SMART AND SUSTAINABLE CITIES: THINKING ABOUT THE FUTURE.
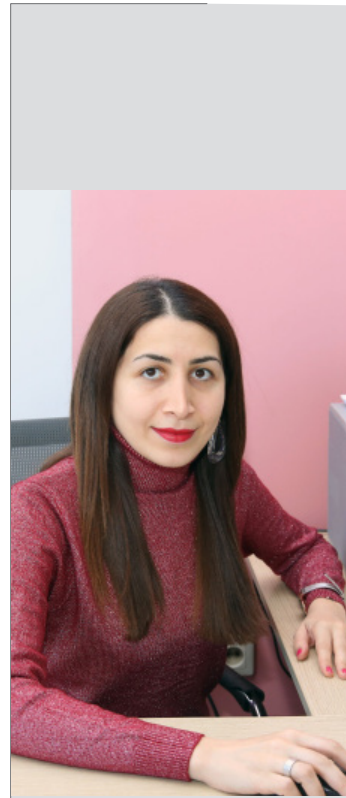## EXAMPLES FROM THE BEST INTERNATIONAL EXPERIENCES

Smart cities have emerged as a possible solution to sustainability problems deriving from rapid urbanization. A smart sustainable city (SSC) is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects. United Nations Member States adopted "The 2030 Agenda for Sustainable Development" in 2015, which has 17 goals, the 11th goal of which refers to Sustainable cities and communities. The paper presents the essence of smart and sustainable cities, main pillars and dimensions, examples of different cities and their steps towards becoming smart and sustainable. Some programs of Yerevan aimed at sustainable development are also presented.

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With the growth of urbanization, many countries began to think about the need of making cities sustainable. The concept of sustainable development was first described by the Bruntland Commission Report in 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". There are four dimensions to sustainable development – society, environment, culture and economy. Sustainability is a paradigm for thinking about the future in which environmental, societal and economic considerations are balanced in the pursuit of

an improved quality of life[1].

United Nations Member States adopted The 2030 Agenda for Sustainable Development in 2015, which has 17 goals, which are an urgent call for action by all countries - developed and developing - in a global partnership by 2030. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.[2]

The 11th goal is about Sustainable cities and communities. The necessity of this goal is explained by the following facts:

► Today 3.5 billion people (half of humanity) live in cities and 5 billion people are projected to live in cities by 2030.

► 95 per cent of urban expansion in the next decades will take place in developing world.

► 828 million people live in slums today and most of them are found in Eastern and South-Eastern Asia.

► The world's cities occupy just 3 per cent of the Earth's land, but account for 60-80 per cent of energy consumption and 75 per cent of carbon emissions.

► Rapid urbanization is exerting pressure on fresh water supplies, sewage, the living environment, and public health.

► Cities account for between 60 and 80 per cent of energy consumption and generate as much as 70 per cent of human-induced greenhouse gas emissions.

► 90 per cent of urban growth is forecasted to happen in Asia and Africa in the next 30 years.

► By 2050 70 per cent of the world population is predicted to live in urban settlements.[3]

Thus, the world's population is constantly increasing. To accommodate everyone, we need to build modern, sustainable and smart cities. For all of us to survive and prosper, we need new, intelligent urban planning that creates safe, affordable and resilient cities with green and culturally inspiring living conditions. Based on this, the main targets of the 11th goal are:

11.1. By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.

11.2. By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

11.3. By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.

11.4. Strengthen efforts to protect and safeguard the world's cultural and natural heritage.

11.5. By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

11.6. By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

11.7. By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

11.A. Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.

11.B. By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters.

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[1] Sustainable development, https://en.unesco.org/themes/education-sustainable-development/what-is-esd/sd
[2] Sustainable Development Goals, https://sdgs.un.org/goals
[3] Goal 11: Make cities inclusive, safe, resilient and sustainable, https://www.un.org/sustainabledevelopment/cities/

11.C. Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.[4]

Smart cities have emerged as a possible solution to sustainability problems deriving from rapid urbanization. They are considered imperative for a sustainable future.[5]

Smart sustainable cities as an integrated and holistic approach to urbanism represent an instance of sustainable urban planning and development, a strategic approach to achieving the long-term goals of urban sustainability - with support of advanced technologies and their novel applications.

Smart cities are increasingly connecting the ICT infrastructure, the physical, social and economic infrastructure to leverage their collective intelligence, thereby striving to render themselves more sustainable, efficient, functional, resilient, livable, and equitable. It follows that smart cities of the future seek to solve a fundamental problems of cities-ensure sustainable socio-economic development, equity, and enhanced quality-of-life at the same time as reducing costs and increasing resource efficiency and environment and infrastructure resilience. This is increasingly enabled by utilizing a fast-flowing torrent of urban data and the rapidly evolving data analytics technologies; algorithmic planning and governance; and responsive, networked urban systems.[6]

The United Nations Economic Commission for Europe (UNECE) and International Telecommunication Union (ITU)[7] developed jointly a definition of smart sustainable cities, through a multi-stakeholder approach which involved over 300 international experts:

"A smart sustainable city (SSC) is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects".[8]

In Smart Sustainable Cities, information and communication technologies (ICTs) are merged with traditional infrastructures. ICTs have a crucial role in SSC as it acts as the platform for the aggregation of information and data to help enable an improved understanding of how the city is functioning in terms of resource consumption and services. ICT based services in SSC include intelligent transport systems, which can significantly improve urban mobility. Integration of ICTs into existing urban services in SSC can also assist in:

• Improving the energy efficiency,
• Operation and transparency of the urban infrastructure,
• Resilience of road networks,
• Efficiency of water distribution systems,
• Wastewater management,
• Security,
• Other services.[9]

Figure 1 presents the main dimensions of smart cities.

UNECE and ITU developed ''Key Performance Indicators for Smart Sustainable Cities (KPIs for SSC)'', a United Nations standard on smart sustainable cities, in 2015. It provides cities with a methodology on how to collect data or information from key performance indicators (KPIs) for smart sustainable cities (SSC). This set of KPIs for SSC was developed to establish the criteria to evaluate ICT´s contributions in making cities smarter and more sustainable, and to provide cities with the means for self-assessments.[10]

4   Sustainable cities and communities, https://www.globalgoals.org/11-sustainable-cities-and-communities
5   Toli A.M., Murtagh N. (2020) The Concept of Sustainability in Smart City Definitions. Frontiers in Built Environment. 6:77. doi: 10.3389/fbuil.2020.00077
6   Bibri S.E., Krogstie J., Generating a vision for smart sustainable cities of the future: a scholarly backcasting approach. European Journal of Futures Research, 7, 2019. https://doi.org/10.1186/s40309-019-0157-0
7   The International Telecommunication Union (ITU) is the United Nations specialized agency for information and communication technologies – ICTs, https://www.itu.int/en/about/Pages/default.aspx
8   Sustainable Smart Cities, https://unece.org/housing/sustainable-smart-cities
9   ITU-T, Smart Sustainable Cities at a Glance, https://www.itu.int/en/ITU-T/ssc/Pages/info-ssc.aspx
10 Collection Methodology for Key Performance Indicators for Smart Sustainable Cities, https://unece.org/DAM/hlm/documents/Publications/U4SSC-CollectionMethodologyforKPIfoSSC-2017.pdf
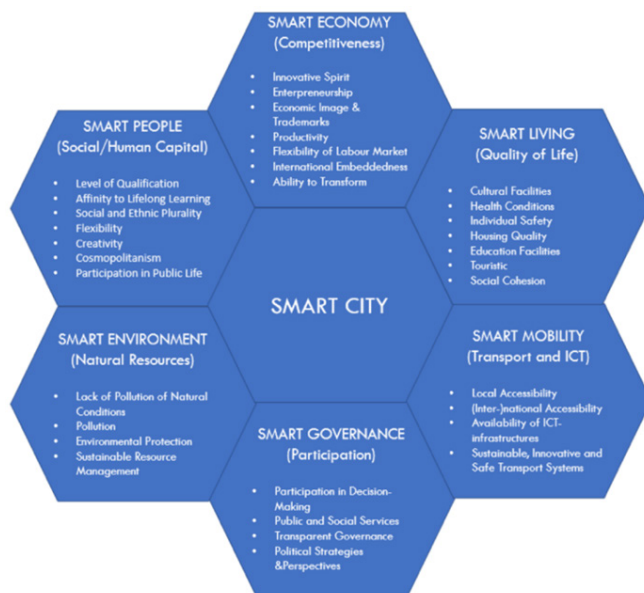
FIGURE 1

Smart city dimensions[11]

In the list of the cities under KPI evaluation by UNECE is Goris from Armenia. Goris was selected as a pilot city for three main reasons: its strategic position in the system of roads in Armenia, its rich cultural and historical heritage, and the commitment of its community and local government to make their city smarter and more sustainable. The list of the UNECE-ITU SSCIs includes 72 indicators which are grouped under the following structure:

• Pillars of sustainability: economy, environment, society and culture (see Figure 2);
• Thematic areas of indicators. Eighteen (18) major thematic areas were identified and each indicator was assigned to one specific topic. Some topics include specific sub-topics, which can be considered as keywords that more thoroughly define the nature of the indicators[12].

ITU is working to improve the reliability, security and interoperability of ICT infrastructure needed for smart sustainable cities, while at the same time advocating for the use of ICTs to reduce the consumption of energy and enhance services and quality of life for city dwellers.

Below are just a few examples showing how ICTs help to build smart sustainable cities:

► In Singapore, sensors and cameras built on the city state's existing digital system enable the government to assess the performance and efficiency of traffic flow and identify problems such as potholes and bumpy bus rides as well as lawbreakers. For example, to strengthen security in public spaces, the city has installed more than 62,000 police cameras in public housing blocks and carparks.

► Copenhagen, Denmark, has upgraded its street lights with efficient lamps connected by a wireless network. Smart street lights save costs because they can be programmed to dim or brighten automatically, optimizing the use of energy while lowering the risk of crime and traffic accidents.

► São Paulo, Brazil, has developed a

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[11] Georgiadis A, Christodoulou P, Zinonos Z. Citizens' Perception of Smart Cities: A Case Study. Applied Sciences. 2021; 11(6):2517. https://doi.org/10.3390/app11062517
[12] For further information visit: SMART SUSTAINABLE CITIES PROFILE GORIS, ARMENIA, UNECE, 2017, pp. 1-71, https://unece.org/DAM/hlm/documents/Publications/SSC_Profile_Goris.pdf
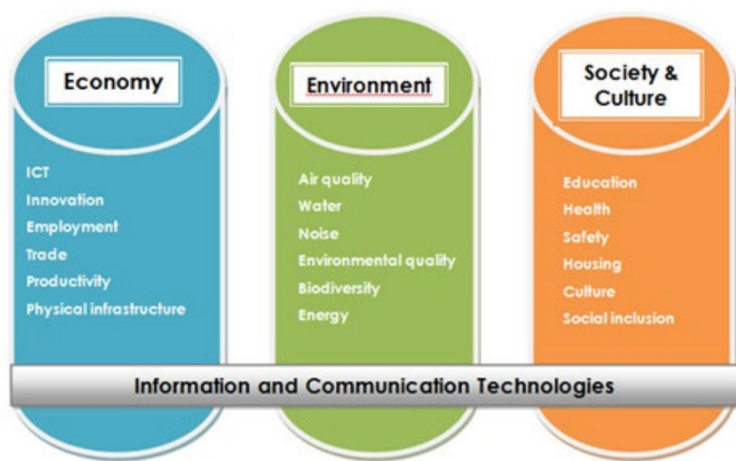
FIGURE 2

The UNECE-ITU Smart Sustainable Cities Indicators[13]

solution to estimate and predict air quality using AI and Big Data analytics. Aggregated, anonymized data is leveraged from the mobile network and layered with data from weather, traffic and pollution sensors. This helps calculate pollution levels 24 to 48 hours in advance, helping policy-makers,

municipalities and governments to take action to prevent death and disease - for example, by redirecting traffic before air pollution hotspots strike.

► In Holon municipality in Israel, the sewage system was plagued with problems such as frequent blockages and overflows. The municipality installed devices
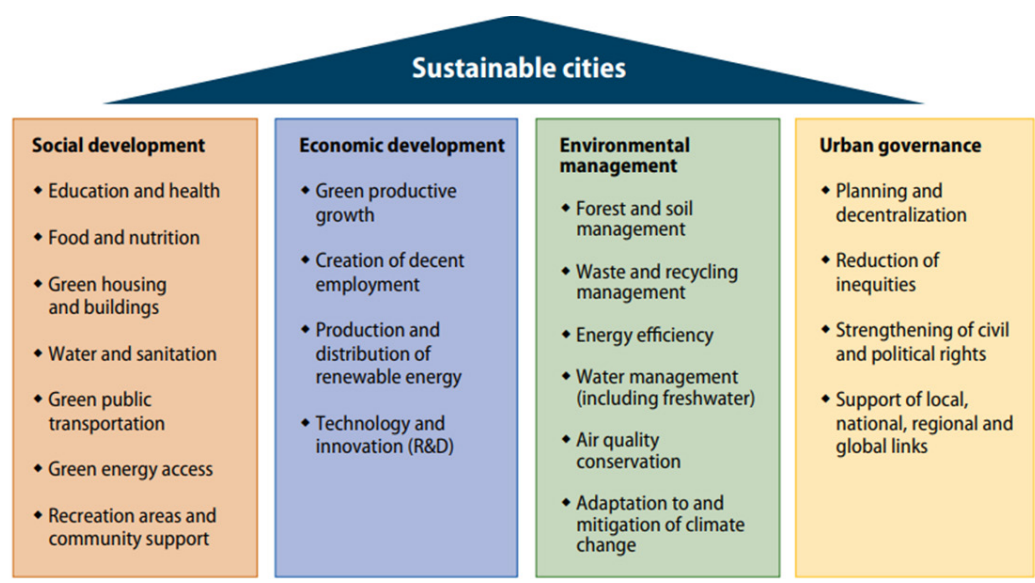

FIGURE 3

Pillars for achieving sustainability of cities[14]

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[13] SMART SUSTAINABLE CITIES PROFILE GORIS, ARMENIA, UNECE, 2017, p. 5, https://unece.org/DAM/hlm/documents/Publications/SSC_Profile_Goris.pdf

[14] World Economic and Social Survey 2013, p. 62, https://www.un.org/en/development/desa/policy/wess/wess_current/wess2013/Chapter3.pdf

equipped with sensors to better manage its sewer systems and send alerts via short message service (SMS) when the level reaches low or high limits.

► Dubai introduced an eComplaints system for citizens to regularly provide feedback on public services.[15]

Achieving the sustainability of cities can be conceived as entailing the integration of four pillars: social development, economic development, environmental management, and urban governance (Figure 3).

Thus, a smart sustainable city (SSC) places emphasis on the need for cities to be sustainable (resilient and inclusive), in addition to being smart, i.e. digitally capable. At the core of the smart sustainable city ecosystem lies an ICT infrastructure for the provision of services and facilitation of effective decision-making.[16]

Arcadis, a leading global design & consultancy firm for natural and built assets, composed a list of *100 Sustainable Cities* around the World that have engaged in initiatives, projects and other forms to resolve the effects of urbanization on the environment.

The city evaluations for Arcadis's Sustainable Cities Index are based on three themes: People, Planet, and Profit.[17] According to Arcadis's Index, Zurich takes first place with a total score of 87.9%. Zurich has initiated several projects that earned them first place such as their long-term goal to becoming a 2000-watt society by 2050. Another project was the Green City Zurich project that aims to preserve and increase all green spaces. Then come Stockholm, Geneva, Vienna, Frankfurt, Wellington, Rome, Sydney, London, Hamburg, etc.[18]

Singapore, Helsinki and Zurich have top positions in the 2020 IMD-SUTD Smart City Index Report, collaboration between IMD and Singapore University of Technology and Design (SUTD). The 2020 Index ranked 109 cities by using both economic and technological data, taken together with citizens' perceptions of how "smart" their cities were.[19]

The Green City Index project was launched in 2008. Its methodology was developed by the Economist Intelligence Unit (EIU) in cooperation with Siemens. First, there is the European Green City Index, which is an evaluation of the environmental sustainability of 30 European cities ranging in size from less than 1 million to more than 3 million people. Following the development of the indexing system, EIU and Siemens worked together to conceptualize and develop a series of city rankings called the Green City Index, which began with a focus on Europe's major cities and has since come to include cities across Asia, Africa and the Americas. The Green City Index series measures cities according to approximately 30 indicators across eight to nine categories, depending on the region. It covers CO_2 emissions, energy, buildings, land use, transport, water and sanitation, waste management, air quality, and environmental governance. About half of the indicators in each index are quantitative – usually using data from official public sources, for example, CO_2 emissions per capita, water consumption per capita, recycling rates and air pollutant concentrations (Figure 4). The remainders are qualitative assessments of the city's environmental policies, for example, the city's commitment to sourcing renewable-energy technologies, as well as implementing traffic - and congestion-reduction policies and air quality codes. Measuring quantitative and qualitative indicators together implies that the indices are based on current environmental performance, as well as the city's intentions

[15] World Economic and Social Survey 2013, p. 62, https://www.un.org/en/development/desa/policy/wess/wess_current/wess2013/Chapter3.pdf

[16] ITU Smart Sustainable Cities, ITU Publications, p. 6, https://www.itu.int/en/ITU-T/ssc/united/Documents/Reports-on-SSC/ITU_smart_sustainable_cities_brochure.pdf?csf=1&e=yIueWP

[17] The Sustainable Cities Index 2018, ARCADIS, https://www.arcadis.com/campaigns/citizencentriccities/images/%7B1d5ae7e2-a348-4b6e-b1d7-6d94fa7d7567%7Dsustainable_cities_index_2018_arcadis.pdf

[18] From Sustainable to Smart Cities, https://www.greenmatch.co.uk/blog/2017/04/sustainable-and-smart-cities-around-the-world

[19] Singapore, Helsinki and Zurich triumph in global smart city index, https://www.imd.org/news/updates/singapore-helsinki-zurich-triumph-global-smart-city-index/
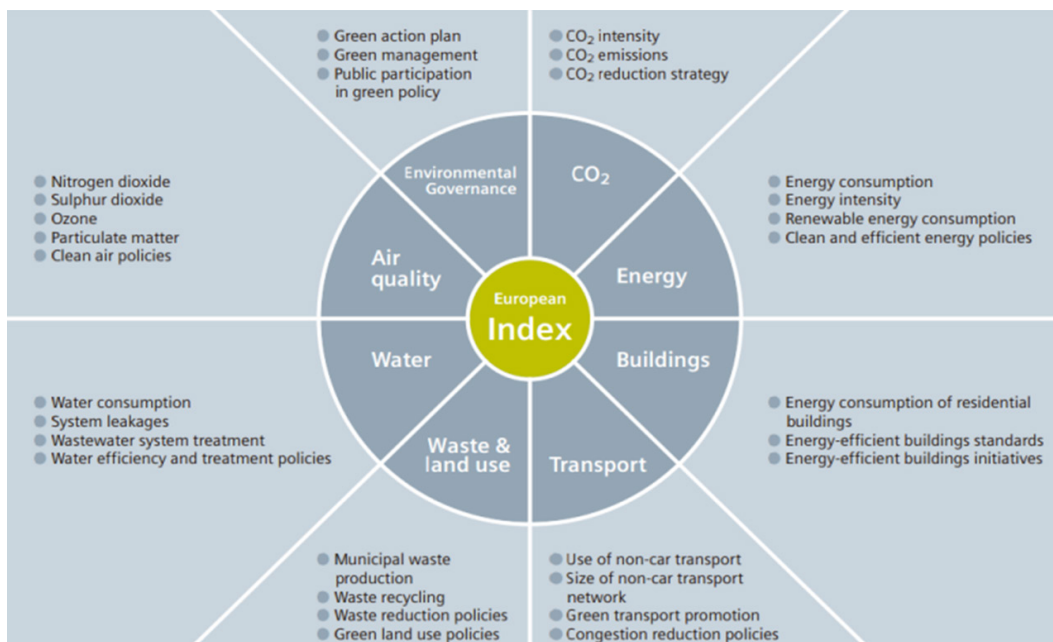
FIGURE 4

The European green city index[20]

to improve.

The results of the recent European green city index are: Copenhagen – 87.31, Stockholm – 86.65, Oslo – 83.98, Vienna – 83.34, Amsterdam – 83.03, Zurich – 82.31, Helsinki – 79.29, Berlin – 79.01, Brussels – 78.01, Paris – 73.21.

Copenhagen sets an ambitious long-term goal for the city to become carbon neutral by 2025, which, if achieved, would make it the first large carbon-neutral city in Europe. The national government's climate change strategy aims to raise the share of renewable energy to 30% of total consumption by 2025.

Stockholm's long-term plan is to be fossil fuel-free by 2050. This means that emissions from energy use related to the heating of houses and commercial premises, vehicles and electricity use in the city will be reduced to a level near to zero by 2050. By 2030 the seaport will be free of fossil fuels; and the seaport will be adaptable to future changes in climate.

Oslo has adopted an energy action plan to improve energy efficiency and replace fossil fuels with renewable sources, and to reduce greenhouse gas emissions from municipal buildings by 95% by 2030.[21]

Here are some examples from the report:
- Oslo uses the highest share of renewable energy at 65%. The Index average is 7%.
- Copenhagen's and Berlin's residential buildings consume almost 40% less energy than the Index average.
- In Stockholm, 68% of people cycle or walk to work, the highest percentage in the European Index. In contrast, in Helsinki only 16% do so.
- Riga offers the longest public transport network at 8.6 km per km², almost four times the Index average of 2.3 km per km².
- In Kiev, 74% of the population uses public transport to get to work. This is the highest figure in the European Index and the best result for Kiev, which ranks 30th

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[20] Sustainable City Indexing: Towards the Creation of an Assessment Framework for Inclusive and Sustainable Urban-Industrial Development, United Nations Industrial Development Organization, 2017, https://www.unido.org/sites/default/files/files/2018-02/BRIDGE%20for%20Cities_Issue%20Paper_2.pdf

[21] European Green City Index, 2009, https://assets.new.siemens.com/siemens/assets/api/uuid:fddc99e7-5907-49aa-92c4-610c0801659e/european-green-city-index.pdf

overall.

- Tallinn consumes the least amount of water – only 138 litres per person per day, compared with the Index average of 288 litres.
- Amsterdam has the lowest water leakage rate of 4%, in Sofia this is 61%, in Rio de Janeiro is more than 58%. Tokyo has the lowest water leakage rate in the Asian Index, at 3%, compared with the Index average of 22%. Jakarta had the highest water leakage rate, at 50%.
- Helsinki recycles 58% of its waste, compared with the Index average of only 18%.
- Mexico City has the highest level of energy efficiency, only using 0.3 gigajoules of electricity to generate US$1,000 of GDP (Index average: 0.8 gigajoules).
- In Medellín only seven in 100 residents own a car or motorcycle. In Buenos Aires this figures is 66 in 100 residents.
- Population density ranges from fewer than 1,000 people per km^2 in Wuhan to more than 27,000 people per km^2 in Mumbai. New York is densely populated with almost 10,700 residents per km^2. Cairo is also densely populated city, with 19,000 residents per km^2.
- Seoul stands out with the densest public transport network in the Asian Green City Index. 6.6 km per km^2 versus the average of 1.7 km per km^2.
- In Manila, only 12% of the population has access to sanitation.
- Asian Index cities have by far the highest population density among the regional Indexes, at 8,200 people per km^2. The US and Canada Index cities have the lowest, at 3,100 people per km^2 on average.
- Cities in the Asian Index are also the most populous, with an average population of 9.4 million. Latin American Index cities have 4.6 million, African cities 3.9 million, European cities 2.5 million and North American cities 1.4 million people on average.

- Atlanta has almost three times as many LEED-certified energy-efficient buildings as the Index average (18.3 buildings per 100,000 people versus the Index average of 6.4 buildings).
- Vancouver has the longest public transport network in the US and Canada Index, but it's New Yorkers who use public transport most frequently to get to work (37%).
- About 90% of US residents use their cars to get to work.
- CO$_2$ emissions from US Index cities (nearly 16 tonnes per person), are almost double those for Canada (8.1 tonnes), more than double the emissions for mainland Chinese cities (7.6 tonnes), and triple the level of emissions from Europe (5.2 tonnes).
- San Francisco and Los Angeles recycle an astonishing 77% and 62%, respectively, of their waste – more than any city in Europe, except one, Leipzig, at 81%.
- Among the regional Indexes, US and Canadian Index cities consume the most water, at 590 litres per person per day on average. This is more than double the other cities worldwide.
- South African Index cities generate on average 3 tonnes of CO$_2$ emissions from electricity consumption per person. That's more than five times the figure for North African Index cities and 60 times the figure for the other seven Index cities in sub-Saharan Africa.
- Cape Town and Johannesburg have the most green space in the African Index, at an estimated 290 m^2 and 231 m^2 per person, respectively. The Index average is 74 m^2.[22]

In order to improve air quality, many cities try to enlarge green spaces.

Jakarta and Mexico City are investing in massive tree-planting campaigns to improve air quality.

Rotterdam aims to be 100 per cent climate proof by 2025. By mixing grey and green infrastructure, with a focus on adaptive

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[22] The Green City Index, 2012, http://81.47.175.201/etms-project/rankings/2012_European_Green_City_Index_sum_report.pdf

measures to capture rainwater and slow drainage, the authorities are aiming to build a waterproof city.

For the last decade Singapore has had a Landscaping for Urban Spaces and High-Rises (LUSH) programme, which aims to encourage more greenery in the built environment; support rooftop urban farming; set Green Plot Ratio standards for private developments; and count vertical greenery and green roofs towards the Landscape Replacement Area requirements.

Lisbon is developing the Main Green Corridor project to provide ecological connection, improve air quality, reduce traffic and support non-motorized transport options.

The "CityAdapt" project in San Salvador is restoring coffee plantations and digging infiltration ditches aiming to reduce flood risks for 115,000 people by 2022.

The UK government has announced that future flood defense efforts will include nature-based approaches such as grassland restoration, the creation of buffer strips, and allowing rivers to flow more freely across the landscape.

In Kathmandu the urban poor regularly face food price inflation because of poor transport connections, a predominance of food imports and increasing climate instability. In response, the city piloted rooftop gardens with rainwater-harvesting systems, increasing residents' food and water security.[23]

Milan has an ambitious plan to plant 3 million trees by 2030 in an attempt to relieve Italy's fashion capital of air pollution and offer a more green touch to the cityscape's grey-predominant architecture. The scheme is estimated to increase the number of trees by 30 percent which would absorb an additional 5 million tons of carbon dioxide a year.[24]

Here are the most *Eco-friendly cities* in the world:

1. Copenhagen, Denmark, where all the buses are changing from diesel to electric energy. Additionally, more of their roads are being specifically made for biking with electric bikes being sold at a low cost. Another amazing fact about Copenhagen is that two-thirds of their hotels are eco-certified, indicating they follow the top standards for sustainable energy, food, and design. Much of their restaurants sell food made of organic ingredients and they have vending machines where you can recycle materials and receive a deposit. As mentioned above, Copenhagen hopes to become carbon neutral by 2025.

2. Zurich, Switzerland. Over 80% of their electricity is now coming from renewable energy sources. Over 40% of the city's waste gets recycled. Over 70% of their hotels are sustainable certified. Similar to Copenhagen, they have bikes all over the city and they offer theirs free of any charge.

3. London, UK. One of the amazing factors that makes London an eco-friendly city is that they have over 3,000 green spaces and parks, which makes up 40% of the city. The city was actually ranked as the most environmentally-friendly city by the IESE Cities in Motion Index 2020. London hopes to reach net zero greenhouse gas emissions by 2050. They are investing in diesel-electric hybrid buses. They hope by 2037 all 9,200 of their buses will produce zero emissions.

4. New York City. More of their apartment complexes are being built with heating and water preservation in mind. Additionally, more people in New York City are driving low emission cars, and businesses within the New York capital are adopting more eco-friendly measures. Urban gardening has all become a big thing in the big apple. Small gardens are being placed on balconies, terraces, and rooftops. They are also

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[23] Smart, Sustainable and Resilient cities: the Power of Nature-based Solutions, UNDP, p. 14, https://wedocs.unep.org/bitstream/handle/20.500.11822/36586/SSRC.pdf?sequence=1&isAllowed=y

[24] Italy's fashion capital wants to plant 3 million trees by 2030, https://www.optimistdaily.com/2018/12/italys-fashion-capital-wants-to-plant-3-million-trees-by-2030/

being placed in apartments and buildings as well. In many ways, NYC is leading the way on achieving better sustainability in the United States.

5. Paris, France. The city has seen a 9.2% drop in greenhouse gas emissions over the ten year period between 2004 and 2014. The city is continuing to implement more initiatives that encourage sustainable mobility and helps to create a more sustainable city.

6. Tokyo, Japan. The city hopes that by 2030, 50% of all the new cars that are sold will be zero-emission. Tokyo also plans to have 30% of its city run by renewable energy sources. They also continue to lead in having one of the most low-carbon emission public transportation systems around the world.

7. Reykjavik, Iceland. Reykjavik is a city that leads in having a variety of hydroelectric and natural geothermal resources. As a result, the city can be completely powered by renewable energy sources without costing much. A majority of Reykjavik's electricity is powered by hydroelectric dams that are built on glacial rivers. The city uses the hot springs, geysers, and other natural heat sources to provide heating for their buildings.

8. Berlin, Germany. The city of Berlin has over 30% of its city filled with woodland and green spaces. People who live in Berlin also tend to be more interested in riding bikes than using cars. They also prefer to use public transport as well.

9. Stockholm, Sweden. As mentioned above, Stockholm hopes to become completely free of fossil fuels by 2040. One of the factors helping them work towards that is bio-fuel generated from sewage. The city has it available at petrol stations and it is used by a lot of cars and taxis. Stockholm is also planning to reuse wasted heat from a stadium to heat up shops, restaurants, and houses.

10. Singapore is working to green 80% of their buildings by 2030. The city wants to become one of the world's greenest cities in the future. But for now, they are considered the greenest city in Asia. It is one of the leading towns in the world for having trees in the area. Nearly 40% of Singapore's water comes from used water that is been purified and treated. With this much innovation, this city is sure to become a leader in sustainability for years to come.[25]

The examples of different cities indicate the major steps and policies of their authorities towards making the cities smart and sustainable.

Some steps were taken also in Yerevan. Yerevan Green City Action Plan was worked out within the framework of cooperation with the European Bank for Reconstruction and Development (EBRD). This program is based on the "Action plan for sustainable energetic development of the city of Yerevan". Yerevan Green City Action Plan is a strategic document for the period till 2030. The aim of Yerevan green City program is assistance in economic and social development of the city by means of solving environmental problems of the capital. The methodology of Yerevan Green City program reveals environmental challenges by means of assessment of the state of air, water resources, soil, biodiversity and ecosystems of the city, factors negatively impacting them and the existing legislative solutions based on international standards. Yerevan Green City Action Plan is aimed at sustainable development, improvement and landscaping of the city, improvement of the quality of utility services, public transport reforms, optimization of the road infrastructure of the capital, disaster risks decrease and increase of resistance to natural disasters, protection of environment and population health.[26]

On September 9, 2014 Yerevan Council of Elders took the decision (N 204-A) on Yerevan's joining the Covenant of Mayors of

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[25] 10 Most Sustainable Cities in The World (2021), https://thesustainablelivingguide.com/most-sustainable-cities/

[26] Yerevan Green City Action Plan, https://www.yerevan.am/en/yerevan-green-city-action-plan/, https://www.yerevan.am/uploads/media/default/0001/72/e7224f93ad7096478f9aaddb96ba61ea0ca693c9.pdf

EU. Joining the Covenant of Mayors initiative of EU Yerevan undertook the obligation to reduce greenhouse gases emissions at least 20% by 2020. Yerevan SEDAP (Sustainable Energy Development Action Plan) was worked out within the scope of technical assistance provided by Yerevan Municipality and the UN Development Program jointly with "Energy saving Fund" NGO.

The program includes main measures aimed at energy efficiency increase in urban infrastructures, the implementation of which brings to reduction of using energetic resources, greenhouse gases emissions and environment improvement. The program involves appropriate actions aimed at energy saving, energy efficiency and application of restorable energy in sectors such as transport, street lighting, public services as well as in residential and public buildings.

On June 24, 2016, the Council of Elders of Yerevan confirmed the Sustainable Energy Development Action Plan of Yerevan. Afterwards, the United Research Center adjunct to European Commission studied and approved the SEDAP of Yerevan.[27]

Another program is "EU for Yerevan Solar Community" project implemented by the Yerevan Municipality, with EU support. The project was approved by a Yerevan City Council's decision N 111-A on 13 February 2018. The objective of this project is to reduce the energy consumption and associated emissions of greenhouse gases (about 850 tons of CO_2 annually) through supporting application of renewable energy sources and energy efficiency measures in multi-apartment buildings of Yerevan.

In the scope of the project support to the 90 multi-apartment building management bodies (condominiums) is offered in managing the energy use through introduction of energy efficiency measures and installing roof top photovoltaic (PV) systems to cover the energy consumption used for common areas. The project also targets to set urban energy planning and management mechanism, and to implement capacity building activities for condominiums, public and other communities, low-income energy efficiency (EE) support. The project duration is 01/03/2018 – 28/02/2021, total project budget is EUR 1,250,004.00, from which EU Contribution is EUR 1,000,000.00, and the rest is financed by the Municipality of Yerevan.[28]

The government of the RA adopted the concept of creating a "Smart City" in 2018 by the protocol decision N 8 of the March 1 session . Currently, one of the priorities of the ''Yerevan City Development Plan 2021'' is the induction of the "Smart City" program.[29]

For making cities smart and sustainable in Armenia, many steps should be taken towards the main pillars which were discussed in the paper, in order to invest intelligent and smart transport system, improve the energy efficiency, urban infrastructure, increase the efficiency of water distribution systems, waste management, expand green areas and improve air quality, etc.

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Գայանե ԹՈՎՄԱՍՅԱՆ
«Ամբերդ» հետազոտական կենտրոնի ավագ հետազոտող, ՀՊՏՀ մենեջմենթի ամբիոնի տնտեսագիտության թեկնածու, դոցենտ

ՔԱՂԱՔԱՅԻՆ ՏՆՏԵՍՈՒԹՅՈՒՆ

ԽԵԼԱՑԻ ԵՎ ԿԱՅՈՒՆ ՔԱՂԱՔՆԵՐ. ՄՏԱԾԵԼՈՎ ԱՊԱԳԱՅԻ ՄԱՍԻՆ: ՕՐԻՆԱԿՆԵՐ ՄԻՋԱԶԳԱՅԻՆ ԼԱՎԱԳՈՒՅՆ ՓՈՐՁԻՑ

Խելացի քաղաքները հանդես են գալիս որպես ուրբանիզացման հետևանքով առաջացող կայունության հիմնախնդիրների և մարտահրավերների հնարավոր լուծում: Խելացի և կայուն քաղաքը նորարար քաղաք է, որն օգտագործում է տեղեկատվական և հաղորդակցական տեխնոլոգիաներ ու այլ միջոցներ՝ կյանքի որակը բարելավելու, քաղաքային գործողությունների և ծառայությունների արդյունավետության ու մրցունակության մակարդակը բարձրացնելու համար՝ միաժամանակ ապահովելով ներկա և ապագա սերունդների կարիքների բավարարումը՝ տնտեսական, սոցիալական, բնապահպանական, ինչպես նաև մշակութային տեսանկյուններից: 2015 թվականին ՄԱԿ-ի անդամ պետությունները ընդունեցին 2030 թվականի կայուն զարգացման օրակարգը, որը պարունակում է 17 նպատակ: 11-րդ նպատակը վերաբերում է կայուն քաղաքներին և համայնքներին: Հոդվածում ներկայացվում են խելացի և կայուն քաղաքների էությունն ու հիմնական բաղադրիչները՝ հիմնվելով համապատասխան օրինակների վրա: Անդրադարձ է կատարվում նաև Երևանի՝ կայուն զարգացմանն ուղղված որոշ ծրագրերի:

Հիմնաբառեր. *խելացի և կայուն քաղաք, տեղեկատվական և հաղորդակցական տեխնոլոգիաներ, ուրբանիզացում, կանաչ քաղաքի ինդեքս, հիմնասյուն*

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ГОРОДСКАЯ ЭКОНОМИКА

УМНЫЕ И УСТОЙЧИВЫЕ ГОРОДА: ДУМАЯ О БУДУЩЕМ. ПРИМЕРЫ ИЗ ЛУЧШЕГО МЕЖДУНАРОДНОГО ОПЫТА

Умные города стали возможным решением проблем устойчивости, возникающих в результате быстрой урбанизации. Умный устойчивый город - это инновационный город, который использует информационные и коммуникационные технологии и другие средства для повышения качества жизни, эффективности городских операций и услуг, а также конкурентоспособности, обеспечивая при этом соответствие потребностям нынешнего и будущих поколений в отношении экономических, социальных, экологических, а также культурных аспектов. В 2015 году государства-члены Организации Объединенных Наций приняли Повестку дня в области устойчивого развития на период до 2030 года, в которой сформулировано 17 целей, 11-я цель, которая касается устойчивых городов и сообществ. В статье представлена сущность умных и устойчивых городов, основные столпы и измерения, примеры различных городов и их шаги к тому, чтобы стать умными и устойчивыми. Также представлены некоторые программы Еревана, направленные на устойчивое развитие.

Keywords: *умный устойчивый город, информационные и коммуникационные технологии, урбанизация, индекс зеленого города, измерения*