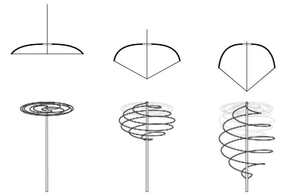
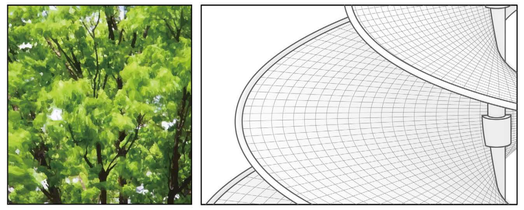
Structural System



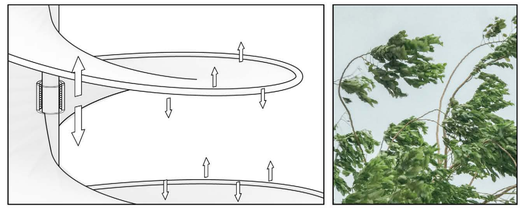
The frame of the eTREE is pre-tensioned to withstand sagging due to gravity.
The GRP(Glass fiber Reinforced Plastic) and the membrane counteract each other's forces in a sturdy equilibrium, just like in a popup tent.

Spinelli Park's average radiation is 1100kWh/sqm and the latitude is 49.48°.
The shape of the membrane is correlate to this radiation value, alongside the trajectory of the sun to maximize output.



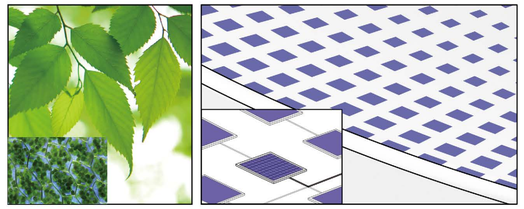
The shape of the tree

The membrane of the e-tree is manufactured by 3d printing with recycled wood cellulose filament. This material is not only lightweight, but also durable and can withstand a large amount of tensile stress. 3d printing provides the material with the freedom to customize shape, size, etc.



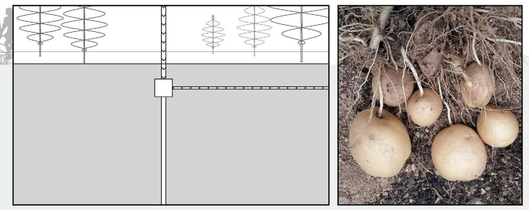
Branches and leaves shaking in the wind

The frame of the e-tree is made from GRP(Glass fiber Reinforced Plastic). In order for the membrane to oscillate in the wind and produce energy, the material must be lightweight and elastic. The membrane and the frame move up and down like a spring in the wind. Generators are distributed along the stem of the e-tree to convert the kinetic energy of this oscillation into electricity.



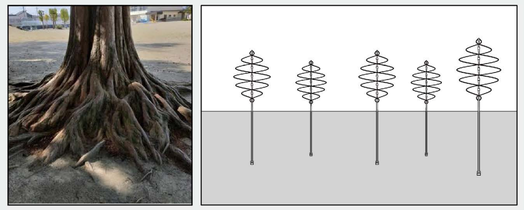
The cell structure of leaves

Solar panels are placed throughout the membrane of the e-tree.
Acting like leaves in a real tree, the panels convert solar energy into electricity and provide shade.



Nutrients stored in the roots

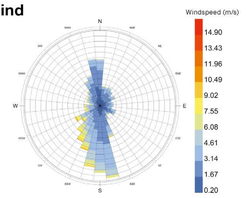
As certain plants store nutrients in their roots, the e-tree stores the generated energy in cells buried in the ground. This stored energy is used to power electric bicycles and other electronic devices of those using the park. The rest of the energy is used at BUGA and sent to the power grid of the city of Mannheim.



The roots supporting the tree

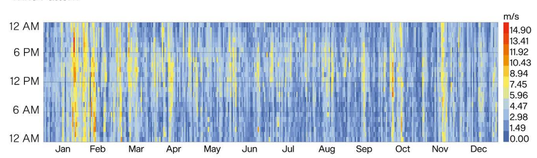
Sturdy roots are essential for a tree to grow tall. precast concrete piles are used as foundations for the eTREE. The precast piles can be dislodged and reused after the e-tree is taken down.

Wind



Source: IWEC Data
Period: 1/1 to 12/31 between 0 and 23 @1
Calm for 3.48% of the time = 305 hours
Each closed polyline shows frequency of 0.6%

Wind Pattern

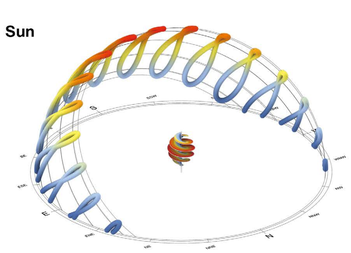


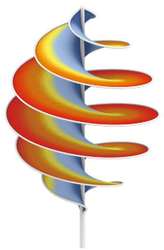
The average windspeed = 3.08m/s
Unlike conventional wind turbines, the eTREE does not have a given directionality and can thus generate wind energy coming from all directions. The membrane of the eTREE vibrates up and down to generate energy, simulating the movement of leaves in the wind. The number of rotations and height of the eTREE is optimized to maximize wind harnessing capacity.

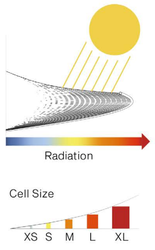
One eTREE's wind turbines generate approximately 0.264kWh of energy(30% efficiency). Operating at 30% efficiency, a total of 0.264 kW is generated through wind.

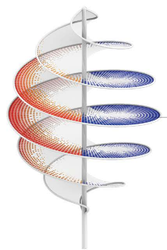
This method of generation is similar to the savonius vertical generator, which the amount of generated energy is proportionate to the area of the surface affected by the wind. The area of the unrolled membrane of the e-tree = A. Area(A)/2 x air density coefficient(0.5*1.225k/m^3) x energy pattern coefficient(1.92) x windspeed^3(m/s)/1000

Sun



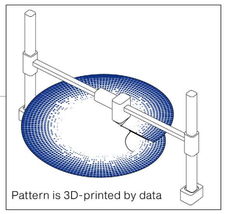






The average radiation = 1100kwh.
Panels on one e-tree is 31.47kWh.
(12% efficiency)

The size of the solar panels located on the membrane is correlated to the exposure to the sun.



1. Energy which eTREE generates = 13.8MW
2. Number of eTREEs in Site = 155 (in case as proposed)
3. Annual Energy Generation in Site by eTREEs = 2,138 MW

Process in site

- **a.** The modular system allows the e-tree to be moved with a much smaller footprint than when it is assembled.
- **b.** The precast concrete pile foundation is installed.
- **c.** The stem of the e-tree is erected.
- **d.** The frame of the membrane is installed at the topmost point of the e-tree
- **e.** The membrane is fed through the frame and gravity and tensile forces allow the structure to be in equilibrium withotut the need for extra substructures.
- **f.** eTrees blending into their natural settings.
- **g.** eTree being disassembled in reverse order.
- **h.** The unfolded membrane is folded again.
- **i.** Disassembled e-tree is moved to a new location.