Within the Architectural Engineering Graduation Studio the main focus is to solve a problem by integrating architecture with technical fascination. The graduation project “Hoist the Colours” is divided into two semesters. The focus of the first semester is to study solar and wind energy generation technologies and apply them in Park Gravenrode in Kerkrade. In order to provide more renewable clean energy to Kerkrade to support its energy neutral goal in 2040.

Three main research questions were raised as follows:
1) Is the nature condition of Park Gravenrode in Kerkrade support solar and wind energy generation?
2) What kinds of solar and wind energy generation technology can be applied in Park Gravenrode in Kerkrade?
3) How to integrate solar and wind energy generation technology with architecture design?

By the end of the first semester, preliminary research results are:
1). Although the solar and wind natural power of Park Gravenrode in Kerkrade is not abundant, they meet the requirements to support solar and wind energy generation technologies.
2) Photovoltaic, solar heating and district seasonal thermal storage systems could be applied as solar energy generation technologies on the site; Medium and small horizontal axis wind turbines, small vertical axis wind turbines, and wind kites/balloons could be used as wind energy generation technologies in Park Gravenrode in Kerkrade.
3). By applying tensile structures to provide large roof areas for solar collectors, and setting wind turbines and wind kites/balloons as multi landscape embellishments, solar and wind energy generation technologies are able to be integrated with architectural design and site planning.

The analysis and planning only focus on aesthetic forms without considering technological practicability is not realistic and eventually lead to unnecessary waste; on the contrary, those analysis and planning only pays attention to how to maximize sustainable energy production without considering the natural landscape and public expectation would be nothing but undesirable machines. Taking the balance between natural landscape with public satisfaction requirement, and sustainable clean energy generation is difficult, but necessary.

Considering the balance between aesthetic and technology requirements, tensile roof structure study and energy park planning become main design topic in the second semester, in order to develop former vision into an architectural story with technical fascination, as a graduation project of AE Studio.

Till the P4 presentation, five design topics have been developed, which are:

**Roof Analysis**

To maximize the efficiency of tensile solar roof, as well as to express more visual aesthetic values through the roof system, various studies have been done. They include form finding study, component system study, scale variation, solar roof installation, roof orientation, roof tilt angel calculation, roof shadow analysis, and so on.
Structural Development

After general studies of the roof system, detailed structural developments have been made. From the analysis of Frei Otto’s tensile roof projects, a “tent” unit for the project was designed. The purpose of the unit design is to integrate all structural elements of the project’s tensile roof structure system into one representative prototype, so that details of the system could be expressed and analysed easily and clearly. Roof, facade, and floor/foundation are the three main structure systems which have been developed in the prototype for the project.

Function Variation

The tensile roof structure system of the project provides large flexible ground floor space under the roof. Thus, permanent or temporary functions, static or dynamic spaces are all possible in the project. After the structural development of the prototype, various functional and spatial possibilities have been discussed.

Climate Design

Since the project origins as a sustainable energy provider, the energy output calculation is the most important factor of climate design. Meanwhile, insulation methods, heating/cooling strategy, ventilation design, and lighting analysis are also considered in the climate design process.

Park Planning

The vision of the project is to design an energetic park for Kerkrade, with organically distributed tensile solar roofs as landscape architecture. Nature, technology, and life have been set up as main themes for the park. SWOT analysis and function requirements were made in the beginning of park planning process. Routes and zoning of the park have been done in many layers. Considering the finance status of local government and companies, the park could be realised in at least three separate phases.

METHODICAL APPROACH

The combination of research and design is the methodical line of approach of AE Graduation Studio. Within the general topic given by the studio, students have the freedom to chose their own approach according to their field of interest. During the research and design process, each student would be assisted mainly by an architectural tutor, a research tutor, and a building technology tutor.

The project “Hoist the Colours” starts from the general topic “Flow” of AE Graduation Studio and focus on the sustainable innovation of Kerkrade in IBA Limburg. Case study, literature study, research by design, and field trip have been applied as main methodologies for the project.

In MSc 3, the research process had been weekly discussed with Anne, the architectural tutor, and Leo, the research tutor. With their guidance, the research finding of appliances of solar and wind energy technologies was translated into an design proposal of an energetic nature park as an attractive landmark for Kerkrade. In MSc 4, the design proposal was further developed with the assistance of Anne and Maarten, the building technology tutor. As a result, the tensile solar roof system was carried out in detail and the energetic nature park was planned organically.

The continue feedback and discussion with different tutors of right expertises was proofed very helpful for the completeness and deepness of the graduation project “Hoist the Colours”.

Hand Drawings of the Ideas of Sustainable Park Planning
SOCIAL CONTRIBUTION

Social and Technological Contribution

The project “Hoist the Colours” is a valuable attempt, showing a positive gesture toward a sustainable and energetic future which balances with natural beauty.

As for this project in Kerkrade, socially, attract more visitors to boost local economy, as well as to integrate natural environment with recreation and sport activities for local people; technologically, the project will provide a possibility to increase the sustainable clean energy production. It can be the host pavilion for IBA Parkstad Limburg exhibition. It is not only an exhibition of technology, nor a landmark architecture of nature and recreation, but a combination of both. Moreover, the framework of social improvements and technical systems are generically applicable for other shrinking industrial areas like IBA Parkstad.

Meanwhile, the tensile solar roof system of the project is an architectural and structural experiment of combining Frei Otto’s light tensile roof system with solar technology, in order to provide a building prototype which is possible to be used widely to assist the sustainable innovation of our living environment at present.

An Education of Sustainability

As an organic part and a representative landmark of the district, the new sustainable architecture design should not only use building technologies to establish energy based sustainable systems for itself and the district planning, but also use architectural factors to express the sustainable system, as an education of sustainability, to general public. Because the implementation of sustainable renovation requires lifestyle and idea changes, from the unawareness of sustainability into a common understanding of greener and healthier living possibilities, of general public. People deserve to receive better education about how their lives are supported by natural resources and what kinds of sustainable ideologies and technologies are available to improve their lives, so that they can play more active parts in the sustainable renovation of their living environment. And this kind of education should be provided in the new sustainable architecture design of this project.