**POWER NEBH**

What if we rethink steam industry as a clean source of energy? The steam engine was a great revolution in industrial terms. In the 18th century it changed the technological paradigm of power generation, moving things that were previously difficult to move, displacing things that were not and automating processes that were previously manual. Mannheim was not exempt from this change, being for many years an industrial city. In its origins this industry was the result of great advances, but totally unaware of its harmful effects on the environment and human health.

Today we know that both external combustion engines (steam) and internal combustion engines (oil) emit large quantities of pollutants into the atmosphere, water and soil.

Today, steam’s technology is mainly used to produce electricity through nuclear energy. Although it’s clean, is highly dangerous and generates radioactive waste, so it is being dismantled and must be replaced.

Energy production generates less waste that is less polluting, it’s true, but what will be the future of steam energy? What if energy production could generate outputs that are not only less harmful, but beneficial to the environment and people? What if, while supplying the energy demands of a growing population, other ecosystem services were offered collaterally, generating a system that isn’t only sustainable but restorative? Can we recover and rethink Mannheim's industrial history to produce a piece of art that enhances the public space by evoking the city's industrial past?

Power Nebh bets on a technology that not only generates energy, but in the process cleans grey domestic water, which usually poses a risk to aquatic and terrestrial ecosystems where it is discharged. Therefore, Power Nebh uses gray water and solar thermal energy as raw materials to produce electricity, providing pedestrians with a playful and sensory experience. In addition, by evaporating water, it contributes to the reduction of climate change by reincorporating it into the water cycle.

In addition to being clean, the output is used. As part of the BUGA, one of the pillars of the project is to transform water for irrigation of the horticultural exhibition, using 50% of the water released for this purpose, the equivalent of 15 Olympic swimming pools per year, and the remaining 50% is reincorporated into the system for greater efficiency.

Power Nebh takes the clouds as a source of inspiration. Considering the aforementioned implications, what other ways are there to produce steam? Looking upwards is the solution, the first form of steam on the planet: clouds, which only need heat, water and wind.

There is a type of cloud that has been seen in Mannheim, and when they appear in the sky they are a real spectacle: Mammatus. They need particular conditions of wind, sun and water, *"they are formed by the collision of cold and humid air pockets and other warmer and drier ones. They can eventually form a cumulus cloud of several kilometers.Their name derives from the Latin mamma, meaning udder or breast."* (perkins, 2015)

How to generate these conditions? That’s where research led us to find Solar Thermal Energy. This uses solar rays to heat fluids that by transferring heat to water, generate the much desired resource: steam. That adding pressure and movement generates electrical energy.

Each module is composed of a parabolic cylinder, a molten salt system, and a structure for capturing and releasing the steam. The 700 modules produce almost a third of the energy required for the Spinelli masterplan. These modules are arranged in groups from 1 to 5 modules allowing various activities at different scales. This also allows it to be replicated around the world. Power Nebh replaces the landscapes of large smoking factories and steamships traveling the Rhine and raising their vapors, with curious and attractive devices that invite activity and appropriation using steam as a beautiful form of energy. The implementation is made according to activity areas and the potential for exposure to solar radiation. Thus, nodes and paths are configured at points of greater or lesser use depending on the case.

Industries using steam technology, both in the last century and today, are hermetic and turn their backs on the city. Power Nebh generates a very playful and versatile urban space. While producing energy, the release and collection devices offer shelter and shade by functioning as architectural canopies. These can be used for sports, community meetings, children's play, reading and other activities. The constant dripping in the perimeter gives it a didactic essence, making the park a more fun, safe and comfortable place to live in.

People of all ages can enjoy this sensory spectacle with water and steam as protagonists. In the distance, the modules can be seen as large clouds at pedestrian level, where the steam interacts with the sun and the wind, connecting users with the weather and the environment.

While producing electricity, it invites reflection in the community, generates curiosity, and curiosity induces learning. This generates a much more enthusiastic approach to these new technologies of clean energy sources. Spaces are created where sensitive interaction plays a fundamental role. Feeling the steam, seeing the sun's rays concentrating, experiencing temperature changes and other experiences allow this curious and didactic approach to complex topics such as renewable energy, environmental issues and many of the implications of energy use on the planet. Power Nebh generates positive experiences where environmental and energy issues are approached with hope and optimism, changing the paradigm of energy production and recreation in public space.

Power Nebh collects greywater from Spinelli Masterplan. Through subsurface horizontal flow artificial wetlands it is partially treated by bioremediation and transferred to storage tanks.

To convert the water into steam, a concentrating solar thermal power system is used, which takes advantage of the availability of solar radiation, with an average of 2604.49 hours of sunlight per year in Mannheim. A parabolic trough concentrates the solar radiation onto a heat-resistant steel absorber tube. There, a closed system of constantly flowing molten salt between 400°C and 600°C transfers the captured heat to the above-mentioned clean water storage tank by conduction. This heat is sufficient to bring the water to 200°C and evaporate it. Due to the pressure increase, the water moves through ferritic stainless steel pipes to the power generation system. Thanks to the high heat capacity of the molten salt the system has an additional 2 hours of autonomy after the sunset. *“Energy can be stored to produce dispatchable power 24 hours a day and long after the sun has set”* (Ferry & Monoain, 2019)

The generation system consists of a 15 kW Green steam Turbine that optimizes the pressure-generated steam velocity. Its blades rotate at high speeds transforming rotating mechanical energy into electrical energy, which is fed directly into Spinelli Masterplan's electrical grid.

A part of the steam is reintegrated into the system, another part is retained by the textile surfaces, generating an immersive rain experience for the user. This, thanks to the sum of the bioremediation process with EM, exposure to high temperatures and UV radiation becomes suitable for plant irrigation in the BUGA exhibition. And a small part is returned to the atmosphere as steam to be reintegrated into the water cycle.

Starting with 700 turbines (one per 1000 m2) that generate 14.25 kWh each at 95% efficiency, 33,256 MWh/year are generated. The consumption of approximately 1050 houses.

This amount is enough to supply 30.2% of the 110,106 MWh of energy required by the 4500 new families that will arrive. In addition, and as an aspect to highlight, the implementation of molten salts contributes to the generation of heat, and therefore of energy, to be maintained autonomously for 2 more hours, regardless of whether it is night or the sky is too cloudy. Thus, adding the additional 730 hours of operation to the 2604.49 hours of average sunlight per year in Mannheim results in the generation of 33,256 MWh per year. To achieve this amount requires the use of 101,162 m3 per year of water filtered by the artificial wetlands, equivalent to 19.94% of the greywater of the 4500 families per year.

In addition, Power Nebh uses the roof surface to capture and generate additional energy through transparent photovoltaic panels, achieving an additional 2,016 mWh/year without affecting either the public space or the architectural quality of the module.

Power nebh seeks to contribute to the UN Goals from its conception. First and foremost, it seeks a clean energy source that decontaminates water, also contributing to the reduction of sanitation problems in the area. It attempts to contribute significantly to the health and well-being of the citizens through recreation and play through a natural resource. It also contributes to connecting users with nature and the environment.

It seeks to preserve the health and life of aquatic ecosystems by cleaning water that would otherwise be treated with chemical processes and disposed of in these ecosystems. Power Nebh contributes to reducing hunger by supporting horticulture planting. By using treated irrigation water obtained as a secondary output from other processes, it makes the local cultivation of food plants more profitable and sustainable.

ENVIRONMENTAL IMPACT SUMMARY

Power Nebh aims to be an eco-productive project, which offers ecosystem services, generating a positive impact on the environment in the long term. To achieve this, it is necessary firstly, to develop a technology of low consumption and high productivity of ecosystem services, in this case: clean energy, water purification and recreation through natural resources. Secondly, it is necessary to reduce the construction’s embodied energy. For this purpose, resistant and low-maintenance materials, mostly recycled and local, were selected.

In line with the proposals of the BDSV (Bundesvereinigung Deutscher Stahlrecycling- und Entsorgungsunternehmen), which seeks to open up more space for the scrap recycling market in the EU, the main structural components use a cutting-edge material for the EU: recycled steel, which, according to this organization, as a secondary raw material meets the technical and safety conditions for use.

For greater durability and less maintenance of the structural parts, protection against humidity is proposed with a single-component organic sealant from a local company. And for protection against weathering and high temperatures, a titanium dioxide (TiO2) coating, which requires little maintenance, and requires less than other coatings. It is a material highlighted in the European Green Pact. Glazed surfaces above, and textile surfaces below, are used for collection. There are two types of textile surfaces: Cloth Sympatex waterproof, for recapture and Filter cloth Gore Tex permeable to allow dripping and vapor release. Both are made from recycled polymers.

Finally, some of the pipes to be used will be Composite Piping for Drilling, recovered from oil wells, because they resist high temperatures and pressures and it is a technology that in a context of renewable energies must become obsolete due to its environmental implications. With these low embodied energy and high durability materials, the positive impact of the proposal will come quickly.