SALT CIRCUIT

A COMMUNITY-BASED HALITE SYSTEM CONCEPT FOR BURNING MAN'S FLY RANCH

NARRATIVE:

Under vast cerulean skies lay the remnants of the once great Lake Lahontan, a massive salt-water body that spread across the region. Present for thousands of years, it shrunk gradually as the globe eased into the end of the Pleistocene. Cut off from its headwaters and severed from local aquifers, Lahontan boiled away until all that remained was its mineral precipitate, a saline fossil scarring the landscape.

We've chosen to draw our inspiration for Fly Ranch from the halite crystal, the distilled form of elemental residue abstracted from the absence of the lake.

Our goal for Fly Ranch strives to incorporate novel energy generation, local food production and community development all within the limits of one space. Our halite inspired houses are composed of modular and adaptable forms that draw inspiration from the isometric structures of the halite crystal. This self-sustaining space composed of individual homes and communal kitchens is supported by a saltwater greenhouse powered through the combination of solar technology and passive saline evaporation. Connecting the site is a series of solar concentrating boardwalks which function as the solder of our circuit. These connectors simultaneously protect pedestrians from the harsh elements of the site as they move around, while also generating renewable energy. Ecozoic toilets incorporated across the site allow for the safe and ecologically responsible management of biological waste, as well as the eventual incorporation of said waste into our desert botanical garden as fertilizer.

The pride of our site is our land art generator sculpture, which doubles as a central pavilion. Yet another form on-site that draws inspiration from the cubic nature of the halite crystal, our sculpture incorporates a unique take on solar energy by using transparent, tinted solar panels. This system is supported by a salt brick matrix, sourced directly from the playa and the precipitate provided by the saltwater greenhouse. The combination of these two materials embodies the site on both a physical and derivative level, and will serve as an iconic addition to the Fly Ranch landscape.

We strive to develop a system powered by its own landscape that simultaneously evokes the structure and architectural characteristics of the halite crystal.

ACTIVITIES:

- ***Experimental Energy Generation and Distribution***
- *Similar to earlier sections, the Fly Ranch space is a perfect candidate for experimentation. By installing uncommon technologies, it provides a chance for these forms to be tested in a high intensity environment but at a low-stakes setting where they can receive plenty of exposure and public attention.*

- ***Artistic Opportunity***
- *Surrounded by the visual splendor of mountains, deserts, playas and hot spring, Fly Ranch has the raw environmental quality to inspire any artist. Combine this with a level of isolation so unrivaled that the Fly Ranch area is ranked as one of the highest in the nation for lack of nocturnal light pollution. Not to mention, the vastness and the inert condition of the playa lends itself to large scale sculptural experimentation, perfect for massive installations that test the capabilities of integrating art and science into one unit.*

- ***Research Center***
- *While the visual character of the site is stunning, Fly Ranch has a plethora of features that are rarely found across the surface of the entire planet. Take for example the biological diversity found in the local water systems. Because of the unique solutes found in the water, a variety of extremophilic biotic communities have risen, many of which are composed of site specific organisms. Even the playa itself serves as a living laboratory. The presence of halophytic botanical communities provides an opportunity for an investigation into how we can better prepare our coastal ecosystems for the increase in soil salinity that's sure to come as our planet's oceans rise. Fly Ranch is an ecosystem taken to the extremes, and it has the research potential to fascinate ecologists, biologists and planners for decades.*

- ***Camping***
- *A site like Fly Ranch deserves to be engaged. Between the vast natural splendor and the immense potential for developable programming, Fly Ranch lends itself to visitors as a space to be explored. By providing a system for visitors to do just this, we'll be establishing an outlet for human engagement with the unique ecosystems and geographies spanning the area.*

RESOURCE INPUT:

- **Solar energy**
- Our generative technology is centered around utilizing solar energy, due to its local abundance. Out of 365 days in the year, the area received 251 days of sun, which we estimate will provide us with an irradiance value of 5.5 kilowatt-hours per meter squared.
- Access to the dissolved saline water provided by the flooded playa
- Required to operate the seawater greenhouse
- **Link:** *https://seawatergreenhouse.com/*

- **Solar panel maintenance and cleaning**
- Due to the density of the airborne particulates across the site, solar panel cleaning would have to occur at a higher rate than usual. Luckily, recent developments into AI and robotics have led to the creation of robotic, waterless cleaning systems, perfect for use in the desert.
- **Link**: *https://www.ecoppia.com/about/*

- **Circuitry analysis**

- **Greenhouse maintenance**

- **Saline water balancing**
- When the playa isn't flooded, we still need a source of water to maintain the cooling and irrigation systems that maintain the greenhouse. For this, we propose seasonal connection to the local aquifers. The water provided by these was deemed non-potable by the surveyors, but is suitable for crop irrigation, and can be redirected to maintain the saline solution.
- **Greenhouse farming and crop tending**
- **Link**: *https://d1nw62gticy6e9.cloudfront.net/uploads/Vegetable_Yield_Calculator.xlsx*
- **Link**: *https://aggie-horticulture.tamu.edu/smallacreage/crops-guides/greenhouse-nursery/greenhouse-vegetables/)*
- **Link**: *https://www.gardencentermag.com/article/sizing-the-greenhouse-water-system/*

Greenhouse Footprint	# of Growing Cycles	Food Potential per sq./ft	lbs. Produced per season	# of Greenhouses	Total lbs. Produced	Laborers Required	Irrigation Requirement
3750 sq. ft	*2*	*2.5 lbs.*	*9375 lbs.*	*1*	*18750 lbs.*	*2 laborers*	*1312.5 gallons*

SALT CIRCUIT

A Halite-Based System Module for Burning Man's Fly Ranch

Energy Consumption and Generation Calculations

Lat.	41.25 N	
Long.	-119.7 W	
ANNUAL	(kWh)	(MWh)
Total Production	610,271.68	610.27
Total Consumption	(143,345.99)	(143.35)
Net Site Energy	466,925.69	466.93
Walkway System Production	373,022.41	373.02
Total Residential Production	133,981.14	133.98
Total Greenhouse Production	88,767.14	88.77
Solar Cube System	14,501.00	14.50
Total Residential Consumption	(105,120.00)	(105.12)
Total Green House Consumption	(38,225.99)	(38.23)

Walkway System

Area of Main Pathway		
CAD m^2		Conv. Ft^2
	2,436.80	7,994.75
	62.4	204.72
Area of Secondary Pathways		
CAD m^2		Conv. Ft^2
	42	137.80
	15.2	49.87
	18.6	61.02
	24.5	80.38
	26.4	86.61
	18.4	60.37
	51.4	168.64
	19.8	64.96
	17	55.77
	15.4	50.52
	24.6	80.71
	23.4	76.77
Total Area		
	2,795.90	9,172.90
Total Allowable Solar Area		
	1,845.29	6,054.11
System Sizing		
Product	Solar Roadway	
Efficency		18.5%
System Size (kW)		276.3
Tilit		0
System Losses		11.42%
Inverter Eff.		0.96%
Annaul Energy Production (kWh)		414,469
System Size (kWh/m^2)		148
Annaul Energy Production After Transmission (kWh)		373,022
Annaul Energy Production After Transmission (kWh/m^2)		133
Month	System Output (kWh)	
January		14,203
February		20,135
March		32,619
April		41,243
May		51,356
June		54,232
July		55,218
August		50,481
September		38,016
October		27,407
November		16,295
December		13,264

Residential Roof System (per home)

Area of System		
m^2		Conv. Ft^2
	60.3504	198
System Sizing		
Product		
Efficency		19.0%
System Size (kW)		8.9
Tilit		20
System Losses		11.42%
Inverter Eff.		0.96%
Annaul Energy Production (kWh)		14,887
Annaul Energy Production After Transmission (kWh)		13,398
Month	System Output (kWh)	
January		749
February		844
March		1,259
April		1,384
May		1,575
June		1,640
July		1,706
August		1,668
September		1,447
October		1,198
November		801
December		616
		14,887

https://www.cesa.org/assets/2017-Files/Standards-and-Requirements-for-Solar.pdf

Residential Energy Consumption (per home)

Area of Home		
m^2		Conv. Ft^2
	182.88	600
Residential Consumption Retracted		
Electrical Loads	2 w/ft^2	
Area	600 ft^2	
System Loads (kWh)		1.2
Annaul System Loads (kWh)		10,512.00

Greenhouse Energy Production

Allowable Solar Area		
m^2		Conv. Ft^2
	377.19	1237.5
System Sizing		
Product	Soliculture	
Efficency		7.0%
System Size (kW)		56.6
Tilit		23
System Losses		11.42%
Inverter Eff.		0.96%
Annaul Energy Production (kWh)		98,630
System Size (kWh/m^2)		261
Annaul Energy Production After Transmission (kWh)		88,767
Annaul Energy Production After Transmission (kWh/m		235
Month	System Output (kWh)	
January		4,703
February		5,864
March		8,135
April		9,121
May		10,532
June		10,695
July		11,199
August		11,044
September		9,378
October		7,772
November		5,475
December		4,714
		98,630

http://www.soliculture.com/lumo-technology/

Greenhouse Energy Consumption

Area of Green house		
m^2		Conv. Ft^2
	1143	3750
Greenhouse Consumption		
	(kbtu/ft^2)	(kWh/ft^2)
Baseline Source EUI	52.7	15.44484536
Proposed Salt Greenhouse EUI	34.782	10.19359794
Annual Energy Consumption	130432.5	38225.99226

https://www.sciencedirect.com/science/article/pii/S0011916417302400?via%3Dihub
https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf
https://www.sciencedirect.com/science/article/abs/pii/S0376738803002175

Solar Cube Design

Dimensions per Cube		
Average Area per side		
m^2	Conv. Ft^2	
	0.896112	2.94
Average Area all sides		
m^2	Conv. Ft^2	
	5.376672	17.64
Average Single Cube Volume		
m^3	Conv. Ft^3	
	155.4320698	5489.031744
Dimensions Total Design		
m^3	Conv. Ft^3	
	2642.345187	93313.53965
Allowable Solar Area		
m^3	Conv. Ft^3	
	1321.172594	46656.76982
Solar Production per Cube		
System Size (kW)		0.2
45 degrees west (kWh/year)		252
45 degrees east (kWh/year)		263
22.5 degrees south (kWh/year)		338
Total (kWh/year)		853
Total System Production		
Annual Production		14501

MATERIALS:

- **BOARDWALK**
- Planking
- Posts
- Fasteners
- Sub-grade Protection

- **HOUSING**
- Corrugate metal paneling
- Glass paneling
- Electrical utility systems
- Sub-grade protection
- Electrical utility systems

- **ECOZOIC TOILETS**

- **COMPRESSED SALT BLOCKS**

- **CLEAR SOLAR PANELS**
- ***Transparent Luminescent Solar Concentrator (TLSC) ®***
- Technology developed my Michigan State University
- **Link**: *https://www.extremetech.com/extreme/188667-a-fully-transparent-solar-cell-that-could-make-every-window-and-screen-a-power-source*
- ***ClearVue Solar Panels***
- **Link**: *http://www.clearvuepv.com/products-solutions/technology/*

- **STANDARD SOLAR PANELS**
- **Link**: https://www.wholesalesolar.com/1977433/astronergy-solar/solar-panels/astronergy-chsm6612p-hv-345-silver-poly-solar-panel

- **SALTWATER GREENHOUSE**
- ***Seawater Greenhouse ®***
- **Link**: *https://seawatergreenhouse.com/*
-
- **GREENHOUSE SOLAR PANELS**
- **Link**: http://www.soliculture.com/wp-content/uploads/2019/04/Datasheet-LUMO20M100GH.pdf

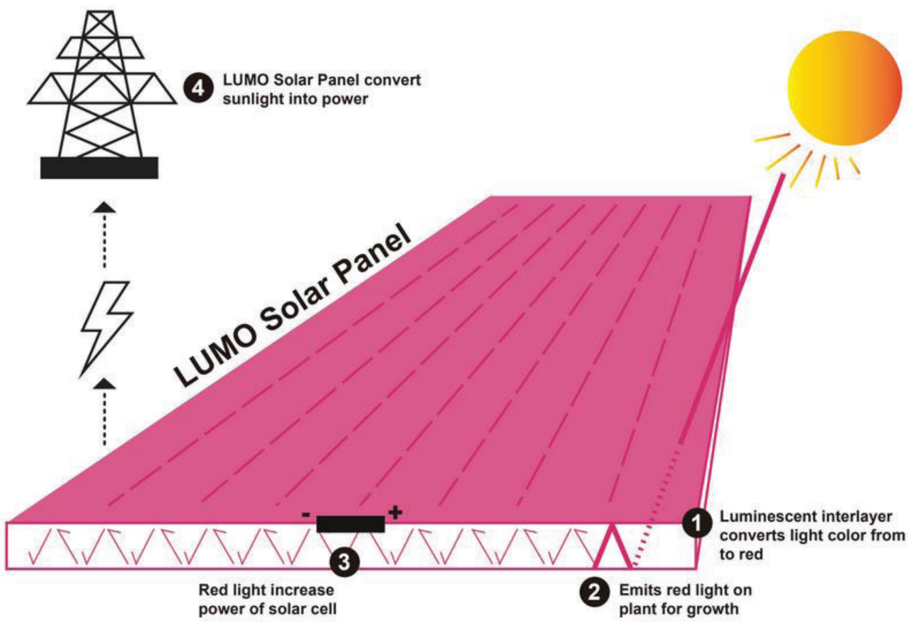
TECHNOLOGY:

After a careful analysis of the natural resource capabilities of the site, we've decided to center our sustainable technological development around solar electrical generation, using a variety of forms to establish a visually interesting yet productive land art generator model.

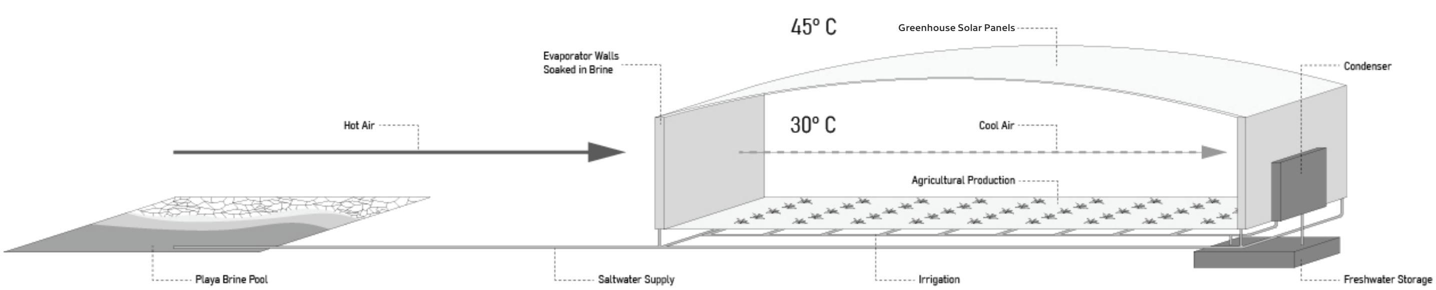
Our primary generative form is the clear solar panel, a developed take on standard luminescent solar concentrator technology. The clear solar panel, used in our land art generator sculpture and central pavilion, differs from the standard form in that it absorbs only a select portion of the light spectrum, specifically the non-visible infrared and ultraviolet regions, thus allowing the rest of the spectrum to flow freely through the panel. Within the confines of the standard glass panels that encompass the solar absorption unit lies a system of organic salts and circuits that capture the solar radiant energy. These salts are excited by the presence of certain wavelengths of light, and then transfer this energy to the adjacent circuits which then convert it into usable electricity. These can be modified in a variety of ways to allow different sections of the visible spectrum to escape capture and subsequently, flow through, effectively altering the color of the glass. Across our site, we'll be using a fuchsia tinted solar panel, for both visual aesthetic and experimental reasons. Current research shows that greenhouses that incorporate glass with the same fuchsia tint our panels contain can expect a higher produce yield. This can be attributed to the shift in the light spectrum the tint establishes, which stimulates the photosynthetic process better than standard white light would (**link**: https://www.engineering.com/ElectronicsDesign/ElectronicsDesignArticles/ArticleID/16509/Little-Pink-Greenhouses-for-Food-and-Electricity.aspx)

Connecting our structures on site is our boardwalk system, a rectilinear system that mimics the standard electrical circuit as an homage to the Salt Circuit title. To shield pedestrians from the harsh conditions, the boardwalk is covered in a solar panel shade structure, which simultaneously protects patrons and generates solar energy.

Our greenhouse was inspired by structures used across similarly saline adjacent systems and draws its power directly from solar energy. The greenhouse is adjacent to the playa, which when flooded, provides an ample supply of salt-saturated water. By pumping the water across certain walls of the greenhouse, air-currents that intersect with the structure work to passively cool the inside of the structure. The reduced temperature of the system stabilizes the local internal environment, increasing its habitability and potential for growing crops. In addition, the originally salt-saturated water, an originally unusable resource on site, is stripped of its halite component through evaporation, and is condensed in a subterranean system, which stores the newly purified freshwater. The condensed freshwater is to be used as the irrigation supply for greenhouse crop production, effectively completing the greenhouse resource circuit.



Colored Solar Panel Diagram
April, 2020



Saltwater Greenhouse Diagram
April, 2020

ENVIRONMENTAL IMPACT SUMMARY:

As the majority of our design interacts with the playa and its surrounding halophytic landscape, we expect the overall environmental impact of our land art generator project to be minimal.

With the playa being an ecosystem of minimal biotic development occurring on or below its salt-crust surface, our major concern is centered around the dust and airborne particulates that might be agitated during the period of construction development. Visitors to the adjacent Burning Man Festival have described the dust phenomenon in great detail, explicitly stating its detrimental effects on human health. To mitigate the risks of the dust, we plan to mirror Burning Man's coping technique by mildly saturating the ground adjacent to construction, effectively reducing the ability of dust to establish an airborne presence.

In terms of inland development, we acknowledge that our proposed design does intersect with an established sagebrush community, which we intend to restore. Our project includes a planting palette and modular planting plans that incorporate only native and locally present species. We intend to redevelop the disturbed ecological community in a method that not only restores the native biota, but also utilizes the on-site botanical diversity to increase visual quality across the site.

Biological waste is always a topic of concern when a space is being developed for human use, and because of its serious health and environmental impacts, we've worked to find a solution that will not only negate the risks, but will also benefit the ecology of our design. Ecozoic toilets have been used across Fly Ranch for some time now, and we're interested in expanding their presence throughout our site. Ecozoic toilets have the capability to convert human waste into usable fertilizers, which we plan on using for the development of our desert botanical garden, thus maintaining a closed-circuit nutrient system within the confines of the site.

As this is an energy generator project, it must be acknowledged that some raw material is to be subtracted from the site in order to fund the generation of usable energy. The greenhouse model utilizes the on-site saline water provided by the flooded playa, but strictly subtracts the saline solution from the environment and does not input any locally produced byproducts to the ecosystem. As the amount of saline solution subtracted is minimal and no product is returned into the system, the introduced system will have little, if any, negative impact on the local ecosystem. Our solar absorption unit requires the presence of sunlight, and to function, must absorb and effectively remove sunlight from the local system. In many situations, this would restrict the photosynthetic capabilities of the adjacent landscape, severely limiting the botanical development of a space. However, as our primary solar panel system is located in an area with minimal botanical development in the first place, the level of disturbance is minimal and should not negatively affect the local ecosystem.