JURNAL EDUNITRO
JURNAL PENDIDIKAN TEKNIK ELEKTRO
HTTPS://EJURNAL.UNIMA.AC.ID/INDEX.PHP/EDUNITRO
E-ISSN 2776-284X
P-ISSN 2776-2920
Vol. 5, No. 2, October 2025

Economic Analysis of Electrical Energy in the Development of Tomohon City as a Tourism Hub

Billy Kilis[1*], Hendro Sumual[2], Freike Eugene Kawatu[3], and Titof Tulaka[4]
[1,2,3,4] Faculty of Engineering, State University of Manado
[*]Corresponding author, e-mail: billykilis@unima.ac.id[1]

Received: October 8th, **2025.** Revised: October 22nd, **2025.** Accepted: October 28th, **2025**
Available online: November 7th, **2025**. Published: November 7th, **2025**.

Abstract— The development of Tomohon City as a tourism hub in North Sulawesi has accelerated significantly, triggering a surge in economic activities and consequently increasing the demand for electrical energy. This study aims to analyze the relationship between economic growth and electricity consumption in Tomohon City, identifying the implications for energy infrastructure planning. A descriptive survey method was employed, using secondary data sourced from the Central Statistics Agency and PT PLN. Data on electricity supply and economic indicators such as Gross Regional Domestic Product (GRDP) were presented in tables, graphs, and diagrams to illustrate growth patterns from 2010 to 2021. Findings reveal that both electricity consumption and installed capacity have increased steadily, with electricity sales rising from 38.4 GWh in 2014 to 48.3 GWh in 2020 and customer numbers increasing from 24,575 to 29,770 over five years. Economic indicators such as GRDP also showed consistent growth, particularly in the tourism, trade, and accommodation sectors. The average annual growth in electricity production was 4.68%, highlighting the need for proactive energy planning. The study concludes that the economic development of Tomohon City is positively correlated with rising electricity demands. It recommends that stakeholders, including PT PLN and local government bodies, develop anticipatory infrastructure strategies to ensure sustainable energy supply, particularly as tourism continues to expand. This research provides critical insight into aligning energy provision with regional economic development priorities.

Keywords: electrical energy, economic growth, gross regional domestic product, Tomohon City, tourism development.

I. INTRODUCTION

Tomohon City, renowned for its religious, student, and flower industries, as well as tourism, has experienced a relatively significant acceleration of development. Tomohon City is one of the cities in North Sulawesi Province has an area of approximately 147.61 km² (14,761.0 ha). The population of Tomohon City in 2015 was around 100,373 people, estimated to reach 105,000 people by 2025. The need for electrical energy continues to increase, in line with population growth from the previous year. In 2014, there were 98,686 people, representing an increase of around 1,687 people, or 1.68% (Kota Tomohon Dalam Angka 2020, 2020). Based on data from the Central Statistics Agency of Tomohon City, as published in Tomohon in Figures 2020, the installed electricity capacity in Tomohon City has increased every year, reaching 19.2 GVA in 2010, 21.3 GVA in 2011, 23.4 GVA in 2012, and 42.7 GVA in 2019, the latest available data. In contrast to the amount of installed power capacity, the sold capacity, or electricity consumption in Tomohon City, has fluctuated but not significantly, namely, it has increased every year. In 2016, the amount of electricity consumption in Tomohon was 41.6 GWh, which increased from the previous year. In 2015, the amount was 39.7 GWh, and in 2012, it was 35.5 GWh. This trend is increasingly evident as various tourist attractions are built and developed; currently, several new destinations require a constant energy supply (Kota Tomohon Dalam Angka 2020, 2020). As a city, Tomohon certainly has a development plan to support its socio-economic and cultural aspects.

We were confirmed in the Development Planning Deliberation (abbreviated as Musrenbang) of the Tomohon City Regional Development Work Plan (RKPD) for 2020, as reported by the online news portal beritamanado.com. There are five priorities for Tomohon City Development in 2020, including improving human resources, promoting economic growth, enhancing competitiveness, attracting investment, addressing socio-cultural aspects, and promoting tourism. The provision of adequate electrical energy must support all of these plans. Specifically for tourism, Tomohon City has established a Tourism Village, starting in Kakaskasen Village, which will subsequently involve all tourism potential in several other villages.

Referring to Article 28 and Article 29 of Law Number 30 of 2009 concerning Electricity, Perusahaan Listrik Negara (PLN), as the Holder of a Business License for the Provision of electricity in the public interest, is required to provide electricity continuously in sufficient quantities, of good quality, and with reliability. Thus, PLN must be able to serve

the current and future electricity needs so that PLN can fulfil the obligations required by the Law. As an initial step, PLN must be able to estimate electricity needs in an area, driven by several primary factors, namely economic growth, population growth, electrification programs, and government programs. Referring to the Electricity Supply Business Plan (abbreviated in Indonesian, RUPTL) of PT. Perusahaan Listrik Negara (Persero) for 2018-2027, the need for electricity in a region is driven by several primary factors, namely economic growth, population growth and electrification programs and government programs including building Special Economic Zones (KEK), industrial areas (KI), national tourism strategic areas, integrated marine and fisheries centers and cross-border post electricity networks (PLBN). PLN will electrify all of these areas. In this RUPTL, the preparation of the forecast utilises a regression model based on historical data from several indicators, namely: economic growth, which in this case refers to Gross Regional Domestic Product (abbreviated in Indonesian as PDRB), according to business fields, population growth, and electricity tariffs.

Therefore, based on several data and electricity policies as well as increasing energy needs and economic growth in Tomohon City, planning is needed, including energy estimates or prognoses for the next few years. This study can guide specific actions that the energy sector must take to support economic growth (Fauzy, 2023; Siregar & Hasbi, 2023; Stern, 2019). Based on the background that has been stated previously, several problems can be identified, namely: Rapid economic growth. More and more tourist attractions are being developed, and communities are becoming increasingly dependent on electricity usage (in Watts) (Caramizaru & Uihlein, 2020; Opiyo, 2020; Prastika, 2023; Sousa et al., 2019). The increase in electricity needs (in Watt-hours, abbreviated as Wh) is not in line with the increase in electricity supply, as the installed power capacity remains the same (Arifin & Hermawan, 2021; Gielen et al., 2019; Lindberg et al., 2019; Simamora et al., 2022). In contrast, community needs continue to rise, influenced by economic growth, electricity tariffs, and population growth. The implementation of rolling blackouts is caused by an excess load and a lack of power, resulting in the paralysis of activities in various sectors of electricity consumers (Sharma et al., 2021). Lack of awareness among electricity customers regarding the limited availability of electricity. Lack of community participation in electricity conservation. There is a need to plan and forecast electricity needs for the coming years, taking into account the current energy needs and economic development in Tomohon City. Planning and forecasting the provision of electrical energy needs in the coming years, in anticipation of being a tourism city.

Some of these problems are formulated as follows: What is the economic condition of Tomohon City as of 2023? What is the demand for electrical energy in Tomohon City concerning tourism development? The objectives of this study are as follows: To find out how the Economic Condition of Electrical Energy in Tomohon City is in line with tourism growth, The benefits of this study are: Theoretical Benefits, Providing, data presentation related to electrical energy needs that are important for the study or analysis of current and future electrical energy needs. As study material for students and stakeholders in the field of electrical energy. Practical Benefits: Serve as primary data for the development of electricity in Tomohon City, providing an important guide for Stakeholders in the Energy sector, as well as the Tomohon City Government and North Sulawesi Province. Economic development and growth are directly proportional to the need for and consumption of energy, including electrical energy. Therefore, discussing energy must also discuss economic trends in a particular area or region. Both factors will be discussed in detail to provide an overview of their importance and relationship. The concepts of economy and energy are illustrated in the Pareto equilibrium diagram on Figure 1 (Yusgiantoro, 2018).

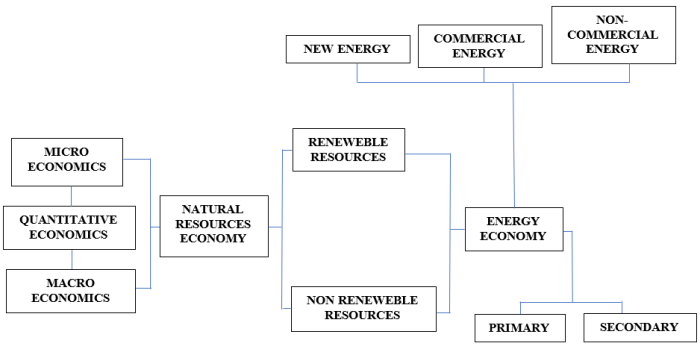

Figure 1. Pareto optimal

Energy economics can be defined as the science that studies individuals or groups in society to choose, decide, utilise and allocate scarce resources efficiently and effectively according to various uses in commodity production and distribution (Yusgiantoro, 2018). Several economic factors had a significant influence on distribution planning in the 1980s.

1. The first is inflation. Triggered by energy shortages, energy source conversion costs, environmental concerns, and government deficits, inflation will continue to be a significant factor.
2. The second economic factor is imports. Imports are the increasing cost of acquiring capital. As long as inflation continues to erode the real value of the dollar, the government will make efforts to reduce the amount of money in circulation.
3. The third factor that must be considered is the increasing difficulty in assessing interest rates. (Yusgiantoro, 2018)

Economic growth is the process of increasing the output of goods and services (Stern, 2019; Surya et al., 2021). The process requires electricity as one of its inputs, in addition to other inputs of goods and services. In addition, the result of economic growth is an increase in people's income, which drives an increase in demand for electrical goods and equipment, such as televisions, air conditioners, refrigerators, and others. As a result, electricity demand is expected to increase (Parrish et al., 2019; Surya et al., 2021). Macro and Microeconomics in an Energy Perspective: The framework of microeconomic theory is associated with the Analysis of the optimal allocation of energy resources among various alternative uses. The key lies in determining the optimal solution for allocating energy resources. In general, three key factors contribute to the importance of this problem. First, if there is a dislocation of the use of energy resources as capital, then the problem of inefficiency arises. Second, the characteristics of non-renewable energy resources are depletable; the availability of these resources is limited (Yusgiantoro, 2018). Third, it is associated with energy policy as an important instrument for regulating optimal use.

From a macroeconomic perspective, the relationship between energy and the balance of payments comprises two main components: the balance of trade and services, and the capital balance. The impact of energy on inflation is determined by the national price level, which is obtained from the balance between aggregate demand and supply (Antonietti & Fontini, 2019; Bednář et al., 2022). Changes in demand and supply factors will impact prices overall. Energy is something abstract that is difficult to prove but can be felt. Energy is the ability to do work (Energy is the capability for doing work). Energy is a form of power or force that enables us to do something (Cays, 2021). This definition is a broader formulation than the understanding of energy commonly adopted in the scientific world. In everyday terms, energy can be defined as the ability to perform work (Stern, 2019).

Energy is categorised into several types, namely mechanical energy, electrical energy, electromagnetic energy, chemical energy, nuclear energy, and thermal energy (heat). Electrical energy is energy related to the accumulation of electron flow, expressed in Watt-hours or kilowatt-hours (von Meier, 2024). Its transition form is the flow of electrons through a specific type of conductor. Energy Classification, namely natural resources in general, can be divided into renewable resources and non-renewable resources. Non-renewable resources or depletable resources. This classification is highly dependent on the role of the time variable. Renewable natural resources are resources that are continuously available as production inputs with an infinite time limit (Ray, 2019).

Water, forests, and solar heat are included in renewable natural resources—the Role of Energy in Economic Growth. The energy crisis that hit the Indonesian nation resulted in a prolonged economic crisis and had a broad impact on the nation's life (Sumarno et al., 2022). Therefore, the relationship between energy and a country's economy can be observed through several macroeconomic components, including government revenues, export revenues, and the balance of payments. The problem lies in the significant role energy plays in a country's macroeconomics. The GDP level of a region is a key indicator (Cherevatskyi & Smirnov, 2021). The only way to determine whether there is a relationship between the energy economy and macroeconomics, as well as economic growth, is to examine empirical evidence from the energy crisis of the 1970s. The energy crisis had an impact on the overall economic crisis. Conversely, when the economy grows rapidly, it must also be accompanied by the provision of energy because usage will increase significantly. Energy preparation must be planned carefully because the development of energy infrastructure takes a relatively long time (Liu et al., 2022).

II. METHOD

This research is a form of survey and is descriptive. Description and presentation of data in the form of tables, graphs and images. This research was conducted in the city of Tomohon, and more specifically on PLN electricity producers and those related to it. Data sources include the Statistics Office

for the economy and the tourism office. Data Analysis Techniques, Data are presented in the form of images/diagrams, tables and graphs to show the economic and energy profile in the city of Tomohon. Data were obtained from documentation from the statistics office of Tomohon City and PLN Tomohon Branch. Data Collection Techniques Data collection was carried out to determine the availability of energy and economic conditions through documentation and surveys. Data in the form of graphs and tables were then analyzed and interpreted through the numbers and graphic forms obtained. The results of the interpretation were then analyzed and a summary discussion and conclusions were made which were the results of this research. Research steps: survey, data collection, data presentation and analysis (see on Figure 2). To conduct data analysis, a literature study and empirical study were carried out to complete the data description obtained from diagrams, tables.

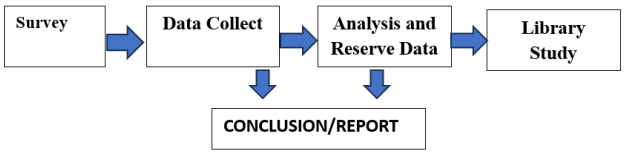

Figure 2. Research stages

Data obtained concerning Energy and economy include energy data such as installed power, Electricity production, and distribution. Economic data includes GRDP based on current prices by business sector, GRDP according to constant or fixed prices, and the Percentage of GRDP distribution according to current prices, as well as the available employment and business sectors.

Between 2014 and 2020, the installed power increased continuously, from 38,376 kWh to 48,315 kWh. This increasing trend reflects the annual growth in energy use in Tomohon City. The number of customers also increased from 24,575 customers in 2017 to 29,770 in 2021. This increase in customers is spread across the 5 Districts of Tomohon City. In the comparison for PDAM customers that show new connections, it also indicates the presence of housing developments (new houses that continue to increase), with 72,851 customers. Gross Regional Domestic Product (GRDP) is the gross added value of all goods and services created or produced in the domestic territory of a country, arising from various economic activities in a specific period, without regard to whether residents or non-residents own the production factors. The preparation of GRDP can be done through 3 (three) approaches, namely the production, expenditure, and income approaches presented at current prices and constant prices. Gross Domestic Product (GDP) at current prices, also known as nominal GDP, is calculated based on prices in effect during the specified period and aims to reflect the structure of the economy. While GRDP at constant prices is prepared based on prices in the base year, it aims to measure economic growth. Since 2015, the calculation of GRDP has used the base year 2010, differing from previous years, which still used the base year 2000. Consequently, several changes have been made to the methodology, classification, concepts, and explanations.

National income data is one of the key macroeconomic indicators that can provide an annual assessment of the national economy's condition. The benefits that can be obtained from this data include:

1. GRDP at current prices (nominal) shows the ability of economic resources produced by a region. A considerable GDP value indicates the ability to utilise ample economic resources, and vice versa.
2. GRDP at constant prices (real) can be used to show the overall economic growth rate or the growth rate of each category from year to year.
3. The distribution of GRDP at current prices by business sector shows the economic structure or role of each economic category in a region. Economic categories that play a significant role show the economic base of a region.
4. GRDP per capita at current prices shows the value of GRDP and PNRB per person.
5. GDP per capita at constant prices helps know the real economic growth per capita of a country's population.

III. RESULTS DAN DISCUSSIONS

Tomohon City is one of the areas included in the regional electricity distribution service of the North Sulawesi System (Sulbagut), organised by PT. PLN (Persero) Area Distribution and Load Regulation (AP2B) Minahasa system in Tomohon City. PLN AP2B oversees 4 Transmission & Substation units (TRAGI) of North Sulawesi, Gorontalo and Central Sulawesi Provinces, namely: TRAGI Sawangan, TRAGI Lopana, TRAGI Gorontalo and TRAGI PALU.

Electricity distribution in Tomohon City is divided into three feeders: the Lokon Feeder, the Soputan Feeder, and the Klabat Feeder. These three feeders provide electricity distribution to the five sub-districts in Tomohon City: South Tomohon, Central Tomohon, East Tomohon, West Tomohon, and North Tomohon.

Figure 4 shows a map of the division of areas per sub-district in Tomohon City. Tomohon City is divided into five sub-districts, namely: West Tomohon with an area of 40.69 km2), South Tomohon with an area of 32.95 km2), Central Tomohon with an area of 9.41 km2), East Tomohon

with an area of 21.88 km2) and North Tomohon with an area of 42.28 km2). Astronomically, Tomohon City is located at 01 18' 51" North Latitude and 124 49' 40" East Longitude. Based on its geographical position, Tomohon City is entirely bordered by Minahasa Regency. Referring to statistical data on industry and energy published in 2020 by the Central Statistics Agency of Tomohon City, titled "Tomohon City in Figures 2019," it shows the conditions of electricity availability and electricity consumption in Tomohon City from 2012 to 2019 as follows.

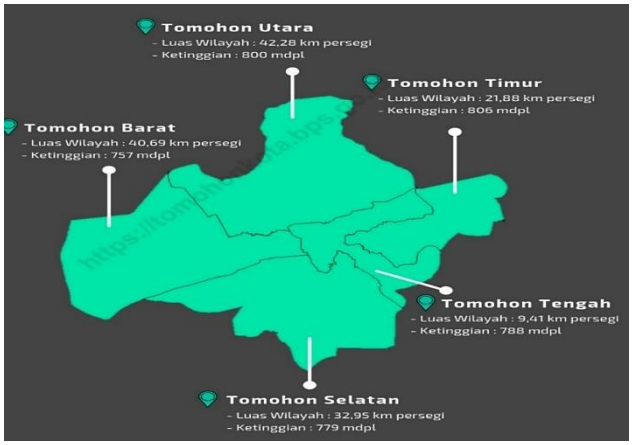

Figure 3. Map of the division of areas per sub-district in Tomohon City

Figure 3 shows a map of the division of areas per sub-district in Tomohon City. Tomohon City is divided into five sub-districts, namely: West Tomohon with an area of 40.69 km2), South Tomohon with an area of 32.95 km2), Central Tomohon with an area of 9.41 km2), East Tomohon with an area of 21.88 km2) and North Tomohon with an area of 42.28 km2). Astronomically, Tomohon City is located at 01 18 51" North Latitude and 124 49 40" East Longitude. Based on its geographical position, Tomohon City is entirely bordered by Minahasa Regency. Referring to statistical data on industry and energy published in 2020 by the Central Statistics Agency of Tomohon City, titled "Tomohon City in Figures 2019," it shows the conditions of electricity availability and electricity consumption in Tomohon City from 2from2-201 to as follows.

Table 1. Installed Power and Sold Power/ Electricity Consumption in Tomohon City

Year	Installed Capacity (kVA)	Electricity Sold (kWh)	Growth Percentage	
			Installed	Sold
2010	17.697.800	21.424.264	8.63%	22.68%
2011	19.668.558	34.602.973	11.14%	61.51%
2012	23.419.600	35.563.179	19.07%	2.77%
2013	27.302.300	35.440.661	16.58%	-0.34%
2014	29.904.350	38.376.792	9.53%	8.28%
2015	31.282.900	39.746.317	4.61%	3.57%
2016	32.194.500	41.683.726	2.91%	4.87%
2017	37.099.400	41.324.246	15.24%	-0.86%
2018	39.328.600	43.144.357	6.01%	4.40%
2019	42.790.350	42.413.150	8.80%	-1.69%
		Average growth	10,25%	2,62%

Source: Tomohon City in Figures 2022

In Table 1, the installed power and sold power/electricity consumption in Tomohon City have increased over the past 10 years. The percentage of additional power is influenced by the addition of customers, with an average growth of around 10.25%. Meanwhile, the sold power or electricity consumption by customers has increased by an average of 2.6%, although in 2012-2013, 2016-2017, and 2018-2019, it decreased by around 0.34%, 0.86%, and 1.69%, respectively.

Table 2. Electricity Production of AP2B Tomohon Sub-station, 2012-2018

Year	Electricity Production (kWh)	Growth Percentage
2012	55.428.730	2.6%
2013	61.618.513	11.17%
2014	65.503.014	6.30%
2015	67.435.888	2.95%
2016	68.681.492	1.85%
2017	65.521.465	-4.60%
2018	75.408.895	15.09%
	Average growth	4,68%

Source: Tomohon City in Figures 2022

Table 1 shows the production of electrical energy managed by the Load Regulator Service Area (AP2B), Main Substation. Throughout the last 7 years, electrical energy production has increased by an average of 4.68% per year. However, there was a decrease of around 4.6% in 2017. The need for electrical energy has increased again from 2017 to 2021. Thus, electrical energy is increasing in line with this trend, as evidenced by economic growth as measured by the GDP, both in terms of constant prices and current prices (Koščak Kolin et al., 2021; Stern, 2019). This increase is also attributed to the growth of the tourism sector, which has encouraged several other sectors to expand as well. Tourism. The accommodation provision business is a service that

offers lodging services, often complemented by other tourism services. Accommodation provision businesses can take various forms, including hotels, villas, tourist cottages, campsites, caravan parks, and other accommodations used for tourism purposes. Hotels offer daily accommodations in the form of rooms within a single building, often equipped with food and beverage services, entertainment activities, and other facilities. Hotels are categorised into starred hotels and non-star hotels. A star hotel is a business that provides accommodation, food and beverage services, and other amenities for the public by using part or all of a building. This business is managed commercially and meets the requirements of a star hotel (including diamonds) as stipulated in the decree of the agency that oversees it—for example, a five-star hotel, a four-star hotel and so on. Thus, answering the question of how the economic condition of Tomohon City is in 2023, the post-COVID trend from 2022/2023 tends to increase. These results also indicate that the amount of electricity required in line with economic growth can still be met (Stern, 2019).

IV. CONCLUSION

Based on the data and discussion of this study, it is evident that the economic conditions of Tomohon City tend to increase annually, as reflected in the GRDP for both price and types of businesses. The development of the tourism sector, supported by various international activities, has driven rapid economic growth. In the data on energy consumption, especially electricity, there has been a significant increase in both the number of customers and the amount of energy consumption. The growth of 4.68% needs to be anticipated, considering that the development of energy production support takes a relatively long time. Therefore, economic growth and energy consumption support each other; it is concluded that energy needs must be increased from now on to prepare infrastructure and support for stakeholders in the energy sector. In anticipation of economic growth, increasing energy consumption, and the growing number of electricity customers, stakeholders in the energy sector must prepare all planned infrastructure immediately. The support of the Tomohon City government, even as early as possible, was crucial in planning, which involved the provincial government to support policies in the energy sector. The data and results of this study will serve as a guide for stakeholders in the energy sector, particularly those in the electricity sector, to inform their planning.

REFERENCES

Antonietti, R., & Fontini, F. (2019). Does energy price affect energy efficiency? Cross-country panel evidence. *Energy Policy*, *129*, 896–906. https://doi.org/https://doi.org/10.1016/j.enpol.2019.02.069

Arifin, Y. R., & Hermawan, S. (2021). DILEMATIKA KEBIJAKAN KETENAGALISTRIKAN DALAM USAHA PENYEDIAAN TENAGA LISTRIK DI INDONESIA. *Jurnal Ius Constituendum*, *2*. https://doi.org/10.14203/JEP.24.1.2016.29-41

Bednář, O., Čečrdlová, A., Kadeřábková, B., & Řežábek, P. (2022). Energy Prices Impact on Inflationary Spiral. *Energies*, *15*(9). https://doi.org/10.3390/en15093443

Caramizaru, A., & Uihlein, A. (2020). *Energy communities: an overview of energy and social innovation*. https://doi.org/10.2760/180576

Cays, J. (2021). The Energy Essential: Physical Forces Animate All Things. In J. Cays (Ed.), *An Environmental Life Cycle Approach to Design: LCA for Designers and the Design Market* (pp. 15–38). Springer International Publishing. https://doi.org/10.1007/978-3-030-63802-3_2

Cherevatskyi, D. Y., & Smirnov, R. G. (2021). On the correlation between gdp and energy consumption in macroeconomic development. *Economy of Industry*, *2*(94). https://doi.org/10.15407/econindustry2021.02.059

Fauzy, P. R. (2023). PELUANG DAN TANTANGAN TRANSISI ENERGI: IMPLIKASI KEBIJAKAN PASCA PRESIDENSI G20 INDONESIA. *Taxpedia*, *1*(1). https://doi.org/https://doi.org/10.61261/muctj.v1i1.14

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. *Energy Strategy Reviews*, *24*, 38–50. https://doi.org/https://doi.org/10.1016/j.esr.2019.01.006

Koščak Kolin, S., Karasalihović Sedlar, D., & Kurevija, T. (2021). Relationship between electricity and economic growth for long-term periods: New possibilities for energy prediction. *Energy*, *228*, 120539.

https://doi.org/https://doi.org/10.1016/j.energy.2021.120539

Kota Tomohon Dalam Angka 2020. (2020).

Lindberg, K. B., Seljom, P., Madsen, H., Fischer, D., & Korpås, M. (2019). Long-term electricity load forecasting: Current and future trends. *Utilities Policy*, *58*, 102–119. https://doi.org/https://doi.org/10.1016/j.jup.2019.04.001

Liu, J., Huang, Z., Fan, M., Yang, J., Xiao, J., & Wang, Y. (2022). Future energy infrastructure, energy platform and energy storage. *Nano Energy*, *104*, 107915. https://doi.org/https://doi.org/10.1016/j.nanoen.2022.107915

Opiyo, N. N. (2020). How basic access to electricity stimulates temporally increasing load demands by households in rural developing communities. *Energy for Sustainable Development*, *59*, 97–106. https://doi.org/https://doi.org/10.1016/j.esd.2020.09.006

Parrish, B., Gross, R., & Heptonstall, P. (2019). On demand: Can demand response live up to expectations in managing electricity systems? *Energy Research & Social Science*, *51*, 107–118. https://doi.org/https://doi.org/10.1016/j.erss.2018.11.018

Prastika, A. (2023). Hubungan antara tingkat konsumsi energi listrik dengan pertumbuhan ekonomi di Indonesia. *Jurnal Ilmu Ekonomi JIE*, *7*(1), 18–29.

Ray, P. (2019). Renewable energy and sustainability. *Clean Technologies and Environmental Policy*, *21*(8), 1517–1533. https://doi.org/10.1007/s10098-019-01739-4

Sharma, N., Acharya, A., Jacob, I., Yamujala, S., Gupta, V., & Bhakar, R. (2021). Major Blackouts of the Decade: Underlying Causes, Recommendations and Arising Challenges. *2021 9th IEEE International Conference on Power Systems (ICPS)*, 1–6. https://doi.org/10.1109/ICPS52420.2021.9670166

Simamora, M. S., Saparuddin Siregar,) ;, & Syariah, J. A. (2022). Analisis Faktor-Faktor Yang Mempengaruhi Penjualan Listrik Pada PLN ULP Medan Timur. *Jurnal Akuntasi, Manajemen, Dan Bisnis Digital*, *1*(2), 165–176. https://doi.org/https://doi.org/10.37676/jambd.v1i2.2395

Siregar, S. W., & Hasbi. (2023). Analisis Pengaruh Keterbukaan Perdagangan, Konsumsi Energi, dan Pertumbuhan Ekonomi terhadap Emisi Karbon di Negara D-8. *Jurnal Magister Ekonomi Syariah*, *2*(1 Juni), 61–77. https://doi.org/10.14421/jmes.2023.021-05

Sousa, T., Soares, T., Pinson, P., Moret, F., Baroche, T., & Sorin, E. (2019). Peer-to-peer and community-based markets: A comprehensive review. *Renewable and Sustainable Energy Reviews*, *104*, 367–378. https://doi.org/https://doi.org/10.1016/j.rser.2019.01.036

Stern, D. I. (2019). Energy and economic growth. In *Routledge Handbook of Energy Economics* (1st ed.). Routledge.

Sumarno, T., Sihotang, P., & Prawira, W. (2022). Exploring Indonesia's Energy Policy Failures through the JUST Framework. *Energy Policy*, *164*(112914). https://doi.org/https://doi.org/10.1016/j.enpol.2022.112914

Surya, B., Menne, F., Sabhan, H., Suriani, S., Abubakar, H., & Idris, M. (2021). Economic Growth, Increasing Productivity of SMEs, and Open Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(1). https://doi.org/10.3390/joitmc7010020

von Meier, A. (2024). *Electric Power Systems: A Conceptual Introduction* (2nd ed.). John Wiley & Sons.

Yusgiantoro, P. (2018). *Ekonomi Energi: Teori dan Aplikasi*. Yayasan Purnomo Yusgiantoro.