Kütahya Dumlupınar University
Institute of Graduate Studies

Journal of Scientific
Reports-A
E-ISSN: 2687-6167
Number 50, September 2022

RESEARCH ARTICLE

ECONOMIC FEASIBILITY ANALYSIS of a GRID-CONNECTED PV ENERGY SYSTEM: A CASE STUDY of KUTAHYA DUMLUPINAR UNIVERSITY, TÜRKİYE

Kerim KARABACAK[1*]

[1]Kütahya Dumlupınar Üniversity, Kutahya Technical Sci. Vocational School, Dept. of Electronics and Automation, Kütahya,kerim.karabacak@dpu.edu.tr, ORCID: 0000-0002-9724-4612

Receive Date:29.03.2022 *Accepted Date: 09.08.2022*

ABSTRACT

Due to their clean energy generation process, PV energy systems are an important alternative energy production system against fossil fuel-based energy production systems. However, it is important to make a clear and brief economic feasibility analysis before the installation of a PV energy system. The return time of the investment should have been calculated carefully. So, this paper presents an economic feasibility analysis of a grid-connected PV energy system. The system is planned to locate on the campus of Kutahya Dumlupinar University, Türkiye. The proposed system is planned to establish approximately 3000 m^2 of an unused field near a pond on the campus. The DC side power plant installed power capacity has been determined as 150kWp. The network side power of the system is determined as $125kW_e$. The total cost of the system is determined and the monthly energy production of the proposed PV energy system in years is calculated according to solar radiation data. The overall profit of the system is calculated by years. It is found that the system will start to make profits at the middle of the 5^{th} year of the investment.

Keywords: *Renewable energy systems, photovoltaic energy systems, feasibility analysis*

1. INTRODUCTION

These days, the usage of renewable energy sources for electricity production is increasing due to fossil fuels and coal-based electricity production having enormous pollution effects on the atmosphere. In the year 2019, renewable energy production is 11.41% of total energy production in the world (includes hydropower, solar, wind, geothermal, bioenergy, wave, and tidal), In the year 2019, without hydropower, the total renewable energy production in the world is 3137.47 TWh. In the year 2020, this production increased up to 3322.94 TWh. The change ratio of renewable energy production without hydropower for one year is 5.9%. The yearly representation of the world's electrical energy production based on hydroelectric, solar energy, wind energy, and other renewable energy sources is given in Figure 1 [1].

On the other hand, photovoltaic (PV) energy systems are one of the most common renewable energy-based electric production systems. In the year 2011, the total installed solar capacity in the world was 72.04 GW. In the year 2021, the world’s total installed PV energy capacity is 707.5 GW and PV

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energy systems constitute 3.27% of total renewable energy in the world's electricity production. So, the world's renewable energy installed power capacity has increased 9.82 times in a decade [1].

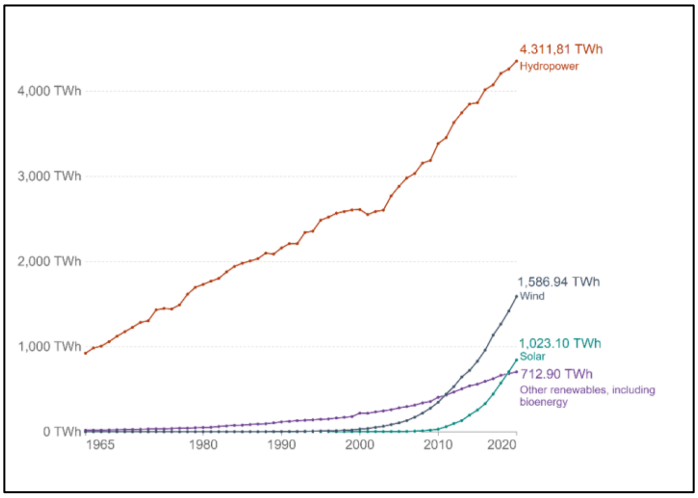

Figure 1. World renewable energy generation by years [1].

In Türkiye, renewable energy sources-based electricity production (without hydropower) was 5.75 TWh in 2011. In 2021, this value reached 61.3 TWh. It is seen that renewable energy production without hydropower is increased 5 times in one decade. In 2014, Türkiye's total installed PV power capacity was 0.07 GW. From the beginning of 2015, PV energy system investments have increased exponentially. In 2020, the total installed PV power capacity is increased to 6.67 GW. This shows that solar energy system investments are increased 95.28 times in 6 years. The total installed PV power capacity in Türkiye by years is shown in Figure 2 [1].

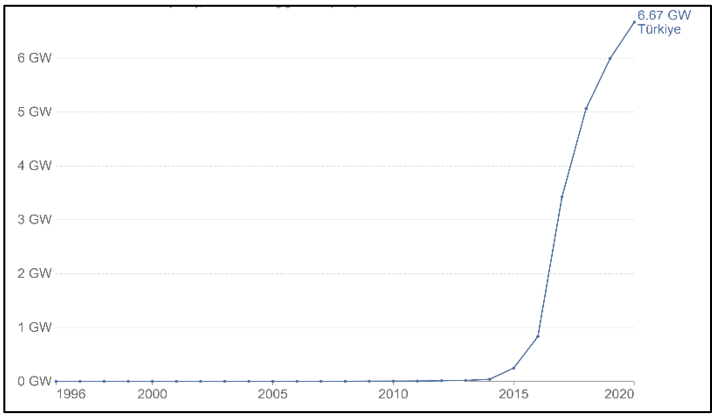

Figure 2. Total installed PV power capacity in Türkiye by years [1].

In the year 2011, PV energy systems constituted less than 0.01% of the total electricity production in Türkiye. In 2021, PV energy systems constitute 3.91% of the total electricity production of Türkiye.

Karabacak, K., Journal of Scientific Reports-A, Number 50, 200-216, September 2022.

The share of solar energy in total energy production in Türkiye is increased 391 times higher in one decade. Since the year 2018, the share of the PV electricity production of Türkiye is over the share of the PV electricity production of the world. The share of solar energy in electricity production in Türkiye and the world by years is illustrated in Figure 3 [1].

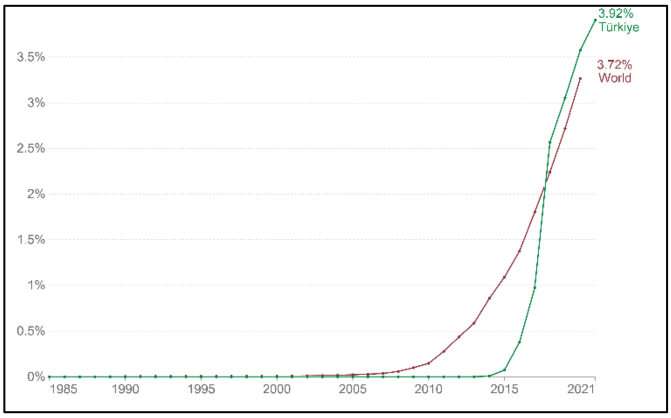

Figure 3. Share of the solar energy world and Türkiye by years [1].

In 2015, Türkiye's total electricity generation from solar energy was 0.19 TWh. In 2021, this production increased to 12.91 TWh. The change in the solar energy-based electricity generation in 6 years is 67.9 times. Figure 4 illustrates the total electricity generation from solar energy in Türkiye by years [1].

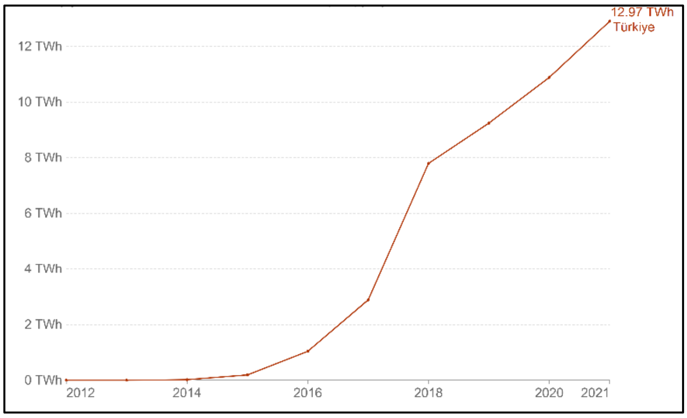

Figure 4. Total PV electricity generation in Türkiye by years [1].

In the literature, there are some studies about the economic feasibility analysis of PV systems in Türkiye and its neighbors. Celik [2] proposed a photovoltaic house concept that uses PV energy as the main energy source to assess the techno-economic feasibility of grid-connected photovoltaic systems in Türkiye. Abbasoglu et al. [3] examined economically and environmentally feasible places in Türkiye to build a 10 MW PV-grid connected solar photovoltaic power plant. Duman and Guler [4]

presented the economic analysis of grid-connected residential rooftop PV systems in nine locations in Türkiye.
Kalinci [5] investigated a PV array feasibility analysis for Bozcaada island, Istanbul. Akpolat et al. [6] presented a simulation study for the Rooftop Solar Photovoltaic System (RSPS) design and calculation for the faculty building at Marmara University in Istanbul. Aykut et al. [7] presented a techno-economic and environmental feasibility study of a hybrid grid-connected wind/PV/biomass energy system for Marmara University Goztepe Campus in Istanbul. Batman et al. [8] presented a feasibility study of grid-connected photovoltaic systems in Istanbul, Türkiye. In their study, power output and temperature data collected from PV modules in Istanbul, Türkiye in 2009. This data have been analyzed to determine solar power generation potential.

Caglayan [9] examined the technical and financial viability of a grid-connected 1 MW photovoltaic PV power plant in the province of Antalya, Türkiye. Karaveli et al. [10] presented the differences in the feasibilities of Photo Voltaic Solar Power Plant (PV SPP) installments in two Turkish cities (Antalya and Ordu) by using the Economic Feasibility Concept (EFC), Kirbas et al. [11] evaluated a feasibility of grid-connected PV SPP for the vicinity of Lake Burdur, Burdur, Türkiye. Their proposed PV SPP system is 1220 MW.

Cetinbas et al. [12] explained a design, performance analysis, and optimization of a hybrid microgrid that includes a PV energy plant for the hospital complex located on the Eskisehir Osmangazi University (ESOGU) campus. Taner [13] presented a techno-economic feasibility analysis of a PV SPP for Yapilcan village, Aksaray city, Türkiye. Adan et al. [14] determined the technical and economic evaluation of a standalone and on-grid hybrid system to supply power to the Department of Electrical and Electronics Engineering at Eskisehir Technical University. Ates and Salmanoglu [15] proposed an economic feasibility study for the installation of an on-grid PV plant was planned on the roof of Manisa Celal Bayar University Koprubasi Vocational School. Ayran and Aslan [16] presented a feasibility analysis for an unlicensed on-grid 336 kWh PV SPP at Sehzade Park in Kutahya, Türkiye. Akpinar et al. [17] proposed an economic feasibility analysis of a PV SPP for a house in Türkiye with a program that created a simulation model in the MATLAB GUI environment. Gurturk [18] presented a cost analysis of a PV SPP, which is located in Elazığ, Türkiye is calculated according to Levelized Cost Analysis (LCA) method. In that study, the payback period of investing in the solar power plant was calculated as 13 years.

Atikol et al. [19] demonstrated an economic feasibility assessment of a PV energy system in North Cyprus. Turjman et al. [20] proposed a 6 kW PV SPP with a wind energy system for Northern Cyprus. Sadati et al. [21] presented a microgrid of a PV array for a university campus-scale community on a Mediterranean island. Abujubbeh et al. [22] presented a techno-economic feasibility assessment for an on-grid PV-Wind hybrid system to cover a typical household annual energy demand in Amman, Jordan. Kassem et al. [23] examined the economic and financial assessments of solar and wind power potential for nine selected regions in Libya.

The main objective of this paper is to make an economic feasibility analysis of a grid-connected PV SPP, which is planned to be established in order to reduce the cost of electricity expenditure at Kütahya Dumlupinar University. The total PV SPP system cost, amount of electricity production, and the investment return time is examined. For optimal sizing of the proposed system, cost per watt comparison of various rated-power types of PV panels are investigated.

The study also aims to reduce the amount of carbon dioxide emitted from the generation of electrical energy using fossil fuels. With the publication of the study, awareness in the society about the use of renewable energy resources and the prevention of carbon emissions will be raised.

There are many other studies about the economic feasibility analysis of PV power systems. Although, the difference in this paper includes the calculation of the shadow distance of PV panels according to the sun's path. The worst-case scenario for the shading effect of PV panels in the year is calculated. The distance between PV panel strings is calculated accurately. So, the optimal sizing of the proposed PV SPP is achieved for economic feasibility analysis.

The remainder of this paper is organized as follows: In introduction part, Türkiye's renewable energy production change in years is given. Also, Türkiye's solar energy installed capacity change by years is interpreted. Then, a literature review is given about economic feasibility analysis of on-grid PV power systems. Then, the purpose of the study is given. In Materials and Methods section, the methodology is explained for the calculation of the sizing of the proposed PV SPP. In results section, the solar radiation falling on the panel surface, total possible energy production of the proposed PV SPP, monthly expected energy from the system is investigated. Then, PV SPP average turnkey installation cost is determined and cash flow statement of the investment in equity is examined. In Conclusion section, the benefits of the proposed system are explained. The planned improvements of the proposed system in the future are expressed.

2. MATERIALS and METHODS

In the investigation, it is seen that the five-years average annual total electricity consumption of Kutahya Dumlupinar University campus is 90.369.725 kWh [24]. In this study, it is planned to establish a grid-connected PV SPP on Kutahya Dumlupinar University Campus area in Kutahya, Türkiye. The electrical energy produced in the system will be sold to the electricity distribution company. Thus, it is planned less electricity bills will be paid as the amount of income to be obtained from the electrical energy produced by the installed system. The system is planned to run on-grid. There isn't any energy storage part is proposed to reduce the total cost of the system.

The selected PV SPP installation area is an empty area near the pond on the campus is a south-facing sloping land. The area is approximately 3000 m^2 (200m x 15m), The planned PV system location is given in Figure 5.

Figure 5. Planned installation place (in yellow rectangle),

2.1. Selection of PV Panels

Today, the most widely used PV technology is slice-based Crystalline Silicon (c-Si) technology and its market share is around 85%. So, within the scope of this project, it is planned to use c-Si based PV modules. In the market, it can be found c-Si structured PV panels in various rated-power values with various prices. So, for the proposed system, PV panels with at various rated-power values are investigated for cost per watt. (450 watts, 400 watts, 350 watts, 285 watts, 250 watts, 175 watts, ...etc.) In the investigation, it is seen that the PV panel with the lowest cost per watt is the monocrystalline panels with a rated-power of 285 watts. Figure 6 shows the comparison of different c-Si structured PV panels with cost per watt.

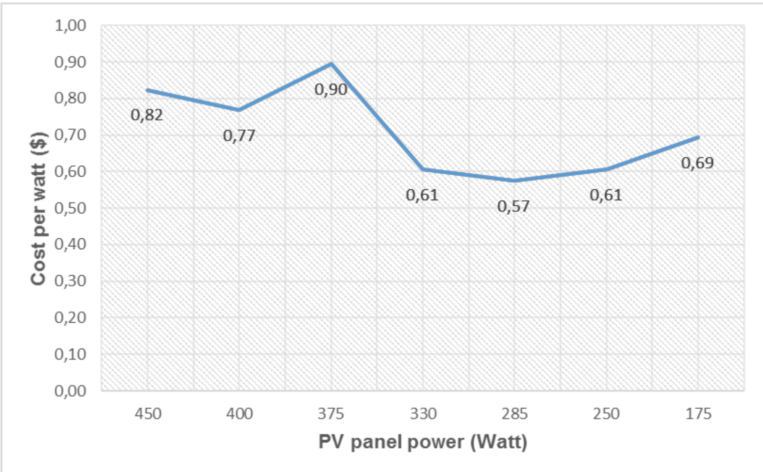

Figure 6. Cost-per-watt comparison of PV panels in the market.

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2.2. Determining the Distance Between PV Panel Strings

For determination of the distance between PV panel strings, the shading distances of PV panels has to be calculated. For this reason, sun path chart of the proposed PV SPP location is examined. Figure 7 shows one-year sun path chart for 39.29° North Latitude and 29.54° East Longitude. According to the sun path chart, the system is planned to start produce energy from 9:00 AM to 3:00 PM efficiently.

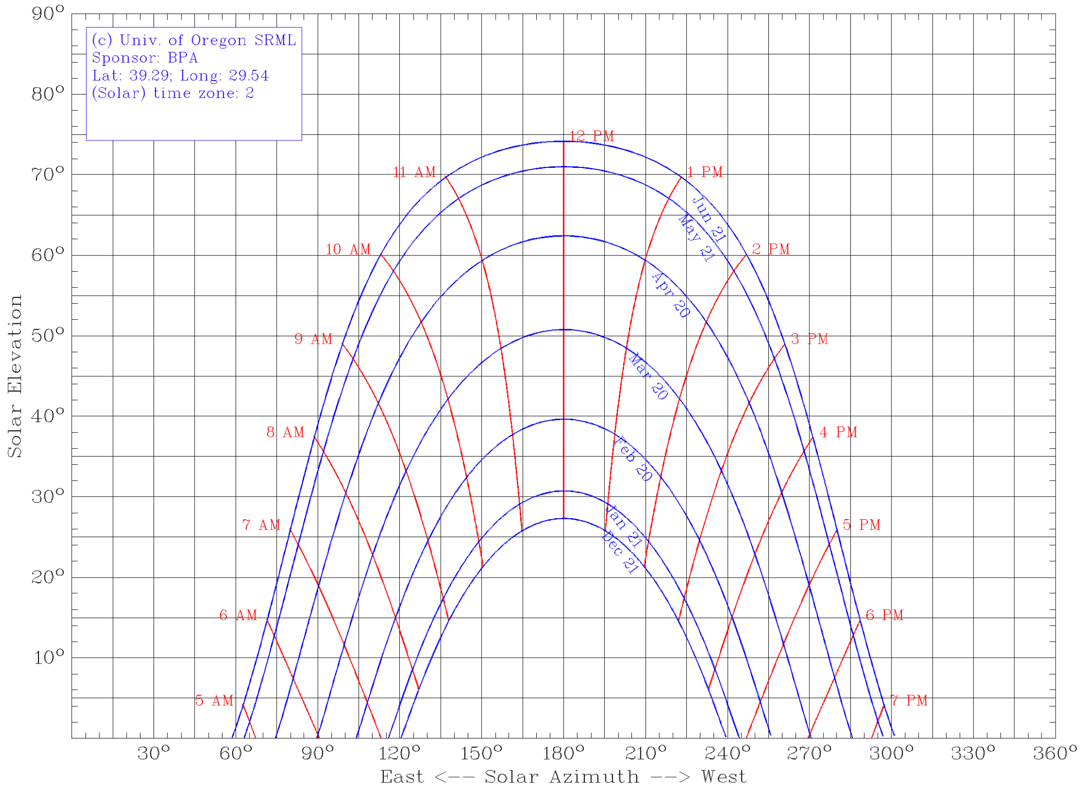

Figure 7. Sun path chart for 39.29° North, 29.54° East [25].

The worst scenario for the shading effect, is 21th of December due to solar elevation angle (α) reaches the minimum value in the year. So, the shadow length of the PV panels become maximum. In Figure 7, it is seen that the solar altitude angle on 21th of December at 9:00 AM is 15°. Symmetrically, in the same day, the solar altitude angle at 3:00 PM is 15°. So, maximum shading distance calculation can be made for 21th of December at 9:00 AM.

Figure 8 illustrates the calculation method of maximum shading distance. The black lines indicate the shadow area of one PV panel. In the proposed system, PV panel dimensions are 1 m width and 1.63 m length. The PV panel tilt angle (denoted as β) is chosen 31° for the proposed location, according to similar studies made neighborhood of Kutahya [26]. The length of the panel is denoted as *l*. So, the height of the panel (denoted as *h*) can be found from the blue triangle in the figure by Equation 1.

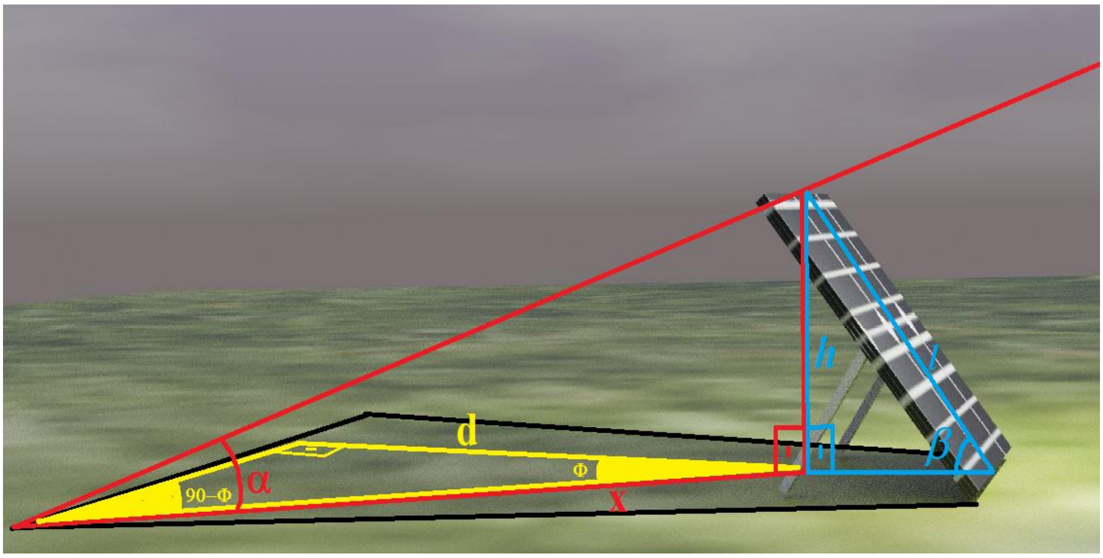

Figure 8. Calculation of maximum shadow distance

$h = l.sin\beta$ (1)
$h = 1.63.\sin(31°)$
$h = 0.839$ meter

When the worst case scenario is considered, the sun elevation angle (denoted as α) is 15°. Thus, from the red triangle, the distance between the edge of the shadow and the projection of the upper edge of the panel to the ground can be found (denoted as *x*) by Equation 2.

$x = h/tan(\alpha)$ (2)
$x = 0.839/0.267$
$x = 3.142\ meter$

From the sun path chart, the azimuth angle (denoted as Φ) on 21th o December at 9:00 AM is 52.5° (180°-127.5°), So, the shadow length (denoted as d) can be calculated by Equation 3.

$d = x.sin(90 - 52.5)$ (3)
$d = 1.91\ meter$

In practice, the calculated shadow length value can be round up to 2 meters.

2.3. The System Overall Properties
The length of proposed field of the PV SPP is measured as 200 m. In order for the carrier vehicles to be used for the installation to maneuver easily, it is foreseen that there will be 12m of space at the beginning and end of each PV panel string. The surface area of a 285 watts-rated monocrystalline PV panel is 1.63 m^2 (1 m x 1.63 m), So, the length of one PV panel string is considered as 176 meters. Thus, one PV panel string is considered as have 176 PV panels in series. The width of the planned

installation field is 20 m. In order to prevent shading lost for the proposed PV SPP, the shading distance between two panel string must be at least 2 meter in the 39th North latitude as mentioned in section 2.2. So, when walking ways between the PV panel strings and shadowing spaces are considered, it is decided 3 PV panel strings are suitable for the proposed PV SPP field. Thus, the total PV panels in the proposed PV system is determined as 528 (176x3) pieces.

Table 1. General information for the planned PV system.

City	Kutahya
Location	Kutahya Dumlupinar University Campus Area
Geographical location	39.474762°N- 29.903181°E
Considered Radiation Data	European Union Photovoltaic Geographical Information System (PVGIS)
Planned PV SPP Installed Power	125kW$_e$ (150 kW$_p$)
Number of Inverters	5 x 25kW Grid Connect Inverters
PV Panel Surface Area (Including Shadow Spaces)	~ 3000 m^2
The number of PV Modules:	528 pcs (PV Module with 285Wp Power and c-Si Technology each)
Panel efficiency	16.3 %
Inverter efficiency	98 %
Cable losses	1 %
Other losses (Temperature, shading, dust, etc.)	10 %
Total system efficiency	14.23 %

The overall summary of the proposed PV SPP and important system parameters are given in Table 1. On the DC side, 528 pieces of 285-watt rated-power PV panels are planned to be used. So, the planned DC side power is calculated as 150 kWp. The selected PV panels are mono-crystalline type and their efficiency is 16.3%. The inverter side power is proposed as 125 kW. There are five 25kW rated power three-phase on-grid string inverters in the proposed system. Each inverter is connected to 106 PV panels on the DC power side. On the AC power side, each inverter is connected to the national power network in parallel. Considering inverter losses, panel losses, cable losses, temperature losses, etc., total system efficiency is determined as 14.23%.

3. RESULTS

Considering the solar energy potential of the project installation region, the amount of radiation per unit area on a photovoltaic module placed at a fixed angle at the optimum tilt angle (31 degrees) is 4847.00 Wh/m^2/day [27]. This value is approximately 1.5 times Türkiye's average of 3600 Wh/m^2/day. Therefore, a PV SPP to be established in the examined site location is in a more advantageous position than the average of Türkiye in terms of both the electricity generation potential and the return time of the initial investment cost.

In Table 2, solar radiation coming to the horizontal surface at the installation site and solar radiation coming to the panel surface placed at the best tilt angle (31°) is compared. As the tilt angle of the panel approaches horizontal in summer, it is understood that more solar radiation reaches the panel surface. On the other hand, in other months, much more solar radiation comes to the surface of the panel placed at the best tilt angle.

Table 2. Radiation coming to the horizontal surface at the installation site (H_h, Wh/[m^2.d]) and radiation coming to the panel surface placed at the best tilt angle (H_{opt}, Wh/[m^2.d]),

Month	**H_h Wh/[m^2.d]**	**H_{opt}, Wh/[m^2.d]**
January	1.680,32	2.412,58
February	2.399,64	3.137,86
March	3.562,90	4.189,68
April	4.871,67	5.161,00
May	5.809,68	5.680,00
June	6.779,00	6.349,00
July	7.544,84	7.228,06
August	6.844,19	7.168,06
September	5.037,33	5.904,33
October	3.311,94	4.376,13
November	2.413,67	3.781,67
December	1.700,65	2.669,68
Annual average	4.329,65	4.838,17

The daily and monthly energy production values for the 150kWp PV SPP to be placed at the optimum angle (31^o) on Kutahya Dumlupinar University Campus are shown in Table 3. The average production in winter is 10332 kWh. The average monthly production in spring is 18580 kWh. The average monthly production in summer months is 23900 kWh. The average monthly production in autumn months is 16778 kWh. The installation site's expected annual electrical energy generation will be approximately 208781.38 kWh.

Table 3. Daily and monthly average electricity generation of proposed PV SPP.

Months	**kWh/150kWp-day**	**kWh/150kWp-Month**
January	309,10	9.582,00
February	393,46	11.016,89
March	526,40	16.318,39
April	627,45	18.823,61
May	664,50	20.599,48
June	723,70	21.710,98
July	809,74	25.101,86

August	802,94	24.891,07
September	677,72	20.331,67
October	519,25	16.096,78
November	463,61	13.908,21
December	335,50	10.400,44
Total kWh/year		208 781,38

The total investment cost of the proposed PV SPP is calculated as 145000$ + Tax. In the investment costs, 285W mono c-Si PV panels, 25kW on-grid string inverters, remote monitoring system, DC and AC electric panels, Solar DC cables, AC cables, panel carrier constructions, grounding materials, infrastructure and construction works, cable trays, etc. are considered. The investment costs of the proposed PV SPP that specified in Section 2 are given in Table 4 below.

Table 4. PV SPP Average Turnkey Installation Cost.

System Equipment	Quantity	Unit	Total cost ($)
285Wp Mono c-Si PV Panel	528	Number	145.000 $+Tax
25kW On-grid String Inverter	5	Number	
Remote Monitoring System	1	Set	
DC and AC Electric Panels	1	Set	
Solar DC cable 1x4mm^2	6.000	meter	
AC Cable	1	Set	
Panel Carrier Construction	1	Set	
Grounding Materials and Apparatus	1	Set	
Infrastructure and Construction Works	1	Set	
Cable Trays	1	Set	
Lightning, Fire, and Electrical Protection Components and Warning Signs	1	Set	
Process Management, Consulting, Installation, Assembly, Cabling, Labor, and other related costs	1	Set	

According to the calculations, it is predicted that the investment made with equity will pay back its entire cost at the middle of the 5th year of the investment. The expected cumulative return from the system at the end of the 25th year is calculated as 1 030 482.54 $. Repayment and cash flow details are presented in Table 5. In all calculations, it is assumed that the energy production performance of the system decreases by 1% every year. In addition, it has been taken into account that the energy obtained from the system is deducted from the current consumption, the price of purchasing energy from the current grid is 0.1333 $ cents, and the sales prices of the grid have increased by 5% on an

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annual basis. In addition, since all of the electrical energy produced will be offset against the current consumption, no network usage fee has been taken into account.

Table 5. Cash Flow Statement of Investment in Equity.

	1. year	**2. year**	**3. year**	**4. year**	**5. year**
Investment Cost ($)	-$171.100,00	$0,00	$0,00	$0,00	$0,00
Annual Energy Production (kWh)	208.781,38	207.319,91	205.868,67	204.427,59	202.996,60
Network Price ($)	$0,1333	$0,1400	$0,1469	$0,1543	$0,1620
Annual Cash Flow ($)	$27.837,52	$29.024,79	$30.262,69	$31.553,40	$32.899,15
Cumulative Cash Flow ($)	-$143.262,48	-$114.237,70	-$83.975,00	-$52.421,60	-$19.522,45
	6. year	**7. year**	**8. year**	**9. year**	**10. year**
Investment Cost ($)	$0,00	$0,00	$0,00	$0,00	$0,00
Annual Energy Production (kWh)	201.575,62	200.164,59	198.763,44	197.372,10	195.990,49
Network Price ($)	$0,1701	$0,1786	$0,1876	$0,1969	$0,2068
Annual Cash Flow ($)	$34.302,30	$35.765,29	$37.290,68	$38.881,13	$40.539,41
Cumulative Cash Flow ($)	$14.779,85	$50.545,14	$87.835,82	$126.716,95	$167.256,36
	11. year	**12. year**	**13. year**	**14. year**	**15. year**
Investment Cost ($)	$0,00	$0,00	$0,00	$0,00	$0,00
Annual Energy Production (kWh)	194.618,56	193.256,23	191.903,43	190.560,11	189.226,19
Network Price ($)	$0,2171	$0,2280	$0,2394	$0,2514	$0,2639
Annual Cash Flow ($)	$42.268,42	$44.071,16	$45.950,80	$47.910,60	$49.953,99
Cumulative Cash Flow ($)	$209.524,78	$253.595,95	$299.546,74	$347.457,35	$397.411,33
	16. year	**17. year**	**18. year**	**19. year**	**20. year**
Investment Cost ($)	$0,00	$0,00	$0,00	$0,00	$0,00
Annual Energy Production (kWh)	187.901,61	186.586,29	185.280,19	183.983,23	182.695,35
Network Price ($)	$0,2771	$0,2910	$0,3056	$0,3208	$0,3369
Annual Cash Flow ($)	$52.084,53	$54.305,93	$56.622,08	$59.037,01	$61.554,94
Cumulative Cash Flow ($)	$449.495,86	$503.801,79	$560.423,87	$619.460,88	$681.015,82
	21. year	**22. year**	**23. year**	**24. year**	**25. year**
Investment Cost ($)	$0,00	$0,00	$0,00	$0,00	$0,00

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Annual Energy Production (kWh)	181.416,48	180.146,56	178.885,54	177.633,34	176.389,91
Network Price ($)	$0,3537	$0,3714	$0,3900	$0,4095	$0,4300
Annual Cash Flow ($)	$64.180,26	$66.917,54	$69.771,58	$72.747,34	$75.850,01
Cumulative Cash Flow ($)	$745.196,08	$812.113,62	$881.885,20	$954.632,53	$1.030.482,54

As it is shown in Figure 9, the proposed system starts to gain profit in the middle of the 5th year of the investment. At the end of the 6th year of the investment, the cumulative cash flow will be 14.779,85 $. At the end of the 10th year of the investment, the cumulative cash flow reaches 167.256,36 $. In a 25 years of perspective, the total profit of the system is calculated as 1.030.482,54 $.

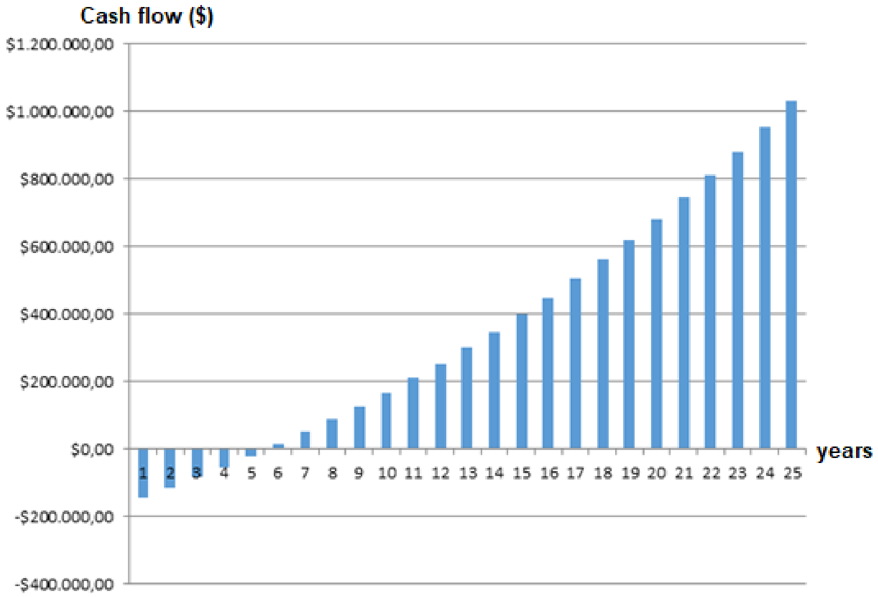

Figure 9. Cash Flow Balance of Investment with Equity.

With the establishment of the proposed system, the electrical energy transferred to the electricity grid will be a renewable energy-based energy, and it will also have an impact on the CO_2 footprint. According to the International Energy Agency (IEA) data, Türkiye's average grid emission intensity is 459.6 g/kWh. In return, the amount of CO_2 emission in the current grid of 208781.38 kWh energy, which is expected to be produced from the proposed system, is approximately 95.96 tons/year. On the other hand, lifetime emission values of silicon solar panels are in the range of 22-46 g/kWh. In this case, the CO_2 footprint in the proposed system is expected to be 7.30 tons/year (by taking an average value of 35 g/kWh), With the system going into production, 88.65 tons of CO_2 emissions per year will be avoided.

4. CONCLUSION

In this study, an economic feasibility analysis is made for a PV SPP which is planned to locate in the campus area of Kutahya Dumlupinar University. First, renewable energy production in the world and Türkiye's situation is investigated. The PV energy-based renewable energy production of Türkiye is interpreted by years.

Then, the area where the PV SPP will be installed on the Kütahya Dumlupınar University campus was examined. A 3000 m^2 area where face to south is selected for PV SPP installment. Different rated-power PV panels are compared by cost per watt. Contrary to popular belief, despite the increase in PV panel rated power, it has been observed that the cost per watt has not decreased. The minimum cost per watt value is achieved for 285 watt c-Si monocrystalline PV panels.

Shading distance of PV panels is calculated. Shading distance of PV panels are calculated not only by using solar altitute angle, but olso used combination of solar azimuth angle and solar altitude angle together. The distance between two PV panel string is determined as 2 meters. When longer distances between two PV panel strings cause less installed power capacity, shorter distances cause decrease in power generation during the day.

After the shading distance is calculated, the dimensions of the proposed PV SPP were determined. The proposed PV SPP is considered as 3 PV panel strings and each string has 176 PV panels in series. So, in the proposed system, there are 528 pieces of 285-watt power-rated PV panels, and the total installed capacity of the proposed PV SPP is considered 150 kWp. On the AC power side, it is considered that 5 pieces of 25kW power-rated three phase on-grid string inverter are used that each inverter connected to 106 pieces of 285-watt power-rated PV panels.

The solar radiation coming to the horizontal surface at the installation site are investigated. Grid-connected crystalline silicon-based PV SPP basic efficiency parameters are presented. Then, the daily and monthly energy production of the planned PV SPP is examined. In the results, the system total cost is calculated as 145000$ and the annual energy production of the planned system is calculated as approximately 208000.00 kWh/year. It's found that the system will start to make profits at the middle of the fifth year of investment.

The future workflow for further studies can be as follows:

- Comparision of an on-grid PV SPP and an autonomous (off-grid) PV SPP for the campus can be made.
- Distrubuted PV SPPs for top roof applications of some faculty buildings in the campus can be planned.
- Feasibility analysis can be made with considering using wind-PV hybrid systems.

ACKNOWLEDGEMENT

The author declares that there was no conflict of interest in the course of this study.

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