1.0 PROJECT PROGRESS REPORT

1.1 Project Introduction

1.1.1 Project Summary

Figure 1: Solis House South Side Rendering

As students that are highly passionate about sustainable buildings, Third Quadrant Design has come together with the common goal of designing buildings for the future. To better understand our local environment, this design project is situated close to the University of British Columbia, in a neighbouring community. The 2411 ft^2 home is built with occupant comfort, neighbourhood values, and local buyer characteristics in mind, while achieving extremely high energy efficiency goals and overall net-zero energy use. Affordability continues to be a concern in Vancouver, so in keeping with local housing trends, Solis House features a rental unit with kitchen, laundry, and bathroom appliances while still maintaining extremely low energy demands. This addition contributes to our overall design goal of resilience in a changing climate. The flexible occupancy and alternate source of income is supplemented by the use of innovative, natural, and recyclable materials, with low carbon life-cycle costs where possible, and grid and high seismic resilience.

Design Strategy

In an area likely to be affected by a rapidly fluctuating climate in coming years, it was our goal to plan for a home that would withstand environmental changes in the years ahead. With future-oriented resilience a key driving factor in our design decisions, our strategy was based upon optimizing the building envelope and the interaction between building systems to perform optimally and withstand any climate differences coming our way. The team focused on designing with passive strategies to optimize natural ventilation and lighting, reduce heating loads through a highly insulative envelope, in addition to maximizing on-site collection of energy, food and water to create a home ready for future climates. Energy Star appliances, among other energy and water-saving strategies were also used. Then, heat recovery in domestic hot water and space conditioning was incorporated, and only after loads were greatly reduced, photovoltaic panels were incorporated to offset the remaining energy loads.

Table 1: Project Details

Location	Hastings-Sunrise,
Climate Zone	4, Cool-Temperate
Lot Size	373.9 m^2 (4024.6 sq.ft.)
Building Footprint	123 m^2 (1324 sq.ft.)
Total Floor Square Footage	213 m^2 (2292 sq.ft.) *2.5 stories, 2 units*
Occupancy	5 (3 bdrm/3 bath)
HERS score	34 (-11 with PV array)
Est. Electrical Bill	$240 CAD per year
Total Cost	$349,012 CAD

Table 2: Technical Specifications

Walls R-60	**Foundation** R-49	**Roof** R-60
Windows	Operable	U-val: 0.14 BTU/hr.F.ft^2, PH cert[1].
	Fixed	U-val: 0.13 BTU/hr.F.ft^2, PH cert.
HVAC	6.74 kW GSHP (15.0 EER, 4.7 COP) 3kW Ground Coupled ERV(95% thermal yield) Radiant Heating/Cooling	
DHW	5 kW 246 L Heat Pump Water Heater	
Onsite PV	8.8 kW South Facing Fixed Roof Mounted	
Battery	13.2 kWh Battery	

[1] All windows and doors are Passive House certified

Project Highlights

*Solis House focuses on using **innovative** and **locally sourced** strategies, materials, and technologies to exceed the objectives of the Design Challenge, as follows:*

Energy Performance

An energy efficient design was achieved through utilizing passive design principles such as simplifying building massing and orientation, employing effective shading strategies, ensuring high levels of insulation, reducing thermal bridging, increasing airtightness, achieving heat recovery in ventilation and drainage, and daylight harvesting. Once loads were optimized to reduce required energy usage, onsite photovoltaic (PV) panels provide supplemental energy to achieve net-zero standards.

Engineering

All systems were designed to integrate together for maximum efficiency. Mechanical systems were optimized with the use of heat pumps and heat recovery. The building envelope was specifically designed to address the wet Vancouver climate, while ensuring high levels of insulation, thermal mass, and natural, low-carbon materials. Rainwater harvesting accounts for 100% of the zoning-restricted demand within the house, and excess water is used for irrigation.

Financial Feasibility & Affordability

Early estimations of the construction cost of the design is approximately $349,012 CAD, with low total lifecycle cost due to Solis House's onsite energy generation. For our market in Vancouver, BC, this cost is well within the reasonable range for a property of this caliber and performance.

Resilience

The house contains many features to increase climate resilience including a single electric vehicle (EV) charging station with allocated space for future EV infrastructure, rainwater collection, and mass-timber construction for high seismic resilience. The lot features water-sensitive on-site food production, supported by a local community farming company, CityBeet farms, and locally sourced semi-permeable landscaping elements. This strategy increases site permeability and supports resilience to future increases in precipitation. Additionally, with an 8.8 kW PV array and 9 kWh battery system, Solis House could survive 88 % of grid 12 hour grid failure with a 75 % critical load factor, in December (lowest potential PV efficiency).

Architecture

Along with ensuring an aesthetically pleasing structure and interior, the design of the home was approached with an envelope-first ideology to minimize loads and losses, while supporting natural stack ventilation and daylighting. The building form and layout is simple, to minimize the building envelope area and piping lengths, while the large south facing roof allows for a solar array. The building also promotes resilience in use, through open-plan, multi-function spaces and the incorporation of a rental unit. Materials are locally sourced, with low embodied-carbon when possible.

Operations

Solis House was designed for maximum resident comfort. An integrated system of sensors is used to monitor and control thermal comfort throughout the house, providing independent conditioned spaces and autonomy between main and rental suites. Smart home capabilities include access to thermal controls on resident smartphones to program systems in accordance with their daily routines.

Market Potential

Solis House embodies community values, while responding to market trends by providing high density, high performance housing.

Comfort & Environmental Quality

Advanced control systems with air quality monitors ensure consistent occupant comfort and health by automating natural ventilation and HVAC systems, while providing data on the functioning of building systems. Abundant glazing and exterior shading is used to balance thermal and visual comfort. Materials such as locally sourced cork were implemented to enhance acoustic performance.

Innovation

The design of Solis House focused on integrating locally sourced-and-developed innovative technologies and strategies. This includes community-based food production, wood-fibre insulation panels, bubble-deck slab-on-grade to reduce carbon emissions by 50% and a geo-exchange system as a stable energy source and sink in a changing climate.