

| MOBILE PLANT FACTORY

| P5 REFLECTION

| MSc Thesis in Building Technology 2017 - 2018

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INTRODUCTION

Plant factory with artificial light PFAL is an advanced facility has been developing through many research based on experimental field work in greenhouses as fully insulated and the airtight production facility. PFAL is one form of "closed plant production system" (CPPS) unit. It is a system where the growing environment optimally controlled and therefore, can provide various type of crops in different climatic conditions at a higher production level. The standard PFAL only use artificial lighting to ensure the plant with the light required for photosynthesis needed for growth. The research by design intends to fill the gap between the architecture, agriculture and environmental studies and to reproduce the PFAL in a Hybrid lighting system to benefit from solar light and in combination with an intensive form of hydroponics. There are two main parts literature study and the practical section that finally complete with proposed design (Mobile Plant factory) Hybrid system.

1. RELATIONSHIP BETWEEN PROJECT AND WIDER SOCIAL CONTEXT

The need for new cultivation system is essential to overcome global issues associated with the sustainability, food security and tackling hunger. The world is in shifting process to renewable energy. The plant factory is still expected to be the exceptional value. Although the possibility to use the plant factory in different climatic conditions, the energy cost is still high. The projected design aims to develop the current system and achieve lower energy load per cultivated area. Two selected contexts provide insight into the potential use of hybrid plant factory system. The first is in Amsterdam where the city planning for 2040 going of enormous challenge for shifting to the sustainable energy system and become fossil free, The design will minimise the supply chain cycle and reduce the traffic energy cost. In the second site in Damascus Syria, the plant factory creating an additive value to the local diet.

2. RELATIONSHIP BETWEEN RESEARCH AND DESIGN

Primary focus on literature part is on light and temperature for better internal environmental control. Light is the primary source of the photosynthetic process in the plant where the temperature level is always associated with growth speed and therefore higher production level. However, there are other factors such as ventilation and CO₂ concentration, but as the PFAL is airtight facility these aspects are highlighted briefly in the literature part. The design part based on research literature findings and design strategies by the manipulating temperature level since it is playing a vital role in plants growth and minimise energy costs.

3. RELATIONSHIP BETWEEN BUILDING TECHNOLOGY AND PLANT FACTORY

In agriculture, most of the themes are discussing the CPPS units and plants from a biological perspective and rarely looking to the design or the installation. This leads to a lack of information in the first design phase Such as building orientation, materiality and evaluation of the design. Plant photosynthesis process occurred by the daylight penetrate the facade are rarely discussed from an architectural point of view, and in the most cases the facade is a result of standard design. The adapted solution in nature has the potential to solve such complexity. This process leads to an exploration of light management in some organisms. Specific materials and production were discussed extensively in that sense, such as ETFE, haze effect and selective spectral materials. These results from translating the light control in the selected biological model "Deep Venus flower basket sponge".

4. REFLECTION ON LIMITATIONS

There are limitations encountered in the research when its related to validating the design through the computational workflow process. The current tools implemented are mainly not considered to be used in CPPS facility as its intended to be produced for occupants rather than plants production. These occurred in translating the plant's energy flux analysis and defining spectral properties of the materials in the light simulation are still not possible for ETFE material therefore alternative glazing materials used with similar performance (G-value, U-value).

5. FINAL REFLECTION ON RESEARCH OUTCOME

The literature study provided relevant information about the light study that can change the way standard greenhouses designed the phrase "every light percentages transmittance through the facade is increasing the growth" not applicable. The temperature stability level, spectral properties and its distribution on the cultivated area are critical factors for practical design.

Plant factory with a hybrid lighting system successful design required specific requirements of production technique, internal climate control, the target is energy efficient design of the building envelope can compete with greenhouse and PFAL. The climatology of location has an impact on the selection criteria of production type and skin.

Where the design strategies, light and temperature study applies to all contexts. The analysis explains the process through developing a design example and creating a base guide for helping designers in the early design phase. The final figures of energy load show the potential of combining both natural and artificial light.

The envelope is the most active part of the design proposal. The mobility required adaptive skin that function in different climatic conditions and achieve a balance between best energy performance and production capacity. The adaptive envelopes help accomplish this balance which can be seen in the energy output that has limited variation in diverse locations.

The hybrid facility can offer lower EUI than PFAL and greenhouse based on specific criteria influence the energy output. The Biomimetic inspired a new approach to enhance the light management in the skin. The selective spectral "shading" materials alongside haze effect. These proposed strategies are executed to answer the main questions that the paper proposes to discuss and solve.