INTELLIGENT LIGHTING – NEW DIRECTION OF RURAL AREAS DEVELOPMENT IN POLAND

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Abstract. This paper presents best practices of selected rural areas development through the implementation of intelligent, energy-efficient lighting. Polish villages usually do not have established a complete technical infrastructure. As a rule, new roads are built without the accompanied lighting, which is due to economic reasons. Looking for savings local authorities often turn on lights only for a few hours in the evening and early morning. Smart investment implementing LED lighting system enables the lighting of roads and streets throughout the night, while reducing the energy costs by more than 50 %, which has a significant impact on the finances of poor rural communes. The article describes the system procedure for setting up the power network in Poland in terms of the legal and technical aspects of rural development. Moreover, economic benefits from the completed projects of intelligent lighting are identified. The article is a description of the best practices and emerging needs.

Keywords: Geodetic Registry of Utilities Networks, public lighting, intelligent lighting.

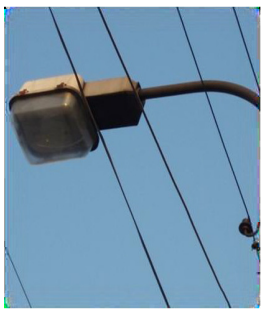
Introduction

The motto of rapid development in the seventies of the last century became the "faster, better, stronger" and in the late 20th and early 21st century it is "sustainable development". Climate protection is a topic that preoccupies politics, science, business, civil society and citizens of the world. Everyone is responsible for their actions, but also all bear consequences of inaction [1].

In the time of recession and crisis, rational use of energy, energy efficiency, the application of new green technologies and renewable energy sources is an imperative but also a challenge and impulse for economic development, opening new workplaces and a brighter perspective for our young generations.

Energy savings and user satisfaction are two major design considerations for modern lighting systems [2]. Replacement of the old to the new lighting is common in Poland.

Figure 1 shows photos with Polish types of luminaries – the old, for example, sodium ones and new LED luminaries.



a) Old luminaries[3]

b) New luminaries[3]

c) New styled "old" luminaries

Fig. 1. **Types of luminaries** (source: A. Klimach)

New luminaries can also look like the old ones as in Fig. 1, c. These luminaries can match the architecture in old towns.

Energy in Poland will come from renewable sources; municipalities are looking for savings and change the old lighting to the new one – cheaper. The impact of such actions is also a need to reduce carbon dioxide emissions into the atmosphere.

This paper presents best practices of selected rural areas development through the implementation of intelligent, energy-efficient lighting. The article describes the system procedure for setting up the power network in Poland in terms of the legal and technical aspects of rural development. Moreover, economic benefits from the completed projects of intelligent lighting are identified.

Research methodology

The main object of the research was intelligent lighting. The research method was the case study based on an extensive analysis including a number of key issues outlined in the diagram shown below in Figure 2.

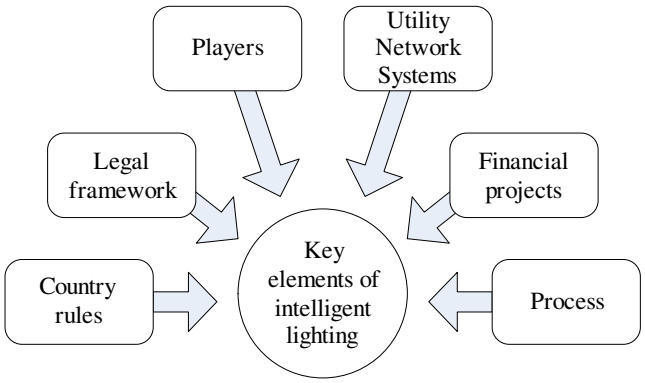


Fig. 2. **Key elements of intelligent lighting issue** (source: own study)

The adopted analytical method supplemented diagnosis of all elements (rules, legal framework, players, utility network system, financial projects, process) that determine creating intelligent lighting. Thanks to this broad approach, it will be possible to identify the conditions and trends.

Results and discussion

1. The rules of lighting in the municipality

Municipality tasks in the supply of electricity are the following:

- planning and organization of electricity supply;
- planning public places lighting and roads located within the municipality;
- financing lighting of streets, squares and public roads located within the municipality - Article 18 Energy Law, [4].

The tasks of the municipality concerning the road do not apply to highways and expressways within the meaning of the provisions on toll motorways [4]. The lighting design must take into account the local zoning plans or district development plans included in the study of conditions and directions of spatial management and air protection program.

The Local Government Act indicates that supply of electricity is the task of the municipality [5]. Commune-specific tasks are tasks that cannot be taken away from the municipality by the legislature without demonstrating that it lost its character. Municipality implements its own tasks with its own income alone on its own behalf and at your own risk [6].

The municipality must provide lighting the roads that are on its territory. In the Polish legal system there are four basic categories of public roads:

- state roads;
- regional (Voivodeship) roads;
- province (Powiat) roads;
- communal (local) roads.

In Poland, the public real estate resources are managed by the local, regional and state government bodies (local authorities), according to the administrative division of the country.

The public real estate constitutes an immense resource which greatly affects the real estate market [7]. It comprises the following public real estate resources – Art. 20 Act on Real Estate Management [8]:

- the real estate owned by the State Treasury, comprising 11.7 million ha of land, including 7.5 million ha of forest;

- communal (2479) real estate resources, comprising about 0.72 million ha of real estate, situated mainly in urbanised areas;
- provincional (poviat – 380) real estate resources, comprising about 0.08 million ha of real estate, situated mainly in urbanised areas;
- regional (voivodeship – 16) real estate resources, comprising about 0.03 million ha of real estate, situated mainly in urbanized areas;
- other – comprising about 31.32 million ha of real estate.

In Poland there are 16 regions (Voivodeships). Each region contains provinces (Poviats). Municipality is the smallest administrative division of the country. The percentage of ownership in Poland is presented in Figure 3.

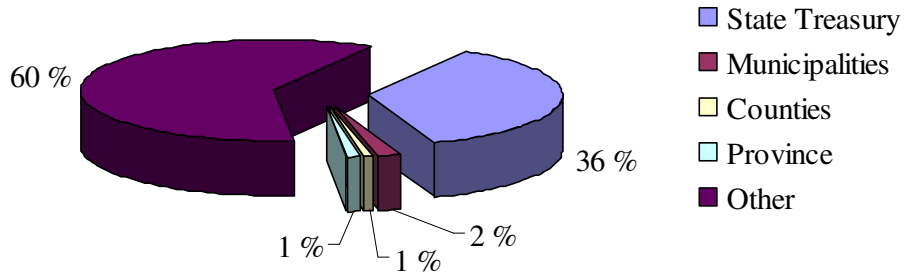


Fig. 3. **Percentage of ownership in Poland – as on January 1, 2011**
(source: own study on the data from the Survey Office)

As shown in the above diagram, 40 percent of all real estate in Poland is part of the public real estate resources.

2. Public roads

Public road, in accordance with Art. 1 of the Act on public roads, is the way, which can be used by anyone in accordance with its intended purpose, limitations and exceptions set out in this Act or any other specific provisions. State roads are owned by the Treasury. Regional, provincial, municipal roads are the property of the the relevant authorities at these levels. The shares of road belonging are shown in the following diagram (Fig. 4).

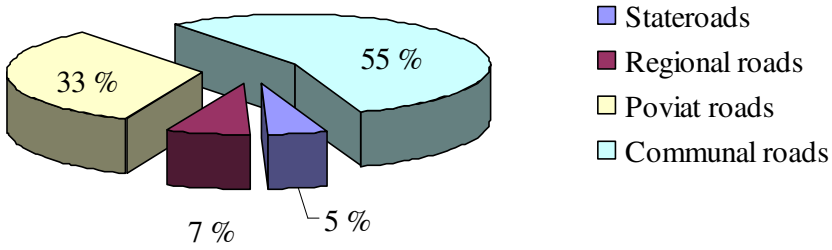


Fig. 4. **Percentage of category of roads in Poland – as on January 1, 2011**
(source: own study based on [9])

The road is a building with road engineering structures, equipment and installations, representing utility, designed to drive traffic, located in the traffic lane (article 4 Act on public roads, [10].

The municipality must finance street lighting which is located on its premises. Regulation of the Minister of Transport and Maritime Economy of 2 March 1999 on the technical conditions for public roads and their location [11], determines how a public road must be illuminated. The road should be illuminated for reasons of safety, in particular (§ 109 Regulation on the technical conditions for public roads and their location) the following.

1. When it runs through the illuminated area and there is a risk of glare road users.
2. Within a node or an intersection, if one of the intersecting roads is lit.
3. At the junction with the expressway road.
4. roundabout.

5. At the junction of channeled to the islands in the curbs – if this is the main way of accelerated motion.
6. Between segments illuminated – if the length of it is less than 500 m.
7. On the section adjacent to the bridge structure – if the bridge structure is illuminated.
8. Within the space of toll collection.
9. In the street class expressway.
10. On the single carriageway road of four or more traffic lanes.
11. At the junction in the building area, which is surrounded by public buildings, public transport stops.
12. Within the crossing and arrival at public transport stops in the building area.

Light illumination cannot change the color of signs. The requirement for the distribution of light intensity and light points is defined by the Polish Standard. Electricity costs can be a significant proportion of the expenditure of the municipality.

3. Selected projects realization of LED lighting in rural areas

An example of the development practices is the rural municipality Trzebielino located near Slupsk – Voivodeship Pomorskie in the north of Poland. In 2012, the municipality Trzebielino exchanged all street lamps with energy-saving LED. The following two Figures 6,7 show the lighting situation. The municipality Trzebielino has upgraded 354 lighting luminaries. Trzebielino replaced 213 luminaries with new fixtures Selenium Philips Led power of 55W and 73W. In other fixtures, light sources are listed on the energy-efficient LED. Before upgrading the power of street lighting in the municipality was 54 kW, after the exchange for LED luminaries it is 26 kW. The installed fixtures were also equipped with Dynadimmer drivers, factory programmed changing illumination devices. Dynadimmer drivers can get an additional 30 % energy savings [12]. In 2011 Municipality consumed 162742 kWh (cost 111609,60 PLN) after changing to energy efficient lighting 120106 kWh (cost 59481,22 PLN). Savings amounted to approximately 47 %. Investment cost 300 000 PLN [13].

Fig. 5. **Old columns with the new luminaries**

Fig. 6. **Situation of Trzebielino [2]**

The municipality Trzebielino is certified 100 % LED, it is the first municipality with this certificate. This certificate is awarded to municipalities in which the lighting is energy efficient.

Przytyk Municipality is the largest rural municipality which owns 100 % lighting LEDs [14].

The municipality Lelów in the district of Czestochowa will replace the entire street lighting to LED fixtures. Modernization of street lighting in the municipality of Lelów will be completed in the spring of 2015. It is estimated that the cost will be approx. 2 million PLN. This community will receive subsidies for the project from the program SOWA (in English OWL) [15].

It is possible to obtain funds from the National Fund for Environmental Protection and Water Management. In the program of green investment (GIS- Green Investment Scheme) there is a part SOWA [16] – energy efficient street lighting. The purpose of this program is to reduce carbon dioxide emissions by funding projects to improve the energy efficiency of street lighting systems. The beneficiaries of this program are local governments who have the title to dispose of street lighting infrastructure for the ongoing project. One of the conditions of financing is that the municipality must be the owner of the street lighting infrastructure. Rural and urban-rural can apply for support for projects in the field of modernization and expansion of municipal lighting of the Rural Development Programme (RDP), the actions called Village renewal and development. Assistance will be provided in the form of reimbursement of eligible costs to a maximum of 75 per cent. of the eligible costs [17].

4. The process of setting up lighting

In Poland all public utilities must be registered in the Geodetic Registry of Utilities Networks (GESUT short for Polish "Geodezyjna Ewidencja Sieci Uzbrojenia Terenu") that includes information on the networks of utilities: designed, appearing in the course of construction, existing, as well as the entities (utilities managers) that administrate these networks.

Article 2 point 11 of Act of geodesy and cartography (PGiK short from polish "Prawo Geodezyjne i Kartograficzne" [18] defines utility networks as: all kinds of aboveground, ground and underground cables and equipment: water, sewage, gas, thermal, telecommunications, electricity and other, excluding the specific water management facilities, and underground structures as tunnels, transition, car parks, reservoirs. In point 14 there is the definition of the Geodetic Registry of Utilities Networks as an information system that provides collection, updating and sharing information about utilities networks in a uniform manner for the entire country.

Database of GESUT is conducted at various levels of the country territorial division and transparently shown on below juxtaposition:

Database GESUT	The entity assuming the base	The responsible entity	Legal framework
Country database GESUT	General Surveyor of Country	General Surveyor of Country	Article 7a paragraph 1 point 16a PGiK
Poviat (district) database GESUT	Starost	Starost	Article 7d point 1 letter a second indent PGiK

The provisions of the Act of geodesy and cartography regulate the way to reconciliation the location of the proposed network utilities. These provisions shall apply in the event of network positioning in urban or developed areas and lanes in the existing or proposed built-up country areas. The rules are not for the proposed connections and network utilities to be located exclusively within the building site. The procedure can be divided into stages. The first step is the submission of documents containing a proposal for the network design (article 28b paragraph 3 PGiK). The proposed network is presented on the site plan or on a copy of the basic map shown in Figure 7.

The Starost after receiving the proposal of the network location determines the timing of the council coordination. The coordination council is informed about other entities managing network utilities, mayors in which municipalities are to be affluent designed utility networks. The applicant shall be notified. Other entities that may be interested are announced, for example, entities managing closed areas on which the network utilities will be located. The next step is to conduct council coordination and preparation of the protocol. The council is chaired by the Starost or the person authorized by him (Article 28b, paragraph 5 PGiK). Following the conference on coordination of the project documentation shall contain the annotation that the dossier was the subject of deliberation. that The chairman of the council prepares the annotation (Article 28c).

During establishing and running records of public utilities, the companies wielding networks of utilities are obliged to cooperate with the governor. Article 28e paragraph 2 imposes an obligation on persons wielding the network; it is the obligation of the representatives of coordination meetings.

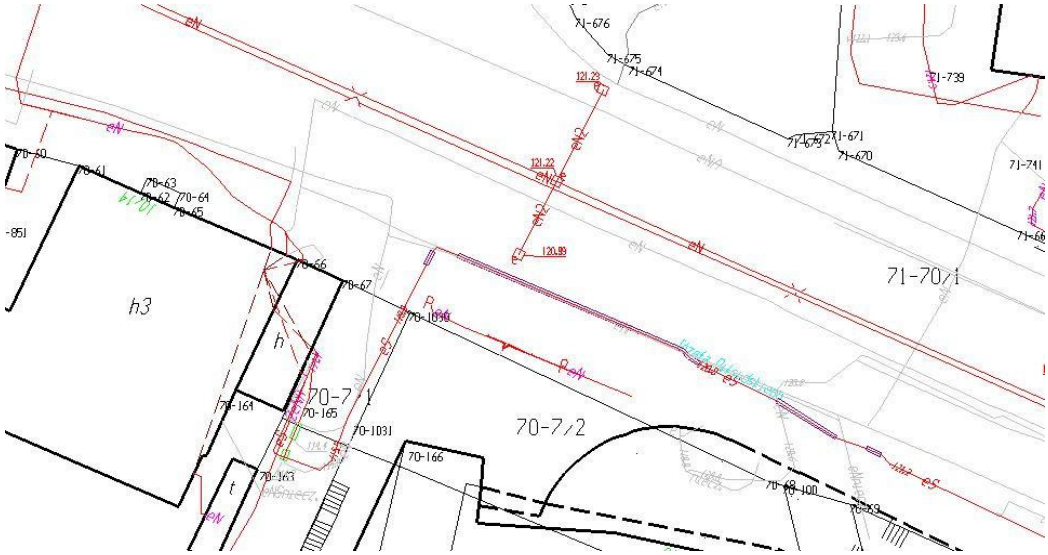


Fig. 7. **Designations of energy networks on the GESUT map**
(source: Map copy from GESUT system)

The cost of the proposed utility networks is defined in Table 16 which is an attachment to the Law Geodetic and Cartographic. The cost negotiated for one network is 150.00 PLN, a connection 105.00 PLN (as at 27-08-2014).

Conclusions

In the context of the research overall methodology it can be concluded that the assumption of efficient lighting depends on many factors. First of all, it is important that all indicated key elements were existing. There are needed all the key elements listed in Figure 2, which determine the realization of intelligent lighting projects. Moreover, the analysis of lighting in rural areas in Poland identified the beneficial effects towards the development of cost-effective system solutions. The trend towards the establishment of intelligent lighting not only in urban areas is visible. It can be assumed that this trend is growing due to favorable circumstances (transparent rules, adequate legal framework, competent players, efficient utility network system, open financial projects, clear process).

It is important to have a database that contains all techno-economic parameters as well as spatial locations of poles (position of columns) as a register of public lighting. Such a register should contain a list of streets, list of measurement points, list of columns, switching conditions, list of events, monthly expenses and consumption. Establishment of such database, control spending, reduces the costs of maintenance and allows planning for future needs and for expansion of lighting systems. It is also necessary to monitor the cost and energy consumption parameters, possible tariff model changes and react due the changes in the market (e.g., eligible customers, changes in tariff item, etc.).

In view of these conclusions it can be stated that the Polish system of intelligent lighting setting up is high and worth promoting.

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