
VC.5: Window: South (A180°, 11.68 ft², width 6.271 ft)	4	90	0.171	0.4	72.6	49.1	2,224.4	2,854.1	1,480.7	2,397.7
VC.5: Window: South (A180°, 11.68 ft², width 2.588 ft)	3	90	0.159	0.4	51.2	43.8	1,148.7	1,463.1	935.2	1,620.1
VC.5: Window: South (A180°, 18.26 ft², width 6.271 ft)	9	90	0.142	0.4	77.6	53.9	8,083.8	10,646.3	6,026.1	5,106.2
VC.5: Window: East (A90°, 11.68 ft², width 6.271 ft)	16	90	0.171	0.4	85.2	76.1	6,423.4	7,000.1	6,624.9	5,713.7
VC.5: Window: East (A90°, 7.22 ft², width 2.588 ft)	16	90	0.185	0.4	84.6	76	2,697.7	3,888.6	3,020.8	6,482.6
VC.5: Window: East (A90°, 11.68 ft², width 2.588 ft)	16	90	0.159	0.4	85.8	74.8	6,786.1	7,687.2	6,358.8	5,527.1
VC.5: Window: East (A90°, 18.26 ft², width 6.271 ft)	18	90	0.142	0.4	87.7	75.2	11,125.1	17,343.1	8,068.2	12,208.6
VC.5: Window: East (A82°, 7.22 ft², width 2.588 ft)	6	90	0.185	0.4	84	73.9	546.1	1,103.9	853.1	1,309.2
VC.5: Window: East (A82°, 11.68 ft², width 2.588 ft)	6	90	0.159	0.4	85.6	74.7	1,242.8	2,126.9	1,268.2	1,893.4
VC.5: Window: East (A82°, 11.68 ft², width 6.271 ft)	6	90	0.171	0.4	85	76.2	1,190	1,996.6	1,256.4	1,918.2
VC.5: Window: East (A82°, 18.26 ft², width 6.271 ft)	6	90	0.142	0.4	88.4	75.5	2,309.3	3,883.4	1,788.4	2,713
VC.5: Window: North (A0°, 11.68 ft², width 6.271 ft)	4	90	0.171	0.4	55.3	44.4	539.5	998.2	1,480.7	2,397.7
VC.5: Window: North (A0°, 7.22 ft², width 2.588 ft)	2	90	0.185	0.4	53.7	43	138.4	216.9	631.4	546.5
VC.5: Window: North (A0°, 18.26 ft², width 6.271 ft)	9	90	0.142	0.4	58.3	45.6	2,273.7	3,406.8	6,026.1	5,106.2
VC.5: Window: North (A0°, 11.68 ft², width 2.588 ft)	3	90	0.159	0.4	44.8	65.6	366	436.7	935.2	1,620.1
VC.5: Window: South (A180°, 11.33 ft², width 2.557 ft)	4	90	0.159	0.4	77.4	53.1	2,692.4	3,205	1,464.1	2,363.8
VC.5: Window: South (A180°, 7.11 ft², width 2.557 ft)	4	90	0.185	0.4	76.2	49.7	1,249.6	1,512.1	1,055	1,517
VC.5: Window: North (A0°, 11.33 ft², width 2.557 ft)	4	90	0.159	0.4	55.7	44	580	1,068.7	1,464.1	2,363.8
VC.5: Window: North (A0°, 7.11 ft², width 2.557 ft)	4	90	0.185	0.4	57.2	44.8	347.2	446.4	1,055	1,517
VC.5: Window: South (A180°, 4.78 ft², width 2.708 ft)	12	90	0.197	0.4	74.4	48.5	2,217.5	2,797.2	2,200.6	3,337.8
VC.5: Window: East (A90°, 4.78 ft², width 2.708 ft)	8	90	0.197	0.4	80	71.2	910	1,667	1,655.9	2,224.2
VC.5: Window: North (A0°, 4.78 ft², width 2.708 ft)	8	90	0.197	0.4	71	48.7	631.5	555	1,655.9	2,224.2
VC.5: Window: South (A180°, 17.48 ft², width 2.462 ft)	3	90	0.151	0.4	78.4	56.3	2,468.9	3,288.5	1,354.4	2,071.6
VC.5: Window: East (A90°, 17.48 ft², width 2.462 ft)	5	90	0.151	0.4	73.3	59.3	2,591.4	6,401.8	2,731	6,162.7
VC.5: Window: North (A0°, 17.48 ft², width 2.462 ft)	3	90	0.151	0.4	53.9	42.4	550.5	1,015.6	1,354.4	2,071.6
VC.5: Window: South (A180°, 4.66 ft², width 2.708 ft)	2	90	0.201	0.4	77.1	48.7	361.2	627.2	341.4	433.1
VC.5: Window: East (A90°, 4.66 ft², width 2.708 ft)	26	90	0.201	0.4	86	72.4	2,538.3	6,091.4	6,217.6	5,397.4
VC.5: Window: East (A82°, 4.66 ft², width 2.708 ft)	8	90	0.201	0.4	83.8	72.4	808.7	1,349.2	1,604.8	2,132.4
VC.5: Window: North (A0°, 4.66 ft², width 2.708 ft)	5	90	0.201	0.4	71.7	49.3	292.9	642.8	1,046.6	1,499.6
VC.5: Window: West (A270°, 4.79 ft², width 2.708 ft)	8	90	0.197	0.4	71.5	53.9	802.1	1,307	1,658.2	2,227.1
VC.5: Window: West (A270°, 4.66 ft², width 2.708 ft)	8	90	0.201	0.4	54.3	49.1	565.5	1,055.6	1,604.8	2,132.4
VC.5: Window: North (A0°, 5.8 ft², width 2.708 ft)	10	90	0.188	0.4	53	42	527.3	955.8	2,052.8	3,129
VC.5: Window: South (A180°, 5.8 ft², width 2.708 ft)	15	90	0.188	0.4	70.6	46.3	3,515.6	6,469.7	3,300.6	4,005.6
VC.5: Window: West (A270°, 5.8 ft², width 2.708 ft)	45	90	0.188	0.4	74.2	57.6	7,544.2	12,424.9	11,441.4	17,422.5
VC.5: Window: North (A350°, 5.8 ft², width 2.708 ft)	5	90	0.188	0.4	56.5	43.6	384.5	496.9	1,237.7	1,877.6
VC.5: Window: South (A180°, 4.3 ft², width 1.792 ft)	4	90	0.202	0.4	75.1	51.2	865.9	1,086	850.4	1,304.3
VC.5: Window: West (A270°, 4.3 ft², width 1.792 ft)	2	90	0.202	0.4	70.1	56.5	174.8	296.4	366.2	422.1
VC.5: Window: North (A0°, 4.3 ft², width 1.792 ft)	4	90	0.202	0.4	70.9	48.5	269.1	386.1	850.4	1,304.3
VC.5: Window: West (A270°, 21.74 ft², width 6.4 ft)	2	90	0.167	0.4	36.1	25.5	532.9	935.8	1,030	1,452.6


Transmission heat losses - windows
Heating period
Cooling period
VC.5: Window: South (A180°, 7.22 ft², width 2.588 ft)
VC.5: Window: South (A180°, 11.68 ft², width 6.271 ft)
VC.5: Window: South (A180°, 11.68 ft², width 2.588 ft)
VC.5: Window: South (A180°, 18.26 ft², width 6.271 ft)
VC.5: Window: East (A90°, 11.68 ft², width 6.271 ft)
VC.5: Window: East (A90°, 7.22 ft², width 2.588 ft)
VC.5: Window: East (A90°, 11.68 ft², width 2.588 ft)
VC.5: Window: East (A90°, 18.26 ft², width 6.271 ft)
VC.5: Window: East (A82°, 7.22 ft², width 2.588 ft)
VC.5: Window: East (A82°, 11.68 ft², width 2.588 ft)
VC.5: Window: East (A82°, 11.68 ft², width 6.271 ft)
VC.5: Window: East (A82°, 18.26 ft², width 6.271 ft)
VC.5: Window: North (A0°, 11.68 ft², width 6.271 ft)
VC.5: Window: North (A0°, 7.22 ft², width 2.588 ft)
VC.5: Window: North (A0°, 18.26 ft², width 6.271 ft)
VC.5: Window: North (A0°, 11.68 ft², width 2.588 ft)
VC.5: Window: South (A180°, 11.33 ft², width 2.557 ft)
VC.5: Window: South (A180°, 7.11 ft², width 2.557 ft)
VC.5: Window: North (A0°, 11.33 ft², width 2.557 ft)
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VC.5: Window: South (A180°, 4.78 ft², width 2.708 ft)
VC.5: Window: East (A90°, 4.78 ft², width 2.708 ft)
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VC.5: Window: South (A180°, 17.48 ft², width 2.462 ft)
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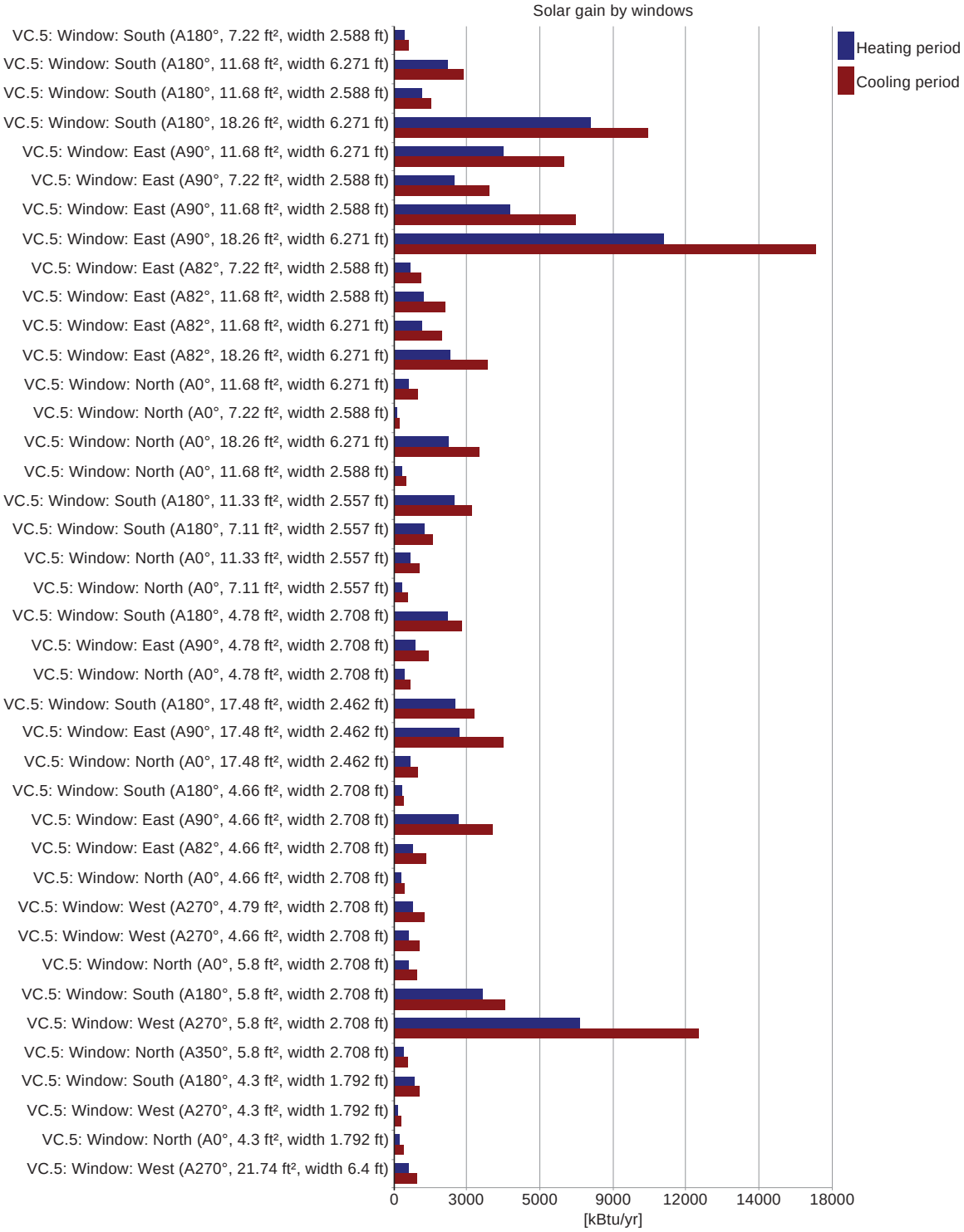
VC.5: Window: South (A180°, 4.66 ft², width 2.708 ft)
VC.5: Window: East (A90°, 4.66 ft², width 2.708 ft)
VC.5: Window: East (A82°, 4.66 ft², width 2.708 ft)
VC.5: Window: North (A0°, 4.66 ft², width 2.708 ft)
VC.5: Window: West (A270°, 4.79 ft², width 2.708 ft)
VC.5: Window: West (A270°, 4.66 ft², width 2.708 ft)
VC.5: Window: North (A0°, 5.8 ft², width 2.708 ft)
VC.5: Window: South (A180°, 5.8 ft², width 2.708 ft)
VC.5: Window: West (A270°, 5.8 ft², width 2.708 ft)
VC.5: Window: North (A350°, 5.8 ft², width 2.708 ft)
VC.5: Window: South (A180°, 4.3 ft², width 1.792 ft)
VC.5: Window: West (A270°, 4.3 ft², width 1.792 ft)
VC.5: Window: North (A0°, 4.3 ft², width 1.792 ft)
VC.5: Window: West (A270°, 21.74 ft², width 6.4 ft)
0
3000
5000
9000
12000
14000
18000
[kBtu/yr]


Solar gain by windows
Heating period
Cooling period
VC.5: Window: South (A180°, 7.22 ft², width 2.588 ft)
VC.5: Window: South (A180°, 11.68 ft², width 6.271 ft)
VC.5: Window: South (A180°, 11.68 ft², width 2.588 ft)
VC.5: Window: South (A180°, 18.26 ft², width 6.271 ft)
VC.5: Window: East (A90°, 11.68 ft², width 6.271 ft)
VC.5: Window: East (A90°, 7.22 ft², width 2.588 ft)
VC.5: Window: East (A90°, 11.68 ft², width 2.588 ft)
VC.5: Window: East (A90°, 18.26 ft², width 6.271 ft)
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VC.5: Window: East (A82°, 11.68 ft², width 6.271 ft)
VC.5: Window: East (A82°, 18.26 ft², width 6.271 ft)
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VC.5: Window: South (A180°, 17.48 ft², width 2.462 ft)
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VC.5: Window: East (A90°, 4.66 ft², width 2.708 ft)
VC.5: Window: East (A82°, 4.66 ft², width 2.708 ft)
VC.5: Window: North (A0°, 4.66 ft², width 2.708 ft)
VC.5: Window: West (A270°, 4.79 ft², width 2.708 ft)
VC.5: Window: West (A270°, 4.66 ft², width 2.708 ft)
VC.5: Window: North (A0°, 5.8 ft², width 2.708 ft)
VC.5: Window: South (A180°, 5.8 ft², width 2.708 ft)
VC.5: Window: West (A270°, 5.8 ft², width 2.708 ft)
VC.5: Window: North (A350°, 5.8 ft², width 2.708 ft)
VC.5: Window: South (A180°, 4.3 ft², width 1.792 ft)
VC.5: Window: West (A270°, 4.3 ft², width 1.792 ft)
VC.5: Window: North (A0°, 4.3 ft², width 1.792 ft)
VC.5: Window: West (A270°, 21.74 ft², width 6.4 ft)
0
3000
5000
9000
12000
14000
18000
[kBtu/yr]

5uS S ar8 building envelope

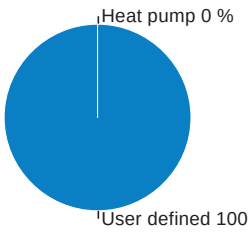
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	31m0) 146 ft²	949, Btu/hr ft² °F	3) 3m83) 43 kBtu/yr
Exterior wall ground:	9 ft²	9 Btu/hr ft² °F	9 kBtu/yr
Basement:	1m71, 4 ft²	9497 7 Btu/hr ft² °F	P, m7034) kBtu/yr
Roof:	- m1904) ft²	9436 Btu/hr ft² °F	PPm73) 43 kBtu/yr
Windows:	) n9, , 47 ft²	943- , Btu/hr ft² °F	7, m6034 6 kBtu/yr
Doors:	9 ft²	9 Btu/hr ft² °F	9 kBtu/yr
Thermal bridge ambient:	9 ft	9 Btu/hr ft °F	9 kBtu/yr
Thermal bridge perimeter:	9 ft	9 Btu/hr ft °F	9 kBtu/yr
Thermal bridge floor slab:	9 ft	9 Btu/hr ft °F	9 kBtu/yr

5hading

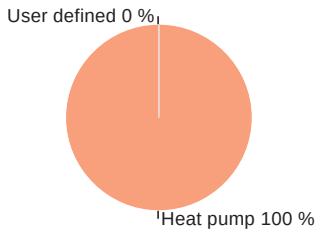
	Heating	Cooling
Reduction factor North:	114) %	, 046 %
Reduction factor East:	7, 4P %	- 04 %
Reduction factor South:	- 04 %	194 %
Reduction factor West:	164) %	134 %
Reduction factor Horizontal:	399 %	399 %

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Source energy demand [kBtu/yr]
Heat pump, VRF	0	0	0	100	0	33,451.2	0	16,765,905.1	50,610.2
User defined, Condensing Gas-Fired Boilers	100	0	156,598.6	0	0	0	1.1	9,921,043.6	181,158.2
Σ	100	0	156,598.6	100	0	33,451.2		26,557,949.4	261,478.6

DHW . final energ8



Heating . final energ8



COOLING UNIT5

	sensible	latent
Air cooling:	9 kBtu/ft²yr	9 kBtu/ft²yr
Recirculation cooling:	P46 kBtu/ft²yr	9 kBtu/ft²yr
Additional dehumidification:		940 kBtu/ft²yr
Panel cooling:	9 kBtu/ft²yr	
Sum:	P46 kBtu/ft²yr	940 kBtu/ft²yr

VENTILATION

Energ8 transportable b8 suppl8 air

Heating energ8

transportable: 34.3 W/ft²

load: 34.93 W/ft²

Cooling energ8

transportable: 9.4 W/ft²

load: 9.4 - W/ft²

Infiltration pressure test ACH40:	9.41 1/hr
Total extract air demand:	3,099 cfm
Supply air per person:	37 cfm
Occupancy:	11

Average air flow rate:	3,099 cfm
Average air change rate:	9.403 1/hr
Effective ACH ambient:	9.43 1/hr
Effective ACH ground:	9 1/hr
Energetically effective air exchange:	9.43 1/hr
Infiltration air change rate:	9.490 1/hr
Infiltration air change rate (heating load):	9.43 1/hr

Type of ventilation system:	Balanced yH ventilation
Wind screening coefficient (e):	9.9-
Wind exposure factor:	3,
Wind shield factor:	9.9,

Ventilation heat losses: , Pm1.1P4 kBtu/yr

Devices

Name	Sensible recovery efficiency [-]	Electric efficiency [W/cfm]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Semco	0.9	0.06	0	0.9
Altogether	0.9	0.06	0	0.9

Ducts

Name	Length (total) [ft]	Clear cross-section [ft²]	U-value [Btu/hr ft² °F]	Assigned ventilation units
ERV-1	10	2.24	16.54	Semco
ERV-1	10	2.24	16.54	Semco
Σ	20			

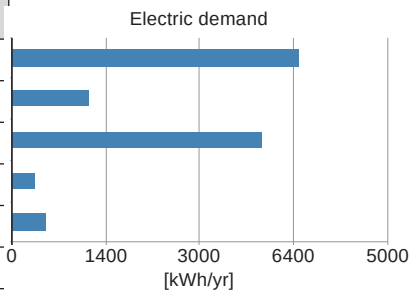
*length * quantity ** thermal conductivity / thickness

5UMMER VENTILATION

ACH night ventilation:	9 1/hr
ACH natural summer:	9 1/hr
Mechanical ventilation summer:	9.0 1/hr
Mechanical ventilation summer with HR:	no

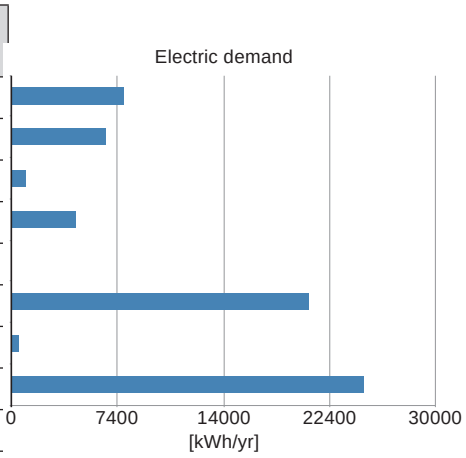
ELECTRICITY DEMAND . AUXILIARY ELECTRICITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Source energy [kBtu/yr]
Ventilation winter	1	no	0.7 W/cfm	6486.6	28146.1
Ventilation Defrost	1	no	5,458.3 W	1227.1	7434.8
Ventilation summer	1	no	0.7 W/cfm	6000.6	26457.3
DHW circulating pump	1	yes	65.4 W	347.7	2195.9
DHW storage load pump	1	yes	188.2 W	434.9	3291.2
Σ				10704.4	54764.3



ELECTRICITY DEMAND RE5IDENTIAL BUILDING

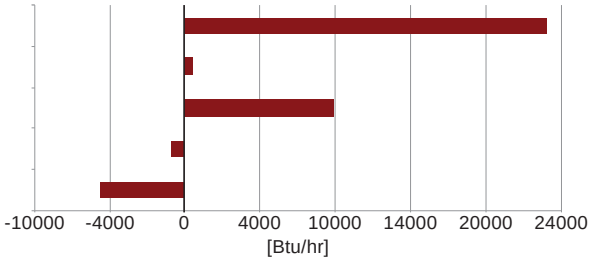
Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Non-electric demand [kWh/yr]	Source energy [kBtu/yr]
Kitchen refrigerator	1	yes	1.2	7920	0	68538.7
Kitchen cooking	1	yes	0.2	5500	0	60432.2
Laundry - washer	1	yes	0.3	980.6	0	5020.8
Laundry - dryer	1	yes	5	6664.5	0	27301.7
Energy consumed by evaporation	0	yes	3.1	0	579.1	2823.2
User defined lighting	1	yes	21,002	21002	0	128978.4
User defined lighting	1	no	486	486	0	3485.4
User defined MELs	1	yes	26,903	26903	0	142934.4
Σ	7			55634	579.1	610817.2



INTERNAL HEAT GAIN5

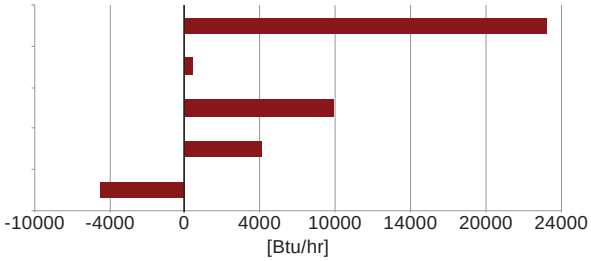
Heating season

Electricity total:	[illegible]	Btu/hr
Auxiliary electricity:	[illegible]	Btu/hr
People:	[illegible]	Btu/hr
Cold water:	[illegible]	Btu/hr
Evaporation:	[illegible]	Btu/hr
Σ:	[illegible]	Btu/hr
Specific internal heat gains:	[illegible]	Btu/hr ft²



Cooling season

Electricity total:	[illegible]	Btu/hr
Auxiliary electricity:	[illegible]	Btu/hr
People:	[illegible]	Btu/hr
Cold and hot water:	[illegible]	Btu/hr
Evaporation:	[illegible]	Btu/hr
Σ:	[illegible]	Btu/hr
Specific internal heat gains:	[illegible]	Btu/hr ft²



DHW AND DI5TRIBUTION

DHW consumption per person per day:	141	gal/Person/day
Average cold water temperature supply:	,P47	°F
Useful heat DHW:	33,ṁ014	kBtu/yr
Specific useful heat DHW:	0ṃ,04P	Btu/ft²yr
Total heat losses of the DHW system:	)9ṁ0904	kBtu/yr
Specific losses of the DHW system:	3ṁR994	Btu/ft²yr
Performance ratio DHW distribution system and storage:	34	
Utilization ratio DHW distribution system and storage:	947	
Total heat demand of DHW system:	30,ṁ,947	kBtu/yr
Total specific heat demand of DHW system:	,ṁ,041	Btu/ft²yr
Total heat losses of the hydronic heating distribution:	9	kBtu/yr
Specific losses of the hydronic heating distribution:	9	Btu/ft²yr
Performance ratio of heat distribution:	399	%

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
In conditioned space	1068	22393
Σ	1068	22393
Individual pipes		
In conditioned space	640	6471.3
Σ	640	6471.3
Water storage		
Device 6 (Water storage: DHW)		1720
Σ		1720

BUILDING INFORMATION

Category:	**Residential**
Status:	**In planning**
Building type:	**New construction**
Year of construction:	
Units:	**37**
Number of occupants:	**127 (Design)**
Occupant density:	**348.5** ft²/Person

Boundary conditions

Climate:	**MA - BOSTON LOGAN INT ARPT (cold year)**
Internal heat gains:	**1.1** Btu/hr ft²
Interior temperature:	**54** °F
Overheat temperature:	**66** °F

Building geometry

Enclosed volume:	**3529215.8** ft³
Net-volume:	**763917.8** ft³
Total area envelope:	**81985.8** ft²
Area/Volume Ratio:	**2.1** 1/ft
Floor area:	**30931** ft²
Envelope area/iCFA:	**1.311**

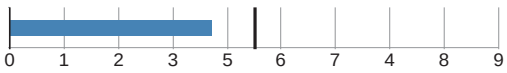
PASSI, VEOUSV RVHUIRVMVNTS

Qerti0cate criteriaf

PEIUS: 7214

Eeating demand

specific:	**3.6** kBtu/ft²yr
target:	**+.8** kBtu/ft²yr
total:	156,660.45 kBtu/yr

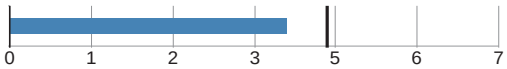


Qooling demand

sensible:	**7.54** kBtu/ft²yr
latent:	**2.34** kBtu/ft²yr
specific:	**3.25** kBtu/ft²yr
target:	**8.4** kBtu/ft²yr
total:	120,350.8 kBtu/yr

Eeating load

specific:	**3.+** Btu/hr ft²
target:	**3.0** Btu/hr ft²
total:	133,721.93 Btu/hr



Qooling load

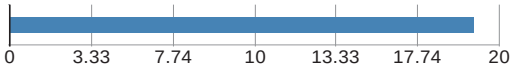
specific:	**7.8+** Btu/hr ft²
target:	**7.4** Btu/hr ft²
total:	99,468.28 Btu/hr

Source energy

total:	**3++9845.0**	kWh/yr
specific:	**39864**	kWh/Person yr
target:	**394+2**	kWh/Person yr
total:	**191685553.78**	kBtu/yr
specific:	29.89	kBtu/ft²yr

Site energy

total:	456,123.3	kBtu/yr
specific:	18.96	kBtu/ft²yr
total:	218,396.75	kWh/yr
specific:	6.66	kWh/ft²

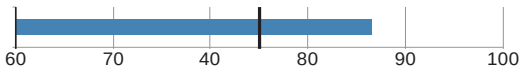


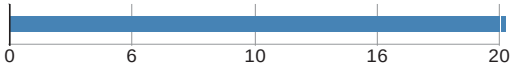
Air tightness

ACH60:	**2.54**	1/hr
CFM60 per envelope area:	**2.25**	cfm/ft²
target:	**2.54**	1/hr
target CFM60:	**2.25**	cfm/ft²

PASSI, VEOUSV RVQOMMVNDATIONS

Sensible recovery efficiency:	**45.5**	%
Frequency of overheating: Cooling system is required	**70.1**	%





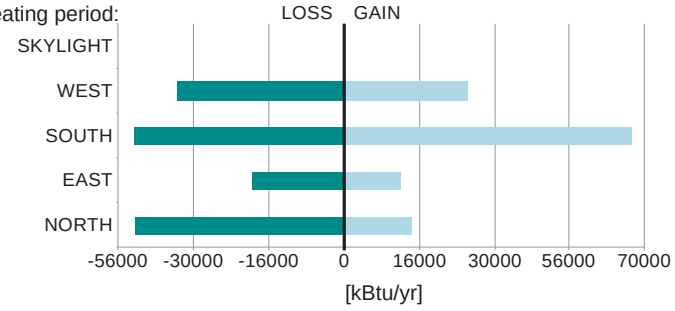
Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

BUILDING VLVMVNTS

Windows

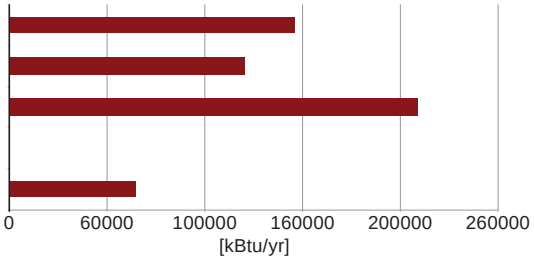
Average SHGC:	2.35
Average solar reduction factor heating:	2.34
Average solar reduction factor cooling:	2.3+
Average U-value:	2.188 Btu/hr ft² °F
Total glazing area:	+9227.1 ft²
Total window area:	59154.6 ft²

Heat gain/loss heating period:



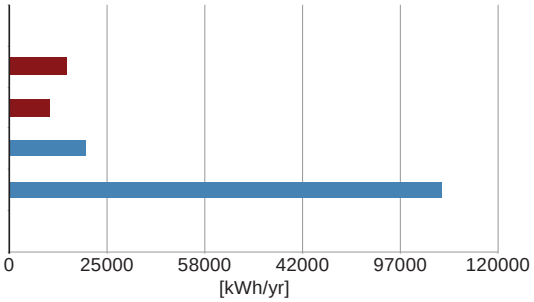
E, AQ

Total heating demand:	1+89881 kBtu/yr
Total cooling demand:	17293+1 kBtu/yr
Total DHW energy demand:	72093823 kBtu/yr
Solar DHW contribution:	2 kBtu/yr
Auxiliary electricity:	5+9818 kBtu/yr



Vlectricity

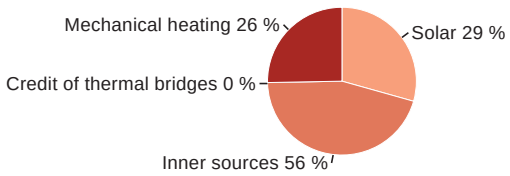
Direct heating / DHW:	2 kWh/yr
Heatpump heating:	1+92274 kWh/yr
Cooling:	09023 kWh/yr
HVAC auxiliary energy:	149020 kWh/yr
Appliances:	1259733 kWh/yr
Renewable generation, coincident production and use:	2 kWh/yr
Total electricity demand:	1+0926+ kWh/yr



EVAT FLOW - EVATING PVRIOD

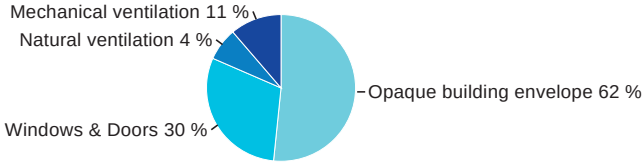
Eeat gains

Solar:	1++9208 kBtu/yr
Inner sources:	77791100 kBtu/yr
Credit of thermal bridges:	2 kBtu/yr
Mechanical heating:	1+89881 kBtu/yr



Eeat losses

Opaque building envelope:	75+91+6 kBtu/yr
Windows & Doors:	18398880 kBtu/yr
Natural ventilation:	3594468 kBtu/yr
Mechanical ventilation:	869753 kBtu/yr

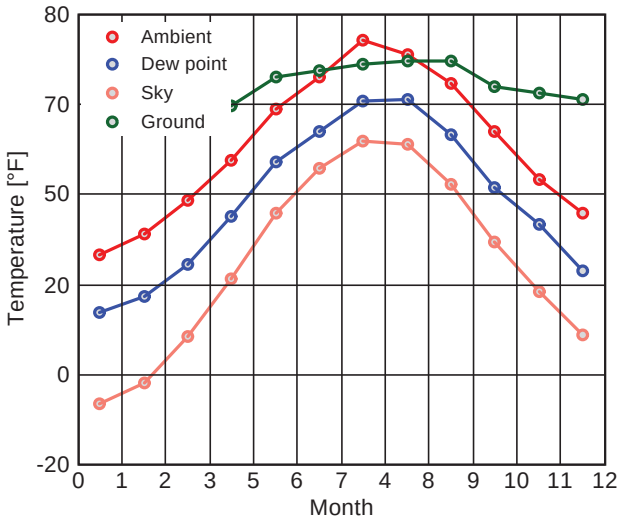


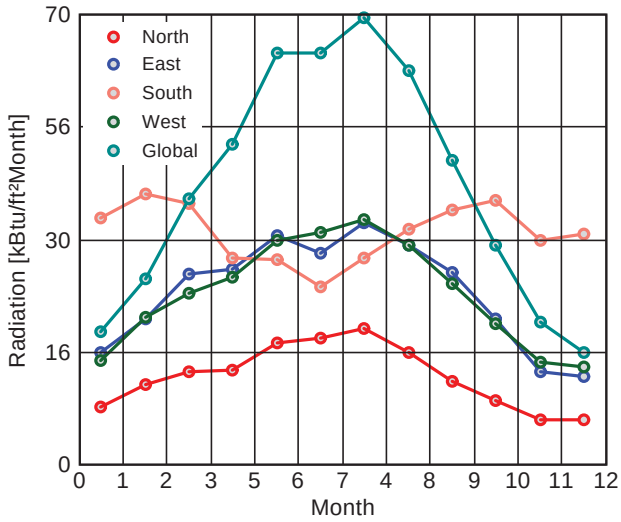
QLIMATV

Latitude:	**+7.+**	°
Longitude:	**-61**	°
Elevation of weather station:	**10.6**	ft
Elevation of building site:	**5**	ft
Heat capacity air:	**2.214**	Btu/ft³F
Daily temperature swing summer:	**1+.4**	°F
Average wind speed:	**13.1**	ft/s

Ground

Average ground surface temperature:	**87.4**	°F
Amplitude ground surface temperature:	**88.4**	°F
Ground thermal conductivity:	**1.7**	Btu/hr ft °F
Ground heat capacity:	**70.4**	Btu/ft³F
Depth below grade of groundwater:	**0.4**	ft
Flow rate groundwater:	**2.7**	ft/d





Qalculation parameters

Length of heating period	**7+3**	days/yr
Heating degree hours	**1+2.0**	kFh/a
Phase shift months	**1.3**	mths
Time constant heating demand	**112.6**	hr
Time constant cooling demand	**2**	hr
Time constant cooling demand with night ventilation	**2**	hr

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	17.9	31.7	83.6
Solar radiation North [Btu/hr ft²]	12	4.9	24.7
Solar radiation East [Btu/hr ft²]	22.8	13.3	71.6
Solar radiation South [Btu/hr ft²]	59.6	24.3	51.8
Solar radiation West [Btu/hr ft²]	22.2	11.5	63.3
Solar radiation Global [Btu/hr ft²]	27.9	17.6	101.5

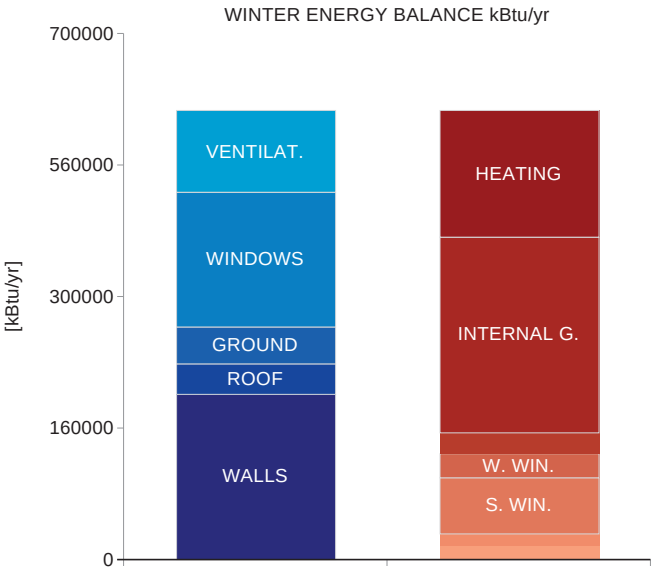
Relevant boundary conditions for heating load calculation: Heating load 1

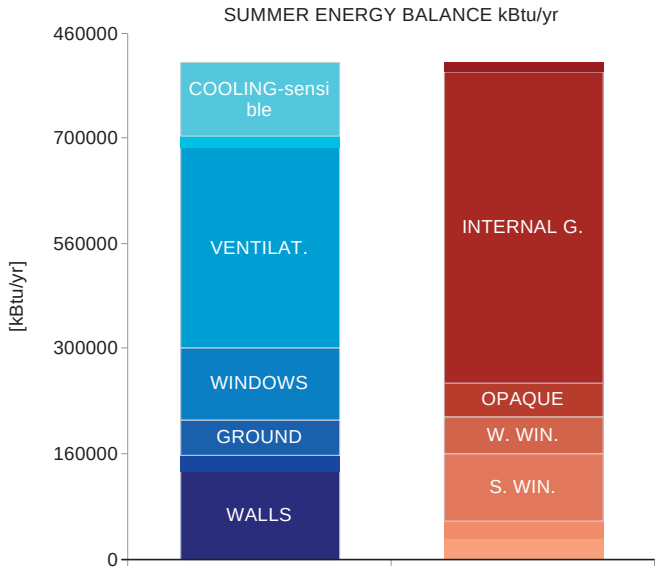
ANNUAL EVAT DVMAND

Transmission losses :	+169625	kBtu/yr
Ventilation losses:	0+9134	kBtu/yr
Total heat losses:	81194++	kBtu/yr
Solar heat gains:	1509234	kBtu/yr
Internal heat gains:	7529553	kBtu/yr
Total heat gains:	+709621	kBtu/yr
Utilization factor:	48.7	%
Useful heat gains:	355970+	kBtu/yr
Annual heat demand:	1+89881	kBtu/yr
Specific annual heat demand:	39621	Btu/ft²yr

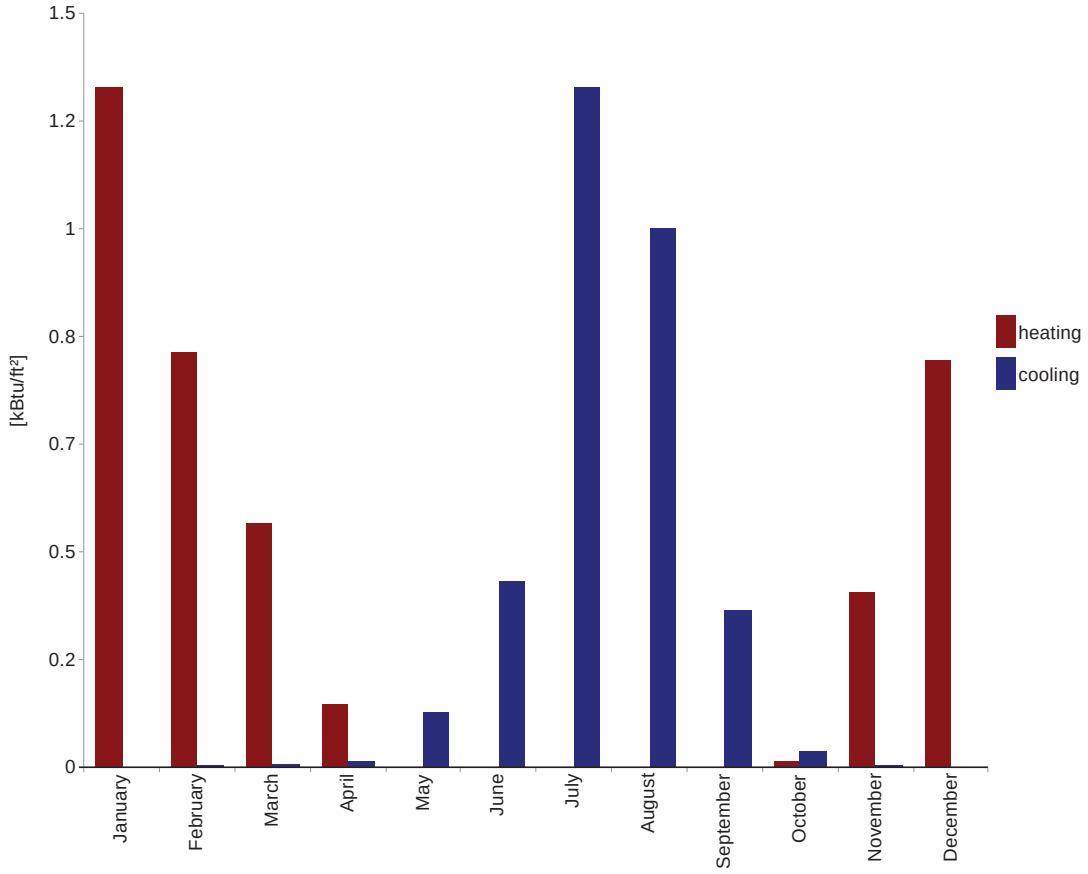
ANNUAL QOOLING DVMAND

Solar heat gains:	7829736	kBtu/yr
Internal heat gains:	++7941+2	kBtu/yr
Total heat gains:	5039266	kBtu/yr
Transmission losses :	5479312	kBtu/yr
Ventilation losses:	58+9++4	kBtu/yr
Total heat losses:	19835584	kBtu/yr
Utilization factor:	++	%
Useful heat losses:	84693+5	kBtu/yr
Cooling demand - sensible:	1289831	kBtu/yr
Cooling demand - latent:	1+9412	kBtu/yr
Annual cooling demand:	17293+1	kBtu/yr
Specific annual cooling demand:	3.1	kBtu/ft²yr





SPVQIFIQ EVAT/QOOLING DVMAND MONTELY



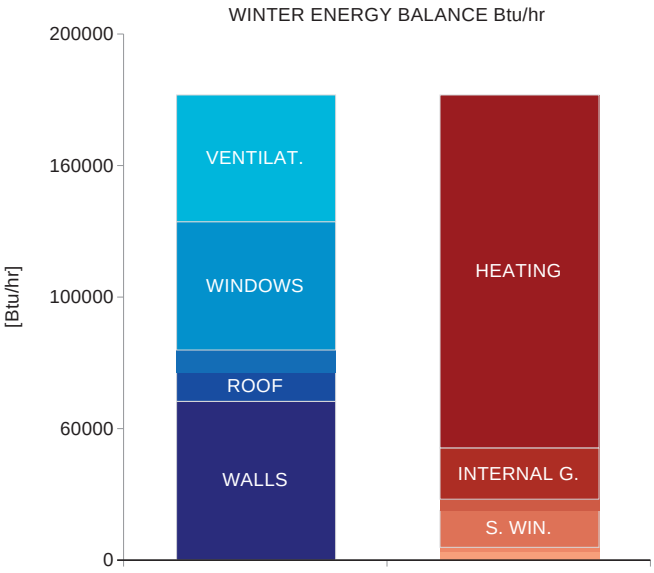
Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1.3	0
February	0.8	0
March	0.6	0
April	0.1	0
May	0	0.1
June	0	0.3
July	0	1.3
August	0	1
September	0	0.3
October	0	0
November	0.3	0
December	0.8	0

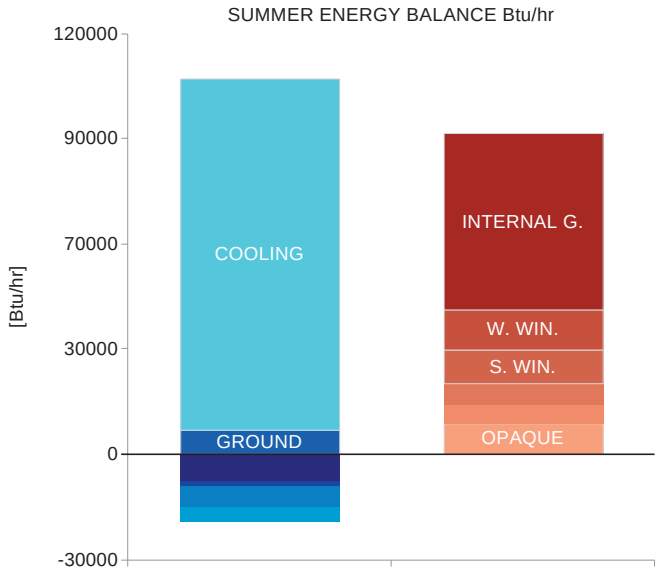
EVATING LOAD

	First climate	Second climate
Transmission heat losses:	1749543.4 Btu/hr	0+9265.+ Btu/hr
Ventilation heat losses:	+69528.6 Btu/hr	3394+4.3 Btu/hr
Total heat loss:	1659740.8 Btu/hr	1769 07+.6 Btu/hr
Solar heat gain:	779610 Btu/hr	179682.1 Btu/hr
Internal heat gain:	1090+4.5 Btu/hr	1090+4.5 Btu/hr
Total heat gains heating:	+79556.5 Btu/hr	379504.6 Btu/hr
Heating load:	1339571.0 Btu/hr	089775 Btu/hr
Relevant heating load:	1339571.0 Btu/hr	
Specific heating load:	3.+ Btu/hr ft²	

QOOLING LOAD

Solar heat gain:	+29052.1 Btu/hr
Internal heat gain:	829886.8 Btu/hr
Total heat gains cooling:	019816.5 Btu/hr
Transmission heat losses:	-+9+20.4 Btu/hr
Ventilation heat losses:	-39432.0 Btu/hr
Total heat loss:	-497+2.6 Btu/hr
Cooling load - sensible:	009684.3 Btu/hr
Cooling load - latent:	2 Btu/hr
Relevant cooling load:	009684.3 Btu/hr
Specific maximum cooling load:	7.8 Btu/hr ft²





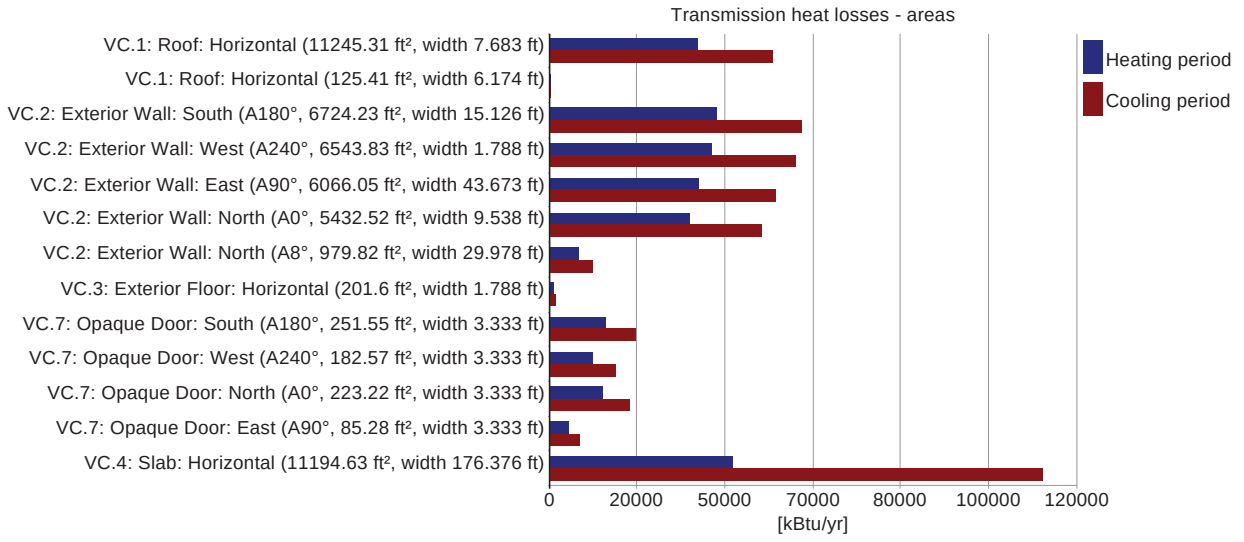
ARVAS

Transmission heat losses - areas

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Roof: Horizontal (11245.31 ft², width 7.683 ft)	11245.3	0.019	0.5	0.9	100	33792.8	61080.1
VC.1: Roof: Horizontal (125.41 ft², width 6.174 ft)	125.4	0.019	0.5	0.9	100	342.4	676
VC.2: Exterior Wall: South (A180°, 6724.23 ft², width 15.126 ft)	6724.2	0.052	0.5	0.9	100	38051.3	64742.4
VC.2: Exterior Wall: West (A240°, 6543.83 ft², width 1.788 ft)	6543.8	0.052	0.5	0.9	100	34005.3	67100.6
VC.2: Exterior Wall: East (A90°, 6066.05 ft², width 43.673 ft)	6066	0.052	0.5	0.9	100	35143.1	61808.3
VC.2: Exterior Wall: North (A0°, 5432.52 ft², width 9.538 ft)	5432.5	0.052	0.5	0.9	100	31992.2	58601.9
VC.2: Exterior Wall: North (A8°, 979.82 ft², width 29.978 ft)	979.8	0.052	0.5	0.9	100	7667.2	9939.6
VC.3: Exterior Floor: Horizontal (201.6 ft², width 1.788 ft)	201.6	0.031	0.5	0.9	100	1008	1628.2
VC.7: Opaque Door: South (A180°, 251.55 ft², width 3.333 ft)	251.5	0.334	0.5	0.9	100	13066.6	19492.8
VC.7: Opaque Door: West (A240°, 182.57 ft², width 3.333 ft)	182.6	0.334	0.5	0.9	100	9877.3	15964.8
VC.7: Opaque Door: North (A0°, 223.22 ft², width 3.333 ft)	223.2	0.334	0.5	0.9	100	12040.2	18299
VC.7: Opaque Door: East (A90°, 85.28 ft², width 3.333 ft)	85.3	0.334	0.5	0.9	100	5664.1	7908.8
VC.4: Slab: Horizontal (11194.63 ft², width 176.376 ft)	11194.6	0.088	0	0	0	51468	112361.9

Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	89.1	136.1
Ground heating	23.7	73.6



TEVRMAL BRIDGVS

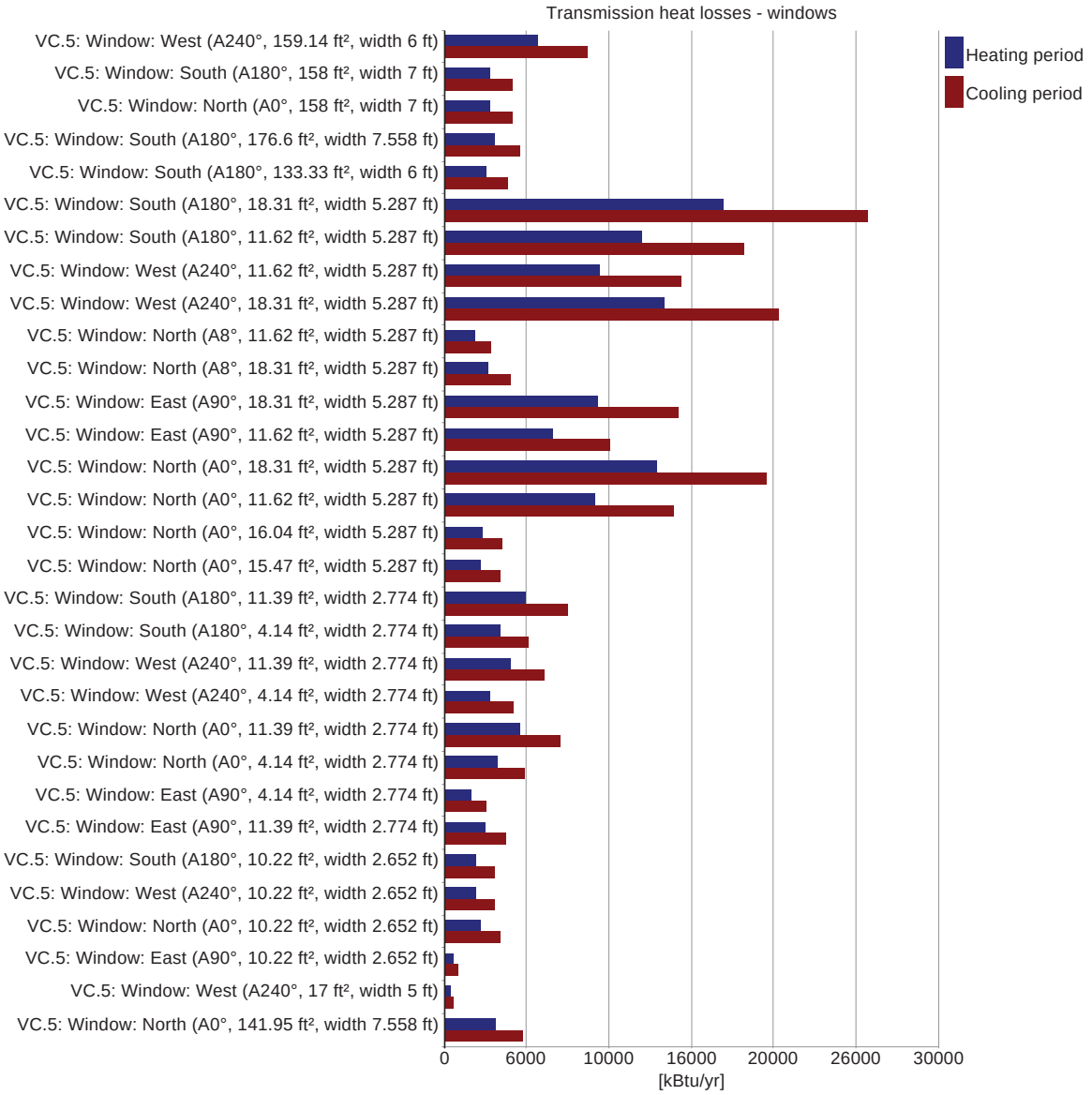
Transmission heat losses - thermal bridges

Name	Length [ft]	Psi-value [Btu/hr ft °F]	Transmission losses [kBtu/yr]	Transmission losses cooling [kBtu/yr]

WINDOWS

Transmission heat losses - windows

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.5: Window: West (A240°, 159.14 ft², width 6 ft)	2	90	0.12	0.5	40.2	77.5	4,334.1	12,692.9	6,451.9	8,406
VC.5: Window: South (A180°, 158 ft², width 7 ft)	1	90	0.117	0.5	85.8	42.1	4,962.7	10,531.3	2,469.5	5,183.6
VC.5: Window: North (A0°, 158 ft², width 7 ft)	1	90	0.117	0.5	79.7	67.6	2,153.8	3,264.6	2,469.5	5,183.6
VC.5: Window: South (A180°, 176.6 ft², width 7.558 ft)	1	90	0.115	0.5	86.4	42	9,132.7	11,911.2	3,036.9	5,702.7
VC.5: Window: South (A180°, 133.33 ft², width 6 ft)	1	90	0.121	0.5	78.9	66.6	6,828.8	4,540	2,648.2	3,908.7
VC.5: Window: South (A180°, 18.31 ft², width 5.287 ft)	38	90	0.162	0.5	46.5	72	27,169.9	33,443	17,946.6	26,436.9
VC.5: Window: South (A180°, 11.62 ft², width 5.287 ft)	38	90	0.141	0.5	41.4	64.8	13,234.8	17,960.6	12,005.3	18,199.2
VC.5: Window: West (A240°, 11.62 ft², width 5.287 ft)	30	90	0.141	0.5	44	77.8	7,734.8	10,694.3	9,544.1	15,374.8
VC.5: Window: West (A240°, 18.31 ft², width 5.287 ft)	30	90	0.162	0.5	49.5	79.3	12,912.6	20,796.3	13,501.4	20,314.8
VC.5: Window: North (A8°, 11.62 ft², width 5.287 ft)	7	90	0.141	0.5	69.6	61.7	629.8	856.6	1,896.5	2,843.7
VC.5: Window: North (A8°, 18.31 ft², width 5.287 ft)	7	90	0.162	0.5	72.3	63.9	1,060.7	1,746.2	2,780.3	5,073.7
VC.5: Window: East (A90°, 18.31 ft², width 5.287 ft)	21	90	0.162	0.5	41.5	76.9	4,921.2	13,087.6	9,381.2	15,222.5
VC.5: Window: East (A90°, 11.62 ft², width 5.287 ft)	21	90	0.141	0.5	78.5	72.4	5,028.6	7,718	7,735	10,064.6
VC.5: Window: North (A0°, 18.31 ft², width 5.287 ft)	29	90	0.162	0.5	75.8	62.8	6,630.3	8,531	12,966	19,750.6
VC.5: Window: North (A0°, 11.62 ft², width 5.287 ft)	29	90	0.141	0.5	75	62.6	2,873	5,393	9,171.2	13,888.9
VC.5: Window: North (A0°, 16.04 ft², width 5.287 ft)	7	90	0.169	0.5	69.1	58.2	808.4	1,233	2,307	3,597
VC.5: Window: North (A0°, 15.47 ft², width 5.287 ft)	7	90	0.17	0.5	68.6	54.4	448.6	1,186.9	2,279.8	3,551.2
VC.5: Window: South (A180°, 11.39 ft², width 2.774 ft)	17	90	0.179	0.5	43	70.7	6,874.3	4,709.6	5,956.5	4,594.6
VC.5: Window: South (A180°, 4.14 ft², width 2.774 ft)	17	90	0.187	0.5	40.8	68.1	3,018.3	3,897.2	3,518.1	6,182
VC.5: Window: West (A240°, 11.39 ft², width 2.774 ft)	13	90	0.179	0.5	46.8	74	2,919	5,428.4	5,018.1	7,091.4
VC.5: Window: West (A240°, 4.14 ft², width 2.774 ft)	13	90	0.187	0.5	45.8	76.7	1,628.8	2,573.5	2,444.2	5,210.5
VC.5: Window: North (A0°, 11.39 ft², width 2.774 ft)	16	90	0.179	0.5	75	62.3	1,669.1	2,349.2	5,737.3	4,028.9
VC.5: Window: North (A0°, 4.14 ft², width 2.774 ft)	16	90	0.187	0.5	75	62.8	817.5	1,267.1	3,205.5	5,868.1
VC.5: Window: East (A90°, 4.14 ft², width 2.774 ft)	8	90	0.187	0.5	40.7	75	885.7	1,538.6	1,409	2,691
VC.5: Window: East (A90°, 11.39 ft², width 2.774 ft)	8	90	0.179	0.5	42.2	77	1,798.3	2,486.2	2,542.4	3,458.4
VC.5: Window: South (A180°, 10.22 ft², width 2.652 ft)	4	90	0.143	0.5	48.7	72.5	2,553.3	3,109.6	1,987.4	3,012
VC.5: Window: West (A240°, 10.22 ft², width 2.652 ft)	4	90	0.143	0.5	81	41.5	1,573	2,373	1,987.4	3,012
VC.5: Window: North (A0°, 10.22 ft², width 2.652 ft)	8	90	0.143	0.5	74.2	66	467.9	1,167.7	2,240.7	3,552.3
VC.5: Window: East (A90°, 10.22 ft², width 2.652 ft)	2	90	0.143	0.5	76.6	72.6	322.8	658	674.7	870.7
VC.5: Window: West (A240°, 17 ft², width 5 ft)	1	90	0.167	0.5	72.9	63.2	296	572.6	501.1	708.1
VC.5: Window: North (A0°, 141.95 ft², width 7.558 ft)	1	90	0.115	0.5	43.7	70.6	2,725.5	5,059.3	3,158.3	5,443.1


Transmission heat losses - windows
VC.5: Window: West (A240°, 159.14 ft², width 6 ft)
VC.5: Window: South (A180°, 158 ft², width 7 ft)
VC.5: Window: North (A0°, 158 ft², width 7 ft)
VC.5: Window: South (A180°, 176.6 ft², width 7.558 ft)
VC.5: Window: South (A180°, 133.33 ft², width 6 ft)
VC.5: Window: South (A180°, 18.31 ft², width 5.287 ft)
VC.5: Window: South (A180°, 11.62 ft², width 5.287 ft)
VC.5: Window: West (A240°, 11.62 ft², width 5.287 ft)
VC.5: Window: West (A240°, 18.31 ft², width 5.287 ft)
VC.5: Window: North (A8°, 11.62 ft², width 5.287 ft)
VC.5: Window: North (A8°, 18.31 ft², width 5.287 ft)
VC.5: Window: East (A90°, 18.31 ft², width 5.287 ft)
VC.5: Window: East (A90°, 11.62 ft², width 5.287 ft)
VC.5: Window: North (A0°, 18.31 ft², width 5.287 ft)
VC.5: Window: North (A0°, 11.62 ft², width 5.287 ft)
VC.5: Window: North (A0°, 16.04 ft², width 5.287 ft)
VC.5: Window: North (A0°, 15.47 ft², width 5.287 ft)
VC.5: Window: South (A180°, 11.39 ft², width 2.774 ft)
VC.5: Window: South (A180°, 4.14 ft², width 2.774 ft)
VC.5: Window: West (A240°, 11.39 ft², width 2.774 ft)
VC.5: Window: West (A240°, 4.14 ft², width 2.774 ft)
VC.5: Window: North (A0°, 11.39 ft², width 2.774 ft)
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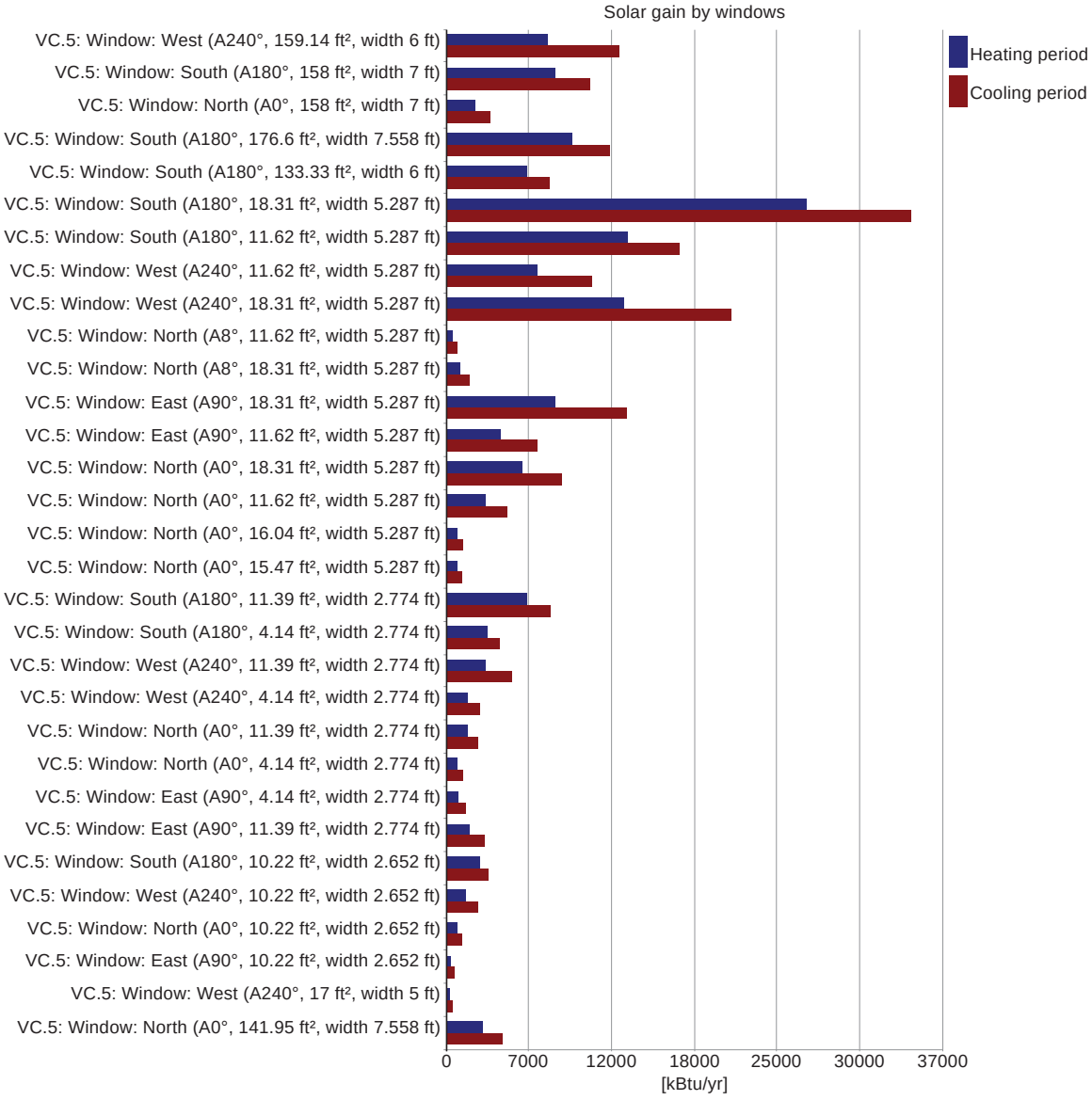
VC.5: Window: East (A90°, 4.14 ft², width 2.774 ft)
VC.5: Window: East (A90°, 11.39 ft², width 2.774 ft)
VC.5: Window: South (A180°, 10.22 ft², width 2.652 ft)
VC.5: Window: West (A240°, 10.22 ft², width 2.652 ft)
VC.5: Window: North (A0°, 10.22 ft², width 2.652 ft)
VC.5: Window: East (A90°, 10.22 ft², width 2.652 ft)
VC.5: Window: West (A240°, 17 ft², width 5 ft)
VC.5: Window: North (A0°, 141.95 ft², width 7.558 ft)
Heating period
Cooling period
0
6000
10000
16000
20000
26000
30000
[kBtu/yr]


Solar gain by windows
VC.5: Window: West (A240°, 159.14 ft², width 6 ft)
VC.5: Window: South (A180°, 158 ft², width 7 ft)
VC.5: Window: North (A0°, 158 ft², width 7 ft)
VC.5: Window: South (A180°, 176.6 ft², width 7.558 ft)
VC.5: Window: South (A180°, 133.33 ft², width 6 ft)
VC.5: Window: South (A180°, 18.31 ft², width 5.287 ft)
VC.5: Window: South (A180°, 11.62 ft², width 5.287 ft)
VC.5: Window: West (A240°, 11.62 ft², width 5.287 ft)
VC.5: Window: West (A240°, 18.31 ft², width 5.287 ft)
VC.5: Window: North (A8°, 11.62 ft², width 5.287 ft)
VC.5: Window: North (A8°, 18.31 ft², width 5.287 ft)
VC.5: Window: East (A90°, 18.31 ft², width 5.287 ft)
VC.5: Window: East (A90°, 11.62 ft², width 5.287 ft)
VC.5: Window: North (A0°, 18.31 ft², width 5.287 ft)
VC.5: Window: North (A0°, 11.62 ft², width 5.287 ft)
VC.5: Window: North (A0°, 16.04 ft², width 5.287 ft)
VC.5: Window: North (A0°, 15.47 ft², width 5.287 ft)
VC.5: Window: South (A180°, 11.39 ft², width 2.774 ft)
VC.5: Window: South (A180°, 4.14 ft², width 2.774 ft)
VC.5: Window: West (A240°, 11.39 ft², width 2.774 ft)
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VC.5: Window: East (A90°, 10.22 ft², width 2.652 ft)
VC.5: Window: West (A240°, 17 ft², width 5 ft)
VC.5: Window: North (A0°, 141.95 ft², width 7.558 ft)
Heating period
Cooling period
0
7000
12000
18000
25000
30000
37000
[kBtu/yr]

Summary building envelope

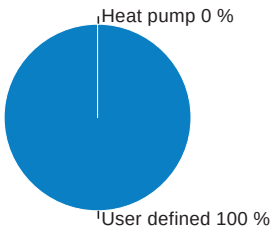
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	779601.7 ft²	2.287 Btu/hr ft² °F	144987+.1 kBtu/yr
Exterior wall ground:	2 ft²	2 Btu/hr ft² °F	2 kBtu/yr
Basement:	119106.8 ft²	2.244 Btu/hr ft² °F	+19684 kBtu/yr
Roof:	119800 ft²	2.210 Btu/hr ft² °F	3+9258.8 kBtu/yr
Windows:	59154.6 ft²	2.188 Btu/hr ft² °F	183984.0 kBtu/yr
Doors:	2 ft²	2 Btu/hr ft² °F	2 kBtu/yr
Thermal bridge ambient:	2 ft	2 Btu/hr ft °F	2 kBtu/yr
Thermal bridge perimeter:	2 ft	2 Btu/hr ft °F	2 kBtu/yr
Thermal bridge floor slab:	2 ft	2 Btu/hr ft °F	2 kBtu/yr

Shading

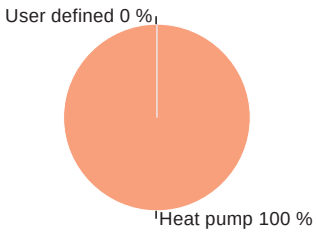
	Heating	Cooling
Reduction factor North:	58.+ %	83.6 %
Reduction factor East:	62.+ %	5+.4 %
Reduction factor South:	68.0 %	57.8 %
Reduction factor West:	65 %	56.5 %
Reduction factor Horizontal:	122 %	122 %

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Source energy demand [kBtu/yr]
Heat pump, VRF	0	0	0	100	0	54,872.5	0	21,030,883.5	87,162.3
User defined, Condensing Gas-Fired Boilers	100	0	237,612.5	0	0	0	1.1	16,329,726.4	270,173.4
Σ	100	0	237,612.5	100	0	54,872.5		37,370,609	357,316.9

DEW - Final energy



Heating - Final energy



COOLING UNITS

	sensible	latent
Air cooling:	2 kBtu/ft²yr	2 kBtu/ft²yr
Recirculation cooling:	7.6 kBtu/ft²yr	2 kBtu/ft²yr
Additional dehumidification:		2.+ kBtu/ft²yr
Panel cooling:	2 kBtu/ft²yr	
Sum:	7.6 kBtu/ft²yr	2.+ kBtu/ft²yr

, VNTILATION

Vnergy transportable by supply air

Eeating energy

transportable: **1.74** W/ft²

load: **1** W/ft²

Qooling energy

transportable: **2.4** W/ft²

load: **2.6+** W/ft²

Infiltration pressure test ACH60:	**2.54** 1/hr
Total extract air demand:	**79822** cfm
Supply air per person:	**14** cfm
Occupancy:	**127**

Average air flow rate:	**79822** cfm
Average air change rate:	**2.88** 1/hr
Effective ACH ambient:	**2.17** 1/hr
Effective ACH ground:	**2** 1/hr
Energetically effective air exchange:	**2.17** 1/hr
Infiltration air change rate:	**2.28** 1/hr
Infiltration air change rate (heating load):	**2.17** 1/hr

Type of ventilation system:	**Balanced PE ventilation**
Wind screening coefficient (e):	**2.26**
Wind exposure factor:	**18**
Wind shield factor:	**2.28**

Ventilation heat losses: **479503.05** kBtu/yr

Devices

Name	Sensible recovery efficiency [-]	Electric efficiency [W/cfm]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Semco	0.9	0.05	0	0.9
Altogether	0.9	0.05	0	0.9

Ducts

Name	Length (total) [ft]	Clear cross-section [ft²]	U-value [Btu/hr ft² °F]	Assigned ventilation units
ERV-1	10	2.26	15.03	Semco
ERV-1	10	2.26	15.03	Semco
Σ	20			

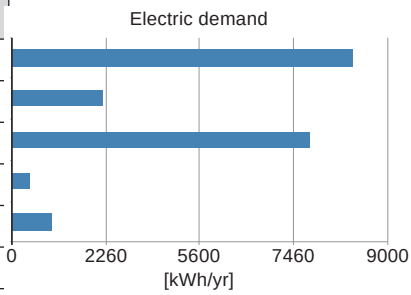
*length * quantity ** thermal conductivity / thickness

SUMMVR , VNTILATION

ACH night ventilation:	**2** 1/hr
ACH natural summer:	**2** 1/hr
Mechanical ventilation summer:	**2.8** 1/hr
Mechanical ventilation summer with HR:	**no**

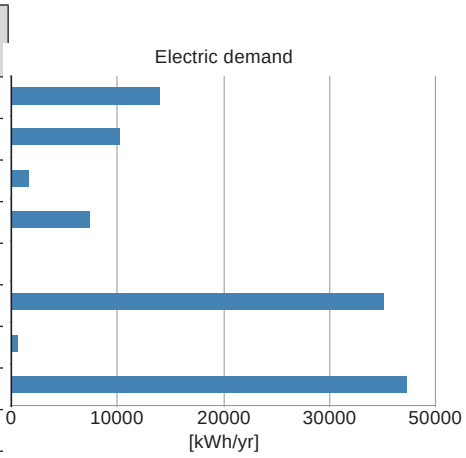
VLVQTRIQITY DVMAND - AUXILIARY VLVQTRIQITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Source energy [kBtu/yr]
Ventilation winter	1	no	0.4 W/cfm	8187.6	60246.1
Ventilation Defrost	1	no	11,429.1 W	2191.2	13567.8
Ventilation summer	1	no	0.4 W/cfm	4153.6	53840.3
DHW circulating pump	1	yes	63.1 W	520.9	2686.1
DHW storage load pump	1	yes	237.6 W	974.1	6939.3
Σ				18909.3	117127.7



VLVQTRIQITY DVMAND RVSIDVNTIAL BUILDING

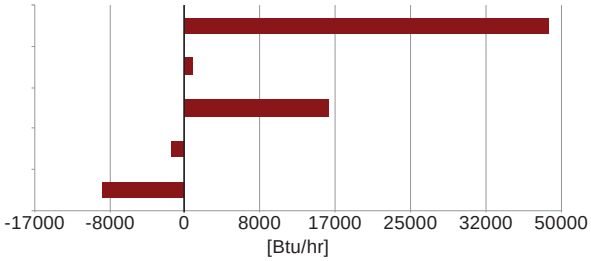
Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Non-electric demand [kWh/yr]	Source energy [kBtu/yr]
Kitchen refrigerator	1	yes	1.2	15080	0	87578.8
Kitchen cooking	1	yes	0.2	10200	0	72750.4
Laundry - washer	1	yes	0.3	1708.1	0	9846.7
Laundry - dryer	1	yes	7	4291.9	0	55481.3
Energy consumed by evaporation	0	yes	3.1	0	982.3	5081.5
User defined lighting	1	yes	36,218	36218	0	217282.6
User defined lighting	1	no	673	673	0	3564.6
User defined MELs	1	yes	34,242	34242	0	228897.7
Σ	4			107233	982.3	767585.6



INTVRNAL EVAT GAINS

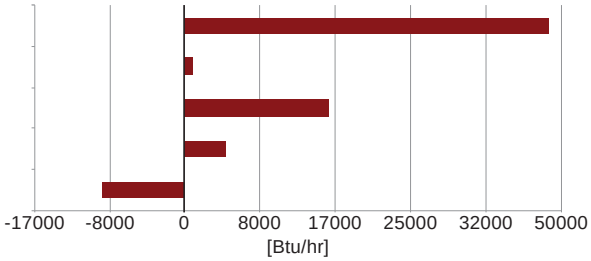
Eeating season

Electricity total:	**3495 3+.0**	Btu/hr
Auxiliary electricity:	**603**	Btu/hr
People:	**1895 13.6**	Btu/hr
Cold water:	**-19+16.7**	Btu/hr
Evaporation:	**-49 621**	Btu/hr
Σ:	**++9500.6**	Btu/hr
Specific internal heat gains:	**1.1**	Btu/hr ft²



Qooling season

Electricity total:	**3495 3+.0**	Btu/hr
Auxiliary electricity:	**603**	Btu/hr
People:	**1895 13.6**	Btu/hr
Cold and hot water:	**+9++2.5**	Btu/hr
Evaporation:	**-49 621**	Btu/hr
Σ:	**++9500.6**	Btu/hr
Specific internal heat gains:	**1.1**	Btu/hr ft²



DEW AND DISTRIBUTION

DHW consumption per person per day:	**5.5**	gal/Person/day
Average cold water temperature supply:	**87.4**	°F
Useful heat DHW:	**1649757.5**	kBtu/yr
Specific useful heat DHW:	**+9837.4**	Btu/ft²yr
Total heat losses of the DHW system:	**3192+2.+**	kBtu/yr
Specific losses of the DHW system:	**640.3**	Btu/ft²yr
Performance ratio DHW distribution system and storage:	**1.7**	
Utilization ratio DHW distribution system and storage:	**2.0**	
Total heat demand of DHW system:	**7209323**	kBtu/yr
Total specific heat demand of DHW system:	**8977.1**	Btu/ft²yr
Total heat losses of the hydronic heating distribution:	**2**	kBtu/yr
Specific losses of the hydronic heating distribution:	**2**	Btu/ft²yr
Performance ratio of heat distribution:	**122**	%

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
In conditioned space	1058	23319.7
Σ	1058	23319.7
Individual pipes		
In conditioned space	560	5138.5
Σ	560	5138.5
Water storage		
Device 5 (Water storage: DHW)		1491.2
Σ		1491.2

BUILDING INFORMATION

Category:	**Residential**
Status:	**In planning**
Building type:	**New construction**
Year of construction:	
Units:	**37**
Number of occupants:	**172 (Design)**
Occupant density:	**48. 5y** ft²/Person

Boundar- conditions

Climate:	**MA SBOPTON LOGAN INT AR6T (cold - ear)**	
Internal heat gains:	**n8**	Btu/hr ft²
Interior temperature:	**27**	°F
Overheat temperature:	**99**	°F

Building geo0 etr-

Enclosed volume:	**998,. 1. 57**	ft³
Net-volume:	**332,89y**	ft³
Total area envelope:	**94,34m**	ft²
Area/Volume Ratio:	**n5**	1/ft
Floor area:	**94,414**	ft²
Envelope area/iCFA:	**15m4**	

6 APPIVEHOUPE REQUIREMENTP

Certificate criteria: 6 HIUP+ ym17

Heating de0 and

specific:	**y52y**	kBtu/ft²yr
target:	**. 5**	kBtu/ft²yr
total:	151,647.18	kBtu/yr

Cooling de0 and

sensible:	**159**	kBtu/ft²yr
latent:	**n543**	kBtu/ft²yr
specific:	**y5n8**	kBtu/ft²yr
target:	**259**	kBtu/ft²yr
total:	170,738.21	kBtu/yr

Heating load

specific:	**y5 9**	Btu/hr ft²
target:	**.**	Btu/hr ft²
total:	180,641.3	Btu/hr

Cooling load

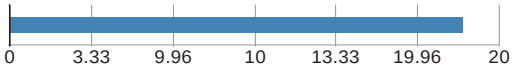
specific:	**1584**	Btu/hr ft²
target:	**4**	Btu/hr ft²
total:	141,995.28	Btu/hr

Pource energ-

total:	2y9,2485	3 kWh/yr
specific:	4,49.	kWh/Person yr
target:	4,7. m	kWh/Person yr
total:	y,1. 1,47. 5	7. kBtu/yr
specific:	25.21	kBtu/ft²yr

Pite energ-

total:	1,376,797.3	kBtu/yr
specific:	18.72	kBtu/ft²yr
total:	356,502.35	kWh/yr
specific:	7.43	kWh/ft²



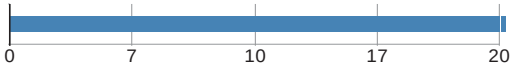
Air tightness

ACH70:	n5 9	1/hr
CFM70 per envelope area:	n5n2	cfm/ft²
target:	n5 7	1/hr
target CFM70:	n5n2	cfm/ft²

6 APPIVEHOUPE RECOMMENDATIONP

Sensible recovery efficiency:	7453	%
Frequency of overheating: Cooling system is required	y. 57	%

Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

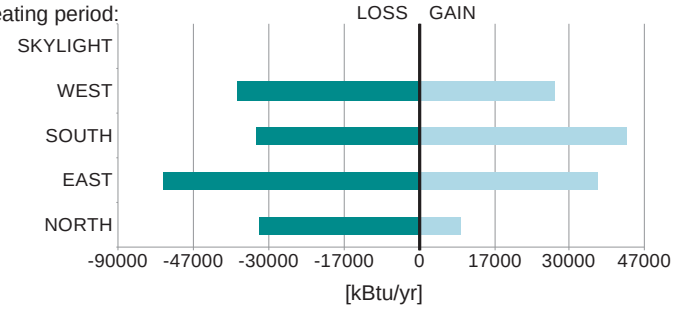


BUILDING ELEMENTP

Windows

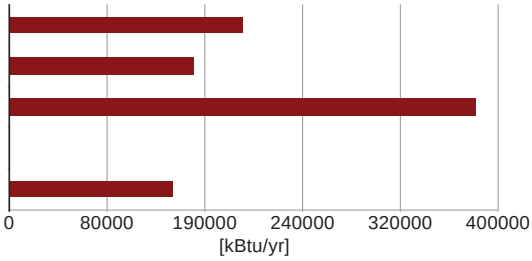
Average SHGC:	m5.42	
Average solar reduction factor heating:	m5.48	
Average solar reduction factor cooling:	m5.43	
Average U-value:	m1.28	Btu/hr ft² °F
Total glazing area:	4,8475y	ft²
Total window area:	2,49y	ft²

Heat gain/loss heating period:



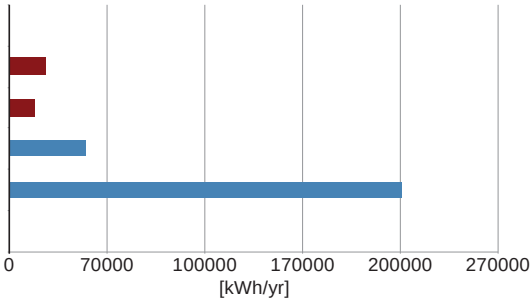
HVAC

Total heating demand:	181,9. 3	kBtu/yr
Total cooling demand:	13m,347	kBtu/yr
Total DHW energy demand:	47y,m78	kBtu/yr
Solar DHW contribution:	m	kBtu/yr
Auxiliary electricity:	14. ,yym	kBtu/yr



Electricit-

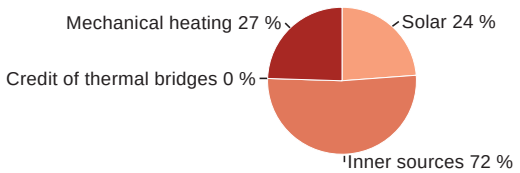
Direct heating / DHW:	m	kWh/yr
Heatpump heating:	17,347	kWh/yr
Cooling:	1y,8y4	kWh/yr
HVAC auxiliary energy:	48,4. m	kWh/yr
Appliances:	ymm,334	kWh/yr
Renewable generation, coincident production and use:	m	kWh/yr
Total electricity demand:	y91,434	kWh/yr



HEAT FLOW SHEATING 6ERIOD

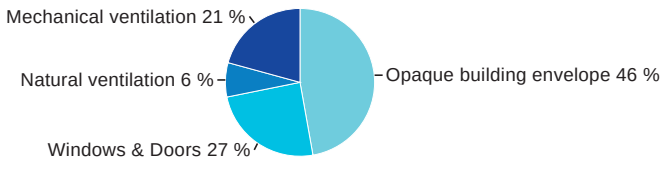
Heat gains

Solar:	12m,478	kBtu/yr
Inner sources:	4. 7,y92	kBtu/yr
Credit of thermal bridges:	m	kBtu/yr
Mechanical heating:	181,9. 3	kBtu/yr



Heat losses

Opaque building envelope:	44m,93.	kBtu/yr
Windows & Doors:	19y,19.	kBtu/yr
Natural ventilation:	3y,. . 9	kBtu/yr
Mechanical ventilation:	1. 3,m4.	kBtu/yr

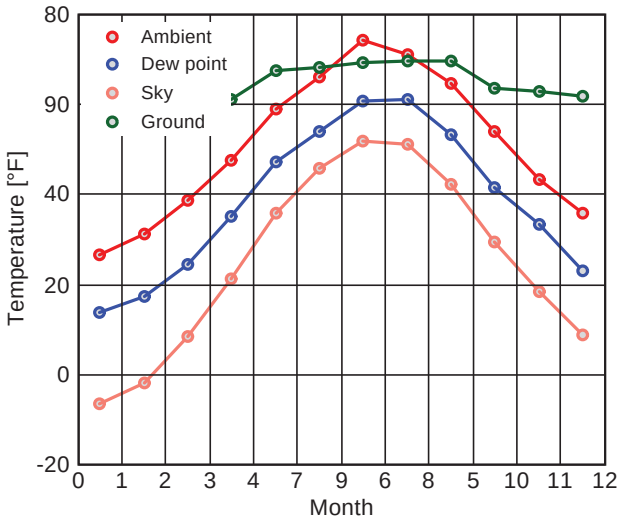


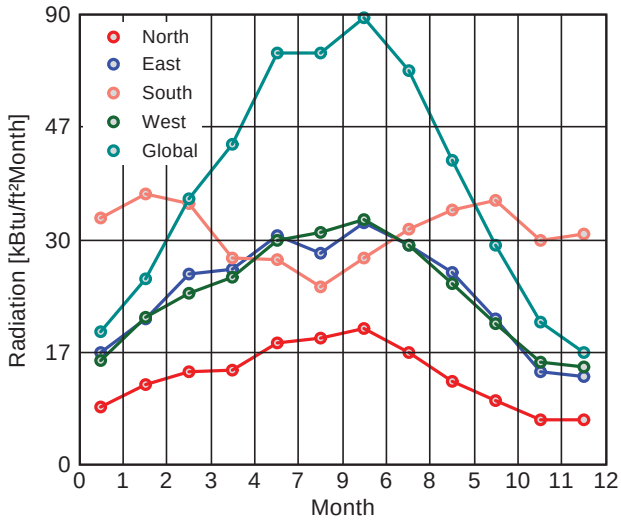
CLIMATE

Latitude:	. y5 °
Longitude:	91 °
Elevation of weather station:	189 ft
Elevation of building site:	2 ft
Heat capacity air:	0.017 Btu/ft³F
Daily temperature swing summer:	1. 7 °F
Average wind speed:	1451 ft/s

Ground

Average ground surface temperature:	3y7 °F
Amplitude ground surface temperature:	337 °F
Ground thermal conductivity:	1y Btu/hr ft °F
Ground heat capacity:	y857 Btu/ft³F
Depth below grade of groundwater:	857 ft
Flow rate groundwater:	y ft/d





Calculation para0 eters

Length of heating period	y. 4 days/yr
Heating degree hours	1. 8 kFh/a
Phase shift months	154 mths
Time constant heating demand	1. . 54 hr
Time constant cooling demand	hr
Time constant cooling demand with night ventilation	hr

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	19.5	31.9	83.7
Solar radiation North [Btu/hr ft²]	12	6.5	26.9
Solar radiation East [Btu/hr ft²]	22.8	13.3	91.7
Solar radiation South [Btu/hr ft²]	45.7	26.3	41.8
Solar radiation West [Btu/hr ft²]	22.2	11.4	73.3
Solar radiation Global [Btu/hr ft²]	29.5	19.7	101.4

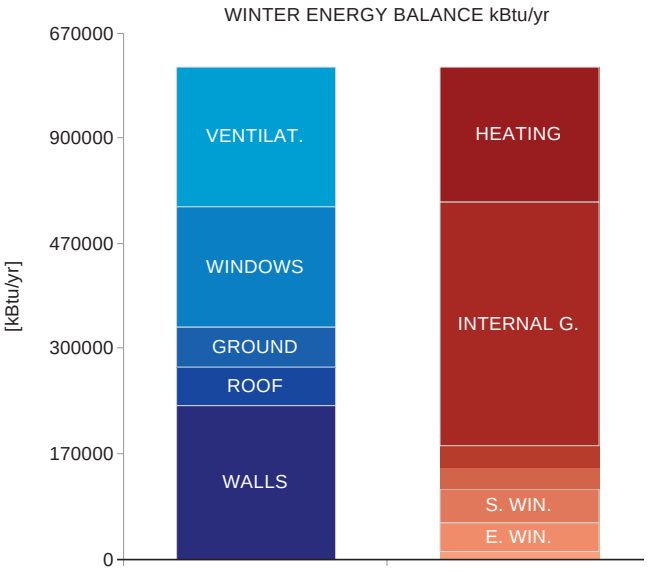
Relevant boundary conditions for heating load calculation: Heating load 1

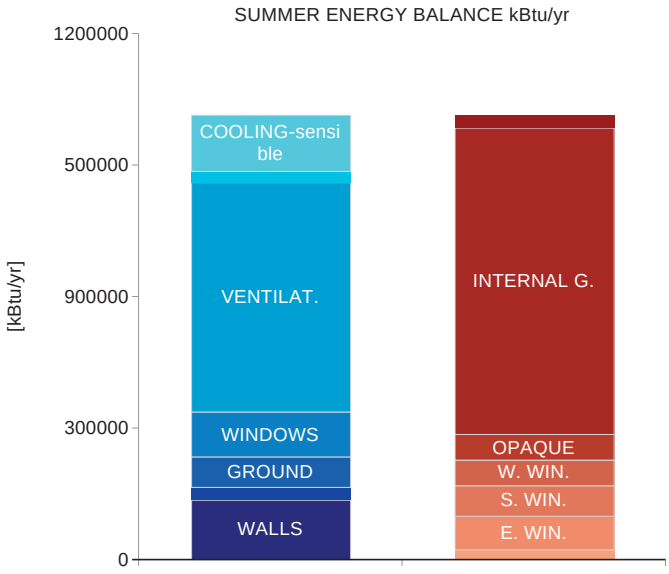
ANNUAL HEAT DEMAND

Transmission losses :	3ny,8y7	kBtu/yr
Ventilation losses:	189,. 71	kBtu/yr
Total heat losses:	9nm,. n8	kBtu/yr
Solar heat gains:	172,41m	kBtu/yr
Internal heat gains:	. m ,32y	kBtu/yr
Total heat gains:	38m,791	kBtu/yr
Utilization factor:	725 1	%
Useful heat gains:	3n7,22.	kBtu/yr
Annual heat demand:	181,9. 3	kBtu/yr
Specific annual heat demand:	y,2135 9	Btu/ft²yr

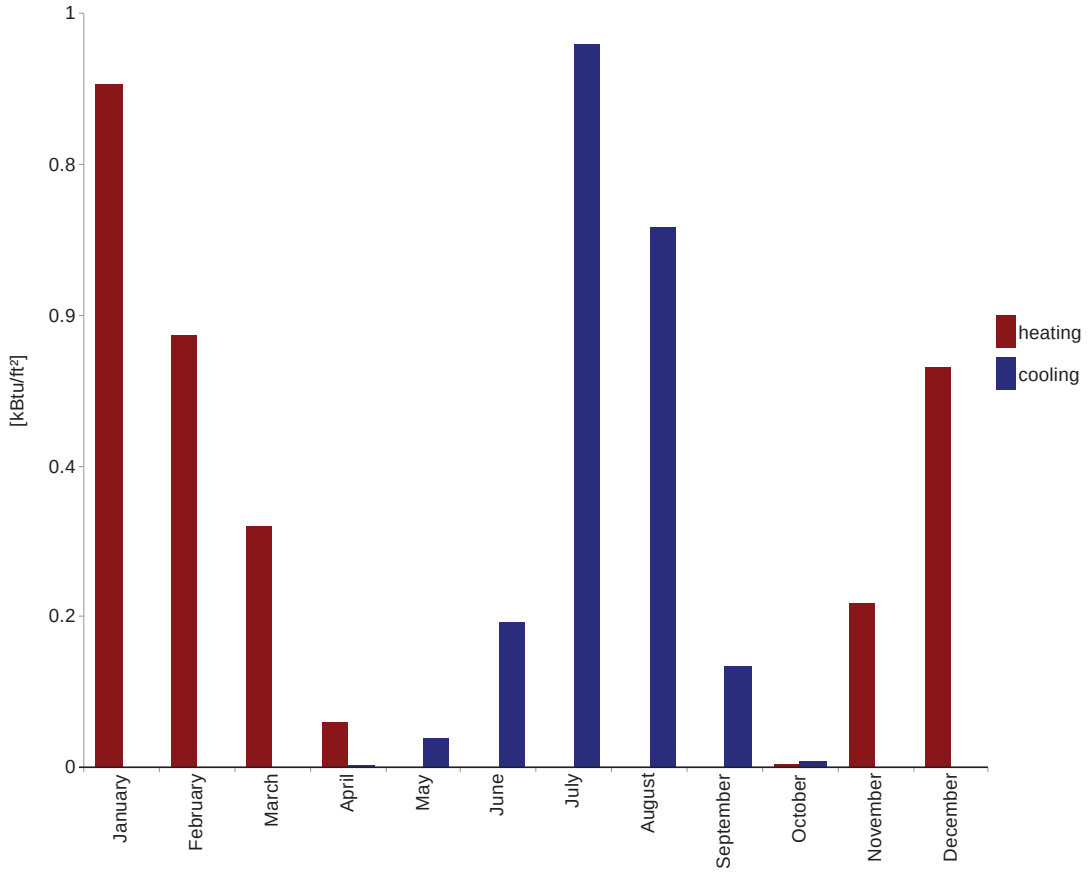
ANNUAL COOLING DEMAND

Solar heat gains:	y74,128	kBtu/yr
Internal heat gains:	9m1,y71	kBtu/yr
Total heat gains:	87. ,. 3m	kBtu/yr
Transmission losses :	731,. 23	kBtu/yr
Ventilation losses:	1,4yy,419	kBtu/yr
Total heat losses:	y,194,97y	kBtu/yr
Utilization factor:	485 2	%
Useful heat losses:	738,94y	kBtu/yr
Cooling demand - sensible:	1y. ,918	kBtu/yr
Cooling demand - latent:	y3,7ym	kBtu/yr
Annual cooling demand:	13m,347	kBtu/yr
Specific annual cooling demand:	y5 1	kBtu/ft²yr





P6 ECIFIC HEAT/COOLING DEMAND MONTHLY



Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	0.5	0
February	0.9	0
March	0.3	0
April	0.1	0
May	0	0
June	0	0.2
July	0	1
August	0	0.6
September	0	0.1
October	0	0
November	0.2	0
December	0.7	0

HEATING LOAD

	First climate	Second climate
Transmission heat losses:	134,9725 Btu/hr	11y,93354 Btu/hr
Ventilation heat losses:	77,ym252 Btu/hr	2y,9125 1 Btu/hr
Total heat loss:	y. 1,884 Btu/hr	193,. 915 Btu/hr
Solar heat gain:	y. ,m2952 Btu/hr	14,31757 Btu/hr
Internal heat gain:	49,17. 51 Btu/hr	49,17. 51 Btu/hr
Total heat gains heating:	21,y3159 Btu/hr	3m,9m4 Btu/hr
Heating load:	17m,9. 154 Btu/hr	1y. ,9275 Btu/hr

Relevant heating load: 17m,9. 154 Btu/hr

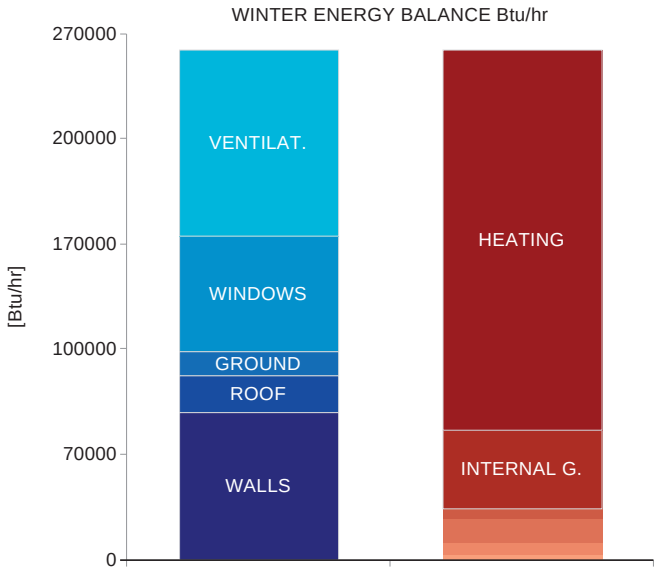
Specific heating load: y53 Btu/hr ft²

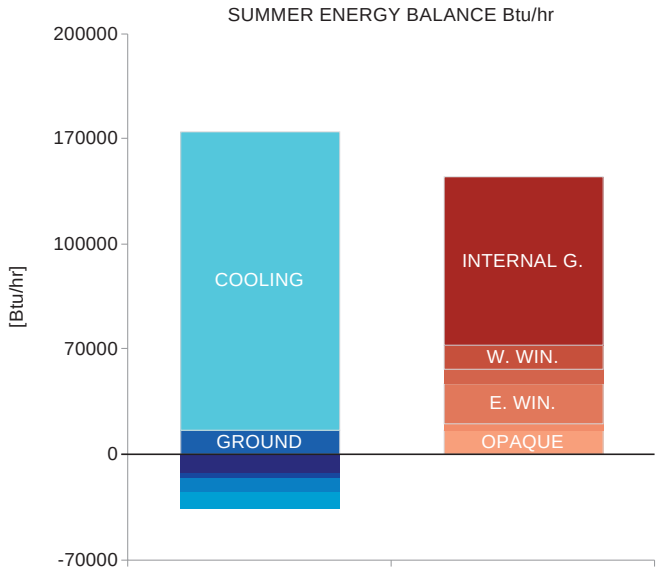
COOLING LOAD

Solar heat gain:	31,73y53 Btu/hr
Internal heat gain:	7m,m2y57 Btu/hr
Total heat gains cooling:	141,81354 Btu/hr
Transmission heat losses:	S1,2835 Btu/hr
Ventilation heat losses:	S7,m8753 Btu/hr
Total heat loss:	S8,93. Btu/hr
Cooling load - sensible:	1. 1,22854 Btu/hr
Cooling load - latent:	m Btu/hr

Relevant cooling load: 1. 1,22854 Btu/hr

Specific maximum cooling load: 153 Btu/hr ft²





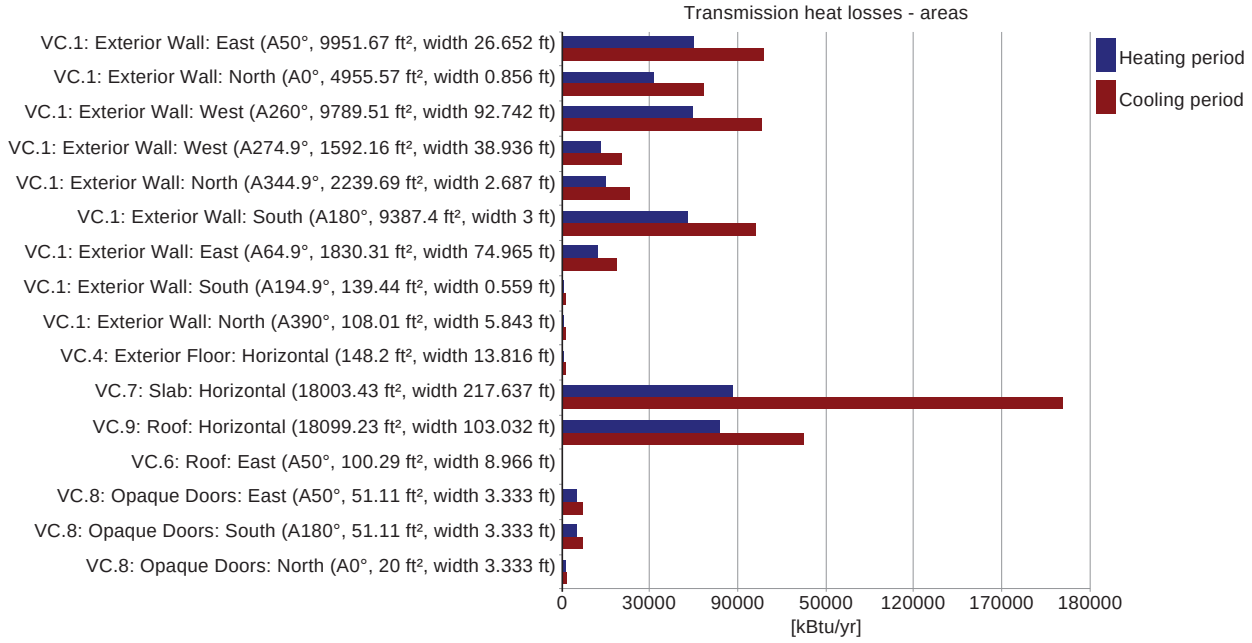
AREAP

Trans0 ission heat losses Sareas

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Exterior Wall: East (A50°, 9951.67 ft², width 26.652 ft)	9951.6	0.042	0.4	0.5	100	47113.8	95067
VC.1: Exterior Wall: North (A0°, 4955.57 ft², width 0.856 ft)	4600	0.042	0.4	0.5	100	31987.6	48714.5
VC.1: Exterior Wall: West (A260°, 9789.51 ft², width 92.742 ft)	9789.5	0.042	0.4	0.5	100	44406	96552.8
VC.1: Exterior Wall: West (A274.9°, 1592.16 ft², width 38.936 ft)	1592.2	0.042	0.4	0.5	100	13228.4	20274.3
VC.1: Exterior Wall: North (A344.9°, 2239.69 ft², width 2.687 ft)	2239.8	0.042	0.4	0.5	100	17065.9	23088.6
VC.1: Exterior Wall: South (A180°, 9387.4 ft², width 3 ft)	9387.4	0.042	0.4	0.5	100	43048.7	97512.8
VC.1: Exterior Wall: East (A64.9°, 1830.31 ft², width 74.965 ft)	1830.3	0.042	0.4	0.5	100	12335.4	18853.2
VC.1: Exterior Wall: South (A194.9°, 139.44 ft², width 0.559 ft)	139.4	0.042	0.4	0.5	100	515.8	1408.3
VC.1: Exterior Wall: North (A390°, 108.01 ft², width 5.843 ft)	108	0.042	0.4	0.5	100	628.2	1114.5
VC.4: Exterior Floor: Horizontal (148.2 ft², width 13.816 ft)	148.2	0.031	0.4	0.5	100	635.4	1132.1
VC.7: Slab: Horizontal (18003.43 ft², width 217.637 ft)	18003.4	0.088	0	0	0	78418.2	160893.6
VC.9: Roof: Horizontal (18099.23 ft², width 103.032 ft)	18099.2	0.015	0.4	0.5	100	73842.3	82435.7
VC.6: Roof: East (A50°, 100.29 ft², width 8.966 ft)	100.3	0.015	0.4	0.5	100	258.8	476.7
VC.8: Opaque Doors: East (A50°, 51.11 ft², width 3.333 ft)	51.1	0.336	0.4	0.5	100	4513.1	6722.9
VC.8: Opaque Doors: South (A180°, 51.11 ft², width 3.333 ft)	51.1	0.336	0.4	0.5	100	4513.1	6722.9
VC.8: Opaque Doors: North (A0°, 20 ft², width 3.333 ft)	20	0.336	0.4	0.5	100	1068.7	1971.3

Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	88.8	139
Ground heating	20.7	90



THERMAL BRIDGEP

Trans0 ission heat losses Sther0 al bridges

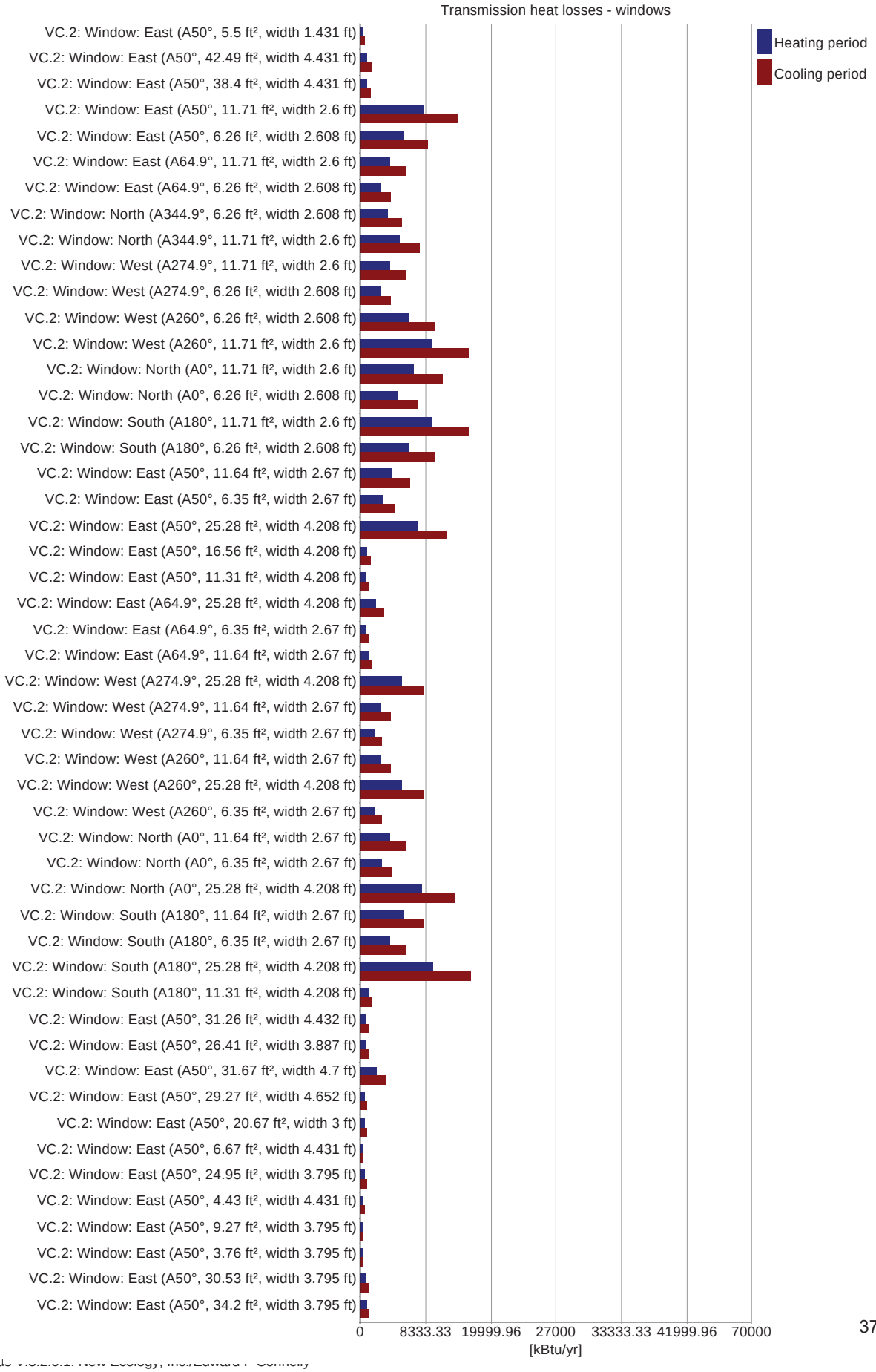
Name	Length [ft]	Psi-value [Btu/hr ft °F]	Transmission losses [kBtu/yr]	Transmission losses cooling [kBtu/yr]

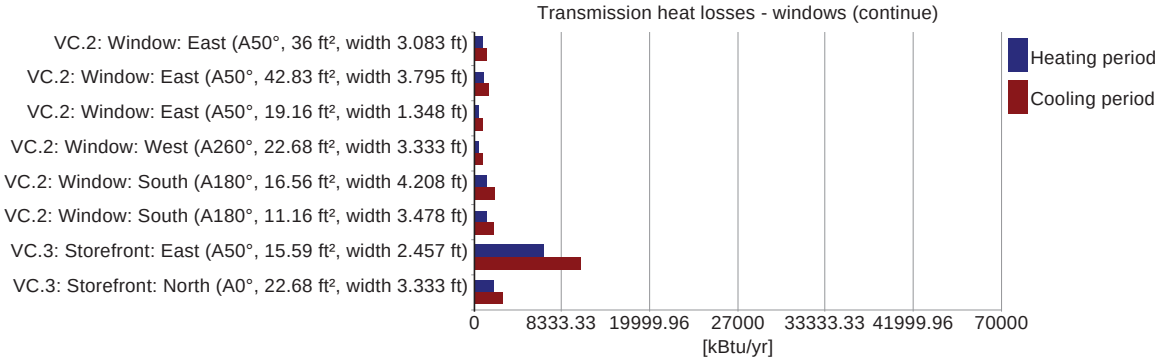
WINDOWP

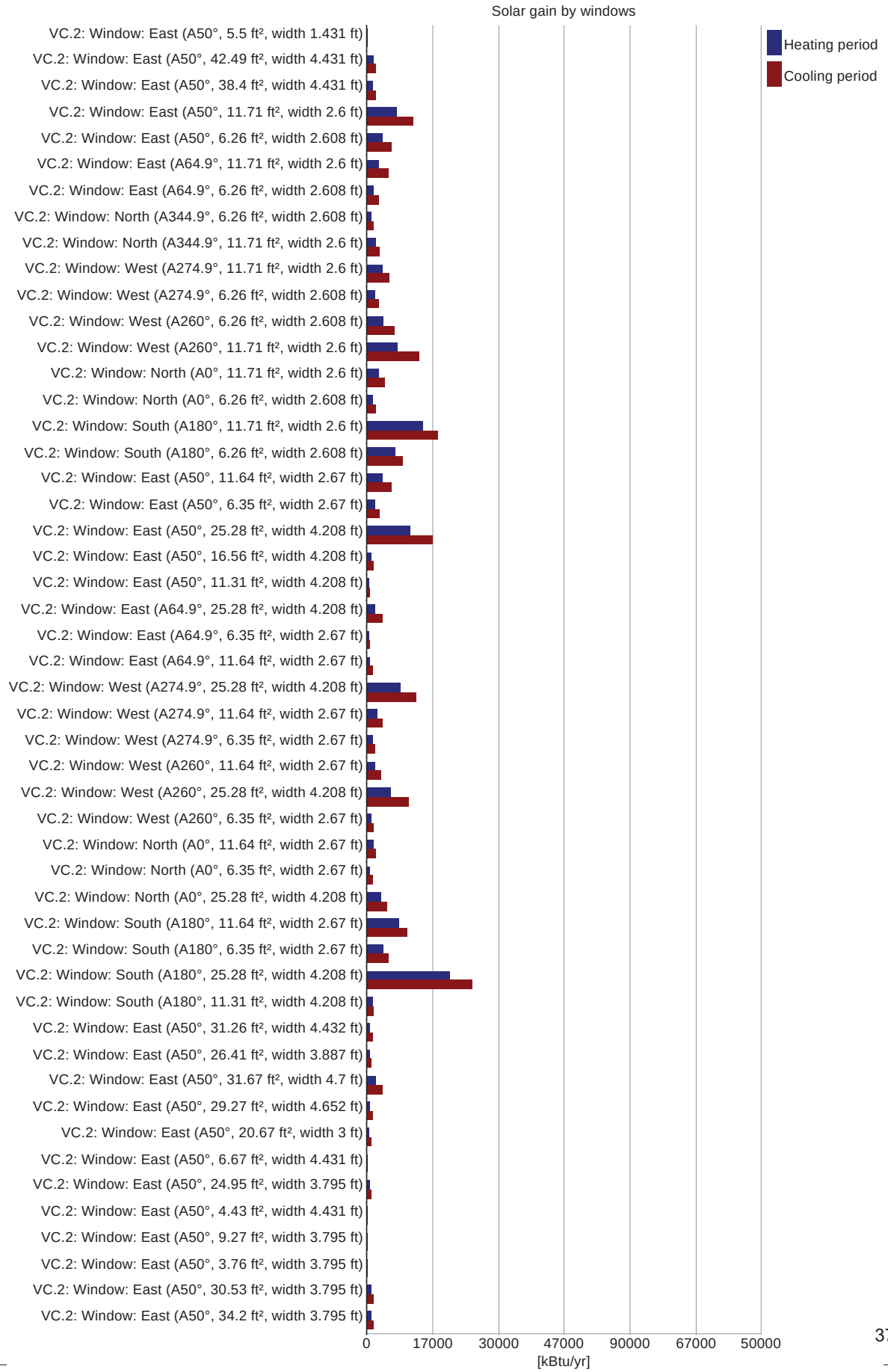
Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.2: Window: East (A50°, 5.5 ft², width 1.431 ft)	1	50	0.201	0.4	83.3	64.7	160.9	295.9	316.9	489.3
VC.2: Window: East (A50°, 42.49 ft², width 4.431 ft)	1	50	0.133	0.4	54.8	84	1,357	2,180.4	509	1,386.3
VC.2: Window: East (A50°, 38.4 ft², width 4.431 ft)	1	50	0.137	0.4	54.6	83.5	1,249.3	1,548.4	828.6	1,298.8
VC.2: Window: East (A50°, 11.71 ft², width 2.6 ft)	29	50	0.195	0.4	87.1	64.5	9,655.2	10,917.6	8,062.3	12,375.8
VC.2: Window: East (A50°, 6.26 ft², width 2.608 ft)	29	50	0.187	0.4	83.5	63.3	3,769.4	7,770.9	7,901	8,767.5
VC.2: Window: East (A64.9°, 11.71 ft², width 2.6 ft)	12	50	0.195	0.4	87.1	64.6	2,989.6	4,880.9	3,627.6	7,604.7
VC.2: Window: East (A64.9°, 6.26 ft², width 2.608 ft)	12	50	0.187	0.4	84	63.2	1,417.4	2,779.8	2,787.1	3,578.1
VC.2: Window: North (A344.9°, 6.26 ft², width 2.608 ft)	19	50	0.187	0.4	62.9	90.1	1,022	1,779.8	3,449.8	7,266.7
VC.2: Window: North (A344.9°, 11.71 ft², width 2.6 ft)	19	50	0.195	0.4	63.1	90.2	1,547.1	2,577	4,596.9	6,909
VC.2: Window: West (A274.9°, 11.71 ft², width 2.6 ft)	12	50	0.195	0.4	84.8	64	3,761.4	7,164.3	3,627.6	7,604.7
VC.2: Window: West (A274.9°, 6.26 ft², width 2.608 ft)	12	50	0.187	0.4	83.1	62.2	1,892.5	2,988.1	2,787.1	3,578.1
VC.2: Window: West (A260°, 6.26 ft², width 2.608 ft)	25	50	0.187	0.4	65.8	60.6	3,968	9,213.4	9,246.3	5,797.4
VC.2: Window: West (A260°, 11.71 ft², width 2.6 ft)	25	50	0.195	0.4	81.8	62.5	6,095.4	12,009.7	5,003.8	13,687.5
VC.2: Window: North (A0°, 11.71 ft², width 2.6 ft)	22	50	0.195	0.4	60.6	76.4	2,763.1	3,528.4	9,830.4	10,478.3
VC.2: Window: North (A0°, 6.26 ft², width 2.608 ft)	22	50	0.187	0.4	61.1	78.2	1,392.9	2,057.1	4,635.3	6,279.7
VC.2: Window: South (A180°, 11.71 ft², width 2.6 ft)	25	50	0.195	0.4	83.3	94.7	12,947.3	17,547.3	5,003.8	13,687.5
VC.2: Window: South (A180°, 6.26 ft², width 2.608 ft)	25	50	0.187	0.4	80.6	92.1	9,722.1	8,158.2	9,246.3	5,797.4
VC.2: Window: East (A50°, 11.64 ft², width 2.67 ft)	13	50	0.198	0.4	89.7	67.6	3,797.3	7,742.1	4,058.5	9,267.5
VC.2: Window: East (A50°, 6.35 ft², width 2.67 ft)	13	50	0.187	0.4	87.1	63.5	1,890.4	2,866.1	2,836.8	4,347
VC.2: Window: East (A50°, 25.28 ft², width 4.208 ft)	11	50	0.14	0.4	85.9	66.6	5,922.7	14,899.4	6,231.8	11,062.5
VC.2: Window: East (A50°, 16.56 ft², width 4.208 ft)	2	50	0.173	0.4	86	67.5	535.2	1,476.9	866.8	1,344
VC.2: Window: East (A50°, 11.31 ft², width 4.208 ft)	2	50	0.161	0.4	84.6	63.6	484.7	645.9	920.2	545.6
VC.2: Window: East (A64.9°, 25.28 ft², width 4.208 ft)	3	50	0.14	0.4	67.2	61.7	1,638.2	3,360.3	1,562.3	3,015.5
VC.2: Window: East (A64.9°, 6.35 ft², width 2.67 ft)	3	50	0.187	0.4	81.5	62.6	346.8	939.9	974.5	1,002.6
VC.2: Window: East (A64.9°, 11.64 ft², width 2.67 ft)	3	50	0.198	0.4	82.5	64.2	992.4	1,215.7	547.5	1,448.3
VC.2: Window: West (A274.9°, 25.28 ft², width 4.208 ft)	8	50	0.14	0.4	89.2	67.3	6,757.4	11,029.5	7,275.7	8,073
VC.2: Window: West (A274.9°, 11.64 ft², width 2.67 ft)	8	50	0.198	0.4	84.8	64	2,441.4	3,742	2,722.4	3,892.1
VC.2: Window: West (A274.9°, 6.35 ft², width 2.67 ft)	8	50	0.187	0.4	82.8	61.5	1,294.4	1,829.7	1,649.3	2,963.8
VC.2: Window: West (A260°, 11.64 ft², width 2.67 ft)	8	50	0.198	0.4	69.1	60.6	1,658.2	3,178.3	2,722.4	3,892.1
VC.2: Window: West (A260°, 25.28 ft², width 4.208 ft)	8	50	0.14	0.4	64.3	61.4	7,225.3	5,426.7	7,275.7	8,073
VC.2: Window: West (A260°, 6.35 ft², width 2.67 ft)	8	50	0.187	0.4	64.9	98.5	536.1	1,939.9	1,649.3	2,963.8
VC.2: Window: North (A0°, 11.64 ft², width 2.67 ft)	12	50	0.198	0.4	60.9	76.4	1,435.7	2,155.8	3,683.9	7,653.2
VC.2: Window: North (A0°, 6.35 ft², width 2.67 ft)	12	50	0.187	0.4	60.5	78.1	679.3	1,197.3	2,915.7	4,010.8
VC.2: Window: North (A0°, 25.28 ft², width 4.208 ft)	12	50	0.14	0.4	48.6	35.9	3,036.8	4,946.7	6,885.3	12,065.7
VC.2: Window: South (A180°, 11.64 ft², width 2.67 ft)	16	50	0.198	0.4	80.5	93.6	6,377.7	5,333.1	7,390.1	8,206
VC.2: Window: South (A180°, 6.35 ft², width 2.67 ft)	16	50	0.187	0.4	68.5	91.2	3,813.9	4,806.8	3,610.5	7,981.5
VC.2: Window: South (A180°, 25.28 ft², width 4.208 ft)	14	50	0.14	0.4	83	99.3	18,518.3	24,146	5,204.1	14,052.6
VC.2: Window: South (A180°, 11.31 ft², width 4.208 ft)	3	50	0.161	0.4	65.4	90.2	1,190.3	1,470.2	530.4	1,424.7
VC.2: Window: East (A50°, 31.26 ft², width 4.432 ft)	1	50	0.135	0.4	95.9	93.9	604.5	1,137.5	952.5	1,090.5
VC.2: Window: East (A50°, 26.41 ft², width 3.887 ft)	1	50	0.143	0.4	60.5	90.3	971.3	586.8	927.9	576.5
VC.2: Window: East (A50°, 31.67 ft², width 4.7 ft)	3	50	0.138	0.4	96.1	75.9	2,123.4	3,340.2	2,103.6	3,221
VC.2: Window: East (A50°, 29.27 ft², width 4.652 ft)	1	50	0.142	0.4	85.5	66.9	667.7	1,153.4	759.3	513
VC.2: Window: East (A50°, 20.67 ft², width 3 ft)	1	50	0.173	0.4	88.3	66.2	791	861.8	706.6	666.3
VC.2: Window: East (A50°, 6.67 ft², width 4.431 ft)	1	50	0.158	0.4	83.4	61.1	121	184.4	247	367.2
VC.2: Window: East (A50°, 24.95 ft², width 3.795 ft)	1	50	0.149	0.4	85.2	66.6	606.7	1,057.6	769.9	882.5
VC.2: Window: East (A50°, 4.43 ft², width 4.431 ft)	2	50	0.276	0.4	81.6	95.2	23.8	39.1	393.7	779.7
VC.2: Window: East (A50°, 9.27 ft², width 3.795 ft)	1	50	0.202	0.4	83.3	61.3	53	142.1	201.5	305.1
VC.2: Window: East (A50°, 3.76 ft², width 3.795 ft)	2	50	0.278	0.4	82.2	95.8	18.7	28	254.5	471.9
VC.2: Window: East (A50°, 30.53 ft², width 3.795 ft)	1	50	0.142	0.4	52.2	81.7	532.9	1,492.2	603.7	1,066.2
VC.2: Window: East (A50°, 34.2 ft², width 3.795 ft)	1	50	0.141	0.4	53.1	82.6	1,044	1,971.9	660	1,165

Trans0 ission heat losses Swindows (continue)

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.2: Window: East (A50°, 36 ft², width 3.083 ft)	1	50	0.144	0.4	51.9	81.7	1,100.7	1,631.6	872.7	1,307.3
VC.2: Window: East (A50°, 42.83 ft², width 3.795 ft)	1	50	0.138	0.4	53.2	82.8	1,336.6	2,117.1	547.3	1,446.4
VC.2: Window: East (A50°, 19.16 ft², width 1.348 ft)	1	50	0.201	0.4	83	64.4	268.9	441.8	721	656.6
VC.2: Window: West (A260°, 22.68 ft², width 3.333 ft)	1	50	0.145	0.4	72	72.4	317.9	909.5	742.3	830.3
VC.2: Window: South (A180°, 16.56 ft², width 4.208 ft)	3	50	0.173	0.4	82.4	93.2	2,260.3	2,870.8	1,319.9	2,019
VC.2: Window: South (A180°, 11.16 ft², width 3.478 ft)	4	50	0.195	0.4	84.4	94.3	1,950	2,119.2	1,207.4	1,847.6
VC.3: Storefront: East (A50°, 15.59 ft², width 2.457 ft)	4	50	0.721	0.3	62	69	1,661.9	3,302.3	9,971.3	10,184
VC.3: Storefront: North (A0°, 22.68 ft², width 3.333 ft)	1	50	0.703	0.3	70	46.3	155.7	377	1,830.6	2,803


Transmission heat losses - windows
Heating period
Cooling period
VC.2: Window: East (A50°, 5.5 ft², width 1.431 ft)
VC.2: Window: East (A50°, 42.49 ft², width 4.431 ft)
VC.2: Window: East (A50°, 38.4 ft², width 4.431 ft)
VC.2: Window: East (A50°, 11.71 ft², width 2.6 ft)
VC.2: Window: East (A50°, 6.26 ft², width 2.608 ft)
VC.2: Window: East (A64.9°, 11.71 ft², width 2.6 ft)
VC.2: Window: East (A64.9°, 6.26 ft², width 2.608 ft)
VC.2: Window: North (A344.9°, 6.26 ft², width 2.608 ft)
VC.2: Window: North (A344.9°, 11.71 ft², width 2.6 ft)
VC.2: Window: West (A274.9°, 11.71 ft², width 2.6 ft)
VC.2: Window: West (A274.9°, 6.26 ft², width 2.608 ft)
VC.2: Window: West (A260°, 6.26 ft², width 2.608 ft)
VC.2: Window: West (A260°, 11.71 ft², width 2.6 ft)
VC.2: Window: North (A0°, 11.71 ft², width 2.6 ft)
VC.2: Window: North (A0°, 6.26 ft², width 2.608 ft)
VC.2: Window: South (A180°, 11.71 ft², width 2.6 ft)
VC.2: Window: South (A180°, 6.26 ft², width 2.608 ft)
VC.2: Window: East (A50°, 11.64 ft², width 2.67 ft)
VC.2: Window: East (A50°, 6.35 ft², width 2.67 ft)
VC.2: Window: East (A50°, 25.28 ft², width 4.208 ft)
VC.2: Window: East (A50°, 16.56 ft², width 4.208 ft)
VC.2: Window: East (A50°, 11.31 ft², width 4.208 ft)
VC.2: Window: East (A64.9°, 25.28 ft², width 4.208 ft)
VC.2: Window: East (A64.9°, 6.35 ft², width 2.67 ft)
VC.2: Window: East (A64.9°, 11.64 ft², width 2.67 ft)
VC.2: Window: West (A274.9°, 25.28 ft², width 4.208 ft)
VC.2: Window: West (A274.9°, 11.64 ft², width 2.67 ft)
VC.2: Window: West (A274.9°, 6.35 ft², width 2.67 ft)
VC.2: Window: West (A260°, 11.64 ft², width 2.67 ft)
VC.2: Window: West (A260°, 25.28 ft², width 4.208 ft)
VC.2: Window: West (A260°, 6.35 ft², width 2.67 ft)
VC.2: Window: North (A0°, 11.64 ft², width 2.67 ft)
VC.2: Window: North (A0°, 6.35 ft², width 2.67 ft)
VC.2: Window: North (A0°, 25.28 ft², width 4.208 ft)
VC.2: Window: South (A180°, 11.64 ft², width 2.67 ft)
VC.2: Window: South (A180°, 6.35 ft², width 2.67 ft)
VC.2: Window: South (A180°, 25.28 ft², width 4.208 ft)
VC.2: Window: South (A180°, 11.31 ft², width 4.208 ft)
VC.2: Window: East (A50°, 31.26 ft², width 4.432 ft)
VC.2: Window: East (A50°, 26.41 ft², width 3.887 ft)
VC.2: Window: East (A50°, 31.67 ft², width 4.7 ft)
VC.2: Window: East (A50°, 29.27 ft², width 4.652 ft)
VC.2: Window: East (A50°, 20.67 ft², width 3 ft)
VC.2: Window: East (A50°, 6.67 ft², width 4.431 ft)
VC.2: Window: East (A50°, 24.95 ft², width 3.795 ft)
VC.2: Window: East (A50°, 4.43 ft², width 4.431 ft)
VC.2: Window: East (A50°, 9.27 ft², width 3.795 ft)
VC.2: Window: East (A50°, 3.76 ft², width 3.795 ft)
VC.2: Window: East (A50°, 30.53 ft², width 3.795 ft)
VC.2: Window: East (A50°, 34.2 ft², width 3.795 ft)
0
8333.33
19999.96
27000
33333.33
41999.96
70000
[kBtu/yr]


Transmission heat losses - windows (continue)
VC.2: Window: East (A50°, 36 ft², width 3.083 ft)
VC.2: Window: East (A50°, 42.83 ft², width 3.795 ft)
VC.2: Window: East (A50°, 19.16 ft², width 1.348 ft)
VC.2: Window: West (A260°, 22.68 ft², width 3.333 ft)
VC.2: Window: South (A180°, 16.56 ft², width 4.208 ft)
VC.2: Window: South (A180°, 11.16 ft², width 3.478 ft)
VC.3: Storefront: East (A50°, 15.59 ft², width 2.457 ft)
VC.3: Storefront: North (A0°, 22.68 ft², width 3.333 ft)
Heating period
Cooling period
0
8333.33
19999.96
27000
33333.33
41999.96
70000
[kBtu/yr]


Solar gain by windows
Heating period
Cooling period
VC.2: Window: East (A50°, 5.5 ft², width 1.431 ft)
VC.2: Window: East (A50°, 42.49 ft², width 4.431 ft)
VC.2: Window: East (A50°, 38.4 ft², width 4.431 ft)
VC.2: Window: East (A50°, 11.71 ft², width 2.6 ft)
VC.2: Window: East (A50°, 6.26 ft², width 2.608 ft)
VC.2: Window: East (A64.9°, 11.71 ft², width 2.6 ft)
VC.2: Window: East (A64.9°, 6.26 ft², width 2.608 ft)
VC.2: Window: North (A344.9°, 6.26 ft², width 2.608 ft)
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VC.2: Window: West (A274.9°, 11.71 ft², width 2.6 ft)
VC.2: Window: West (A274.9°, 6.26 ft², width 2.608 ft)
VC.2: Window: West (A260°, 6.26 ft², width 2.608 ft)
VC.2: Window: West (A260°, 11.71 ft², width 2.6 ft)
VC.2: Window: North (A0°, 11.71 ft², width 2.6 ft)
VC.2: Window: North (A0°, 6.26 ft², width 2.608 ft)
VC.2: Window: South (A180°, 11.71 ft², width 2.6 ft)
VC.2: Window: South (A180°, 6.26 ft², width 2.608 ft)
VC.2: Window: East (A50°, 11.64 ft², width 2.67 ft)
VC.2: Window: East (A50°, 6.35 ft², width 2.67 ft)
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VC.2: Window: East (A50°, 16.56 ft², width 4.208 ft)
VC.2: Window: East (A50°, 11.31 ft², width 4.208 ft)
VC.2: Window: East (A64.9°, 25.28 ft², width 4.208 ft)
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VC.2: Window: East (A64.9°, 11.64 ft², width 2.67 ft)
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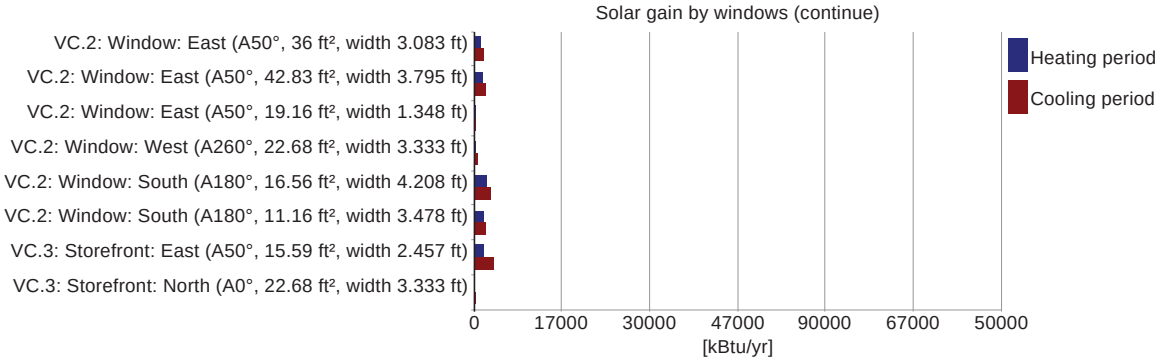
VC.2: Window: East (A50°, 4.43 ft², width 4.431 ft)
VC.2: Window: East (A50°, 9.27 ft², width 3.795 ft)
VC.2: Window: East (A50°, 3.76 ft², width 3.795 ft)
VC.2: Window: East (A50°, 30.53 ft², width 3.795 ft)
VC.2: Window: East (A50°, 34.2 ft², width 3.795 ft)
0
17000
30000
47000
90000
67000
50000
[kBtu/yr]



Pu0 0 ar- building envelope

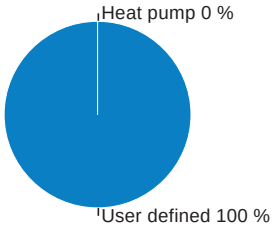
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	4m,8775 ft²	m5m . Btu/hr ft² °F	y17,18. 5 kBtu/yr
Exterior wall ground:	m ft²	m Btu/hr ft² °F	m kBtu/yr
Basement:	17,mm45 ft²	m5m77 Btu/hr ft² °F	37,. 175y kBtu/yr
Roof:	17,12253 ft²	m5m18 Btu/hr ft² °F	3. ,1. 151 kBtu/yr
Windows:	2,49y ft²	m5128 Btu/hr ft² °F	19y,19. 5 kBtu/yr
Doors:	m ft²	m Btu/hr ft² °F	m kBtu/yr
Thermal bridge ambient:	m ft	m Btu/hr ft °F	m kBtu/yr
Thermal bridge perimeter:	m ft	m Btu/hr ft °F	m kBtu/yr
Thermal bridge floor slab:	m ft	m Btu/hr ft °F	m kBtu/yr

Phading

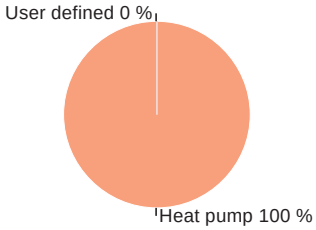
	Heating	Cooling
Reduction factor North:	2457 %	3y5y %
Reduction factor East:	7. 52 %	93 %
Reduction factor South:	7y51 %	2. 54 %
Reduction factor West:	7m89 %	9y5 %
Reduction factor Horizontal:	1mm %	1mm %

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Source energy demand [kBtu/yr]
Heat pump, VRF	0	0	0	100	0	93,248	0	26,651,397.9	113,849.3
User defined, Condensing Gas-Fired Boilers	100	0	431,691	0	0	0	1.1	26,574,055.8	464,536.1
Σ	100	0	431,691	100	0	93,248		77,647,497.4	788,683.4

DHW Sfinal energ-



Heating Sfinal energ-



COOLING UNITP

	sensible	latent
Air cooling:	m kBtu/ft²yr	m kBtu/ft²yr
Recirculation cooling:	15.9 kBtu/ft²yr	m kBtu/ft²yr
Additional dehumidification:		m.5 kBtu/ft²yr
Panel cooling:	m kBtu/ft²yr	
Sum:	15.9 kBtu/ft²yr	m.5 kBtu/ft²yr

VENTILATION

Energ- transportable b- suppl- air

Heating energ-

transportable: 15 3 W/ft²

load: [illegible] W/ft²

Cooling energ-

transportable: [illegible] W/ft²

load: [illegible] W/ft²

Infiltration pressure test ACH70:	[illegible] 1/hr
Total extract air demand:	3,[illegible] cfm
Supply air per person:	17 cfm
Occupancy:	172

Average air flow rate:	3,198[illegible] cfm
Average air change rate:	[illegible] 1/hr
Effective ACH ambient:	[illegible] 1/hr
Effective ACH ground:	[illegible] 1/hr
Energetically effective air exchange:	[illegible] 1/hr
Infiltration air change rate:	[illegible] 1/hr
Infiltration air change rate (heating load):	[illegible] 1/hr

Type of ventilation system:	Balanced 6H ventilation
Wind screening coefficient (e):	[illegible]
Wind exposure factor:	13
Wind shield factor:	[illegible]

Ventilation heat losses: 194,83[illegible] kBtu/yr

Devices

Name	Sensible recovery efficiency [-]	Electric efficiency [W/cfm]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Semco	0.5	0.04	0	0.5
Altogether	0.8	0.04	0	0.8

Ducts

Name	Length (total) [ft]	Clear cross-section [ft²]	U-value [Btu/hr ft² °F]	Assigned ventilation units
ERV-1	10	2.27	14.71	Semco
ERV-1	10	2.27	14.71	Semco
Σ	20			

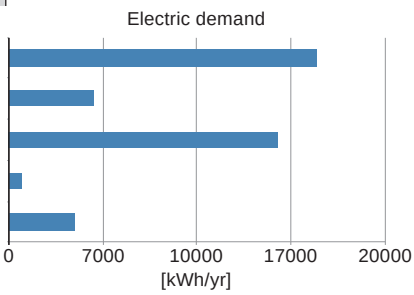
*length * quantity ** thermal conductivity / thickness

PUMMER VENTILATION

ACH night ventilation:	[illegible] 1/hr
ACH natural summer:	[illegible] 1/hr
Mechanical ventilation summer:	[illegible] 1/hr
Mechanical ventilation summer with HR:	no

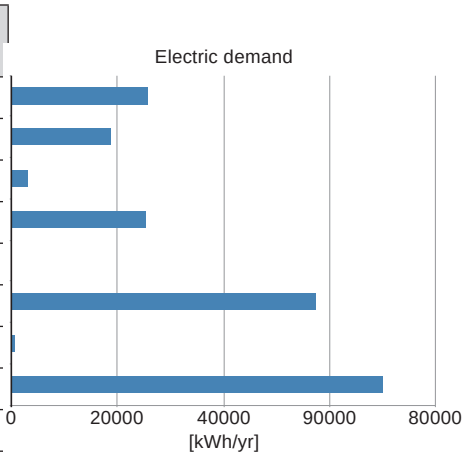
ELECTRICITY DEMAND SAUXILIARY ELECTRICITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Source energy [kBtu/yr]
Ventilation winter	1	no	0.6 W/cfm	19362.5	100770.2
Ventilation Defrost	1	no	24,302.3 W	4740.1	26882
Ventilation summer	1	no	0.6 W/cfm	14286.1	86640.7
DHW circulating pump	1	yes	83.7 W	600.2	4300
DHW storage load pump	1	yes	490.6 W	3435.7	21123.1
Σ				35335.5	241757.8



ELECTRICITY DEMAND REPIDENTIAL BUILDING

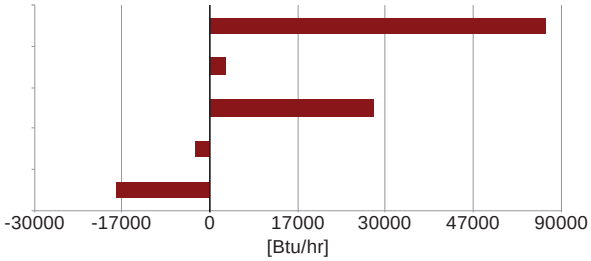
Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Non-electric demand [kWh/yr]	Source energy [kBtu/yr]
Kitchen refrigerator	1	yes	1.2	27720	0	179624.6
Kitchen cooking	1	yes	0.2	18900	0	114226.2
Laundry - washer	1	yes	0.3	2524.7	0	16590.3
Laundry - dryer	1	yes	3.1	27340.3	0	177920.8
Energy consumed by evaporation	1	yes	3.1	0	1670	6101.6
User defined lighting	1	yes	76,478	76478	0	372893.5
User defined lighting	1	no	775	775	0	3433
User defined MELs	1	yes	60,171	60171	0	430814.6
Σ	8			200772.8	1670	1238649.2



INTERNAL HEAT GAINP

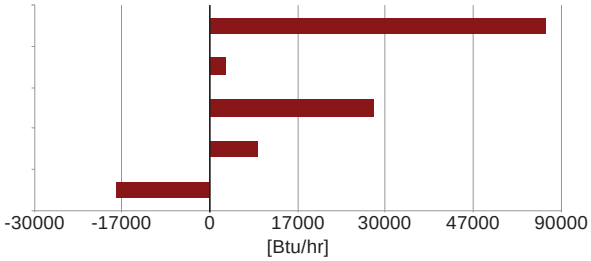
Heating season

Electricity total:	39,4435y	Btu/hr
Auxiliary electricity:	y,23. 53	Btu/hr
People:	y9,8y3	Btu/hr
Cold water:	Sy,37. 5	Btu/hr
Evaporation:	S13,7225 3	Btu/hr
Σ:	28,4925 1	Btu/hr
Specific internal heat gains:	m8	Btu/hr ft²



Cooling season

Electricity total:	39,4435y	Btu/hr
Auxiliary electricity:	y,23. 53	Btu/hr
People:	y9,8y3	Btu/hr
Cold and hot water:	7,1my54	Btu/hr
Evaporation:	S13,7225 3	Btu/hr
Σ:	28,4925 1	Btu/hr
Specific internal heat gains:	m8	Btu/hr ft²



DHW AND DIPTRIBUTION

DHW consumption per person per day:	25.2	gal/Person/day
Average cold water temperature supply:	3y5.7	°F
Useful heat DHW:	4y3,m29.1	kBtu/yr
Specific useful heat DHW:	. ,. 4. 5	Btu/ft²yr
Total heat losses of the DHW system:	39,myy5.y	kBtu/yr
Specific losses of the DHW system:	999.3	Btu/ft²yr
Performance ratio DHW distribution system and storage:	15.y	
Utilization ratio DHW distribution system and storage:	m.8	
Total heat demand of DHW system:	47y,m78.5	kBtu/yr
Total specific heat demand of DHW system:	3,y1y.4	Btu/ft²yr
Total heat losses of the hydronic heating distribution:	m	kBtu/yr
Specific losses of the hydronic heating distribution:	m	Btu/ft²yr
Performance ratio of heat distribution:	1mm	%

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
In conditioned space	1920	39258.3
Σ	1920	39258.3
Individual pipes		
In conditioned space	1470	13705.2
Σ	1470	13705.2
Water storage		
Device 4 (Water storage: DHW)		1803.6
Σ		1803.6

BUILDING INFORMATION

Category:	**Residential**
Status:	**In planning**
Building type:	**New construction**
Year of construction:	
Units:	**37**
Number of occupants:	**712 (Design)**
Occupant density:	**348.1** ft²/Person

Boundar5 conditions

Climate:	**MA yBO- TON LOGAN INT ARST (cold 5ear)**
Internal heat gains:	**7** Btu/hr ft²
Interior temperature:	**P6** °F
Overheat temperature:	**mm** °F

Building geo9 etr5

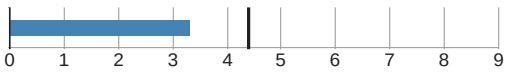
Enclosed volume:	**P440 87m** ft³
Net-volume:	**3670 42P.2** ft³
Total area envelope:	**, m0 2P3.3** ft²
Area/Volume Ratio:	**8.7** 1/ft
Floor area:	**, , 0327** ft²
Envelope area/iCFA:	**7.83,**

SA- - IVEHOU- E REQUIREMENT-

Certificate criteria: SHIU- + 1876

Heating de9 and

specific:	**4.12** kBtu/ft²yr
target:	**3.3** kBtu/ft²yr
total:	182,710.75 kBtu/yr

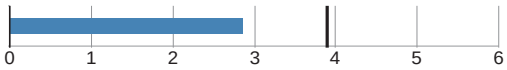


Cooling de9 and

sensible:	**7.23** kBtu/ft²yr
latent:	**8.43** kBtu/ft²yr
specific:	**1.12** kBtu/ft²yr
target:	**P.,** kBtu/ft²yr
total:	126,892.5 kBtu/yr

Heating load

specific:	**1.6,** Btu/hr ft²
target:	**4.2** Btu/hr ft²
total:	157,880.04 Btu/hr



Cooling load

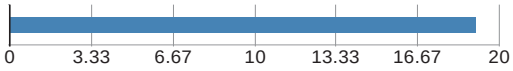
specific:	**1.73** Btu/hr ft²
target:	**4** Btu/hr ft²
total:	118,590.5 Btu/hr

- ource energ5

total:	**3270268.74**	kWh/yr
specific:	**40673**	kWh/Person yr
target:	**40638**	kWh/Person yr
total:	**70Pm60, 38.76**	kBtu/yr
specific:	30.25	kBtu/ft²yr

- ite energ5

total:	1,055,506.11	kBtu/yr
specific:	19.02	kBtu/ft²yr
total:	309,368.84	kWh/yr
specific:	5.58	kWh/ft²

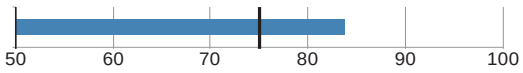


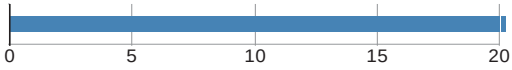
Air tightness

ACH50:	**8.34**	1/hr
CFM50 per envelope area:	**8.8P**	cfm/ft²
target:	**8.34**	1/hr
target CFM50:	**8.8P**	cfm/ft²

SA- - IVEHOU- E RECOMMENDATION-

Sensible recovery efficiency:	**64.m**	%
Frequency of overheating: Cooling system is required	**1, .,**	%





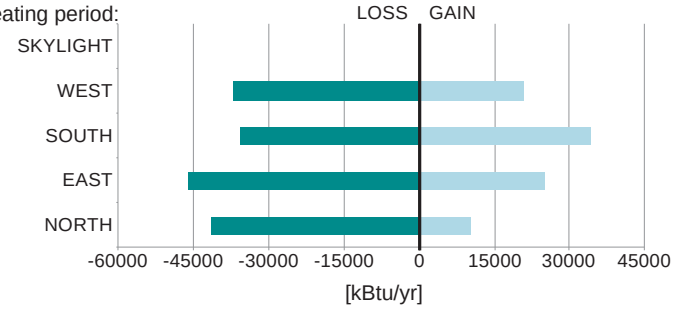
Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

BUILDING ELEMENT-

Windows

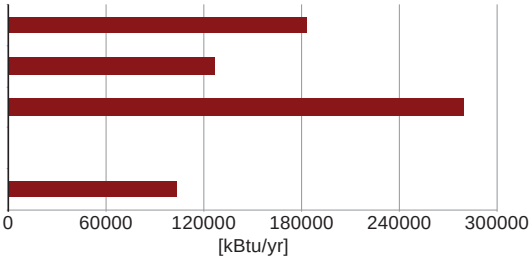
Average SHGC:	8.4P
Average solar reduction factor heating:	8.4m
Average solar reduction factor cooling:	8.43
Average U-value:	8.726 Btu/hr ft² °F
Total glazing area:	40Pm7.7 ft²
Total window area:	, 0m87.1 ft²

Heat gain/loss heating period:



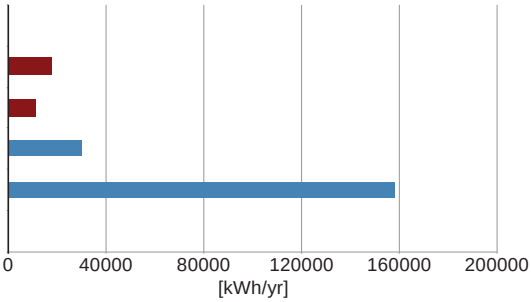
HVAC

Total heating demand:	7610m77 kBtu/yr
Total cooling demand:	71P0624 kBtu/yr
Total DHW energy demand:	1m206P1 kBtu/yr
Solar DHW contribution:	8 kBtu/yr
Auxiliary electricity:	7810 6, 6 kBtu/yr



Electricit5

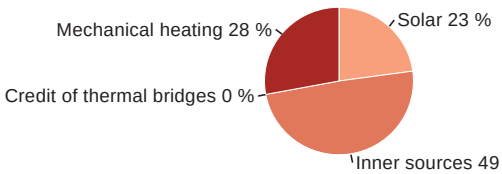
Direct heating / DHW:	8 kWh/yr
Heatpump heating:	7m0P88 kWh/yr
Cooling:	780P21 kWh/yr
HVAC auxiliary energy:	480736 kWh/yr
Appliances:	7, 601146 kWh/yr
Renewable generation, coincident production and use:	8 kWh/yr
Total electricity demand:	17P0Pm6 kWh/yr



HEAT FLOW yHEATING SERIOD

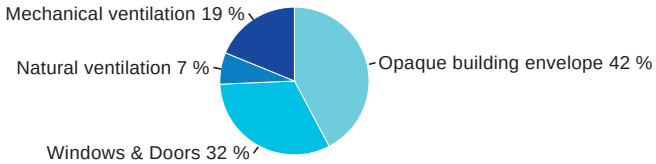
Heat gains

Solar:	74804PP kBtu/yr
Inner sources:	1680 6, 7 kBtu/yr
Credit of thermal bridges:	8 kBtu/yr
Mechanical heating:	7610m77 kBtu/yr



Heat losses

Opaque building envelope:	1, 701m4 kBtu/yr
Windows & Doors:	7280 87P kBtu/yr
Natural ventilation:	370 74m kBtu/yr
Mechanical ventilation:	7770 81 kBtu/yr

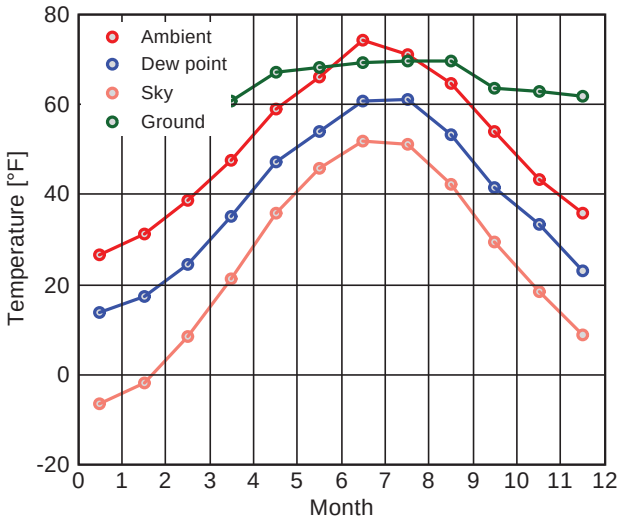


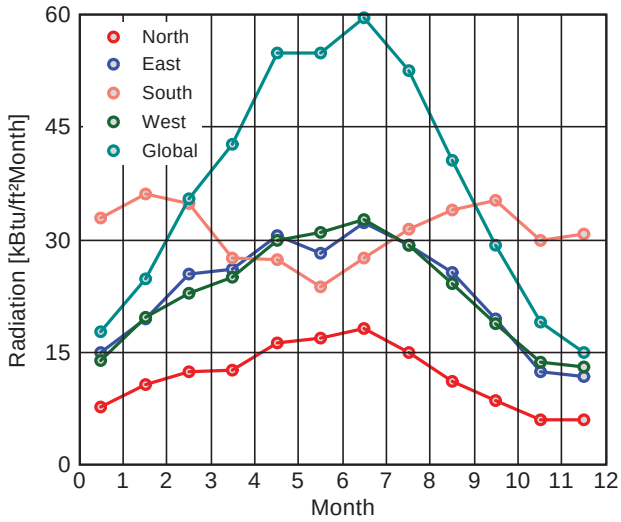
CLIMATE

Latitude:	**31.3** °
Longitude:	**ym7** °
Elevation of weather station:	**72.m** ft
Elevation of building site:	**P** ft
Heat capacity air:	**8.876** Btu/ft³F
Daily temperature swing summer:	**73.6** °F
Average wind speed:	**74.7** ft/s

Ground

Average ground surface temperature:	**, 1.6** °F
Amplitude ground surface temperature:	**, , .6** °F
Ground thermal conductivity:	**7.1** Btu/hr ft °F
Ground heat capacity:	**12.6** Btu/ft³F
Depth below grade of groundwater:	**2.6** ft
Flow rate groundwater:	**8.1** ft/d





Calculation para9 eters

Length of heating period	**134** days/yr
Heating degree hours	**738.2** kFh/a
Phase shift months	**7.4** mths
Time constant heating demand	**741.7** hr
Time constant cooling demand	**8** hr
Time constant cooling demand with night ventilation	**8** hr

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	16.9	31.6	83.5
Solar radiation North [Btu/hr ft²]	12	7.9	27.6
Solar radiation East [Btu/hr ft²]	22.8	13.3	61.5
Solar radiation South [Btu/hr ft²]	49.5	27.3	41.8
Solar radiation West [Btu/hr ft²]	22.2	11.4	53.3
Solar radiation Global [Btu/hr ft²]	26.9	16.5	101.4

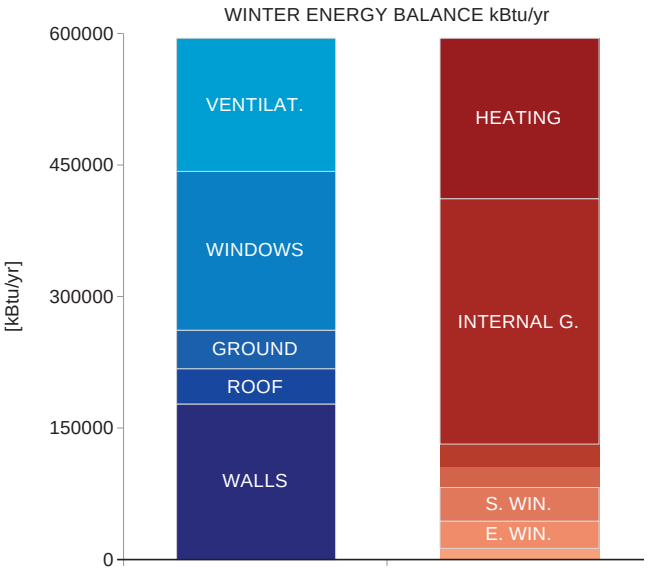
Relevant boundary conditions for heating load calculation: Heating load 1

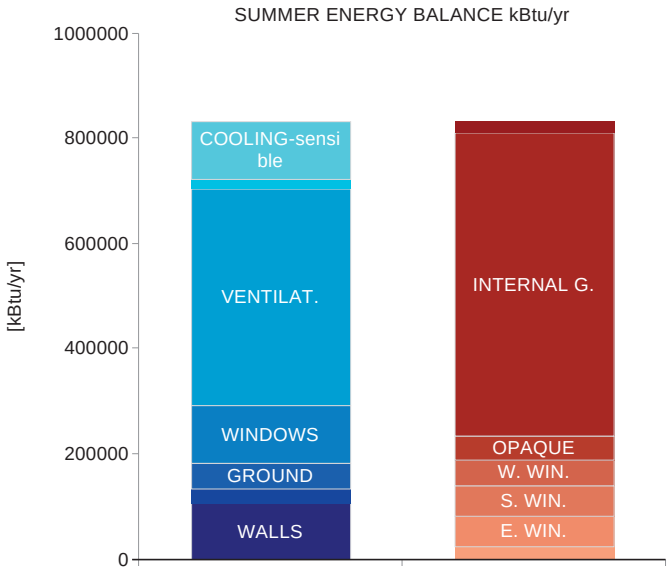
ANNUAL HEAT DEMAND

Transmission losses :	3370166	kBtu/yr
Ventilation losses:	7,10P42	kBtu/yr
Total heat losses:	,2402 1m	kBtu/yr
Solar heat gains:	7320P7P	kBtu/yr
Internal heat gains:	4110413	kBtu/yr
Total heat gains:	3m70237	kBtu/yr
Utilization factor:	6m7	%
Useful heat gains:	3770 17m	kBtu/yr
Annual heat demand:	7610m77	kBtu/yr
Specific annual heat demand:	40121.2	Btu/ft²yr

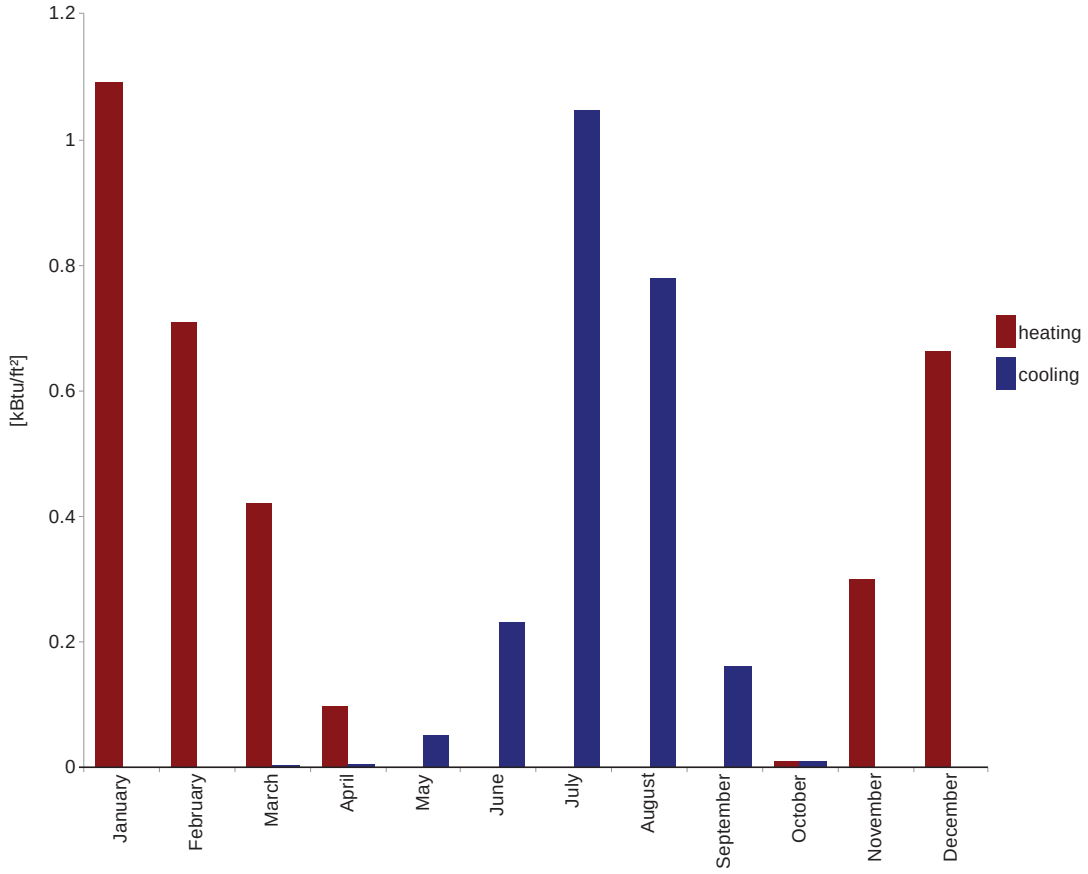
ANNUAL COOLING DEMAND

Solar heat gains:	1440, 3m	kBtu/yr
Internal heat gains:	, mm044m	kBtu/yr
Total heat gains:	6780663	kBtu/yr
Transmission losses :	m4106m2	kBtu/yr
Ventilation losses:	708480, 2m	kBtu/yr
Total heat losses:	70mP403mP	kBtu/yr
Utilization factor:	42.2	%
Useful heat losses:	m8407,	kBtu/yr
Cooling demand - sensible:	78m65P2	kBtu/yr
Cooling demand - latent:	720814	kBtu/yr
Annual cooling demand:	71P0624	kBtu/yr
Specific annual cooling demand:	1.4	kBtu/ft²yr





- SECIFIC HEAT/COOLING DEMAND MONTHLY



Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1.1	0
February	0.7	0
March	0.4	0
April	0.1	0
May	0	0.1
June	0	0.2
July	0	1
August	0	0.8
September	0	0.2
October	0	0
November	0.3	0
December	0.7	0

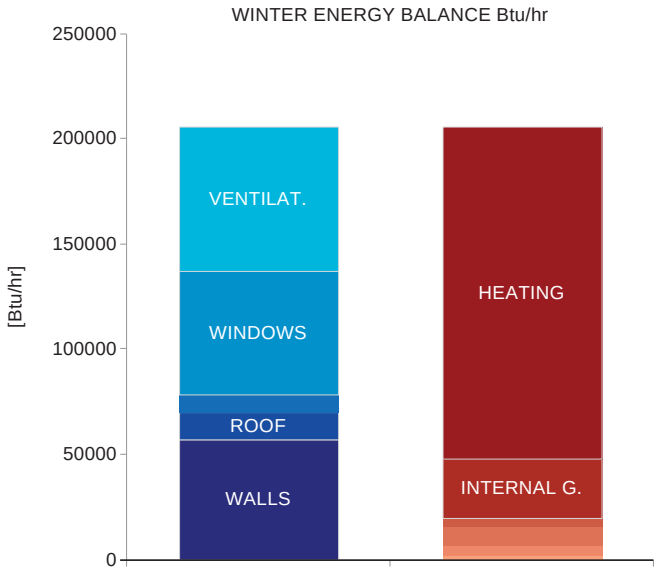
HEATING LOAD

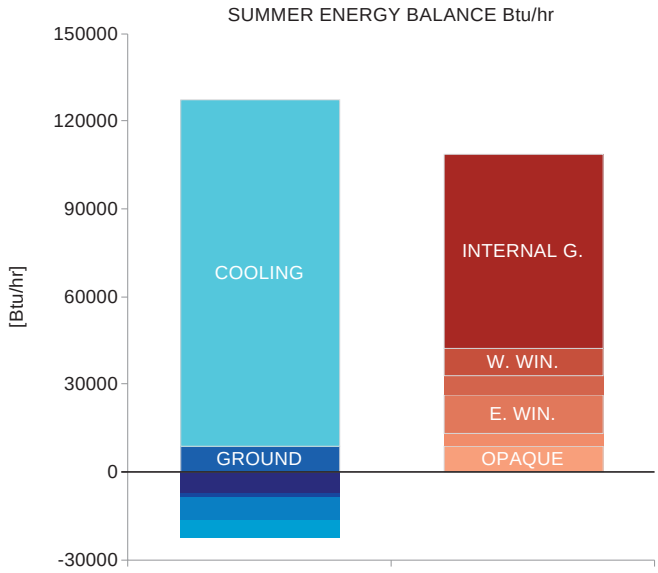
	First climate	Second climate
Transmission heat losses:	74P0, 14.4 Btu/hr	220P17 Btu/hr
Ventilation heat losses:	P60682.6 Btu/hr	3602213.m Btu/hr
Total heat loss:	18, 0444.7 Btu/hr	7360, 3, .m Btu/hr
Solar heat gain:	720486.1 Btu/hr	780626.P Btu/hr
Internal heat gain:	160733.2 Btu/hr	160733.2 Btu/hr
Total heat gains heating:	3m03, 4 Btu/hr	4208334., Btu/hr
Heating load:	7, m0668 Btu/hr	7820, 81.1 Btu/hr

Relevant heating load:	7, m0668 Btu/hr
Specific heating load:	1.6 Btu/hr ft²

COOLING LOAD

Solar heat gain:	3103m1.m Btu/hr
Internal heat gain:	P, 0271., Btu/hr
Total heat gains cooling:	786046, .1 Btu/hr
Transmission heat losses:	y4023, .1 Btu/hr
Ventilation heat losses:	yP01P8.7 Btu/hr
Total heat loss:	y78018, .4 Btu/hr
Cooling load - sensible:	7760, 28., Btu/hr
Cooling load - latent:	8 Btu/hr
Relevant cooling load:	7760, 28., Btu/hr
Specific maximum cooling load:	1.7 Btu/hr ft²





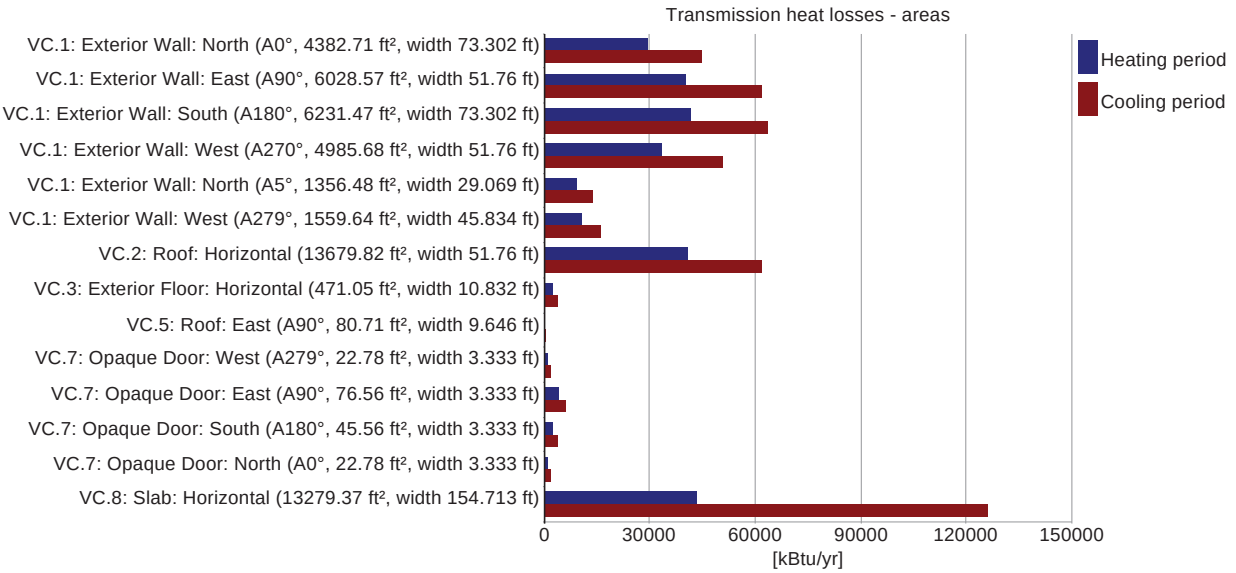
AREA-

Trans9 ission heat losses yareas

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Exterior Wall: North (A0°, 4382.71 ft², width 73.302 ft)	4382.7	0.042	0.4	0.9	100	29398.7	44814.4
VC.1: Exterior Wall: East (A90°, 6028.57 ft², width 51.76 ft)	6028.6	0.042	0.4	0.9	100	40438.9	61643.8
VC.1: Exterior Wall: South (A180°, 6231.47 ft², width 73.302 ft)	6231.5	0.042	0.4	0.9	100	41799.9	63718.5
VC.1: Exterior Wall: West (A270°, 4985.68 ft², width 51.76 ft)	4985.7	0.042	0.4	0.9	100	33443.3	50979.9
VC.1: Exterior Wall: North (A5°, 1356.48 ft², width 29.069 ft)	1356.5	0.042	0.4	0.9	100	9099.1	13870.4
VC.1: Exterior Wall: West (A279°, 1559.64 ft², width 45.834 ft)	1559.6	0.042	0.4	0.9	100	10461.9	15947.8
VC.2: Roof: Horizontal (13679.82 ft², width 51.76 ft)	13679.8	0.019	0.4	0.9	100	40565	61836
VC.3: Exterior Floor: Horizontal (471.05 ft², width 10.832 ft)	471.1	0.031	0.4	0.9	100	2338.3	3564.4
VC.5: Roof: East (A90°, 80.71 ft², width 9.646 ft)	80.7	0.017	0.4	0.9	100	213.8	325.9
VC.7: Opaque Door: West (A279°, 22.78 ft², width 3.333 ft)	22.8	0.337	0.4	0.9	100	1222.1	1863
VC.7: Opaque Door: East (A90°, 76.56 ft², width 3.333 ft)	76.6	0.337	0.4	0.9	100	4107.5	6261.3
VC.7: Opaque Door: South (A180°, 45.56 ft², width 3.333 ft)	45.6	0.337	0.4	0.9	100	2444.2	3725.9
VC.7: Opaque Door: North (A0°, 22.78 ft², width 3.333 ft)	22.8	0.337	0.4	0.9	100	1222.1	1863
VC.8: Slab: Horizontal (13279.37 ft², width 154.713 ft)	13279.4	0.088	0	0	0	43513.8	126523.5

Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	88.4	134.8
Ground heating	20.7	60.3



THERMAL BRIDGE-

Trans9 ission heat losses yther9 al bridges

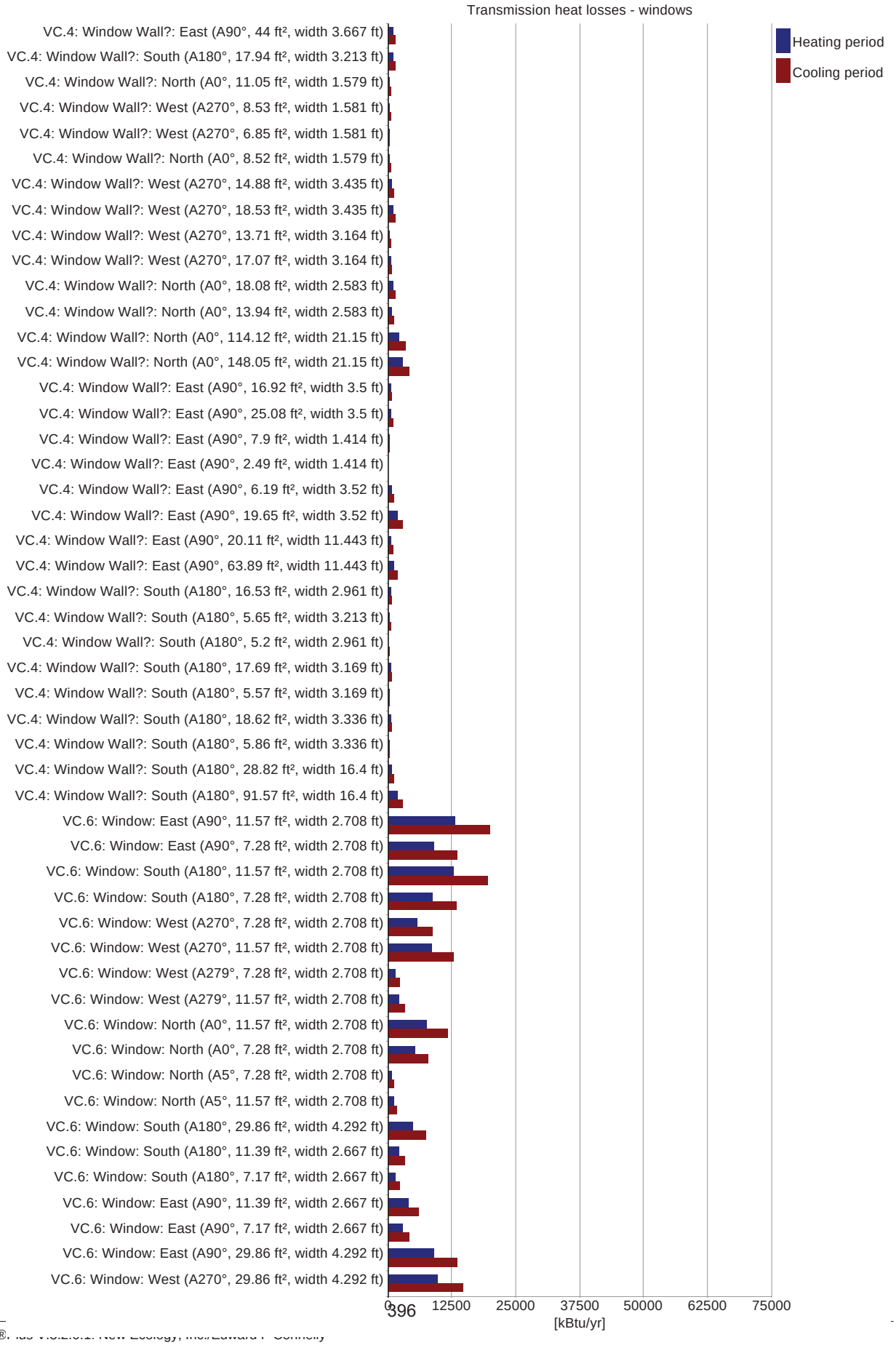
Name	Length [ft]	Psi-value [Btu/hr ft °F]	Transmission losses [kBtu/yr]	Transmission losses cooling [kBtu/yr]

WINDOW-

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.4: Window Wall?: East (A90°, 44 ft², width 3.667 ft)	1	90	0.137	0.4	61	61.5	932.7	1,715.5	959.1	1,462.1
VC.4: Window Wall?: South (A180°, 17.94 ft², width 3.213 ft)	2	90	0.155	0.4	80.7	80.2	1,426.7	2,191.4	882.2	1,344.7
VC.4: Window Wall?: North (A0°, 11.05 ft², width 1.579 ft)	1	90	0.192	0.4	42.6	40.9	57.2	102.7	337.6	514.7
VC.4: Window Wall?: West (A270°, 8.53 ft², width 1.581 ft)	1	90	0.196	0.4	43.3	48.7	71.1	147.4	265.7	405
VC.4: Window Wall?: West (A270°, 6.85 ft², width 1.581 ft)	1	90	0.2	0.4	47.1	52.8	59.7	122.5	217.9	332.2
VC.4: Window Wall?: North (A0°, 8.52 ft², width 1.579 ft)	1	90	0.196	0.4	40	38.7	39.3	71.1	265.5	404.8
VC.4: Window Wall?: West (A270°, 14.88 ft², width 3.435 ft)	2	90	0.159	0.4	34.1	39.9	253.5	537.5	751.7	1,145.9
VC.4: Window Wall?: West (A270°, 18.53 ft², width 3.435 ft)	2	90	0.153	0.4	25.4	27.8	261.7	523.8	901.2	1,373.7
VC.4: Window Wall?: West (A270°, 13.71 ft², width 3.164 ft)	1	90	0.162	0.4	28.1	31.8	95	199.3	352.8	537.8
VC.4: Window Wall?: West (A270°, 17.07 ft², width 3.164 ft)	1	90	0.156	0.4	21.6	23.2	102.4	200.7	423.6	645.7
VC.4: Window Wall?: North (A0°, 18.08 ft², width 2.583 ft)	2	90	0.16	0.4	51	48.6	289.3	516.8	919.6	1,401.9
VC.4: Window Wall?: North (A0°, 13.94 ft², width 2.583 ft)	2	90	0.165	0.4	44.9	42.7	189	335.3	731.4	1,114.9
VC.4: Window Wall?: North (A0°, 114.12 ft², width 21.15 ft)	1	90	0.122	0.4	37	37.4	777.6	1,474.8	2,217	3,379.5
VC.4: Window Wall?: North (A0°, 148.05 ft², width 21.15 ft)	1	90	0.115	0.4	49.6	48.6	1,446.4	2,684.2	2,718.6	4,144.2
VC.4: Window Wall?: East (A90°, 16.92 ft², width 3.5 ft)	1	90	0.155	0.4	74.6	78	370.5	700	417	635.7
VC.4: Window Wall?: East (A90°, 25.08 ft², width 3.5 ft)	1	90	0.146	0.4	63.2	66.4	497.1	947.3	583.2	889
VC.4: Window Wall?: East (A90°, 7.9 ft², width 1.414 ft)	1	90	0.205	0.4	61.6	64.5	96.5	181.9	257.1	391.9
VC.4: Window Wall?: East (A90°, 2.49 ft², width 1.414 ft)	1	90	0.237	0.4	69.3	72	19.6	36.8	93.8	143
VC.4: Window Wall?: East (A90°, 6.19 ft², width 3.52 ft)	4	90	0.202	0.4	63.7	63.6	282.9	517	795.7	1,213
VC.4: Window Wall?: East (A90°, 19.65 ft², width 3.52 ft)	4	90	0.151	0.4	58.3	59.2	1,426.6	2,625.5	1,890	2,881
VC.4: Window Wall?: East (A90°, 20.11 ft², width 11.443 ft)	1	90	0.186	0.4	62.3	59.5	269.4	477.5	594.4	906.1
VC.4: Window Wall?: East (A90°, 63.89 ft², width 11.443 ft)	1	90	0.126	0.4	61.4	59.5	1,463.8	2,611.1	1,282.8	1,955.4
VC.4: Window Wall?: South (A180°, 16.53 ft², width 2.961 ft)	1	90	0.158	0.4	81	79.8	647.4	990.6	415.3	633
VC.4: Window Wall?: South (A180°, 5.65 ft², width 3.213 ft)	2	90	0.204	0.4	77	72.2	251.6	376.7	367.2	559.7
VC.4: Window Wall?: South (A180°, 5.2 ft², width 2.961 ft)	1	90	0.207	0.4	78.8	73.2	116.5	173.7	171	260.7
VC.4: Window Wall?: South (A180°, 17.69 ft², width 3.169 ft)	1	90	0.155	0.4	80.9	80	704.3	1,079.1	436.6	665.5
VC.4: Window Wall?: South (A180°, 5.57 ft², width 3.169 ft)	1	90	0.205	0.4	78.6	73.5	126.3	188.9	181.4	276.5
VC.4: Window Wall?: South (A180°, 18.62 ft², width 3.336 ft)	1	90	0.153	0.4	81	80.2	751.6	1,152.2	453.6	691.5
VC.4: Window Wall?: South (A180°, 5.86 ft², width 3.336 ft)	1	90	0.203	0.4	77.9	73.3	133.1	199.7	189.7	289.2
VC.4: Window Wall?: South (A180°, 28.82 ft², width 16.4 ft)	1	90	0.184	0.4	75.3	72.3	753.4	1,138.3	841.9	1,283.4
VC.4: Window Wall?: South (A180°, 91.57 ft², width 16.4 ft)	1	90	0.123	0.4	79.1	81.2	4,248.4	6,632.8	1,789.8	2,728.4
VC.6: Window: East (A90°, 11.57 ft², width 2.708 ft)	36	90	0.199	0.4	79.7	70.8	8,873.8	14,224.5	13,159.6	20,060.1
VC.6: Window: East (A90°, 7.28 ft², width 2.708 ft)	36	90	0.214	0.4	77.6	68.5	4,778.9	7,621.8	8,932.1	13,615.8
VC.6: Window: South (A180°, 11.57 ft², width 2.708 ft)	35	90	0.199	0.4	73.3	60.1	13,312.5	17,171.6	12,794.1	19,502.9
VC.6: Window: South (A180°, 7.28 ft², width 2.708 ft)	35	90	0.214	0.4	71.4	57.7	7,185.7	9,207.4	8,684	13,237.6
VC.6: Window: West (A270°, 7.28 ft², width 2.708 ft)	23	90	0.214	0.4	74.9	65.9	2,896.5	4,623.5	5,706.6	8,699
VC.6: Window: West (A270°, 11.57 ft², width 2.708 ft)	23	90	0.199	0.4	76.4	67.5	5,339.2	8,565.4	8,407.6	12,816.2
VC.6: Window: West (A279°, 7.28 ft², width 2.708 ft)	6	90	0.214	0.4	82.2	72.9	752.8	1,320.3	1,488.7	2,269.3
VC.6: Window: West (A279°, 11.57 ft², width 2.708 ft)	6	90	0.199	0.4	84.1	74.7	1,397.1	2,453	2,193.3	3,343.4
VC.6: Window: North (A0°, 11.57 ft², width 2.708 ft)	21	90	0.199	0.4	71.5	58.5	2,499.8	3,827.8	7,676.5	11,701.8
VC.6: Window: North (A0°, 7.28 ft², width 2.708 ft)	21	90	0.214	0.4	71.6	58.9	1,372	2,109.4	5,210.4	7,942.6
VC.6: Window: North (A5°, 7.28 ft², width 2.708 ft)	3	90	0.214	0.4	73.3	60.7	199.9	308.3	744.3	1,134.7
VC.6: Window: North (A5°, 11.57 ft², width 2.708 ft)	3	90	0.199	0.4	74	61	367.9	565.5	1,096.6	1,671.7
VC.6: Window: South (A180°, 29.86 ft², width 4.292 ft)	6	90	0.17	0.4	83.3	67.9	8,296.8	10,676.5	4,838.9	7,376.3
VC.6: Window: South (A180°, 11.39 ft², width 2.667 ft)	6	90	0.199	0.4	80.5	64.1	2,484.7	3,166.8	2,167.5	3,304.1
VC.6: Window: South (A180°, 7.17 ft², width 2.667 ft)	6	90	0.215	0.4	77.8	61.3	1,327.7	1,684.4	1,470.2	2,241.2
VC.6: Window: East (A90°, 11.39 ft², width 2.667 ft)	11	90	0.199	0.4	77.9	67.6	2,642	4,156.2	3,973.8	6,057.5
VC.6: Window: East (A90°, 7.17 ft², width 2.667 ft)	11	90	0.215	0.4	76.6	66.1	1,435.4	2,248.7	2,695.4	4,108.8
VC.6: Window: East (A90°, 29.86 ft², width 4.292 ft)	11	90	0.17	0.4	80.9	70.3	8,936.9	14,063	8,871.4	13,523.3
VC.6: Window: West (A270°, 29.86 ft², width 4.292 ft)	12	90	0.17	0.4	79.6	69.8	9,342.4	14,849.2	9,677.9	14,752.7

Trans9 ission heat losses ywindows (continue)

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.6: Window: West (A270°, 7.17 ft², width 2.667 ft)	12	90	0.215	0.4	77.1	67.5	1,528.5	2,427.4	2,940.5	4,482.4
VC.6: Window: West (A270°, 11.39 ft², width 2.667 ft)	12	90	0.199	0.4	79	69.2	2,846.1	4,523.3	4,335	6,608.2
VC.6: Window: West (A279°, 11.39 ft², width 2.667 ft)	3	90	0.199	0.4	83.9	74.6	680.7	1,197.2	1,083.8	1,652.1
VC.6: Window: West (A279°, 7.17 ft², width 2.667 ft)	3	90	0.215	0.4	82.2	73	367.8	645.8	735.1	1,120.6
VC.6: Window: West (A279°, 29.86 ft², width 4.292 ft)	3	90	0.17	0.4	86	76.4	2,276	3,999.1	2,419.5	3,688.2
VC.6: Window: North (A0°, 7.17 ft², width 2.667 ft)	3	90	0.215	0.4	73.2	60.4	194.8	301.1	735.1	1,120.6
VC.6: Window: North (A0°, 11.39 ft², width 2.667 ft)	3	90	0.199	0.4	73.7	60.5	358.1	551.1	1,083.8	1,652.1
VC.6: Window: North (A0°, 29.86 ft², width 4.292 ft)	3	90	0.17	0.4	75.5	62.4	1,188.2	1,839.8	2,419.5	3,688.2
VC.6: Window: North (A5°, 11.39 ft², width 2.667 ft)	6	90	0.199	0.4	74	61	720.5	1,106.9	2,167.5	3,304.1
VC.6: Window: North (A5°, 29.86 ft², width 4.292 ft)	6	90	0.17	0.4	76	63	2,398.1	3,703.6	4,839	7,376.3
VC.6: Window: North (A5°, 7.17 ft², width 2.667 ft)	6	90	0.215	0.4	72.9	60.4	389.4	600.5	1,470.2	2,241.2
VC.6: Window: East (A90°, 19.14 ft², width 4.375 ft)	1	90	0.18	0.4	61.5	53.1	368.5	580.7	548.1	835.6
VC.6: Window: North (A5°, 19.14 ft², width 4.375 ft)	8	90	0.18	0.4	58	48.5	1,456.3	2,254.5	4,385.2	6,684.6
VC.6: Window: South (A180°, 12.17 ft², width 4.458 ft)	1	90	0.197	0.4	63.7	53.9	348.1	453.9	381.7	581.8
VC.6: Window: East (A90°, 11.19 ft², width 3.458 ft)	3	90	0.198	0.4	68.5	65.6	581.5	994.2	1,054.7	1,607.8
VC.9: Storefront: East (A90°, 29.81 ft², width 6.167 ft)	1	90	0.485	0.3	71.2	72.8	705	1,317.7	2,300.2	3,506.4
VC.9: Storefront: East (A90°, 22.1 ft², width 3.083 ft)	2	90	0.507	0.3	61.9	64.6	862.6	1,640.5	3,562.7	5,430.9
VC.9: Storefront: South (A180°, 20.17 ft², width 2.917 ft)	2	90	0.512	0.3	81.1	80.3	1,713.4	2,627.4	3,286.4	5,009.7
VC.9: Storefront: South (A180°, 10.25 ft², width 5.833 ft)	1	90	0.568	0.3	77.3	72.7	384.3	576.1	927	1,413.1
VC.9: Storefront: North (A0°, 27.42 ft², width 3.917 ft)	2	90	0.492	0.3	43.9	41.4	431.5	760	4,290.1	6,539.7
VC.9: Storefront: North (A0°, 14.39 ft², width 2.667 ft)	2	90	0.528	0.3	41.1	39	199.4	352	2,416.4	3,683.5
VC.9: Storefront: North (A0°, 13.49 ft², width 2.5 ft)	1	90	0.533	0.3	42.6	40.2	96.4	169.3	1,144.7	1,744.9


Transmission heat losses - windows
Heating period
Cooling period
VC.4: Window Wall?: East (A90°, 44 ft², width 3.667 ft)
VC.4: Window Wall?: South (A180°, 17.94 ft², width 3.213 ft)
VC.4: Window Wall?: North (A0°, 11.05 ft², width 1.579 ft)
VC.4: Window Wall?: West (A270°, 8.53 ft², width 1.581 ft)
VC.4: Window Wall?: West (A270°, 6.85 ft², width 1.581 ft)
VC.4: Window Wall?: North (A0°, 8.52 ft², width 1.579 ft)
VC.4: Window Wall?: West (A270°, 14.88 ft², width 3.435 ft)
VC.4: Window Wall?: West (A270°, 18.53 ft², width 3.435 ft)
VC.4: Window Wall?: West (A270°, 13.71 ft², width 3.164 ft)
VC.4: Window Wall?: West (A270°, 17.07 ft², width 3.164 ft)
VC.4: Window Wall?: North (A0°, 18.08 ft², width 2.583 ft)
VC.4: Window Wall?: North (A0°, 13.94 ft², width 2.583 ft)
VC.4: Window Wall?: North (A0°, 114.12 ft², width 21.15 ft)
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VC.4: Window Wall?: East (A90°, 16.92 ft², width 3.5 ft)
VC.4: Window Wall?: East (A90°, 25.08 ft², width 3.5 ft)
VC.4: Window Wall?: East (A90°, 7.9 ft², width 1.414 ft)
VC.4: Window Wall?: East (A90°, 2.49 ft², width 1.414 ft)
VC.4: Window Wall?: East (A90°, 6.19 ft², width 3.52 ft)
VC.4: Window Wall?: East (A90°, 19.65 ft², width 3.52 ft)
VC.4: Window Wall?: East (A90°, 20.11 ft², width 11.443 ft)
VC.4: Window Wall?: East (A90°, 63.89 ft², width 11.443 ft)
VC.4: Window Wall?: South (A180°, 16.53 ft², width 2.961 ft)
VC.4: Window Wall?: South (A180°, 5.65 ft², width 3.213 ft)
VC.4: Window Wall?: South (A180°, 5.2 ft², width 2.961 ft)
VC.4: Window Wall?: South (A180°, 17.69 ft², width 3.169 ft)
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VC.4: Window Wall?: South (A180°, 5.86 ft², width 3.336 ft)
VC.4: Window Wall?: South (A180°, 28.82 ft², width 16.4 ft)
VC.4: Window Wall?: South (A180°, 91.57 ft², width 16.4 ft)
VC.6: Window: East (A90°, 11.57 ft², width 2.708 ft)
VC.6: Window: East (A90°, 7.28 ft², width 2.708 ft)
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VC.6: Window: West (A270°, 7.28 ft², width 2.708 ft)
VC.6: Window: West (A270°, 11.57 ft², width 2.708 ft)
VC.6: Window: West (A279°, 7.28 ft², width 2.708 ft)
VC.6: Window: West (A279°, 11.57 ft², width 2.708 ft)
VC.6: Window: North (A0°, 11.57 ft², width 2.708 ft)
VC.6: Window: North (A0°, 7.28 ft², width 2.708 ft)
VC.6: Window: North (A5°, 7.28 ft², width 2.708 ft)
VC.6: Window: North (A5°, 11.57 ft², width 2.708 ft)
VC.6: Window: South (A180°, 29.86 ft², width 4.292 ft)
VC.6: Window: South (A180°, 11.39 ft², width 2.667 ft)
VC.6: Window: South (A180°, 7.17 ft², width 2.667 ft)
VC.6: Window: East (A90°, 11.39 ft², width 2.667 ft)
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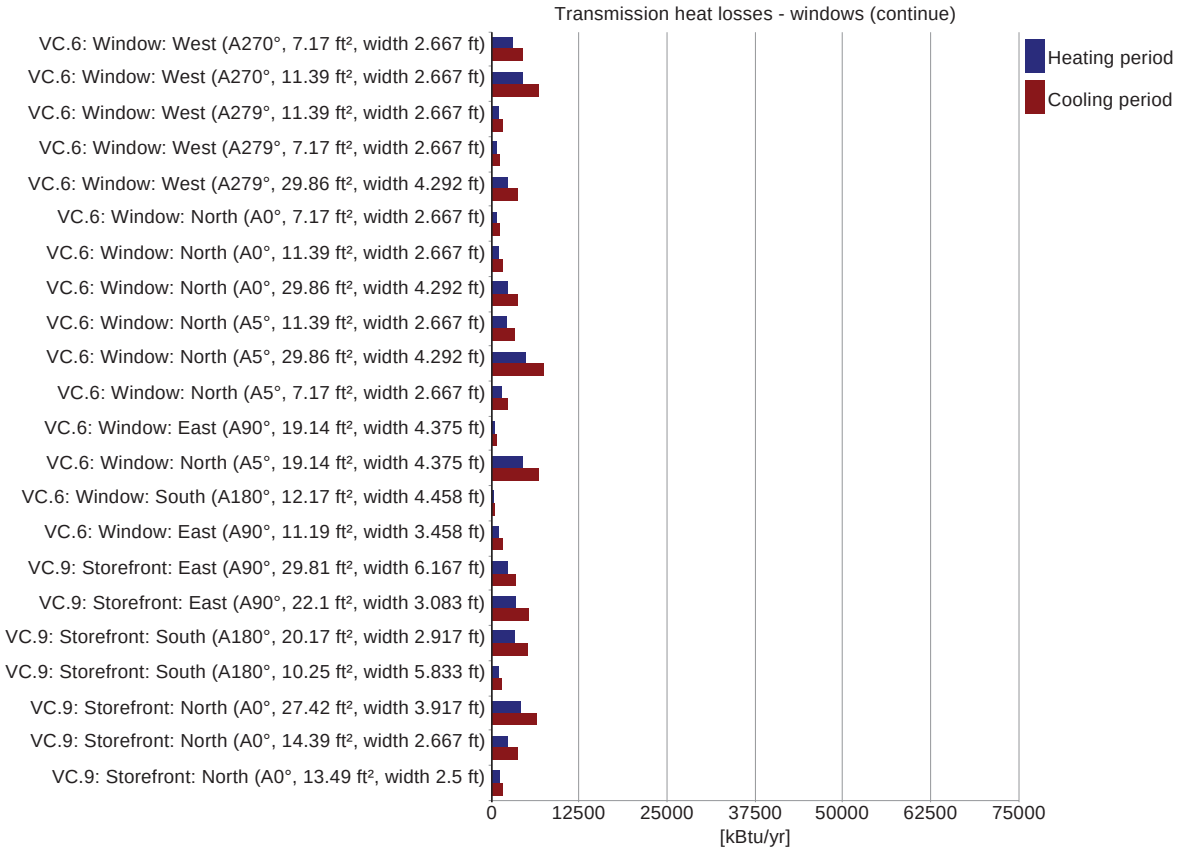
VC.6: Window: East (A90°, 29.86 ft², width 4.292 ft)
VC.6: Window: West (A270°, 29.86 ft², width 4.292 ft)
0
12500
25000
37500
50000
62500
75000
[kBtu/yr]


Transmission heat losses - windows (continue)
VC.6: Window: West (A270°, 7.17 ft², width 2.667 ft)
VC.6: Window: West (A270°, 11.39 ft², width 2.667 ft)
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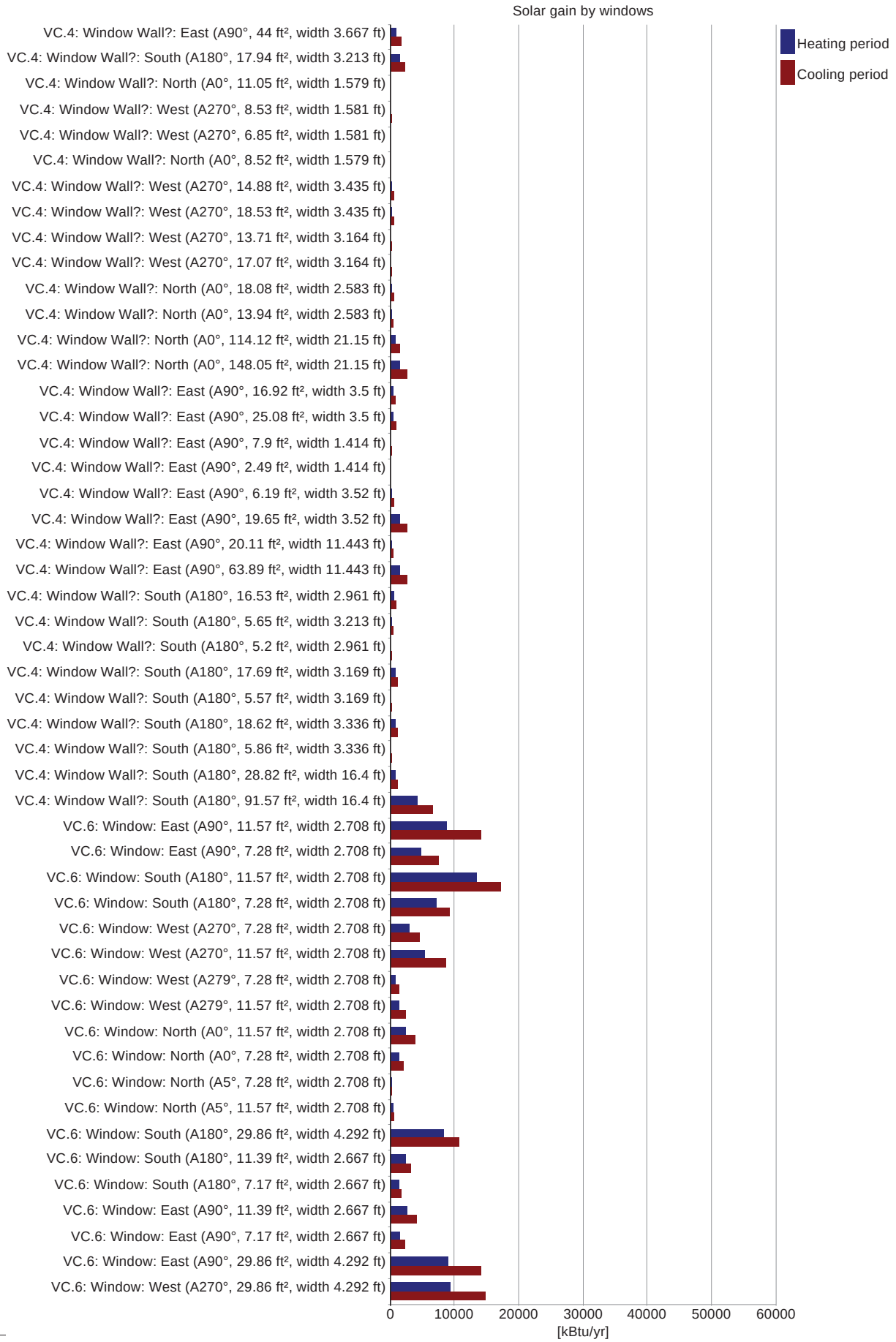
VC.6: Window: South (A180°, 12.17 ft², width 4.458 ft)
VC.6: Window: East (A90°, 11.19 ft², width 3.458 ft)
VC.9: Storefront: East (A90°, 29.81 ft², width 6.167 ft)
VC.9: Storefront: East (A90°, 22.1 ft², width 3.083 ft)
VC.9: Storefront: South (A180°, 20.17 ft², width 2.917 ft)
VC.9: Storefront: South (A180°, 10.25 ft², width 5.833 ft)
VC.9: Storefront: North (A0°, 27.42 ft², width 3.917 ft)
VC.9: Storefront: North (A0°, 14.39 ft², width 2.667 ft)
VC.9: Storefront: North (A0°, 13.49 ft², width 2.5 ft)
0
12500
25000
37500
50000
62500
75000
[kBtu/yr]
Heating period
Cooling period


Solar gain by windows
Heating period
Cooling period
VC.4: Window Wall?: East (A90°, 44 ft², width 3.667 ft)
VC.4: Window Wall?: South (A180°, 17.94 ft², width 3.213 ft)
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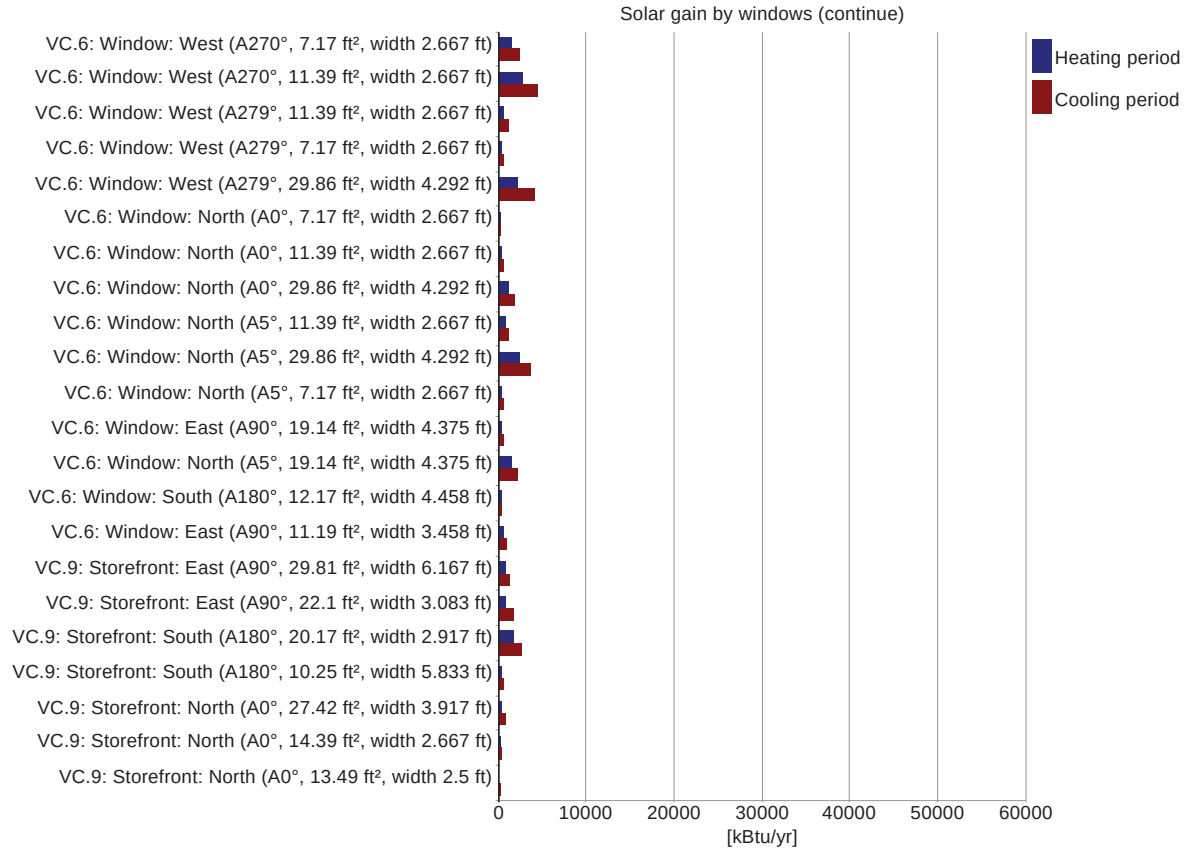
VC.6: Window: West (A270°, 29.86 ft², width 4.292 ft)
0
10000
20000
30000
40000
50000
60000
[kBtu/yr]



- u9 9 ar5 building envelope

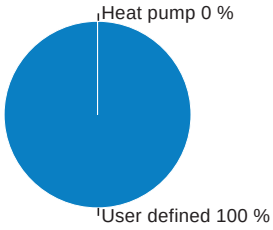
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	1, 087, .P ft²	8.831 Btu/hr ft² °F	7PP0268.7 kBtu/yr
Exterior wall ground:	8 ft²	8 Btu/hr ft² °F	8 kBtu/yr
Basement:	7401m2.3 ft²	8.866 Btu/hr ft² °F	340, 74.6 kBtu/yr
Roof:	740mP8., ft²	8.872 Btu/hr ft² °F	380mm6.6 kBtu/yr
Windows:	, 0n87.1 ft²	8.726 Btu/hr ft² °F	7670872.6 kBtu/yr
Doors:	7Pmm ft²	8.44m Btu/hr ft² °F	6022, .2 kBtu/yr
Thermal bridge ambient:	8 ft	8 Btu/hr ft °F	8 kBtu/yr
Thermal bridge perimeter:	8 ft	8 Btu/hr ft °F	8 kBtu/yr
Thermal bridge floor slab:	8 ft	8 Btu/hr ft °F	8 kBtu/yr

- hading

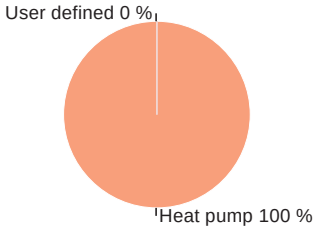
	Heating	Cooling
Reduction factor North:	P1 %	, 4., %
Reduction factor East:	m8.2 %	Pm6 %
Reduction factor South:	mP.m %	PP %
Reduction factor West:	m, .7 %	PP.m %
Reduction factor Horizontal:	788 %	788 %

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Source energy demand [kBtu/yr]
Heat pump, VRF	0	0	0	100	0	60,047.2	0	26,384,947	108,085
User defined, Condensing Gas-Fired Boilers	100	0	316,244	0	0	0	1.1	19,390,234.4	347,868.4
Σ	100	0	316,244	100	0	60,047.2		45,775,181.4	455,953.4

DHW yfinal energ5



Heating yfinal energ5



COOLING UNIT-

	sensible	latent
Air cooling:	**8** kBtu/ft²yr	**8** kBtu/ft²yr
Recirculation cooling:	**7.2** kBtu/ft²yr	**8** kBtu/ft²yr
Additional dehumidification:		**8.4** kBtu/ft²yr
Panel cooling:	**8** kBtu/ft²yr	
Sum:	**7.2** kBtu/ft²yr	**8.4** kBtu/ft²yr

VENTILATION

Energ5 transportable b5 suppl5 air

Heating energ5

transportable: **7.32** W/ft²

load: **8.64** W/ft²

Cooling energ5

transportable: **8.21** W/ft²

load: **8.P4** W/ft²

Infiltration pressure test ACH50:	**8.34** 1/hr
Total extract air demand:	**40288** cfm
Supply air per person:	**76** cfm
Occupancy:	**712**

Average air flow rate:	**308343.31** cfm
Average air change rate:	**8.,** 1/hr
Effective ACH ambient:	**8.77** 1/hr
Effective ACH ground:	**8** 1/hr
Energetically effective air exchange:	**8.77** 1/hr
Infiltration air change rate:	**8.84** 1/hr
Infiltration air change rate (heating load):	**8.86** 1/hr

Type of ventilation system:	**Balanced SH ventilation**
Wind screening coefficient (e):	**8.8m**
Wind exposure factor:	**7,**
Wind shield factor:	**8.8,**

Ventilation heat losses: **74, 0712., 4** kBtu/yr

Devices

Name	Sensible recovery efficiency [-]	Electric efficiency [W/cfm]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Semco	0.9	0.04	0	0.9
Altogether	0.8	0.04	0	0.8

Ducts

Name	Length (total) [ft]	Clear cross-section [ft²]	U-value [Btu/hr ft² °F]	Assigned ventilation units
ERV-1	10	2.25	14.36	Semco
ERV-1	10	2.25	14.36	Semco
Σ	20			

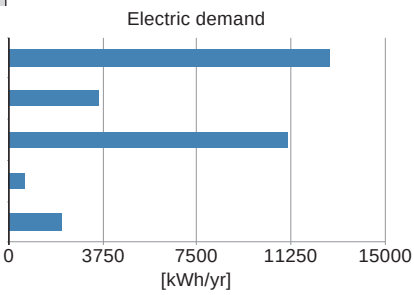
*length * quantity ** thermal conductivity / thickness

- UMMER VENTILATION

ACH night ventilation:	**8** 1/hr
ACH natural summer:	**8** 1/hr
Mechanical ventilation summer:	**8.,** 1/hr
Mechanical ventilation summer with HR:	**no**

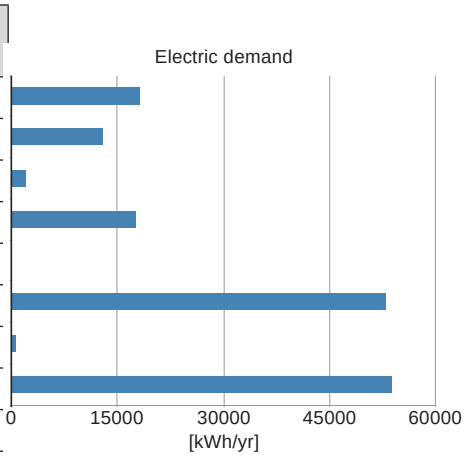
ELECTRICITY DEMAND yAUXILIARY ELECTRICITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Source energy [kBtu/yr]
Ventilation winter	1	no	0.7 W/cfm	12770.9	78429.1
Ventilation Defrost	1	no	18,928 W	3536.1	21716.1
Ventilation summer	1	no	0.7 W/cfm	11143.9	68437.6
DHW circulating pump	1	yes	72.9 W	604.3	3711
DHW storage load pump	1	yes	382.6 W	2092.5	12850.3
Σ				30147.6	185144.2



ELECTRICITY DEMAND RE- IDENTIAL BUILDING

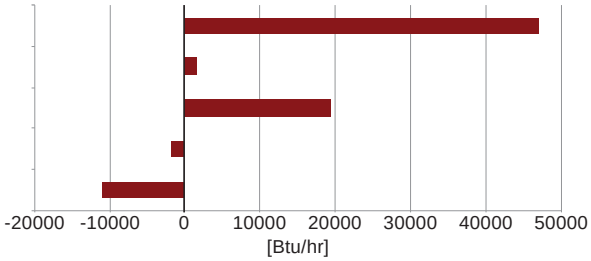
Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Non-electric demand [kWh/yr]	Source energy [kBtu/yr]
Kitchen refrigerator	1	yes	1.2	18040	0	110788.1
Kitchen cooking	1	yes	0.2	12900	0	79222.1
Laundry - washer	1	yes	0.3	2045.5	0	12562
Laundry - dryer	1	yes	3.1	17723.8	0	108846
Energy consumed by evaporation	1	yes	3.1	0	1319.1	5453.4
User defined lighting	1	yes	53,013	53013	0	325566
User defined lighting	1	no	535	535	0	3285.6
User defined MELs	1	yes	53,981	53981	0	331510.7
Σ	8			158238.3	1319.1	977234



INTERNAL HEAT GAIN-

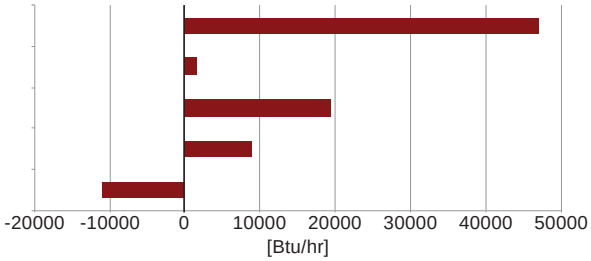
Heating season

Electricity total:	3n0778.P	Btu/hr
Auxiliary electricity:	70P, 7.2	Btu/hr
People:	7204Pm4	Btu/hr
Cold water:	y70n21.3	Btu/hr
Evaporation:	y77083.1	Btu/hr
Σ:	, , 01m4.P	Btu/hr
Specific internal heat gains:	7	Btu/hr ft²



Cooling season

Electricity total:	3n0778.P	Btu/hr
Auxiliary electricity:	70P, 7.2	Btu/hr
People:	7204Pm4	Btu/hr
Cold and hot water:	6063P.,	Btu/hr
Evaporation:	y77083.1	Btu/hr
Σ:	, , 01m4.P	Btu/hr
Specific internal heat gains:	7	Btu/hr ft²



DHW AND DI- TRIBUTION

DHW consumption per person per day:	**P.P**	gal/Person/day
Average cold water temperature supply:	**, 1.6**	°F
Useful heat DHW:	**11, 0832.6**	kBtu/yr
Specific useful heat DHW:	**30 8P4.1**	Btu/ft²yr
Total heat losses of the DHW system:	**, 30871.1**	kBtu/yr
Specific losses of the DHW system:	**268.m**	Btu/ft²yr
Performance ratio DHW distribution system and storage:	**7.1**	
Utilization ratio DHW distribution system and storage:	**8.6**	
Total heat demand of DHW system:	**1m20 6P1**	kBtu/yr
Total specific heat demand of DHW system:	**, 0834.2**	Btu/ft²yr
Total heat losses of the hydronic heating distribution:	**8**	kBtu/yr
Specific losses of the hydronic heating distribution:	**8**	Btu/ft²yr
Performance ratio of heat distribution:	**788**	%

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
In conditioned space	1620	34792.4
Σ	1620	34792.4
Individual pipes		
In conditioned space	1450	12704.3
Σ	1450	12704.3
Water storage		
Device 4 (Water storage: DHW)		1728.9
Σ		1728.9

BUILDING INFORMATION

Category:	**Residential**
Status:	**In planning**
Building type:	**New construction**
Year of construction:	
Units:	**37**
Number of occupants:	**12( )Design4**
Occupant density:	**82. 57** ft²/Person

Boundary conditions

Climate:	**MA - BOSTON LOGAN INT ARPT)cold year4**
Internal heat gains:	**15(** Btu/hr ft²
Interior temperature:	**27** °F
Overheat temperature:	**66** °F

Building geometry

Enclosed volume:	**290,02257** ft³
Net-volume:	**329,(8956** ft³
Total area envelope:	**22,07758** ft²
Area/Volume Ratio:	**951** 1/ft
Floor area:	**0. ,. 92** ft²
Envelope area/iCFA:	**1511(**

PASSIVEHOUSE REQUIREMENTS

Certificate criteria: PHIUS+ (917

Heating demand

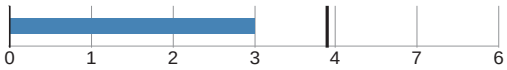
specific:	**(5**	kBtu/ft²yr
target:	**353**	kBtu/ft²yr
total:	153,625.31	kBtu/yr

Cooling demand

sensible:	**(52(**	kBtu/ft²yr
latent:	**956**	kBtu/ft²yr
specific:	**(5 .**	kBtu/ft²yr
target:	**253**	kBtu/ft²yr
total:	159,268.91	kBtu/yr

Heating load

specific:	**851**	Btu/hr ft²
target:	**85**	Btu/hr ft²
total:	180,406.05	Btu/hr



Cooling load

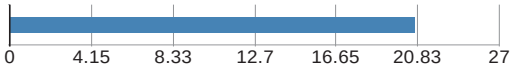
specific:	**(53(**	Btu/hr ft²
target:	**8**	Btu/hr ft²
total:	147,069.64	Btu/hr

Source energy

total:	**063,8865(0**	kWh/yr
specific:	**8,030**	kWh/Person yr
target:	**8,739**	kWh/Person yr
total:	**1,. 0. ,0(25 2**	kBtu/yr
specific:	32.51	kBtu/ft²yr

Site energy

total:	1,238,157.14	kBtu/yr
specific:	20.65	kBtu/ft²yr
total:	362,909.13	kWh/yr
specific:	6.06	kWh/ft²



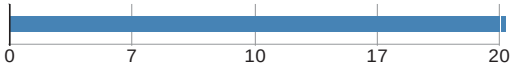
Air tightness

ACH70:	**95 0(**	1/hr
CFM70 per envelope area:	**95 92**	cfm/ft²
target:	**95 0(**	1/hr
target CFM70:	**95 92**	cfm/ft²

PASSIVEHOUSE RECOMMENDATIONS

Sensible recovery efficiency:	**785 3**	%
Frequency of overheating: Cooling system is required	**895 7**	%

Frequency of overheating only applies if there is not a [properly sized] cooling system installed.

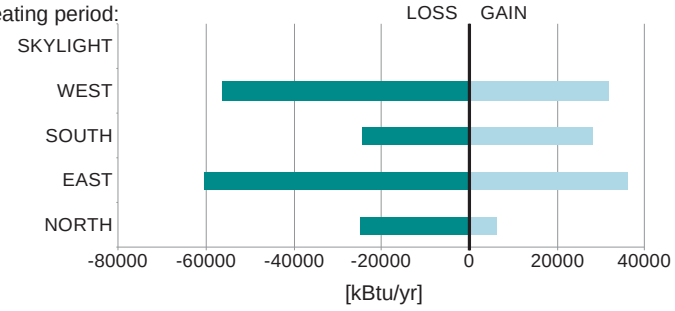


BUILDING ELEMENTS

Windows

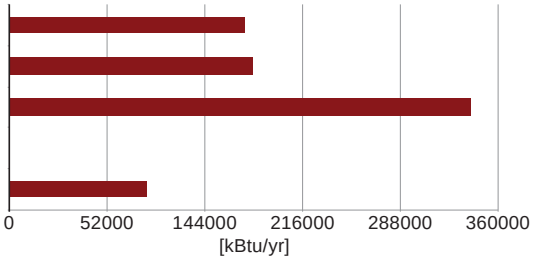
Average SHGC:	95 82
Average solar reduction factor heating:	95 86
Average solar reduction factor cooling:	95 88
Average U-value:	95178 Btu/hr ft² °F
Total glazing area:	8,73057 ft²
Total window area:	2,33353 ft²

Heat gain/loss heating period:



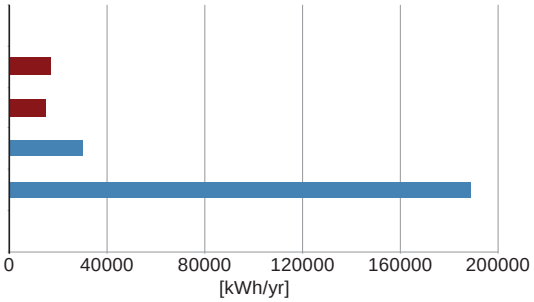
HVAC

Total heating demand:	168,2(6 kBtu/yr
Total cooling demand:	16. ,(2. kBtu/yr
Total DHW energy demand:	839,813 kBtu/yr
Solar DHW contribution:	9 kBtu/yr
Auxiliary electricity:	191,201 kBtu/yr



Electricity

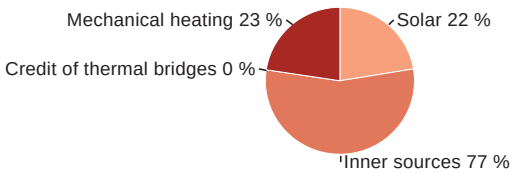
Direct heating / DHW:	9 kWh/yr
Heatpump heating:	12,71(kWh/yr
Cooling:	13,621 kWh/yr
HVAC auxiliary energy:	(. ,6. 3 kWh/yr
Appliances:	177,7(. kWh/yr
Renewable generation, coincident production and use:	9 kWh/yr
Total electricity demand:	(09,1. 2 kWh/yr



HEAT FLOW - HEATING PERIOD

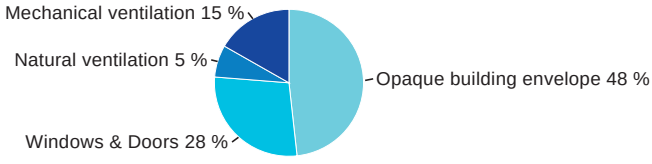
Heat gains

Solar:	133,280 kBtu/yr
Inner sources:	803,216 kBtu/yr
Credit of thermal bridges:	9 kBtu/yr
Mechanical heating:	168,2(6 kBtu/yr



Heat losses

Opaque building envelope:	8(3,796 kBtu/yr
Windows & Doors:	177,862 kBtu/yr
Natural ventilation:	36,376 kBtu/yr
Mechanical ventilation:	11(,(97 kBtu/yr

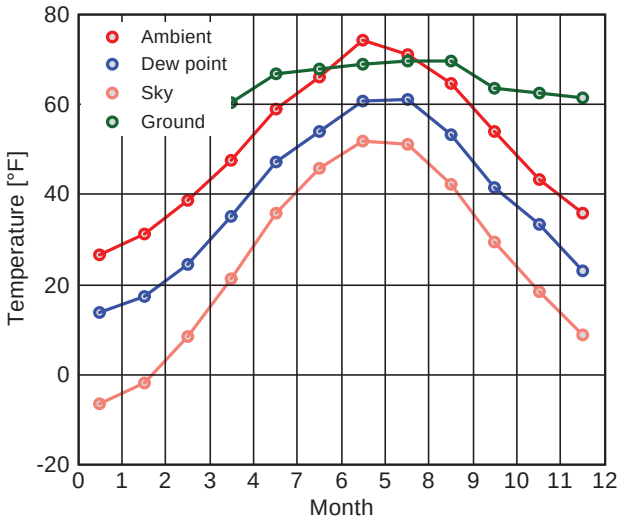


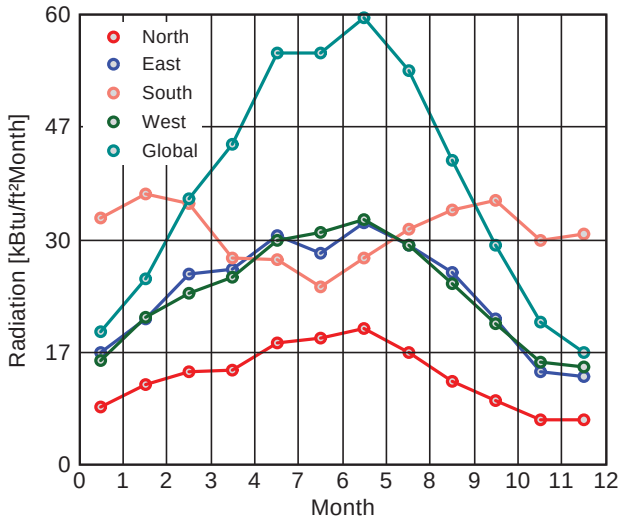
CLIMATE

Latitude:	3(53 °
Longitude:	-61 °
Elevation of weather station:	1. 56 ft
Elevation of building site:	2 ft
Heat capacity air:	95917 Btu/ft³F
Daily temperature swing summer:	1357 °F
Average wind speed:	1851 ft/s

Ground

Average ground surface temperature:	0(57 °F
Amplitude ground surface temperature:	0057 °F
Ground thermal conductivity:	15(Btu/hr ft °F
Ground heat capacity:	(. 57 Btu/ft³F
Depth below grade of groundwater:	. 57 ft
Flow rate groundwater:	95(ft/d





Calculation parameters

Length of heating period	(38 days/yr
Heating degree hours	1395 kFh/a
Phase shift months	15 mths
Time constant heating demand	1(053 hr
Time constant cooling demand	9 hr
Time constant cooling demand with night ventilation	9 hr

Climate for	Heating load 1	Heating load 2	Cooling
Temperature [°F]	16.9	31.6	83.7
Solar radiation North [Btu/hr ft²]	12	5.9	25.6
Solar radiation East [Btu/hr ft²]	22.8	13.3	61.7
Solar radiation South [Btu/hr ft²]	49.7	25.3	41.8
Solar radiation West [Btu/hr ft²]	22.2	11.4	73.3
Solar radiation Global [Btu/hr ft²]	26.9	16.7	101.4

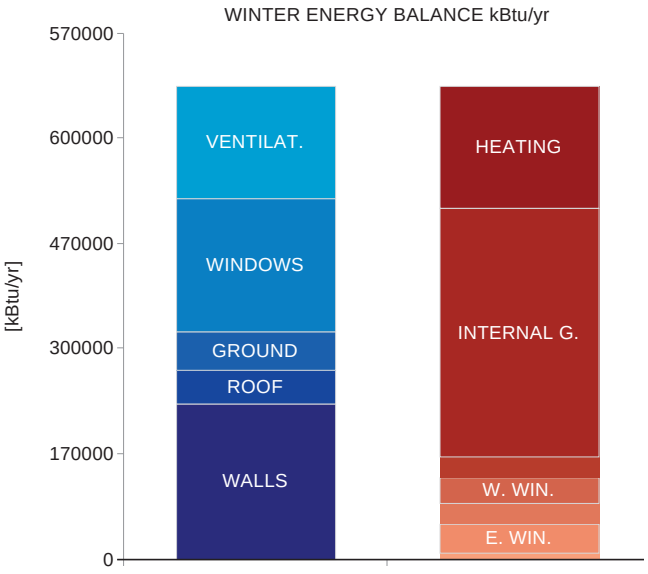
Relevant boundary conditions for heating load calculation: Heating load 1

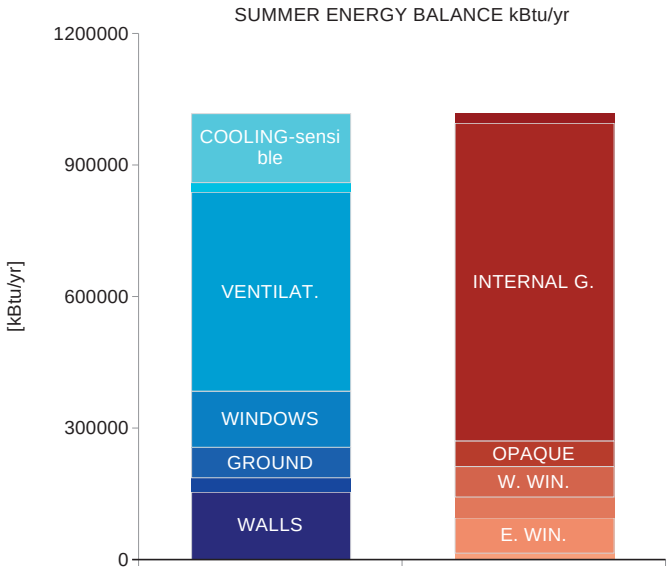
ANNUAL HEAT DEMAND

Transmission losses :	018,173	kBtu/yr
Ventilation losses:	10. ,2. 0	kBtu/yr
Total heat losses:	26(,76.	kBtu/yr
Solar heat gains:	16(,102	kBtu/yr
Internal heat gains:	3((,9. 0	kBtu/yr
Total heat gains:	0. 3,(01	kBtu/yr
Utilization factor:	73	%
Useful heat gains:	3. . ,(01	kBtu/yr
Annual heat demand:	168,2(6	kBtu/yr
Specific annual heat demand:	(,7. 752	Btu/ft²yr

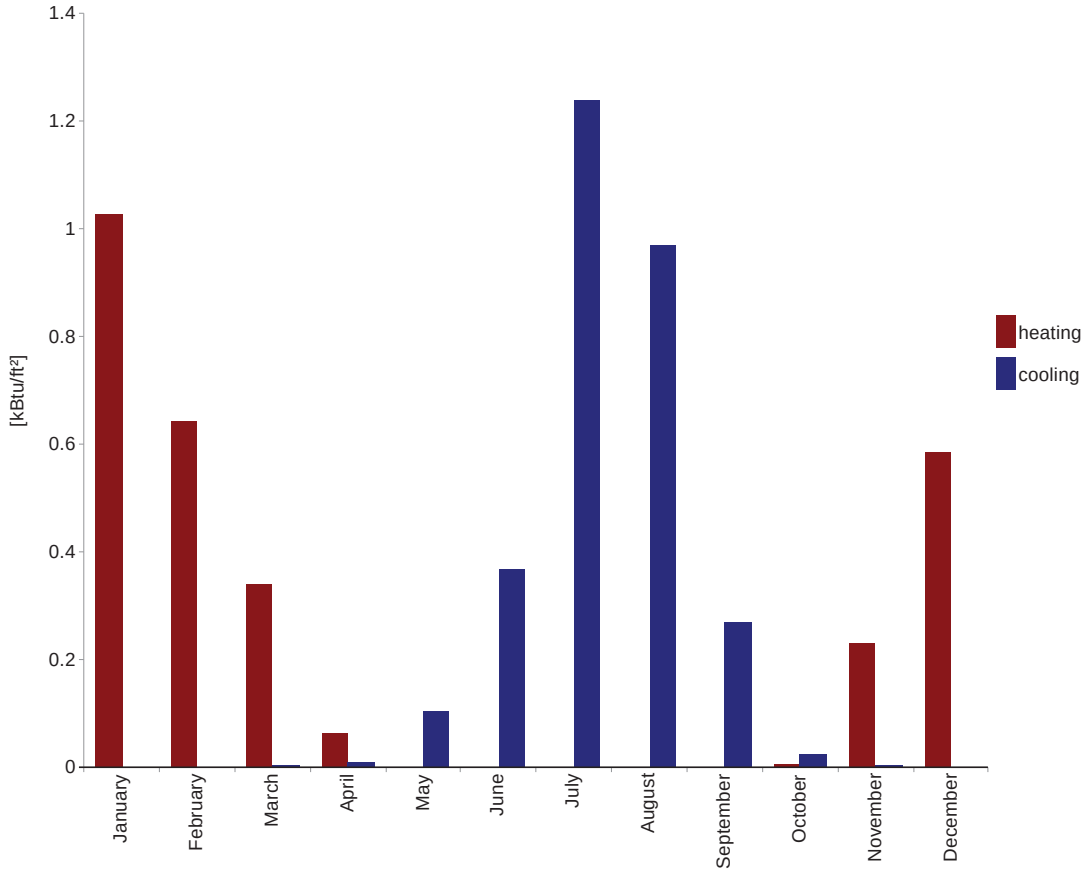
ANNUAL COOLING DEMAND

Solar heat gains:	(2. ,(17	kBtu/yr
Internal heat gains:	6(3,602	kBtu/yr
Total heat gains:	. . 8,. 63	kBtu/yr
Transmission losses :	708,(01	kBtu/yr
Ventilation losses:	1,917,2. 8	kBtu/yr
Total heat losses:	1,761,. 33	kBtu/yr
Utilization factor:	3355	%
Useful heat losses:	782,771	kBtu/yr
Cooling demand - sensible:	106,9. 8	kBtu/yr
Cooling demand - latent:	((,162	kBtu/yr
Annual cooling demand:	16. ,(2.	kBtu/yr
Specific annual cooling demand:	8	kBtu/ft²yr





SPECIFIC HEAT/COOLING DEMAND MONTHLY



Month	Heating [kBtu/ft²]	Cooling [kBtu/ft²]
January	1	0
February	0.6	0
March	0.3	0
April	0.1	0
May	0	0.1
June	0	0.4
July	0	1.2
August	0	1
September	0	0.3
October	0	0
November	0.2	0
December	0.6	0

HEATING LOAD

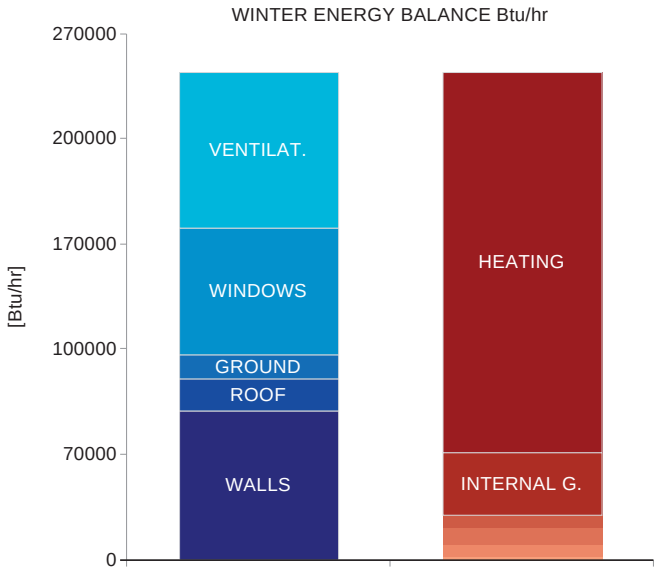
	First climate	Second climate
Transmission heat losses:	106,6015[illegible] Btu/hr	110,3275[illegible] Btu/hr
Ventilation heat losses:	68,6635[illegible] Btu/hr	0[illegible],3035[illegible] Btu/hr
Total heat loss:	[illegible]81,0[illegible]05[illegible] Btu/hr	126,.[illegible][illegible]52 Btu/hr
Solar heat gain:	[illegible]9,6805[illegible] Btu/hr	11,0825[illegible] Btu/hr
Internal heat gain:	89,8735[illegible] Btu/hr	89,8735[illegible] Btu/hr
Total heat gains heating:	01,11.[illegible]5[illegible] Btu/hr	31,.[illegible]95[illegible] Btu/hr
Heating load:	179,3925[illegible] Btu/hr	1[illegible]2,99[illegible]5[illegible] Btu/hr

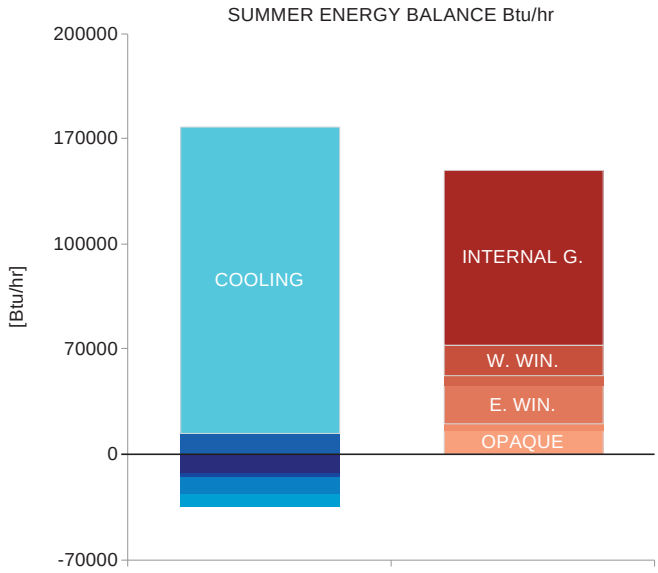
Relevant heating load:	179,3925[illegible] Btu/hr
Specific heating load:	8 Btu/hr ft²

COOLING LOAD

Solar heat gain:	0[illegible],1195[illegible]2 Btu/hr
Internal heat gain:	7[illegible],63[illegible]57 Btu/hr
Total heat gains cooling:	183,7085[illegible]3 Btu/hr
Transmission heat losses:	-8,2.[illegible]75[illegible]3 Btu/hr
Ventilation heat losses:	-2,0165[illegible]7 Btu/hr
Total heat loss:	-19,[illegible]125[illegible] Btu/hr
Cooling load - sensible:	130,92.[illegible]52 Btu/hr
Cooling load - latent:	9 Btu/hr

Relevant cooling load:	130,92.[illegible]52 Btu/hr
Specific maximum cooling load:	[illegible]53 Btu/hr ft²





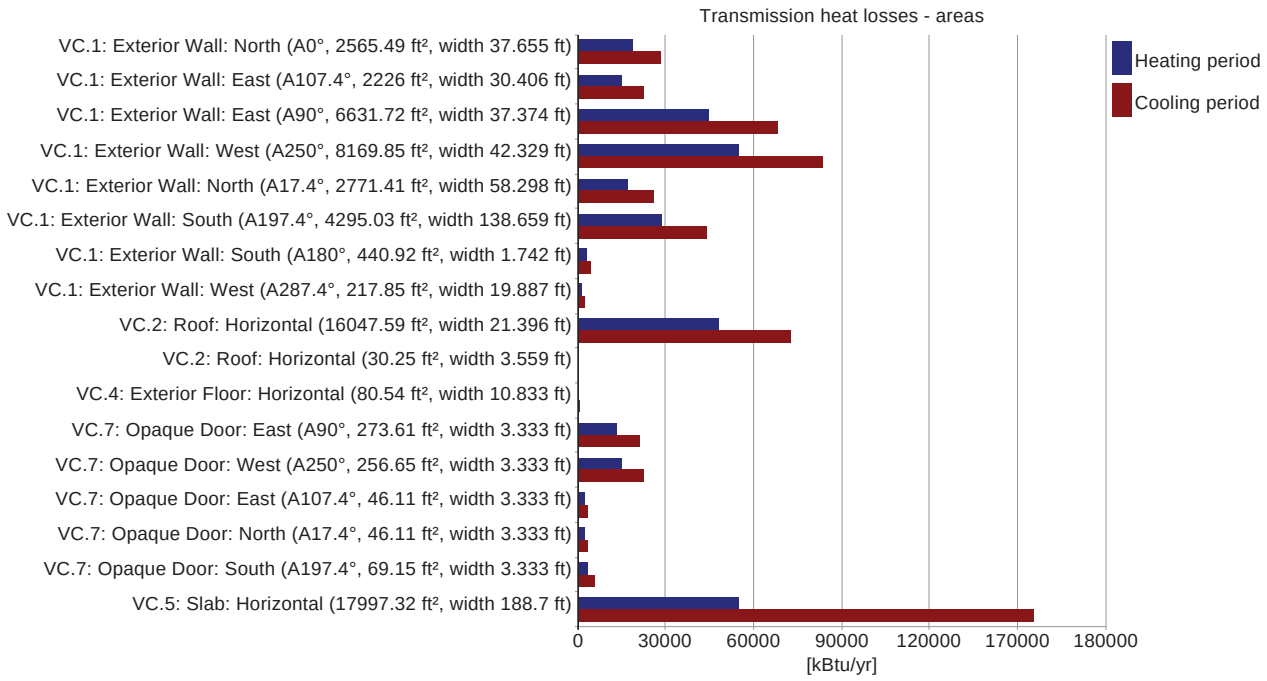
AREAS

Transmission heat losses - areas

Name	Area [ft²]	Average U-value [Btu/hr ft² °F]	Absorption coefficient	Emission coefficient	Reduction factor shading [%]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.1: Exterior Wall: North (A0°, 2565.49 ft², width 37.655 ft)	2565.7	0.042	0.4	0.9	100	18674.2	28416.2
VC.1: Exterior Wall: East (A107.4°, 2226 ft², width 30.406 ft)	2226	0.042	0.4	0.9	100	17004.2	22876.2
VC.1: Exterior Wall: East (A90°, 6631.72 ft², width 37.374 ft)	6631.7	0.042	0.4	0.9	100	44699.7	68091.7
VC.1: Exterior Wall: West (A250°, 8169.85 ft², width 42.329 ft)	8169.9	0.042	0.4	0.9	100	77068.5	83885
VC.1: Exterior Wall: North (A17.4°, 2771.41 ft², width 58.298 ft)	2771.4	0.042	0.4	0.9	100	15195.5	26195.7
VC.1: Exterior Wall: South (A197.4°, 4295.03 ft², width 138.659 ft)	4295	0.042	0.4	0.9	100	28963.9	44121.2
VC.1: Exterior Wall: South (A180°, 440.92 ft², width 1.742 ft)	440.9	0.042	0.4	0.9	100	2952	4725.4
VC.1: Exterior Wall: West (A287.4°, 217.85 ft², width 19.887 ft)	217.9	0.042	0.4	0.9	100	1477.1	2216.6
VC.2: Roof: Horizontal (16047.59 ft², width 21.396 ft)	16047.8	0.019	0.4	0.9	100	45812	52832.5
VC.2: Roof: Horizontal (30.25 ft², width 3.559 ft)	30.3	0.019	0.4	0.9	100	90.2	135.4
VC.4: Exterior Floor: Horizontal (80.54 ft², width 10.833 ft)	80.5	0.031	0.4	0.9	100	402.5	613.7
VC.7: Opaque Door: East (A90°, 273.61 ft², width 3.333 ft)	273.6	0.335	0.4	0.9	100	13653.3	20828.5
VC.7: Opaque Door: West (A250°, 256.65 ft², width 3.333 ft)	256.5	0.335	0.4	0.9	100	14916.3	22522.3
VC.7: Opaque Door: East (A107.4°, 46.11 ft², width 3.333 ft)	46.1	0.335	0.4	0.9	100	2486.1	3585
VC.7: Opaque Door: North (A17.4°, 46.11 ft², width 3.333 ft)	46.1	0.335	0.4	0.9	100	2486.1	3585
VC.7: Opaque Door: South (A197.4°, 69.15 ft², width 3.333 ft)	69.2	0.335	0.4	0.9	100	3529.1	7680.6
VC.5: Slab: Horizontal (17997.32 ft², width 188.7 ft)	17997.3	0.088	0	0	0	77196.3	177791.6

Degree hours [kFh/a]

	Heating	Cooling
Ambient heating	88.8	137.3
Ground heating	21.8	61.7



THERMAL BRIDGES

Transmission heat losses - thermal bridges

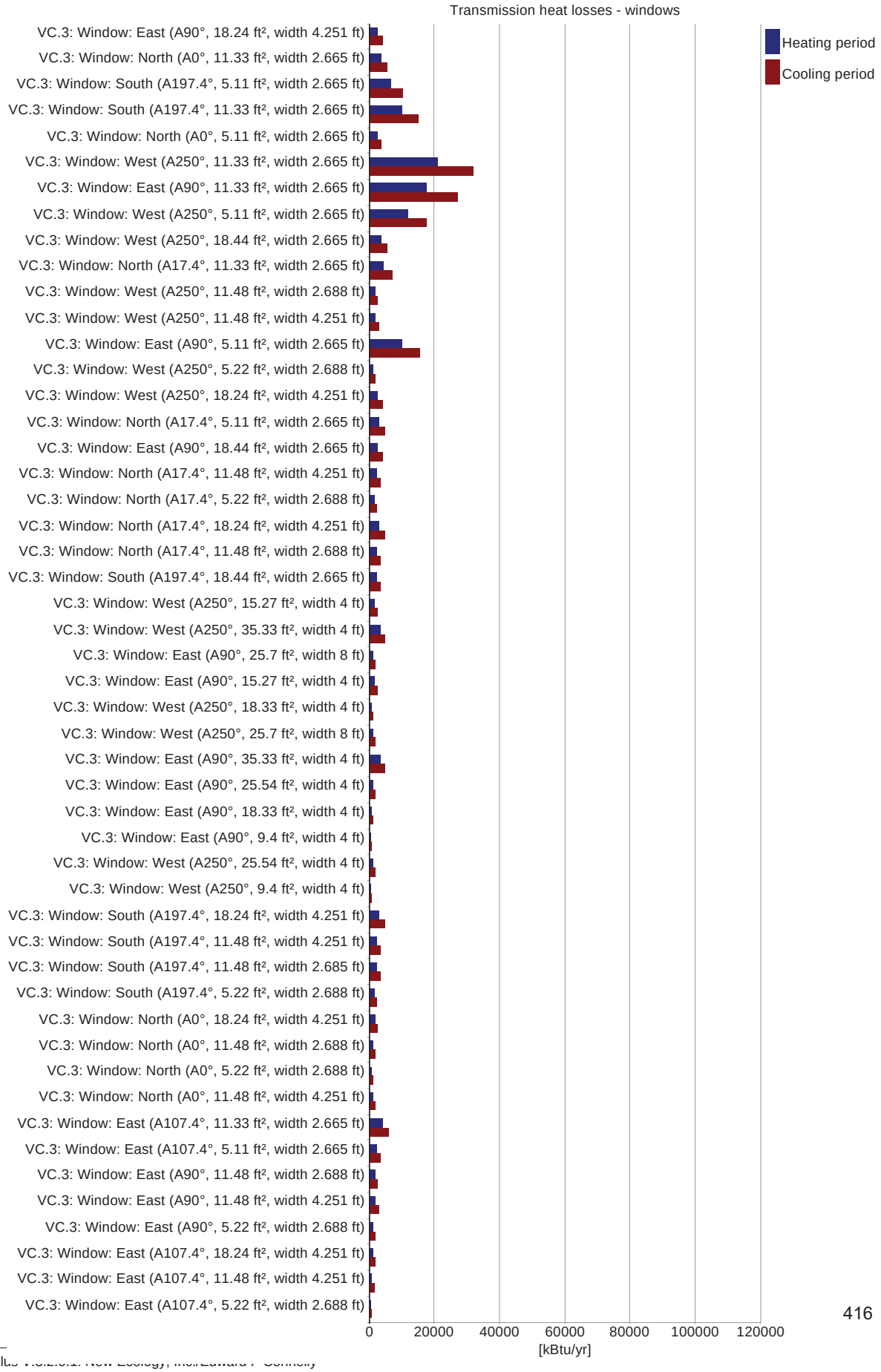
Name	Length [ft]	Psi-value [Btu/hr ft °F]	Transmission losses [kBtu/yr]	Transmission losses cooling [kBtu/yr]

WINDOWS

Name	Quantity	Inclination [°]	U-value total [Btu/hr ft² °F]	SHGC (perpendicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.3: Window: East (A90°, 18.24 ft², width 4.251 ft)	6	90	0.172	0.4	58	50.5	2,498.7	4,130.7	2,664.6	4,079
VC.3: Window: North (A0°, 11.33 ft², width 2.665 ft)	12	90	0.169	0.4	65.1	77	1,293.7	2,021.6	3,683.1	7,610.6
VC.3: Window: South (A197.4°, 5.11 ft², width 2.665 ft)	32	90	0.186	0.4	81.9	64.1	6,932.8	8,838.3	6,556	10,322
VC.3: Window: South (A197.4°, 11.33 ft², width 2.665 ft)	32	90	0.169	0.4	83.9	66.6	13,443.9	15,242.7	9,821.5	14,961.6
VC.3: Window: North (A0°, 5.11 ft², width 2.665 ft)	12	90	0.186	0.4	66	74.6	662.4	1,044.3	2,741	3,850.8
VC.3: Window: West (A250°, 11.33 ft², width 2.665 ft)	68	90	0.169	0.4	55.7	69	17,416.6	27,133.8	20,851.2	31,593.4
VC.3: Window: East (A90°, 11.33 ft², width 2.665 ft)	78	90	0.169	0.4	59.5	51.1	13,551.9	22,499.2	15,801.9	25,115.9
VC.3: Window: West (A250°, 5.11 ft², width 2.665 ft)	77	90	0.186	0.4	57.9	66.8	6,465.9	10,473	11,646.3	15,541
VC.3: Window: West (A250°, 18.44 ft², width 2.665 ft)	8	90	0.178	0.4	83.6	53.8	3,745.2	7,542.1	3,535.8	7,693.9
VC.3: Window: North (A17.4°, 11.33 ft², width 2.665 ft)	17	90	0.169	0.4	67.9	73.3	1,674.5	2,482.9	4,603.9	5,013.2
VC.3: Window: West (A250°, 11.48 ft², width 2.688 ft)	6	90	0.169	0.4	52.1	62.8	1,308.8	2,095.5	1,879.5	2,832.9
VC.3: Window: West (A250°, 11.48 ft², width 4.251 ft)	6	90	0.151	0.4	68.5	79.2	1,183.9	1,881.9	1,884	2,869.9
VC.3: Window: East (A90°, 5.11 ft², width 2.665 ft)	48	90	0.186	0.4	55.8	68.5	7,891.2	9,747	10,164.1	17,483.1
VC.3: Window: West (A250°, 5.22 ft², width 2.688 ft)	6	90	0.186	0.4	50.5	61.5	658.4	1,085	1,287.9	1,978.8
VC.3: Window: West (A250°, 18.24 ft², width 4.251 ft)	6	90	0.172	0.4	50.5	60.8	2,309	3,669.3	2,664.6	4,079
VC.3: Window: North (A17.4°, 5.11 ft², width 2.665 ft)	17	90	0.186	0.4	67.6	73.4	879.9	1,296.8	3,156.3	4,838.7
VC.3: Window: East (A90°, 18.44 ft², width 2.665 ft)	6	90	0.178	0.4	87.9	57.9	2,585.9	4,718.7	2,803.4	4,250.4
VC.3: Window: North (A17.4°, 11.48 ft², width 4.251 ft)	5	90	0.151	0.4	61	49.4	684.8	1,026.8	2,198	3,348.2
VC.3: Window: North (A17.4°, 5.22 ft², width 2.688 ft)	5	90	0.186	0.4	63.2	71.7	397.6	796.4	1,700.2	2,287.3
VC.3: Window: North (A17.4°, 18.24 ft², width 4.251 ft)	5	90	0.172	0.4	61.6	49.7	1,315.6	1,967	3,108.5	4,537.7
VC.3: Window: North (A17.4°, 11.48 ft², width 2.688 ft)	5	90	0.169	0.4	63.1	70.8	577.9	1,128.7	2,169.6	3,307
VC.3: Window: South (A197.4°, 18.44 ft², width 2.665 ft)	7	90	0.178	0.4	87.9	68.3	3,866.6	4,964.7	2,336.1	3,778.5
VC.3: Window: West (A250°, 15.27 ft², width 4 ft)	4	90	0.174	0.4	54	68.2	1,426.9	2,398.7	1,695.5	2,786.1
VC.3: Window: West (A250°, 35.33 ft², width 4 ft)	4	90	0.135	0.4	93.1	82.8	4,765.5	5,455.1	3,253.1	4,987.9
VC.3: Window: East (A90°, 25.7 ft², width 8 ft)	2	90	0.148	0.4	52.4	65.3	1,175.6	1,972.1	1,295.5	1,956.8
VC.3: Window: East (A90°, 15.27 ft², width 4 ft)	4	90	0.174	0.4	55.6	51.2	1,737.3	2,762.2	1,695.5	2,786.1
VC.3: Window: West (A250°, 18.33 ft², width 4 ft)	2	90	0.172	0.4	58.9	50.7	847.6	1,380.9	891.3	1,375.8
VC.3: Window: West (A250°, 25.7 ft², width 8 ft)	2	90	0.148	0.4	51.3	67.8	1,115.5	1,887.9	1,295.5	1,956.8
VC.3: Window: East (A90°, 35.33 ft², width 4 ft)	4	90	0.135	0.4	92.6	82.8	4,610.1	5,783.4	3,253.1	4,986
VC.3: Window: East (A90°, 25.54 ft², width 4 ft)	2	90	0.142	0.4	24.5	21	479.3	524.1	1,260.1	1,919.6
VC.3: Window: East (A90°, 18.33 ft², width 4 ft)	2	90	0.172	0.4	80.9	52	886.1	1,443.6	891.3	1,375.8
VC.3: Window: East (A90°, 9.4 ft², width 4 ft)	2	90	0.18	0.4	55.5	69.2	332.9	742.7	741.1	824.2
VC.3: Window: West (A250°, 25.54 ft², width 4 ft)	2	90	0.142	0.4	59.6	51.7	1,391	2,284	1,260.1	1,919.6
VC.3: Window: West (A250°, 9.4 ft², width 4 ft)	2	90	0.18	0.4	56	66.8	321.5	719.5	741.1	824.2
VC.3: Window: South (A197.4°, 18.24 ft², width 4.251 ft)	5	90	0.172	0.4	85.5	68.2	7,618	5,144.1	3,108.5	4,537.7
VC.3: Window: South (A197.4°, 11.48 ft², width 4.251 ft)	5	90	0.151	0.4	83.4	64.3	2,831.7	3,786.5	2,198	3,348.2
VC.3: Window: South (A197.4°, 11.48 ft², width 2.685 ft)	5	90	0.169	0.4	84	66.5	2,991.8	3,835.2	2,169.6	3,307
VC.3: Window: South (A197.4°, 5.22 ft², width 2.688 ft)	5	90	0.186	0.4	82	64.2	1,771.7	1,958	1,700.2	2,287.3
VC.3: Window: North (A0°, 18.24 ft², width 4.251 ft)	4	90	0.172	0.4	72.5	43.4	613.6	960.4	1,556.4	2,506
VC.3: Window: North (A0°, 11.48 ft², width 2.688 ft)	4	90	0.169	0.4	74.4	44.8	374.8	777.5	1,239.8	1,888.6
VC.3: Window: North (A0°, 5.22 ft², width 2.688 ft)	4	90	0.186	0.4	75.3	45.6	197.9	309.1	875.3	1,307.9
VC.3: Window: North (A0°, 11.48 ft², width 4.251 ft)	4	90	0.151	0.4	77.1	47.6	336.6	729.6	1,276	1,913.3
VC.3: Window: East (A107.4°, 11.33 ft², width 2.665 ft)	13	90	0.169	0.4	81.6	51.2	3,502.4	7,159.4	3,990.1	6,058.1
VC.3: Window: East (A107.4°, 5.11 ft², width 2.665 ft)	11	90	0.186	0.4	80.9	69.9	1,641.2	2,259.5	2,329.3	3,748.2
VC.3: Window: East (A90°, 11.48 ft², width 2.688 ft)	6	90	0.169	0.4	58.3	51.2	1,401	2,323	1,879.5	2,832.9
VC.3: Window: East (A90°, 11.48 ft², width 4.251 ft)	6	90	0.151	0.4	56.4	68.8	1,298.4	2,134.9	1,884	2,869.9
VC.3: Window: East (A90°, 5.22 ft², width 2.688 ft)	6	90	0.186	0.4	55.7	69.9	538.1	1,214.8	1,287.9	1,978.8
VC.3: Window: East (A107.4°, 18.24 ft², width 4.251 ft)	3	90	0.172	0.4	87.3	57.4	1,607.9	2,268.8	1,332.3	2,029.7
VC.3: Window: East (A107.4°, 11.48 ft², width 4.251 ft)	3	90	0.151	0.4	82.2	51.5	824.7	1,173.3	942	1,434.9
VC.3: Window: East (A107.4°, 5.22 ft², width 2.688 ft)	3	90	0.186	0.4	82.2	52	461.2	646.8	642.9	959.4

Transmission heat losses - windows)continue4

Name	Quan-tity	Incli-nation [°]	U-value total [Btu/hr ft² °F]	SHGC (perpen-dicular)	Reduction factor shading [%]	Reduction factor shading summer [%]	Solar gain heating [kBtu/yr]	Solar gain cooling [kBtu/yr]	Transmission losses heating [kBtu/yr]	Transmission losses cooling [kBtu/yr]
VC.3: Window: East (A107.4°, 11.48 ft², width 2.688 ft)	3	90	0.169	0.4	84.3	54.8	885.2	1,275.2	929.8	1,416.4
VC.6: Storefront: West (A250°, 5 ft², width 1 ft)	2	90	0.661	0.3	76.1	78.4	183	349.6	1,458.1	2,271.5
VC.6: Storefront: West (A250°, 3.65 ft², width 4 ft)	4	90	0.698	0.3	69	52.6	213.9	413.9	1,636.2	2,492.7
VC.6: Storefront: East (A90°, 28 ft², width 4 ft)	2	90	0.491	0.3	63.7	51.3	1,093	2,219.2	4,392.1	6,690.6
VC.6: Storefront: East (A90°, 5 ft², width 1 ft)	2	90	0.661	0.3	68.3	54.6	218.5	434.1	1,458.2	2,271.5
VC.6: Storefront: West (A250°, 28 ft², width 4 ft)	2	90	0.491	0.3	60.2	66.6	1,015.8	2,064.3	4,392.1	6,690.6
VC.6: Storefront: West (A250°, 21 ft², width 3 ft)	2	90	0.709	0.3	60.9	66.8	577.5	1,720.4	3,420.5	7,210.8
VC.6: Storefront: East (A90°, 3.65 ft², width 4 ft)	4	90	0.698	0.3	50.5	57.6	221.9	432.6	1,636.2	2,492.7
VC.6: Storefront: East (A90°, 21 ft², width 3 ft)	2	90	0.709	0.3	64.2	51.8	806.9	1,632.1	3,420.5	7,210.8


Transmission heat losses - windows
Heating period
Cooling period
VC.3: Window: East (A90°, 18.24 ft², width 4.251 ft)
VC.3: Window: North (A0°, 11.33 ft², width 2.665 ft)
VC.3: Window: South (A197.4°, 5.11 ft², width 2.665 ft)
VC.3: Window: South (A197.4°, 11.33 ft², width 2.665 ft)
VC.3: Window: North (A0°, 5.11 ft², width 2.665 ft)
VC.3: Window: West (A250°, 11.33 ft², width 2.665 ft)
VC.3: Window: East (A90°, 11.33 ft², width 2.665 ft)
VC.3: Window: West (A250°, 5.11 ft², width 2.665 ft)
VC.3: Window: West (A250°, 18.44 ft², width 2.665 ft)
VC.3: Window: North (A17.4°, 11.33 ft², width 2.665 ft)
VC.3: Window: West (A250°, 11.48 ft², width 2.688 ft)
VC.3: Window: West (A250°, 11.48 ft², width 4.251 ft)
VC.3: Window: East (A90°, 5.11 ft², width 2.665 ft)
VC.3: Window: West (A250°, 5.22 ft², width 2.688 ft)
VC.3: Window: West (A250°, 18.24 ft², width 4.251 ft)
VC.3: Window: North (A17.4°, 5.11 ft², width 2.665 ft)
VC.3: Window: East (A90°, 18.44 ft², width 2.665 ft)
VC.3: Window: North (A17.4°, 11.48 ft², width 4.251 ft)
VC.3: Window: North (A17.4°, 5.22 ft², width 2.688 ft)
VC.3: Window: North (A17.4°, 18.24 ft², width 4.251 ft)
VC.3: Window: North (A17.4°, 11.48 ft², width 2.688 ft)
VC.3: Window: South (A197.4°, 18.44 ft², width 2.665 ft)
VC.3: Window: West (A250°, 15.27 ft², width 4 ft)
VC.3: Window: West (A250°, 35.33 ft², width 4 ft)
VC.3: Window: East (A90°, 25.7 ft², width 8 ft)
VC.3: Window: East (A90°, 15.27 ft², width 4 ft)
VC.3: Window: West (A250°, 18.33 ft², width 4 ft)
VC.3: Window: West (A250°, 25.7 ft², width 8 ft)
VC.3: Window: East (A90°, 35.33 ft², width 4 ft)
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VC.3: Window: South (A197.4°, 18.24 ft², width 4.251 ft)
VC.3: Window: South (A197.4°, 11.48 ft², width 4.251 ft)
VC.3: Window: South (A197.4°, 11.48 ft², width 2.685 ft)
VC.3: Window: South (A197.4°, 5.22 ft², width 2.688 ft)
VC.3: Window: North (A0°, 18.24 ft², width 4.251 ft)
VC.3: Window: North (A0°, 11.48 ft², width 2.688 ft)
VC.3: Window: North (A0°, 5.22 ft², width 2.688 ft)
VC.3: Window: North (A0°, 11.48 ft², width 4.251 ft)
VC.3: Window: East (A107.4°, 11.33 ft², width 2.665 ft)
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VC.3: Window: East (A107.4°, 18.24 ft², width 4.251 ft)
VC.3: Window: East (A107.4°, 11.48 ft², width 4.251 ft)
VC.3: Window: East (A107.4°, 5.22 ft², width 2.688 ft)
0
20000
40000
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80000
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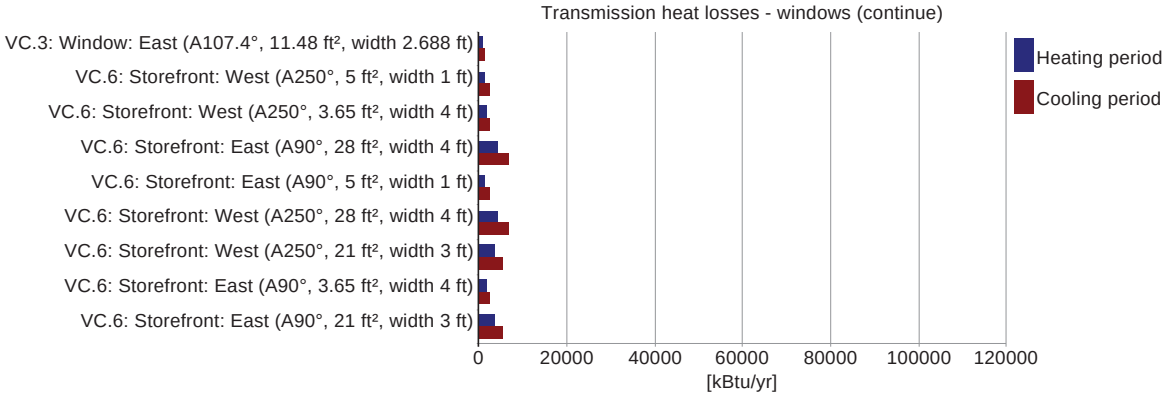
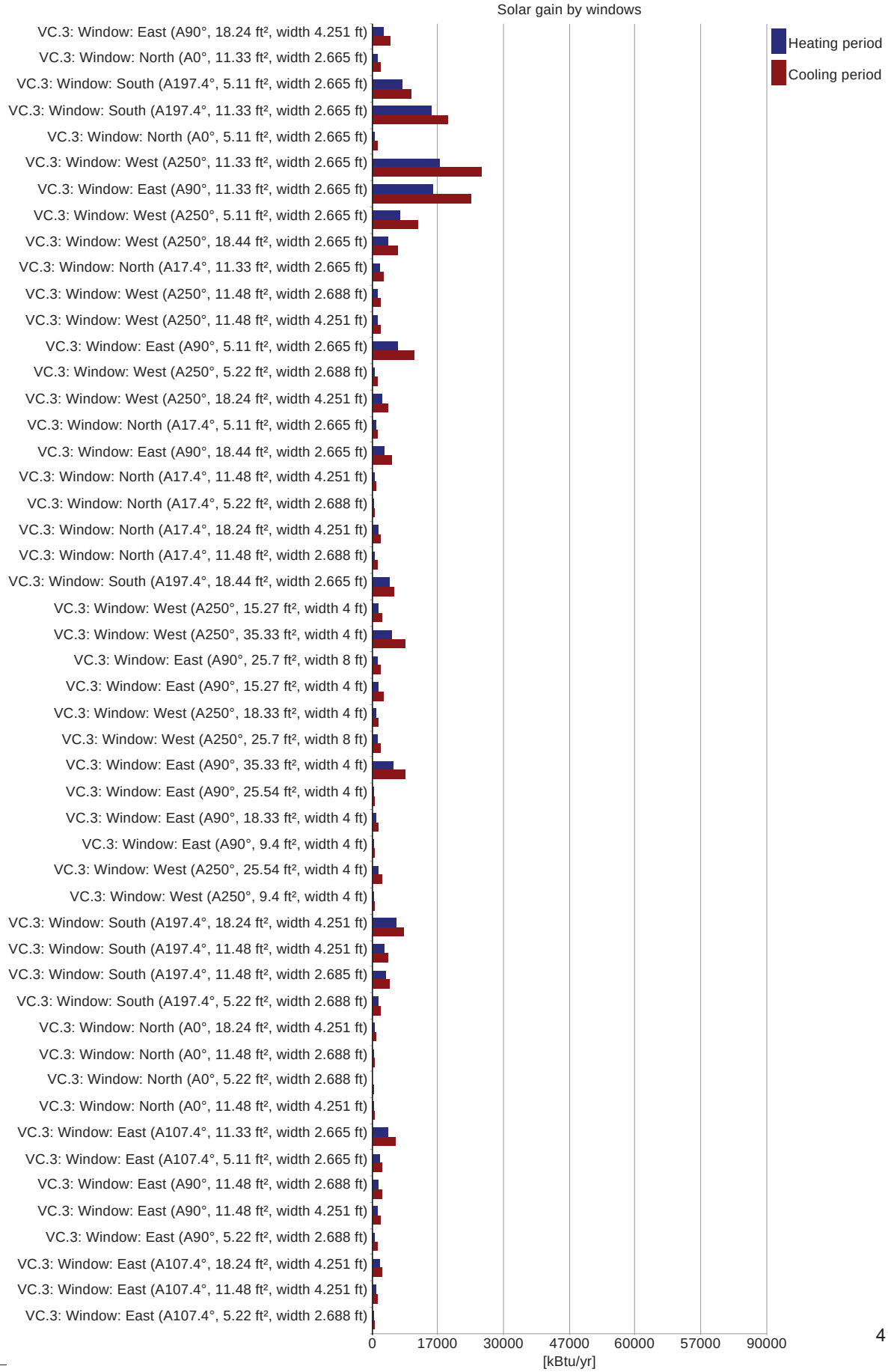
120000
[kBtu/yr]


Transmission heat losses - windows (continue)
VC.3: Window: East (A107.4°, 11.48 ft², width 2.688 ft)
VC.6: Storefront: West (A250°, 5 ft², width 1 ft)
VC.6: Storefront: West (A250°, 3.65 ft², width 4 ft)
VC.6: Storefront: East (A90°, 28 ft², width 4 ft)
VC.6: Storefront: East (A90°, 5 ft², width 1 ft)
VC.6: Storefront: West (A250°, 28 ft², width 4 ft)
VC.6: Storefront: West (A250°, 21 ft², width 3 ft)
VC.6: Storefront: East (A90°, 3.65 ft², width 4 ft)
VC.6: Storefront: East (A90°, 21 ft², width 3 ft)
0
20000
40000
60000
80000
100000
120000
[kBtu/yr]
Heating period
Cooling period


Solar gain by windows
Heating period
Cooling period
VC.3: Window: East (A90°, 18.24 ft², width 4.251 ft)
VC.3: Window: North (A0°, 11.33 ft², width 2.665 ft)
VC.3: Window: South (A197.4°, 5.11 ft², width 2.665 ft)
VC.3: Window: South (A197.4°, 11.33 ft², width 2.665 ft)
VC.3: Window: North (A0°, 5.11 ft², width 2.665 ft)
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VC.3: Window: East (A107.4°, 11.48 ft², width 4.251 ft)
VC.3: Window: East (A107.4°, 5.22 ft², width 2.688 ft)
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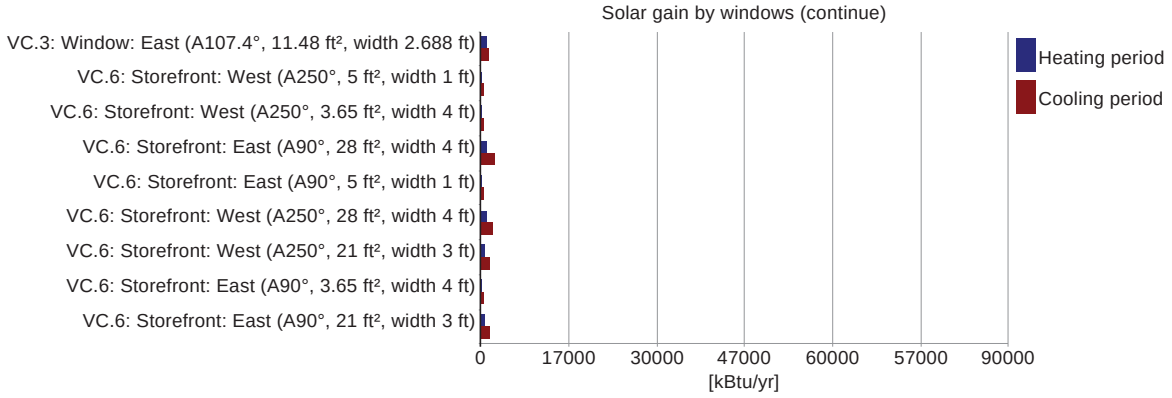
17000
30000
47000
60000
57000
90000
[kBtu/yr]



Summary building envelope

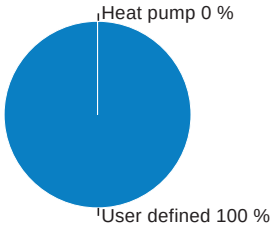
	Total area / length	Average U-value / Psi value	Transmission losses
Exterior wall ambient:	(7,96(50 ft²	9593. Btu/hr ft² °F	((1,6975 kBtu/yr
Exterior wall ground:	9 ft²	9 Btu/hr ft² °F	9 kBtu/yr
Basement:	10,. . 053 ft²	9597 7 Btu/hr ft² °F	00,1. 253 kBtu/yr
Roof:	12,96251 ft²	9591. Btu/hr ft² °F	36,. 9(5(kBtu/yr
Windows:	2,33353 ft²	9517 8 Btu/hr ft² °F	177,86253 kBtu/yr
Doors:	9 ft²	9 Btu/hr ft² °F	9 kBtu/yr
Thermal bridge ambient:	9 ft	9 Btu/hr ft °F	9 kBtu/yr
Thermal bridge perimeter:	9 ft	9 Btu/hr ft °F	9 kBtu/yr
Thermal bridge floor slab:	9 ft	9 Btu/hr ft °F	9 kBtu/yr

Shading

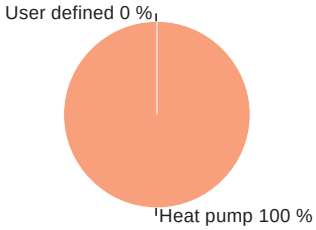
	Heating	Cooling
Reduction factor North:	2(50 %	095 %
Reduction factor East:	6753 %	6952 %
Reduction factor South:	735(%	2253 %
Reduction factor West:	6257 %	2. %
Reduction factor Horizontal:	199 %	199 %

System	DHW			Heating			Total		
	Covered DHW demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Covered heating demand [%]	Estimated solar fraction [%]	Final energy demand [kBtu/yr]	Performance ratio	CO2 equivalent emissions [lb/yr]	Source energy demand [kBtu/yr]
Heat pump, VRF	0	0	0	100	0	75,379.2	0	27,203,825	103,246.6
User defined, Condensing Gas-Fired Boilers	100	0	384,777.2	0	0	0	1.1	24,348,493.2	423,010.5
Σ	100	0	384,777.2	100	0	75,379.2		49,772,320.2	726,275.3

DHW - final energy



Heating - final energy



COOLING UNITS

	sensible	latent
Air cooling:	9 kBtu/ft²yr	9 kBtu/ft²yr
Recirculation cooling:	(52 kBtu/ft²yr	9 kBtu/ft²yr
Additional dehumidification:		953 kBtu/ft²yr
Panel cooling:	9 kBtu/ft²yr	
Sum:	(52 kBtu/ft²yr	953 kBtu/ft²yr

VENTILATION

Energy transportable by supply air

Heating energy

transportable:	1582	W/ft²
load:	9577	W/ft²

Cooling energy

transportable:	9573	W/ft²
load:	9561	W/ft²

Infiltration pressure test ACH70:	950(	1/hr
Total extract air demand:	8,799	cfm
Supply air per person:	17	cfm
Occupancy:	12(	

Average air flow rate:	8,. 3757	cfm
Average air change rate:	9501	1/hr
Effective ACH ambient:	951(	1/hr
Effective ACH ground:	9	1/hr
Energetically effective air exchange:	951(	1/hr
Infiltration air change rate:	9593	1/hr
Infiltration air change rate (heating load):	959.	1/hr

Type of ventilation system:	**Balanced PH ventilation**
Wind screening coefficient (e):	9596
Wind exposure factor:	10
Wind shield factor:	9590

Ventilation heat losses: **139,2. (50** kBtu/yr

Devices

Name	Sensible recovery efficiency [-]	Electric efficiency [W/cfm]	Heat recovery efficiency SHX [-]	Effective recovery efficiency [-]
Semco	0.9	0.04	0	0.9
Altogether	0.8	0.04	0	0.8

Ducts

Name	Length (total) [ft]	Clear cross-section [ft²]	U-value [Btu/hr ft² °F]	Assigned ventilation units
ERV-1	10	2.27	14.37	Semco
ERV-1	10	2.27	14.37	Semco
Σ	20			

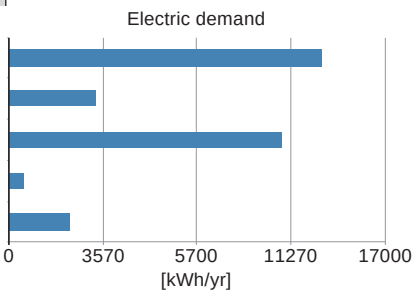
*length * quantity ** thermal conductivity / thickness

SUMMER VENTILATION

ACH night ventilation:	9	1/hr
ACH natural summer:	9	1/hr
Mechanical ventilation summer:	950	1/hr
Mechanical ventilation summer with HR:	no	

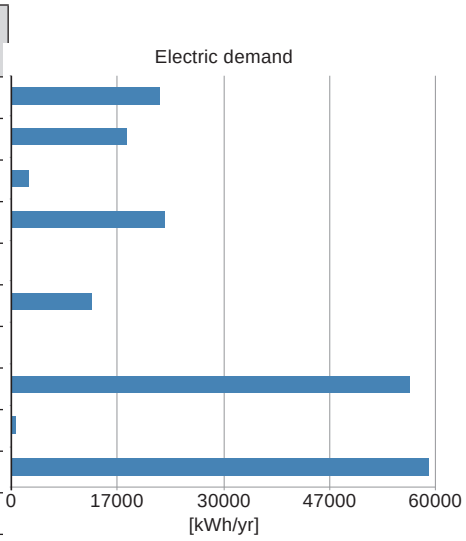
ELECTRICITY DEMAND - AUXILIARY ELECTRICITY

Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Source energy [kBtu/yr]
Ventilation winter	1	no	0.5 W/cfm	12443.4	56418.1
Ventilation Defrost	1	no	18,726.5 W	3461.1	21277.5
Ventilation summer	1	no	0.5 W/cfm	10878.2	66682.8
DHW circulating pump	1	yes	50.9 W	787.9	3798.1
DHW storage load pump	1	yes	365.5 W	2447.4	17018
Σ				29594.1	182952.5



ELECTRICITY DEMAND RESIDENTIAL BUILDING

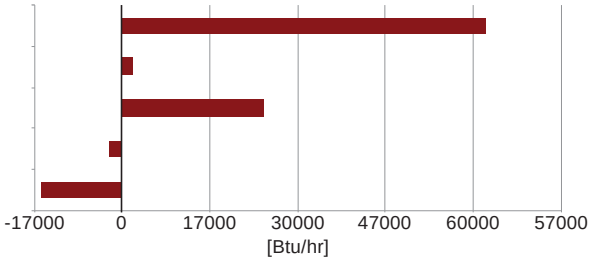
Type	Quantity	Indoor	Norm demand	Electric demand [kWh/yr]	Non-electric demand [kWh/yr]	Source energy [kBtu/yr]
Kitchen refrigerator	1	yes	1.2	21120	0	129503.2
Kitchen cooking	1	yes	0.2	16200	0	99488.2
Laundry - washer	1	yes	0.3	2491.3	0	17299.4
Laundry - dryer	1	yes	3.1	21786.1	0	132767.7
Energy consumed by evaporation	1	yes	3.1	0	8.7	34.5
Laundry - dryer	1	yes	6	11296.5	0	69356
Energy consumed by evaporation	0	yes	3.1	0	0	0
User defined lighting	1	yes	76,436	76436	0	346785.7
User defined lighting	1	no	758	758	0	3749.6
User defined MELs	1	yes	79,121	79121	0	363056.8
Σ	9			188829.1	8.7	1179681



INTERNAL HEAT GAINS

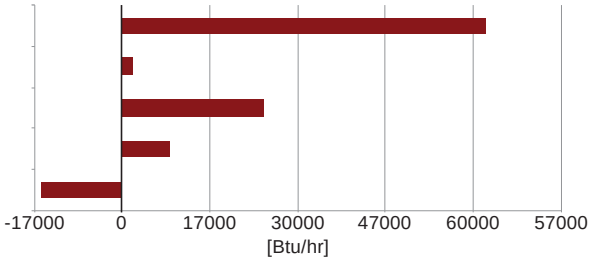
Heating season

Electricity total:	2(,8985	0 Btu/hr
Auxiliary electricity:	1,. 905	2 Btu/hr
People:	(3,8(15	6 Btu/hr
Cold water:	-(,(095	Btu/hr
Evaporation:	-18,71. 5	(Btu/hr
Σ:	6(,87(5	7 Btu/hr
Specific internal heat gains:	15	(Btu/hr ft²



Cooling season

Electricity total:	2(,8985	0 Btu/hr
Auxiliary electricity:	1,. 905	2 Btu/hr
People:	(3,8(15	6 Btu/hr
Cold and hot water:	7,19. 5	1 Btu/hr
Evaporation:	-18,71. 5	(Btu/hr
Σ:	6(,87(5	7 Btu/hr
Specific internal heat gains:	15	(Btu/hr ft²



DHW AND DISTRIBUTION

DHW consumption per person per day:	25.2	gal/Person/day
Average cold water temperature supply:	0(.5	°F
Useful heat DHW:	(78,1(.8	kBtu/yr
Specific useful heat DHW:	3,6(.25.2	Btu/ft²yr
Total heat losses of the DHW system:	06,1..15.8	kBtu/yr
Specific losses of the DHW system:	.035.7	Btu/ft²yr
Performance ratio DHW distribution system and storage:	15(	
Utilization ratio DHW distribution system and storage:	95.7	
Total heat demand of DHW system:	839,8135.8	kBtu/yr
Total specific heat demand of DHW system:	0,2715.8	Btu/ft²yr
Total heat losses of the hydronic heating distribution:	9	kBtu/yr
Specific losses of the hydronic heating distribution:	9	Btu/ft²yr
Performance ratio of heat distribution:	199	%

Region	Length [ft]	Annual heat loss [kBtu/yr]
Hydronic heating distribution pipes		
Σ	0	0
DHW circulation pipes		
In conditioned space	1620	35773.9
Σ	1620	35773.9
Individual pipes		
In conditioned space	1200	12153.1
Σ	1200	12153.1
Water storage		
Device 4 (Water storage: DHW)		1866.1
Σ		1866.1

APPENDIX C: HELIOSCOPE PV ANALYSIS REPORT

Design 1 Jackson Place, Cambridge, MA

Report

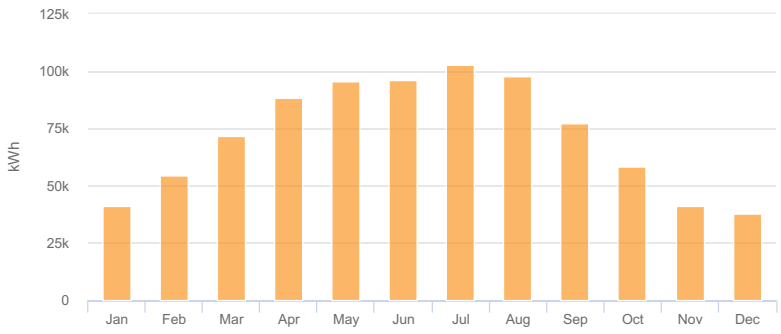
Project Name	Jackson Place
Project Address	Cambridge, MA
Prepared By	Thomas Chase chase@newecology.org

System Metrics

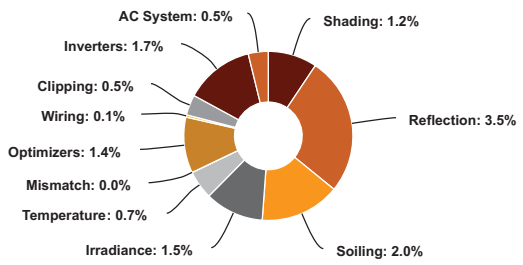
Design	Design 1
Module DC Nameplate	637.6 kW
Inverter AC Nameplate	630.0 kW Load Ratio: 1.01
Annual Production	862.8 MWh
Performance Ratio	87.6%
kWh/kWp	1,353.3
Weather Dataset	TMY, 10km grid (42.35,-71.15), NREL (prospector)
Simulator Version	a531a704d4-acbd214a9b-f77fe81ef7-e9a506aed3

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,422.7	
	POA Irradiance	1,544.7	8.6%
	Shaded Irradiance	1,525.7	-1.2%
	Irradiance after Reflection	1,472.9	-3.5%
	Irradiance after Soiling	1,443.4	-2.0%
	Total Collector Irradiance	**1,443.4**	**0.0%**
Energy (kWh)	Nameplate	920,123.4	
	Output at Irradiance Levels	906,581.3	-1.5%
	Output at Cell Temperature Derate	900,078.4	-0.7%
	Output After Mismatch	900,078.4	0.0%
	Optimizer Output	887,476.3	-1.4%
	Optimal DC Output	886,982.5	-0.1%
	Constrained DC Output	882,466.2	-0.5%
	Inverter Output	867,146.9	-1.7%
	Energy to Grid	**862,811.1**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		12.1 °C
	Avg. Operating Cell Temp		19.3 °C
Simulation Metrics			
	Operating Hours		4692
	Solved Hours		4692

Condition Set

Description	Condition Set 1											
Weather Dataset	TMY, 10km grid (42.35,-71.15), NREL (prospector)											
Solar Angle Location	Meteo Lat/Lng											
Transposition Model	Perez Model											
Temperature Model	Sandia Model											
Temperature Model Parameters	Rack Type	a	b	Temperature Delta								
	Fixed Tilt	-3.56	-0.075	3°C								
	Flush Mount	-2.81	-0.0455	0°C								
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D
	2	2	2	2	2	2	2	2	2	2	2	2
Irradiation Variance	5%											
Cell Temperature Spread	4° C											
Module Binning Range	-2.5% to 2.5%											
AC System Derate	0.50%											
Module Characterizations	Module	Uploaded By	Characterization									
	SPR-X21-345 (SunPower)	Folsom Labs	Sunpower_SPR_X21_345.PAN, PAN									
Component Characterizations	Device	Uploaded By	Characterization									

Components

Component	Name	Count
Inverters	SE100KUS (SolarEdge)	3 (300.0 kW)
Inverters	SE55K-EU-APAC (SolarEdge)	6 (330.0 kW)
Strings	10 AWG (Copper)	63 (9,689.2 ft)
Optimizers	P700 (SolarEdge)	1,848 (1.29 MW)
Module	SunPower, SPR-X21-345 (345W)	1,848 (637.6 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone B1.1	-	11-32	Along Racking
Wiring Zone B1.2	-	11-32	Along Racking
Wiring Zone B2	-	11-32	Along Racking
Wiring Zone B3	-	11-32	Along Racking
Wiring Zone 5	-	11-32	Along Racking
Wiring Zone 6	-	11-32	Along Racking
Wiring Zone 7	-	11-32	Along Racking
Wiring Zone 8	-	11-32	Along Racking
Wiring Zone 4	-	11-32	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
B1.1	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	148	141	48.6 kW
B1.2	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	127	125	43.1 kW
B3	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	197	194	66.9 kW
B2	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	121	115	39.7 kW
B5	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	103	102	35.2 kW
B4	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	181	176	60.7 kW
B7	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	282	274	94.5 kW
B8	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	336	336	115.9 kW
B6	Fixed Tilt	Landscape (Horizontal)	10°	177.43535°	2.0 ft	1x1	387	385	132.8 kW

Detailed Layout

APPENDIX D: GREEN BUILDING CHECKLIST

Green Building Project Checklist

Green Building
Project Location: _____

Applicant

Name: Kelsey Powers
Address: 15 Court Square, Suite 420 Boston, MA 02108
Contact Information
Email Address: powers@newecology.org
Telephone #: (617) 557-1700

Project Information (select all that apply):

- ☒ New Construction – GFA: 379,925 sf
- ☐ Addition – GFA of Addition: _____
- ☐ Rehabilitation of Existing Building – GFA of Rehabilitated Area: _____
  - ☐ Existing Use(s) of Rehabilitated Area: _____
  - ☐ Proposed Use(s) of Rehabilitated Area: _____
- ☒ Requires Planning Board Special Permit approval
- ☐ Subject to Section 19.50 Building and Site Plan Requirements
- ☐ Site was previously subject to Green Building Requirements

Green Building Rating Program/System:

- ☐ Leadership in Energy and Environmental Design (LEED) – Version: _____
  - ☐ Building Design + Construction (BD+C) – Subcategory: _____
  - ☐ Residential BD+C – Subcategory: _____
  - ☐ Interior Design + Construction (ID+C) – Subcategory: _____
  - ☐ Other: _____
- ☒ Passive House – Version: PHIUS+ CORE 2018
  - ☐ PHIUS+
  - ☐ Passivhaus Institut (PHI)
  - ☐ Other: _____
- ☐ Enterprise Green Communities – Version: _____

Project Phase

☒ **SPECIAL PERMIT**

Before applying for a building permit, submit this documentation to CDD for review and approval.

Required Submissions

All rating programs:

- ☒ Rating system checklist
- ☒ Rating system narrative
- ☒ Net zero narrative (see example template for guidance)
- ☒ Affidavit signed by Green Building Professional with attached credentials – use City form provided (Special Permit)

APPENDIX E: GREEN BUILDING PROFESSIONAL AFFIDAVIT

Affidavit Form for Green Building Professional
Special Permit

Green Building
Project Location: 278 Rindge Avenue Cambridge, MA

Green Building Professional
Name: Henry Harvey P.E.

☐ Architect
☒ Engineer

License Number: Massachusetts Mechanical 45042
Company: New Ecology, Inc.
Address: 15 Court Square, Suite 420 Boston MA 02108
Contact Information
Email Address: harvey@newecology.org
Telephone Number: 978-349-8812

I, Henry Harvey , as the Green Building Professional for this Green Building Project, have reviewed all relevant documents for this project and confirm to the best of my knowledge that those documents indicate that the project is being designed to achieve the requirements of Section 22.24 under Article 22.20 of the Cambridge Zoning Ordinance.

(Signature) 3/31/2021 *(Date)*

Attach either: PHIUS Certified Passive House Consultant #2725

☒ Credential from the applicable Green Building Rating Program indicating advanced knowledge and experience in environmentally sustainable development in general as well as the applicable Green Building Rating System for this Green Building Project.

☐ If the Green Building Rating Program does not offer such a credential, evidence of experience as a project architect or engineer, or as a consultant providing third-party review, on at least three (3) projects that have been certified using the applicable Green Building Rating Program.

TRADEMARK LICENSE AGREEMENT

THIS TRADEMARK LICENSE AGREEMENT ("Agreement"), effective as of October 1st, 2012, is by and between Licensor, Passive House Institute U.S., Inc., an Illinois not-for-profit corporation, with its principal place of business at 116 W. Illinois Street, Ste.5E, Chicago, IL 60654 ("Licensor") and Henry Harvey , with an address of 5 Wilderness Rd. Littleton, MA 01460 ("Licensee").

WHEREAS, Licensee has completed the CPHC certification process;

WHEREAS, Licensor is the owner of rights to the marks described in the attached document titled "Logo/Language Guidelines Graphic Passive House Logo and CPHC Certification Marks" ("Marks"); and

WHEREAS, Licensee desires to use the Marks in connection with Licensee's goods and services.

NOW THEREFORE, in consideration of the foregoing and of the mutual promises hereinafter set forth, the parties agree as follows:

1. Grant Of License

Licensor grants to Licensee a non-exclusive, non-transferable, non-assignable, royalty-free license to use the Marks in accordance with the guidelines established in the document titled "Logo/Language Guidelines Graphic Passive House Logo and CPHC Certification Marks," as amended from time to time by Licensor. The current version of that document is attached. Licensor will provide notice of any changes to the document to Licensee at the above address.

2. Ownership Of Marks

a. Licensee acknowledges that Licensor is the owner of the Marks and the goodwill associated therewith. Licensee agrees that it will do nothing inconsistent with such ownership and that all use of the Marks by Licensee shall inure to the benefit of and be on behalf of Licensor. Licensee agrees further that nothing in this Agreement shall be construed as granting to Licensee any right, title, or interest in the Marks, other than the right to use the Marks in accordance with this Agreement. Licensee agrees that it will not attack Licensor's ownership of and title to the Marks or attack the validity of the Marks or this license.

b. Licensee agrees that it shall not at any time apply for registration of any trademark, service mark, business name, domain name, or other designation which would be confusingly similar to, or would otherwise affect Licensor's ownership of, the Marks, nor file any document with any governmental authority to take any action which would affect Licensor's ownership of the Marks.

3. Quality Standards, Notices, Approvals And Samples

a. Licensee agrees that it shall use the Marks only in connection with goods and services that are of a high standard of quality so as to preserve the goodwill and good reputation associated with the Marks. Licensee agrees that if Licensor determines that aspects of the quality of the goods or services offered by Licensee under the Marks are not of a quality adequate to preserve the goodwill and good reputation associated with the Marks, Licensee will comply with reasonable guidelines set by Licensor from time to time to maintain the quality of the goods or services.

b. Licensor shall have the right, upon reasonable notice and during normal business hours, to inspect the operations of Licensee undertaken in connection with the Marks to confirm that the goods or services offered thereunder are of a quality adequate to preserve the goodwill and good reputation associated with the Marks.

4. Infringement Proceedings

Licensor shall be responsible to protect the Marks from infringement. Any recovery as a result of such action brought by Licensor shall belong solely to Licensor.

5. Term And Expiration

This Agreement shall commence and be effective upon the date set forth above (the "Effective Date") and shall continue for an indefinite term so long as the trademark(s) remains valid ("Term"), unless terminated sooner pursuant to section 6 of this Agreement.

6. Termination

In the event that the license to use the Marks terminates pursuant to the terms of the document titled "Logo/Language Guidelines Graphic Passive House Logo and CPHC Certification Marks" or in the event that Licensee violates any term of this Agreement, this Agreement shall immediately terminate.

7. Effect Of Termination Or Expiration

a. Upon termination of this Agreement, Licensee agrees to discontinue immediately all use, and refrain from all further use, of the Marks and any designation confusingly similar thereto.

b. Licensee acknowledges that its failure to cease use and refrain from further use of the Marks at the termination or expiration of this Agreement will result in immediate and irreparable damage to Licensor. Licensee acknowledges and admits that monetary damages will not be adequate compensation for such damage and that there is no adequate remedy at law for failure to cease use of the Marks. Licensee agrees that in the event of Licensee's failure to cease use of the Marks, Licensor shall be entitled to injunctive or other equitable relief and such other relief as any arbitrator or court with jurisdiction may deem just and proper without any necessity of proving damages or any requirement for

the posting of a bond or other security, enjoining Licensee from use of the Marks. Such relief shall be in addition to and not in substitution of any other remedies available to Licensor pursuant to this Agreement.

8. Miscellaneous

a. Licensee shall not assign, transfer, or otherwise encumber this Agreement without prior written approval of Licensor.

b. This Agreement does not create a principal/agent relationship, a partnership, or a joint venture between the parties, and Licensee shall have no power to obligate or bind Licensor in any manner whatsoever.

c. This Agreement shall be governed by the law of the State of Illinois, USA, and all claims arising hereunder shall be brought solely pursuant in the state or federal courts located in Cook County, Illinois, USA.

d. No waiver by either party of a breach or a default hereunder shall be deemed a waiver by such party of a subsequent breach or default.

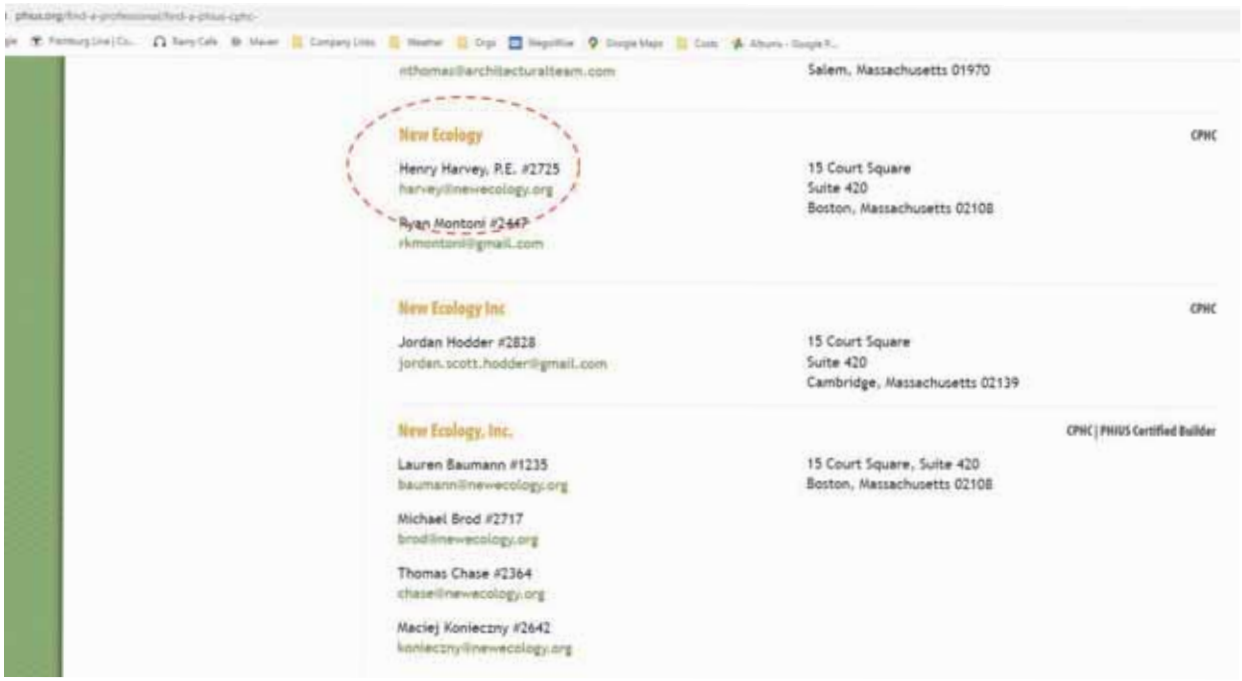
e. This Agreement is complete, constitutes the entire understanding between Licensor and Licensee with respect to the subject matter hereof, and supersedes all prior agreements, whether oral or written, between Licensor and Licensee with respect to the subject matter hereof.

f. No waiver, modification, or addition to this Agreement shall be valid unless in writing and signed by the parties hereto.

g. If any part of this Agreement is found violative of any law or is found to be otherwise legally defective, this Agreement shall be construed and interpreted without reference to such part.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of the day and year first above written.

LICENSOR **Passive House Institute U.S., Inc.,**	**LICENSEE**
BY: _____	_____
DATE: _____	**DATE:** 7/2/2019
TITLE: _____	**TITLE:** Engineering Director, New Ecology



nthomas@architecturalteam.com

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New Ecology, Inc. — CPHC | PHIUS Certified Builder

Lauren Baumann #1235
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Maciej Konieczny #2642
konieczny@newecology.org

15 Court Square, Suite 420
Boston, Massachusetts 02108

APPENDIX 4: CDD REVIEW COMMENTS MATRIX

Section	CDD Comment	CHA Response
1. Submission Organization	1a. Use only the updated AHO submission package and dimensional form (attached) & avoid using the special permit application forms.	Done
	1b. Complete the checklists in the Submission Overview & Drawings Checklist.	Done
	1c. Forms should be print to .pdf so that the form is no longer fillable (security issue).	Done
	1d. Volume 1 (forms and narrative listed under Narrative Volume in Submission Overview)	Done
	1d. Volume 2 (graphics – items as listed in Drawings Checklist)	Done
	1d. Volume 3 (appendices)	Done
	1e. Include Green Building report as an appendix.	Done
	1f. Appendix 2 Community Meetings is not needed; instead prepare a brief report summarizing the community meetings in the narrative (Volume 1)	Done
	1g. Flood response information - clarification about an emergency plan for providing egress to residents and parking cars off-site (since pages 67 and 68 show that the parking area and terrace would flood in a 2070 storm event).	N/A. We are not within 2070-100 year flood zone.
	1g. Utility Requirements – information related to the projects anticipated utility requirements for all public (water, sewer and drain) and private (gas, telecom, electric). Narrative should confirm that adequate service is available, and that project is aware of all regulatory requirements associated with each utility and has made accommodations to meet any requirements for the proposed development.	Done
	1g. Stormwater Control information - project will trigger a Stormwater Control Permit with the DPW. Include narrative acknowledgement of the need for the permit and that all permit requirements can be achieved with the proposed development.	Done
2. Narrative Volume	2a Design Review Submission Checklist: please fill this out.	Done
	2b. Parcel Dimensional Form: Dimensional form for both parcel and building information shows AHO zoning standard for Building Height as 15'; should be revised/corrected or clarified.	Done. Height max = 45'.
	2c. Building Dimensional Form for each building (proposed/existing): o For each individual building, please provide some sort of code/identifier so we can distinguish which building relates to which dimensional form.	Done
	2d. Tenure and Affordability Summary	Done
3. Narrative	3a. Project Narrative: If there are other permits/approvals required (e.g., on-street parking spaces, curb cut, etc.) can those be addressed in the narrative?	Done
	3b. Description of Transportation Demand Management programs (if applicable): Comment	Not applicable because there is a proposed parking ratio over 0.4 (cite AHO).
	3c. Summary of Community Engagement Process: o Include a brief report summarizing the community meetings.	Done
4. Graphics Volume	4a. Throughout: Use larger page numbers, larger text on notes, and larger graphic scales.	Included larger page numbers and larger graphic scales on every page. Included larger text on notes where possible.
	4b.For proposed conditions showing MEP plans, can the titles/legend be amended to clarify what is visible from bona fide streets (requirement of AHO ordinance), versus what is visible from driveway perspectives? Will any MEP be visible without screening from actual streets?	Done. No MEP is visible from actual streets.
	4b. For MEP on the ground level, please provide additional diagrams/illustrations showing screening details for conformance with 11.207.7.5.b.	Done
	4b. Please provide schematic diagram showing compliance with front area requirements in 11.207.7.2.a.	Done
	4b. Please provide a diagram showing compliance with 11.207.7.2.c.	Done
	4b. Please include a plan with labels illustrating conformance with 11.207.7.3.b.	Done. Floor Plan dimensions are intended to show compliance.
	4b. Please identify/label what is being considered non-residential "active use" on the ground story for the purpose of 11.207.7.4.d.	Done
	4b. Please provide diagrammed width of curb cut along Rindge Avenue and document if it is existing or proposed and in conformance with 11.207.7.2.a.	Done
	4c. Page 51 Architectural site plan: Increase the size of the type indicating setback dimensions, major building components, widths of streets, etc. Increase the size of the graphic scale.	Done
	4d. Page 54, Illustrative landscape plan: Coordinate the proposed trees with the Landscape Materials plans, p55 and ff, which show more trees.	Done
	4d. Coordinate the building configurations, shapes of planted areas, locations of building entries, curbs, parking zones, bulbouts, crossing tables with their configurations on page 55 and ff	Done
	4e. Label additional site features (e.g. square boxes on the west side of the site, and at the south end of Main Street)	Done
	4e. Label pavement materials (e.g. at central crossing)	Done
	4e. Coordinate curb locations, configuration of bulbouts, etc with Illustrative Landscape Plan.	Done
	4e. Key additional ground plan materials and increase the scale of the key materials symbols.	
	4e. Match the textures on the plan to the key (e.g. A2 by the community room)	Done
	4e. Will there be significant slopes anywhere? Include spot grades or topos.	Done
	4e. Verify the size of a 23 bike bluebike station.	Done
	4e. Page 60: Key the tree species on the plans	Done
	4e. Page 61 Open Space Calcs: increase the size of the type on the tabulation.	Done

4. Graphics Volume	4e. Include Cool factor calculation?	N/A
	4e. Provide more information on the design of front yards – shrubs, hedges, etc.	Done. See planting plan.
	4f. Page 62 MEP Site Plan: the transformers and generator appear to be oblong in the list, but are squares on the plans, including on page 51	N/A. Transformers moved to interior vault on first floor of Building 6.
	4g. For each building floor plan and elevation, please provide a context map illustrating which building, elevation and its overall organization on the site.	Done
	4g. Include room dimensions or square footage.	Done. See Unit Layouts in Appendix.
	4g. Include overall dimensions.	Done
	4g. Increase the size of the graphic scales.	Done
	4g. Adjust the titles of the units “3 Bedroom Duplex Unit”, etc, to fit more legibly in rooms.	Done
	4g. Contrasting tones on the floor plans of adjoining units would make the plans easier to understand.	We included contrasting tones in common/circulation areas.
	4h. For each building floor plan, elevation, and section, please provide a context map illustrating which building, elevation and its overall organization on the site.	Done
	4h. Show wall mounted exterior lighting if any, through wall vents if any, and overflow scuppers and drains, etc.	This will be resolved by 90% CDs, scheduled for issuance 12/22/2021. There will be a minimal number of through wall vents (at community room, for example). Everything else is going through the roofs.
	4h. Show joint patterns in EIFS. (And see comment below on the use of the material.)	This will be resolved by 90% CDs, scheduled for issuance 12/22/2021. We are starting to develop this now.
	4h.Is the maintenance building depicted?	Yes
	4h. Response to Guidelines says operable windows are casements, but awnings are depicted.	Done
	4h. Show rooftop mechanical (missing from Building 1 on page 125	Done
	4h. Various elevations are not yet depicted: e.g: Building 1 south elevation; Building 2 East exterior elevation, and courtyard; Building 3 East exterior, etc.	Done
	4i. Landscape Plan: o Please provide overall landscape plan that illustrates measured/dimensioned open space areas for the purpose of conformance with 11.207.5.2.4.	Done
	4j. Please provide a diagram showing bike parking calculations similar to what is provided for off-street parking calculations.	Done
	4j. Page 73: show the short-term bike parking locations and include in the tabulation.	Done
	4k. For some of the buildings, the materials are directly noted on the elevations, others are given a key, consider using a consistent system.	Done
	4k. Page 147 include information on material 9 – art. Add description of artist selection, etc.	Done, see matrix. Artist selection to take place in future.
	4k. Page 151 materials names are missing.	See above
	4k. Page 153 Landscape materials – add a plan to show where they are used. (Permeable boardwalk?)	Done.Material palette labels now align with Materials Plan labels
	4k. Show screening materials for site-located electrical.	N/A. Transformers moved to interior vault on first floor of Building 6.
	4k. Show screening materials for rooftop mech equipment.	Done. Screening materials = parapet.
	4l. The draft renderings are hard to evaluate in terms of design. Add plan keys to each sheet to show the vantage point. Show rooftop equipment and screenwalls if they will be within the range of vision. Show through wall vents if there are any.	Done
	4l. Page 147 include information on material 9 – art. Add description of artist selection, etc.	See above
	4l. Page 151 materials names are missing.	See above
5. Appendices	5a. Text is hard to read, could it be enlarged, and the green tone made lighter?	Done
	5a. 1.12 Can a less obtrusive location be found for transformers. Can they be located within buildings?	Transformers moved to interior vault on first floor of Building 6.
	5a. 2.6 Show locations of low plantings on landscape plan.	Done
	5a. 2.9 Clarify note about tree count: “Ask Joe”	Done
	5a. 2.25 Response to Guidelines says operable windows are casements, but awnings are depicted on elevations.	Done. Windows are awnings.
	5a. 3.2 Shouldn’t we be aiming for a lifetime longer than 25 years?	Durability and limiting need for exterior maintenance are both high priorities for CHA. Accordingly, exterior cladding materials are selected for these features. Masonry is typically used at the ground floor and cast stone trim is used below first floor windows close to grade. At a minimum, all exterior materials are expected to require only minimal mantenace for at least 25 years. After that, some maintenance and repairs are to be expected as is required with all building materials, including masory.
	5a. 4.4 Will the community room be equipped as an emergency shelter?	Intention that community room can be used in case of emergencies for residents only such as need for cooling and power. Emergency power so will have heating/cooling, wifi.
	5b. Some of this material seems that it isn’t needed for the Planning Board’s review. And some of it should be moved to the graphics volume.	Done
	5b. Page 281 Tree Inventory: provide a full accounting of trees removed and planted, with detail on caliper and health. Is there a tree study?	A tree inventory has been provided to DPW and presented to the Public Planting Committee.