

# Energy Saving: Political and Economic Aspects in the Context After February 24, 2022

Volodymyr (Vladimir) MAMALYGA<sup>a1</sup> and Tetiana MALAI<sup>b</sup>

<sup>a</sup> *National Technical University of Ukraine 'Igor Sikorsky Kyiv Polytechnic Institute', Kyiv 03056, Ukraine*

<sup>b</sup> *National University of 'Kyiv-Mohyla Academy', Kyiv 04655, Ukraine*

**Abstract.** The article presents approaches to the development of a feasibility study, taking into account economic and political risks. It is important to note that it is political risks that will promote the use of renewable energy sources when choosing technical and technological solutions that do not require the purchase of expensive and not always affordable traditional energy sources. The article can be useful for energy auditors, managers of industrial enterprises, heads of state regulatory bodies, as well as graduate students and undergraduates of universities.

**Keywords.** Feasibility study, political and economic risks, cost of money, cost of equipment, selection, lamp, LED, energy-efficient, incandescent, tariffs, duration of functioning during the day.

## 1. Introduction

When choosing technical and design solutions, a pragmatic approach is needed. In this case, they are usually guided by the rule that the costs for some items of expenditure may differ by 10 ... 20 ... 30%. However, over the past year, prices for primary energy resources have increased several times. This is due to political rather than economic reasons. But even in these conditions, it is possible to take into account only the technical and economic options of the project indicators. Therefore, it is necessary to take into account the conditions of specific projects (cost of equipment, duration of operation during the day, tariffs for energy resources, the cost of equipment and its installation (dismantling, utilization), the cost of replacing the equipment after leaving it, the term of service of various types of installations). However, after February 24, 2022, the world has changed and instead of economic factors (energy prices), it is necessary to take into account political risks (availability of gas, oil, electricity and modern technologies) for different regions and countries of the world. It is also necessary to consider the possible risks of changes in tariffs and the cost of money. These are economic risks, which are caused by political reasons. This was largely due to political reasons - the restriction of oil and gas supplies from traditional suppliers, for example, in Europe. Moreover, for political reasons, there is a restriction on the purchase of energy resources from unreliable suppliers who put forward political demands.

---

<sup>1</sup>Corresponding author, Volodymyr (Vladimir) Mamalyga, National Technical University of Ukraine 'Igor Sikorsky Kyiv Polytechnic Institute', Kyiv 03056, Ukraine; E-mail: v.mamalyga@gmail.com.

An analysis of the prospects of various approaches to the development of a feasibility study is carried out during the selection of equipment.

In the USSR industry standard [1] the methodology for calculating the possible savings in electrical energy is given. However, it does not take into account the value of money. This deficiency has been corrected in [2-4]. Further development of the above approaches is presented in the works [5, 6] - efficient equipment, is described, taking into account the cost of money, the level of electricity tariffs, equipment prices, etc. With regard to lighting systems, this approach is presented in the articles [7-10]. When developing lighting systems, there is usually recommended to use the most economical LED lamps. However, this is not always justified in all cases.

The article presents the current issues of choosing the most rational system for lighting streets and enterprises, as well as residential and office buildings on the example of China. This is important and relevant not only for China, but also for other countries of the world.

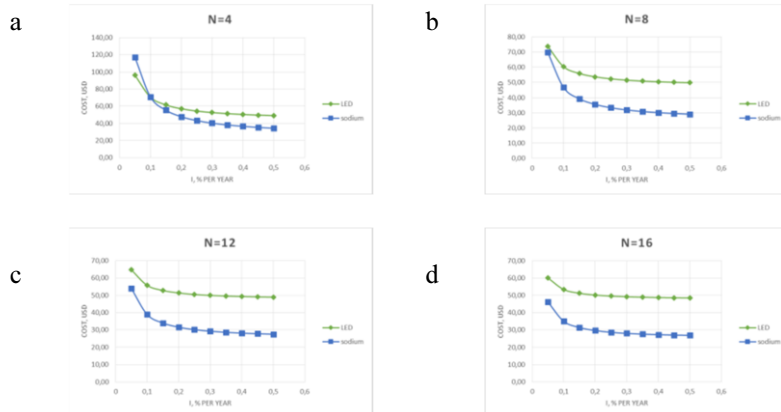
The main part of the article presents calculations and analysis of the results on specific examples.

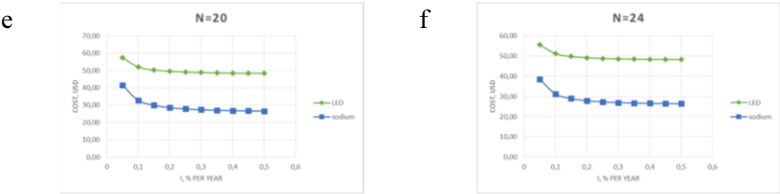
## 2. Calculations and Results Analysis

There is necessary to take into account not only the cost of equipment, but also the level of electricity tariffs when making calculations. It is also important to take into account the technical characteristics of the lamp, the service life, the power of the lamps and the duration of the lamps operation during the day for specific projects, as well as the cost of money that can be used to carry out the project.

Let's analyze the prospects of possible alternative options for street and industrial lighting systems for China. The lamps are from the same local manufacturer and provide the same luminous flux. Power LED lamp - 42 W and sodium lamp - 70 W. Let us analyze the prospects of using these lamps for different durations of work during the day - 4, 8, 12, 16, 20 and 24 hours.

The calculation results for the current level of the electricity tariff are shown in Fig. 1.

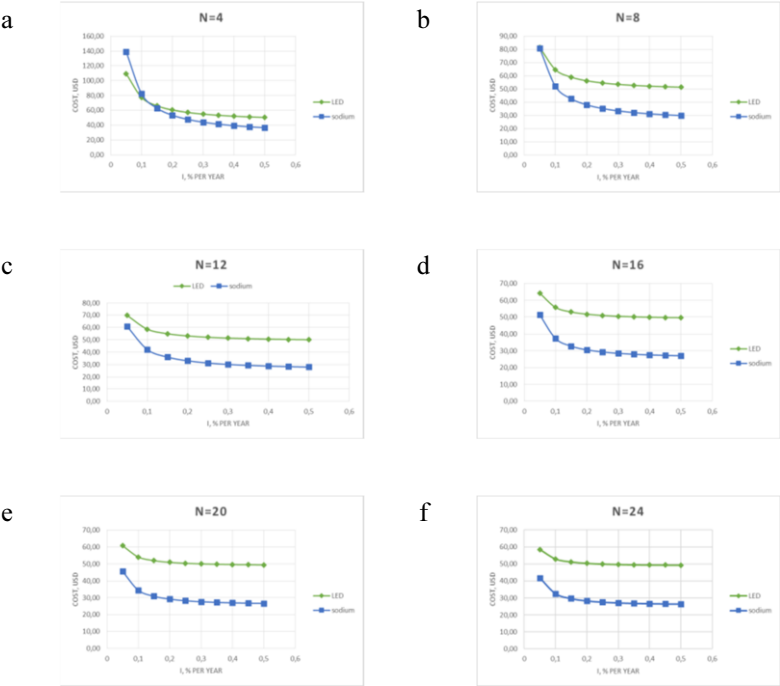




**Figure 1.** Dependence of the costs for the implementation of the street lighting system and industrial enterprises in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day at the current tariff level.

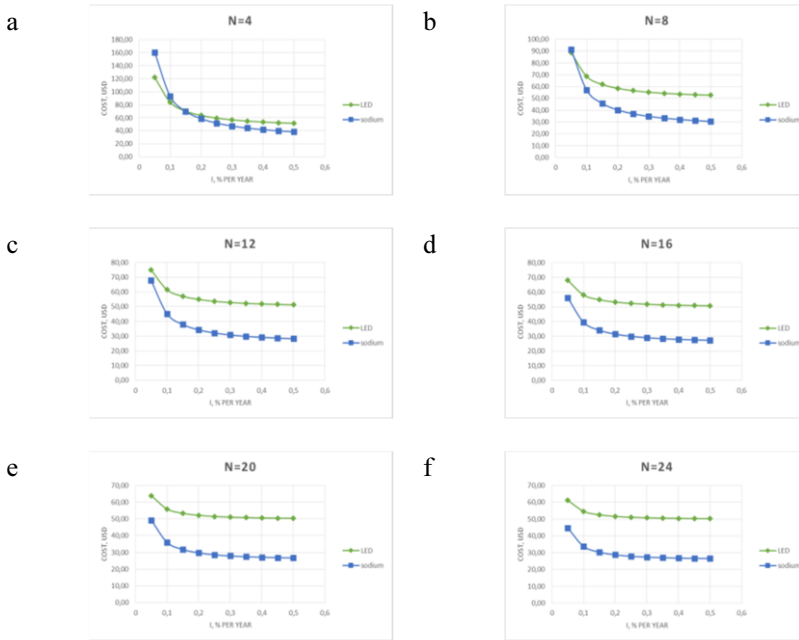
The results of similar calculations in the context of instability in energy prices on world markets for the implementation of street and enterprise lighting systems in China for various tariff levels compared to current tariffs are presented for the following cases:

- +25% - on fig. 2;
- +50% - on fig. 3;
- +75% - on fig. 4;
- +100% - on fig. 5;
- -25% - on fig. 6;
- -50% - on fig. 7.



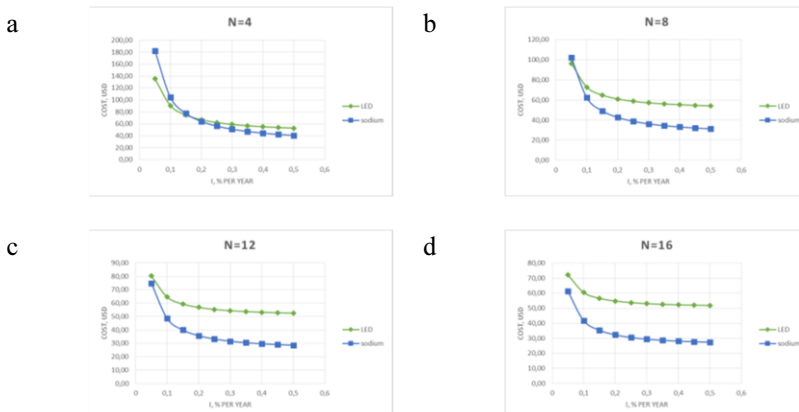
**Figure 2.** Dependence of the costs for the implementation of the street and industrial lighting system in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day with a 25% increase in tariffs.

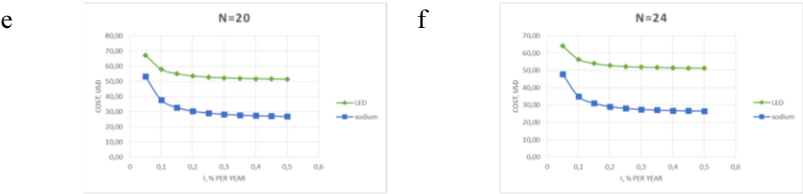
The analysis showed that LED lamps are more profitable when the cost of credit resources is less than 12% for the case of working for 4 hours a day.



**Figure 3.** Dependence of the costs for the implementation of the street and industrial lighting system in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day with a 50% increase in tariffs.

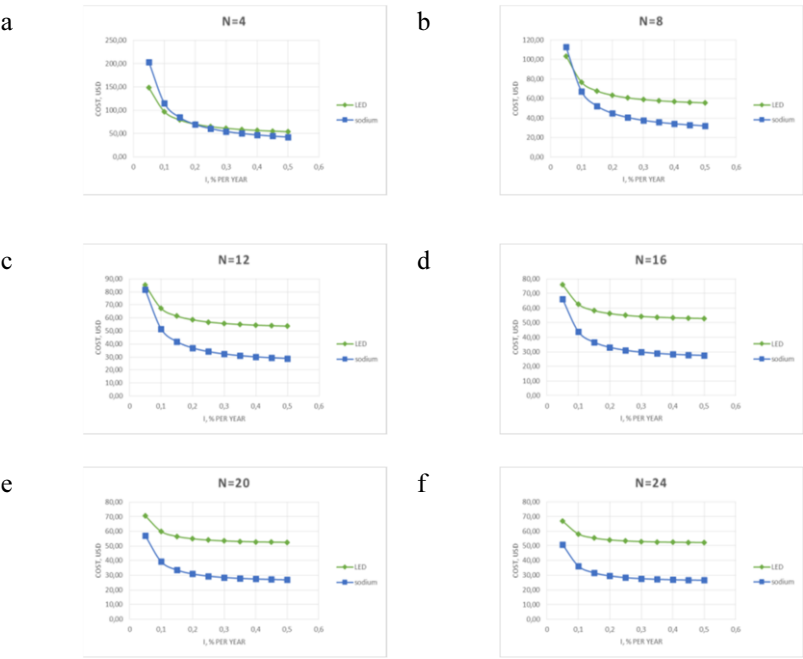
The analysis showed that LED lamps are more profitable when the cost of credit resources is less than 15% for the case of working for 4 hours a day and less than 6% for working up to 8 hours a day.





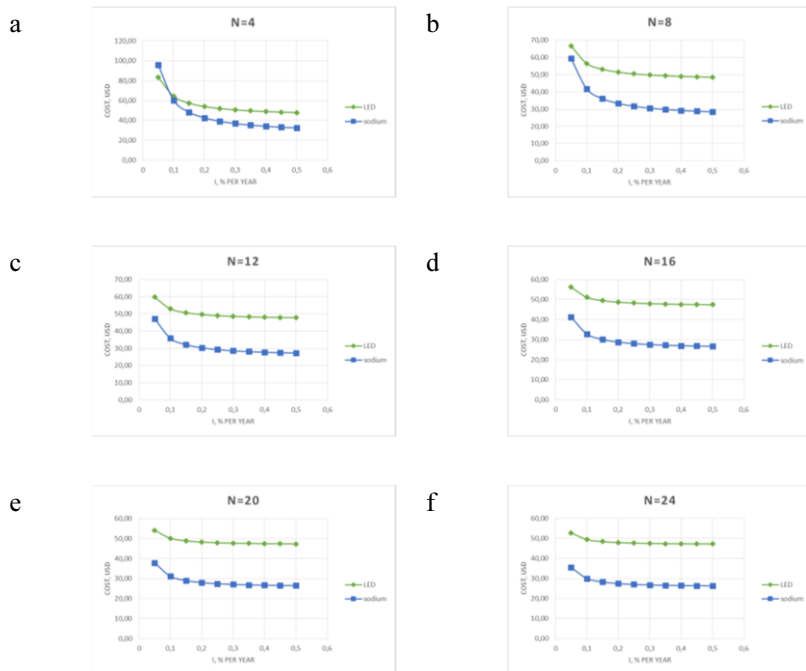
**Figure 4.** Dependence of the costs for the implementation of the street and industrial lighting system in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day with a 75% increase in tariffs.

The analysis showed that LED lamps are more profitable when the cost of credit resources is less than 17% for the case of working for 4 hours a day and less than 6.5% for working up to 8 hours a day.



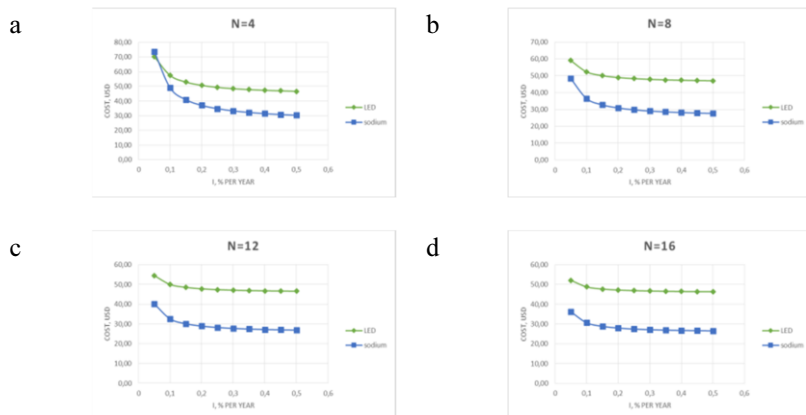
**Figure 5.** Dependence of the costs for the implementation of the street and industrial lighting system in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day with a 100% increase in tariffs.

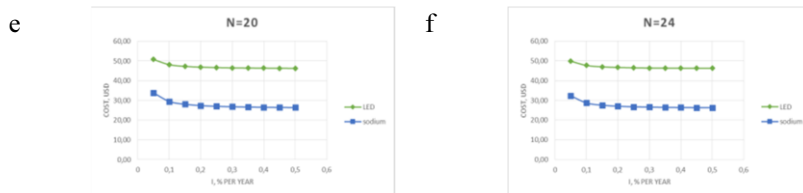
The analysis showed that LED lamps are more profitable when the cost of credit resources is less than 19% for the case of working for 4 hours a day and less than 7% for working up to 8 hours a day.



**Figure 6.** Dependence of the costs for the implementation of the street and industrial lighting system in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day with a reduction in tariffs by 25%.

Analysis of dependencies presented in fig. 6 showed that the use of LED lamps is more profitable when the cost of credit resources is less than 8% for the case of working for 4 hours a day.





**Figure 7.** Dependence of the costs for the implementation of the street and industrial lighting system in China for the case of (a) 4, (b) 8, (c) 12, (d) 16, (e) 20 and (f) 24 hours of operation during the day with a reduction in tariffs by 50%.

The analysis showed that LED lamps are more profitable when the cost of credit resources is less than 6% for the case of working for 4 hours a day.

It is determined that LED lamps are more profitable when working during the day for less than 4 hours. The higher the tariff level, the more expensive the money is to use LED lamps, even for enterprises with a low IRR level or for municipal and provincial governments.

When the lighting system operates up to 8 hours a day, LED lamps are more profitable only at higher tariffs (more than 50% growth compared to the current level).

It should be said that with an increase in the duration of work during the day, the total duration of the lamps decreases. Therefore, the influence of the value of the cost of the lamp increases.

Thus, in the current conditions in China, it is advisable to opt for sodium lamps when the lighting system of streets and enterprises is operating for more than 12 hours a day, even taking into account the possible risks of changes in electricity tariffs (from - 50% to + 100%).

A feasibility study was carried out for the use of possible alternatives for lighting systems for office and residential buildings. It should be noted that China has moved away from incandescent light bulbs in favor of LED lighting (see [<https://recyclemag.ru/news/kitaj-otkazalsja-ot-lamp-nakalivanija-v-polzu-svetodiodnogo-osveschenija>]). An analysis of the lamp market in China showed that as of today, LED lamps are 10-15-20% cheaper than energy efficient lamps. Therefore, it is quite obvious that in China it is more rational to use more durable and cheaper LED lamps for office and residential premises at different tariff levels. The calculations that were carried out according to the method presented above confirmed this. In addition, LED lamps are the most environmentally friendly modern means of lighting. These lamps do not contain substances harmful to people and the environment and do not require special disposal. LED lamps for lighting office and residential premises meet the main requirements of the modern consumer - cost-effectiveness (payback of initial costs due to a long service life), energy efficiency and environmental friendliness.

### 3. Conclusion

Last year there was a sharp increase in prices for primary energy resources, especially for oil and gas. This was due not so much to economic reasons as to political reasons and restrictions. This also led to an increase in electricity tariffs. The pragmatic approach to the analysis of the prospects of lighting systems presented in the paper

makes it possible to take into account changes in electricity tariffs when choosing a promising option for a lighting system.

The comparison of alternatives is based on the correct approach, when all options must provide the same luminous flux and have the same lamp base. Moreover, these lamps were produced in the same country - China. It is important to note that the use of incandescent lamps is not allowed in China, although these lamps are manufactured in Chinese factories for sale in many countries of the world.

In conclusion, it should be noted that when choosing the type of lamps for lighting streets and enterprises, as well as for office and residential buildings, a pragmatic approach is needed that takes into account regulatory requirements and specific site conditions. It is also necessary to take into account the value of electricity tariffs, taking into account possible risks, the cost of alternative lighting system options, the cost of money that can be used to implement the project, the duration of the lighting system operation during the day (week, month and year), etc.

The analysis showed that LED lamps are more profitable when the cost of credit resources is less than 6% for the case of working for 4 hours a day.

There is determined that LED lamps are more profitable when working during the day for less than 4 hours. When the lighting system operates up to 8 hours a day, LED lamps are more profitable only at higher tariffs (more than 50% growth compared to the current level).

Thus, in the current situation in China, it is advisable to opt for sodium lamps when the lighting system of streets and enterprises is operating for more than 12 hours a day, even taking into account the possible risks of changes in electricity tariffs (from - 50% to + 100%).

There is also shown that it is more rational to use more durable and cheaper LED lamps for office and residential buildings for different tariff levels.

Similar approaches to the development of feasibility studies are used in the teaching of courses "Computer Eco-Energy-Economic Monitoring", "Energy Management", "Energy Audit", "Business Planning", etc.

Some results of the article were presented at international conferences:

- Fifth International Investment Forum "Renewable Energy & Energy Efficiency" (IFREEE2018) - 4-6 December 2018 in the MENA Region, Jordan.
- Second International 4Smart Sustainability 4All Forum - 28-30 April 2019, Jordan.
- 2nd Edition of "Power & Energy Technology Summit (PowerTech 2021)", virtual, 21-23 January 2021, India.
- "Fifth International Conference on "Advances in Steel, Power and Construction Technology (ICASPCT 2022)", 15-16 June 2022, India etc.

## References

- [1] OST 12.25.011 - 84. Saving electrical energy in coal mines. Basic activities and calculation methods. - M.: Ministry of Coal Industry of the USSR, 1984. - page 136.
- [2] National Standard of Ukraine DSTU 3886-99 "Energy saving. Electric drive systems. Method of analyses and selection". -National Standard of Ukraine.
- [3] Standard of Joint-Stock Company "UKRTRANSNAFTA" COY 74.1-20077720-024: 2006 "Oil Pipelines. Energy saving. General requirements".



- [4] Mamalyga VM. Justification of the use of energy efficient equipment for the coal industry. *Coal of Ukraine*. 2014; 5 (689): 23-28.
- [5] Mamalyga VM. Development of a feasibility study for projects in the field of energy and resource conservation. *East European Journal of Advanced Technologies*. 2014; 3 (69):51-56.
- [6] Volodymyr VM. Saving energy - politics or business?. *International Solutions to Sustainable Energy, Policies and Applications. Part 11.*, P. 211-220. - Stephen A. Roosa. Reference - 460 Pages - ISBN: 9780815381020 - CAT# K339285.
- [7] Mamalyga VM, Gorb IY. Paradoxes of technical and economic substantiation of choice of energy efficient equipment (on the example of lighting devices). *State Research Economic Institute of Informatization and Modeling of Economy: Formation of market relations in Ukraine*. - Kyiv, 2017; 5(192):79-87.
- [8] Volodymyr VM. LED Lamp – it is so cheap and effective? *Polityka Energetyczna – Energy Policy Journal*. 2022, National Standard of Ukraine.
- [9] Volodymyr VM, DSTU 4065-2001 “Energy saving. Energy audit. General requirements”. - Kyiv: Derzhspozhyvstandart of Ukraine. 2002, 34 p.
- [10] Mamalyga VM, Malai TV. Feasibility study for the choice of street and indoor lighting systems using lamps of different types for the European Union (Germany, Denmark, Poland) and Ukraine. *Formation of market relations in Ukraine*. 2021; 3 (238): 62-69.