**LAGI 2022 Manheim**

**Windwald**

**Summary About Windwald**

What would a sustainable city look like? It is certain that the form of a self-sufficient place, where cities and suburbs produce energy by themselves, Therefore, we would like to suggest a project called Windwald, which produces electricity with wind and people’s activities.

The location of the Windwald is a suburb where a military camp used to exist. Since the army was removed, the temperature of the site has decreased. Also, the wind from the east was a feature of the site with a strong wind along the Green Corridor, which connects the site and the downtown. In addition, the housings in a row near the site provides accessibility to peoples, giving them a chance to interact with Windwald in a new form of garden.

By using this natural source of wind and human activities, Windwald utilizes wind power and human interaction to realize the possibility of producing indefinite energy. Consequently, Windwald’s generator module has been developed based on these two power sources: wind and human activities.

The unit of Windwald consists of two big units.

The first unit is its structure. The structure made of plywood looks like a tree and plays the role of supporting the generator module. There are two different sizes of the structure, which can react to each location and program.

The second unit is the generator module. The module is in the form of a sphere, and four or five of them hang on a wire coming from the structure in a row. Each sphere works as an independent generator module. From the inside, the module is covered with non-conductor(plastic) balls, electric wire combined with an LED diode, a conductor(aluminum plate), and acrylic covering. Since the wire is hidden by the structure, it is invisible from the outside. Also, the steel rebar is covered by wires which plays the role of supporting the suspended generator modules. Finally, the role of the wire is to connect the generated electricity to the battery storage.

The unit will be displayed according to the passage of the Green Corridor and U-Halle. The dispersed units all around the site can be connected to make a plaza or a private space for meditation. The spectacular point is that each person can enjoy the energy garden in their own way. The role of the generator module will be highlighted at night. The modules that glow through LED diodes at the same time they produce energy will give people pleasure by presenting an image like shining comets.

**Technologies in Windwald**

The technological theory of the generator module is the method of using Triboelectric Nano Generator (TENG). Unlike the existing turbine type, the Triboelectric Nano Generator is a rising method for the next in that it can make the generator lightweight and miniaturized. The theory is simple. Two rubbed objects are charged to the cathode(-) and anode(+) according to the electron preference, and at this time, electricity is generated to narrow the potential difference between the two electrodes. Many researchers have already proved that the electricity generated by a small module can operate a single LED. Even though the amount of energy from the single module is minimal, the sum of several modules consecutively connected will produce a staggering amount of electricity.

If each module were suspended in the path of an endless wind, the wind would become the power source that generates energy indefinitely. When people pass by and touch the module out of curiosity, it will also generate energy.

People can enjoy the hanging module safely because it is lightweight and electrically safe. In addition, the mobile-like hanging modules are effective in that they can vibrate like a pendulum even with a small stimulus.

In other words, this environmentally friendly method is effective and sustainable.

**Annual Electricity Production**

Individual modules will be vibrated continuously by wind and human actions, which means that the energy production will never end.

If “aluminum” and “non-conductor part made of ping-pong ball material” are used as the friction components, it takes 10 seconds for the entire surface of the unit to be rubbed once. The power generated by rubbing the entire module (aluminum and non-conductor ball) is 100mWh. Therefore, 100mW of power is generated every 10 seconds by each module. Considering the fact that the daytime is windy due to the site’s temperature difference for about 5 hours a day, it can be assumed that 1800\*100 = 180,000 mWh/day = 180 Wh/day of energy is generated.

5 modules for 150 wires per unit.

150\*5=750 modules are placed in one unit, and it is assumed that the entire area is evenly frictioned is 375, which is one half of the entire module in one unit.

About 200 structures are placed on the site.

The power generation per day is 180 \* 375 \* 200 = 13,500,000 Wh/day = 13.5 MWh.

The annual power generation is 13.5 \* 365 = 4,927 MWh.

Expected annual power generation: around 4,920 MWh.

**Materials with Initial Cost**

The materials of the unit’s structure are eco-friendly because plastic and aluminum for the power generation modules and renewable trees for the structure can be made from recycled materials.

Plywood structure made from recycled wood: 1500$/unit.

Modules for power generation (aluminum, plastic, wire, electric wire): 380 $/unit.

Battery storage and power transmission cable: 520$/unit.

Cost of construction: 330$/unit.

The initial cost for one unit is: 1500 + 380 + 520 + 330 = 2730$.

Site-wide initial cost: 2730 \* 200 = 546,000$.

Total: 546,000$ (The calculated amount varies by country.)

The power generation module is sustainable and eco-friendly because it can be replaced, and all materials constituting the unit can be used for other purposes. (Recycled wood plywood could be recycled as a toy for children, and plastic and aluminum can be recycled in different ways.)

**Environmental Aspects of Windwald**

In a whole new kind of garden with Windwald, four typical actions can be expected.

1. As Windwald will function as a component of public park, the site will change from a desolate area to a place for walking and resting for the citizens.
2. With Windwald, the site can be a place for playing. It will become a playground not only for children but also for families.
3. Furthermore, Windwald can create a public plaza where people can take a walk along a continuous path, get along together, and enjoy their hobbies.
4. U-Halle and Green Corridor, which already exist on the site, will be the central points, and Windwald will be placed along the walkways as a landmark.

The perception of conventional energy sources is that production and consumption are clearly separated. However, Windwald approaches this view completely differently.

Now, production and consumption of energy can be achieved at the same time, and people can play the role of producing energy with nature together. Windwald eventually aims to be utilized for other essential functions in our lives, like a streetlight. The project ultimately looks forward to a futuristic, energy-self-sufficient city with Windwald.