the collectors

CONCEPT

Scattered across a clear blue sky, an array of black *collectors* are lifted high above the grounds of Fly Ranch. The sharply defined shapes open up towards the cosmos indicating their functional purpose: to capture rainwater and solar energy. The repetition of the shapes convey a system at work. The *collectors* cast subtle reflections of the surrounding landscape and remind us of our vital relationship to the Sun. A dome is suspended within the center of each *collector*. The dome is positioned down towards the earth to create a covered area for human activity. A combination of power, water, and shelter create a place for unlimited possibilities. The *collectors* are envisioned as an open-source framework. The post and beam structure is intentionally basic (and the ground area kept open) so that modifications such as walls or curtains can be added to expand the range of use. The *collectors* create a place to make, play, work, and share. With the help of people, they become art.

DESIGN COMPONENTS

Each *collector* is comprised of 4 major parts: (1) the timber structure, (2) the solar and rainwater glass collection panels, (3) the distribution gutters, and (4) a dome thatched roof made of locally harvested sedge grass. These parts are assembled in consecutive order and are only dependent on the proceeding part. This strategy supports phased construction and allows for parts to be disassembled for relocation or repurpose. We present each component in more detail:

1. A timber frame, measuring 6.5 meters square and 5.5 meter high, is the structural framework of the *collectors*. Timber was selected because it is a lightweight, carbon neutral, construction material and favored considering limited access to skilled labor and equipment. The species choice is western red cedar, a strong and durable softwood that grows abundantly in the pacific northwest region of the United States. The timber is to be protected by charring the outermost layer of the material. This process is known as Shou Shigou Ban, a traditional japanese technique that has proven to increase the durability and useful life of wood. This approach compares environmentally and financially favorable in comparison to other maintenance techniques such as painting or sealing.
2. The solar and rainwater collection panels are made from 134 square meters of recycled glass. Glass was selected because it is lightweight, weather-resistant, and conducive to solar cell technology. The glass panels are fastened to the underside of the timber structure in a sloped position at 30 degrees to assist in solar collection efficiency. The solar cell technology and associated electrical wiring are installed atop the glass panel, concealed to view from the ground plane. The sloped glass panels concurrently acts as a drain plane for rainfall to direct water into the distribution gutters.
3. The distribution gutters are also made of charred western red cedar timber. Wood gutters have been successfully used for hundreds of years and are recognized for their strength and weather durability. The gutter system connects to downspouts at each post. At the ground plane, the water is received by a holding and distribution system that is not included in this assessment as it should be determined according to site-specific needs. At this time, we promote a below-grade system to preserve the visual quality of the landscape and provide an unobstructed ground plane.
4. A dome thatched roof, measuring 5.75 meters in diameter, is suspended in the center of the frame to provide shelter and support a variety of activities below. At the center of the dome, a 2 meter diameter oculus permits light into the space below. The dome is constructed by wood frame and thatched (roofed) with a thick layer of locally occurring sedge grass. Sedge grass is a carbon neutral material that has been used in roofing for hundreds of years. The dome is designed to be assembled on the ground and hoisted up to attach to the 4-post timber structure.

It is presumed that the *collectors* will utilize a natural crushed rock foundation to eliminate the need for carbon emitting concrete. The load bearing capacity of the soil will need to be analyzed to confirm.

ELECTRICAL PRODUCTION

Each collector can be customized to produce up to 12.7 megawatts annually, however it is more appropriate to phase the installation of solar cells according to demand. In general, we recommend outfitting the two of the four south facing planes to produce 7.3 megawatts per year. This layout is 15% more efficient than total fit-out and more likely to meet the actual needs of Fly Ranch. The solar cells will need to be routed to a central inverter within 500’. The inverter will link to a central power main (or battery). Strategically placed electrical hubs and power distribution will need to be designed. This infrastructure is not included in our assessment.

WATER PRODUCTION

Considering historic climatic data of Gerlach, NV — each collector is expected to capture 20,000 liters of rainwater annually. Our rainwater collection system relies on sky-facing, sloped glass panels and wood gutters to direct rainwater by gravity. At each post, a downspout brings the rainwater down to the ground plane. In general, we recommend connecting the downspouts to a below-grade water holding and distribution system in which a solar-powered or manual mechanical water pump may be utilized. The entire gutter and downspout system is easily installed and serviced by ladder.

OPERATION AND MAINTENANCE

The major input for the *collectors* is rainwater and sun but to use those resources requires basic support infrastructure (i.e. distribution and holding) and that associated maintenance is critical. A technical person will need to monitor the support infrastructure to ensure the system is balanced and in good working order. Solar cell technology was chosen because it is considered reliable and self-sufficient, but occasional repairs and troubleshooting can be expected.

Maximizing the useful life of the *collectors* is essential to success. The *collectors* will need to be monitored on a regular basis for defects, deformation, or excessive wear. Any indication that a component is not on track to meet its expected use of life must be properly addressed. Regular cleaning is expected. The glass panels should be washed with natural soap and water at least once a year. The gutters and thatched roof should be kept clear of debris.

ROUGH ORDER OF MAGNITUDE

Our master plan calls for infrastructure that can be phased to meet the financial means of the community. On a large-scale (as proposed), we suggest installing multiple *collectors* with structure and collection panels while potentially omitting energy, rainwater, or shelter components until there is a demand for that feature. In regards to construction costs, we estimate materials for all parts of a single *collector* to be about $15,000 with an additional $10,000 allowance for shipping and miscellaneous paid work. Therefore, with a contingency factor, it is prudent to consider the cost of a single collector to be in the range of $30,000 to $50,000. The size of various design components may be able to be optimized to reduce cost and multiple purchase orders are likely to net additional savings with economies of scale.

PROTOTYPE DEVELOPMENT

Use of funds for on-site prototype development can be used to create a complete small scale model made to exact material specifications with accurate construction detail. This is an opportunity to test aspects of the design relating to constructability and site including the bearing capacity of soil, charred wood technique, and attachment details. A trial phase would also allow us to develop a more accurate model for cost and embodied energy.

ENVIRONMENTAL IMPACT ANALYSIS

We have been diligent to create infrastructure that does not generate greenhouse gas emissions during its operational life and is in fact net positive by harvesting water and solar energy. And while it cannot be easily measured, we also consider the infrastructure to have direct and indirect benefits for human life — both qualitatively and quantitatively.

The collectors are designed to mitigate potential environmental impacts. Foremost, the collection system is lifted to reduce the burden on the natural ground plane with dark finishes selected to reduce the surrounding glare and visual pollution. We have specified 75% of the design (by weight) to be sourced in carbon neutral material which includes timber and sedge grass, the later which grows locally. The use of wood, while considered inherently sustainable, requires responsible forest management: fortunately this appears to be a growing standard in the pacific northwest of the United States. We must also trust that the community of Fly Ranch will be good environmental stewards of the local ecosystem. The on-site renewable resources generated by the collectors must be used to make a positive impact to be considered a gain.

There is a carbon footprint associated with the life-cycle of the collectors. In order to offset it, we must first know what the deficit is. We begin our calculations by assessing the carbon emissions per kilogram of material for a single collector:

western red cedar 0

glass panels 1,210

67 m2 photovoltaic cells 33.5

wood frame for dome 0

thatch roof for dome 0

Next, we account for carbon emissions to transport the materials to Fly Ranch:

western red cedar 104

glass panels 76

67 m2 photovoltaic cells 10

wood frame for dome 24

thatch roof for dome 0

That is a net balance of 1457 kilograms of carbon with the presumption that construction can be executed with a negligible amount of carbon-emitting activity.

Now, we must try to value the tangible assets of the infrastructure: 20,000 liters of harvested rainwater per year, 7.3 megawatts of solar energy per year, and shelter. One collector alone can power an electric car to drive 33,800 kilometers — that means 8,600 kilograms of carbon emissions diverted. Yes, solar energy will divert a substantial amount of carbon but the collectors should also be used to complete meaningful work for carbon sequestration. The community of Fly Ranch should consider using the infrastructure to help implement large-scale carbon sequestration projects such as sustainable land management which has the potential to sequester up to 70,000 kg of carbon per hectare. We may also look up-stream, in the production of the collectors, to reduce the environmental carbon footprint. We estimate the locally occurring sedge grass to sequester .05 kg of carbon per square meter; this is an opportunity to grow, manage, and replenish a local construction material with added environmental value.

The most effective way to minimize the environmental impact of the infrastructure is to extend its useful life. We have selected materials that will endure for years and have chosen a finish technique (Shou Shigou Ban) that delays the degradation process of timber. We estimate the useful life in years:

western red cedar structure 100

glass panels 100

photovoltaic cells 30

western red cedar gutters 50

dome wood structure 35

dome thatch roof 35

In regards to decommissioning, 75% of the construction materials (by weight) are considered biodegradable and therefore do not require any special disposal procedure. Wood and grass can be used as compost fuel to generate energy or grow plants. The glass can be recycled and repurposed. Photovoltaic cells may have salvageable technology, or can be modified to be made useful again.

REFERENCES

References used for calculations were inferred from a variety of online resources, often double-checked and then estimated for conceptual purpose:

1 kg wood = (1.65) kg of CO2 sequestered

1 kg glass = 1.1 kg of CO2 emitted

1 square meters of photovoltaics = .5 kg of CO2 emitted

1 square meter of thatch = 95 square meters of sedge grass

1 square meter of sedge grass = (.05) kg of CO2 sequestered

1 ton-kilometer for freight truck transit = .1 kg of CO2 emitted

A single collector is assumed to conceptually measure:

Structure = 1,390 kilograms / 3.7 cubic meters

Collectors (glass) = 1,100 kilograms / 134 square meters

Collectors (photovoltaic) = 67 square meters

Distribution = 150 kilograms / .4 cubic meters

Shelter (wood) = 950 kilograms / .64 cubic meters

Shelter (thatch) = 1,350 kilograms / 45 square meters

A collector is assumed to be sourced from the following regions:

Structure = 610 km from source / western Oregon

Collectors (glass) = 625 km from source / Sacramento, California

Distribution = 610 km from source / western Oregon

Shelter (wood) = 240 km from source / east Tahoe National Forest, California

Shelter (thatch) = 0 km from source / Fly Ranch, Nevada