OPERATIONAL CHARACTERISTICS OF THE CHP PLANT IN THE DISTRICT HEATING SYSTEM OF BELGRADE

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The combined production of electricity and thermal energy (CHP or cogeneration) is the most efficient and convenient approach to reduce costs for energy at industrial power plants and district heating plants that use natural gas as fuel to produce thermal energy for various needs. This paper analyses the operational characteristics of the CHP plant, which has been operating since January 1, 2021, at the Voždovac Heating Plant as part of the Belgrade district heating system. The CHP plant consists of three gas engine units with a total nominal electric power of 10 MW and thermal power of 10.1 MW, which use natural gas as fuel. The CHP plant is used for district heating and preparing domestic hot water (DHW) while electricity is sold to the local electric grid. The analysis in this paper focuses on the plant's operational characteristics: the number of working hours, the total energy consumption and energy production, the efficiency as well as the operational and maintenance costs. Also, the impact of the drastic changes in the prices of natural gas, electricity, and maintenance costs in the last year on the financial profitability of the CHP plant was analysed in particular.

Keywords*: CHP, district heating, operational costs, maintenance costs*

1. Introduction

District heating systems (heating plants), industrial plants, and power plants that use natural gas as a fuel to produce and supply continuous consumers with electricity, heating and/or cooling energy can achieve significant financial savings by applying cogeneration.

Combined heat and power (CHP) plants have been promoted in the European Union by Directive 2004/8/EC [1]. CHP has become widespread in industrial, commercial, and residential sectors applications for several reasons: the rise in fuel prices, the liberalization of the electricity market, improvements in CHP technology, tax exemptions when CHP is adopted, the introduction of environmental restrictions etc.

The analysis in this paper focuses on the CHP operated by PUC "Beogradske elektrane" in the district heating system of Belgrade city, its operational costs and feasibility in general taking into account high fluctuations on Serbian energy market in the last year. Techno-economic analysis of

CHP plants had been subject of research of many authors even before energy market volatility in 2022 as briefly described in the following paragraphs.

In paper [2], a comparison of district heating CHP and distributed generation CHP with energy, environmental and economic criteria for Northern Italy is presented. The results showed that payback periods as low as 1.6 years for district heating systems with internal combustion engines could be achieved, but the frequent changes concerning CHP incentives in Italy did not encourage investments in this sector [2]. Furthermore, the price of electricity was occasionally lower than that of fuel in recent years, resulting in many CHP plants reduced their operation, and investments in new CHP capacities were relatively rare [3].

Paper [4] presents a techno-economic assessment of a small-scale biomass ORC-CHP for district heating. The general conclusion is that the plant's economic performance is very low, because only under the combined existence of multiple favourable factors (high electricity and heat prices, low biomass cost) and extended operating hours, it was possible to achieve discount payback periods of at least 5–7 years. Authors Koch et al. [5] presented a techno-economic analysis of flexible biomass combined heat and power plant operation in a modelled district heating system with a CHP, a peak load boiler, and thermal heat storage. The simulation model compares two cases - natural gas and wood-chip gasifier. The most significant difference between the two fossil models and the biomass model from an economic point of view is the higher maintenance cost of about 177,000 EUR for the wood gasifier system.

Other authors conducted a sensitivity analysis to evaluate the effect of Feed-in Tariff rates on the design of biomass CHP systems [6]. Iliev et al. [7] performed a multi-parameter analysis in order to select an optimal cogeneration technology for one of the largest district heating plants in Central and Eastern Europe. The application of gas turbine installation and gas-piston engines was investigated with several influencing parameters (technical, economic, and environmental) to help make the right investment decision. The results have shown that regarding return on investment, flexibility over large load ranges, and maintaining high efficiency in all possible modes, the most appropriate option would be a group of gas-piston modules with an electrical power of approx. 9.5 MW total productivity. Despite the higher associated operating costs, this configuration had the shortest estimated payback period of 4.4 years.

In this paper, the operational characteristics of the CHP plant located at heating plant "Voždovac", which has been operating since January 1, 2021, within the Belgrade city district heating system, have been analysed, with emphasis on the impact of the severe disruption in the prices of natural gas, electricity, and maintenance costs in 2022 on the financial profitability of the plant.

The district heating plant "Voždovac" supplies thermal energy for the heating and preparation of domestic hot water (DHW) to the consumers of several city districts of Belgrade. The total thermal capacity of installed boilers is 232 MW (2·58 MW + 116 MW). In addition, two steam boilers with a capacity of 11 t/h of steam each are also in operation for technological needs and the preparation of DHW in the summer period. The total thermal power consumption is 170 MW, of which 24 MW is used for DHW. DHW is distributed to the consumers 24 hours a day, 365 days a year, with primary design water temperatures of 70/55°C for supply and return, respectively.

The primary fuel source in the plant is natural gas, while the alternative fuel is heavy fuel oil. Three cogeneration modules JMS 620 GS-N.LC, gas-piston engines manufactured by Jenbacher with a total rated electric power of 10 MW and a thermal power of 10.1 MW, were built in 2020 at the

location of the "Voždovac" Heating Plant. The operation of the CHP system is set to be the priority of thermal energy consumption. Basic components of the CHP system include a 4-stroke air-cooled gas engine and alternating current generator. Mechanical energy generated in a gas engine is transformed via an electric generator, while thermal energy from the engine, lubrication oil, and exhaust gas cooling is utilized for heating DHW and heating of fresh feed water for filling the district heating network [8].

2. Methodology

2.1. Regulations for CHP based electricity production in Serbia

Public utility company (PUC) "Beogradske elektrane" as an operator of the CHP plant, started the procedure for acquiring the status of privileged electricity producer in 2019 according to the provisions of national regulations valid at the time in Serbia [9]. Suppose power producers for power plants with combined electricity and thermal energy production with an installed capacity of up to 10 MW wants to acquire the status of the privileged producer. In that case, a regulation defines a minimum annual efficiency rate of 75%. With a designed and measured efficiency rate of 92.7%, the CHP plant "Voždovac" meet the criteria in terms of energy efficiency for acquiring the status of a privileged electricity producer. The heat efficiency of similar plants can reach 45.46%, and the total efficiency can be up to 93.76% [7]. However, due to legal problems with property ownership, the plant acquired the status of a temporarily privileged producer of electricity on January 20, 2020, with a decision issued for two years. With this status, the feed-in electricity price is only 50% of the incentive price which is guaranteed for privileged producer.

In addition to the direct profit from the electricity and thermal energy production, the operation of the plant achieves long-term positive effects for the system of PUC "Beogradske elektrane" and heating plant "Voždovac", namely:
- Increasing the available capacity in the production of thermal energy for the preparation of DHW;
- In the future, produced thermal energy can be used for district cooling in summer conditions by application of an absorption chiller;
- District heating plant "Voždovac" is a privileged producer of electricity, that is, a producer of "green" or more environmentally friendly energy;
- Cheaper, more efficient, and more reliable heat energy production;
- Reduction of CO_2 emissions, i.e., acquisition of green certificates;
- The possibility of applying to European Union funds for further investment in renewable energy sources and cogeneration.

PUC "Beogradske elektrane" is currently in the process of extending the status of a temporary privileged producer of electricity and obtaining the status of a privileged producer of electricity, which is conditioned by the resolution of the legal property status of two parcels of the heating plant complex.

The national regulations have been changed with the new Law on energy efficiency and rational use of energy (LEERUE) and accompanying regulation documents adopted in April 2021 [10-11]. LEERUE defines highly efficient cogeneration as production providing primary energy savings compared to reference values for separate thermal and electrical energy production. Reference values are specified as a percentage and calculated following the methodology for determining the efficiency

of cogeneration in small and micro-cogeneration units. In addition, the LEERUE specifies incentives (i.e., feed-in tariffs or market premiums) for highly efficient cogeneration. However, legal documents regulating roles and incentives for privileged producers in the energy market are constantly changing, which can be challenging to follow. Document [11] does not recognize highly efficient cogeneration (as the CHP plant in the district heating plant "Voždovac" is categorized according to the previous valid legal document). However, LEERUE elaborates in Chapter XIII on the legal framework for highly efficient cogeneration and its role in the energy market.

2.2. Feed-in tariffs for CHP based electricity production in Serbia

The methodology for calculating the price of electricity for temporarily privileged and privileged producers of electricity foresees a price correction concerning:
- Annual inflation rate in the Eurozone,
- Change in the price of natural gas.

$$C_3 = C_2 \cdot 0.33 + \frac{C_0 \cdot 0.67 \cdot G}{312.58} \tag{1}$$

Where:

C_3- corrected feed-in tariff price for power plants with highly efficient combined production of electricity and heat in cEUR/kWh,

C_2- adjusted electricity price due to inflation in the Eurozone,

C_0- baseline electricity price determined on the date of starting the regulation governing incentive measures,

G- correction coefficient for gas price changes published by the Ministry responsible for energy affairs.

According to regulations [9], the basic incentive purchase price (feed-in tariff) for electricity for natural gas fired CHP was 8.89 cEUR/kWh with a guaranteed purchase period of 12 years. The electricity price at which PUC "Beogradske elektrane" as a temporarily privileged producer, sold electricity to the national power utility company (EPS) was 3.75 cEUR/kWh (4.43 RSD/kWh) and 4.7 cEUR/kWh (5.55 RSD/kWh), in 2021 and 2022, respectively, which is an increase of 25%. As mentioned earlier, this price represents approx. 50% of the feed-in price guaranteed to a privileged electricity producer.

It should be noted that the agreed methodology for correcting the price at which privileged producers sell produced electricity to EPS does not follow sufficient changes in the energy market in Serbia, which puts electricity producers in a disadvantageous position. Therefore, in this paper a correction coefficient for equation (1) is proposed in order to adjust feed-in tariff margin so that the profitability of the plant remains unaltered.

3. Operational characteristics of the plant

Tab. 1 and Tab. 2 show data on the produced electrical and thermal energy, natural gas consumption, "parasitic" electricity consumption, and total operating hours for all three engines in 2021 and 2022.

Table 1. Operational characteristics of the plant in 2021

Month	Electricity production, MWh	Heat production, MWh	Natural gas consumption, 1,000 m³	Parasitic electricity consumption, MWh	The sum of operating hours of all three engines, h/a
January	4,965.0	5,079.7	1,312.4	200.0	1,496.0
February	4,690.7	4,701.6	1,178.7	250.0	1,437.0
March	7,171.4	7,188.2	1,647.3	250.0	2,194.0
April	6,174.6	7,081.1	1,530.1	142.8	1,890.0
May	4,958.8	5,640.0	1,135.4	130.0	1,552.0
June	3,438.2	3,985.1	800.3	133.5	1,148.0
July	2,951.7	3,353.6	693.7	119.7	1,053.0
August	2,921.9	3,346.0	698.2	106.2	1,007.0
September	3,619.7	4,001.0	851.6	111.6	1,204.0
October	5,367.7	5,899.3	1,259.9	134.3	1,715.0
November	5,956.3	6,462.4	1,372.8	140.3	1,849.0
December	6,450.0	6,985.4	1,463.3	161.6	1,989.0
Sum:	58,666.0	63,723.4	13,943.7	1,880.0	18,534.0

Table 2. Operational characteristics of the plant in 2022

Month	Electricity production, MWh	Heat production, MWh	Natural gas consumption, 1,000 m³	Parasitic electricity consumption, MWh	The sum of operating hours of all three engines, h/a
January	4,352.9	4,422.3	965.1	133.9	1,350.0
February	5,577.7	5,904.7	1,293.6	121.6	1,699.0
March	7,004.7	7,208.2	1,579.3	148.8	2,113.0
April	6,909.4	7,117.7	1,540.9	166.4	2,090.0
May	4,591.5	4,914.6	1,040.6	147.1	1,494.0
June	3,501.8	3,737.5	784.5	128.6	1,187.0
July	2,949.9	3,194.7	667.5	126.9	1,016.0
August	2,842.6	3,057.2	649.6	120.6	938.0
September	3,647.8	3,868.1	825.2	97.4	1,184.0
October	4.138,9	4.407,2	944,6	107,6	1.337
November	7.085,4	7.385,4	1.576,2	142,2	2.141
December	6.870,6	7.004,1	1.499,1	136,0	2.070
Sum:	59.473,2	62.221,7	13.366,2	1.577,1	18.619

Based on the data presented in Tab. 1 and 2, with an average heating value of natural gas of 34.8 MJ/m³, the average efficiency of the plant at the annual level was 91.2% and 94.2% in 2021 and 2022, respectively. "Parasitic" consumption of electricity was at the level of 3.2% and 2.6% of the produced electricity amount in 2021 and 2022, respectively.

In the period 2021-2022 natural gas prices in Serbia increased by approximately 20% (from 28.5 cEUR/m³ to 34 cEUR/m³ at standard gas conditions), and the price of electricity, which is paid for "parasitic" consumption, by as much as 40% (from 4.8 cEUR/kWh to 6.68 cEUR/kWh) while the price of thermal energy remained approximately constant (7.55 cEUR/kWh). The price of thermal

energy delivered to district heating consumers is determined by PUC "Beogradske elektrane" with previous approval of the Assembly of the City of Belgrade, which also gives consent to price changes.

The agreed initial price of engine maintenance per operating hour is adjusted once a year every January based on statistical data published by the Republic Serbia Institute of Statistics, namely:

- Average gross earnings (salary) for the city of Belgrade,
- Capital goods,
- Liquid fuels and fuel oil prices.

Considering the given coefficients, where the most significant share is the average gross salary, a resulting coefficient is obtained by multiplying the initial contracted price for system maintenance. The unit price for the maintenance of gas engines increased by 25% (from 44.75 EUR/h to 55.68 EUR/h) in 2022 compared to 2021. Regular periodic maintenance and oil change on the engine is done during service shutdown, which takes 24 h and is carried out after every 2,000 hours of engine operation.

4. Results and discussion

As stated in the previous chapter of the paper, in 2022 compared to 2021, a significant increase in energy prices and maintenance costs in industrial sector was recorded in Serbia, while the price of thermal energy remained practically unchanged. The feed-in tariff for the generated electricity has also increased, but not sufficient to offset the increase in operating costs. Tab. 3 and 4 show the results of the economic analysis, which accounts for nominal income and costs, as well as their impact on the investment payback period.

Table 3. Economic analysis of the CHP plant in 2021

No.	Description	Unit prices	1,000 EUR
1	2	3	4
	I INCOME		
1	Electrical energy sale income (50% of the feed-in price until status of the privileged producer is obtained)	3.75 cEUR/kWh	2,200.0
2	Heating energy income	7.55 cEUR/kWh	4,811,1
	Total income		7,011.1
	II COSTS		
1	Natural gas cost	28.5 cEUR/m^3	3,973.9
2	Maintenance		829.4
3	Salaries		173.0
4	Cost for parasitic electrical energy consumption	4.8 cEUR/kWh	90.2
5	Depreciation costs, 10% of the investment		653.3
	Total cost		5,719.8
	REVENUE		1,291.3
	INVESTMENT		6,532.6
	PAYBACK PERIOD		**5.06**

Table 4. Economic analysis of the CHP plant in 2022

No.	Description	Unit prices	1,000 EUR
1	2	3	4
	I INCOME		
1	Electrical energy sale income (50% of the feed-in price until status of the privileged producer is obtained)	4.7 cEUR/kWh	2,795.2
2	Heating energy income	7.55 cEUR/kWh	4,697.7
	Total income		7,492.9
	II COSTS		
1	Natural gas cost	34 cEUR/m^3	4,544.5
2	Maintenance		1,036.7
3	Salaries		174.0
4	Cost for parasitic electrical energy consumption	6.68 cEUR/kWh	105.3
5	Depreciation costs, 10% of the investment		653.3
	Total cost		6,513.8
	REVENUE		979.1
	INVESTMENT		6,532.6
	PAYBACK PERIOD		**6.67**

From the results, it can be concluded that the change in energy prices and maintenance costs in 2022 compared to 2021 led to the fact that the revenue from plant operation was reduced by 24.2%, which led to an increase in the investment payback period from 5.06 to 6.67 years.

Further increase in electricity and natural gas prices is announced in Serbia for 2023. It is interesting to analyse how additional energy price increases would affect the plant profitability and investment payback period. For example, if the prices of natural gas and "parasitic" electricity increase by 15% and the feed-in tariff for electricity for privileged producers also increases by 15%, with other income and cost parameters unchanged, the investment payback period would increase to 11.3 years. In this case, the profitability of the CHP plant, which was designed for 12 years, will be threatened. More detailed sensitivity analysis of energy and operating costs is shown in Tab. 5. The sensitivity analysis is done using the generalized reduced gradient (GRG) nonlinear method provided by Microsoft Excel software solver [12]. The baseline values of operating parameters are taken with reference to 2022. Five different scenarios are considered with estimated increase of income and costs for six operating parameters varied in the range from +5% to +20% compared to baseline scenario. Other operating parameters such as electricity production, heat production, natural gas consumption, "parasitic" consumption of electricity and plant working hours are assumed to be unchanged with reference to 2022.

Table 5. Sensitivity analysis of energy and operational costs

Operating parameter	Baseline	Change constraints	Scenario				
			#1	#2	#3	#4	#5
Feed-in price for sold electricity, cEUR/kWh	4.7	+10÷20%	5.17 (+10%)	5.64 (+20%)	5.64 (+20%)	5.17 (+10%)	5.17 (+10%)
Heating energy price, cEUR/kWh	7.55	+5÷10%	7.93 (+5%)	8.31 (+10%)	8.31 (+10%)	7.93 (+5%)	7.93 (+5%)
Natural gas cost, cEUR/m^3	34	+15÷20%	39.1 (+15%)	40.8 (+20%)	39.1 (+15%)	40.8 (+20%)	40.1 (+18%)
Maintenance cost, 1,000 EUR	1,036.7	+10÷15%	1,140.4 (+10%)	1,192.2 (+15%)	1,140.4 (+10%)	1,140.4 (+10%)	1,140.4 (+10%)
Salaries, 1,000 EUR	174	+5÷10%	182.7 (+5%)	191.4 (+10%)	182.7 (+5%)	182.7 (+5%)	182.7 (+5%)
Cost for parasitic electrical energy consumption, cEUR/kWh	6.68	+15÷20%	7.68 (+15%)	8.02 (+20%)	7.68 (+15%)	8.02 (+20%)	8.02 (+20%)
Depreciation costs, 1,000 EUR	653.3	constant	653.3	653.3	653.3	653.3	653.3
Income, 1,000 EUR	7,493		8,007.4	8,521.8	8,521.8	8,007.4	8,007.4
Costs, 1,000 EUR	6,513.8		7,323.7	7,616.7	7,323.7	7,556.2	7,463
Revenue, 1,000 EUR	979.2		683.7	905.1	1,198.1	451.2	544.4
Payback period, years	6.67		9.55	7.22	5.45	14.47	12

Note: Scenario #1-minimal change constraints; Scenario #2-maximal change constraints; Scenario #3-minimal payback period; Scenario #4-maximal payback period; Scenario #5-payback period equal to 12 years.

The results showed that with minimal estimated increase of income from sold energy and operating costs (Scenario #1) investment payback period will increase from 6.67 to 9.55 years, which represents increase of 43.2%. On the other hand, with maximal estimated increase of income from sold energy and operating costs (Scenario #2) investment payback period will increase from 6.67 to 7.22 years, which represents increase of 8.2%. Minimal payback period of 5.45 years can be achieved with maximal income increase and minimal increase of operating costs (Scenario #3). Opposite to Scenario #3, with minimal income increase and maximal increase of operating costs (Scenario #4) investment payback period will increase to 14.47 years, making the plant operation unprofitable. The marginal value of the profitability of the plant when the payback period is equal to 12 years is reached with minimal income increase and maximal increase of operating costs, except for the increase of natural gas cost which in this scenario (Scenario #5) equals to 18% (40.1 cEUR/m^3).

With recent changes in the regulations and the trend of increasing energy prices and maintenance costs, the plant operator must consider revising contractual obligations with the power utility company (EPS) into a prosumer contract model. This contract model implies that all electricity produced at this CHP plant can be used for electricity consumers within the district heating plant "Voždovac" rather than sold electricity to the local grid.

Other solution may include correction of the methodology for calculating the price of electricity for temporarily privileged and privileged producers given by equation (1), although this is not easy task because several levels of decision and institutions are involved in this process. In this particular case, if the feed in tariff for the produced electricity had been 5.52 instead of 4.7 cEUR/kWh in 2022, the plant revenue would have remained unchanged in 2022 compared to 2021. Therefore, feed-in tariff for produced electricity calculated using equation (1) should be increased by 17.4% or multiplied by coefficient of 1.174 in order to achieve the designed profitability, without changing other energy and operating costs.

5. Conclusion

This paper analyses the operational characteristics of the natural gas-fired CHP plant, which has been operating since January 1, 2021 in Belgrade city district heating system. Special attention is paid to the impact of the severe disruption in the prices of natural gas, electricity, and maintenance costs in 2022 on the financial profitability of the plant.

The results showed that the average efficiency of the plant at the annual level in 2021 was 91.2%, while in 2022, it was 94.2%. "Parasitic" electricity consumption was reduced from 3.2% to 2.6% of the electricity generated in 2021-2022. Based on these data, it can be concluded that the plant achieved better technical performance in the second year of operation.

The results of the economic analysis, in conditions with the unstable energy market, indicated a significant increase in energy prices (20% and 40% for natural gas and electricity, respectively) and maintenance costs (by 25%) in the period 2021-2022. Increasing costs reduced the plant's revenue by 24.2%, which negatively impacted the investment payback period from 5.06 to 6.67 years.

The trend of rising energy and other operating costs expected in 2023 is additionally analysed in the paper. Five different scenarios are obtained estimating increase of income and costs for six operating parameters varied in the range from +5% to +20% with a reference to baseline scenario. Resulting investment payback periods are in range from 5.45 to 14.47 years, which means that the designed profitability of the plant can easily be threatened if the investment payback period increase to approximately 12 years.

For this reason, it makes sense to think about changing contract obligations with the power utility company (EPS) in terms of getting a prosumer contract model, i.e., the possibility of using the produced electricity for electricity consumers within the District heating plant "Voždovac" rather than sold to the local grid, which is enabled by the new national Decree on market premium and feed-in tariff.

Other solution may include correction of the methodology for calculating the price of electricity for temporarily privileged and privileged producers given by equation (1) so that the feed in tariff for CHP based electricity production better match energy market volatility. However, this is not an easy task because it involves approval of several national institutions and changing the energy policy.

6. References

[1] European Parliament and Council. Directive 2004/8/EC "Promotion of cogeneration based on a useful heat demand in the internal energy market", Off J Eur Union 2004; L52: 50–60 [21.02.2004].

[2] Torchio, M. F., Comparison of district heating CHP and distributed generation CHP with energy, environmental and economic criteria for Northern Italy, *Energy Conversion and Management*, 92 (2015), pp. 114-128

[3] Wiltshire, R., *Advanced district heating and cooling (DHC) systems*, Elsevier Science&Technology, 2016

[4] Braimakis, K., Charalampidis, A., Karellas, S., Techno-economic assessment of a small-scale biomass ORC-CHP for district heating, *Energy Conversion and Management*, 247 (2021), https://doi.org/10.1016/j.enconman.2021.114705

[5] Koch, K., Hofner, P., Gaderer, M., Techno-economic system comparison of a wood gas and a natural gas CHP plant in flexible district heating with a dynamic simulation model, *Energy*, 202 (2020), https://doi.org/10.1016/j.energy.2020.117710

[6] Ling, W. C., Andiappanb, V., Wan, Y. K., Ng D. K.S., A systematic decision analysis approach to design biomass combined heat and power systems, *Chemical Engineering Research and Design*, 137 (2018), pp. 221-234

[7] Iliev, I.K., Terziev, A.K., Beloev, H.I, Nikolaev, I., Georgiev, A.G., Comparative analysis of the energy efficiency of different types cogenerators at large scales CHPs, *Energy*, 221 (2021), https://doi.org/10.1016/j.energy.2021.119755

[8] ***, Feasibility study for cogeneration plant on natural gas fired district heating plant "Voždovac" in Belgrade, "Termoprojekt" Belgrade, 2017. (in Serbian)

[9] ***, Decree on the conditions and procedure for acquiring the status of privileged electricity producer, temporary privileged producer, and producer of electricity from renewable energy sources, "Official Gazette of the Republic of Serbia" No. 56/16, 2016. (in Serbian)

[10]   ***, Law on energy efficiency and rational use of energy, "Official Gazette of the Republic of Serbia ", No. 40/21, 2021. (in Serbian)

[11]   ***, Decree on market premium and feed-in tariff, "Official Gazette of the Republic of Serbia", No. 40/21, 2021. (in Serbian)

[12]   ***, Microsoft Corporation, Microsoft Excel, (2018), Available at: https://office.microsoft.com/excel.