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The Impact of climate change on sustainable architecture in smart cities

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Abstract

Climate change is an irreversible trend in today's reality and future economic growth and social development of industrialized and industrializing countries in the world. We may only limit the negative impact of this phenomenon to preserve the sustainable development of our economy, society and surrounding environment. One of important steps forward is to develop sustainable architectural solutions for

residential buildings, community houses and public utilities as well as for the whole city's sustainable urban planning. Cities in Northern Europe are much more advanced in an orientation toward this strategic direction of development and they could deliver perfect examples for cities in developing countries to follow to become livable places in the world.

Keywords: climate change, sustainable development, sustainable architecture

1. Introduction: Industrialization and climate change

Climate change is a global issue and therefore global solutions are needed. At the 1992 Rio Earth Summit, leaders in 172 countries came to the same conclusion that changes in attitudes and approaches to environmental issues need to be addressed and a close look at these issues should be taken in economic and political decisions of each country. Summit participants have signed the Framework Convention on the prevention of increasing greenhouse gases (GHG) emissions in atmosphere leading to climate change. The treaty's ruling was further extended by the Kyoto Protocol signed in December 1997 and entered into force on 16 February 2005. One of the main rulings of this treaty is that developed countries in the coming years must reduce emissions of six greenhouse gases by 5% compared to 1990 levels. The Kyoto Protocol also provides the opportunity to offset some of the cost of emissions with new mechanisms that allow the purchase and sale of rights to GHG emission [1; w1].

The European Community has pledged to cut 8% of its total GHG emissions. This commitment, as decided by the European Council (2002/358 / EC) and agreed upon by the members of the EU15, is unequally distributed in each member state. Adhering to the principle of unity, member states agree that the least developed countries in the EU will be allowed to increase their emissions quota in the years 2008-2012 compared to 1990 levels. These countries and their allowed levels of increase included Portugal (27%), Greece (25%), Spain (15%), Ireland (13%). The remaining countries and levels of reductions included Luxembourg (28%), Germany and Denmark (21%), Austria (13%), United Kingdom (12.5%), Poland (6%) [1; 3].

2. Sustainable architecture

Sustainable development is a concept of global, regional and local development, opposing to the narrowly perceived economic growth concept. It is a response to the global character of environmental threats. Sustainable development is defined as a socio-economic development in which a process of integrating all political, economic and social activities is taking place maintaining at the same time the natural balance and durability of basic natural processes in order to guarantee possibilities to fulfill the basic needs of each community and each citizen both of contemporary and future generation [2; 4].

The essence of sustainable development consists in preserving a balance between economic, social and ecological system. This balance is especially essential in largest cities where human activities directly interfere with natural environment and where the forms of these activities and their effects are dependent on nature. Because the city dwellers, according to Wos [2; 5], are trustees of large part of natural resources, they have a great impact on preserving those resources to be in perfect state for the sake and benefit of future generations.

Since the concept of green building emerged in the 1960s and 70s, sustainable architecture has become one of the

fastest-growing architecture trends in today's eco-conscious world and has contributed to the sustainable development of business and society. The idea behind sustainable architecture is to use only environmentally friendly techniques and materials during the building process. It also seeks to minimize the negative impact of buildings through efficient energy consumption and development space.

During the 60s and 70s, the construction industry often used materials or methods that inflicted harm or destruction to their surroundings. Because of this negative impact, individuals and groups took up initiatives to promote eco-friendlier types of construction. Because of these initiatives, sustainable architecture was born. Architects, who design sustainable buildings, typically use natural and renewable resources such as concrete, harvested wood and rock as well as recycled materials like glass and lumber. They may also reuse architectural components of other buildings, including doors, windows and flooring in the structure. However, sustainable architecture involves much more than just the materials used [w3].

Sustainable architecture also focuses primarily on how energy will be used for the structure and how to effectively conserve it. This process involves ensuring that the building has excellent insulation and the use of shades and awnings as passive building coolers. Sustainable buildings often also rely heavily on solar energy or other alternative energy sources. Also, the use of natural and recycled building materials combined with renewable energy sources typically make sustainable buildings much cheaper to construct and maintain [w3].

Besides the benefits to the environment and cost savings, one of the greatest benefits of sustainable architecture is that style and design need not be compromised by the emphasis on natural materials and energy conservation. In fact, sustainable architecture places emphasis on not only style and design, but also innovation. This has led to many sustainable buildings becoming known for their impressive looks [w3].

Sustainable architecture provides not only an eco-friendly alternative to traditional construction techniques but also added energy efficiency and superior style. There's no doubt that sustainable architecture is the way and philosophy of smart cities in the world and will become more prevalent as the concern for the environment grows in parallel with the approaching 4th Industrial Revolution.

3. Sustainable architecture in smart cities of developed world

In developed world, cities across the globe are installing technology to become smart, in the hopes of becoming financially stronger, environmentally cleaner, reducing traffic jam, and improving urban life. Smart cities must deal with energy management, disaster preparedness, public safety, and other important issues.

Oslo, Norway is one of the shining stars of the burgeoning smart city movement. Founded around 1040, the city is consistently highly rated in terms of quality of life. The population's quality of life continues to improve as a growing public-private partnership makes major investments to make Oslo a smarter, greener, more inclusive, and more creative city for all citizens. The key to Oslo's success has been the application, deployment, and integration of new technology, as well as an ambitious and aggressive series of pilot programs designed to prove that futuristic technology can be

used to build a smarter city.

The cornerstone of Oslo's smart city efforts is the collaborative project FutureBuilt [w2] which was established to support climate-friendly urban development in the region. With urban population of over 650,000 residents in the city alone and over 1.7 million citizens in the metropolitan area, climate-friendly architecture and deliberate urbanism were the key to protecting its citizenry from harm. The Oslo region faces major climate challenges. FutureBuilt is a 10-year program with the aim of developing 50 pilot projects involving climate-friendly buildings and city areas. It's collaboration between nearly a dozen disparate partners, including several municipal authorities, the Ministry of Local Government and Modernization, the Norwegian State Housing Bank, and the National Association of Norwegian Architects, among others. There are specific criteria for being selected as a FutureBuilt project. The projects must reduce their carbon footprint by at least 50% compared to today's standards, be located near major transport hubs, and be of high urban and architectural quality. To encourage innovation and quality, most FutureBuilt projects originate as the result of an architecture competition.

There are stunning jewels in the FutureBuilt portfolio of projects already. **The Bjørnsletta School**, built by Østengen & Bergo Landscape Architects, is a futuristic primary and secondary school for approximately 800 students. This passive-energy design uses automation to ensure an optimal indoor climate and energy use, while the design uses unusual spaces like the roof to offer more room for classes and places for students to stretch out and play. Solar access, minimum parking allocation, and expanded bike parking complete the picture of this architectural marvel.

Elsewhere in Oslo, it is the Gullhaug torg, a 16-floor multifunctional building that demonstrates Oslo's commitment to urban densification. The building is very close to net-zero energy use and doesn't purchase any energy for ventilation, heating, or cooling. The building lines up perfectly with the goals of FutureBuilt by reducing carbon dioxide emissions by 50%. There's no parking at all for cars, but it's situated near a public transport hub.

New Munch Museum located on east side of the Aker River in Bjørsvika, which is expected to be completed in 2019. The architectural mock-ups of the building seem to bend the laws of physics, but the Spanish architectural firm studio Herreros assures that the building will make a fine home for Edvard Munch's collection. The building is a 12-story tower sheltered by a ventilated skin of corrugated, perforated aluminum plates. This ambitious project also meets FutureBuilt's ambitious requirements and is expected to be a vital destination for tourists visiting Oslo.

The pilot projects are the core of FutureBuilt's work, but that's not its sole endeavor. In 2014, the organization launched a competition as an attempt to make *bicycles the city's preferred means of transportation*. Oslo Byskkel, the city's bike-sharing program, has over 130 rental hubs throughout the city. FutureBuilt also organizes most important *conference for climate-friendly architecture and urban development* and is a major partner in Oslo Architecture Triennial, Scandinavia's biggest architecture festivals. It's taken some time for local leaders to embrace such ambitious innovation, but they're starting to come around. What used to be innovative madness is now the natural way of thinking.

Another innovation in Oslo is its dramatic embrace of *electric*

vehicles (EV) and alternative transportation. In addition to the biking changes already well underway, Oslo's government has put its support behind innovations like electric vehicles. This effort is vital to the city's environmental goals, as emissions from transportation account for 60% of the greenhouse gas emissions in Oslo. EV buyers don't pay the 25% sales tax and enjoy free parking, access to the bus lane, free charging, and free transport on ferries. It's an electric-car-owner's paradise. Oslo kick-started the program by deploying a radically improved electrical infrastructure that includes over 2,000 charging points for EV throughout the city. Oslo sees these major investments not as a burden but a benefit. These changes have proven to have corollary benefits, including new business opportunities in sectors like charging equipment, EV manufacturing, smart-grid technology, and renewable energy services.

The city also doubled down on commitment to reducing emissions as well as creating new funds for smart-city projects when it instituted the *Oslo toll ring*. Automated toll stations are located on all roads leading into Oslo, with favored rates for zero-emission vehicles. Revenues from the Toll Ring are used to foster the use of public transportation, bicycle programs, and pedestrian-friendly design in the city. The goal by 2019 is no cars in the city at all.

The beauty of Oslo's smart city community is that no one government agency, company, or institution is solely responsible for it. The government, companies, non-profits, and other constituents all contribute ideas on how to make Oslo a better place.

For one innovation, Oslo has challenged the construction market to develop *trenchless connections from buildings to main water lines*. The concept uses techniques similar to those used in the oil industry and the idea is to disrupt city life as little as possible by making such projects shorter, less disruptive to traffic, cleaner, and quieter.

Oslo has also made a major investment in improving its *streetlights*. These state-of-the-art lights can respond to light conditions or weather forecasts to dim or get brighter as needed. This program was one of the first widespread implementations of intelligent lighting in Europe. The project also succeeded beyond even its initial goals, ultimately reducing energy costs by more than 60%.

Finally, there are innovative new organizations like *Smart Oslo Accelerator*, which is the first portal launched to create a dialogue between the City of Oslo and the startup community. The organization puts on a regular contest which encourages entrepreneurs and startups to create game-changing ideas to improve the mobility, health, climate, and other challenges to the citizenry of Oslo. After all, they're the ones who reside there, so they might as well be involved in making it even more livable [w2].

4. Implementing sustainable architecture in smart cities in Binh Duong New City

According to Mr. Tran Thanh Liem, Chairman of Binh Duong People's Committee [6]: "Building smart city is a necessary trend of development. Model for smart city development will give a premise to implement synchronized solutions in development policy, especially for Binh Duong, a region with high economic development, growing population, strongly developing process of urbanization, the planning and building smart city is really an urgent issue".

According to the assessment of Mr. Peter Portheine, development director of Brainport group [7], "Binh Duong is

a newly developed city, however, the communication and telecommunication infrastructure has been perfectly connected. This is a prerequisite for building a smart city. With more than 20 years of experiences, we will make use of what Binh Duong has to support the city to transform toward reducing labor intensive industry, while increasing high-tech industry as well as to support building smart city. With favorable conditions that Binh Duong now has, I am convinced that in the future Binh Duong will move forward quickly and become a smart city"

We will discuss some of the ideas of sustainable architecture that have been or could be applied in Binh Duong New City (BDNC). With urban population planned to be over 200,000 residents in the city alone and over 300,000 high skilled workers travelling to BDNC to work on a daily basis, climate and environment-friendly architecture is the key to protecting its citizenry from hot weather condition in a region where only dry and wet seasons are available each year. The BDNC is facing major climate challenges over years, typically flooding and air pollution. The ideas of sustainable architecture have been seen in the process of building smart city here. It's collaboration between nearly a dozen disparate partners, including several municipal authorities and departments, local universities, among others. A lot of scientific conferences and business seminars devoted for development of BDNC as a smart city have taken place. Summits concerning the developing smart city are hosted by Binh Duong provincial authorities in coordination with disparate partners, i.e. the Netherlands General Consulate in Ho Chi Minh City last year. The summits include events activities, targeting a wide range of stakeholders, thereby increasing the awareness, advocacy and active engagement of the public, communities, social and political organizations, businesses, academia, scientists, students, promoting Triple Helix model (the State, academia and businesses) and strengthening cooperation with international organizations and adjacent provinces in developing Binh Duong smart city. The summits are the opportunities to share vision, direction and initiation process of Binh Duong smart city project which is contributing to the sustainable development of the province; to discuss and exchange ideas from the world and national leaders and experts on the vision, strategy and action program of smart city project around the world; to get a better insight into the development orientations of smart city that is currently been implemented. Hereafter, we propose some practical and feasible solutions that might make Binh Duong New City a really smart city:

- a. Besides building more pedestrian and bicycle paths, parks and green corners (to offset negative impact of industrial zones dispersed across the city), innovations in implementing infrastructure (in terms of building more charging stations) for electric vehicles (EV) as alternative transportation to reduce gas emission. EV owners should enjoy free parking, access to the bus lane, free access to charging stations. These changes certainly have corollary benefits, including new business opportunities in sectors of charging equipment, EV manufacturing, smart-grid technology, and renewable energy services.
- b. A major investment should be made to improve streetlights to reduce the energy costs. The state-of-the-art, smart lighting can respond to light conditions or weather forecasts to dim or get brighter, to switch on or switch off as needed.

- c. The government authorities should create dialogue between them and the startup community prone to bring about business innovations. Local government should more frequently hold regular contests which encourage entrepreneurs and startups to create game-changing ideas to improve the mobility, health, climate, and other challenges for the benefits of citizens, business, community and other parties. After all, they're one of the parties involved and that motivate them to make the city smarter and more livable.
- d. Finally, we should engage all levels' governments and bodies, businesses, universities, non-profits, charitable and environmental organizations, disparate constituents and stakeholders to contribute ideas and be collectively responsible for making Binh Duong city a truly smart, socially, environmentally and architecturally sustainable city.

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