Complete bookmarks should be included.

TEAM ONTARIO

2013 U.S. Department of Energy Solar Decathlon

Use of correct naming convention should be included. Use www.solardecathlon.gov/commstandards page.

SCHEMATIC DESIGN SUMMARY

April 19th, 2012

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TEAM MISSION STATEMENT

Goal. *To win the 2013 U.S. Solar Decathlon by creating a functional and liveable starter family home that strikes a balance between engineering and architecture and sets a higher standard of sustainable housing.*

Mission. *To work collaboratively as a multi-disciplinary and multi-institutional team to design, construct, and operate an affordable, net-positive, sustainable house, while inspiring the public to demand more from the next generation of homes.*

Vision. *We envision a future where sustainable homes are a scalable reality throughout Canada.*

DETAILED STRATEGY FOR WINNING

Team Ontario is collaboration between Queen's University, Carleton University and Algonquin College. We are comprised of students and professors with expertise in architecture, engineering, business and the skilled trades. These skills make up the four cornerstones of a passionate and committed team.

We have been working together for three years to realize our dream of a winning entry in the U.S. Department of Energy Solar Decathlon. Capitalizing on the enthusiasm, dedication, and drive of our students, and guided by the experience and knowledge of our faculty, Team Ontario will be a force to be reckoned with in California in 2013.

Our strength lies in our student team, faculty advisors, home institutions, and industry partners:

- Senior students take responsibility for completion of deliverables, and assist the more novice members who will eventually take their place. The team has allocated $250,000 for student wages to build enormous capacity and provide continuity of skills, knowledge, and experience.
- Our faculty team provides a wealth of experience and knowledge in core disciplines represented in the Solar Decathlon, including architecture, engineering & energy modeling, the skilled trades, construction management including health & safety, and business & marketing.
- Our three institutions are eager partners in our efforts, providing time, money, space, and equipment to ensure our success. Through Algonquin College, we have access to an indoor housing construction facility, allowing us to maintain full-paced construction through the cold, dark Ontario winter. This permits an ambitious construction schedule that will allow more time for commissioning and testing in the spring and summer.
- Our industry partners, who are leaders in their fields, provide material and professional support necessary to win.

Team Ontario uses an integrated design process, where all disciplines have an opportunity to provide input at each step of the process. This ensures that all relevant aspects, such as efficiency, aesthetics, and constructability are considered on a continual basis. It also builds student capacity by exposing the team to a multitude of different perspectives and priorities.

Communication is a priority for our team, as we are comprised of three schools in two cities. The team holds bimonthly face-to-face design charrettes that bring together the students and faculty from all three institutions. Through a subversion server, every team member can access design work and the body of knowledge whenever they have internet access. Working groups and the student executive both meet on a weekly basis. We make extensive use of cloud computing, videoconferencing, email, text messaging, and phone calls to ensure we work as a team.

Our core belief in sustainable design and our study of prior competitions will help us succeed in juried contests. Team Ontario will also excel in the performance aspects of the competition by:

- Reducing energy demand and maximizing efficiency;
- Making full use of passive energy technologies;
- Incorporating practical constraints such as reliability, shipping, and constructability;
- Utilizing heat recovery and energy storage to manage the use of available energy; and,
- Applying active solar technologies (PV and thermal) to minimize conventional energy consumption and peak loads

Table 1: Contest-by-Contest Breakdown

Contest	Strategy	Goal
Architecture	Our design balances aesthetics and performance. Through an integrated design process, the architecture will incorporate engineering and constructability in an appropriate manner. Our Architectural Technologist students are trained to produce high-quality, professional drawings. Our architectural philosophy informs each step of the design process, resulting in a coherent narrative guided by our goal, mission, and vision. Considering the spread of points in the architecture contest from the 2011 U.S. Solar Decathlon Competition, we are confident that a target of 90 points in this competition is a realistic goal.	90
Market Appeal	Our home is targeted for a young family in Eastern Ontario. We seek to advance innovations in planning, design, and construction, while ensuring our house is easy to maintain and operate. Ontario's Feed In Tariff program for small solar PV installations dramatically increases the return on investment of the project, while reliable solar thermal technology will be used to reduce heating and air-conditioning loads. Our home is adaptable to changing family conditions, meaning that as young families grow, the family home will grow with them.	93
Engineering	Engineering is a core strength of Team Ontario and is driven by Carleton's High Performance Housing Project and Queen's University Final Design Projects. We have extensive experience with envelope design, solar thermal systems, civil engineering of modular homes, electrical engineering, and building control. Our ambitious construction schedule provides time to commission and test the home, and calibrate our systems and simulation models.	95
Communications	The public exhibit has been taken into consideration for all of our design decisions. Twenty three students from our current Team have been to previous decathlon competitions and understand the importance for a strong public exhibit presentation and exhibit materials.	91

	Team Ontario has also dedicated significant resources towards the development and maintenance of a comprehensive website. Algonquin College has programs that specialize in building information modeling and video production; we plan to have a high level of integration with these programs to ensure that a tier one audiovisual presentation will be created. Based on the results from the 2011 competition, the communications contest was the second lowest scoring sub contest overall. We have identified this as an area for us to gain an advantage over the other competitors.	
Affordability	To further our goal of having a technically innovative house, Team Ontario is willing to sacrifice 2 points in this competition to use another $20,000 towards the house. We will aim for a total house cost of $270,000. Exchange rates will be considered when making price estimations.	98
Comfort Zone	The heating, ventilation and air-conditioning system will have the capability to keep within comfort zone of 22°C to 24°C and below 60% relative humidity. Careful monitoring, gained through practical experience and testing, coupled with a thorough understanding of HVAC principles, will allow us stay within the required boundary conditions. We have allowed for a 2 point loss for random variability in control.	98
Hot Water	The domestic hot water tank will be able to provide required draws of 56.8L at least 43.3°C in less than 10 minutes. An electric instantaneous back-up heater will ensure full points in this contest – although the potential detriment to the Energy Balance competition is acknowledged. Since 7 teams scored perfect in this contest in 2011, we think that a target of 100 points is an achievable goal.	100
Appliances	The appliances will meet specifications with the exception of the odd anomaly (e.g. fridge door was open) The refrigerator will be kept between 1.1°C and 4.4°C, the freezer will be kept between -29°C and -15°C, the clothes washer will be able to wash 6 organizer-supplied towels on its normal setting, the clothes dryer will be able to dry the towels to 100% and 110% of its original weight, and the dishwasher will be able to run a complete cycle and reach a maximum temperature of 48.9°C as required. Since the scores in this contest were high in the 2011 competition we believe that we can meet this goal.	99
Home Entertainment	**Lighting**: All lights will be on during the specified periods of time. **Cooking**: The appliances will be able to vaporize 2.268kg of water in the required time period. **Dinner Party**: Team Ontario will utilize the skills of the Algonquin College Culinary Arts Program to produce a superb meal -typical of an Ontario family meal. **Home Electronics**: A TV and computer will be operated during the specified time periods and will meet minimum size and brightness requirements.	95

	Movie Night: Team Ontario will host a movie night to showcase their home theater system and ambiance. This was the highest scoring contest overall in the 2011 competition so we feel that 95 points is a reasonable goal.	
Energy Balance	A house that is designed to be net-zero in Ontario will be net-positive in Southern California. Although space cooling and dehumidification loads will be higher, space heating and domestic hot water loads will be dramatically lower, and solar thermal and PV output will be higher. Based on the 2011 results, despite that fact that 7 teams scored perfect in this contest, it was still the lowest scoring over all contest of 2011. We have identified this contest as a "make or break" contest and we plan to devote significant resources into ensuring that we do well in this competition.	100
Total		**959**

ENGINEERING AND ARCHITECTURAL DESIGN APPROACH

The theme of *Evolved Living* is a unifying, core concept of the engineering and architectural design. The term has multiple meanings. It signifies the changes or evolution that must occur in the housing industry to ensure a sustainable future. It refers to a design that is informed by, and adapts to, changing climatic conditions. Finally, *Evolved Living* implies a home that adapts to the changing needs of a young family.

One of the greatest challenges facing the Canadian housing industry is to make a sustainable lifestyle possible for the average Canadian family living in a single detached house, while also making it affordable and attainable in the near future. This challenge is important to address because single detached housing represents a large portion of residential energy usage in Canada. Current practices must be radically changed if a sustainable future is to be achieved. For this reason, the target demographic for the *Aurora Home* is the next generation of young Canadians who will soon be starting their own families. The architectural and engineering approach is to design a home that is attractive for a young 'starter family' with one or two children living in Canada. Design decisions will be made with the intent of creating an integrated and flexible home that caters to the housing needs of a starter family, which includes maximizing the ease of use and liveability, and minimizing the cost and maintenance, while meeting the performance requirements.

The development of the *Aurora Home* is proceeding as an integrated design process. The collaboration of architectural, engineering, and skilled trades' ideas is crucial to the development of visual and spatial comfort, energy saving technological innovation, modularity of form, and research goals of the project team. Decisions for architectural form and space requirements are being informed by the requirements for maintainable, high-performing engineering systems, constructability, geographical and demographic appropriateness, and modularity.

Team Ontario will use all methods at its disposal for designing the house and evaluating the engineering design. This includes using engineering analysis software such as ESP-r, TRNSYS, and EnergyPlus, evaluating and analyzing many options before making informed decisions, consulting with experienced and knowledgeable faculty and professionals, and collaboration with all sub teams throughout the design process.

The form of the home is being developed through an "in-out" approach. This process encourages more efficient and effective use of space while maintaining a natural occupant flow through the house. Each of the interior spaces is defined by the programmatic needs of the individual space, both architectural and technical, as well as the connection it shares to the adjoining functional space. This interior development, along with engineering constraints such as solar requirements, defines the exterior form. This connection between interior and exterior allows the space to function effectively while maintaining maximum solar exposure and an attractive aesthetic.

The interior space is designed to be transitional and multi-purpose. This makes the house a flexible space that accommodates changing occupant requirements, such as the birth of a child or the need to work from home. Transitional and integrated furniture will make the interior space feel larger.

Because the house is designed for use in Eastern Ontario, we are presented with particular challenges. We experience a wide spectrum of temperatures and weather conditions that vary seasonally. Cold, snowy winters require consideration of significant heating loads, snow and ice coverage of outdoor surfaces and equipment, and moisture accumulation in the building envelope. Conversely, summer weather that can at times be hot and humid means that sensible and latent cooling loads cannot be ignored. A robust design is critical, so that the house is capable of dealing with all of the challenges that the climate presents - not through brute force, but through intelligent use of energy and passive heating and cooling strategies. The Team is aware, however, that with such an extreme environment, an additional and appropriately-sized integrated energy system may be required to ensure occupant comfort and energy performance.

While designing for a starter family in a Canadian climate is an important design goal, Team Ontario's goals also include winning the Solar Decathlon competition. Therefore, decisions will be made with the purpose of designing a suitable house for Canada, while still ensuring winning performance during the competition. One example of this approach is using two sets of climate data for simulation models – one representing Eastern Ontario, and another representing the Irvine, California area.

Team Ontario recognizes that the Solar Decathlon is much more than just a competition, but is also an opportunity to design and evaluate new ideas for sustainable housing, and showcases these ideas to the public so that they may be inspired to demand more from their next home. For this reason, creativity and innovation are strongly encouraged. However, it is also recognized that innovation can be risky, and delivering a product that performs as required is often challenging. Therefore, the design approach is to have a design that is unique and innovative, but places a premium on reliability and performance, backed up by intensive testing.

DESIGN DRAWINGS AND DESCRIPTIONS

Foundations, Tie-Downs, and Other Structural Considerations

We are currently proposing to use concrete block piers, pressure-treated wood with 0.60pcf (94N/m^3), or adjustable metal or concrete piers.

Concrete block piers

We are investigating the use of load bearing, vertically stacked concrete blocks with a nominal dimension of at least 8in x 8in x 16in. Nominal 4in x 6in shims could be used to level the home and fill any gaps between the base of the I-beam and the top of the pier cap.

Pressure-Treated Permanent Wood Footings

A minimum of 2 in thick pressure treated wood having 0.60 pcf (N/m^3)retention, can be used as the footing, or a single layer of a minimum thickness of 3/4 in. (19 mm) and a maximum size of 16 in. ×16 in. (410 mm × 410 mm). For larger sizes, two pieces of nominal 3/4 in. thick (22/32 actual) (19 mm) plywood is required.

Clearance under Homes

We plan to maintain a minimum clearance of 12 in. beneath the lowest member of the main frame in the area of utility connections. As well, no more than 25 percent of the lowest member of the main frame should be less than 12 in. above the grade.

Location and Spacing

All piers must be no more than 24 in. from both end, and not more than 120 in. centre to centre under the main rails. Supports must be placed on both sides of side wall exterior doors and any other side wall openings greater than 48 in.

Relevant SD2013 rules

- SD2013 rule ***4-4. Impact on the Competition Site*** requiring low impact footings comply
- SD2013 rule ***4-7. Lot Conditions*** stating that up to 18 in. (45.7 cm) of vertical elevation change may exist across a lot.
    - requires variable footings
- SD2013 rule ***4-3. Ground Penetration*** requiring tie-downs to be installed to comply with the seismic and wind loading criteria specified in the Solar Decathlon Building Code.

Tie Down Straps and Anchors

National Conference of States on Building Codes and Standards and American National Standards Institute, NCSBCS/ANSI A225.1-1994, is the reference of the wind zones, corresponding net drag, and uplift loads defined in the MHCSS-1994. We plan to design within the following specifications:

- For a single tie, the shaft of the ground anchor is to be aligned with the tie;
- For diagonal ties, the angle between the tie and the vertical may range from 40 to 50 degrees.
    - The maximum allowable anchor spacing in Zone I is 3.35 m (11 ft). The Zone I drag and uplift loads are to be multiplied by a factor of 1.5 when proportioning windstorm protection systems.
- All anchoring components are to be certified as having a minimum 21.0 kN (4725 lbf) load capacity and a working capacity of 14.0 kN (3150 lbf). The same load capacity is implied for anchor pull-out resistance.

Soil Conditions

For hardpan/rock, the allowable bearing capacity is ~ 4000 lb/ft^2. To provide a safety factor, our limit will be 3000 lb/ft^2.

Seismic & Wind Loading

An indicative wind loading diagram is shown in Figure 1.

Anchorage requirements for manufactured homes are specified in Uniform Building Code (UBC-94) and ASCE 7-93.

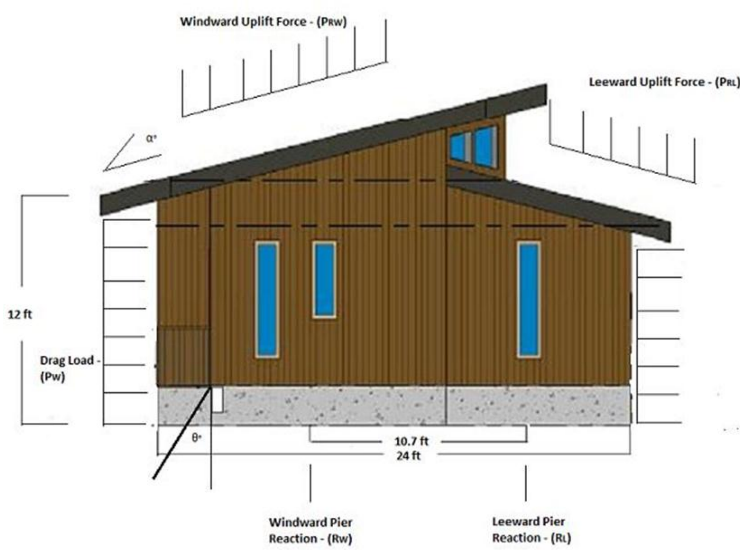

Figure 1: Wind load diagram

Issues of note include:

- Base shear due to wind loading and earthquake loading
- Providing positive (tensile) connections between the main frame and the foundation piers
- Providing resistance to rotational displacements of the piers in order to prevent loss of support
- Making sure that the integrity of supporting piers and their connections to the main frame are under the action of net uplift forces

Irvine is located in Zone I, where the basic wind speed is 29.1 m/s (65 mph)[1]. It lies within a special wind region[2], therefore higher wind speeds may be expected due to local topographic features. The probability of tornadic wind speeds governing the design for wind loading is extremely small; therefore tornadoes should not be a part of the wind load design criteria.

Interior Finishes and Furnishings

Sustainability will be the main driver when choosing finishes and furnishing. A number of criteria will be considered, including:

- Responsible extraction, manufacturing, and distribution. Products with reputable third party certifications, such as FSC Certification, will be pursued to help ensure environmental protection. Whenever possible, Canadian companies will be used.
- Low levels of volatile organic compounds, off-gassing, and toxic chemicals.
- Low embodied energy, recyclability, reusability, or a combination of all three.
- Consideration to sourcing interior millwork and furniture through Algonquin College's trade programs, benefiting the local economy and building student capacity.
- Consideration of the small footprint of the *Aurora Home*, including the use of 'transitional' furniture.

The *Aurora Home* will be fitted with a dual flush toilet and low flow, aerated faucets and showerheads. LED lighting will be used. All appliances will be energy star certified.

Ramps, Railings and Guards

All runways, ramps, or platforms will be designed, constructed and maintained to support or resist, without exceeding the allowable unit stress for the materials of which it is made (OSHA 73.1).

a. All loads and forces to which it is likely to be subjected
b. At least 2.4 kN per square meter

Ramps shall be constructed at a slope no greater than 1:12 (IRC R311.8.1).

c. A 3 foot by 3 foot landing will be constructed at the top, bottom, and any change in direction of the ramp (IRC R311.8.2).
d. Handrails will be constructed on all ramps exceeding a slope of 1:12 (IRC R311.8.3).
e. Handrails will be constructed between 34" and 38" from the bottom of the ramp. (IRC R311.8.3.1).

Energy Modeling

Annual energy requirements have been predicted based on a combination of building & systems simulation, and research. It is expected that these loads will change as the architectural design is finalized, engineering systems are optimized, appliance and lighting schedules are chosen, and a

[1] Manufactured Home Construction and Safety Standards (MHCSS-94)
[2] America Society of Civil Engineers (ASCE 7-93)

more rigorous control scheme is implemented. Preliminary loads based on an Ottawa climate file are shown in Table 2:

Table 2: Preliminary annual energy requirements in Ottawa

	Annual Loads	
	GJ	**kWh**
Space Heating	12.5	3475
Domestic Hot Water	16.0	4450
Sensible Cooling	7.7	2140
Latent Cooling	2.1	585
Lighting	2.0	555
Appliances	14.0	3890
Total	54.3	15095

Initial modeling of systems has provided benchmark efficiencies, solar fractions, and coefficients of performance. Predicted electrical loads are shown in Table 3, with assumptions:

Table 3: Initial electrical load predictions in Ottawa

	Annual Loads		**Notes**
	GJ	**kWh**	
Space Heating	5.0	1390	60% solar fraction, electric back-up
Domestic Hot Water	4.8	1335	70% solar fraction, electric back-up
Sensible Cooling	2.0	556	SEER 15 Air Conditioner
Latent Cooling	0.5	152	SEER 15 Air Conditioner
Lighting	1.5	416	High efficiency lighting
Appliances	12.0	3330	High efficiency appliances
Total	25.8	7180	

RETScreen simulations conducted for a 6.67 kW PV system in Ottawa suggest 7400 kWh is a reasonable output over a typical year (the same parameters at Santa Ana Airport result in 8900 kWh annually). Although this suggests the home net-positive over a year in Ottawa, this is a preliminary estimate only. Further energy modeling tasks include refining the models and examining expected performance in Irvine, over a full year and during the competition.

Glazing Type and Location

The preliminary design for *Aurora Home* incorporates large south facing windows that will contain both casement and fixed framed glazing. The use of overhangs, and the selection of the appropriate glazing and shading combinations will be used to minimize overheating while still maximizing daylighting and winter passive heating. Clerestory glazing located along the north elevation will also be a combination of fixed and casement framed glazings to facilitate natural ventilation when appropriate. The remaining glazing locations, as seen in the architectural drawings will be fixed framed glazing units unless the requirement for operable windows according to the Ontario Building Code, International Residential Code, and Solar Decathlon Building Code have not already been met.

Team Ontario is currently exploring two different possibilities for the windows to be used within the *Aurora Home*. The first is using a high efficiency window with the following specifications:

- Insulated fibreglass frame
- Triple glazing (possibility of using double glazed windows on south side to promote solar gains in the winter months)
- Argon fill
- Insulated spacers
- Low-e coating

Team Ontario is also considering the possibility of using vacuum sealed windows, providing a higher insulating value when compared to standard triple pane windows. However, more analysis still needs to be conducted, including a cost/benefit analysis of the improved insulating value and an investigation into reliability and shipping concerns. As well, the placement and utilization of various glazing options will be investigated to optimize both "solar control" for peak cooling reduction, and solar heat gain for passive heating and daylighting.

DC Electrical

Direct current (DC) is used in the photovoltaic (PV) equipment, the light-emitting diode (LED) lighting arrays and in any data logging or communication equipment.

Initial specifications suggest a photovoltaic array of approximately 29 230W PV panels is appropriate. A potential model is the Motech IM60, a 60 cell, 230W design. Each panel could be paired with a microinverter to convert the DC power directly into AC power compatible with the village microgrid. Microinverters provide optimization of the home's solar array on a per panel basis. By performing the maximum power point tracking for each panel, the array performance should be greater than traditional string inverters during partial shading conditions. This is a large advantage for the Canadian climate's cold and snowy months were individual panels may be partially snow covered. The team is currently investigating the trade-offs associated with added cost of using microinverters instead of the less expensive but potentially lower-performance string inverter systems.

Currently, the team is exploring several microinverters but the Sparq Systems' S215NA3250, 215W microinverter appears to be a top candidate as it was developed at Queen's University and the Team has success to full technical support. The Sparq microinverters are compliant with the UL1741, IEEE 1547 standards. Each microinverter is capable of continuous monitoring which makes performance evaluation and fault detection straightforward. Each microinverter can provide fault details, the DC current, voltage and power from the PV panel it is connected through Sparq's powerline communication hub. This information is very valuable in the monitoring of the array's performance and troubleshooting of any problems which may arise. The utilization of microinverter technology also eliminates high voltage DC wiring runs, fuses, combiners and DC disconnects, further simplifying the path between the PV panel and the village's microgrid interface.

The total DC nameplate power generating capacity of the PV array as currently specified is 6,670W. The 29 PV panel and microinverter combinations can be divided into 3 strings. Under this configuration, the maximum of 13 microinverters per AC string in the daisy-chained configuration will not be surpassed as per the microinverter manufacturer's datasheet. Each unit will have specific grounding hardware that will be implemented in accordance with Sections 690.41, 690.42, and 690.43 of the National Electric Code, and ANSI/NFPA 70.

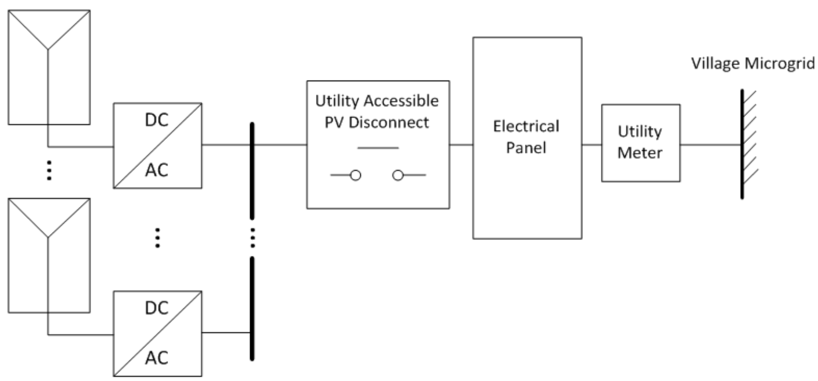

Figure 2: One-line diagram of photovoltaic power generation connected to microgrid

The grounding hardware consists of 2 locking washers, 1 hexagonal nut, and 1 bolt for each microinverter as well as lay-in grounding lugs for the panels. A 6 AWG bare, grounding electrode conductor will be connected from the first inverter in the set to a dc grounding electrode which is bonded to the ac grounding electrode. Every inverter except the first in the string will also have a short 6 AWG grounding electrode conductor which will be irreversibly spliced to the dc grounding electrode conductor running underneath each inverter. A one-line diagram of the PV system is shown in Figure 2.

LED lighting requires DC electrical power at some point in the system. AC mains power may have to be converted to DC power and then distributed to the nearby LED lighting locations. These locations may be in tight areas such as under cabinets where there is insufficient space for each light to have its own power supply. In such circumstances, the appropriate in-wall rated devices and copper wire will be selected. Devices meeting Underwriters Laboratories' standards for LED equipment (LED arrays, control circuitry and power supplies) safety (UL8750) will be chosen for use.

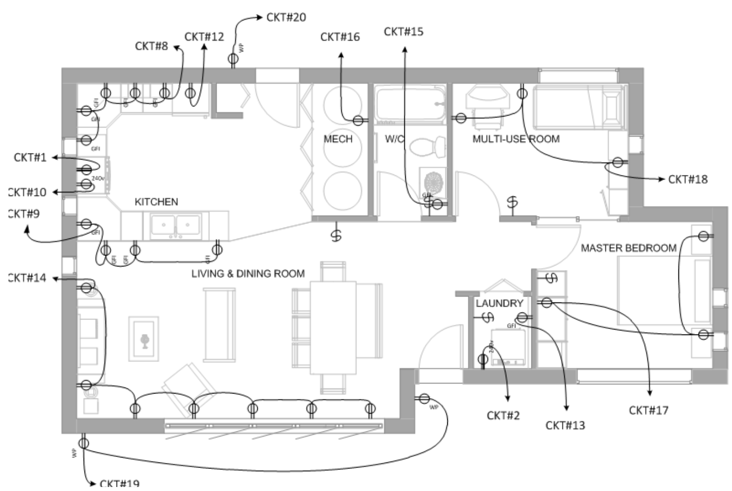

Figure 3: One-line diagram of the power distribution

Devices used primarily for research purposes, such as temperature and humidity sensors, will be placed in various locations around the home. These devices typically operate with low power and low voltage DC (below 50Vdc). Lines providing the DC power and signal connections will be routed through conduits to protect the in-wall installations. Continuous, un-spliced conductors of the appropriate gauge will travel through the conduits between a hub and the endpoint.

AC Electrical

The proposed AC electrical design is based around the home's modular structure. The majority of the home's electrical load and circuits are placed in the northern module. This minimizes the number of electrical connections that will have to be made during the assembly process. The *Aurora Home* hopes to take advantage of the development of wireless technologies to bring the concept of a "smart grid" into the home.

Table 4: Anticipated schedule of branch circuits

Circuit	Description	Voltage	Rated Load (Amps)
1	Electric Range	240	40
2	Clothes Dryer	240	30
3	Hot Water Heater	240	30
4	Fire Pump	240	20
5	Grey Water	240	10
6	Heat Pump	240	30
7	PV Array	240	50
8	Kitchen 1	120	20
9	Kitchen 2	120	20
10	Microwave + Range Hood	120	20
11	Dishwasher	120	15
12	Refrigerator	120	15
13	Laundry Room	120	15
14	Living + Dining + Entryway	120	20
15	Bathroom	120	15
16	Mech Room (GP)	120	15
17	Master Bedroom	120	20
18	Office	120	20
19	Outdoor (Back)	120	15
20	Outdoor (Front)	120	15

Lights, switches, receptacles, and appliances will all be able to communicate back to the home's central controller. This will enable the server to remotely sense usage and enable or disable the circuit as needed. Relays integrated into the receptacle or placed inside junction boxes at light locations will provide the switching capabilities. Monitoring of the electrical power consumption of the home is also aided by dedicated circuits for appliances. This allows for more accurate measurement at the electrical panel, as opposed to the receptacle. Through this design, peak energy demands should be managed and limited.

The design of the lighting and power distribution branches is done in compliance with chapters 34-42 of the International Residential Code. Figure 3 shows a layout of the *Aurora Home*'s receptacle locations as a one-line diagram. The schedule of the proposed branch circuits is shown in Figure 3.

Wall Design

A innovative wall assembly is being investigated for use in the house. It consists of a built up section of structurally insulated panels, vacuum insulation panels (VIPs), extruded polystyrene, cold-formed steel framing (narrow steel studding), and mineral fiber insulation. It is designed to achieve an overall effective wall R-value of R_{SI}-10.6 or R-60 in a thin wall cross section allowing for more interior space in the building. The orientation of these building materials within the wall assembly is shown in cut-away sample wall shown below.

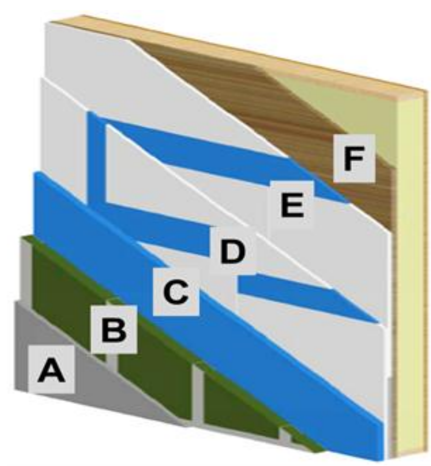

Figure 4: Cut-away diagram of potential wall design

The Proposed Wall Layers Are:

F – Structurally Insulated Panel (SIP)

Sized according to manufacturer design charts, the SIP will carry the axial and lateral loads of the house. The SIP will also provide the primary air barrier system to the wall design. The SIP will consist of vertical splines at 1200 mm or 4 ft on center. Vertical splines will be single or double 2x4 dimensional lumber to be determined once the final design loads for the house are calculated.

E, F – Vacuum Insulation Panels (VIPs)

Panasonic Canada VIPs will provide the main thermal resistance layer of our wall assembly. The VIPs are sized 455 mm x 555 mm x 12 mm. Custom sized VIPs have not yet been considered, therefore gaps will exist in each VIP layer. Subsequently we have utilized 2 layers of VIPs. The theoretical thermal resistance value of a single VIP is R_{SI}-5 or R-28. The gaps left in each VIP layer will be filled with extruded polystyrene insulation of the same thickness of the VIPs. The VIPs will be installed using a non-toxic adhesive yet to be determined.

C – Extruded Polystyrene (XPS)

A 25 mm or 1 in. layer of XPS will be adhered to VIP layer E. The XPS is to protect the VIPS from damage during construction, transportation or fasteners protruding into the wall assembly.

B – Cold-formed Steel Framing and Mineral Fiber Insulation

Sized according to an interior non-load bearing partition wall, the cold-formed steel framing members are to be a width of 41 mm or 1 5/8 in., installed on 400 mm or 16 in centers. The top track of the steel framing will be fastened to the roof framing or the house. The bottom track of the steel framing will be fastened to the subfloor assembly of the house. This eliminates thermal bridging through layers E,F, and C in our wall design. Electrical chases for electrical boxes and data wiring will be placed within layer B. Mineral fiber insulation (Roxul Acoustical Fire Batt) will be installed within the steel framing to provide sound damping and fire protection to the structural and thermal resistance layers of the wall design.

A – Gypsum Board Sheathing

The proposed wall design includes a ½ in. gypsum board installed on the inside layer of the wall. Since foam insulation will be used within the structurally insulated panel and the wall contains an extruded polystyrene layer, as per section 3.6 of the 2013 Solar Decathlon Building Code, this layer will comply with the minimum requirements for fire resistance. This gypsum board layer creates a fire barrier, separating the foam insulating materials from the from the house's occupants.

The building envelope design is one area to which Team Ontario will devote significant research. Alternative envelope designs are also being considered, with consideration to performance, cost, constructability and other factors. Vacuum insulation panels are a relatively unproven technology, and there are still a number of questions relating to the design.

Currently an 8 ft x 8 ft wall specimen of the wall design has been constructed by Team Ontario. The wall specimen is outfitted with temperature, relative humidity and moisture detection instrumentation and installed in Carleton University's wall test facility. Experimental in-service data is being collected to determine the hygrothermal performance of the wall design in response to exterior conditions.

A vapour barrier has yet to be defined for the wall design as theoretical simulations of layers D and E are under investigation and comparison to experimental results. Further experimental testing is required to determine a suitable material and location within the wall design to place a vapour barrier. Layer C, D, or E can easily be defined as a vapour barrier by sealing the joints within any of the layers with a low vapour permeable tape or sealant. A compromise between California conventional building practice for a cooling dominated climate, where vapour barriers are placed exterior to insulating materials, and Ontario conventional practice (for a heating dominated climate), where the vapour barrier is interior to insulating materials, is currently being studied.

Roof and Floor Design

It is anticipated that design of the roof and floor will be dictated by the wall design. In addition to mechanical performance, such as thermal bridging control and condensation concerns, structural loading will have to be considered. In particular, roof design will have to consider excess loading from solar collectors and potential snow build-up, and modularity constraints requiring quick installation assembly and installation.

Building Control

Team Ontario will be using building automation to its full potential as a competitive advantage in the Solar Decathlon. We plan to equip the Aurora Home with predictive control systems, energy systems monitoring, and comprehensive user control to enhance both energy performance and convenience for occupants. Team Ontario believes that all components of our building control system, described below, can be installed and operated while conforming to the International Residential Code for One- and Two-family Dwellings. However, some unconventional monitoring systems may not be directly addressed by the Code.

The proposed building control system includes a router, a server, and a display monitor. The router provides internet access, which is required to centralize all monitoring and control systems in the home. The proposed location for the router, server and display is indicated in Figure 5.

The building control system would include the following components, all of which are commercially available. Wireless communication between entities ensures ease of installation and safe operation. Sensor installation can be accomplished using a 5V conduit throughout the home.

Predictive shading control system

The predictive shading control system is very much an experimental application. It will be thoroughly tested to ensure accurate and robust performance. It will also function as a 'fail-safe' system, where, if the automated controls do not function as intended, the occupants can control shading manually.

The proposed system should reduce heating and cooling loads of the home by automatically adjusting mechanical blind. A bottom-up roller blind, installed on the exterior of the south-facing fenestration, can be adjusted hourly to control thermal gains entering the home. The system would use advanced energy simulation software on the server to facilitate the shading control. A commercially-available microcontroller would be used to communicate necessary information from the computer to an encased motor which moves the blind.

Solar power performance monitoring system

The production of the rooftop solar PV array can be monitored using module-level, string-level, and array-level systems. If microinverters are specified, they will communicate performance data directly to the server. If string inverters are to be used, a commercially-available steel combiner box can be used to communicate monitoring information to the server via wireless internet. These boxes typically come with built-in fuses, ground-fault

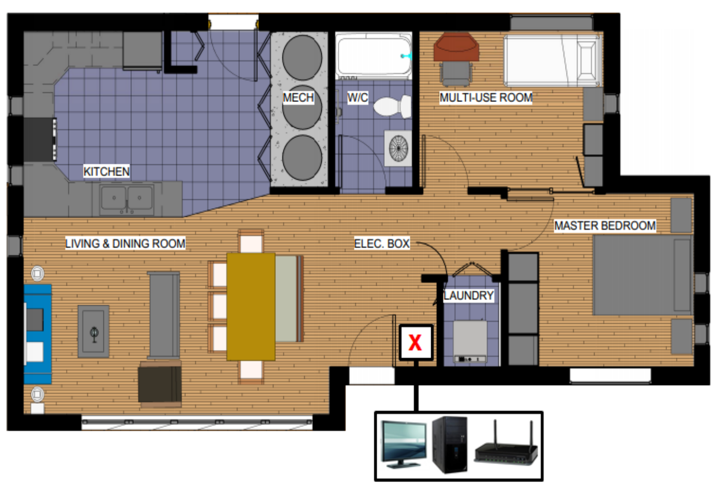

Figure 5: Potential location of router, server, and display

detection, and automatic string isolation. They meet ANSI safety standards and can be controlled remotely from the display monitor.

HVAC monitoring and remote control system

Day-to-day HVAC system operation can be monitored using sensors installed on mechanical equipment such as pumps, condensers, compressors and fans. Data will be communicated to the server to ensure safe operation and indicate system performance. A programmable thermostat, accessible from the computer display or by mobile phone, will allow occupants to control the indoor temperature of various home zones. Intermittent ventilation can have schedules informed by open windows and carbon monoxide sensors, with easy manual override for occupants. HVAC controls will have built in redundancy to deal with server failures.

Electricity usage monitoring

Sensors will be installed in the circuit breaker panel to monitor the electricity usage of various circuits. Commercially-available software will identify and graphically display the electricity draw of various end-uses within the home. Studies have shown that simply providing real-time feedback of electrical consumption can cause occupants to reduce usage[3].

Lighting automation

Ambient light sensors and motion sensors, commercially available from Ontario's *Regulvar*, can be installed within the home and connected to the LED lighting system. This system can automatically control artificial lights based on incoming daylight. Override control would be provided via switch, mobile application, and/or computer display.

Mobile application

A mobile phone application is being planned, which will communicate with the router to allow occupants to track and manage all building control systems from any location within or remote from the *Aurora Home*.

Additional building control systems that will be explored include remote control of door locks, mechanical window operation, and home entertainment system control. An emphasis will be placed on easy-to-use systems incorporating simple feedback mechanisms.

Ventilation

Specifications for mechanical ventilation are based on ASHRAE Standard 62.2[4] and the ASHRAE Handbook[5]. A balanced air flow will supply sufficient fresh air individually to every room. Best practices, such as venting dryers outdoors and providing local exhaust in bathrooms and kitchens, will be followed.

The design strategy acknowledges the importance of fresh air while respecting the heat load attributed to mechanical ventilation in modern Canadian housing construction. We will investigate reduction in unnecessary ventilation through an intermittent strategy as specified in ASHRAE 62.2. Carbon monoxide sensors may be used to provide a safety override during unoccupied periods of

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[3] S. Darby. The Effectiveness of Feedback on Energy Consumption. Environmental Change Institute, Univ. Oxford. April 2006.

[4] ASHRAE. 2010. *ANSI/ASHRAE Standard 62-2-2010, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.*Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[5] ASHRAE. 2005. *2005 ASHRAE Handbook—Fundamentals*, p. 367. Atlanta: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

lower ventilation, with the system defaulting to 'on' if the sensors lose power. Natural ventilation effects will be simulated and then tested during the commissioning and testing phase.

An energy recover ventilator (ERV), which recovers both latent and sensible heat, will be investigated for use during the competition. The use of an ERV will be investigated for Eastern Ontario, with an understanding that pre-heating may be required due to concerns with frost build-up in the heat exchange core. This feature may be accomplished by preheating of make-up air through the use of a "dual–mode" solar collector described below or PV/Thermal solar arrays. In the event that this issue cannot be resolved adequately, alternative integrated system ssuch as described below will be considered to augment heating and air-conditioning loads

Solar-Thermal Systems

We are investigating using solar thermal energy for domestic hot water (DHW), space-heating, and air-conditioning/dehumidification. Space-heating will be accomplished using a radiant floor while a solar-regenerated liquid desiccant system will be is being studied for dehumidification. Current specifications show space-heating and dehumidification as one system and domestic hot water as a second system. The goal is to combine all three functions in a single integrated solar-thermal assisted system. Other concepts are also under study such as the integrated energy system proposed by [add reference here] that could include a solar-augmented heat-pump system (see below).

Initial simulation studies of the conventional solar thermal system are given below. The specifications of the system studied are given below in Table 5, while a preliminary TRNSYS simulation model is shown in Figure 6.

Table 5: Solar thermal component specifications

Component	Collectors	Storage Tank	Backup	Mounting	Estimated Solar Fraction (Ottawa)
Solar DHW	6 m2 glazed flat plate	350 L	8 kW instantaneous electric	Roof	70%
Space Heating	8.5 m^2 evacuated tube; 11.5 m^2 glazed flat plate collector	800 L preheat, 130 L secondary	Split air-source heat pump	Roof (flat plate); southeast wall (tube)	60%

For the radiant floor studied, a pump would circulate warm water through flexible cross-linked polyethylene tubing placed in regularly spaced channels in the floor. The radiant floor heating system was considered because it provided a much larger surface area for heat transfer. This allows the use of lower delivery temperatures which can in turn increase the solar fraction for space-heating. It is more

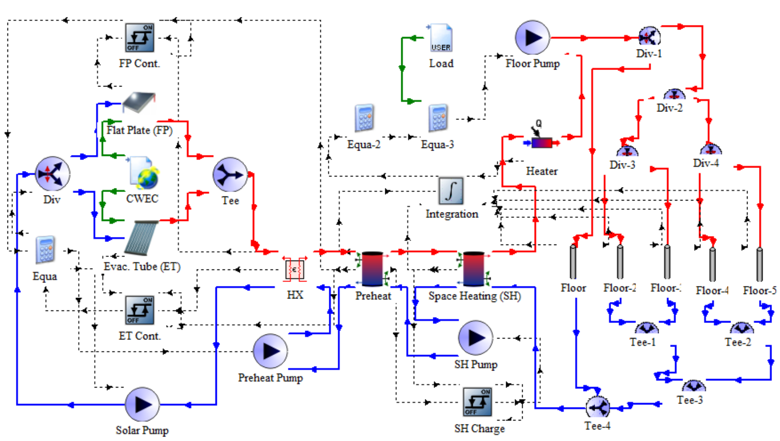

Figure 6: TRNSYS model of space-heating system

efficient to transport liquid than air and the floor can be zoned. Currently, the floor is modelled with five 300 ft loops of 0.5 in. tubing. Each loop would be contained in a single module to decrease the amount of connections required to assemble the house at the competition.

The liquid desiccant system under consideration utilizes the excess energy collected in the summer by the solar-thermal collectors to regenerate as liquid desiccant solution that would be used to dehumidify the space. The system will likely use a lithium chloride solution with a maximum concentration of 40%. The desiccant would absorb moisture from the air within the house and incoming ventilated air. As per Solar Decathlon Rule 8.4, the system will be regenerative by using solar-thermal energy to heat the solution, causing water vapour to be desorbed. This process occurs in a regenerator which expels water vapour outdoors. There is a possibility that the conditioner will be made an architectural feature of the house. Sensors will be in place to track the concentration of the desiccant solution in the conditioner. Significant research has been undertaken by team members over the past 3 years to design an effective liquid desiccant system for a Solar Decathlon Home.

There will be periods of time where the storage is fully charged and the solar collectors are at risk of overheating. Automatically controlled temperature valves may be installed to divert the exiting flow from the collectors to a set of external radiators to dissipate the excess heat. The use of Enerworks HeatSafe flat plate collectors will prevent dangerous stagnation conditions by using their patented integral stagnation control technology.

Dual Mode Solar Thermal Collectors

Team Ontario will investigate the use of a commercial flat plate solar collector that can use both water and air as a working fluid. The collector's novel integrated stagnation control system utilizes a passively activated channel behind the absorber to vent excess heat during power outages or other periods when stagnation occurs. Several student projects have investigated the potential to use this channel for air-based thermal collection which could provide added flexibility to the collector's main function as a fluid based collector.

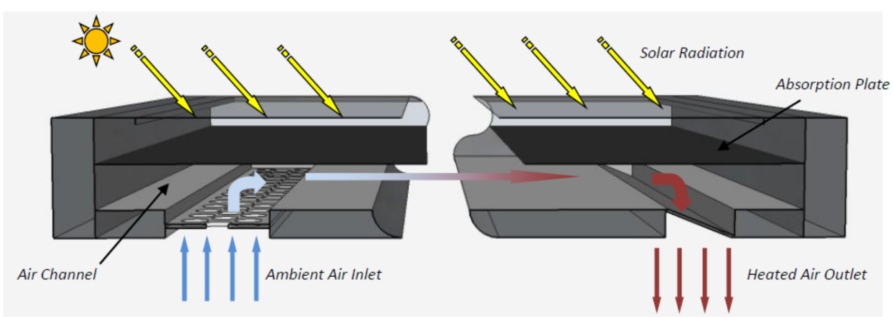

Figure 7: Schematic cross-section of an Enerworks HeatSafe Panel and its air channel

CFD was used to determine a preliminary header design which allows for an even flow distribution across the width of the panel minimizing pressure losses. A heat transfer model was then developed to determine the efficiency of the dual-mode collector. An experimental characterization of the collector was also undertaken and results suggest the air channel could provide an effective second mode of thermal energy collection that could be used to regenerate a desiccant dehumidification system or to preheat ventilation air. Testing of a full scale system is planned for the summer of 2012.

Photovoltaic Thermal systems (PV/T) and Solar Assisted Heat Pumps (SAHP)

Maximizing limited roof space is a key design challenge for Solar Decathlon teams. Large flat roof areas present significant constraints to architecture while increasing challenges with transportation. An attractive solution is to use combined photovoltaic/thermal panels which have the potential to provide substantial energy gains for a fixed collector area. As PV panels are only capable of converting 10-20% of solar radiation into electrical energy, much of the remaining radiation is absorbed and converted to heat, reducing the efficiency of the panel. A PV/T panel makes use of the excess heat for thermal loads in the house, increasing the module efficiency.

Team Ontario is currently investigating the potential of air-based and liquid-based PV/T collectors for use in meeting the energy requirements of the home. Air-based PV/T, similar to the Dual –mode collector described above, provides an opportunity to pre-heat ventilation air and can be implemented at relatively low cost. Liquid-based PV/T collectors will also be considered and will provide an opportunity to collect higher grade heat for use in space heating or domestic hot water, however these configurations may require the use of a heat-pump to increase the temperature of the collected energy (see SAHP discussion). Experience and knowledge gained from the implementation of liquid-based PV/T in Stuttgart University's submission to the 2010 Solar Decathlon Europe will assist in determining a suitable arrangement. Current research through our institutions and the Solar Buildings Research Network will be also be leveraged[6].

Solar assisted heat pumps (SAHPs) will be investigated. Heat pumps can be used to significantly reduce solar thermal collector operating temperatures, increasing collector efficiency and in some instances allowing additional heat gain from ambient air. These systems also help mitigate performance problems common with air-source heat pumps in colder Canadian climates[7]. Combining these concepts, an indirect PV/T solar assisted heat pump will be studied to provide flexible space heating and domestic hot water while generating electricity delivered to the grid. This combined system will minimize required roof area, lower collector temperatures to increase photovoltaic and thermal efficiency[8], while providing sufficient high grade heat and electricity to meet the required loads.

Integrated Mechanical Systems

One concept that is currently under investigation is the coupling these advanced solar collector concepts with a fully integrated mechanical system could provide an opportunity to dramatically increase system efficiency by minimizing waste heat and providing flexible storage. An added benefit of such a system is the ability to investigate time of use strategies which will become increasingly important as net-zero homes become a commercial reality.[9]

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[6] Athienitis, A.K. *Design of a Solar Home with BIPV-Thermal system and Ground Source Heat Pump*. Canadian Solar Buildings Conference Proceedings. 2007; Carriere, J., Harrison, S., *A 2-Dimensional Heat Transfer Analysis of a Sheet-And-Tube Flat Plate PV/Thermal Collector*. 2008.; Athienitis et al. *A prototype photovoltaic/thermal system integrated with transpired collector*. Solar Energy. 85, 1. 2011.

[7] Freeman, G. A., and Harrison, S. J., "Solar Assisted Heat Pump Hot Water Heaters for the Canadian Environment," Proceedings of the 1997 SESCI Conference; Bridgeman, A. Harrison, S., (2008), "Experimental Evaluation of Solar Assisted heat Pump Systems", EuroSun 2008 Conference, Lisbon, Portugal.

[8] Daghigh R., Ruslan, M.H. and Sopian K. *Advances in Liquid based photovoltaic/thermal (PV/T) collectors*. Renewable and Sustainable Energy Review. 15. (2011).

[9] Morofsky, E. *Integrated Mechanical Systems and Demand Side Management in the Advanced House*. IEA Conference on Advanced Technologies for Electric Demand-side Management. 1991.

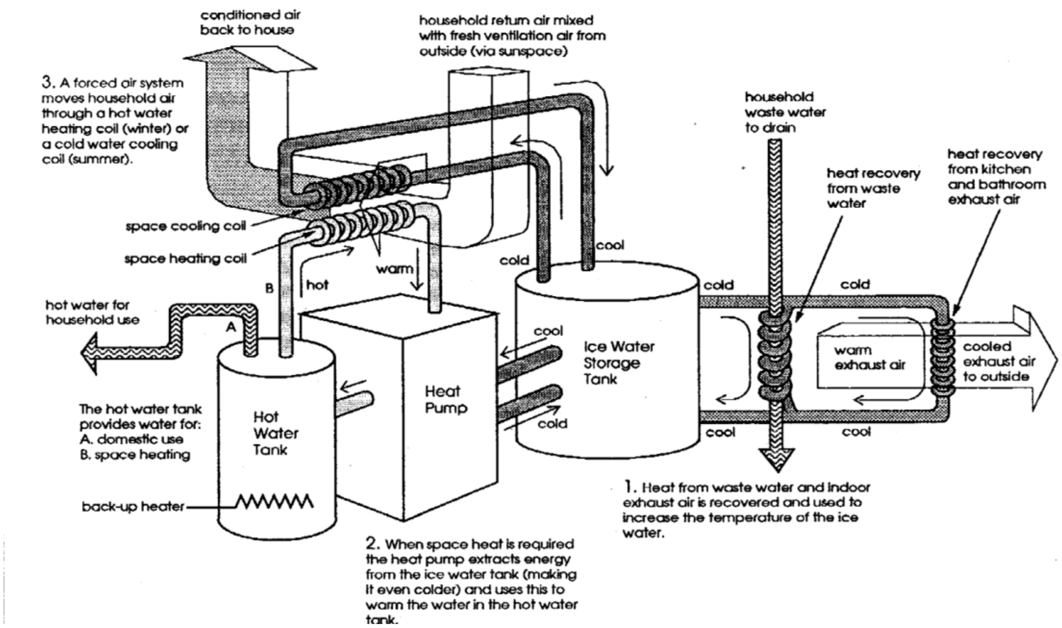


Figure 8- Schematic of integrated mechanical system concept.

We believe that recent improvements in high performance building envelopes, residential scale heat pumps, and the flexible solar collector concepts previously described, can facilitate the implementation of a high performance integrated mechanical system which can meet space heating, cooling, and domestic hot water needs in a compact and economical package.

Water Storage & Service

Container Location

The location of the container is still to be determined. The potential for locating the storage tanks under the deck has been proposed; such an arrangement would require an effective horizontal surface area of 12.5 m^2 and a height of approximately 0.5 meters. An estimated capacity of 5700L would result in a load of 55 kN distributed over approximately 12 meters, which conforms to local bearing capacity standards.

Possible under-house plumbing and tank placement are shown in Figure 8 and 9, respectively.

The final decision on tank location will consider deck design and potential impacts on the solar envelope, as well as aesthetics. Relevant Solar Decathlon rules include Rule 9-1: Container Location and Rule 9-8: Water Delivery and Removal.

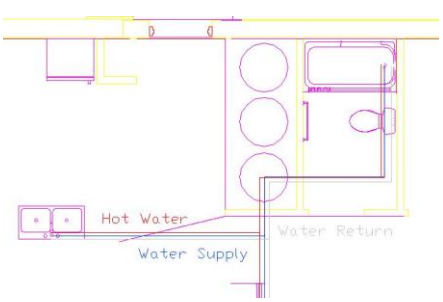


Figure 10: Potential under-floor plumbing route

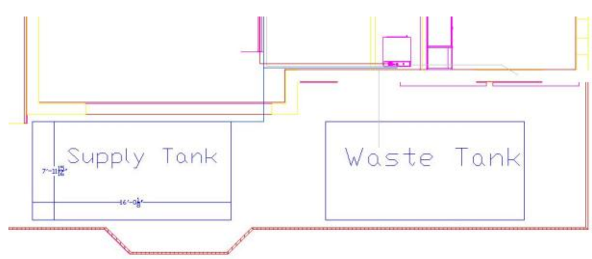


Figure 9: Potential tank placement

Plumbing

All plumbing systems will adhere to the International Residential Code, in particular Chapter 26, subsections P2601-P2609, and Chapter 27, subsections P2701-P2724.

Unique systems and components that may require special consideration include the liquid desiccant system, solar thermal collectors, liquid-based PV/T collectors, the greywater system, and the radiant floor.

Fire Protection

An emergency plan will be developed for construction, testing, and the public exhibit. A fire marshall will be appointed to oversee the design and implementation of the plan. During testing and the public exhibit, smoke detectors will be installed and fire extinguishers will be available in at least two locations.

Relevant International Residential Code, Ontario Building Code, Solar Decathlon Rules, and OSHA Regulations will be used to develop the fire protection plan and systems.

UTILITY METER AND ORGANIZER DATALOGGERS

Utility Meter

The entry point for the electrical service connection to the Village Microgrid is anticipated to be from the east. By placing the utility meter on the east of the home to meet this connection, the meter and utility accessible disconnect for the PV system have ample space and are hidden from direct view. The disadvantage of this configuration is the distance between the electrical panel, the PV system disconnect and the utility meter. Figure 10 shows the connection of the electric and information technology services to the home from the village infrastructure.

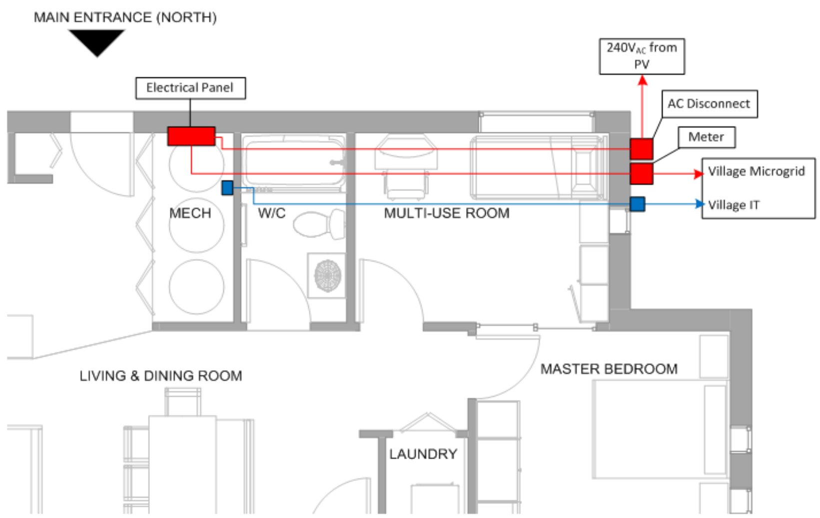


Figure 11: Anticipated village grid connection

Organizer Data Loggers

The proposed location for the data logging equipment is in the mechanical room. This centrally located room in the home will ideally hold the access point to the village's information technology services (internet, telephone). From the mechanical room, room temperature and humidity sensors can be placed in the living and dining room.

PUBLIC EXHIBIT, COMMUNICATIONS, AND OUTREACH STRATEGY

Public Exhibit

As can be seen in Figure 11, the proposed public exhibiting route will begin in the west entranceway of the home, to the south of Decathlete Way. As patrons wait in line, they may sit to rest and look at the house from an alternative angle, or they can look above and around the seating area and read information about the house. There will be text, different materials used in the home on display, and small mechanical models demonstrating tangibly the components and technologies within the Aurora Home. This will also keep any children waiting in line entertained, and with an interactive quiz or game within the display or with durable parts to assemble, will allow patrons to learn and interact.

Visitors will have the opportunity to view ongoing demonstrations situated around the waiting area. This will allow visitors to see, discuss, ask questions, and have a deeper visual and tactile understand of how the technologies work and are incorporated into the house. This could be done, for example, with the home's finalized wall design or with a solar panel.

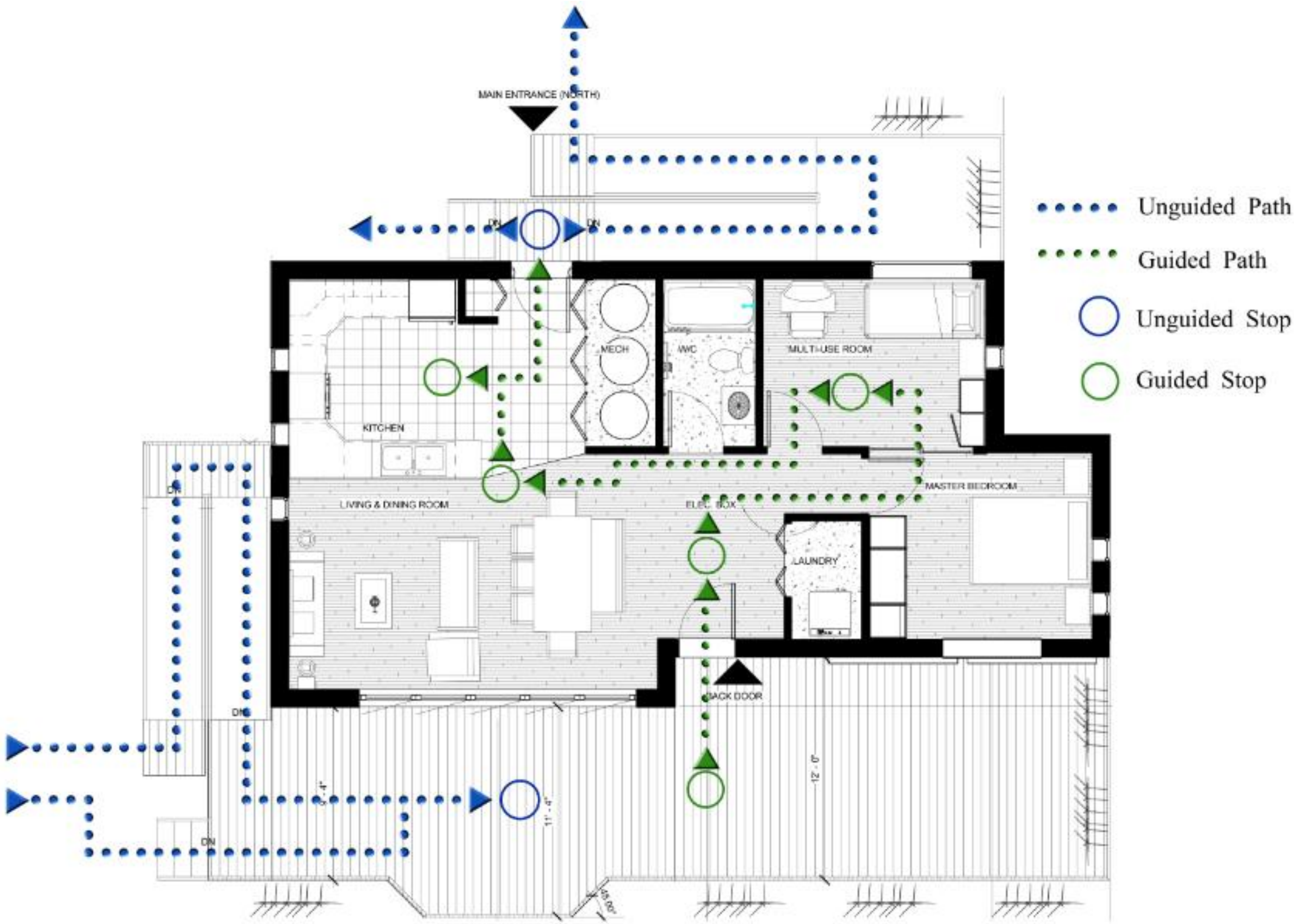
Overhead shading may be incorporated into waiting areas. This will help protect visitors from excessive sunlight while touring the solar village, and would provide a refuge in the event of a rainfall. The 'roof' of this overhead shading could have an artistic installation portraying the 'Aurora Borealis', or could also be used as an interactive or visual learning display.

The public exhibit will be fully accessible to all handicapped visitors. Leading up to the house, the porch design includes a ramp that complies with specified code and Solar Decathlon rules.

As the visitors approach the southern deck, a guide waits to greet them. The number of visitors inside the house at any given time will be controlled, so the guide will provide some background information and chat with visitors if a wait is necessary.

Three main types of tours could be held. A longer 10-minute tour could be used when lineups are short, whereas an abbreviated 5-minute tour could be used when lines get longer. A 5-minute kid/young-family-friendly tour could also be implemented, with the text of the tour more appropriate for a younger audience. At the end of the tour, our team also plans on offering surveys for visitors to fill out and provide feedback on the success of the displays, public exhibit, house design and the tours. This will allow 'tweaking' during the competition and valuable feedback for future competition teams.

Figure 12: Proposed accessible routes and public exhibit strategy



Communications

Communications has, in the past, been one of the lower-scoring competitions. Recognizing an opportunity to gain a competitive advantage on other teams, significant resources will be devoted to communications, both during the coming months and for the competition itself.

A comprehensive, attractive website is being developed and will serve as a primary vehicle for external communications, such as with the public, sponsors, and other outside stakeholders. It will provide a venue for showcasing the work of the team, and for acknowledging the support of sponsors. Talented graphic design work and adherence to web design best practices, including accessibility requirements for the competition, will ensure an excellent website.

The website may be augmented with a periodic newsletter. This will help build an audience for Team Ontario and assist us in our goals of educating the public, providing value to sponsors, and building the base for potential future competitions.

Throughout the exhibition, our team will have clear signage indicating our team's name and team's house name. Visual and tactile displays, communicated in a colourful and interesting manner, will help explain our design choices and educate visitors.

Innovative marketing literature and house souvenirs will also be given to patrons. This allows them to remember our home, read additional information about the technologies of our home, and also is a take-away with our team's website URL. All communications and public exhibit materials will be submitted to organizers for review before the competition. All items (marketing literature, team paraphernalia, signage, etc.) shown or given away at the competition will be in compliance with Rules 10-2, 10-3, 11-4b, 11-4c, and 11-5. The Plan drawings of the site depicting exhibit materials and the tour route will be to 1:48 scale.

Outreach

Our team takes an active approach to community outreach and education. Through opportunities at our schools and in our communities, we promote our mission to inspire the public to demand more from the next generation of homes. Recent and planned events include the opening of the Queen's Solar Educational Centre, Engineering Day with the Professional Engineers of Ontario, and an Energy-themed weekend event at the Canadian Museum of Science and Technology. We aim to involve a wide audience, including elementary and secondary students, professional associations and sponsors, fellow design professionals, and the general public.

INTERIOR AND EXTERIOR ACCESSIBLE TOUR ROUTES

Accessible routes through the house are shown above in Figure 11. An accessibility review before architectural design decisions are made will ensure compliance with codes and standards. Doors will be wheel-chair accessible, and there are no elevation changes within the home.

Means of Egress

1. Two egress doors will be provided for the house, each with a minimum clear width of 32 inches. (IRC R311.2)
2. A landing will be installed on each side of the egress doors with a minimum measurement of 36 inches in the direction of travel. (IRC R311.3)
    a. The landing will be no lower than 1½ inch below the top of the threshold. (IRC R311.3.1)
3. The minimum width of the hallway will be no less than 3 feet. (IRC R311.6)

HEALTH AND SAFETY PLAN OUTLINE

Health and Safety training is an integral part of the Algonquin College construction programs, providing a base of experience from which to develop Team Ontario's safety plan. The Health and Safety Plan will ensure compliance with all OSHA requirements.

Roles & Responsibilities and Training

Roles and responsibilities of the Construction Manager, Health & Safety Officer, and workers will be clearly established. The Construction Manager will develop a provincial occupational health and safety strategy, prepare an annual report on safety, and delegate a Health & Safety officer. Both the Construction Manager and Health & Safety Officer will undergo a 30 hour construction safety training course before the end of August 2012, if not already completed as a part of the Advanced Housing program at Algonquin College. The written health and safety strategy will include health and safety goals, key performance indicators for measuring the achievement of the goals, and any other matters specified by the DOE.

Outline

- Roles and Responsibilities
  - Construction Manager
  - Health & Safety Officer
  - Workers
  - Potential visitors
- Training
  - Fall Protection
  - Working with Heights
  - Personal Protective Equipment
  - WHIMS
  - First aid
- Provision and Maintenance of Safety Equipment and Materials
  - Personal protective equipment
  - Guards and railings
- Site Safety
- Hygiene
  - Toilets
  - Drinking water
  - Site clean-up
- Housekeeping
  - Recyclability
  - Hazardous storage
  - Debris disposal
- Site Inspections
  - Equipment checks
  - Auditing
- Emergency Procedures
- Fire Protection
  - Fire Marshall
  - Location and provision of fire-fighting equipment
  - Fire procedures & evacuation plan

IDENTIFICATION OF AND SUMMARY OF QUALIFICATIONS FOR THE LICENSED DESIGN PROFESSIONAL STAMPING THE DRAWINGS

Team Ontario has partnered with CIMA+ to help develop and stamp our structural, mechanical and electrical drawings for the 2013 U.S. Solar Decathlon. CIMA+ is a large firm with over 2000 employees. CIMA+ has been active in engineering and planning consulting across Canada since 1988. Its head office is located in Laval, QC, with branch offices located in 8 other provinces. Previously CIMA+ has delivered a wide range of new constructions and renovations. They have also conducted numerous structural assessments and upgraded many existing structures to standard. Currently they are working on the restoration of the McDonald Cartier interprovincial bridge connecting Ottawa to Gatineau and the parking facilities at the Canadian Museum of Nature.

Team Ontario will be working with PEO accredited engineers active in the disciplines of mechanical, structural, and electrical engineering located in CIMA+'s Ottawa office. The three professionals that we will be working closely with will be Mr. Andre Chaumont, P.Eng., the General Manager of the Ottawa, Mr. Daniel Roy, P.Eng., LEED AP, the Director of Structural Engineering and Mr. Chris Fox, P.Eng., LEED AP, the Director of Mechanical and Electrical Engineering. Each with over 25 years of experience as professional engineers, these professional engineers will be directly overseeing the certification of the of Team Ontario's design drawings.

1 3D VEIW EXTERIOR

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TEAM ONTARIO

THE AURORA HOME

Carleton University | Algonquin College | Queen's University

No.	Description	Date

3D VIEW

Project number	SD2013	A 101
Date	04/11/2012	
Drawn by	S. DAVILA	
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1/4" = 1'-0"

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TEAM ONTARIO

THE AURORA HOME

Carleton University ALGONQUIN COLLEGE Queen's University

No.	Description	Date

FLOOR PLAN

Project number	SD2013	A 102
Date	04/11/2012	
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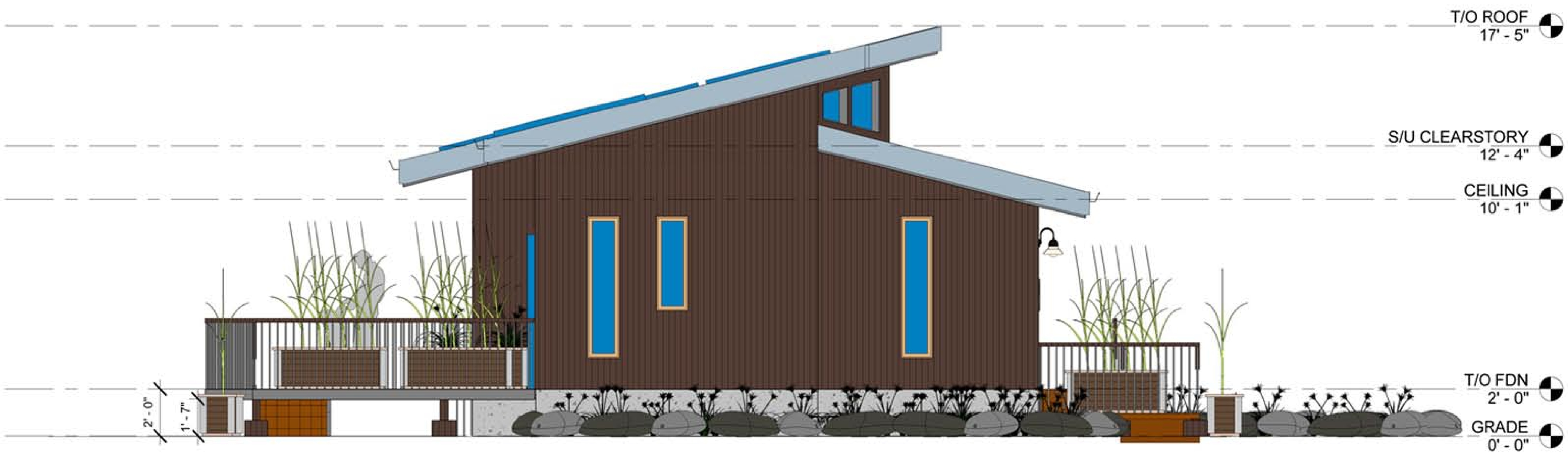

1 East
1/4" = 1'-0"

2 West
1/4" = 1'-0"

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TEAM ONTARIO
THE AURORA HOME

Carleton University | Algonquin College | Queen's University

No.	Description	Date

EAST AND WEST ELEVATIONS

Project number	SD2013	A 103
Date	04/11/2012	
Drawn by	S. DAVILA	
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1 Exterior - North

2 Exterior - West

3 Exterior - South

4 Exterior - East

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TEAM ONTARIO

THE AURORA HOME

Carleton University | Algonquin College | Queen's University

No.	Description	Date

3D VIEWS

Project number	SD2013	A 104
Date	04/11/2012	
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Checked by	Checker	Scale

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1 3D VEIW INTERIOR

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TEAM ONTARIO

THE AURORA HOME

Carleton UNIVERSITY ALGONQUIN COLLEGE Queen's UNIVERSITY

No.	Description	Date

INTERIOR RENDERING

Project number	SD2013	A 105
Date	04/11/2012	
Drawn by	S. DAVILA	
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