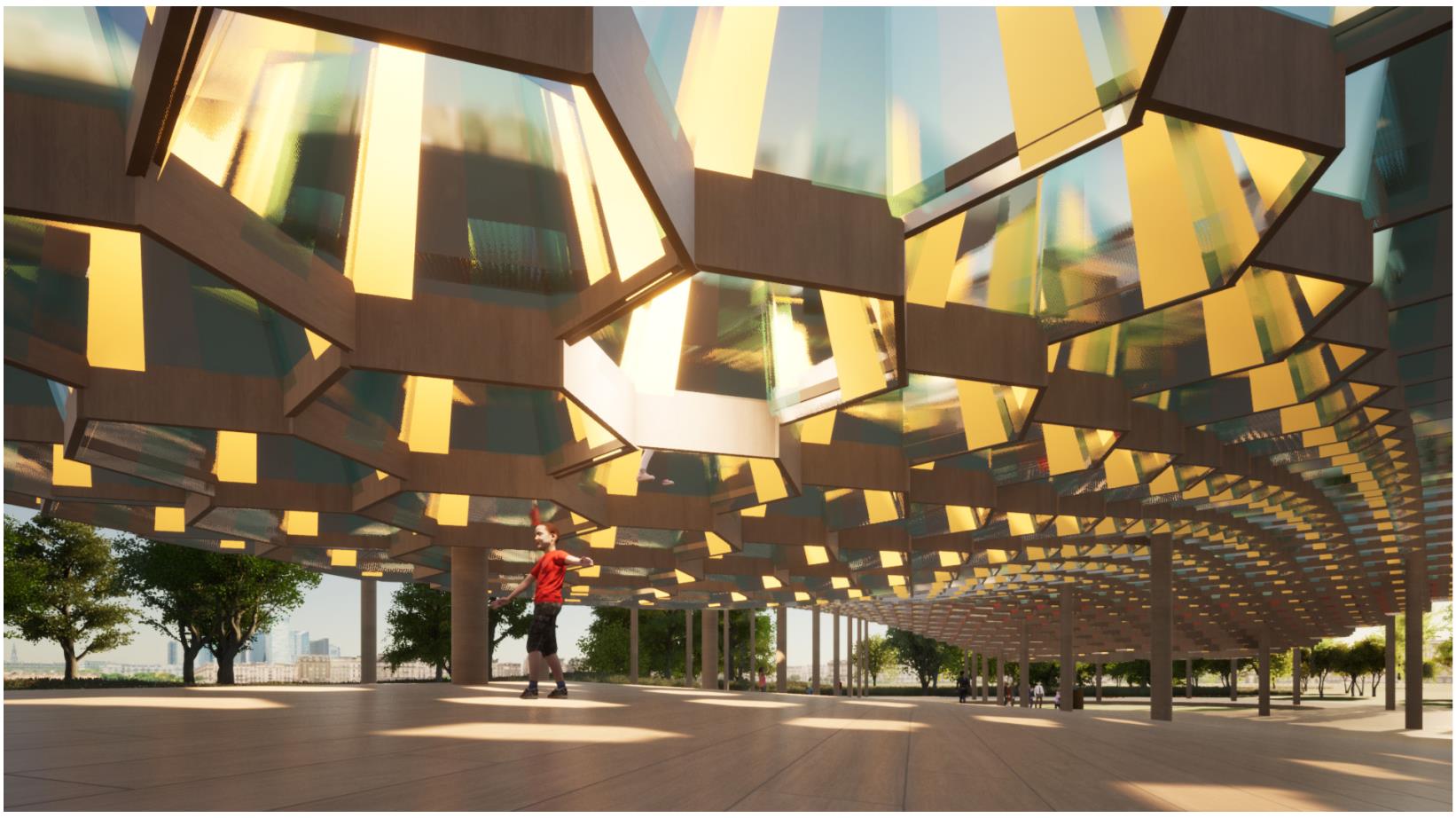
Kaleidoscopic Dune

LAGI 2022 Mannheim / Complementary information



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Kaleidoscopic Dune

I. Project statement

Our response to inclusion of renewable energy sources:

The Spinelli barracks once used by the German Wehrmacht as a pioneer barracks and by the US

army as a warehouse is to be dismantled and connect them to a continuous green corridor, which

would improve the microclimate and supply fresh air in the surrounding districts in the long run.

The aim of our design is to apply the principles of modularity, scalability with a focus on the renewable

energy generation and sustainable sourcing of materials. Also, the design was based on the idea of

reassembly so that it can be reassembled elsewhere without the need to be fabricated.

Our design was inspired by light and it is evident in the choice of our renewable energy technology,

the inclusion of kaleidoscope and bioluminescent plants.

A concentrating solar collector was chosen as it can give more energy output for the same photo-

voltaic cell area. The energy generated by the photovoltaic cells will be used to power the pavilion

and its equipments namely, light for the concert area, cell phone charging points, musical instru-

ments, electric vehicle charging points. The remaining energy is then sent through the grid to be

used by the city of Mannheim.

A Kaleidoscope is equipped to the wooden construction so that it gives a unique visual eﬀect. Bio lu-

minescent plants have also been included so that less energy for light can be used during the night

time. Our design takes into consideration the location, locality, site history, future expectations so

that a holistic solution can be proposed. Therefore, with the mission to inspire the community about

renewable energy technologies, we propose this design with the technological inclusions.

The yearly AC power output for our main structure is about 84.88 MWh.

Environmental impact summary

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Kaleidoscopic Dune



Our design is rooted in the principles of modularity, scalability, innovations of renewable energy ge-

neration and sustainable sourcing of materials. The aim is to generate enough renewable energy

from the sun to power the pavilion, its equipments and pass the remaining energy to the city of

Mannheim through the power grid.

Firstly, renewable, and reclaimed wood is sourced to build the structure. The machine operations are

simple and direct which makes it easier for mass production ensuring that the time is saved. Then

the wooden parts are coupled in a male-female system so that additional elements for ﬁxing of the

parts are eliminated. The intention is to collect the wood on site and from the nearby demolition

areas to reduce the carbon foot in material transportation.

The timber used is light timber so that it is easier to be transported and less energy is consumed

for transportation. For other materials, prefabricated products with low environmental impact will

be used to complement the proposal’s intent. The structure does not require heavy maintenance

and regular checks can ensure that large repair costs can be avoided. The structure has been de-

signed based on the principles of modularity and scalability with a high reassembly potential. This

means that the structure if it is built once can be reassembled elsewhere, without the need to be

fabricated again.

In conclusion, our proposal has low embodied energy in building materials, low energy intensity of

construction methods, high modularity and scalability and excellent reassembly potential.

Our proposal aims to inﬂuence the community about the extraordinary potential of renewable ener-

gy technologies and to encourage future designs to continually include them.

We can conﬁdently say that our project responds to many of the sustainable development goals, in-

cluding «Aﬀordable and clean energy», «Industry, innovation and infrastructure», «sustainable cities

and communities», «responsible consumption and production», as well as «Education» to a certain

extend, as our project as a recreational / learning aspect to it.

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Kaleidoscopic Dune



II. Modular structures conceived for both in-

habitants and public

In terms as of planning, the ﬂexibility of our structure allows us to cater to the needs of both public

and inhabitants, as the system is highly modular. we chose to focus our intervention on an axis that

will be probably very used. We concentrate the more public functions: Concert/ exhibition / Event /

Light Experimentation, as well as siting areas / garden, at the center of the site, at the crossroad of

all the directions. We dedicated smaller, more intimate area for the inhabitants, alongside this same

road with private gardens, playgrounds, and observatory.

We chose to focus our intervention on an axis that will be probably very used, as it deviates from the

main pedestrian axis, linking the «Theme gardens» and «Neo-Dune»

In addition, our project use bioluminescence plants to guide people navigate the area during the

evening, linking the diﬀerent pavilions. Those plants, created by a group of scientists, glow in the

dark. It is originally found in insects, sea creatures, mushrooms. The light of the plants, naturally

A group of scientists created plants that glow in the dark. This phenomenon is Bio Lumines-

cence. It is found in insects, sea creatures, mushrooms. They made it glow by injecting DNA from

glowing mushrooms into them. Their report says that plants injected with the DNA from the glowing

mushrooms glowed continuously throughout their life cycle from seedling to maturity. The light is

formed from a chemical reaction in the body. In the case of animals, the glow is used for diﬀerent rea-

sons including communicating with each other, ﬁnding prey, hiding from or warning oﬀ predators and

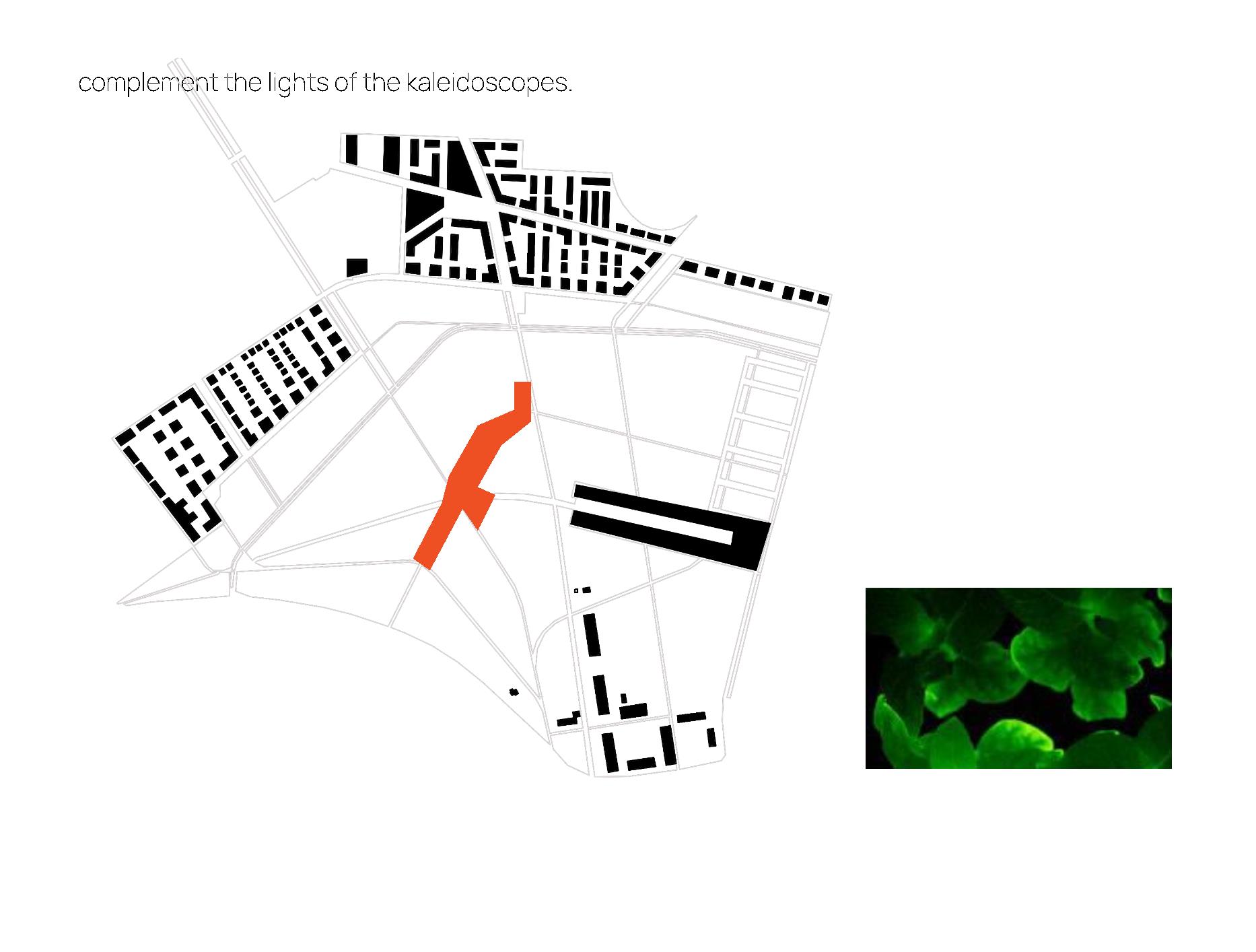
aꢀracting a mate. As much as 76 percent of ocean animals are bioluminescent, producing their own

light through a series of chemical reactions or containing bacteria give oﬀ light.

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Kaleidoscopic Dune



III. Conceiving an interactive and ever-chan-

ging space

Mankind has been living on the earth for a long time. It can’t be denied that in order to live, humans

need many elements from nature, ‘Light’ is one of the main elements that we need for living. We have

been using light for many activities, such as hunting, cooking, celebrating, or even for a funeral. It can

be seen that we can’t live

without ‘light’. Therefore, in this project, we would like to design a project that aims to celebrate the

relationship between humans and light, we would like to present another beautiful aspect of light

and we also would like to present the idea of how can we use the combination between technology,

art, and light to generate electricity in order to provide and inspire an idea of how we could produce

the clean energy and support the sustainable goal of the world.

The idea of this project is to design a modular structure system that can be adjusted to several de-

signs and can be connected to each other in order to create a bigger pavilion. One modular system

consists of more than 70 hexagonal kaleidoscope solar cell module. Inside Each hexagonal module

has a color glass and reﬂective glass which will reﬂect the light and it will create a kaleidoscope

eﬀect in the pavilion where users could experience another aesthetic or light during the daytime

and nighꢀime. On the top of hexagonal modules, we design an automatically rotatable solar system

that will harvest the sun’s energy in order to be used for activities in the pavilion and to be used in

Manheim city.

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Kaleidoscopic Dune



IV. Technology

Tracking system

rotational axis

rotational axis

A responsive facade system based on concentrating solar collectors called the Integrated Concen-

trating Solar Facade (ICSF)

The individual pyramid-shaped suspended glass modules can capture 85% of sunlight by moving

around a pin, rotating around the horizontal and vertical axis to respond to the path of the sun and

maximize the natural lighting. The structure of the pyramidal glass is particularly complex because it

is characterized by a primary (POE) and secondary optical element (SOE), a highly eﬀicient concen-

trator photovoltaic cell (CPV), and a water heat exchanger (HX).

The tracking system used is a bi-axis tracker which optimizes the position based on the altitude and

azimuth of the sun at that point of time for a particular location. The GPS sensor tracks the position

of the sun and provides the input to the altitude and azimuth positioning controller. They inﬂuence

the motor drivers and stepper motors to change the position accordingly. Then the information is

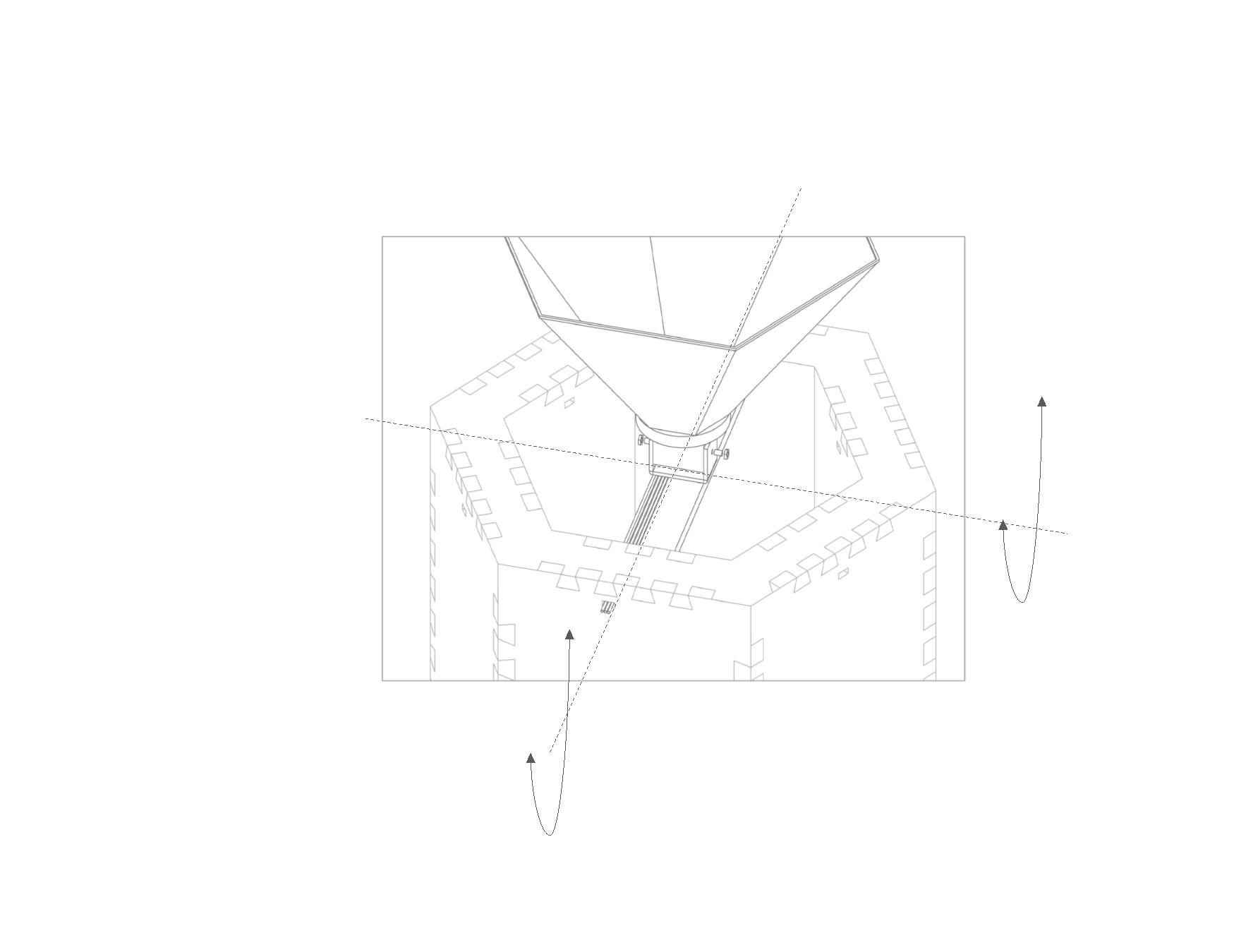
passed to an azimuth or altitude value encoder which provides feedback to the azimuth or altitude

positioning controller in a loop.

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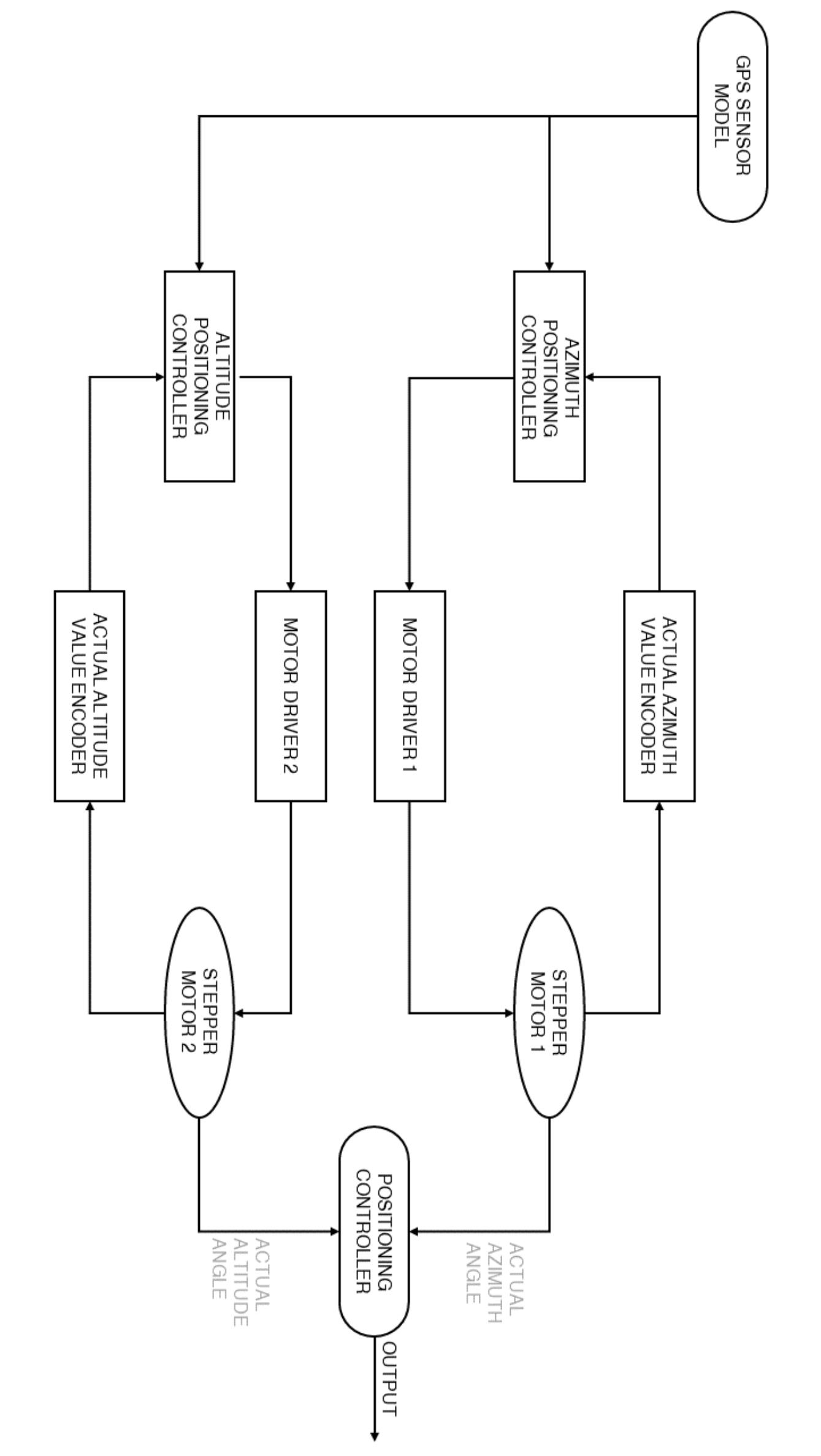
Kaleidoscopic Dune



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Kaleidoscopic Dune



The type of photovoltaic system used is a solar concentrating system with the help of a fresnel lens.

The photovoltaic cell (PV) has an initial contact layer which is placed side by side to anti reﬂective

coating. The top cell comes beneath this and is made of Indium Gallium Phosphide. The wide band

gap tunnel junction is underneath the top cell layer. The middle cell layer is made of Indium Gallium

arsenide. Then comes the tunnel junction beneath it. The region which acts as a buﬀer is then un-

derneath it and it is followed by the nucleation layer. Then the boꢀom cell made of Germanium is

under this, followed by the contact layer.

A multi-junction solar cell has multiple layers of diﬀerent semiconductor materials, each of which

produces electric currents in response to diﬀerent wavelengths of light. This means that, theoreti-

cally, multi-junction solar cells are capable of converting more sunlight that hits them to electricity

when compared to single-junction cells.

They produce electricity through the photovoltaic eﬀect. Light is absorbed by solar cells and elec-

trons in the semiconducting material. Loose electrons ﬂow through the p-n junction between se-

miconductor layers, creating an electrical current. The current is captured and transferred to wires.

Single-junction solar cells have one p-n junction to direct the ﬂow of electricity created when sun-

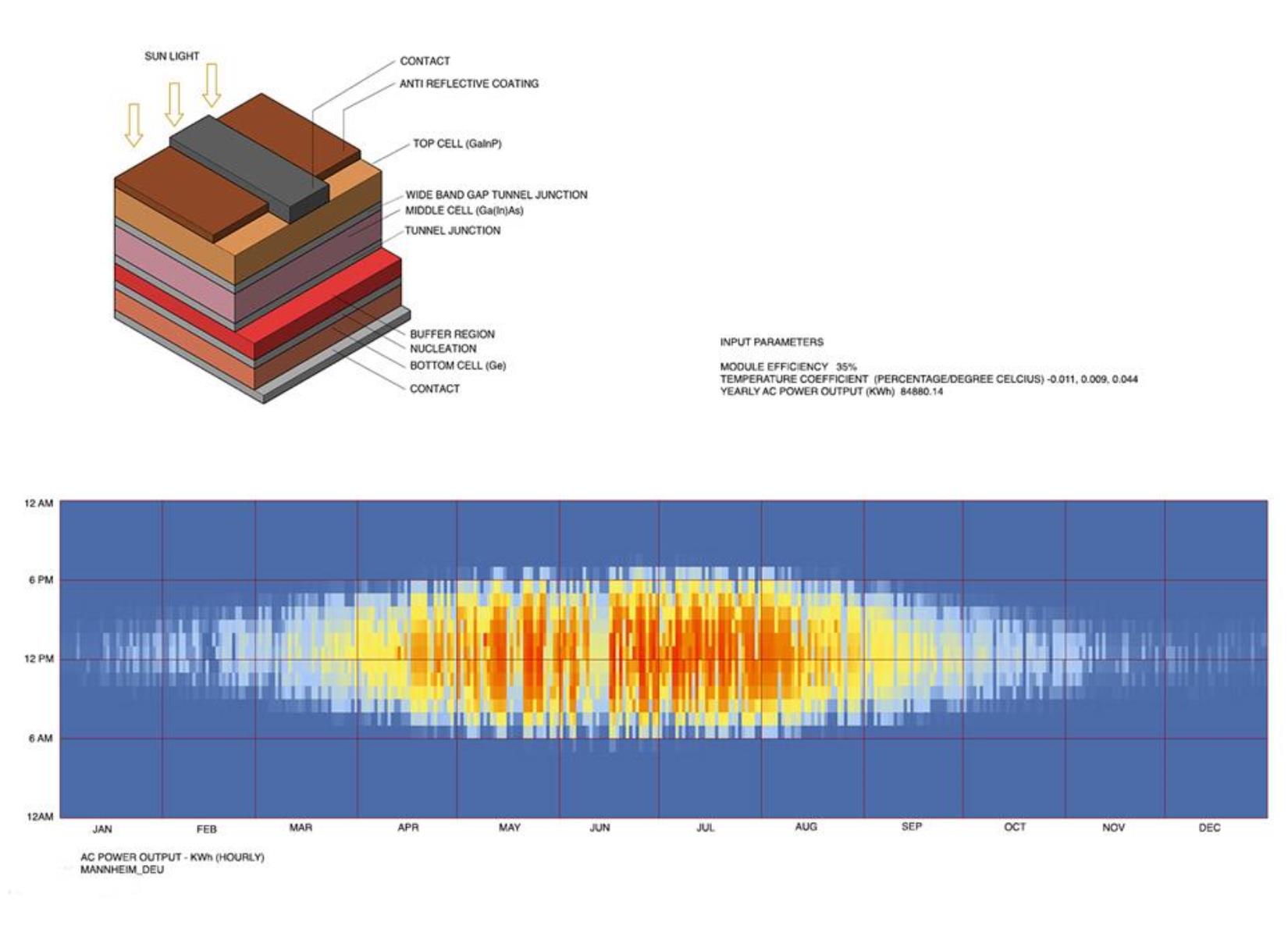
light hits a semiconducting material. In a multi-junction solar cell, there are multiple p-n junctions

that can induce a ﬂow of electricity.

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Kaleidoscopic Dune



Electrical System Details

Sun’s energy is the main input for our electrical system, each hexagonal module will harvest the sun’s

energy and every electric wire will be connected, and it will be combined into one electric wire. These

energies will be store in the main baꢀery which is located in between the foundation structure and

it will distribute to ﬂoor power outlets located at the 4 corners of the module.

Light bulbs

Charge controller

DC Load

Musical instruments,

electric vehicules,

cell phones

PV Module

Power grid to

Mannheim

city

Baꢀerie

Inverter

Switch control

AC Load

Back up

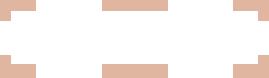
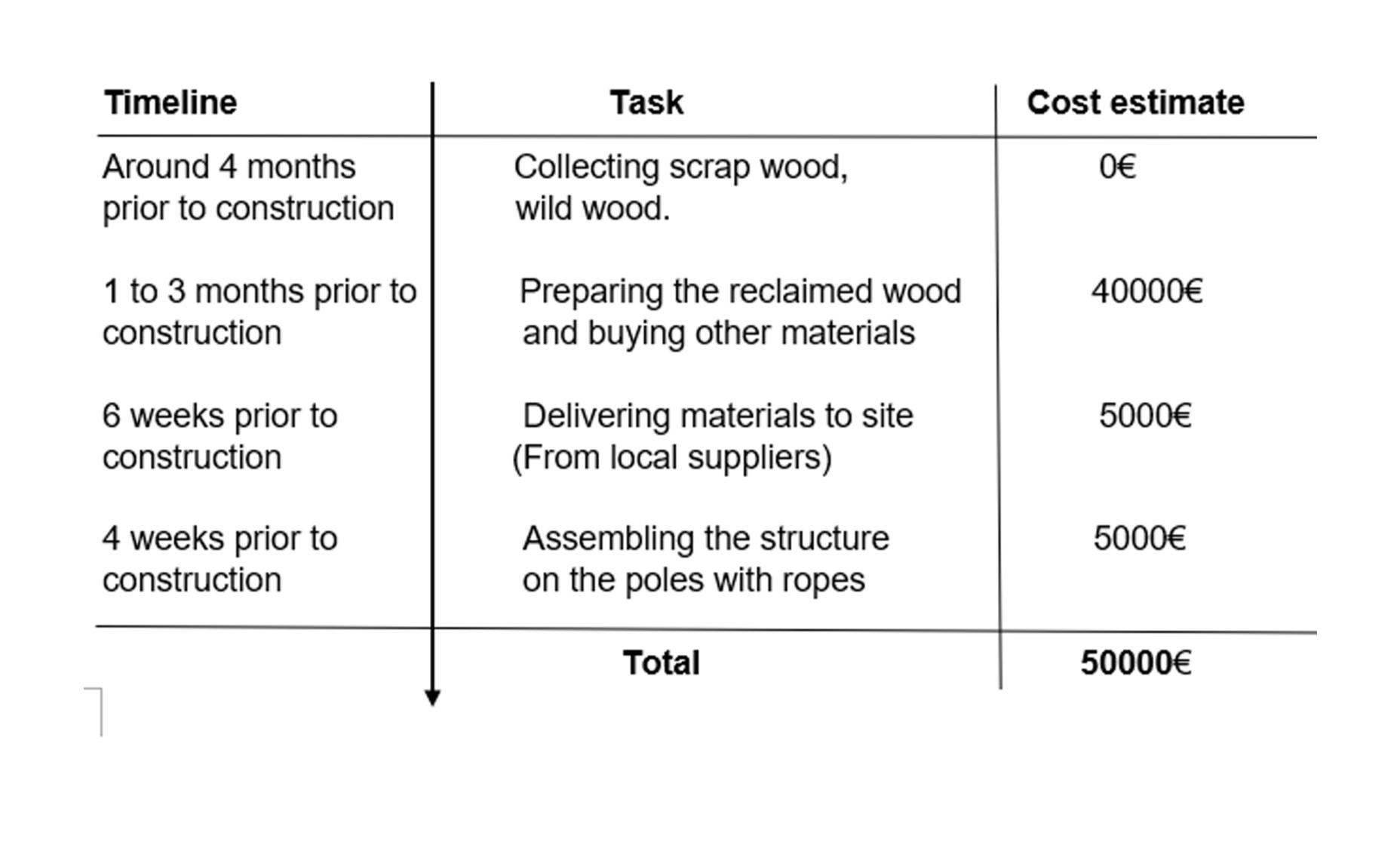
power

V. Cost estimate (main pavilion)

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Kaleidoscopic Dune



VI. Modular System Details

Top Anchor Point

Kaleidoscope

Solar Cell Module

Bottom Anchor Point

Floor

Galvanized

Hex Bolts

Manila Rope

⌀ 40 mm

Metal Plate

10 mm

Metal Plate

10 mm

Manila Rope

⌀ 40 mm

Hollow Steel Post

⌀ 20 mm

Tension System 2

The second point which need to be connected

by the tension system is the 4 corners of the

structure.

Tension System 1

At the ﬁrst tension system point, at the top

of the post, there are 4 metal plates that are

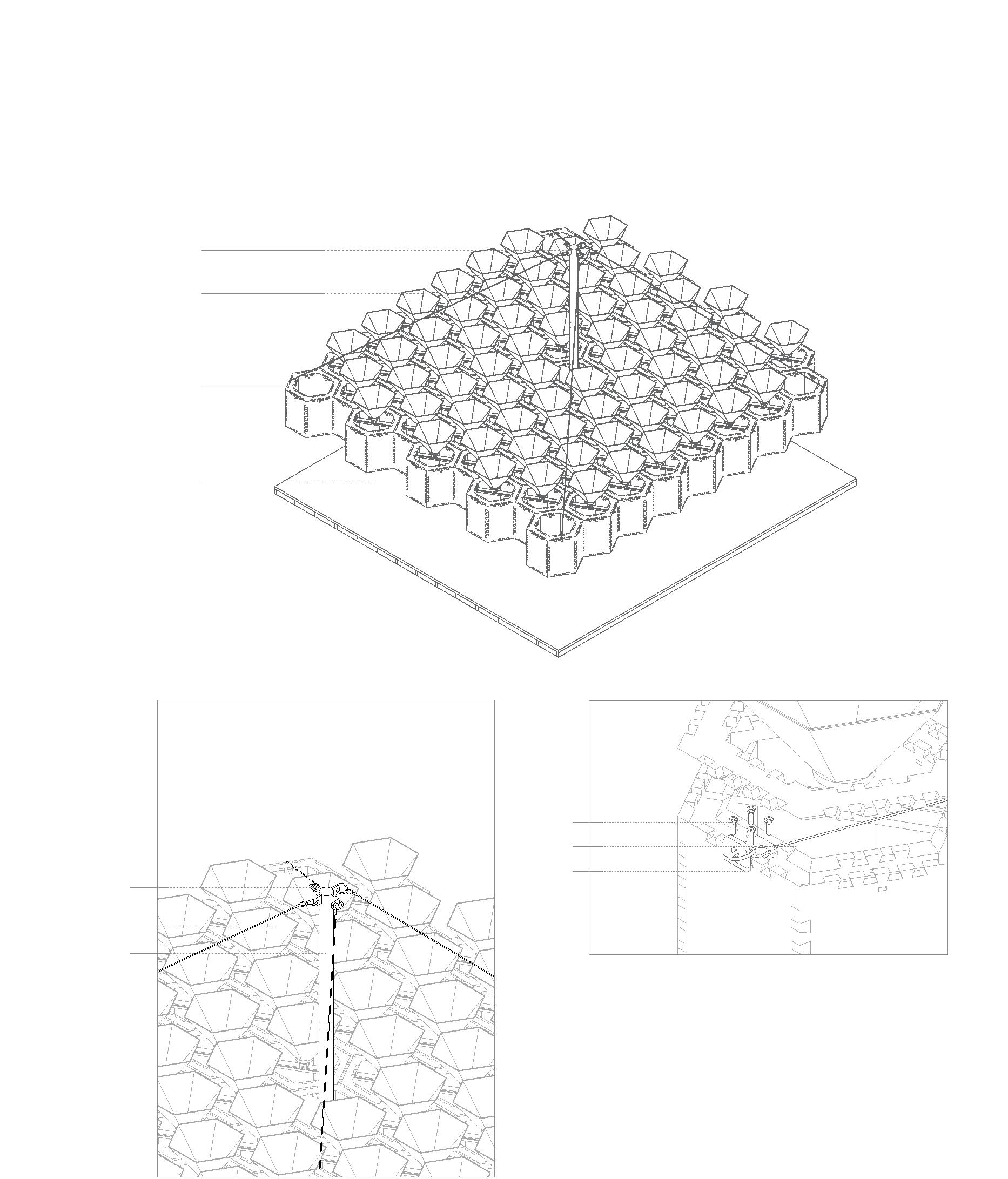
connected with the Manila rope for creating

tension.

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Alternative

Roof Shape

Flat Roof

Alternative Designs

The system that we’ve designed can be

adjusted into many designs by adjusting

the height of each hexagonal module and

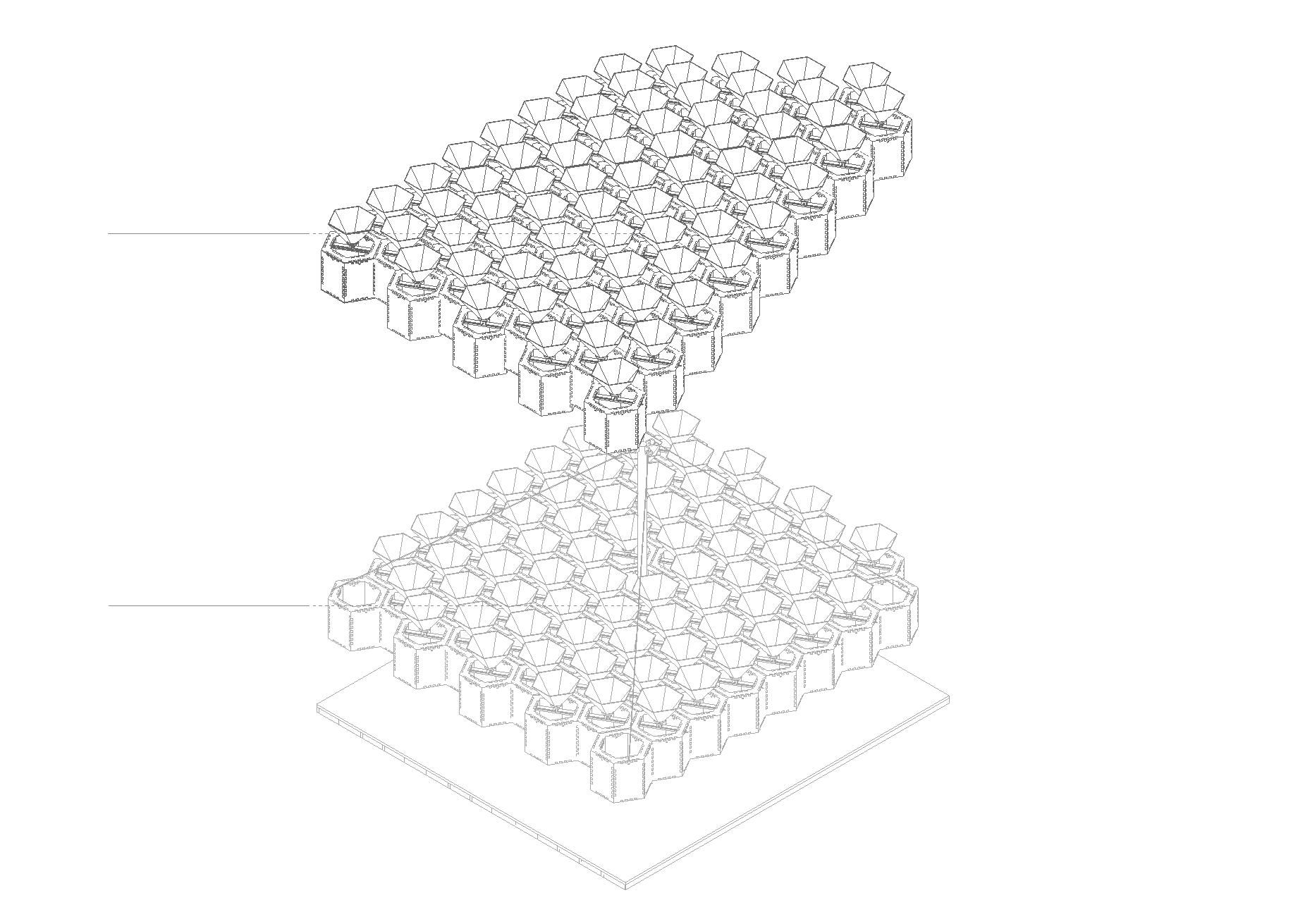
they can be connected to each other in or-

der to create a bigger space.

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Kaleidoscopic Dune



Kaleidoscope Solar Cell Module

Solar cell

Mirror

One Hexagonal Module

In one kaleidoscope module

consisits of the solarcell system

and the kaleidoscope system

Kaleidoscope Module

Coniferous Lumber

60 mm

Joint

The dovetail joint is used for the

joint system in order to reduce

unnecessary materials.

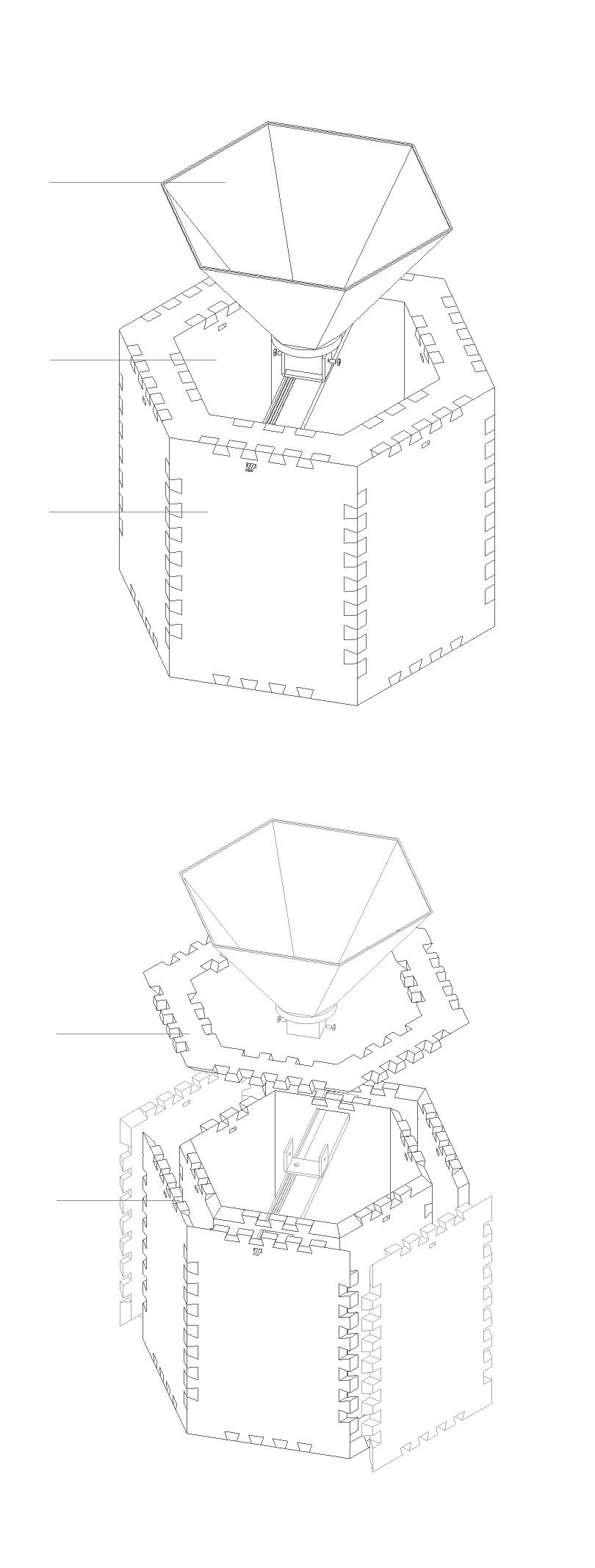
Dovetail Joint

@ 50 mm

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Kaleidoscopic Dune



Rotation Joint

10 mm

Galvanized Hex Bolts

Transparent Acrylic

10 mm

Wire Connector

20 x 40 mm

Solar Cell System’s Detail

The solar cell will be connected to

the rotating joint which will make the

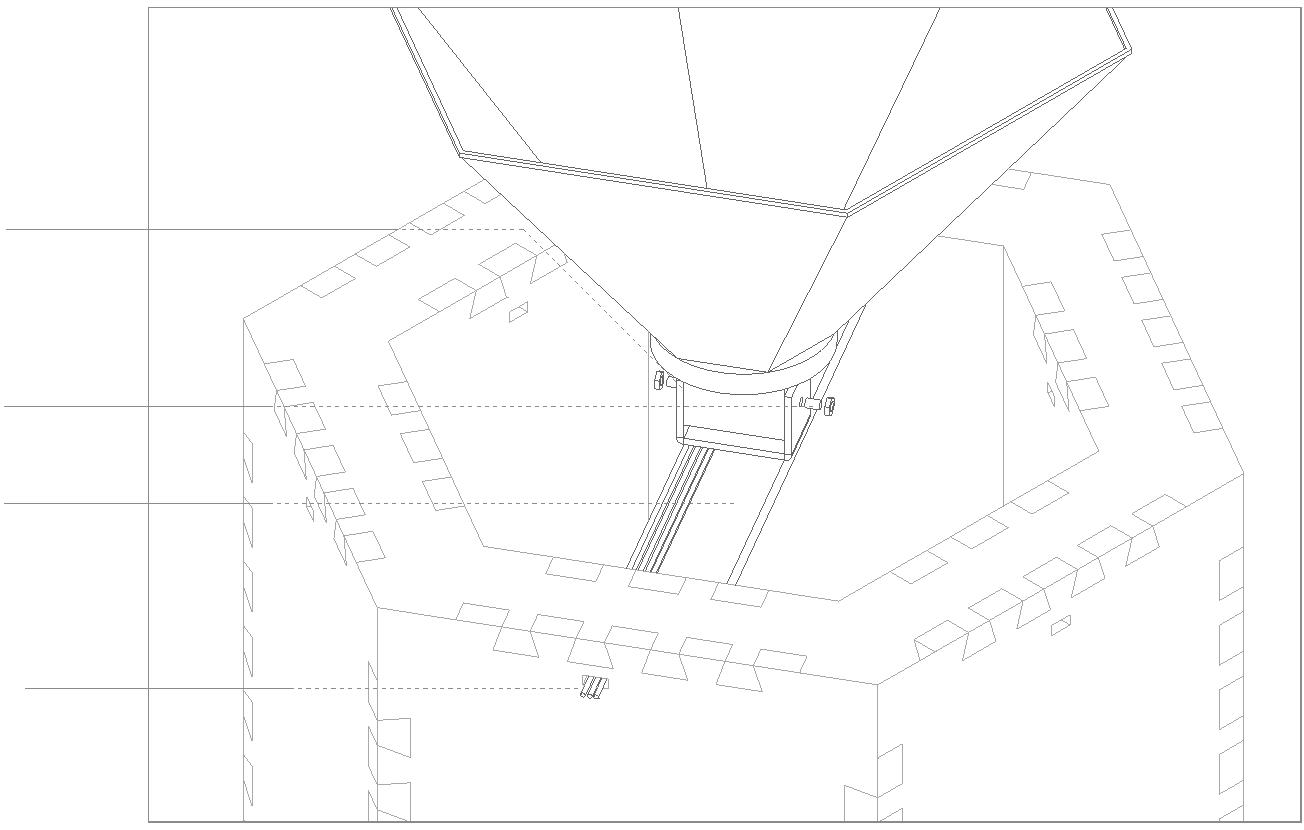
solar cell harvest the sun’s energy

from any direction.

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Kaleidoscopic Dune



Female Joint

Male Joint

Joint Between Each Modules

This part consists of 2 elements,

male and female joints. They can

be easily connected to each other

with the dovetail joint.

Male Joint

Detail of Joint Between Each Modules

In order to connect between each module, the male and

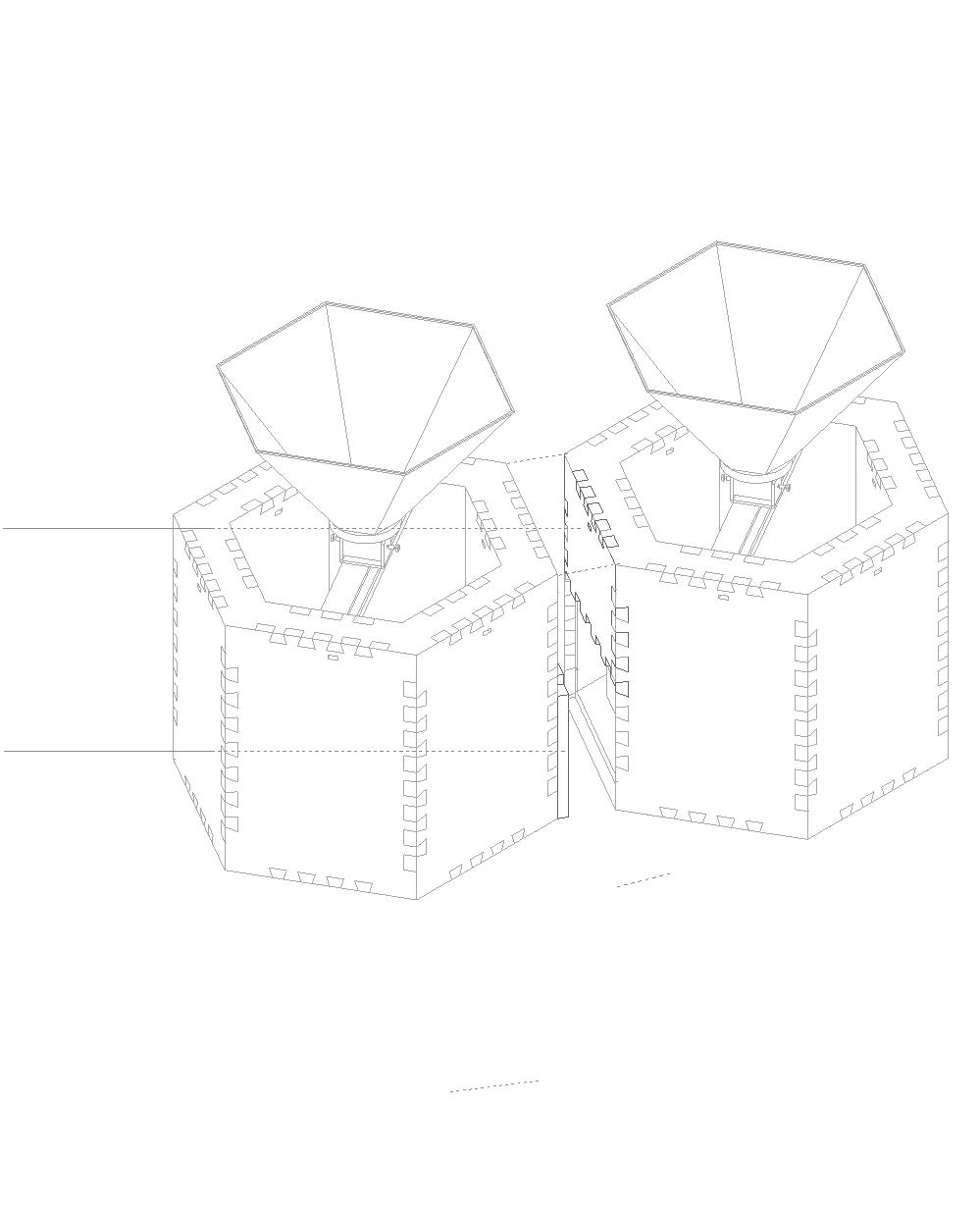
female joints need to be cut at a

speciﬁc length according to the pavilion’s height.

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Kaleidoscopic Dune



Main Pavilion

Exhibition Space

Semi Outdoor Concert Space

+ 9.00 m

▽

▽

+ 8.00 m

+ 1.00 m

+ 0.00 m

▽

▽

0.50 m

1.00 m

1.00 m

1.00 m

1.00 m

1.00

10.00

A

B

C

D

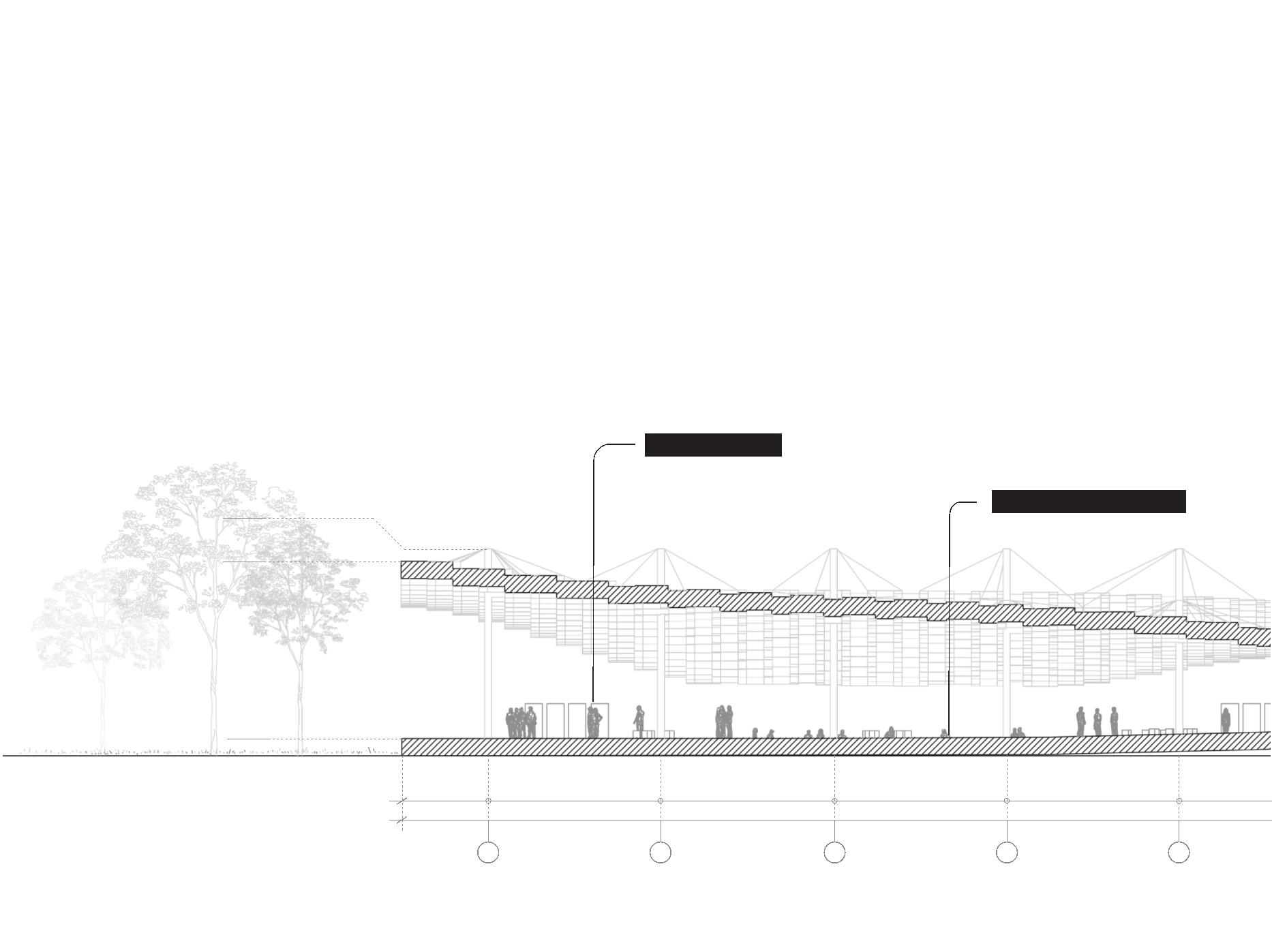
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Section

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Kaleidoscopic Dune



Semi Outdoor Concert Space

Kaleidoscope Modules

Exhibition Space

Relaxing Space

Light Testing Space

Entrance

Kaleidoscope

Solar Cell Module

Light Testing Space

Roof Tension System

Bioluminescent Plants

0 m

0 m

1.00 m

1.00 m

1.00 m

1.00 m

0.50 m

F

G

H

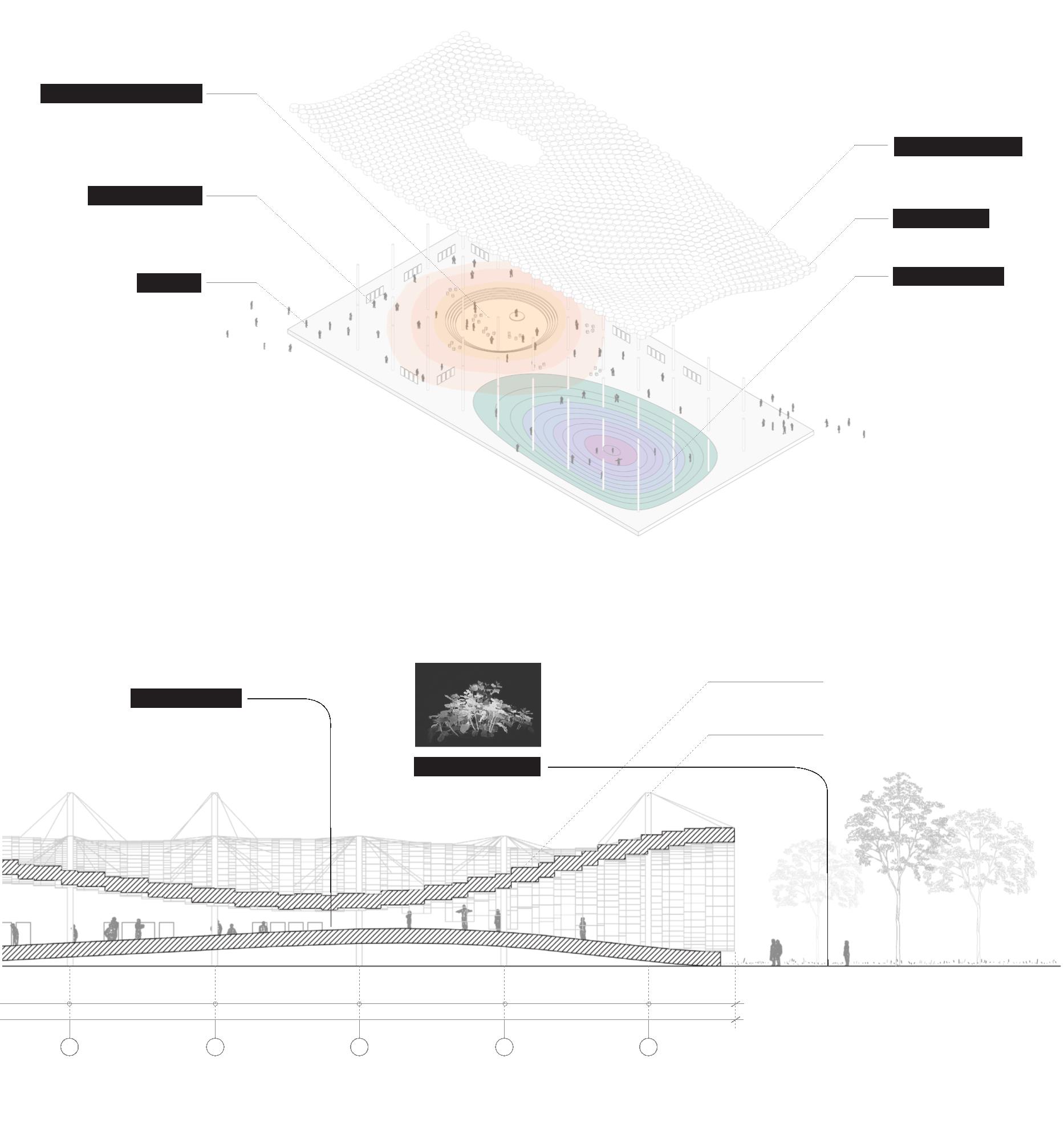
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J

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Kaleidoscopic Dune



Appendix: prototype model

We wanted to experiment

the kaleidoscope eﬀect by

creating a physical model

that would help us beꢀer

understand. We tried to

combine both color from the

ICFS system as well as addi-

tional colors within the ka-

leidoscope and then tested

out its eﬀect at diﬀerent

times of the day.

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Kaleidoscopic Dune



Appendix: prototype model

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Kaleidoscopic Dune

