Environmental retrofitting

A mandate for liveable GCC smart cities

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Enabling the public space to welcome the citizens and be the platform for a smart city requires a consistent environmental approach to the public space in the GCC, not an easy task. An integrated strategy to fight the urban heat is mandatory, considering extreme weather conditions. Several strategies are in place in the main Gulf countries: United Arab Emirates (UAE), Qatar, and Saudi Arabia, to create districts' cooling systems. I want to highlight the importance of extending these policies on the environmental consistency of the existing buildings. The target of livable and walkable districts requires a comprehensive approach, including macro and micro-scale interventions that cooperate to minimize energetic consumption and the related CO2 footprint for new and existing built environments. It can be achieved in new constructions through the already consolidated and shared environmental labels and protocols, and – in the case of the existing districts – it can be further enhanced into a wider sustainable strategy, including a built environment retrofitting.

The GCC's capitals are experiencing 1/3rd of the years at a temperature above 40 °C. This trend is increasing across the years for all of them, except for Muscat, which has a decreasing trend. According to scientific studies, the maximum daily temperature could exceed 50 °C for all the cities, except for Manama and Jeddah (AlMazroui, 2020). Moreover, the Arab peninsula is considered the most hot-humid spot worldwide, with a humidity rate doubled in the last 40 years, making the perceived temperature in all the coastal cities up to 10 °C degree higher (Bardsley, 2020).

Buildings are completely dependent on Air conditioning (A/C) to protect inhabitants from heat stress, but, on the other hand, this is contributing dramatically to increase the street's temperature, as A/C is discarding heat into the air. The air temperature increase by A/C discharge can be locally measured, in a range from 1°C to 4 °C, depending on the type of the implant. It generates a vicious circle of increasing street'S temperature and, therefore, increasing the air cooling demand (Tremeac et al., 2012). This extra warmth gets piled on top of the urban heat island effect, the phenomenon describing how cities tend to generate their little heat bubble. A city of 1 million people can be as much as 3 ºC hotter than the area immediately around it; obviously, the A/C may be contributing to that already and exacerbates it. It truly is a vicious cycle, with our need to cool off making it harder and harder to do so. This effect, generated by a complex of co-causes, is known as the heat island effect and suggests that a downtown building would require 25 percent more air conditioning and 6 percent less heating than the same building in a rural area, all else being equal (Shatz, 2016). It means, the actual use of A/C generates a temperature rise in the districts and a massively increasing energy consumption while offering a lower benefit to the inhabitants. It has been demonstrated how in hot and dry cities due to air conditioning use at night time indicate that the nocturnal urban heat island and increases cooling demands.

The implementation of a comprehensive sustainable mitigation strategy in the A/C use would achieve several objectives: successfully reducing the urban heat island temperature by an average of 2 °C, reducing A/C electricity consumption on a city scale, and providing a real example of urban climate mitigation and environmental quality. It would also have a significant economic impact: an estimation made for the Phoenix metropolitan area, shows that successfully reducing the urban heat island temperature, would bring at least 1200-1300 MWh of direct energy savings per day alone (Olson, 2014). The solution is not simple and requires some creative thinking, including research about re-using the heat wasted from A/C (Salamanca et al., 2014). In the UAE, to give an example, buildings consume more than 80 percent of the total electrical generation, where the cooling systems are responsible for approximately 70 percent of the buildings' peak electrical load despite that the government of Dubai initiated several efforts to improve building efficiency and move towards a more sustainable city (Jose-

Urbinaz et al., 2020). The existing real estate intervention is essential and takes a combined short-middle-long term approach strategy.

King Abdullah Petroleum Studies and Research Center (KAPSARC), supported a circular carbon economy approach (CCE) in Saudi Arabia, as an implementation framework to reach its net-zero target by 2060, tackling emissions in the cities. The framework advocates for incorporating an additional 'R- remove' to the "three Rs" of the circular economy concept (Mansouri and Al-Sarihi 2021). It results in the 4Rs of CCE: Reduce, Reuse, Recycle and Remove (KAPSARC, 2021). The first step of Reducing is essential, possibly from the design phase, to make all the further steps effective. It becomes essential to consider efficiency at all stages of the construction value chain, including clinker manufacturing in buildings, structures design, and use and reducing the factors affecting the heat island.

In particular, the Reducing approach to the new and existing buildings must include a starting from passive environmental solutions. Those can apply visibly or invisibly. In the first case, these contribute to a re-shaping of the building and eventually enhancing its volume or livable spaces; in the second case, the building gets an extra coating of insulating materials. Passive strategies, especially in GCC with their extreme temperature, include insulation of the building: R1 (Reduce), the heat transfer from indoor/outdoor and limits the need of A/C. It could give unexpected solutions, considering the basic standard of most residential buildings, mainly having no or minimal contribution of warm insulation. The insulation's implementation must be conducted on different elements of the envelope: external walls, and roofs, usually missing completely or having insufficient thermal insulation, on envelope's openings as doors/windows, mainly not having thermal cut systems and lair leaking frame. It is also the highest cost in the process and requires two main strategies from the governments: incentives and starting a self-production of high-end windows systems. Air leaking also generates constant dust indoor and co-related unhealthy indoor air. Those actions can follow a synergic plan and eventually concur to a completely new appeal from the building by encapsulating it into a new façade or adding extra volumes. Finally, a more comprehensive approach would require a strategic revision of layouts. A second strategy for GCC is to minimize the solar radiation and exposure to heating sources and can have a big visual impact on the outlook of the building by adding self-shading systems as balconies, extra vertical and horizontal screening, and shading systems, and also a contribution by improving the environmental performance of the immediate surrounding by trees and other shading devices.

Only after applying these strategies of reducing and minimizing the heat exchange is it possible to minimize the energetic consumption and integrate systems for energy production. Those are the most expensive interventions and would not benefit without the first applied strategies on saving. Minimizing energy consumption comes from Rs Recycling and Re-use: starting from greywater recycling and optimizing materials. Natural ventilation strategies and indirect lighting can be implemented, arriving until fully integrated building systems through high technology envelopes, sensors, and smart devices to support energy management. Finally, buildings can be upgraded through active systems for energy production by renewable sources: geothermal, natural air pre-cooling /pre-heating, thermal mass, heat exchanging systems, photovoltaic. The governments must control this kind of strategic approach to avoid the propaganda effect of running into photovoltaic systems, and any other manifesto approach, without first respecting the right protocol for saving energy leakage. It would have a boomerang effect regarding investments, sustainability, and public awareness, getting upset for the scares results achieved despite a big investment (Petrucci, 2018).

Those strategies have to be integrated case by case, looking at a cost-benefit matrix and a funnel process moving from general to specific strategies and then from the strategies into specific selected actions. The process always starts from a design approach to the built environment, considering as beneficial side effect of the environmental strategy itself, also an enhancement in the aesthetic of the building, of its indoor functionality, and external linking with the surrounding district. The eventual related extension in terms of built cubic meters could serve the client in financing the retrofitting procedures through a governmental office to make a tutoring function during the first phase. The integrated design service could also be one of the facilities offered by the government to the citizens to facilitate the transition.

Similar interventions in the GCC are not recorded so far. However, they can be considered the main strategy for the existing real estate and the need to densify the cities. The most successful benefit from the government could be: tax reduction, however not consistent in the GCC, it could apply reducing the VAT and urbanization contribution, reduction on energy bills, the concession of extra built volume, and extended benefits from other government authorities, like school taxes, health care, traveling and other facilities. The investors could even choose these within a package of possible incentivizing offers.

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