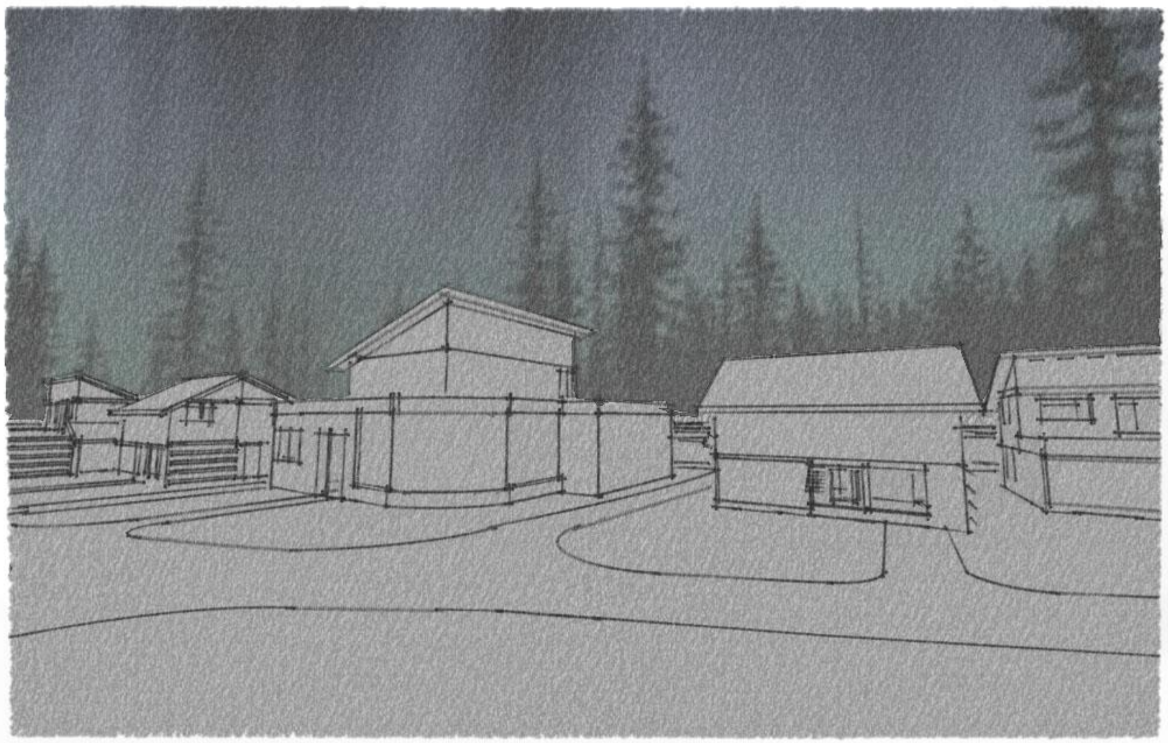
UAF Sustainable Village

laboratory demonstration solution



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Project Vision

Foxes, moose, and arctic hares traverse small trails and birds chirp from the scraggly branches of black spruce, tipped over by unstable permafrost. Grass grows tall and wild, framing small, murky ponds, and, in the bounty of late summer, wild cranberries and raspberries add splashes of red color to the forest floor. This is the scene of the future UAF Sustainable Village. Between Geist Road and the main campus, the site is a haven of wild Alaskan life in the midst of development. The Sustainable Village will harmoniously coexist with the current inhabitants of the site, providing a place for students to research and live lightly on the land of interior Alaska. At the UAF Sustainable Village, the built environment exists in balance with the harsh, but beautiful, Alaskan environment.

The design of this village is inspired by the natural world it exists within, and many of the design strategies are reflections of the wisdom of the other beings on the land. Many animals use a thick layer of fat to keep their bodies warm during the long winters. Similarly, the village's buildings use super-insulated walls, floors and ceilings to keep occupants comfortable and energy loads manageable. Raven keeps his unprotected feet from freezing by stopping the flow of blood to his feet when it is not needed, and Bear's hibernation brings her heart rate to an incredibly slow beat – two examples of ultra-conservative demand-based energy use. Similarly, when the Commons is unoccupied, it will shut itself down like the sleeping Bear, providing minimal heating and ventilation. When rooms are unoccupied, the thermal, lighting and ventilation systems will be minimized like the featherless feet of the wise Raven. Another example of Biomimicry can be seen in the social nature of so many mammals in the Arctic. Whether it's huddling for warmth, hunting in groups, or raising the next generation, both Caribou and Wolf know the power of community when it comes to surviving in the far north. Shared resources (such as green bikes, cross-country skis and perhaps an electric vehicle) and centralized systems (such as electrical generation, heating, water harvesting and wastewater treatment) are the village's way of harnessing the power of community.

Human Interface

The most important component of a sustainable village is not the walls, or the forest paths, but the people who fill those walls with their laughter and leave their footprints on those paths. It is these people who turn the buildings into a *village*, and it is their vision and passion which will drive its success and shape its future. An organizational structure will have to be established, including work requirements of all residents to maintain the health and efficiency of the village. After all, a sustainable village requires an active relationship between people, buildings and the land. We envision a labor structure involving several specialty "crews", such as a gardening crew, a green cleaning crew, and a house maintenance crew. All residents will be a member of at least one crew and will have an expected weekly labor contribution (for example, 2 hours of garden work per week in the spring and summer). Since building maintenance and garden work will be demanding in the summer, a minimum number of residents will be required to live at the village through the summer. This detail will be handled by the application process, whereby there will be, for example, 10 "school year" leases and 6 "full-year" leases.

A requirement for residency at the UAF Sustainable Village should be a pre-requisite or co-requisite class on sustainable living skills, such as building maintenance, communal living social systems, sustainable agriculture, electric car conversion, or traditional snowshoe making. After a few years, all new residents may also be required to take a seminar course about the inner workings of the village's social and building systems. This class will be taught by experienced residents of the village, so it will serve as a vehicle for the transmission of knowledge and "lessons learned" from one generation of village residents to another. Informative posters will be located throughout the village, educating residents and visitors about the sustainability features of the village's buildings.

Finally, village residents may choose to harness the power of community by sharing certain resources, such as having a few community "green bikes", or sharing cross-country skis, or even an electric car (built by a resident in the electric car conversion course) for carpooling to town. Or they may simply choose to share fellowship and organize gatherings such as potlucks, in the community center.

The Built environment

Site

Integrating home life and studies with the natural world, providing a strong sense of community, and maximizing potential renewable energy and water sources, the initial development of the UAF Sustainable Village consists of four four-bedroom houses and a Commons. It will contain a classroom, study areas, and the central, interactive working systems of the buildings. The five initial buildings are situated in the northeast corner of the site, where the permafrost is more stable and the trees are much less dense. Situating the buildings on this more stable ground follows conventional wisdom about constructing on permafrost and allows the facilities to test functionality in a more standardized way. Potential future housing may be constructed in the black spruce areas with less stable permafrost to test foundation designs.

With two houses on each side of the Commons, the buildings face south and form a stepped pattern, forming a diagonal line from southwest to northeast. This allows the buildings to take full advantage of morning and afternoon sun, with some shade relief provided for the hot evening sun in the summer. It also opens the view corridor to the Alaska Range, which may be visible from the rooftop gardens, and provides a buffer from the noise of the university.

The main pedestrian pathway parallels the building layout to the south, following the general shape of the existing clear area. Walkways branch out from the main path, connecting each house entry, the Commons, the gardens, and leading back to the pedestrian bridge from main campus. Vehicular traffic on site is restricted to water and wood pellet delivery, a residential drop off area, and emergency vehicles, with residential parking connected via pedestrian path from the Nenana lot on campus.

The gardens are divided and distributed about the site. South of the buildings, landscape gardens provide the homes and Commons with solar gain potential. These gardens are shared and interactive, with paths winding through, passing by benches and creating a peaceful environment. The less attention-intensive root crops are planted in a supplemental garden in the fertile ground near the road to CCHRC. In addition, the Commons hosts gardens on its roof, away from moose and mosquitoes. Each home has private plots in front or on a second story balcony and welcomes residents and guests to the entry with a an edible green wall. Across from the supplemental garden, a large tracking photovoltaic array collects solar energy and ties it back to the grid.

House

To foster a sense of community and ease of construction, the four houses are based off two similar prototypes, one with a second story balcony garden, and one with simple geometry and the garden at ground level. The programming of each house is identical and easily replicable for future development, with options to incorporate program adjustments for new family housing in later phases.

Each house is entered from the south via an arctic entry to reduce heat loss through open doors. The arctic entry carries the resident into the open kitchen/dining/living area which is flooded with natural light from large south-facing windows. The open plan of these areas helps facilitate a community feel.

Views towards the public gardens and the forest continue the community beyond the built environment and into the natural world as a whole. The kitchen and bathroom share a wall for efficient water delivery and are on the first floor for central access and to prevent additional pump power to the second level. The kitchen makes use of an induction stove top for efficiency and safety. The bathroom consists of a hand wash sink and toilet; shared shower facilities are located in the Commons. Water, heat, and power all enter the house from the central facilities in the Commons.

The bedrooms are the private spaces of the house, lining the north wall and receiving natural daylight through transom glass from the south rather than cold north facing windows. In the shed-roofed houses, the second floor opens onto a sunny, south-facing balcony garden for residents' personal vegetable and flower plots. The green roof/balcony continues down the east wall with vertical garden space that borders the entry path. Outdoor storage for bikes and skis is provided to the north of the arctic entry.

The balcony garden prototype home has a large shed roof, facing north, catching rain water and piping it back to the Commons. The second prototype has a gabled roof. Both roofs are planted with resilient, shade tolerant native plants, typical of traditional sod roofs. The green roof continues down the north wall with sod, completely tying the raised plants back to the earth.

Materials used inside the home are low-emitting, and made from rapidly renewable or recyclable materials. All finishes are zero- or low-VOC and bio-based when possible. Natural ventilation through operable windows and heat-recovery ventilation (HRV) with filtration for fire-season continually refresh indoor air. Southern windows paired with light-colored walls fill the home with natural daylight. FSC certified or locally obtained wood adds a warm, northern look.

Each house features a different construction type for observation and research.

Commons

The Commons is the heart of the UAF Sustainable Village. The facility is the research center, learning center, and community gathering space. It provides showers, a community kitchen, and integrated gardens while serving to collect and distribute utilities for all the houses on site.
This two-story building, like the houses to its east and west, faces south to maximize natural light and solar gain in the winter. The building is entered from the main path to the south, bringing the visitor directly into a large atrium space. This space serves as lobby and study area, with moveable seating that allows students to choose a large group setting or a more intimate, private one. Sunlight floods the area through south-facing glass, providing valuable energy for an exciting feature of the Commons: the Living Machine. The Living Machine treats the wastewater (black-water) for the entire compound entirely through natural processes, utilizing bacteria, plants, and organisms like snails and clams to purify the water to a level suitable for flushing toilets and irrigating gardens. Rather than burying the wastewater treatment system within the foundation or a utilidor, this Living Machine is integrated into the lobby design, providing seating throughout a lush green indoor environment. The incorporated plants assist in purifying the interior air, as well as providing a beautiful backdrop for studying students. In addition, the Living Machine is a learning and research opportunity for students and visiting community members alike. The organic, layered compartments of the Living Machine lead into a large mechanical room where the central systems for the village are housed, including storage tanks for harvested rainwater and recycled water, in addition to a large, thermal storage tank filled from rooftop solar thermal collectors. Far from being secluded and accessed only by maintenance crews, the mechanical room is another opportunity for learning, research, and observation of the inner workings of the village systems.

Water, along with heat and electricity, is supplied not only to the houses on site, but to the remainder of the Commons, serving a small community kitchen open to use for the community of students and for potential harvest events that may be held in the Commons. Near the kitchen is a large root cellar for storage of the community garden harvest, as well as potential storage for residents' personal vegetable and herb harvests. The root cellar is thermostatically controlled and takes advantage of insulated isolation from the main building and the exterior cold that Fairbanks has to offer. Also housed in the commons, in addition to public restrooms for the buildings patrons, are showers for the village residents. To pipe and pump hot water efficiently, the houses on site do not have showers. Instead, private shower rooms are provided in the Commons, designed to support the residents of the first and second phases of housing, thirty-two students in all.

On the second level of the Commons, an open classroom looks over the Living Machine and central study area, taking in southern sunlight from clerestories above. The classroom is designed to hold 20-25 students while creating an integrated feel with the rest of the building. A door to the east of the classroom leads to the roof, where extensive community garden beds take advantage of direct southern sun and create a pleasant atmosphere above the mosquitoes with wide views towards the Alaska Range. In the northeast corner of the rooftop garden, large arrays of solar thermal collectors pipe sun-heated glycol to the storage tanks and mechanical heating system down below.

Like the houses, the Commons is constructed from recyclable and rapidly-renewable materials, uses low- or zero-VOC finishes and paints, and shares the warm, sunny aesthetic brought by natural lighting and ventilation, light paints, FSC certified wood products and an abundance of living green plants which purify the air and reinforce the feeling of being a part of the larger community of the natural world.

Building Materials

Throughout the design and construction process, much attention is paid to the “Three R’s” of sustainable material use: Regional, Recycled and Rapidly Renewable. Whenever possible, we have chosen materials and systems that are locally sourced, greatly reducing the carbon footprint associated with building components. This is typically one of Alaska’s greatest challenges in green building, but we’ve focused on supporting the Alaska economy and reducing the embodied energy of our materials by using Alaska Spruce lumber, straw bales from Delta Junction and wood pellets from North Pole. Using recycled materials is always better than consuming virgin resources, so we incorporated a lot of cellulose insulation, which promotes the recycling industry in Alaska. Rapidly-renewable materials make much more efficient use of valuable land resources since they are renewable and have higher long-term yields than forest products (which also are needed to satisfy habitat, recreation and water and air purification needs). By using straw bales and bio-based interior finishes (such as Marmoleum flooring and EcoProcote), we are preserving our forests and reducing demand for non-renewable mining products.

Low-Impact Construction Activities

For any project of this scale a plan must be in place to minimize the ecological damage that can occur. To begin with, the site will be surveyed and markers will be placed where the village will be. Each house will be built one at a time and all materials will be staged in the future footprint of other houses that will be built, or on the side of the nearby road. The buildings farthest from the road will be built first so the footprints of buildings closer to the road can be used for material staging. All area outside of a small radius around the building site will be restricted and signs will be posted to inform all participants. When trees need to be cleared this will create biomass that can be used in the future boiler or firewood for the CCHRC masonry heater. Finally, a rigorous construction waste management (CWM) program will ensure that at least 80% of construction waste gets recycled.

Building Systems

STRUCTURAL

Foundation

In order to minimize the impact on the land and to maintain the existing thermal regime of the soil, the entire structure will be above grade. The most challenging structural consideration with this arrangement is the lack of clear resistance to lateral forces and uplift from seismic events. In order to reduce over-turning potential, large concentrated loads (such as a 10,000 gallon thermal storage water tank, and the Living Machine) are located towards the extremities {OR "at opposite corners"} of the Commons building. This provides a very large moment of inertia for the structure and may make the building self-stable. If further calculations prove that lateral or uplift resistance is inadequate, a resistance pier and helical tie-back anchoring system (by Chance Civil Construction) will be integrated with either local timbers or salvaged steel beams which support the building. This system is a series of auger-like anchors that will be driven at least 4 feet deep with power and hand tools, avoiding the use of heavy equipment. A super-insulated (R-80) engineered wood floor system will be seismically-tied to the anchored support beams. Thermal transmission from the building to the soil (which has a permafrost layer at a depth of about 15 feet) will be further reduced by passive ventilation. Ducts will be attached to opposite ends of the foundation, and will have risers that extend above the snow line, maintaining a clear path for the heat from the building to be vented. The duct risers will be taller on one side of the building than the other, to create a natural draft for improved air circulation.

Special structural loading considerations

There are several unique loading conditions that require special attention in the houses and the Commons. The most formidable loads are the two previously mentioned water system components that also serve as seismic ballasts. The span and spacing of I-Joists that are typical to the rest of the floor is modified underneath these structures to accommodate the larger loads. Whereas the typical beam layout is 10' O.C., and joists are spaced at 2' O.C., these structures will require 5' O.C. beam layout and the stronger BCI 90 I-joists at 12" O.C. . The cords of the whole house trusses in the influence area of these tanks will be sized up to 2x6, and extensive blocking will prevent buckling. Finally, all buildings will have green roofs which will add considerably to the roof loading regime. Consequently, trusses and walls will be designed accordingly, and attention will be paid to stacking vertical load members for direct shear transfer. This is easily accomplished since stud layout (and other framing details) will be in accordance with Advanced Framing methodologies.

Wall Systems

Four different wall sections will be used in the village to allow testing of building techniques in an occupied environment. The four houses will all have a different wall sections but the same ceiling insulation of 20'' of loose fill cellulose. In addition, all wall sections will follow advanced framing practices in order to reduce materials and thermal bridging.

The first wall section that will be used is the REMOTE wall that has now been used extensively in Alaska. This wall is constructed of 2x6 lumber at 24'' OC with 4''-6'' of rigid insulation on the exterior and fiberglass bats in the framing cavity. This wall is able to achieve r-50 with 6'' of foam and a r-21 batt. The Commons will also use this wall section.

The next wall that will be utilized is a wall truss in the style that was used in Cripple Creek by CCHRC's Sustainable Northern Shelter program. This innovative construction will contain the floor, walls, ceiling and roof all in one truss. This simplicity offers many benefits, such as lower labor costs, material efficiency and quick construction. The walls will be 17'' thick, filled with cellulose insulation. The floor will be thicker, on the order of 22'' with an r-value of 80, in order to keep the permafrost soil under the house frozen.

Another wall section that will be used is a double wall. This will be made of two 2x4, 24''oc walls that have been offset to avoid thermal bridging. The two walls will be moved as far apart as possible in order to leave space for cellulose insulation. This wall would achieve an r-value of 50.

The last wall will be of straw bale construction. We want to have a wall that really pushes the bounds of conventional building. Straw is a rapidly renewable material and is produced locally, so it doesn't displace precious forest ecosystems and it has a much lower transportation footprint. An R-50 straw bale wall can be made by stacking two bales side by side and placing rebar inside. Different techniques will be explored to make this wall feasible in the northern environment we live in.

Living Walls

The north walls and eastern walls of houses (near the arctic entry) will be living walls, a vertical garden of edible plants on the bottom and native plantings toward the top. The living wall will be constructed of steel tubing and will be offset from the house wall to provide air movement behind the plants. Pre-constructed living wall panels, such as ELT Easy Green or the GSky VersaWall will hang from the steel framing. Drip irrigation can be integrated into the panels and excess water is recirculated back to the top of the living wall. A small container of rain water from roof downspouts is placed behind the living wall, and feeds the automatic irrigation system. While adding beauty and deep integration of the natural and built environments, the Living walls also serve to provide habitat, reduce heat island effect (which occurs even up here), and reduces the development footprint by providing food crops on vertical surfaces.

WATER

Water Source

The Sustainable Village will be a demonstration of wise water management, and will possibly achieve Net Zero Water, arguably the toughest petal in the Living Building Challenge. At the heart of the village's water system is the Living Machine, an onsite biological wastewater treatment system that will turn all wastewater into tertiary-treated water ready for reuse. But the village needs a sustainable source of water to feed the system in the first place, and that's not easy during the frozen winters, so a seasonal storage approach will be employed.

Rainwater and snow melt will be harvested from all roofs. Even though the vegetation on the roofs and walls will reduce the sediment suspended in the runoff, it is still crucial to filter the water before it is used. Leaf screens will be placed over all gutters, and seasonal maintenance will prevent gutters from getting clogged. The gutter downspouts will be plumbed directly to a 5000 gallon storage tank in the Commons. There will also be a 500 gallon tank on the Commons lower roof which will take all of the water from the Commons upper roof and store it for watering the roof's garden beds. The main rainwater storage tank in the Commons will have a series of increasingly finer filters that are placed in series upstream of the tank. The water in this tank will be used for toilet flushing, but if the tank is full, than an automatic valve diverts the water to one of two tall and skinny 500 gallon outside tanks that will be tapped for irrigation. The water in the large tank in the Commons will pass through a small mixed-oxidant disinfection unit (such as a MIOX BPS or HYPO-S) and then flow to the toilets and washing machines in the Commons. This disinfection system uses electrolysis of table salt to produce Chlorine only as needed, greatly reducing disinfection byproducts and the hazards associated with NaOH. The toilets in the houses will also draw their water from this large tank. However, control valves will give priority to recycled water from the Living Machine (see next section) over the harvested rainwater, so the rainwater is preserved as long as possible.

Water usage

Efficient usage of water is essential to sustainable living. The village's appliances and fixtures use water very efficiently and many are centrally located to minimize pump energy and encourage moderate use. All laundry and showering facilities are located in the Commons. This requires a little extra effort, and the intent is to avoid casual, wasteful use of washing machines, for example. Of course, the washing machines are high-efficiency (20 gallons per load), and the low-flow shower heads are 1.0 gpm. There are no bathtubs in the village. All urinals are waterless and all toilets in the village are 1.6 gpf/ 0.8 gpf dual-flush toilets. Low-flow lavatories consume 1.5 gpm and dishwashers use only 6 gallons per load (the equivalent of washing by hand). Drip irrigation will be employed to reduce the gardens' water consumption. Educational displays will encourage residents and visitors to reduce their water consumption. A water budget was performed to analyze projected water performance of the village, even after 4 more houses are added to the cluster. It is estimated that the village's water consumption will be completely offset by rainwater harvesting and water recycling.

Water treatment & recycling

All wastewater from the village will be treated on-site by a Living Machine installation in the Commons building. The Living Machine is a biological wastewater treatment system that is designed to mimic nature by utilizing many species such as aquatic and wetland plants, bacteria, algae, plankton, snails, clams, and fish. The Living Machine turns wastewater into tertiary-treated water which will be reused for toilet flushing, laundry and irrigation. A portion of the treated water will be further purified with UV light, rendering it potable. This potable water will supply all kitchen and bathroom sinks, and the showers in the Commons.

The Living Machine is not a black box. It is an open environment, full of beauty and educational opportunity. Glass panels will allow visitors to see a snail filter colloidal solids from 40 liters of water each day. And even casual building occupants will enjoy the oxygen-rich air that the multitudes of plants provide. The Living Machine cycles water through different "cells" to mimic tidal flows and to maintain an aerobic environment. Each of these cells will be an organically-shaped "island" in the main lobby area of the building. Benches will be built in to the sides of these islands, inviting building users to rest alongside the lush wetlands environment and listen to the relaxing sounds of the cascading waters.

ENERGY

Electricity

Electricity will be provided through both PVs and grid power. A dual axis tracking PV panel (2640 watts) will be placed close to the existing PV panels near CCHRC and be connected to the grid. As a result, the village can participate in GVEA's net-metering program— SNAP Plus. Our projections show that one PV panel will provide nearly 12% of the village's annual electric needs. Additional panels can be added in the future once PVs drop in price.

Electricity consumption will be lowered through conservation efforts and design. A layered lighting plan will be used to deliver comfortable and efficient lighting densities. General area lighting will be kept to a minimum, while task lighting will provide specialized zone lighting. Efficient lamps, such as compact fluorescents and LEDs will be utilized, and most rooms will be equipped with vacancy sensors to reduce electrical waste. Energy efficient appliances such as induction stoves and condensing dryers will be used to reduce the building's electrical load. In addition, phantom loads will be reduced by master switches which turn off appliances at night. Monitors located in the Commons will display electrical consumption data for each house. This will enable competition among the different homes that will further drive down electrical consumption.

Heating

Our first step with designing a thermally efficient building is to make the structure as airtight and insulated as possible. All of our buildings will have at least an R-50 wall and an R-70 ceiling. Foundations will be super insulated to R-80 to reduce energy consumption and protect the permafrost we are building on. All buildings will be constructed to maximize air-tightness with the goal of achieving an ACH50 of 0.5. An airtight building envelope drastically reduces cold air infiltration.

Space heating for the building will be provided by passive solar design, solar thermal collection, and a wood pellet boiler. During the summer, when there is excess solar gain, the buildings will shade one another in the hot afternoons. In contrast, under the winter sun the village will maximize solar gain. Windows facing south will let heat in during the day and R-10 thermal shutters will help retain the heat at night. Concrete floors will act as a thermal mass that stores the sun's heat for night-time re-radiation.

18 solar thermal collectors, mounted on the Commons roof, and a wood pellet boiler will be used to heat the water inside a 10,000 gallon "heat battery" thermal storage tank, located inside the Commons. When there is a call for heat, glycol-filled hydronic lines will be used to transfer heat from the large heat battery to the building's baseboard heaters. According to our projections, this system will provide over 50% of the village's annual heating needs. In the summer, the solar thermal system's drain-back capabilities will be utilized to avoid overheating the Commons by putting too much heat into the heat battery, when it is not needed. During the shoulder seasons, the village will be solely heated by the solar thermal collectors and when more heat is needed, the pellet boiler will automatically turn on. This pellet boiler will be sized to produce 100% of heating demands for all buildings, and will use local pellets that are made predominantly of waste wood. This system will be constructed with a large silo that will hold at least three weeks' worth of pellets.

Ventilation

Each house will be equipped with its own high-efficiency heat recovery ventilator (HRV) which provides fresh air that is pre-heated by the heat recovered from the stale, exhaust air. The HRV will be housed in the centrally-located utility closet, so ducting runs will be short and relatively straight, which increases system efficiency and reduces noise. Each bedroom will be supplied with about 10 cfm of pre-warmed fresh air, and the bathroom and kitchen will exhaust 20 cfm each. A booster switch in the bathroom will increase the ventilation rate, quickly expelling odors. Stale air from inside the home is exhausted to the north of the house, near the living wall, where plants will benefit from the warm, moist, CO_2-rich air. Fresh air is brought into the house from the warmer south side of the house. The duct for this air passes under the house before it penetrates the building envelope through the floor below the utility closet. By using this ducting strategy, the cold, fresh air is slightly pre-heated by escape heat from the building. In this way, the HRV intake air is also part of the ducted foundation strategy which expels heat accumulation under the house to maintain the thermal integrity of the soil.

The Commons will use a similar strategy for ventilation. Exhausted air passes through a heat exchanger which warms up the fresh air coming into the building. Since the Commons is a commercial building, there is a minimum ventilation rate required by building code. But sometimes that minimum ventilation rate is not sufficient due to high occupancy. For example, when there is a class in the building, or a tour of the building, or a village community event, there is greater need for fresh air. So CO_2 sensors will be installed in certain areas of the building to determine how much ventilation is required. This "demand-controlled ventilation" is a part of the smart building controls, which minimizes energy use when the building is not being used. Another example of the automated building system is the occupancy sensors and timers that will be used to lower the temperature in the building at night. Individual rooms of the Commons will be separately controlled by the Direct Digital Control (DDC) system. This means that the indoor environment of each area of the building will be automatically controlled to provide comfort when it is being occupied, but the HVAC system will revert to an energy-savings mode when it is vacated.

Food Production & Storage

Vital systems of food production, storage and preservation sustain the residents and bring together the community. Food production will focus on efficient use of space to minimize impact to ecology and necessary upkeep. Emphasis will be placed on growing storage crops, such as cabbage, carrots and potatoes, so the summer's crop will be available during the fall and winter when more students are living in the village. The efficient use of space improves food production as well as minimizing ecological impact. Locations for production include balconies, the large roof of the Commons, green walls on all houses, and a large area of fertile ground near CCHRC. Plants needing lots of attention or used often, such as salads, herbs, tomatoes, and strawberries, will be placed in locations on the buildings. The more remote garden (near CCHRC) will be used for growing lower-maintenance crops.

Compost collected from village kitchen scraps, Lola Tilly Commons, and other organic materials such as grass clippings from UAF, will be composted and used as fertilizer. Chickens living in mobile chicken tractors will provide soil fertilization and weed maintenance in fallow sections of the garden, as part of a comprehensive crop rotation system.

Production embraces ideas of conservation and natural systems as a form and model to growing strategies. Drip irrigation, rainwater collection, and mound and raised gardening focus on natural conservation. Efficiency for plant health will support crop diversity, trees for wind breaks, such as apple or cherry, and use of green manures (cover crops). Nature will be integrated into living space with building-integrated agriculture.

Residents of the village who are skilled in farming, such as an NRAS student, will work as garden managers, whereas other 'garden crew' members work about two hours a week. Students interested in agriculture can research soil, crops and various methods of growing.

Long term storage and healthy preservation of food are needed for sustainable living in Fairbanks. After harvesting, food can be blanched, canned, dried, or frozen. Some vegetables, including root vegetables, will be stored in a "root cellar", which will be a super insulated room that is decoupled from the Commons building. A thermostatically-controlled fan will bring warm air from the building into the "root cellar" room to maintain perfect storage temperatures. Frozen foods will be put in a thermostatically-controlled outside freezer. An indoor passive refrigerator will be used for the personal use of residents.

Transportation

The driveway to the village will be accessible by vehicles through a curved road that will lead up to the back of the Commons. All personal parking will take place across the bridge in the Nenana parking lot in order to minimize site disruption. Bike racks will promote emission-free travel. Carpooling will be encouraged and a board will be placed in the Commons where people can coordinate grocery shopping and other outings. As a transportation amenity, the community will have an electric car which can be signed out in the commons. Green bikes and shared cross-country skis will provide human-powered transportation options. On site, there will be easily navigable pathways between the Commons, houses and gardens, and the pedestrian bridge provides easy access to UAF, while Fairbanks Street leads to several bus stop locations on Geist Rd.

Conclusion

As a result of a superior building envelope, passive solar design and solar thermal collection, these homes will require 80%-90% less energy for space heating than the average Alaskan home. By using a layered lighting plan with efficient fixtures and vacancy sensors, smart appliances and phantom load control, the village will achieve reductions in energy consumption of 30%-40%, while providing 12% of its own electricity from the sun. By treating 100% of the wastewater on site, the village reduces the economic and ecological impacts associated with municipal wastewater treatment. The recycled water that the Living Machine produces will reduce the village's potable water demand by about 90% to well under 10 gallons per person per day. With low-impact construction techniques, a thermally-stable foundation system and green roofs which provide habitat and reduce stormwater runoff, the UAF Sustainable Village will coexist harmoniously with the environment.

The village is a laboratory, testing innovative ideas in the Alaskan environment.
The village is a demonstration to the world that sustainability is feasible in the far north.
The village is a solution to the most pressing challenges of our time.