Black Rock Vitality

In the words of Philip Auslander, “The Burning Man festival is a case in point-an event featuring performance that is itself a performance.” Each year, the annual Burning Man event transforms the deserted, barren grounds of Nevada into a thriving environment fueled by innovation and creativity. By means of further exploring Burning Man culture, the organization has recently acquired Fly Ranch, a site that currently calls for a sustainable infrastructure to host Burning Man gatherings, activities, and projects. The proposed solution, Black Rock Vitality, is an ingenious work of art in the desert landscape that promotes innovation, artmaking, and the exchange of ideas.

To address current climate challenges, Black Rock Vitality consists of a tree-like infrastructure that generates clean energy, water harvesting, and recycling in a site known for its ecosystem of extremes. Inspired by steampunk design, the structure incorporates technology and aesthetic design influenced by 19th-century industrial steam-powered machinery. It demonstrates the relationship between Man and technology, and what happens when humanity uses technology for nature’s benefit.

To elaborate, an array of dye-sensitized solar panels at the top of the structure harness solar energy to provide electricity for the site. The panels are composed of coloured plastic materials that capture sunlight and concentrate it along their edges. The sunlight is then intercepted by photovoltaic cells and converted into electricity. The panels were chosen due to their transparent qualities, lightweight material, and ability to produce in unique forms. To increase efficiency, the solar panels also consist of photovoltaic cells on both sides. The panels lie on a dual axis tracker, which allows them to rotate 360 degrees to follow the sun over the course of the year. Investing in bifacial solar panel systems will have significant advantages regarding the ecosystem at hand and its energy needs.

The other primary focus of the design is technology’s connection to water. A water harvesting mesh is attached to the curvilinear branches of the tree, and then used to collect atmospheric water vapor from rain, fog, or dew, and condenses against the surface of the mesh. In unison, the form of these trees collects rainwater and funnel it underground through a series of filtration systems. After, the water moves to large storage tanks that pump water back to the surface when needed to service the site and its users. To accommodate more users, pumps at the base of trees are placed within the reservoir and generate double the harvested amount when needed.

**SYSTEM INPUTS**

1. Solar Panel Maintenance: Any issues with solar panel performance will most likely be related to electricity production, which will require careful monitoring of the system’s production.
2. Water System Maintenance: To water harvesting and reuse, it will be necessary to detect defective portions/contaminated water by performing periodic maintenance and inspection. Filters will need to be regulated and replaced in accordance with the amount of water harvested per month. All funnels and collection tanks will need biannual maintenance to clear debris and other things that may affect collection intake. Meshing needs to be observed for rips, tears, holes, or detached cables caused by animals, wind, and sun exposure.

**SYSTEM OUTPUTS**

1. Solar Energy Output: Assuming a typical solar panel sits at 20 watts per sq.ft. and there are approximately 10 hours of daylighting per day, each sq.ft. panel will generate 200 Wh per day. This equates to 200 Wh x 322.9 days (42.1 rain days in Nevada) = 64,580 Wh per sq.ft., or 64.6 kWh per year.

Accounting for 20 solar trees measuring at 706.86 sq.ft., 706.86 sq.ft. x 20 trees = 14,137.2 sq.ft. total x 64.6 kWh per year = 9.1326 MWh per year x 11% efficiency (average) dye-sensitized solar cell efficiency = 1005 kWh per year.

1. Water Harvest Output

Roof Harvest

Assuming 1” rain on a 1,000 sq.ft. roof yields 623 gallons of water. Accounting for our roof area of 14,137.2 sq.ft. at 15.5 inches of rainfall/year, our yield = 136,513.94 gallons per year or 374.01 gallons per day.

Fog (Mesh) Harvest

Assuming fog harvest yields 1 quart - 3 gallons (avg1.625 gal) per day of water per sq yd of fog mesh.

Our Mesh area is as follows:

Roof area per tree = 706.6 sq.ft.

Mesh area = 706.6 x .5 = 353.3 sq.ft.

Circumference of mesh = 3.14 x 8ft= 25.12 sq,ft.

Mesh total area = 25.12 x 353.3 = 8,874.896 sq.ft. / tree

Mesh total = 8,874.896 x 20 tree = 177,497.92 sq.ft.

Mesh yd total = 177,497.92 / 3 = 59,165.97 yd

Considering Fog collectors require light wind(4-7mph) and are 10% efficient. We can assume the efficiency is 5% at Fly ranch as avg wind speed is 11mph. Therefore avg. yields are calculated as follows:

Best yield = 59,165yd x 3 gal/yd = 177,497 gallons at 5% eff. = 8,874.89 gal per day

Worst yield = 59,165yd x .25 gal/yd = 14,791.25 x 5%eff = 739.5625 gal per day

Avg = 59,165 x 1.625 gal/yd = 96,143.125 gal x 5%eff = 4,807.15 gal per day

Even at worst case yields of 177,497 gal x 1%eff = 1,774.97 gal per day

Worst yield = 59,165yd x .25 gal/yd = 14,791.25 x 1% eff = 147.9125 per day

365 day x 147.9125 gal = 53,988.06 gal per year

Avg = 59,165 x 1.625 gal/yd = 96,143.125 gal x 1%eff = 961.43125 gal per day

365 day x 961.43gal = 350,921.95 gallons per year

Water Collection Overalls:

Roof collection total = 136,513.94 gallon annual, 374 gal per day

Mesh collection best case scenario 10% efficiency avg = 9,614.3125 gal per day

= 3,509,224.06 gal per year

Reality outcome best case 5% efficiency = 4,807.15 gal per day

= 1,754,609.75 gal per year

Mesh Collection at 1 % efficiency = 961.43125 gal per day

= 350,921.95 gallons per year

Roof collection + mesh at 1% = 487,435.89 gallons per year

1,335.44 gallons per day

Considering Fly Ranch would like to see over 4,000 visitors throughout the year and the festival brings in more than 78,000 visitors. We can assume 84,000 visitors in a year. Recommended amount of water per visitor according to the burning man website is 1.5 gal per person.

84,000 people x 1.5 gal per person = 126,000 gallons of water

Water collection vs visitor requirement

487,435.89 gal - 126,000 gal = + 361,435.89 gallons per year

In the event more water is needed, a pump is placed within the reservoir that can be in unison with the roof and mesh harvesting method. Accommodations are as follows:

Assuming 1” rain on a 1,000 sq.ft. roof yields 623 gallons of water. Accounting the adjacent reservoir area is 524,433.34 sq.ft. at 15.5 inches of rainfall/year, the reservoir yield = 524,433.34 sq ft x 15.5 inch = 5,064,190.55 gal/year. We decided to estimate an amount for conservation and loss in evaporation.

Production w/o reservoir pump = 487,435 gal/year or 1,335 gal/day

Visitor accommodation @ 1.5 gal/vis = 324,956 vis/year or 890 vis/year

Production with reservoir pump = 2.8 million gal/year or 7,671 gal/day

Visitor accommodation @ 1.5 gal/vis = 1,866,666 vis/year or 5,114 vis/day

**PRIMARY MATERIALS**

\*The trees vary in dimensions, ranging from 30-60 feet tall. The diameter of the top of the structure ranges from 15-45 feet.

1. Scrap materials and metals: Taken from the Gerlach Recycle Camp utilized to support the base of the structure
2. Ponderosa Pine: A local, replenishable material easy to manipulate
3. Dye-sensitized Solar Panels: (As mentioned in narrative)
4. Mesh Polyester Material: Collects water vapor to be harvested and reused
5. Galvanized steel and concrete: utilized for underground water storage, pipes, tanks, and pumps.
6. Steel: The primary structural material to support the form

**CONCEPTUAL COST ESTIMATE**

1. Ponderosa Pine: $300/MBF
2. Scrap Metal: $0 (collected from recycle camp in Gerlach)
3. Polyester Mesh: $0.58/sq.ft.
4. Solar Panels: $0.70/watt
5. Concrete: $120/sq.yd.
6. Steel: $6-20/ft

**STRATEGY FOR PROTOTYPE DEVELOPMENT**

First, a large capacity storage tank will need to be placed. Concrete foundations for the tree’s center poles will need to be dug and placed. Steel Columns will need to be attached and plumbing will need to be dug in and placed underground. Once all plumbing and electrical lines including a filtration system, the necessary pumps, pipes, electrical converters, charge controller, and energy bank, construction can begin on the tree assembly. The column will be wrapped in concrete. A small water collection tank, electrical converter, necessary plumbing and electrical lines will be attached to the column. Steam bending will be used to create the curvilinear forms of the structure. The water catching funnel will be constructed and placed at the top of the center column attaching to the proper plumbing lines. Next, the photovoltaic panels will be installed on dual axis trackers on the canopy like structure within the center of the form. Finally, the meshing and collection points will be installed utilizing eyelet screws and small gauge cables attaching the mesh to the steam bent forms. Recycled materials will wrap the exterior of the trees as finishing touches.

**ENVIRONMENTAL SUMMARY**

Black Rock Vitality seeks to engage visitors of Fly Ranch through a regenerative form that targets three systems: water, energy, and shelter. The project aims to generate the site’s energy needs from renewable resources, of which will all be generated on the site itself. In order to create a successful design, it was most critical to understand the needs of the land and its users.

Considering Fly Ranch desires to increase the annual visitor count, along with understanding the Burning Man Festival is an extensive event infused within the land, the need for water harvesting is at most high. The tree's design focuses on two systems in regards to water harvesting. First, the roof spans across a large amount of square footage collecting rainfall throughout the year. The large funnel at the top of the tree uses gravity to drain water into collection tanks. The mesh within the curvilinear shapes harvests atmospheric water vapor from rain, fog, or dew. The mesh condenses the vapor into water droplets. Gravity then drains the water into collection tanks awaiting to enter the filtration process. Considering the recommended water intake for a visitor to the burning man festival is 1.5 gal per day per person and there can be over 90,000 visitors per year requiring 135,000 gallons of water. These two systems can generate over 487,000 gallons of water per year which can accommodate 325,000 visitors. In the event these two systems can not produce enough or fail, a pump is placed within the adjacent reservoir. Together, the three systems can generate 2.8 million gallons of water per year and accommodate over 1.8 million visitors.

In addition to the water harvesting component of the design, there are also other means of caring for the site. Adhering to the Burning Man principle of “leaving no trace”, Black Rock Vitality respects the environment and maintains the purity of the site. The proposed design is intended to be used and operated by its visitors. This is the primary factor in facilitating success of the installation as both sustainable design and an interactive, educational model. One of the key objectives of the project is to create a replicable model that can be implemented in other areas; the overall design is easy to manufacture. In terms of carbon offset, thin film, dye-sensitized solar panels have an advantage over standard solar panels. In regards to the effects of our proposal on the natural environment, the solar panels require much less material to produce, thus reducing emissions. They are also easy to install, which minimizes costs.

The main intention in Black Rock Vitality is to allow the visitors to pause and reflect. Not only is the design useful in the regenerative sense, but it also is work of art in the landscape, thus serving multiple purposes for its users. It shows the unique collaboration between art, architecture, and nature. Users are urged to change their current habits and create a more sustainable future, thus honoring the Burning Man philosophy.