Sostenibilidad: el arte de la arquitectura moderna ☆

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Over the last 10-15 of years the building industry has been faced with an increasing demand for sustainable solutions. According to Peter Bakker, president and CEO of the World Business Council for Sustainable Development WBCSD, buildings are the largest energy consumers in the world economy, accounting for over one-third of final energy use and approximately 30% of global carbon emissions [1]. These figures do not take into account the energy and carbon emissions due to production of building materials or for logistics and building construction. The demand for both energy and resources is soaring as global construction booms, especially in countries such as China and India. This means that developments in building practice can significantly contribute to tackling climate change and energy use. The use of ETFE foils as a new transparent material substitute for glass provides the potential for not only vast savings in material quantities but simultaneously makes possible a new type of space for living and working. The environmental benefits are presented as results of a comparative study between glass and ETFE solutions on two projects in Germany, Domaquarée in Berlin and Kapuzinergraben in Aachen, based on a life cycle analysis. The social benefits will be presented using the example of Kingsdale School in London and Kuwait Avenues, Kuwait. It will be shown that the introduction of ETFE foil systems in modern architecture will significantly contribute not only to environmental sustainability, but also create economic and social advantages compared to more classic building materials.

. Introduction The term “sustainability” has been applied extensively to many products and activities in recent years. It is generally considered that there are three distinct sectors in which sustainability can be effected and enhanced. • environmental sustainability • economic sustainability and • social sustainability. In the case of the building industry there is a strong demand for solutions that provide benefits for all of the three sectors. As global warming has increasingly become one of the main areas of social concern, reduction of energy consumption as well as significant prevention of pollution and damage to the natural environment is recognized as a task of highest priority [2]. As a consequence and in order to provide sufficient well protected living space for a still growing population worldwide the building industry is asked to provide more building space whilst simultaneously using less materials. Additionally a building’s energy consumption during the use phase should be minimized, which is not only a criterion for new buildings but for existing buildings and particularly heritage buildings. These parameters should be taken into account as well in the context of energy efficiency refurbishment.

Special attention has always to be payed to the costs involved in building structures. Environmentally sustainable buildings offend against fundamentals of economic sustainability if cost-efficiency is not taken into account. “Plusenergy-houses” that cannot be afforded by most of the building owners are by no means models for environmental sustainability. Additionally new buildings as well as refurbishment of buildings have to allow for the altered social demands of multicultural societies. Light and spacious but well protected areas should come along with comfort, energy savings and aesthetics in order to create living spaces where people can meet. The objective of this paper is to explore the potential of new building cladding systems, ETFE foil membrane systems in particular in comparison to more classic concepts, for instance glazed roof structures. Special attention has been payed to environmental sustainability by means of a comparative life cycle assessment of two projects that were originally designed with glazed roofs but, due to loading problems, were subsequently realized with a Texlon® ETFE foil cladding system. All materials and their corresponding masses for the cladding system as well as for the primary supporting structure are well known for both the glazed and the ETFE foil solutions. The Life Cycle Assessment (LCA) framework was used to analyze the whole lifetime of the products and their components, from extraction of raw materials to disposal or recycling [3].

Social Sustainability Refurbishment of the Kingsdale School in London is an example not only for alternatives offered by ETFE foil cladding systems regarding energy efficiency but also regarding creation of large well protected and comfortable areas for people to meet and work. Due to the lightweight of ETFE cladding structures, the transparency for nearly the whole of the solar spectrum and the high acoustic transparency [14] the inner space of the atrium provides a high comfort environment. Regarding acoustic comfort plane surfaces of modern architecture using concrete, steel and glass produce enhanced reverberation and enlarged reverberation time, responsible for a high level of acoustic background. Due to the high background noise levels there is a tendency to increase vocal intensity, the fundamental frequency, and the word duration this is recognized as the Lombard effect [15]. Acoustically, the effect of noise generated by heavy rain or hail under ETFE roofs is very well known and has been documented by C. Hopkins and M. Burdett in a BRE report in 2004 already [16]. In order to reduce the noise due to rainfall or hail impact a mesh was installed as an overlay on top of the outer foil [17]. A reduction of the Aweighted sound intensity level LIA of 13 dB (100 to 3150 Hz) is documented. The low sound absorption properties of ETFE cushion systems are usually considered as a disadvantage in noisy environments, but because of the low reverberation time they do not require any additional installation of acoustic absorptive materials. These properties allow for new forms of living and education. Whereas acoustic performance very often is identified as a problem Carl Maywald and after the building has been populated and acoustic discomfort can be managed by installation of additional sound absorption materials ETFE cladding structure will automatically provide the necessary acoustic comfort due to low reverberation time [14]. The overall properties of ETFE cushion system thus provide an environment analogous to outside conditions but well protected against the environment. This basic property of the ETFE systems creates a perfect atmosphere for people to meet, i.e. for any kind of building cladding structure that intends to provide space for many people. A good example is the project Kuwait Avenues (architects: Gensler, London) which actually undergoes the fourth enlargement (phase 4b). Approximately 35000 m² have been built during the last 4 years, and another 30000 m² is going to be built. The Texlon® ETFE cushion systems cover whole a region of the town attracting people from all over the country. In harsh environments like Kuwait with extremely high temperatures, high amount of dust and humidity no one really likes to be outside. A print pattern that covers 84% of the outer ETFE foil reduces the gvalue to 0.26 thus providing sufficient shading for inner spaces. Due to thermal layering in

hot climates warm air goes upwards and cold air provided by air conditioning inside the building (shops, restaurants, offices) stays at the floor level creating a high thermal comfort.