Aimon, Hasdi; Kurniadi, Anggi Putri; Triani, Mike

Article

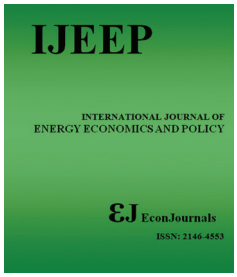
Determination of Natural Gas Consumption and Carbon Emission in Natural Gas Supplying Countries in Asia Pacific

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Aimon, Hasdi/Kurniadi, Anggi Putri et. al. (2022). Determination of Natural Gas Consumption and Carbon Emission in Natural Gas Supplying Countries in Asia Pacific. In: International Journal of Energy Economics and Policy 12 (6), S. 96 - 101. https://econjournals.com/index.php/ijeep/article/download/13536/6994/31585. doi:10.32479/ijeep.13536.

This Version is available at:
http://hdl.handle.net/11159/593832



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2022, 12(6), 96-101.

Determination of Natural Gas Consumption and Carbon Emission in Natural Gas Supplying Countries in Asia Pacific

Hasdi Aimon, Anggi Putri Kurniadi*, Mike Triani

Faculty of Economics, Universitas Negeri Padang, Indonesia. *Email: anggiputrikurniadi11@gmail.com

Received: 17 July 2022 **Accepted:** 17 October 2022 **DOI:** https://doi.org/10.32479/ijeep.13536

ABSTRACT

This study investigates determination of natural gas consumption and carbon emission in the middle income group of natural gas supplying countries in Asia Pacific, including China, Indonesia, Malaysia, Myanmar and Vietnam during the period 2000-2021 by applying the simultaneous equation analysis. The results of this study are that carbon emission increase due to the real exchange rate, population and natural gas production, but carbon emission will reduce natural gas consumption. Furthermore, natural gas consumption increases due to natural gas production, GDP per capita and energy intensity. This study recommends the government to develop clean and efficient alternative energy to reduce carbon emission in response to natural gas demand for domestic and foreign market needs.

Keywords: Natural Gas Consumption, Carbon Emission, Lower Middle Income, Asia Pacific
JEL Classifications: C33, C51, Q21, Q43

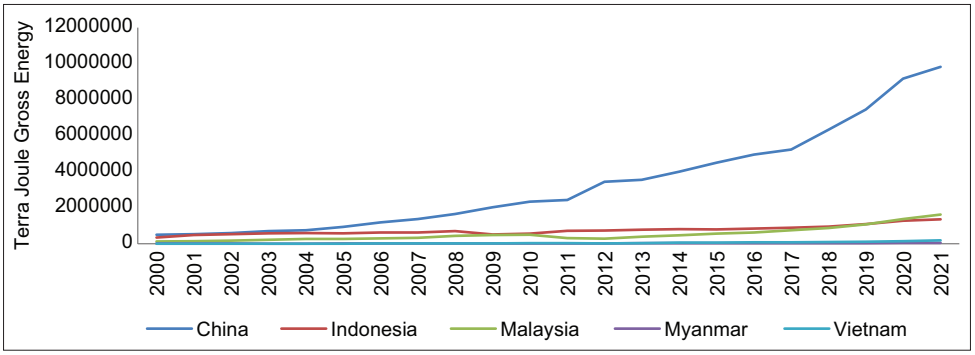
1. INTRODUCTION

Natural gas is one type of energy source that plays an important role in meeting global energy needs because all life activities are currently still dominated by its use (Liu et al., 2021; Šebalj et al., 2017; Yemelyanov et al., 2021). The components that make up natural gas come from millions of years of fossils and micro-organisms, which is the same as other non-renewable energy sources (Li et al., 2019; Liang et al., 2019; Zhi-Guo et al., 2018). Although the constituent components of natural gas are the same as other non-renewable energy sources, the residue produced from burning natural gas is not as severe as other non-renewable energy sources, such as those produced by fuel oil and coal, but the low intensity of carbon emissions from this energy will resulting in a decrease in environmental quality due to emission residues that accumulate on an ongoing basis (Jiang et al., 2020; Liu et al., 2018; Sen et al., 2019; Zhang et al., 2021).

Global warming and climate change will occur as a result of the high intensity of carbon emissions from the use of natural gas if its use is not reduced, resulting in a decrease in air quality due to natural gas combustion, which cannot be equated with the use of renewable energy that produces clean and environmentally friendly energy. Previous studies have found that the rate of natural gas emission has caused a decrease in environmental carrying capacity, especially in air quality indicators (Chen et al., 2019; Fadiran et al., 2019; Goncharuk and Cirella, 2020; Li et al., 2021). This condition occurs in countries in the Asia Pacific region which have a total emission of 50.5% of the world's total emission basis (Aimon et al., 2021; Kurniadi et al., 2021). These conditions are summarized in Figures 1 and 2.

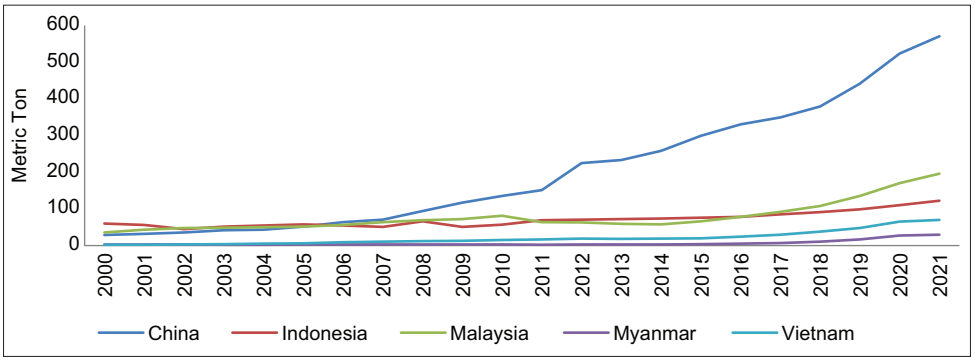
The phenomenon in Figures 1 and 2 is that natural gas consumption tends to increase which results in high carbon emission, so it is necessary to consider carbon emission as the focus of research because it acts as a response to the use of natural gas. This study selects natural gas supplying countries for middle-income groups in Asia Pacific because these countries facilitate the world's need for natural gas energy through export activities which result in higher carbon emission.

Figure 1: Natural gas consumption in middle income group of natural gas supplying countries in Asia Pacific



Source: International energy agency

Figure 2: Carbon emission in middle income group of natural gas supplying countries in Asia Pacific



Source: International energy agency

The existing solution from previous research is that the study of carbon emission is positioned as an exogenous variable from natural gas consumption, even though the study of carbon emission needs to be positioned as an endogenous variable because its contribution is very large to achieve sustainable development. The limitation of existing solutions from previous research is that policy recommendations only focus on natural gas consumption which results in increased carbon emission and continued exploitation of natural resources. Meanwhile, this research will conduct a simultaneous analysis by making carbon emission the focus of the research. Thus, the gap that is filled in this study is to analyze the factors that influence of natural gas consumption and carbon emission simultaneously. The advantage of the solution offered from this research is that it will produce policy recommendations in achieving sustainable development to reduce the exploitation of natural gas and carbon emission.

2. LITERATURE REVIEW

Research on natural gas consumption and economic growth in China for the period 2000-2014 by applying panel regression, they found that the contribution of natural gas played a role in encouraging economic conditions (Li et al., 2019). A further study was conducted in Malaysia to investigate the same case but involving several determinants, including capital formation, globalization and carbon emissions for the period 1980-2014 by applying cointegration analysis, they found that long-term equilibrium was reached for their analysis (Etokakpan et al., 2020). Furthermore, the development of studies carried out for the natural gas industry sector and the economy affected by exports and cointegrated labor in Mozambique for the period 1999-2015 by applying ECM, they found that an increase in industrial natural gas would boost the economy, which would create a balance in the short term (Bay and Hong, 2020). Different studies were conducted to investigate in Indonesia for the period 1980-2017 by applying ARDL, he found that natural gas contributed to the economy (Sinaga, 2019). Furthermore, studies for several countries in Northeast Asia for the period 1991-2015 by applying Granger causality, they found that there was no two-way relationship, but there was a unidirectional effect between natural gas consumption on the economy in China, while for Japan and Korea does not (Zhi-Guo et al., 2018). Then, applying the same methodological approach for the period 1977-2013 in Pakistan, they found that integrated analysis over the long term (Hassan et al., 2018). The same analysis was also conducted for Korea for the period 1991-2008, they found that there was a long-term mutually influencing relationship (Lim and Yoo, 2012). Then, applying a different analytical method, named ARDL in Pakistan for the period 1972-2011, they found that natural gas consumption and economic growth are interrelated in generating output (Hassan et al., 2018). Furthermore, applying a different analytical method, called VECM in several OECD countries during the period 1991-2013, they found that natural gas consumption is one of the important sectors in improving the economy and there is a one-way influence that goes from natural gas consumption to the economy, which these results support the short-run growth hypothesis. In addition, they also found a bidirectional relationship in the long term between natural gas consumption and carbon emission, thus supporting the feedback hypothesis (Fadiran et al., 2019).

An analysis conducted on several natural gas consuming countries for the period 1994-2015 by applying causality panels, he found that natural gas consumption should be encouraged to trigger economic growth, but this will result in an increase in carbon emission (Aydin, 2018). Further studies were carried out for the analysis of several European countries by applying cointegration panels and VECM, they found that natural gas consumption was able to encourage economic growth in the long term, while in the short term it did not provide a strong contribution (Fadiran et al., 2019). Then, a study for Nigeria by applying the Granger causality test, they found that there is a mutually reinforcing relationship between natural gas consumption and carbon emission in the long term (Galadima and Aminu, 2020). Then, a study in Iran applied a different approach, called the multivariate production model with the limit test approach, they found that there was a reciprocal relationship and mutual influence in the long run (Heidari et al., 2013).

The novelties of this research are: (1) Previous research has focused on analyzing energy and economic studies, while this study analyzes energy and environmental studies which have been neglected, even though this study plays an important role in achieving sustainable development; (2) Previous research conducted the analysis separately, so this research fills the gap by conducting simultaneous studies; (3) Previous research has not conducted analysis on groups of countries that are oriented towards natural gas exports, even though this is very important to produce policy recommendations to reduce carbon emission from natural gas production and consumption activities at the world level.

3. METHODOLOGY

3.1. Data and Variables

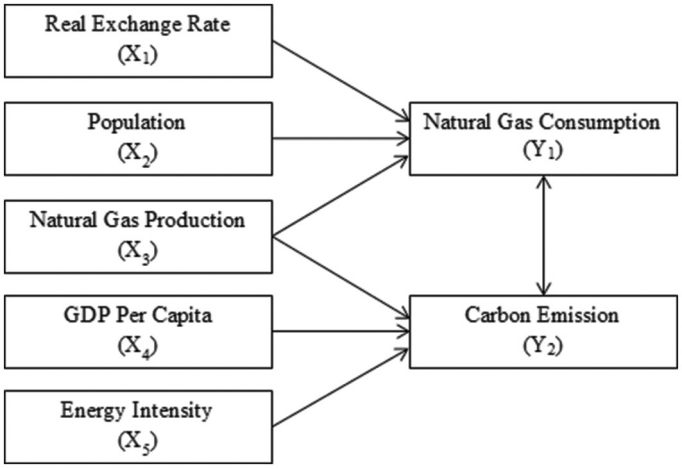
This study uses panel data, where the time series is the period from 2000 to 2021 and the cross section is six middle-income countries in the Asia Pacific, including China, Indonesia, Malaysia, Myanmar and Vietnam. Furthermore, this study uses two categories for the types of variables used, including endogenous and exogenous. The group of variables that fall into the endogenous category is natural gas consumption and carbon emission. In addition, groups of variables that fall into the exogenous category are real exchange rate, population, natural gas consumption, GDP per capita and energy intensity. Based on the categories for the types of variables used in this study, it can be determined the relationship between variables in a conceptual framework of research, which is summarized in Figure 3.

Based on Figure 3, the indicators for each of the variables used are described in Table 1.

3.2. Data Analysis Model

This study applies a simultaneous equation model, which consists of more than one dependent variable and more than one related equation. Furthermore, a variable has two roles at once, namely as an independent variable and as a dependent variable called endogenous variables and exogenous variables as independent variables in the simultaneous equation model. In general, the

Figure 3: The Relationship between endogenous and exogenous variables



Source: Author's work

structural equations of the simultaneous equation model in this study are summarized in equations (1) and (2).

$$Y_{1it} = \alpha_{1.0} + \alpha_{1.1}Y_{2it} + \alpha_{1.2}X_{1it} + \alpha_{1.3}X_{2it} + \alpha_{1.4}X_{3it} + \varepsilon_{1it} \quad (1)$$

$$Y_{2it} = \alpha_{2.0} + \alpha_{2.1}Y_{1it} + \alpha_{2.2}X_{3it} + \alpha_{2.3}X_{4it} + \alpha_{2.4}X_{5it} + \varepsilon_{2it} \quad (2)$$

Where:
α = Parameter coefficient
i = Cross section
t = Time series
ε = Error term.

The next step after determining the form of the structural equation of the simultaneous equation model is to test the identification of the simultaneous equation model through order conditions. The possibilities that occur from the identification of the simultaneous equation model are, not identified, correctly identified and too identified. Based on the results of the identification test carried out, if it is too identified, then the simultaneous equation analysis is carried out using the two stage least square (TSLS) approach. Meanwhile, if it is correctly identified, then the simultaneous equation analysis is carried out using the indirect least squares (ILS) approach.

The identification test for this study concluded that it was too identified, so he analysis in this study used TSLS. The application of TSLS produces a single estimate. TSLS has no difficulty in estimating the standard error, because the structural coefficients are estimated directly from the OLS regression in the second step. Based on this explanation, this study used simultaneous equations with the TSLS approach.

4. RESULTS AND DISCUSSION

4.1. Simultaneous Equation Analysis of Natural Gas Consumption

Simultaneous equation analysis for natural gas consumption and its influencing determinants are summarized in equation (3).

Table 1: Variable indicator

Variable	Indicator	Source
Natural gas consumption (Y_1)	The amount of natural gas consumed in a given period, data in terra joule gross energi	International Energy Agency
Carbon emission (Y_2)	CO_2 emission generated by the production and consumption of natural gas in a certain period, data in metric ton	International Energy Agency
Real exchange rate (X_1)	Real effective exchange rate index (2010 = 100), data in index	World Bank
Population (X_2)	Total population regardless of legal status or citizenship, data in total	World Bank
Natural gas production (X_3)	The amount of natural gas produced in a given period, data in terra joule gross energi	International Energy Agency
GDP per capita (X_4)	Gross domestic product divided by mid-year population, data in constant 2015 U.S. dollars.	World Bank
Energy intensity (X_5)	Contribution of renewable energy to final energy consumption, data in MJ/$2017 PPP GDP	World Bank

$$Y_{1it} = -17.25^{**} - 1.80\,Y_{2it}^{**} + 6.15\,X_{1it}^{**} + 5.20\,X_{2it}^{***} + 3.41\,X_{3it}^{*} \quad (3)$$

***Significant at α=1%, **significant at α=5%, *significant at α=10%.

Information in equation (3) is the effect of X_1, X_2 and X_3 will increase Y_1. Meanwhile, the increase of Y_2 will reduce Y_1.

Carbon emission will reduce the consumption of natural gas because high carbon emissions are interpreted as a decrease in environmental carrying capacity, which is caused by the use of high carbon inputs such as natural gas. Environmental degradation in the form of decreasing air quality from accumulated carbon emissions can be overcome by implementing a transition to energy use towards low-carbon energy, such as renewable energy. These results support the investigation Dong et al. (2017), they found that increased carbon emissions will shift the use of natural gas towards cleaner energy.

The real exchange rate (X_1) will encourage the natural gas consumption (Y_1) because the higher the real exchange rate, then this condition indicates that the domestic currency of a country will appreciate against the dollar. Natural gas import activities from natural gas supplying countries are increasing when the domestic currency of the importing country experiences an increase or appreciation, there will be an increase in the real effective exchange rate. These results support the investigation Panapakidis and Dagoumas (2017), they found that an appreciation of the real exchange rate makes the prices of commodities imported by a country become cheaper, which will have an impact on increasing demand.

The population (X_2) will encourage natural gas consumption (Y_1) because the higher the population, the greater their need for energy consumption. This condition is caused by the dependence of the population on the energy sector to support their needs, such as consumption and production activities to improve their welfare. These results support the investigation Chen et al. (2019), they found that high population must be responded by providing ample energy sources to meet their needs.

Natural gas production (X_3) will encourage natural gas consumption (Y_1) because the large supply of natural gas will cause people to exploit it to meet the needs of the energy sector in the domestic and foreign markets, which is resulting in high consumption of natural gas. These results support the investigation Antonini et al. (2020), they found that natural gas production is an important component in determining the level of natural gas consumption.

4.2. Simultaneous Equation Analysis of Carbon Emission

Simultaneous equation analysis for carbon emissions and their influencing determinants are summarized in equation (4).

$$Y_{2it} = -12.40^{**} + 1.24\,Y_{1it}^{**} + 3.86\,X_{3it}^{**} + 2.10\,X_{4it}^{**} - 8.26\,X_{5it}^{***} \quad (4)$$

***Significant at α=1%, **significant at α=5%, *significant at α=10%.

Information in equation (4) is the effect of increasing Y_1, X_3, X_4 and X_5 will increase Y_2. While, the effect of increasing X_5 will decrease Y_2.

Natural gas consumption (Y_1) will encourage carbon emission (Y_2) because natural gas is one type of environmentally unfriendly energy that produces emission, so this condition will exacerbate the greenhouse effect and the highest risk for the surrounding environment if an error occurs in processing such as air, water and soil pollution. The consumption of natural gas that dominates the use of energy will trigger the accumulation of large amounts of carbon emission. These results support investigation Dong et al. (2017), they found that consumption of natural gas contributes to carbon emissions in the long term.

The production of natural gas (X_3) will encourage carbon emission (Y_2) because people will use it to encourage economic activities. This condition is caused by the need for the energy sector which is met by natural gas stocks, but natural gas is one type of energy that produces residue from the combustion process, so that the production of natural gas will cause carbon emission. These results support investigation Awodumi and Adewuyi (2020), they found that natural gas production is a determining factor in generating carbon emission.

GDP per capita (X_4) will encourage carbon emission (Y_2) because it is a standard measure of the welfare of society in a country. People who have a high GDP per capita will tend to carry out high economic activities for their needs, which will

have implications for increasing carbon emission due to high energy use. These results support investigation Akalpler and Hove (2019), they found that high GDP per capita will result in people consuming high quantities of energy, resulting in carbon emission.

Energy intensity (X_5) will reduce carbon emission (Y_2) because it is a measure of the level of effective and efficient energy use to maintain the environmental carrying capacity of burning energy use that produces emission residues, so that energy intensity will reflect the dominance of the use of clean energy as a solution to carbon emission. These results support the investigation Emir and Bekun (2019), they found that energy intensity can overcome the problem of carbon emission from natural gas pollution.

5. CONCLUSION

Natural gas consumption and carbon emissions are indicators in achieving sustainable development because uncontrolled use of this energy will result in the environment experiencing a decrease in carrying capacity, such as a decrease in air quality due to accumulation of pollution from the combustion process.

The policy in supporting the control of natural gas consumption to reduce carbon emissions is that the government actively participates in the net zero emission programs and ensures that the amount of carbon emissions released into the atmosphere does not exceed the amount of emissions that can be absorbed by the earth. One of the steps that the government can take to implement the net zero emission program is to reduce the amount of gas emissions generated from various community activities and activities within a certain period of time, or better known as the carbon footprint which will have a negative impact on life on earth. such as extreme weather. Furthermore, the government also needs to make a transition from a natural gas energy system to a clean energy system in order to achieve a balanced condition between human activities and natural conditions.

6. ACKNOWLEDGEMENTS

The authors would like to thank the research and community service center - Universitas Negeri Padang for funding this work.

REFERENCES

Aimon, H., Kurniadi, A.P., Amar, S. (2021), Analysis of fuel oil consumption, green economic growth and environmental degradation in 6 Asia Pacific countries. International Journal of Sustainable Development and Planning, 16(5), 925-933.

Akalpler, E., Hove, S. (2019), Carbon emissions, energy use, real GDP per capita and trade matrix in the Indian economy-an ARDL approach. Energy, 168, 1081-1093.

Antonini, C., Treyer, K., Streb, A., Van der Spek, M., Bauer, C., Mazzotti, M. (2020), Hydrogen production from natural gas and biomethane with carbon capture and storage A techno-environmental analysis. Sustainable Energy and Fuels, 4(6), 2967-2986.

Awodumi, O.B., Adewuyi, A.O. (2020), The role of non-renewable energy consumption in economic growth and carbon emission: Evidence from oil producing economies in Africa. Energy Strategy Reviews, 27, 100434.

Aydin, M. (2018), Natural gas consumption and economic growth nexus for top 10 natural gas-consuming countries: A granger causality analysis in the frequency domain. Energy, 165, 179-186.

Bay, A.G.N., Hong, L. (2017), Dynamics of the natural gas industry and economic growth in Mozambique. Science Journal of Energy Engineering, 5(3), 68-77.

Chen, J., Yu, J., Ai, B., Song, M., Hou, W. (2019), Determinants of global natural gas consumption and import-export flows. Energy Economics, 83, 588-602.

Dong, K., Sun, R., Hochman, G., Zeng, X., Li, H., Jiang, H. (2017), Impact of natural gas consumption on CO_2 emissions: Panel data evidence from China's provinces. Journal of Cleaner Production, 162, 400-410.

Emir, F., Bekun, F.V. (2019), Energy intensity, carbon emissions, renewable energy, and economic growth nexus: New insights from Romania. Energy and Environment, 30(3), 427-443.

Etokakpan, M.U., Solarin, S.A., Yorucu, V., Bekun, F.V., Sarkodie, S.A. (2020), Modeling natural gas consumption, capital formation, globalization, CO2 emissions and economic growth nexus in Malaysia: Fresh evidence from combined cointegration and causality analysis. Energy Strategy Reviews, 31, 100526.

Fadiran, G., Adebusuyi, A.T., Fadiran, D. (2019), Natural gas consumption and economic growth: Evidence from selected natural gas vehicle markets in Europe. Energy, 169, 467-477.

Galadima, M.D., Aminu, A.W. (2020), Nonlinear unit root and nonlinear causality in natural gas-economic growth nexus: Evidence from Nigeria. Energy, 190, 116415.

Goncharuk, A.G., Cirella, G.T. (2020), A perspective on household natural gas consumption in Ukraine. The Extractive Industries and Society, 7(2), 587-592.

Hassan, M.S., Tahir, M.N., Wajid, A., Mahmood, H., Farooq, A. (2018), Natural gas consumption and economic growth in Pakistan: Production function approach. Global Business Review, 19(2), 297-310.

Heidari, H., Katircioglu, S.T., Saeidpour, L. (2013), Natural gas consumption and economic growth: Are we ready to natural gas price liberalization in Iran? Energy Policy, 6(3), 638-645.

International Energy Agency. Paris: International Energy Agency Available from: https://www.iea.org/data-and-statistics [Last accessed on 2022 Jun 11].

Jiang, H., Dong, X., Jiang, Q., Dong, K. (2020), What drives China's natural gas consumption? Analysis of national and regional estimates. Energy Economics, 87, 104744.

Kurniadi, A.P., Aimon, H., Amar, S. (2021), Determinants of biofuels production and consumption, green economic growth and environmental degradation in 6 Asia Pacific countries: A simultaneous panel model approach. International Journal of Energy Economics and Policy, 11(5), 460-471.

Li, H., Shahbaz, M., Jiang, H., Dong, K. (2021), Is natural gas consumption mitigating air pollution? Fresh evidence from national and regional analysis in China. Sustainable Production and Consumption, 27, 325-336.

Li, Z.G., Cheng, H., Gu, T.Y. (2019), Research on dynamic relationship between natural gas consumption and economic growth in China. Structural Change and Economic Dynamics, 49, 334-339.

Liang, T., Chai, J., Zhang, Y.J., Zhang, Z.G. (2019), Refined analysis and prediction of natural gas consumption in China. Journal of Management Science and Engineering, 4(2), 91-104.

Lim, H.J., Yoo, S.H. (2012), Natural gas consumption and economic growth in Korea: A causality analysis. Energy Sources Part B Economics Planning Policy, 7(2), 169-176.

Liu, G., Dong, X., Jiang, Q., Dong, C., Li, J. (2018), Natural gas consumption of urban households in China and corresponding influencing factors. Energy Policy, 122, 17-26.

Liu, J., Wang, S., Wei, N., Chen, X., Xie, H., Wang, J. (2021), Natural gas consumption forecasting: A discussion on forecasting history and future challenges. Journal of Natural Gas Science and Engineering, 90, 103930.

Panapakidis, I.P., Dagoumas, A.S. (2017), Day-ahead natural gas demand forecasting based on the combination of wavelet transform and ANFIS/genetic algorithm/neural network model. Energy, 118, 231-245.

Sinaga, O. (2019), The dynamic relationship between natural gas and economic growth: Evidence from Indonesia. International Journal of Energy Economics and Policy, 9(3),388-394.

Šebalj, D., Mesarić, J., Dujak, D. (2017), Predicting natural gas consumption-a literature review. In: Central European Conference on Information and Intelligent Systems. Croatia: Faculty of Organization and Informatics Varazdin. p293-300.

Sen, D., Günay, M.E., Tunç, K.M. (2019), Forecasting annual natural gas consumption using socio-economic indicators for making future policies. Energy, 173, 1106-1118.

World Bank. United States: World Bank. Available from: https://www.data.worldbank.org [Last accessed on 2022 Jun 11].

Yemelyanov, O., Symak, A., Petrushka, T., Vovk, O., Ivanytska, O., Symak, D., Lesyk, L., Havryliak, A., Danylovych, T. (2021), Criteria, indicators, and factors of the sustainable energy-saving economic development: The case of natural gas consumption. Energies, 14(18), 5999.

Zhang, R., Li, H., Chen, T., Hou, B. (2021), How does natural gas consumption affect human health? Empirical evidence from China. Journal of Cleaner Production, 320, 128795.

Zhi-Guo, L., Cheng, H., Dong-Ming, W. (2018), Empirical research on the relationship between natural gas consumption and economic growth in the Northeast Asia. Energy and Environment, 29(2), 216-231.