ENERGY GENERATION

*energy (en·er·gy)*

*noun*

1. the strength and vitality required for sustained physical or mental activity. "changes in the levels of vitamins can affect energy and well-being"
similar: vitality, vigor, life, liveliness
2. power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines. "nuclear energy"

*generation (gen·er·a·tion)*

*noun*

1. all of the people born and living at about the same time, regarded collectively. "one of his generation's finest songwriters"
2. the production of something. "methods of electricity generation"

*Energy Generation* is an approach to the design of the Spinelli Barracks that democratizes accessibility to renewable energy resources by utilizing the energy of youth in the creation of clean energy for the city. With the influx of new inhabitants to the Spinelli Barracks, the kinetic energy generated in this dual park and playscape brings forth a new era of reimagining utilitarian infrastructure. In this project, four main technologies and reforestation make way for an interactive, inspirational, playful, purposeful, and productive landscape.

SUSTAINABLE ENERGY

The park features four unique categories of renewable energy generation: solar, hydro, wind, and kinetic. Like your favourite museum or art exhibit, these different models are showcased throughout the park and have varying levels of interaction, forms, and sizes.

Here the mundane is transformed into the sublime as you get to experience different forms of energy generation, see them in action and be a part of it. The park becomes a pedagogical and interactive experience, where renewable energy is embedded in public space as wayfinders, sculptures, shade, and playscapes inspiring generations to come.

The hope is that perhaps this inspires the greater city of Mannheim to take inspiration and implement these technologies throughout the rest of the city, or that individuals feel inspired to invest in smaller-scale renewable energy for their properties.

ENGAGEMENT

The main proposal is to generate energy from the interaction between people and systems while also creating sculptural structures that serve as both playscapes and way finders. An emphasis was placed on the development of innovative ways for individuals to engage with renewable energy to improve the exposure and normalization of these technologies.

REFORESTATION

Considering the significance of the site as a cooling corridor, a critical component of the design proposal was the reforestation of the Spinelli Barracks. The city of Mannheim has a forest cover of 12.7% in its urban district, a whopping 54% below the average in other large cities in Baden-Württemberg. According to the city, its vision for the forest is a healthy, ecologically valuable, and climate-stable mixed forest that offers spaces for recreation and relaxation, functional habitats, carbon neutrality and a supply of raw material for the city.

The species introduced feature English Oak (Quercus robur), Sessile Oak (Quercus petraea), European Ash (Fraxinus excelsior), Sycamore Maple (Acer pseudoplatanus), Norway Maple (Acer platanoides), European Hornbeam (Carpinus betulus), and Scots Pine (Pinus sylvestris). During the selection process, species were chosen according to their capacity for adaptation and long-term climatic suitability, particularly considering the site’s conditions and future climatic development. The diversity of species was a significant consideration as species diversity decreases the effects of forest disturbance on carbon storage and increases forest resilience and function. The reforestation of the site allows for increased carbon sequestration, cooling and transpiration, reduction of energy use, improvement in air quality, and the reduction of stormwater runoff.

TECHNOLOGY

WIND

High Altitude Wind Turbines (HAWT) are a consistent source of energy that is able to gather more wind than average wind turbines. They are located on the southwestern part of the park, collecting the abundant southern winds in Mannheim. They are used as both energy generators and as wayfinders marking the southern area of the ­park. The modular version of the HAWT is a customizable fence containing smaller modules of turbines at ground level. The structure is a hybrid between an inflatable and a fixed fibre-glass skeleton, which makes it a very robust but lightweight structure. A Dyneema® line connects the structure to a ground station that converts mechanical energy into electrical power.

The average power was calculated based on experiments performed on high-altitude wind turbine generators such as Kites. Based on that, a 60m² kite, at an average of 110 km/h flight speed, 70-450 meters high, can produce 450MWh per year.

The site has 30 proposed structures, each composed of 8 modules measuring 2m x 2m, stationed at 40-200m high, with 32m² of coverage. The average wind at a high altitude in Germany is 110km/h2, so we can estimate that the structure would have 50% efficiency, generating 225MWh.

30\*225MWh

Totalizing 6,750MWh per year.

The scalable solution for the wind turbine —the fence— would generate less energy due to the lower speed of air. Although it would still be able to transform wind into power, its efficiency would depend on site conditions.

WATER

The Vortex Turbine Electricity (by Turbulent™) is a low noise submerged design that generates power on the continuous flow of water using an elevation drop of 1.5m. The water features use a small part of the energy generated from the High Wind Altitude Turbines to create a continuous flow that can generate power and be stored on portable batteries. This feature aims to regulate temperature and connect people with water. The feature has 2 different modules, one that allows people to play in the shallow areas and another that allows people to sit close to water.

Based on the Turbulent Hydro Catalogue, smaller turbines can generate up to 120MWh per year. On the site, we have 30 proposed structures.

30\*120MWh

Totalizing 3,600MWh per year.

SUN

Organic Photovoltaic Thin Film (by ASCA™) is a customizable, flexible, lightweight and light-sensitive solar panel. The flexibility of the material is optimized in its utilization in both a large pavilion and a smaller-scale umbrella. The umbrellas provide shade throughout the park, inviting individuals to familiarize themselves with solar power. The larger pavilion can be used for large events and gatherings, creating a flexible program area.

According to the fabricant, 1m² of the OPV produces 40Wh.

Each umbrella has 4.3m², generating 172Wh. 10 umbrellas in the park would generate 1720Wh; (15MWh/year).

Each pavilion has 27.7m², generating 1,108Wh. 2 connected pavilions in the park, 2,216Wh; (19.4MWh/year).

Totalizing 34.4MWh per year.

KINETIC

Energy harvesting pavers (by Pavegen™) are tiles that utilize kinetic energy from footsteps to create energy. Here they are utilized in main paths, playscapes, the skate park, and the BMX park. The resulting energy is stored in portable batteries or used in lighting. Within the park’s playscapes, pavers encase a sculptural mound to create a sensory and tactile experience that allows children to observe the generation of energy in real time, watching as their movements animate a light installation connected to the mound. The playscapes create a visual and comprehensible experience connecting movement to energy creation while entertaining and captivating interest.

Each paver produces 5 watts per step.

1m² = 8 pavers

Considering a capacity factor of 15%, it will produce approximately 0.06MWh/year per square meter.

Playscape = 113,050m²

Totalizing 6,873MWh per year

MWH GENERATED PER YEAR

(WIND = 6,750.0) + (WATER = 3,600.0) + (SOLAR = 34.4) + (MOVEMENT 6,873.0) = 17,257.4 MWh per year used to power the site's electrical needs. Excess power will be used to power the Spinelli district.

DESCRIPTION OF PUBLIC ACTIVITIES & SOCIAL CO-BENEFITS

The site is centrally located in a growing district comprising the second largest development area for housing in Mannheim. The proposed design addresses the entirety of the site and provides a variety of experiences to cater to a diverse demographic and provide sufficient social infrastructure. Spaces have been designed throughout the site with specific programming in mind.

Along the proposed master plan development area, various playscapes will be installed to encourage socialization and kinesthetic engagement. Bürgerpark Skatepark and the existing BMX track will be expanded and redesigned along the northeast portion of the site, creating another form of play for various demographics to engage with. The remaining designated playscapes will be allocated towards playgrounds designed for younger children. The goal of this approach was to create centralized hubs for youth to engage with others of similar ages to increase socialization and build relationships within a growing community.

Reforestation of the site also allows for the creation of various walking trails, with clearings available for recreational activities. These clearings offer spaces for rest and relaxation under pavilions made of flexible solar film panels or opportunities for engagement with hydro-generation through water play areas.

HOW THE DESIGN SUPPORTS UN SUSTAINABLE DEVELOPMENT GOALS

*Goal 3. Ensure healthy lives and promote well-being for all at all ages.*

*Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all.*

*Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable.*

*Goal 12. Ensure sustainable consumption and production patterns.*

*Goal 13. Take urgent action to combat climate change and its impacts.*

*Goal 15. Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.*

*Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.*

The project takes a holistic approach in its design, considering the site’s context, projected futures, and equity for biotic species at all scales. The excess energy generated as a result of the Spinelli Barracks Park will be allocated towards powering the surrounding homes within the district, allowing for the subsidization of electricity costs and ensuring access to affordable, sustainable, and reliable energy for all. The reforestation of the site promotes healthy living for individuals of all ages and improves the resiliency and sustainability of the site. It also establishes a source for the sustainable consumption and management of forests, the sequestration of carbon, the creation of terrestrial ecosystems, and the diversification of biodiversity in the area.

ENVIRONMENTAL IMPACT SUMMARY

This project has a positive environmental impact. As the largest on site intervention, the project’s environmental impact predominantly stems from the reforestation of the Spinelli Barracks. The establishing of a forest on the site allows for improved biogeochemical processes such as carbon cycling, the addition of oxygen and nutrients among the atmosphere, and the creation of biomass. Research shows that extensive tree plantings (10 hectares or more) provide greater habitat and provide improvements to local carbon sequestration and water recycling. Urban forests are also an effective method for offsetting the Urban Heat Island (UHI) effect through increased evapotranspiration and the direct shade provided by additional canopy cover.

Although historically wind turbines and birds have not been compatible, the total surface area of the High Altitude Wind Turbines are relatively small (16m x 2m) in comparison to conventional models of wind energy. Their opaque and vertical nature also increases their visibility, preventing collisions with wildlife.

The site also produces plentiful energy, allowing it to be self-sufficient. Within the water features, water waste is reduced through the recycling of water. The energy produced onsite is utilized to power pumps that carry water from the bottom of the feature’s cycle back to the top to continue the generation process. The energy produced on site is also utilized to power park amenities such as lights.

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