

# Chapter 31

## Alternative Lights for Public Transport in Smart Cities



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**Abstract** It is estimated that in the year 2050, almost 70% of people will live in urban areas. Cities need to go through evolution and change into smart cities. They are energy efficient, save resources, produce low emissions, and provide citizens a better quality of life. Also in Slovakia public opinion and idea about what smart city means in practice is formed. It is a complex innovation in all spheres of life of the people and infrastructure of the city, using new materials and the latest information and communication technologies. The aim of the presented paper is to show chosen developed technologies at the Institute of Earth Sources, which can be used for smart cities.

### Introduction

Residents expect from their city real innovation, not only small improvements. They want single point of contact and access to information at the level of the twenty-first century, without unnecessary forms, stamps, and office visit. They want to know if their residence is not on the maps of crime or flood maps in the critical region. They want to keep track of traffic conditions and parking spaces [10].

[AU1]

Together with the concept of smart city, we get another term – placemaking. This deals with life and spaces between objects. In the foreground are the people and their needs. People who are from the city, from their living space, expect some elementary functionality and require decent infrastructure and smooth transport, sufficient amenities and services, lots of greenery, low emissions, and a safe environment for themselves and their children. In each group of people, each sector (e.g., entrepreneurs in trade and services, cultural, community and nonprofit organizations), however, has specific requirements [10].

[AU2]

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Buildings are responsible for 36–40% of global energy consumption. Therefore, the concept of smart city is often associated with energy savings, finding alternative sources, and reducing carbon footprint. Thanks to smart energy solutions, the concept has reached 5% of the potential savings in smart cities. One of the solutions is a smart-connected infrastructure, which is able to increase its value tenfold. For example, data from energy metering and lighting (public and private) that is collected and evaluated contribute to better energy balance [10].

The concept of “smart cities” is characterized by the interconnection of information and communication technologies (ICT) with already extensive and costly critical infrastructure such as energy networks, transport networks, waste management, health, etc. and thanks to precise monitoring and control system allows increased efficiency and amount of savings. In addition to the deployment of intelligent sensors and universal access to smartphones (and their complementarity), “smart cities have the potential to empower communities and realize significant benefits in terms of efficiency, creativity, and even participation of local citizens in the democratic process. Therefore, the concept of smart cities naturally becomes an interesting opportunity for the city government, and often so there is a rapid adoption of “smart” solution. However, uncontrolled, rapid development of smart initiatives and technology complexity for integrating existing infrastructure with ICT opens the door to potential cyber threats, which in turn can have a negative impact on the community [6].

## Mobility and Transportation in Smart City

Mobility and transportation are essential parts of the urban infrastructure. Smart city should be easily accessible to visitors and its inhabitants. Travel through the city should be smooth and comfortable but also environmentally friendly. The aim is to provide a versatile, efficient, safe, and comfortable transportation systems that are connected to the infrastructure of information and communication technologies and open data [9].

Within the concept of smart cities are the trends in transport as follows [9]:

- Operation monitoring system
- Sharing of transport
- Intelligent traffic management
- Intelligent traffic lights
- Intelligent traffic information
- Sharing experiences of citizens with transportation
- Intelligent parking spaces
- Bike sharing
- Electric vehicles
- Optimization and popularization of public transport

[AU3] In most large cities in the Czech Republic and Slovakia, there are similar problems of transport such as in Brno [9]:

- Incomplete main ring road
- The lack of a complete system of superior communications
- State railway junction
- Unfinished part of the city sewer and unresolved flood protection
- Collision of parking and traffic (mainly pedestrian)
- Stagnation in the development of infrastructure for rail transportation
- Preference of individual car transport to the detriment of pedestrians, cyclists, and public transport
- Lack of bicycle paths and bicycle lanes
- Lack of parking and garage space in the city center and housing estates
- The lack of car parks
- Lack of public transport attractiveness

In terms of transport, urban mobility is often used. Mobility is defined here as the ability to move as efficiently as possible from place to place and is related to expanding road capacities and faster means of transport. With regard to smart cities, however, the authors of this article prefer to move away from mobility toward availability. With clever urban planning and with the use of modern technology, for example, homeworking, demand for transport can be greatly reduced [7]. Another approach with the future is today's dynamically growing Car Sharing, which is based on car sharing [8]. There are two different ways in which car owners are either private companies that rent cars directly to customers or individuals, who lend their cars to customers through Car Sharing companies. Drivers who do not own a car and drive at least a few miles a year are more likely to use the car sharing method. Companies also provide mobile apps to manage bookings, track mileage and total costs, or even unlock and lock the car. There are already many companies in the world like the Czech Republic who are trying to gain a share in the growing market.

[AU4]

[AU5]

[AU6]

Car parking in big cities is getting heavier and it is a relatively big problem. According to various studies, drivers spend an average of about 20 min searching for a parking space. This results in an increase in CO<sub>2</sub> emissions; cars getting into places unnecessarily, thereby increasing the likelihood of traffic jams; and, the most important of all, people wasting time. Of course, any future road construction or its reconstruction should be an Intelligent Transport System (ITS) that integrates information and telecommunication technologies with transport engineering with the support of other related fields (economics, transport theory, system engineering, etc.) to ensure the management of transport and shipping processes for existing infrastructure [10]. Their aim is above all to provide better and safer traffic management and more effective support for the transport of persons or things. The main benefit of introducing intelligent transport systems and services in terms of societal benefits is to increase traffic safety. The important goals of ITS are, of course, the sustainability of the city and the reduction of emissions. With this in mind, the concept of Green ITS is also used – transport management and management with regard to urban sustainability [10]. If there is an unexpected event in traffic, such as a traffic

accident or traffic jam, traffic can be regulated, decelerated/accelerated, deflected, and so on.

Another part of smart transport is, for example, urban public transport (public transport). It can be assumed that the entrance will be limited to the center of most large cities or a fee will be charged for each entry. The city's goal is clear, to minimize city traffic in order to reduce emissions and maximize passenger transport via public transport. It is necessary to construct parking garages on the outskirts of the city, where the drivers can leave their vehicles and then continue with public transport. With regard to smart cities, these aspects must be interconnected so that the driver gets information about the free parking space on the parking lot, can book it (or pay), navigate to the place, and can buy a public transport ticket and information best to get to his or her destination. [AU7]

Autonomous vehicles are also a huge topic, for example, in logistics, they are nothing new and have been used for many years in modern storage and production plants where they provide full or partial automated delivery of goods, parts, or materials. Of course, road and real traffic is quite different, but from the point of view of the difficulty of autonomous driving, it is probably the easiest ride on the highway.

## Proposed Public Lighting

Public lighting is not only part of the local color of each town or village but is also an essential part of the transport system. One of the important aspects of smart cities is not only lighting in motorized traffic but also lighting of walkways. A considerable part of the expenses of municipal government. With the growth of prices for consumed energy by lighting system grows and requirement of self-sufficiency in the acquisition. Currently it is taking place in the whole territory of Slovakia reconstruction of public lighting, which is addressed by implementing European standards. There are several types of street lamps, which on its operation used renewable energy sources. Our proposal is an intelligent LED solar lamp of public lighting with wind aggregate. In general, the lighting system consists of a set of features and technical means to ensure the correct lighting such as lamps, luminaires, poles with electric equipment, power cables, switchgear, etc. [AU8] [AU9]

Intelligent LED street lighting combines a camera system, wireless networks, and sensors. In addition to significant energy savings and energy supply management, it contributes to a better awareness of the city traffic conditions and parking, while it is increasing safety on the streets. Linkable also for applications in smart-phones, with street lamps, it serves as a "beacon" for navigation of tourists. They can also be transmitters of marketing messages and important announcements of the city management. Ecologic production and moderate energy consumption are only one side of the coin. It is important to be able to predict the state of freedom of the regulatory power and the unused energy office building over the weekend to divert to residential block. Smart city's vision is to achieve complete energy self-sufficiency city, which will not produce and "export" waste, all these by respecting local conditions and individual character of the city [10]. [AU10] [AU11]

Public lighting in Slovakia is made up of several types of lighting columns with the most commonly used as concrete and steel. Lights are placed on these types using the boom arm with different angles or directly [1]. The lamps currently used are incandescent, fluorescent lamps, compact fluorescent lamps, LEDs, and other species.

As a source of electricity, we propose two alternatives: Savonius rotor and technology “wind belt,” respectively. Savonius rotor belongs to the device with a vertical axis of rotation (VAWT). Rotor blades with a vertical axis of rotation are long and rounded at both ends and fixed. Their main advantage over systems with the horizontal axis of rotation is that it is not necessary to capture the wind flow in different directions.

Savonius rotor is low-speed wind machine. It is a type of vertical-axial wind turbine. It uses the pressure difference in the flow of air and the round hollow semi-circular scoop which, when viewed from above, has the form of letter “S”. The efficiency of the device is moved only by the  $\eta = 0.2$  but is structurally simple with good start-up characteristics even at low speeds of wind and is characterized by a high starting torque [2].

[AU12]

Currently, are widespread construction with two or three wings, because the higher number is decreasing effectiveness. Semicircular blades are curved and mounted in the middle of the opposite. The direction of rotation can be from the right to the left. The speed of the rotor depends on its diameter, the load, and the wind speed. Our proposed road lamp with wind aggregate consists of a steel mast with a height of 8 m and a length of boom 1.5 m.

Rotor area is 4 m<sup>2</sup>. It is essential that the blades are made of a light material; it is proposed to construct the plastic with addition of glass fiber. The rotor is mounted through the cage surrounding the shaft that transmits torque to the transmission. Transmission with gears is used for converting the input torque for the rotational movement. It allows to set up several gears and transfers energy to the flywheel, which converts mechanical energy from the rotor into electrical energy which produces a direct current. In order to ensure business continuity in times of operation lamp, it is necessary to provide switching between battery and distribution networks which support element having a switching function. This element battery charged automatically connects the lamp to the network which distributes electricity. The battery is charged continuously for 24 hours. The final appearance of such a lamp in 3D can be seen in Fig. 31.1.

Savonius rotor does not cover the overall demand for electricity, and the lighting should be equipped with PV panel.

Another alternative is to use technology of wind belt. The aim of our research is the applicability of technologies to generate electricity from the airstream as part of an autonomous light source. Lack of equipment for the use of low potential winds prompted the present investigation; one of the objectives is to optimize technology for air flow rate which is low at the same time the production of sufficient power for lighting and meet the safety parameters.

The principle of wind belt is as follows: tensioned membrane (tape), under the influence of wind flow vibrates (see Fig. 31.2). Flapping causes movements of the

**Fig. 31.1** View of a wind accumulation lamp



**Fig. 31.2** Wind belt technology [8]

permanent magnet, which is attached to the membrane. Oscillating magnet moving between these coils induces a voltage coils. Since the Wind belt a number of other “flutter” wind harvester devices have been designed, but like the Wind belt almost all have efficiencies below turbine machines. But the main advantage is that it can produce electricity at wind speed lower as conventional wind devices. One-meter version that could be used to power LED lights can generate 10 W average.

[AU13]

At present, it remains the most effective way of using solar energy, so-called photovoltaic panels (see Fig. 31.3). Scientists are already quite a long period

[AU14]



**Fig. 31.3** Innovative transparent PV panels [4]

considering the idea, as one would use photovoltaic panels in practice even more effective [7].

Innovative photovoltaic panels are the first fully transparent, which is considered a key point of this innovation. Upgrading these panels is the fact that during the day, the sun's rays impinge on transparent photovoltaic panel that performs two functions. The first function is that the space required by the sun's rays is released, and the second function is that some of these rays are directed to the perimeter of the panel. The great advantage of this innovation is also that all the so-called glass building to become producers of their own electricity would also save costs and reduce the pressure on the ecology. In the past there were a number of attempts to package glass building by photovoltaic panels; however, the problem is that the panels change the visibility of these windows while reducing the amount of natural light in a given area, which was simply undesirable. The problem is, as with a number of developed technologies low efficiency, yet [4].

[AU15]

## Conclusion

The use of renewable sources for smart cities is essential, but useful technologies are particularly photovoltaic panels and wind energy. In implementing the concept of smart cities, however, it must also have in mind not only trendy and marketing issues but also consider the potential risks, for example, cooling of server stations for managing the infrastructure and with the possible increase of energy consumption, cyber threats, and possible energy outages. Therefore, autonomous lighting sources and new technology could be beneficial solutions while these risks are not solved, but these technologies do not contribute to their formation.

[AU16]

## References

[AU17]

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10. Digitálna transformácia inteligentné mesto. Atos e-book.



# Author Queries

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