**BIRD HIVE**

*Project Narrative*

How can our means of energy generation mimic nature in a way that invites its interaction; whether in a residential garden, urban city center, or anywhere in between? Bird Hive seeks to answer this question through a scalable design which grants flexibility and adaptiveness to properly fit the context of any site.

Bird Hive is a series of energy generating “flowers” designed to invite interaction with local fauna, i.e. birds. Like the honeycombed home of a bee, these “flowers” create a nesting hive for local bird species to occupy. An invitation to nature through designed form, calling it back to a zone of human interaction and occupation for the betterment of all which occupy it. A retracement back to once was, just as Mannheim’s Rhein-Neckar Green Corridor is inviting nature back within its cityscape.

Bird Hive seeks to support the return to nature that BUGA and Mannheim’s Rhein-Neckar Green Corridor are carefully planting back into the city by enhancing the experience of nature and green space in both Spinelli Park and anywhere Bird Hive is implemented through habitation by local bird species. In Spinelli Park, Bird Hive is strategically located adjacent to the BUGA gardens in order to provide direct access to occupying birds.Set along the north-south axis to take advantage of predominant winds from the south and morning to afternoon sun, Bird Hive hugs a primary circulation path. This offers an opportunity for passersby to pause, look, and listen. Occupied nesting platforms in each “flower” provide opportunity to witness and learn about local bird species. Visitors can begin to learn about some of their smaller neighbors and how to identify them by both sight and sound as they navigate through this green corridor.

In an effort to ensure Bird Hive’s viability wherever it may be desired, it is completely scalable to fit its location and surrounding context as well as reach desired energy generation goals. Bird Hive’s scalability generates its flexibility in use. It is not limited to a single context but is instead adaptable to work where needed. From a tree in your backyard to a towering skyscraper in the city, Bird Hive can scale appropriately and bring a joyful hint of nature along with it.

*Public Activities and Social Co-Benefits*

Bird Hive invites people to create a deeper connection to nature through an understanding of their local bird species. Many people are not familiar with what species occupy their location, what they look like, sound like, or how to identify them. Bird Hive can serve as a teaching tool to aid those interested in learning by serving as a node for bird activity resulting in greater sightings and interactions. Schools can use it as a teaching aid while bird watchers can use it as a hotspot for their hobby.

While Bird Hive has its benefits for people, it also has its benefits for the surrounding ecosystem. Through habitation of the area, birds can help the plants around them by spreading seeds, pollinating them, and eating pest insects, all of which will help to create a healthier ecosystem.

*UN Sustainable Development Goals*

Bird Hive supports two UN Sustainable Development Goals:

* Goal 7: Affordable and Clean Energy
* Goal 15: Life on Land

Goal 7 addresses “ensuring access to affordable, reliable, sustainable and modern energy for all”. Due to its ability to be scaled up or down as needed, Bird Hive ensures access to anyone that would like to use it and is not limited to large scale operations. This also allows for flexibility in manufacturing and materials. For example, smaller units could be quickly and cheaply made through 3D printing, opening opportunities to just about anyone, including those in developing areas.

Goal 15 addresses protecting, restoring, and promoting sustainable use of terrestrial ecosystems, sustainably managing forests, combating desertification, halting and reversing land degradation, and halting biodiversity loss. By inviting interaction and habitation by local bird species, Bird Hive supports halting biodiversity and protecting ecosystems. Occupation by the birds helps to keep the species’ in place while their habitation naturally aids in maintaining a healthy surrounding ecosystem.

*Technology and Energy Generated*

Bird Hive generates energy through three methods; wind, solar, and piezoelectric disks. While all three work together, the primary generation method is wind. The turbine that forms the outer shell mimics flower petals in its form. Made of lightweight aluminum, it kicks into motion with the slightest breeze, mimicking the adjacent flowers as they flow with the wind. The solar ring, consisting of thin-film CIGS solar cells, provides additional opportunity to harness energy. If winds are not present, energy generation is still viable through solar exposure. Finally, the piezoelectric nesting platform allows the occupants of each “flower” to contribute to its total energy generation value through their movements in the nest. At the same time, vibrations associated with the spinning of the turbine contribute to the energy generation of the piezoelectric nesting platform.

Bird Hive consists of units (“flowers”) at three scales; Large (0.91m dia.), Medium (0.61 m dia.), and Small (0.36 m dia.). The energy generation for each method and scale is calculated below followed by the total energy generation of a single unit at each scale. Finally the total energy generation for all 64 units of Bird Hive is calculated for the overall MWh generated per year.

**Wind**

P = π/2 \* r² \* v³ \* ρ \* η

r = radius

v = wind speed

ρ = air density

η = efficiency factor

*Small* = π/2(0.36)(4.8)(1.2)(0.4)

 = 0.011 kWh

0.011 (8,760) = **97 kWh/yr**

*Medium* = π/2(0.61)(4.8)(1.2)(0.4)

 = 0.031 kWh

0.031 (8,760) = **272 kWh/yr**

*Large* = π/2(0.91)(4.8)(1.2)(0.4)

 = 0.069 kWh

0.069 (8,760) = **605 kWh/yr**

**Solar**

E = A(r)(H)(PR)

A = solar panel area (m2)

r = efficiency (%)

H = average sun hours

PR = performance ratio

*Small* = 0.13(0.2)(6.2)(0.75)

 = 0.12 kWh/day

0.12 (365) = **43.8 kWh/yr**

*Medium* = 0.2(0.2)(6.2)(0.75)

 = 0.19 kWh/day

0.19 (365) = **69.35 kWh/yr**

*Large* = 0.29(0.2)(6.2)(0.75)

 = 0.27 kWh/day

0.27 (365) = **98.55 kWh/yr**

**Piezoelectric**

E = # of disks (2 mWh)

Small = 130 disks (2 mWh)

260 mWh (8,760) = **2.28 kWh/yr**

Medium = 220 disks (2 mWh)

440 (8,760) = **3.85 kWh/yr**

Large = 316 (2 mWh)

632 (8,760) = **5.54 kWh/yr**

**Total Energy by Unit**

Small = 43.8 + 97 + 2.28

 = **143.1 kWh/yr**

Medium = 69.35 + 272 + 3.85

 = **345.2 kWh/yr**

Large = 98.55 + 605 + 5.54

 = **709.1 kWh/yr**

**Total Bird Hive Energy Generated**

Bird Hive Total = 709.1 (26) + 345.2 (20) + 143.1 (18)

 = 18,436.6 + 6,904 + 2,575.8

 = 27,916.5 kWh/yr

 = **28 MWh/yr**

*Environmental Impact Summary*

Bird Hive is constructed of primarily recycled materials. Structural components are made of recycled steel while the turbine and nesting platform are made of recycled aluminum. In smaller scale applications the unit can be 3D printed to aid in quick and cheap production. The filament used in this application would be recycled-PLA which is bio-based and biodegradable under industrial composting conditions. Parts can also be replaced as needed to make complete replacement of a unit unnecessary in most situations. Additionally, all parts can be recycled at the end of a unit's lifespan, including 3D printed parts. Overall, the goal of Bird Hive is to have zero negative environmental impact and aid in creating a better and healthier world for every species that inhabits it.