Smart city - a solution for dealing with climate change in European cities

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Abstract

Smart City – a concept for which there is no valid general definition, but has been defined by the Organization for Economic Cooperation and Development as " initiatives or approaches that effectively leverage digitalisation to boost citizen well-being and deliver more efficient, sustainable and inclusive urban services and environments as part of a collaborative, multi-stakeholder process". This broad area has six pillars, including Smart Environment, which is the one that approaches the fight against climate change. Therefore, the objective of this article is to present the positive externalities of the implementation of policies regarding Smart Cities at central level in order to reduce the negative effects caused by climate change. Smart cities create a clean and healthy environment for the development of its citizens, promoting alternative solutions to combat the disastrous impact of industrialization in modern times. Research results show that using technology in various forms can significantly reduce environmental problems and improve quality of life.

Keywords: *environment, climate change, digitalisation, sustainability, pollution.*

1. Introduction

1.1. Smart environment – a concept

To develop a smart city, more technology deployment sources are needed from a variety of areas of activity. In this respect, the environment and sustainable lifestyles are presented as basic elements of smart cities [2]. These aspects are part of the smart environment, which leads to a sustainable development of the quality of human life.

In order to attain a permanent human settlement, the natural environment it's being transformed and shaped by cities, using physical elements. Extensive and invasive infrastructures and buildings are the main reasons through which conversion is obtained and conclude a significant impact on the environment [3]. Consumption of natural resources and energy, atmospheric emissions and waste discharge are a few examples of what urban development processes causes inside the environment. Due to the fact that cities are growing even larger year by year, the percentage of CO_2 emissions and world's energy are expected to continue rising more than 70% as it has been estimated currently [4]. The major sustainability challenges the cities face today are exemplifications such as the increasing intensity of urban metabolism and its effects on climate change.

"Research and academic view -where primary focus is given to achieving sustainability (mainly environmental sustainability) reflecting quality of life and the economy emerge as second-level priority factors. Corporate sector's view (mainly technology companies) where ICT as a panacea is the primary agenda in the sense that the required outcomes such as city efficiency, management, infrastructure, environment, and quality of life follow automatically." [5]

The sustainability of the urban environment is analysed from two approaches: one from the point of view of energy and the prevention of consumption; involving renewable energy, technological grids, pollution control and management, green buildings, green urban management, efficiency, reutilization and so on; and the other linked to the urban grid and the management of resources: waste, street lighting, waste management, drainage systems, monitoring water resources, reducing contamination and improving water quality [6][7].

When talking about environmental sustainability we should turn our attention towards the concept of smart mobility which promotes the goal of decreasing emissions, by encouraging the use of public transportation and alternative vehicles [7].

1.2. Climate change

Studies show that the temperature of earth and water has increased significantly in recent years. Starting with 1880, the temperature threshold is constantly exceeded from year to year. With these worrying figures, to be specific, 0.5 degrees Celsius and 62 % annual CO_2 emissions, several negative environmental impacts were found. With the excessive population growth, at the opposite pole, the

number of mammals, reptiles, amphibians, birds and fish is decreasing, which could lead to natural imbalances. Also, because of deforestation, almost 300 million acres forests were turned into agricultural land. As an immediate result of this process, the increase in carbon emissions and thus in global temperatures can be noted [8].

Human activities are the main source of greenhouse gas emissions (GHG), which include simple tasks, from mismanaging household waste to industrial activities and combustion of fossil fuels. The main producers of greenhouse gas emissions are fossil fuels utilized to generate electricity and heat, produce goods, construct buildings and infrastructures and in transport. To a lesser extent, greenhouse gas emissions come from other activities that do not involve fuel combustion such as agricultural activities and waste management. In the figure below, it can be see how much every sector contributes to the emission of GHG.
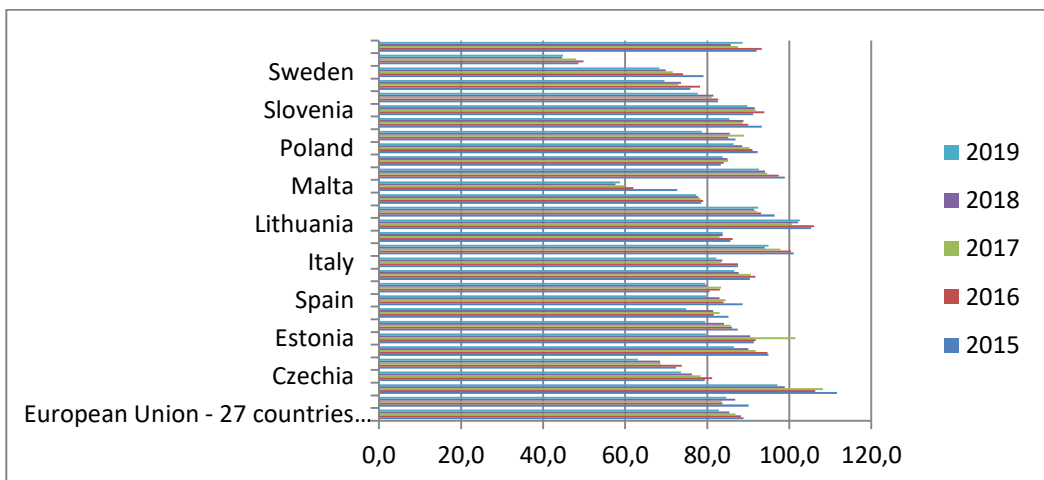

Greenhouse gas emissions by IPCC source sector, EU, 2019
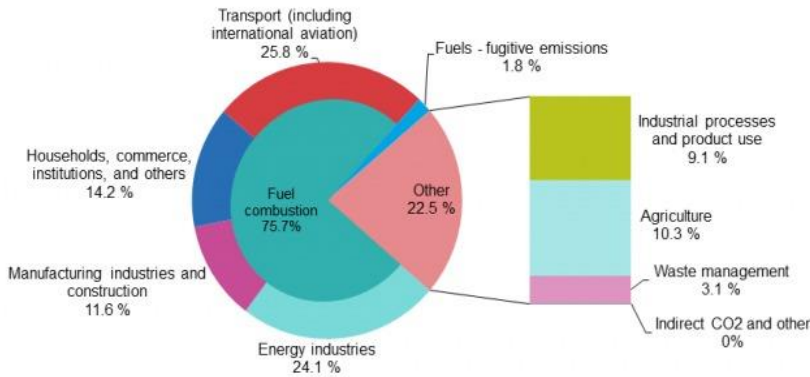
Source: EEA, republished by Eurostat (online data code: env_air_gge)

eurostat

Fig. 1.

Fig. 2. Greenhouse gas emissions intensity of energy consumption (source: EEA and Eurostat), 2015-2019

The indicator is part of the EU Sustainable Development Goals (SDG) indicator set. It is used to monitor progress towards SDG 13 on climate action and SDG 7 on affordable and clean energy; which are embedded in the European Commission's Priorities under the European Green Deal. The energy sector plays a key role in the fight against climate change. The EU, based on its European Green Deal and the 2030 Climate and Energy Policy Framework, works to implement efficient sustainable energy policies that meet the greenhouse gas emission reduction objectives by increasing energy production from low-carbon energy resources, in particular renewables while improving energy efficiency, managing energy demand, increasing the stability and transparency of energy markets, developing and transferring clean energy technologies and intelligent solutions [9].

2. Materials and methods

Even though the idea of a greenhouse effect has been theoreticized about for a century or so, societies had a hard time believing this was actually a threat [10]. Human expansion of the "greenhouse effect" is attributed to the global warming trend. There are certain gases categorised as "forcing" climate change which do not respond physically or chemically to changes in temperature and there are also gases categorised as "feedbacks" which respond physically or chemically to changes in temperature [11].

"In a Smart environment, the pollution is carefully managed in order to reduce the emissions. A careful management of water resources is carried out and abetter waste management is sought in order to achieve a zero impact on the whole territory of the cities." [12]

Three main causes of climate change had been identified by scientists, namely: a) humanity's increased use of fossil fuels; b) deforestation; c) increasingly intensive agriculture.

a) Humanity's increased use of fossil fuels

"Since the beginning of the Industrial Revolution, the increasing use of fossil fuels (coal, petroleum, natural gas) has added to the atmospheric burden of carbon dioxide." [13] The carbon dioxide is a gas that absorbs part of the infrared radiation that Earth's surface emits, the consequence being the unusual rise in the temperature of the lower atmosphere. This is what scientists call the greenhouse gas effect and the more carbon dioxide is emitted, the warmer the earth's atmosphere will be. The experts in the international climatological community warn that if we don't do something to decrease the carbon dioxide in the atmosphere, in the next 50 years mankind will cause a significant global warming [13].

In order to transition to low-carbon economies, country producers, fossil energy companies and their investors need to redesign their portfolios and change their focus from the current industries that emit significant volumes of carbon dioxide through the combustion of fossil fuels. Regions where the main source of fiscal revenue is dependent on fossil fuels will likely face a risk in the upcoming future, unless they concentrate their efforts on diversifying their economies [14].

"Without the influence of humans burning these fossil fuels for energy, this carbon would be unlikely to reach the atmosphere" [18].

b) Deforestation

The climate system includes the land surface and its vegetation; given the statement above, natural changes and manmade in the land can affect either positive or negative the climate [15]. During the last decades, Europe has experienced substantial deforestation, accordingly, it was noticed a reduction of almost 70% of the forest fraction in most parts of continental Europe [16][17]. The carbon dioxide is absorbed by trees and other plant and the stored in the plant's branches, leaves, trunks, roots and in the soil. While forests draw down carbon dioxide from the atmosphere, the carbon remains stored as long as the trees are standing. Once the trees die or decay, the carbon is released back into the atmosphere.

"Burning fossil fuels, in combination with destruction of carbon sinks due to deforestation and other activities, has contributed to more and more carbon dioxide building up in the atmosphere – more than can be absorbed from existing carbon sinks such as forests. The build-up of carbon dioxide in the atmosphere is driving global warming, as it traps heat in the lower atmosphere. Carbon dioxide levels are now at their highest in human history." [18]

c) Increasingly intensive agriculture

Greenhouse gas (GHG) is posing serious risks for ecosystem health. After carbon dioxide (CO_2) there are two most important GHGs, Methane (CH_4) and nitrous oxide (N_2O). Methane (CH_4) and nitrous oxide (N_2O) are receiving more and more attention because of their contribution to climate warming [19][20][21][22]. While upland soils are the major CH_4 sink, the dominant sources of CH_4 are natural wetlands, anthropogenic activities, and biomass burning [23][24]. Reactive nitrogen inputs from synthetic nitrogen fertilizer and animal manure applications, cropland expansion, and processes associated with fossil-fuel combustion and biomass burning have seemingly increased the atmospheric N_2O concentration. Both biotic and abiotic processes are included in the production and consumption of N_2O in soils [25].

Elevated atmospheric CO_2 could significantly increase N_2O emission due to the increase of soil moisture and soil labile carbon only under the condition of high nitrogen supply [26][27][28]. "Meanwhile, the increasing effect could be small or even negative in nitrogen-limited ecosystems since increased plant growth may result in less nitrogen availability for nitrifiers and denitrifiers" [29].

People tend to misunderstand the ideas revolving around climate change and its causes and that leads to creating an obstacle in the way of developing and implementing effective solutions [30]. " Much climate change communication research has focused on understanding public beliefs and attitudes and their drivers, which include cognitive, experiential, sociocultural, and other factors." [31] A small portion of the studies was actually based on empirical contributions used as an efficacious instrument for shaping climate opinions. However, there is a lot of evidence to prove that there is a connection between how the public perceives the causes of climate change and the rise in risk perceptions and the backing for solutions to deal with it [32][33][34][35][36].

It is known from previous climate change communication studies that notifying people about the high percentage (97%) of climate scientists concur that human activities lead to climate change can have a major impact on individuals' belief and cause a greater concern about the subject [31][37][38][39][40]. Public opinions about considering that the causes of climate change are human related have clearly increased (from 46% to 56% between 2008 and 2020) to the detriment of attributing climate change to attribution of climate change to human industrial activities, concern about the issue, and support for climate policy. Therefore, it is useful to encourage the comprehension of the scientific senses of the climate change, but it is not enough to make the people grasp the genuine causes of climate change, to cause distress about it or implement policies to address it [30].

When comparing the impact of delivering information about the human causes versus the impact of delivering information in a more solution-oriented way, people are more likely to stand for policies when they trust that those are efficient in solving their concern. It creates a greater influence for them to see the cause and effect relation and a way to solve it. In order to affect the concern about climate change, it would be better to talk about the causes along with the impacts or solutions, or both [30].

"The European Union's environment and climate policies aim to protect the environment and minimise risks to climate, human health and biodiversity." For it to be a success it is needed to combine both economic and social initiatives with environment and climate policies [41].

There are several collaborations between EU states, such as European Green Deal and the 2030 agenda for sustainable development, the 7th Environmental Action Programme 'Living well, within the limits of our planet' and the most recent Climate change summit COP26.

Ursula von der Leyen (European Commission president-designate) has assured the european citizens that the EU climate policy would be broaden and strengthen and for it to be achieved, she aims to create a European Climate Law with the purpose of making the EU climate neutral by 2050 [42].

The European's Green Deal purpose is to improve the well-planed usage of resources by choosing a more clean and circular economy, regress biodiversity deprivation and cut pollution. It highlights the need for investment and provides the already available financing tools, in order to have a smooth transition to a green economy. The European Green Deal makes it clear that it is important to enact change in all sectors of the economy, notably transport, energy, agriculture, buildings, and industries such as steel, cement, ICT, textiles and chemicals [43].

The European Green Deal should be formulated as a redistribution instrument, promoting investment shifts and labour substitution in key economic sectors and, at the same time, the most vulnerable segments of society being supported in the decarbonisation process. The deal would be focused on these four pillars carbon pricing, sustainable investment, industrial policy and a just transition [44].

The UN 2030 agenda for sustainable development is one of the most ambitious agreements negotiated at a global scale on the subject of sustainability. It

is structured on 17 sustainable development goals (SDGs), some of which talk about conserving life on land and below water; combating climate change; and promoting productive employment, quality education, gender equity, clean energy, and sustainable agriculture (United Nations 2015) [45].

"This new Agenda enshrines the expectations, aspirations and priorities of the international community for the next 15 years. It is a transformative Agenda that places equality and dignity front and centre and calls for a change in our development pattern while respecting the environment. It is a universal commitment, undertaken by developed and developing countries alike, in the framework of a strengthened global partnership that takes account of the means of implementation to achieve this change, the prevention of natural disasters, and climate change mitigation and adaptation." [46]

One of the specific environmental policies is the the 7th Environmental Action Programme 'Living well, within the limits of our planet', which has three main strategic initiatives, like the resource efficiency roadmap, the biodiversity strategy and the low carbon economy roadmap [41].

The programme promotes the concept of a healthy environment reached by having in place a circular economy that means no waste and "where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience" [47].

"Significant progress was made at the United Nations climate conference in Glasgow which came to a close on 13 November after two weeks of negotiations between the parties to the United Nations convention on climate change (UNFCCC).

Among the key initiatives were: increased commitments to provide funds to help developing countries tackle climate change, the adoption of the global methane pledge and the finalisation of the Paris rulebook." [48]

Competent consumption, a high culture of relationships between individuals and a healthy lifestyle are the main approaches in order to achieve a smart lifestyle for smart people. This healthy characteristics encourage people towards self-enhancement, to be interested and evolved in the issues of the society and to nurture the development of the ICT skills. The main problems that can occur in the environment that people need to be careful about are sustainable consumption of energy, making use of the renewable energy sources, protecting the environment starting from the soil to natural habitats and animals and keeping at a minimum the consumption of the non-renewable resources [49].

"Environmental protection and the efficient use of resources is usually an essential factor of motivation for the implementation of smart city strategies. In this sense, fostering the use of ICT tools is a way of promoting more efficient solutions, which will improve the state of economic activities and, simultaneously, make better use of the resources within the territory of the city." [50]

There are several elements of a smart city such as IoT systems and sensors which can help design and sustain a smart environment. One of the main problems of the environment is the pollution, characterized by the presence of substances which can cause harm to the living organism [51].

The wireless sensors networks (WSNs) are autonomous nodes that combine the benefits of being small, efficient and cheap [51]. In order to collect data on the factors that cause air pollution (smoke, dust and other gases), mobile nodes can be installed on public transport with the purpose of covering a wider range, connecting to nodes nearby and transmitting data to the cloud. The network of notes is designed in such a way that a cluster is formed in key areas [52].

Another smart solution for the environment is a waste monitoring system such as the one developed by SENSONEO, which uses smart sensors that have an ultrasound technology for measuring the fill levels in bins and containers several times a day and send the data to a powerful cloud base platform via the IoT. This system optimizes the waste collection routes frequencies and vehicle loads, bin distribution resulting in overall waste collection cost reduction by at least 30% and carbon emission reduction up to 60% in cities [53].

Another key aspect of a smart environment is efficient urban planning with regard to resource management as to reduce future sources of greenhouse gas emissions and create a more livable urban space. Smart buildings would be powered by a low carbon electricity ecosystem that has a low carbon footprint with a much positive impact on energy consumption. By making use of this system, the pressure on natural habitats and biodiversity and the risks of natural disasters would be considerably reduced [54].

3. The conclusions of the case study

An important pillar of a smart city is a sustainable environment in which production efficiency is maximized, all the while preventing the degradation of environment's components by minimizing the use of natural resources and having a well-organized household and industrial waste management system [55].

"In 2020, the United Nations Development Programme estimated that cities account for 70% of the world's greenhouse gas emissions and are facing natural disasters such as flooding and heat stress because of climate change. The proportion of the global population living in cities and towns is expected to rise from 54% in 2015 to 66% by 2050. " [1] Because of overpopulation and urban migration which have a considerable impact on the environment, researchers have designed the concept of smart cities as a solution for enhancing the quality of life [1].

Technology has also been identified as a cause for pollution and so professionals came together and created the field of sustainable of AI which uses ecofriendly technology to reduce climate change effects. Certain aspects of technology have been assessed, such as energy use, emissions and waste for categorizing whether that technology is ecofriendly or not. Lately, there has been a surge of awareness in the field of technology related to how AI affects the environment [56].

The recognized benefits of using AI in landfills and community waste processing machines are considerably reducing micro-plastic pollution and managing a nation's recyclable waste internally [56].

In the state we are today, dealing with the effects of climate change is an absolute emergency which requires viable solutions of mitigating there impact [57].

There is no perfect solution for completely resolving climate change, but, at the same time, all technologies and methods discussed in our study are feasible and if implemented could significantly reduce the harmful effects of climate change.

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