AMERICAN JOURNAL OF MULTIDISCIPLINARY BULLETIN
ISSN: 2996-511X (online) | ResearchBib (IF) = 9.512 IMPACT FACTOR
Volume-4| Issue-4| 2026 Published: |30-04-2026|

SELECTION OF THE ECONOMICALLY OPTIMAL CROSS-SECTION OF POWER TRANSMISSION LINES

https://doi.org/10.5281/zenodo.19791100

Kurbanova Munisakhon Sandjar kizi
magistrant
Karshi State Technical University
ORCID: 0009-0002-1230-0601

Abstract

This article is devoted to the development of measures using the method of economic current density to choose the optimal section of power lines in order to improve the quality of electricity in low-voltage electrical networks**.**

Keywords

Line; optimal section; expenses; economic corrent density.

Аннотация

В данной статье с использованием методики экономической плотности тока осуўествляется выбор оптимального сечения линий электропередачи с целью повышения качества электроэнергии в низковольтных электрических сетях.

Ключевые слова

Линия; оптимальное сечение; расходы; экономической плотности тока

The traditional method for economically rational selection of cross-sections of power transmission lines is based on the indicators of economic current density. The use of outdated economic indicators leads to a deterioration of the technical and economic performance of the network. The initial conditions for selecting an economically feasible cross-section of wires and cables are clear: as the cross-section increases, the cost of power transmission lines rises, but electrical energy losses decrease, and accordingly, the cost of lost energy is reduced.

In the current methodology for selecting the cross-sections of wires and cable conductors based on economic current density, apart from general guidelines, there are no clear recommendations for determining the calculated load. It is necessary to consider development prospects for at least 5 years, as well as the annual growth rate of electricity prices [2].

The selection of conductor cross-sections should be carried out according to a certain calculated current value, taking into account load changes over the calculation period [2].

The calculated current is determined as:

$$I_{хис}=I_0\cdot(1+q\cdot t) \qquad (1)$$

where I_0 - nominal current, A; q - coefficient considering load growth dynamics; t- calculation period, years.

The cost of electrical energy is determined as:

$$C=C_0\cdot(1+z\cdot t) \qquad (2)$$

where C_0 - initial electricity price for the base calculation period, UZS/kWh; z - coefficient reflecting the growth rate of electricity prices; t- calculation period, years.

Capital costs for power transmission lines are modeled by a linear function including two components .

$$K=\lambda L+\gamma FL=L\cdot(\lambda+\gamma F) \qquad (3)$$

Where λ - part of the capital costs accounting for installation of the transmission line, million UZS; L - length of the transmission line, km; γ - part of capital costs proportional to the conductor cross-section, million UZS/(km·mm²); F- conductor cross-sectional area, mm² .

Discounted costs are determined as:

$$З=\lambda L+\gamma FL+\sum_{t=t_0}^{T_p}\frac{\alpha_{absl}(\lambda L+\gamma FL)+\frac{3\cdot C_0 {I_{хис}}^2\cdot\tau\cdot\rho\cdot L}{F}}{(1+E)^t}=\rightarrow \text{мин} \qquad (4)$$

According to the criterion of minimum discounted costs, the analytical optimal cross-sectional area can be obtained from expression (4). Solving the equation $\frac{dЗ}{dF}=0$ makes it possible to derive an economically justified formula.

The main cross-section of the conductor is determined as [3]:

$$\frac{dЗ}{dF}=\gamma L+\sum_{t=t_0}^{T_p}\frac{\alpha_{абсл}\cdot\gamma L}{(1+E)^t}-\sum_{t=t_0}^{T_p}\frac{3\cdot(C_0\cdot(1+z\cdot t)\cdot(I_0\cdot(1+q\cdot t))^2\cdot\tau\cdot\rho\cdot L}{F^2\cdot(1+E)^t} \qquad (5)$$

$$\sum_{t=t_0}^{T_p}\frac{3\cdot(C_0\cdot(1+z\cdot t)\cdot(I_0\cdot(1+q\cdot t))^2\cdot\tau\cdot\rho\cdot L}{F^2\cdot(1+E)^t}=\sum_{t=t_0}^{T_p}\frac{\gamma L+\alpha_{абсл}\cdot\gamma L}{(1+E)^t}$$

$$F_{ek}=\sqrt{\frac{\sum_{t=t_0}^{T_p}3\cdot(C_0\cdot(1+z\cdot t)\cdot(I_0\cdot(1+q\cdot t))^2\cdot\tau\cdot\rho\cdot L\cdot(1+E)^t}{\sum_{t=t_0}^{T_p}(1+E)^t\cdot(\gamma L+\alpha_{абсл}\cdot\gamma L)}}=$$

$$\sqrt{\frac{L\cdot\sum_{t=t_0}^{T_p}3\cdot(C_0\cdot(1+z\cdot t)\cdot(I_0\cdot(1+q\cdot t))^2\cdot\tau\cdot\rho\cdot(1+E)^t}{L\cdot\sum_{t=t_0}^{T_p}(1+E)^t\cdot(\gamma+\alpha_{абсл}\cdot\gamma)}}$$

$$\sqrt{\frac{3\cdot\rho\cdot\sum_{t=t_0}^{Tp}\tau\cdot(I_0\cdot(1+q\cdot t)\cdot(\text{C}_0\cdot(1+z\cdot t))^2\cdot(1+E)^t}{\gamma(1+\sum_{t=t_0}^{Tp}\alpha_{\text{абсл}}(1+E)^t}} \qquad (6)$$

where $\alpha_{\text{абсл}}$ - coefficient of capital costs for maintenance and repair of the line, UZS/year; ρ - resistivity of the conductor material, Ом мм^2/ м;

τ- time of maximum losses; E - discount rate equal to the return on capital, %

When constructing the technical and economic model of economic current density, the following assumptions are made:

1. Linear dependence of the construction cost of 1 km of line (K_0) on the section.
2. Possible differences in linear active resistances.

The economic current density, A/mm^2, is determined by the following expression:

$$j_{\text{эк}} = \frac{I_{\text{ҳис}}}{F_{\text{иқт}}},$$

$$j_{ek} = \frac{I_0}{F_{\text{иқт}}} = I_0 \cdot \sqrt{\frac{\gamma(1+\sum_{t=t_0}^{T_p}\alpha_{\text{абсл}}(1+E)^{-t})}{3\cdot\rho\cdot\sum_{t=t_0}^{T_p}\tau\cdot\left(I_0\cdot(1+q\cdot t)\right)^2\cdot(C_0\cdot(1+z\cdot t)\cdot(1+E)^{-t}}} =$$

$$= \sqrt{\frac{\gamma(1+\sum_{t=t_0}^{T_p}\alpha_{\text{абсл}}(1+E)^{-t})}{3\cdot\rho\cdot\sum_{t=t_0}^{T_p}\tau\cdot(1+q\cdot t)^2\cdot(C_0\cdot(1+z\cdot t)\cdot(1+E)^{-t}}}$$

Table 1

Dynamics of electricity consumption growth in the region

Year	Electricity Consumption (%)
2021	100
2022	101.17
2023	103.56
2024	104.32
2025	106.15

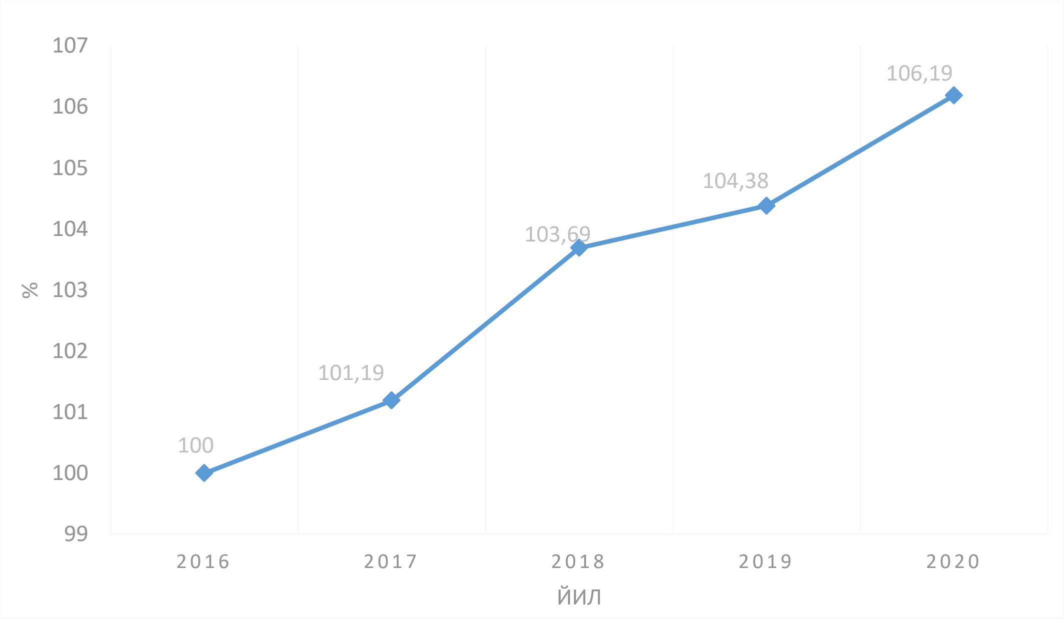

Figure 1. Dynamics of electricity consumption growth in the region.

Analysis of the obtained results allows us to draw the following conclusions: in order to use traditional methods for selecting economically optimal cross-sections of wires and cables based on economic current density, it is necessary to recalculate economic current density tables for different variants of initial data. However, many technical and economic parameters influencing the economically justified value of conductor cross-sections remain uncertain, including constant changes in the cost of cable and wire products and the construction of power transmission lines.

The increasing trend in electricity prices, as well as the cost of cable and overhead transmission lines, justifies the use of larger cross-sectional areas for more efficient energy utilization, which in turn reduces the value of economic current density. Taking into account the actual value of economic current density in the design of cable and overhead transmission lines increases the validity of engineering decisions.

REFERENCES:

1. Muxitdinova, A. S. (2024). METHODOLOGICAL ANALYSIS OF SCIENTIFIC KNOWLEDGE IN TEACHING SCIENCE. *SUSTAINABILITY OF EDUCATION, SOCIO-ECONOMIC SCIENCE THEORY*, *3*(25), 155-158.

2. Аликулова, С. (2023). Формирование специальных компетенций будущих инженеров инженерно-энергетической профессии в технических высших учебных заведениях. *Общество и инновации*, *4*(11/S), 113-117.

3. Аликулова, С. М. (2023). ТЕПЛОВАЯ ЭФФЕКТИВНОСТЬ СИСТЕМЫ СОЛНЕЧНОГО ОТОПЛЕНИЯ НА ОСНОВЕ ПЛОСКИХ РЕФЛЕКТРОВ, УСТАНАВЛИВАЕМЫХ С СЕВЕРНОЙ СТОРОНЫ ЗДАНИЯ. *Oriental renaissance: Innovative, educational, natural and social sciences*, *3*(4-2), 556-559.

4. Shukurova, O., Pirimov, O., Alikulova, S., & Juraev, H. (2024, November). Problems of control of compressor devices in GTL technologies and construction of a model of the injection process. In *AIP Conference Proceedings* (Vol. 3244, No. 1, p. 060008). AIP Publishing LLC.

5. Karimov, I., & Alikulova, S. Pedagogik Mahorat Asosida Ta'lim Metodlarining Samaradorligini Oshirish. *Maktabgacha va Maktab Ta'limi Jurnali*, 676124.

6. Shouket, H. A., Ameen, I., Tursunov, O., Kholikova, K., Pirimov, O., Kurbonov, N., ... & Mukimov, B. (2020, December). Study on industrial applications of papain: A succinct review. In *IOP Conference Series: Earth and Environmental Science* (Vol. 614, No. 1, p. 012171). IOP Publishing.

7. Usmanov, E., Rajabboeva, A., Kurbonov, N., & Kurbanova, K. (2024, June). Operational logic scheme of the sketch base for an educational simulator in the fundamentals of power supply. In *AIP Conference Proceedings* (Vol. 3152, No. 1, p. 050029). AIP Publishing LLC.

8. Turdiboyev, A., Aytbaev, N., Mamutov, M., Tursunov, A., Toshev, T., & Kurbonov, N. (2023, March). Study on application of electrohydraulic effect for disinfection and increase of water nutrient content for plants. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1142, No. 1, p. 012027). IOP Publishing.

9. Abdullayevich, Q. N. Muzaffar o'g'li, NT (2024). *NORMALIZATION MODES OF HYDROGENERATORS. THE THEORY OF RECENT SCIENTIFIC RESEARCH IN THE FIELD OF PEDAGOGY*, *2*(25), 368-371.

10. Abdullayevich, Q. N. (2023). REACTIVE POWER COMPENSATION. *IMRAS*, *6*(6), 506-508.

11. Abdullayevich, Q. N. Almardon o'g'li, NA, & Bahodir o'g, QOA (2024). *INFLUENCE OF ELECTRICAL ENERGY QUALITY ON ELECTRICAL ENERGY WASTE. Научный Фокус*, *1*(9), 786-789.

12. Abdullayevich, K. N. (2024). ЭНЕРГИЯНИ ТЕЖАШ ВА ЭНЕРГИЯ САМАРАДОРЛИГИ СОҲАСИДА ИННОВАЦИОН ФАОЛИЯТНИ БОШҚАРИШДА ЛОЙИҲА ЁНДАШУВИДАН ФОЙДАЛАНИШ. *THE THEORY OF RECENT SCIENTIFIC RESEARCH IN THE FIELD OF PEDAGOGY*, *2*(25), 363-367.

13. Abdullayevich, Q. N., & Qizi, Q. M. S. (2023). Ways to Reduce Losses in Power Transformers. *Texas Journal of Engineering and Technology, 20*, 36-37.

14. Mahmutxonov, S. J., Qurbonov, N., & Babayev, O. (2022). ELEKTR TARMOQLARIDA SIFAT KO 'RSATKICHLARI VA ISROFLAR. *Innovatsion texnologiyalar, 47*, 14-15.

15. Abdullayevich, K. N. (2024). ЭЛЕКТР ЭНЕРГИЯ СИФАТИНИ ЭЛЕКТР ЭНЕРГИЯ ИСРОФИГА ТАЪСИРИ. *PEDAGOG, 7*(9), 183-188.

16. Abdullayevich, K. N., & Olimjon o'g'li, E. J. (2024). Using consumer-regulators to equalization of electrical energy system load schedule. *Journal of Multidisciplinary Bulletin, 7*(4), 25-29.

17. Abdullayevich, K. N. (2024). Analysis and evaluation of the effectiveness of energy saving in industrial enterprises. *SCIENTIFIC APPROACH TO THE MODERN EDUCATION SYSTEM, 3*(28), 75-81.

18. Курбонов, Н. А., Халикова, Х. А., & Неъматов, Б. А. О. (2024). ВОПРОСЫ ПАРАЛЛЕЛЬНЫЕ РАБОТЫ ЭНЕРГОСИСТЕМЫ АФГАНИСТАНА, УЗБЕКИСТАНА И ТАДЖИКИСТАНА С УЧЕТОМ НОВОГО СТРОИТЕЛЬСТВА. *Eurasian Journal of Academic Research, 4*(6-1), 37-41.

19. Abdullayevich, Q. N., & Elmurodovich, B. O. (2023). ПРОВЕДЕНИЕ ЛАБОРАТОРНЫХ ЗАНЯТИЙ ПО ЭЛЕКТРИЧЕСКИМ СХЕМАМ. *Новости образования: исследование в XXI веке, 1*(7), 1006-1010.

20. Abdullayevich, Q. N. (2023). REDUCING ELECTRICITY LOSSES IN ELECTRICAL DISTRIBUTION NETWORKS DUE TO MULTICRITERIA OPTIMIZATION OF LINE SECTIONS. *MODELS AND METHODS FOR INCREASING THE EFFICIENCY OF INNOVATIVE RESEARCH, 3*(28), 275-279.

21. Abdullayevich, K. N. (2024). ОЦЕНКА ВЛИЯЮЩИХ ФАКТОРОВ НА ПОКАЗАТЕЛИ УДЕЛЬНОГО РАСХОДА ЭЛЕКТРОЭНЕРГИИ НА ПРОМЫШЛЕННЫХ ПРЕДПРИЯТИИ. *PROSPECTS AND MAIN TRENDS IN MODERN SCIENCE, 2*(13), 531-536.

22. Abdullayevich, K. N. (2024). ИНТЕЛЛЕКТУАЛЬНЫЙ МОНИТОРИНГ РЕЖИМОВ ЭЛЕКТРИЧЕСКИХ СЕТЕЙ. *Новости образования: исследование в XXI веке, 3*(26), 203-208.

23. Abdullayevich, K. N., & Abduzairovna, N. M. (2024). ЭЛЕКТР ТАЪМИНОТИ ТИЗИМИДА РАҚАМЛИ ПОДСТАНЦИЯЛАРДАН ФОЙДАЛАНИШ МАСАЛАЛАРИ. *Eurasian Journal of Social Sciences, Philosophy and Culture, 4*(9), 71-75.

24. Abdullayevich, K. N. (2024). НОРМАТИВНЫЕ ПОТЕРЬ ЭЛЕКТРОЭНЕРГИИ В РАСПРЕДЕЛИТЕЛЬНЫХ СЕТЯХ 10, 6 и 0, 4 кВ. *THE*

THEORY OF RECENT SCIENTIFIC RESEARCH IN THE FIELD OF PEDAGOGY, *2*(21), 55-60.

25. Abdullayevich, Q. N., & Ikrom o'g, T. A. A. (2023). Efficiency OF Use OF Frequency Converter with Smooth Control OF Asynchronous Motor Speed. *Galaxy International Interdisciplinary Research Journal*, *11*(5), 448-449.

26. Abdullayevich, K. N., O'G'Li, M. F. A., O'G'Li, E. J. O., & O'G'Li, P. A. B. (2024). MARKOV ZANJIRI USULI VA O 'LCHANGAN SHAMOL TEZLIKLARIDAN FOYDALANGAN HOLDA YANGI SHAMOL TEZLIKLARINI BASHORAT QILISH. *Eurasian Journal of Academic Research*, *4*(11-2), 7-12.

27. Abdullayevich, K. N., Akrom o'g, N. M. B., & Olimjon o'g'li, E. J. (2024). Functions of facts devices with innovation technology in the electrical energy system. *Journal of Engineering Sciences*, *7*(5), 12-16.

28. Abdullayevich, K. N., & Abdullayevna, X. X. (2024). EFFECTIVENESS OF USING A FREQUENCY CONVERTER WITH SMOOTH SPEED CONTROL OF AN INDUCTION MOTOR. *Новости образования: исследование в XXI веке*, *3*(27), 151-154.

29. Abdullayevich, K. N. Shuhrat o'g'li, OS, & Olimjon o'g'li, EJ (2024). *STRUCTURE OF LOW VOLTAGE ELECTRICAL NETWORKS. AMERICAN JOURNAL OF MULTIDISCIPLINARY BULLETIN*, *2*(5), 112-119.

30. Abdullayevich K. N., Tulqin o'g'li X. M., Mansur o'g'li C. D. УМЕНЬШЕНИЕ ПОТЕРЬ ЭЛЕКТРОЭНЕРГИИ В РАСПРЕДЕЛИТЕЛЬНЫХ ЭЛЕКТРИЧЕСКИХ СЕТЯХ ЗА СЧЕТ МНОГОКРИТЕРИАЛЬНОЙ ОПТИМИЗАЦИИ СЕЧЕНИЙ ЛИНИЙ //IMRAS. – 2025. – Т. 8. – №. 3. – С. 35-43.

31. Shouket, H. A., Ameen, I., Tursunov, O., Kholikova, K., Pirimov, O., & Kurbonov, N. & Mukimov, B.(2020, December). Study on industrial applications of papain: A succinct review. In *IOP Conference Series: Earth and Environmental Science* (Vol. 614, No. 1, p. 012171).

32. Abdullayevich K. N. et al. ВОПРОСЫ ПАРАЛЛЕЛЬНЫЕ РАБОТЫ ЭНЕРГОСИСТЕМЫ АФГАНИСТАНА, УЗБЕКИСТАНА И ТАДЖИКИСТАНА С УЧЕТОМ НОВОГО СТРОИТЕЛЬСТВА //Eurasian Journal of Academic Research. – 2024. – Т. 4. – №. 6-2. – С. 19-23.

33. Abdullayevich Q. N. CONDUCTING LABORATORY CLASSES ON ELECTRICAL CIRCUITS. Finland International Scientific Journal of Education //Social Science & Humanities. – 2023. – Т. 11. – №. 1. – С. 1095-1098.

34. Abdullayevich K. N., Mansur o'g'li C. D. МЕТОДЫ И МЕРЫ ЭНЕРГОСНАБЖЕНИЯ В СИСТЕМЕ НАРУЖНОГО ОСВЕЩЕНИЯ ГОРОДА //INNOVATIVE DEVELOPMENTS AND RESEARCH IN EDUCATION. – 2025.

35. Abdullayevich K. N., Shuhrat o'g'li O. S., Olimjon o'g'li E. J. STRUCTURE OF LOW VOLTAGE ELECTRICAL NETWORKS //AMERICAN JOURNAL OF MULTIDISCIPLINARY BULLETIN. – 2024. – Т. 2. – №. 5. – С. 112-119.