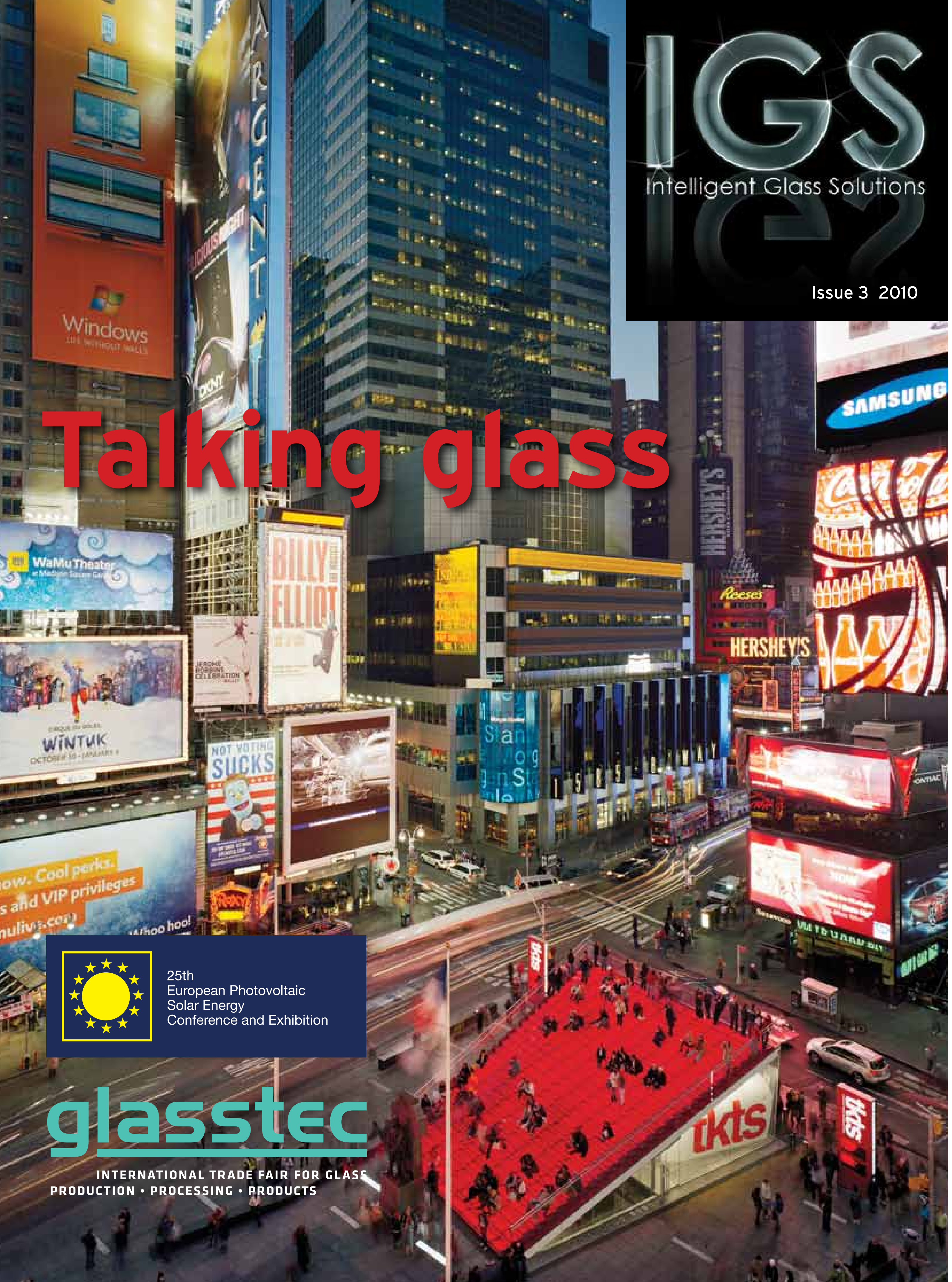

Pushing the envelope

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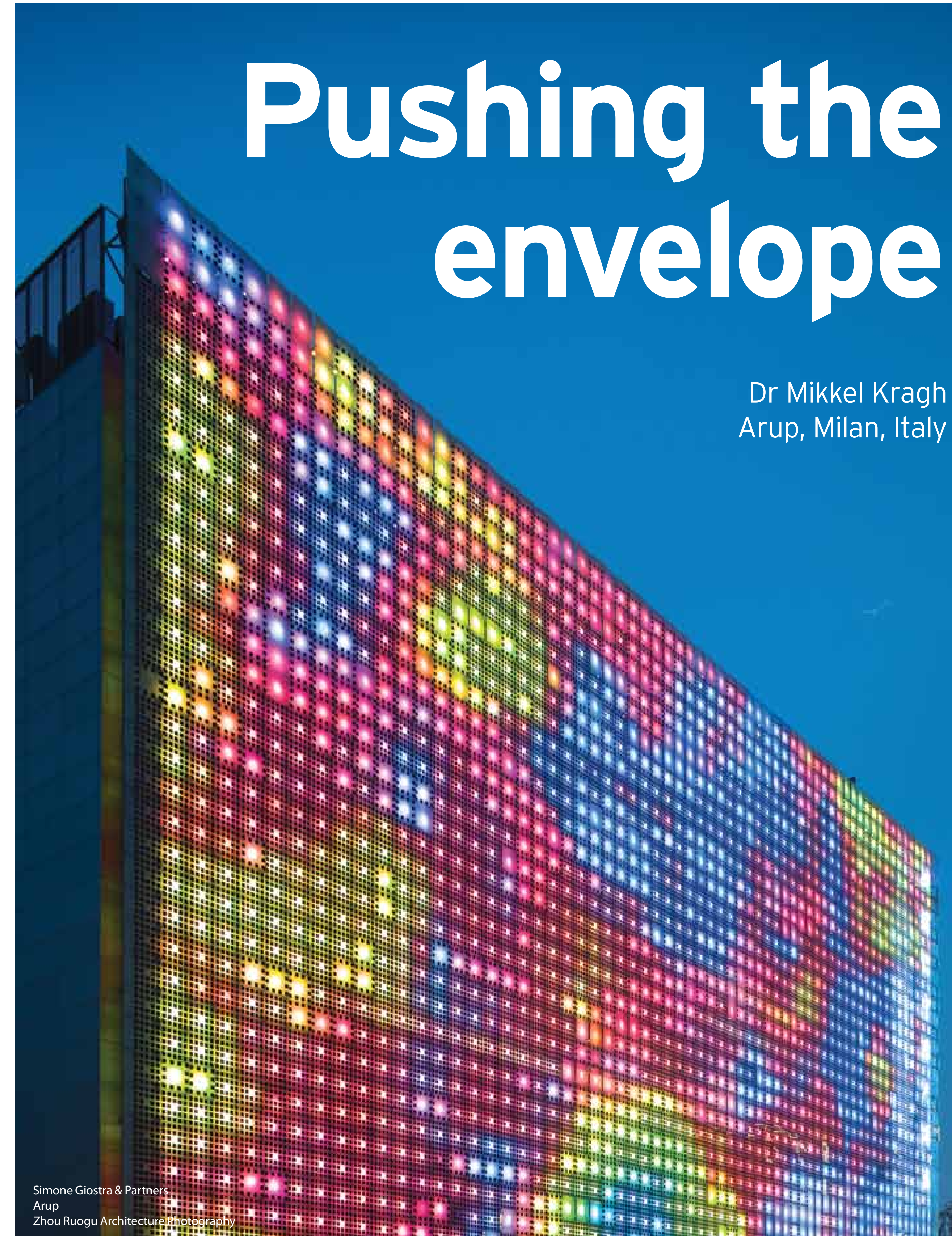

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The past year has been dominated by two issues, which will continue to impact on the way we go about our business as building designers. Firstly, the implications of climate change and the way our buildings increasingly need to deliver high performance and low impact. The effects are felt in the form of legislation, but also increasingly as a demand in the marketplace for sustainability rated buildings. Secondly, the economic crisis has had – and continues to have – significant implications, and both businesses and professionals are feeling the strain.

During these difficult times, the Society of Facade Engineering (SFE) has been steadily expanding and raising awareness of the facade engineering as an essential component of integrated design and delivery of buildings and building envelopes. The discipline is potentially maximising value for clients and offering the broad technical approach needed for the realisation of sustainable buildings to increasingly challenging programs and budgets in a global market. This could be the decade of the Facade Engineer.

The Society is embryonic and a step change is needed in terms its uptake by the industry. We need to reach critical mass for industry to identify SFE membership as the only recognition of professional qualifications and experience, for individuals to seek membership as a way of furthering their careers, and for clients to come to expect accredited professionals working on the delivery of their projects. Good work is being done and we are continuing to reach out geographically and across the more traditional disciplines.

In his influential work De Architectura, Roman architect Vitruvius talks about the three elements of Architecture: Commodity, Firmness, and Delight. There are interesting parallels to the nature of façade engineering in that the building envelope needs to fulfil the functional requirements and meet the specified performance criteria, while having a fundamental impact on architectural aesthetics and the intangible qualities of the resulting enclosed space. This, then, is perhaps one of the aspects that appeal to a new generation of technically minded architects and architecturally minded engineers? There is no doubt that the nature of façade engineering can be both complex and stimulating. Appropriate application of highly specialised

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skills is potentially the difference between a successful project and a less successful one. 2

The need for specialist input stems from the gradual transition from traditional to nontraditional methods and technologies. Technological progress and the industrialisation of the construction industry mean that the role of the Architect is changing from that of controlling the design through a profound knowledge of materials and techniques to a role of orchestration of a multitude of specialist skills, knowledge, and industry intelligence – possibly benefiting from façade engineering input throughout the various stages of the design process. The increasing complexity of the technology and the recognition that not many architectural practices can sustain in-house skills in every field resulted in façade engineering as a relatively new professional discipline. The first façade engineering groups were set up around 20 years ago in response to the need for specialist input on technically challenging projects. Façade engineering covers the grey area between the more traditional disciplines but also overlaps significantly with all of them, to varying degrees depending on the circumstances.

The advances of computational design tools have empowered designers and manufacturers and the results show in the realisation of large scale freeform architectural projects. While the designs are made possible by technology, they also pose significant challenges in term of communication and coordination across the design team and the entire supply chain. The management of information is paramount in terms of delivery and the early stage engineering is critical in order to test technical feasibility and assess the building envelope budget.

One of the key challenges for the years to come is the existing building mass, which needs to be upgraded to perform to today's standards and contribute to the mitigation of climate change. We need to fundamentally alter the prevailing perception that existing buildings are somehow less exciting than new ones. Requalification of buildings and cities will become an increasingly important market and we need the right technologies and skills to face the challenges ahead. The building envelope is instrumental to the successful combination of upgraded performance and architectonic qualities. Both aspects will drive up the value of assets and lead to the demand for new retrofitting technologies and techniques, including thermal insulation and solar shading systems.

We are seeing an increasing focus on materials in the design of building envelopes. The term new materials frequently refers to high tech products being developed by the industry and/or sometimes transferred from other sectors such as aerospace or automotive. As an example, we are seeing an increase in the uptake of composite materials such as fibre-reinforced polymers (FRP) in architectural applications. Similarly, a number of adhesives have been adopted in the 3 development of advanced glazing technology. Just as frequently though, the materials are merely used in a novel way or introduced as a modern interpretation of traditional methods of construction. An example is the recent focus on timber-based construction, which is increasingly popular as cladding due to its aesthetical qualities and sustainable characteristics.

The performance of commercially available curtain walling systems is enhanced incrementally through design optimisation and development of glazing technology. In terms of thermal performance, the principal limiting factor is the framing, which is typically based on use of thermally broken aluminium extrusions. The combination of aluminium frames and the glazing edge conditions leads to linear thermal losses and relatively high thermal transmittance (U-value). The benefit of high performance insulation is somewhat limited by the performance of the framing and can therefore be hard to justify the associated costs.

There is a need for façade systems that respond to the building energy regulations and the significantly more stringent requirements in the future. The technological response must be environmentally responsible as planning and legislation are increasingly used as instruments to drive a more sustainable development. More visionary clients will often rank sustainability very highly from the outset, while comparatively more conservative clients will need to address the issues in order to meet the building regulations and/or get planning permission.

The challenges are being dealt with at different levels across the industry. The Integrated Building Envelope is an example of joint development of novel technological solutions in collaboration across the value chain. The Danish foundation Realdania supported the collaborative project under the Building Lab DK programme. As part of a wider-ranging commercial development project, an industry consortium explored the use of composite materials in curtain walling. The initiative is an effort to challenge conventional technologies and maximise the opportunities offered by pultruded FRP materials in architectural applications. FRP's low thermal conductivity means that there is no need for additional thermal breaks to achieve high thermal performance. The pultrusion process allows for production of large cross sections, which means that it is possible to reduce the number of components, thereby potentially simplifying the assembly process and creating a new architectural expression. A simple and highly integrated modular system can be realised with significantly reduced depth of the façade system, thus potentially maximising the value of the building footprint.

A first concept has been developed, aimed at maximum utilisation of the intrinsic properties of the composite material within the context of curtain walling:

- Low thermal conductivity
- Large pultruded FRP sections
- Compact (slim) system
- Structurally bonded connections
- Lightweight
- Limited number of parts
- Appearance (potentially translucent)

The concept addresses the fabrication and assembly processes and actively aims to minimise the number of parts and the need for machining. The result is a potentially highly rationalised manufacturing process and reduced risk in terms of workmanship.

The drive for buildings to become energy efficient and carbon neutral (i.e. not resulting in emissions of carbon dioxide, the exact definition of carbon neutrality is currently being debated extensively) may ultimately result in range of buildings that are – on average – net exporters of energy. The approach is to first maximise energy-efficient design and operation (minimising demand) and subsequently introduce appropriate renewable energy systems such as ground source heat pumps. Low cost photovoltaic technology is an area where the building envelope offers true integration potential and consequently acceptable payback periods. The ability for professionals to introduce such systems appropriately is increasingly important. The feasibility of concepts needs to be tested during the early stages of design in order to avoid gain confidence that the project will meet the required performance standards, be technically feasible, and that the budget is likely to be met. The linking of analytical design tools is potentially facilitating this process. Again, integration and transdisciplinary working is a recipe for success and the careful definition of interfaces by suitably qualified professionals will prove crucial in order to avoid costly problems downstream, during commissioning and operation.

The development of advanced technology has often led to what appears to be complex buildings with variable and automated facades that respond to changes in environmental conditions and user behaviour. Clearly these systems represent progress in a technological sense and, when dealt with appropriately, the technology can facilitate high performance and bring about interesting architectural opportunities. There is, however, also a risk that certain systems are incorporated because they are seen as advanced technology and have come to symbolise high performance design (or even sustainable solutions). 'Green Wash' is the term 5 used to describe design which is over-sold and under-delivered as sustainable through high tech gimmicks as opposed to pragmatic, evidence-based (and perhaps less exciting) solutions. Every project is unique and needs to respond to the client's requirement, local climate, etc, and there is no one-size-fits-all solution for building design. The aim should always be high performance - low impact. At times the appropriate solution will be a highly technological design, at other times a passive design will be more appropriate. Passive design is based on fundamental principles and seeks to maximise the benefit of the natural climate and the physics of the building form, orientation, materials, etc. To this end, the building envelope is of fundamental importance and much can be gained from early stage studies of the impact of the building envelope on the environmental performance of the building. Advanced design tools and appropriate use of building physics has a lot to offer in this field. In a sense, we are witnessing a return to design before the era of air-conditioning and a rediscovery of fundamental design principles coupled with cutting edge technological solutions.

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