REFLECTION

The topic of this project thesis comes in response to the general building requirements as derived from the regulations soon to be activated in the Netherlands and the European Union about the energy labels of the office buildings. The current situation displays a building stock of high-rises with poor energy performance and extremely high energy demands, proportionally even higher than small-sized buildings. Therefore, complying with the future energy targets, becomes a challenging task, for engineers, who are called to implement "out-of-the-box" solutions responding to a variety of challenges as well as for architects who are called to implement the proposed solutions to these landmark buildings. The first aspect requires the development of guidelines based on objective rules and building physics laws, whereas the second requires the development of subjective criteria with respects to the individual attributes of the project. This process, which determines the extent of successful integration of optimized performance systems into the building environment is, at the same time, the key aspect of the general implementation of sustainable innovations into every-day life. The optimization of the specific proposed system lies on two sustainability aims. The first one is regarding the improvement of the performance of the HVAC system, by reducing the energy consumption and the second is energy production by producing electricity and thus, the energy demands from external sources. The main renewable energy source that guides both fields of optimization is the sun, hosted into a single building element, embedded in a façade unit, that combines two solar systems.

In order to be able to drive this optimization process, the work relied on multi-objective criteria along with the literature research which helped define the most influential parameters to serve as the main variables of the process. In further extent, due to the requirements of the developed prototype (Solar Decathlon competition) and the personal interests of the author, the multicriteria analysis was also developed based on different climates and scales, which however gave better insight of the climatic limits, the scale limits and the directions for further optimization of the system also in the Dutch climatic zone which inevitably will be the main environment of future research. The undergone research and prototyping, apart from the tested functions, gives also indications for other uses and helps filter out the most effective strategies for energy generation. However, such multi-criteria optimization required several separate analyses on the different individual aspects. This was a restrictive factor, regarding the coherency of the final design and its implementation in practice, but this challenge offers the ability for other architects and engineers facing similar challenges come in contact with a recorded strategy of how to approach an issue from the initial, conceptual stage, through simulations and design improvement to detailed design and real construction circumstances, in order to result in a built prototype, assembled and tested in real life.

Specifically, the part of constructing and assembling the façade, under real life circumstances, displays a universe of challenges not often encountered or easily evaluated in more theoretical system optimizations. Time and cost constrains along with details of more practical nature and the collaborative architectural intentions of quite high significance, increase the complexity of the design as a lesson to be evaluated on its own, apart from the evaluation on the performance of the individual aspects. This balance which was consistently held and recorded within the size of this research is indicative of the required effort by larger collaborative groups, as well, in order to be able to adequately fulfil a complete range of intentions on this or other similar projects. That includes the role of the architect to help keep the aesthetical intentions and engineering support to promote the performance in a strict time and cost framework that is closer to the regular, commercial construction process than to a scientific research project,

This attribute of this specific research development, is what determined many the choices based on market criteria, on the one hand, but also prevented making use of previous similar examples as reference. That interesting factor, of assembling market products into an innovative custom-made element, increased the design challenge, on the one hand, but on the other, it gave a clearer view of each and every part of the system as a field of improvement. Additionally, the fact that the produced outcome had to comply with the aesthetics and architectural desires of a group of more than 20 architects, who were the designers of the Solar Decathlon prototype, was the strictest measurement unit of the success of the PV/T chimney as a product.

The Solar Decathlon 2019 competition insisted on a renovation concept that had to take place in less than 12 days. Apart from that, the prototype had to be built in the Netherlands at first, In Hungary secondly and back in the Netherlands, lastly. These factors determined other aspects of the design that perhaps would have been avoided otherwise. The PV/T chimney had to be part of a façade unit that is easily assembled and disassembled, within some minutes of the hour, fast connected to the different parts of the HVAC as well as to each other and with the least amount of expertise. The main advantage that this challenge promoted, is that the PV/t-chimney product is now integrated in a coherent construction strategy, meant for high-rises, in which no surprises in future implementations are expected to be met. A great range of issues was faced and methodically tackled and therefore the existing outcome is beyond the stage of development one would expect from an academic scientific research. Apart from that, though, this gives the additional potential to the PV/T chimney product to be attached to different buildings, except for the particular case study building, with the fast assembling-disassembling techniques that it was designed to adapt to.

However, the scientific value should not be undermined by the "commercial" manufacturing-constructing adaptability of the product. The simulations and the experiment verification confirm that it can provide a positive sign, compared to the single PV building integration, which can compensate for the increased energy demand of high-rises. Furthermore, it promotes, to a new level, the self-explanatory advantage of exploiting the façade of high-rises for energy generation instead of simply the roofs, something that remains still undeveloped in the largest parts of the building industry. However, it should not be undisclosed that the effectiveness of a solution as energy positive, does not rely only on the outcome of the energy generation values but on other values as well. Mainly, that involves the environmental footprint due to the manufacturing process and the embodied energy each of the parts includes. On this regard, further development should be expected in order to clarify that field of applicability as a sustainable alternative.

All things considered, with the end of this process, the PV/T chimney remains to be a highly promising element of building-integrated innovations, for high-rises in the Netherlands, as initially assumed. In a future, in which zero energy buildings are expected to be the norm, the combination of passive techniques with energy generation on full extent across the building envelope, can prove vital for the fulfillment of the ambitious targets on sustainable development of the building industry.