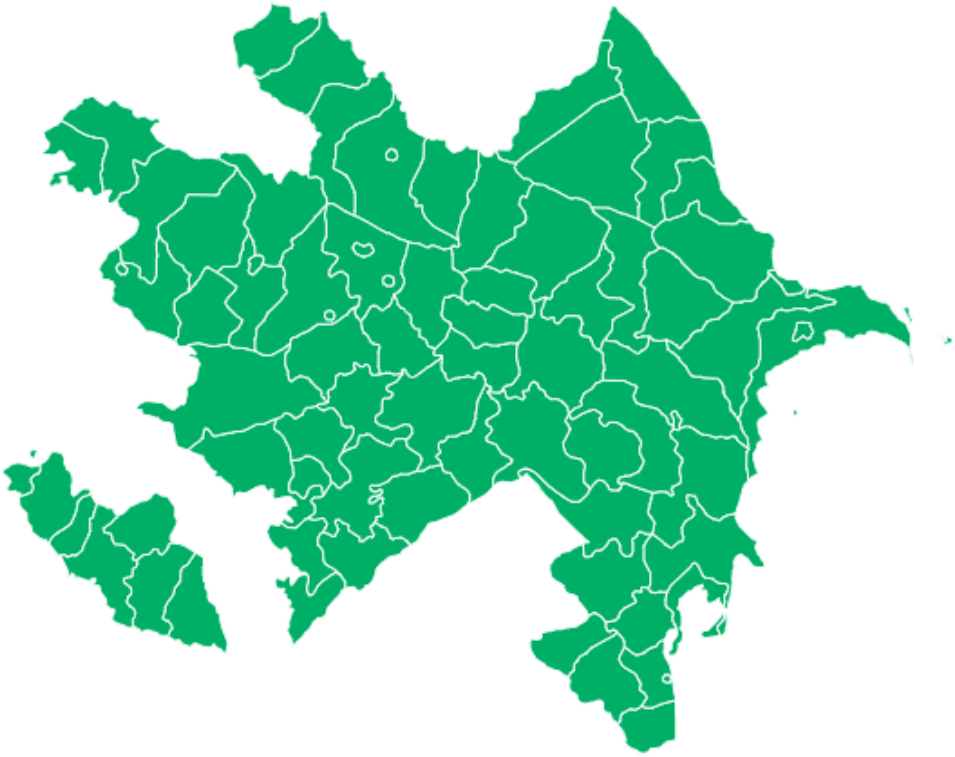
ENABLING PV in Azerbaijan



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Published by:
eclareon GmbH
Albrechtstr. 22
10117 Berlin, Germany
E: info@eclareon.com
T: + 49 30 8866740-0
Fax: + 49 30 8866740-11
www.eclareon.com

Person responsible for content under §55 paragraph 2 RStV: Christoph Urbschat (eclareon)

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Authors of the study:

Julian Scheider, Alik Aylarov, Éléonore Ray, eclareon GmbH

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List of Acronyms

Acronym	Definition
ADB	Asian Development Bank
AKIA	Agribusiness Credit and Development Agency
AGT	Azerbaijan-Georgia-Turkey power bridge
AERA	Azerbaijan Energy Regulatory Agency
AREA	Agency for Renewable Energy Sources
AZN	Azerbaijani Manat
bcm	Billion cubic meters
BP	British Petroleum
BSW	Bundesverband Solarwirtschaft (German Solar Industry Association)
CAPEX	Capital expenditures
C	Celsius
CHP	Combined heat and power plant
CDA	Central Dispatch Administration
CIS	Commonwealth of independent states
DCF	Discounted cash flow
DSCR	Debt service coverage ratio
DSO	Distribution system operator
EAS	e-Agriculture information system
EIB	European Investment Bank
EBRD	European Bank for Reconstruction and Development
EUR	Euro

FDI	Foreign direct investment
GDP	Gross domestic product
GTI	Global tilted irradiation
GTI opta	Global tilted irradiation at optimum angle
GW	Gigawatt
GWh	Gigawatt per hour
ha	Hectare
HPP	Hydro power plant
HV	High voltage
IFC	International Finance Corporation
IRR	Internal rate of return
JSC	Joint stock company
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt per hour
kWp	Kilowatt peak
LCOE	Levelized costs of electricity
LLCR	Loan life cycle coverage ratio
LTD	Limited company
mcm	Million cubic meter
m^2	Square meters
m^3	Cubic meters
MoU	Memorandum of Understanding
MoE	Ministry of Energy
MW	Megawatt

MWh	Megawatt per hour
NPV	Net present value
PJ	Petajoule
PP	Power plant
PPA	Power purchase agreement
PV	Photovoltaic
PV out	Photovoltaic power output
RES	Renewable energy source
SCADA	Supervisory control data acquisition
SOCAR	State Oil Company of Azerbaijan Republic
SOFAZ	State Oil Fund of the Republic of Azerbaijan
SHPP	Small hydro power plant
SPP	Solar power plant
SSC	State Statistical Committee
TPP	Thermal power plant
TWh	Terawatt per hour
UAE	United Arab Emirates
USAID	United States Agency for International Development
USD	US dollar
VAT	Value added tax

Objectives of the ENABLING PV Azerbaijan project

The market for solar PV installations has become more and more international over the last decade. While the first solar boom was mainly restricted to developed countries, who decided to support renewable energies with often similar support schemes such as feed-in tariffs, the landscape today is different and much more diverse. Having already reached or being on the verge of reaching cost competitiveness with conventional energy sources in many countries, the number of markets and of viable business models have multiplied in the last years. And just as every project is different, so are the framework conditions in every country.

It is in this context of the intensely growing international PV market that the consulting company eclareon along with the German Solar association BSW have started in 2013 to investigate business models and the business environment for PV in different countries under the project "ENABLING PV". The first study was published in 2014 and since then many more studies have been published, covering countries such as Tunisia, Jordan, Kazakhstan, Brazil, Argentina, Nigeria, Angola, Iran, Pakistan and Afghanistan.

The name of the project itself "Enabling PV" demonstrates the main aim of this report: enabling the growth and development of solar-based energy around the globe. In order to achieve this goal, projects are needed and the first step towards this may be the generation, distribution and also discussion of country-specific knowledge. **ENABLING PV reports shall provide a starting point for those investors and entrepreneurs, who have a specific interest in the field of solar energy and are willing to expand their business to new markets**.

This report on the photovoltaic energy potential in Azerbaijan is part of eclareon's overarching project "ENABLING PV, Solar Schools and Solar Universities in Central Asia and the Caucasus". The first contact with local stakeholders in Azerbaijan was established in June 2022, when eclareon's director Christoph Urbschat visited Baku and held a workshop with local stakeholders and organizations responsible and interested in the development of PV in Azerbaijan.

Since then, the search for pilot projects has predominantly focused on the application of PV for agricultural irrigation, i.e. solar-powered irrigation systems. In the exchange with local stakeholders in Azerbaijan, a large demand for these solutions has been identified. At the same time, medium-sized solar and water management companies from Germany can provide the required solutions, sharing their know-how with Azerbaijani companies and specialists. As a result, several pilot projects are currently being discussed with the active participation of German and Azerbaijani companies and the government.

In September 2022, a round table was organized in Azerbaijan with the support of the German Chamber of Commerce and Industry in Azerbaijan with the aim to identify key areas of development of photovoltaic solutions in the region. As a result of the talks, priority projects were identified in the field of solar-powered irrigation. Therefore, this report, apart from providing a comprehensive overview of the current framework conditions for PV in Azerbaijan, assesses the economic potential for solar-powered irrigation systems in Azerbaijan.

Berlin, December 20th, 2022

Julian Scheider
Project Manager, "ENABLING PV in Azerbaijan"

Executive Summary

Azerbaijan covers its domestic energy needs with its vast reserves of oil and gas and also exports large quantities of fossil fuels. Due to the large gas and oil reserves in the region, thermal power plants play a major role in the energy sector, many of which are inherited from the Soviet past. Although in recent years diversification strategies have been launched, Azerbaijan's economy remains largely dependent on fossil fuel exports and vulnerable to volatile fossil fuel prices of the world market.

Despite favorable natural conditions for the deployment of PV, Azerbaijan is still in the early stages of developing the renewable energies sector. Global trends as well as the economic and geographical predisposition of Azerbaijan prompted the Azerbaijani government to state the plan of achieving a share of 30% for renewable energies in the national energy mix until 2030. One of the goals of this report is to identify economically viable business models that can enable the country to achieve this goal.

It is in this context, that the international consultancy company eclareon GmbH, which specializes in renewable energy and energy efficiency, with the support of the German Solar Industry Association (BSW-Solar), has analyzed the current processes and possible barriers in the Azerbaijani photovoltaic sector. This study includes key data on the electricity market of the Republic of Azerbaijan, as well as an analysis of potentially attractive PV business cases identified for the country.

A fundamental aspect of the project is to provide the most significant and detailed information on the current state of the PV market in the Republic of Azerbaijan. All the information published in this report shall be used to support the development of the renewable energy sector in Azerbaijan by both national energy sector participants and external stakeholders.

The legal, regulatory and market conditions for the development of PV systems in the Republic of Azerbaijan are crucial factors in attracting investors in renewable energy projects. In addition, a cost-benefit analysis can help to identify viable business cases for PV systems in the country.

While investigating the Azerbaijani PV market, water scarcity was identified as one of the key environmental issues in Azerbaijan. In light of the planned large-scale development of PV along with the importance of the agricultural sector in Azerbaijan and recurring problems of water scarcity, this ENABLING PV report presents a business case on a solar water pump with a water storage tank, which can be implemented and utilized in different regions, taking into account the various geographical conditions of the country.

One of the main findings of this report is that PV powered irrigation systems are already highly profitable when introduced into the agricultural sector in Azerbaijan, which often faces difficulties with irrigation efficiency. However, substantial barriers for investment remain in other areas of the fledgling PV market, with solar energy representing a mere 48 MW, i.e. 0.6% of total installed capacity, in 2021. Regarding the required legal framework for renewables in Azerbaijan, the law "On the Use of Renewable Energy in the Production of Electricity" was published in 2021, representing the very first step in providing a reliable legal mechanism for the development of renewable energy projects. However, support mechanisms for renewable energies have only been announced but not been elaborated in detail and implemented in practice yet.

The report is structured as follows: Section 1 gives an overview of the energy market in Azerbaijan, including key data on installed capacity, electricity consumption and demand,

stakeholders and the structure of the energy market. Section 2 provides information on the current status of the PV market in Azerbaijan. Section 3 outlines the regulatory and business framework for renewable energies in Azerbaijan. Section 4 provides key information on irrigation and the agricultural sector of Azerbaijan, the main focus area of this report. Section 5 presents a business case, with a profitability analysis for solar-powered irrigation in Azerbaijan. Section 6 gives an assessment of the PV market in Azerbaijan and suggests measures for the further development of the renewable energy market in Azerbaijan.

Xülasə (Executive Summary)

Neft və qaz resurslarının geniş ehtiyatları ilə Azərbaycan öz daxili enerji ehtiyaclarını ödəyir, eyni zamanda, xaricə külli miqdarda artıqlıq ixrac edir. Azərbaycanın enerji sektoru özünüməşğulluq subyektidir. Bölgədəki böyük qaz və neft ehtiyatlarına görə termik elektrik stansiyaları enerji sektorunda böyük rol oynayır. Onların çoxu sovet keçmişindən miras qalıb. Son illər diversifikasiya strategiyalarına start verilsə də, Azərbaycan iqtisadiyyatı qalıq yanacaq ixracından asılıdır və ixrac bazarında qeyri-sabit qalıq yanacağı qiymətləri qarşısında acizdir.

PV-nin geniş miqyasda yerləşdirilməsi üçün əlverişli təbii şəraitə baxmayaraq, Azərbaycan hələ də bərpa olunan enerji sektorunun inkişaf etdirilməsinin ilkin mərhələsindədir. Qlobal tendensiyalar, eləcə də Azərbaycanın iqtisadi və coğrafi meyilli olması Azərbaycan hökumətini milli enerji qarışığında bərpa olunan enerjilər üçün 30% paya nail olmaq üzrə iddialı planı bəyan etməyə vadar etdi. Bu hesabatın məqsədlərindən biri ölkənin bu məqsədə çatmasına şərait yaradan iqtisadi cəhətdən əlverişli biznes modellərini müəyyənləşdirməkdir.

Məhz bu kontekstdə Almaniya Günəş Sənayesi Assosiasiyasının (BSW-Solar) dəstəyi ilə bərpa olunan enerji və enerji səmərəliliyi üzrə ixtisaslaşmış "eclareon GmbH" beynəlxalq məsləhətçi şirkəti Azərbaycan fotovoltaik sektorunda baş verən və mövcud olan aktual prosesləri və mümkün maneələri təhlil edib. Bu araşdırmada bütövlükdə Azərbaycan Respublikasında elektrik enerjisi bazarındakı vəziyyətə dair əsas məlumatlar, eləcə də ölkə üçün müəyyən edilmiş potensial cəlbedici biznes hallarının təhlili yer alıb.

Layihənin əsas istiqamətlərindən biri Azərbaycan Respublikasının PV bazarının cari vəziyyəti haqqında ən əhəmiyyətli və ətraflı məlumatların verilməsidir. Bu hesabatda dərc olunan bütün tədqiqat məlumatlarından Həm daxili enerji sektorunun aktyorları, həm də xarici hüquqi şəxslər üçün Azərbaycanda bərpa olunan enerji sektorunun inkişafı üçün istifadə oluna bilər.

Azərbaycan Respublikasında PV sistemlərinin inkişafı üçün hüquqi, normativ-hüquqi və bazar şərtləri bərpa olunan enerji layihələrində investorların cəlb edilməsi üçün həlledici amillərdir. Bu nöqtələr investorun nöqteyi-nəzərindən xərc-mənfəət analizi ilə birlikdə, regionda PV sistemləri üçün iş halının müəyyən edilməsi üçün kömək edir. Bundan əlavə, bu nöqtələr daha dərindən araşdırma və praktiki iş üçün də istifadə oluna bilər.

Azərbaycan PV bazarında araşdırma apararkən azərbaycanda əsas ətraf mühit məsələlərindən biri kimi su qıtlığının olduğu müəyyən edilib. Azərbaycanda kənd təsərrüfatı sektorunun əhəmiyyəti və su çatışmazlığının təkrarlanan problemləri ilə yanaşı PV-nin planlaşdırılmış iri miqyaslı inkişafı nəzərə alınaraq, bu "ENABLING PV" hesabatında su anbarı olan günəş su nasosu ilə bağlı işgüzar hal təqdim olunur. Ölkənin müxtəlif coğrafi şəraiti nəzərə alınmaqla, müxtəlif regionlarda bu iş həyata keçirilə və utilizasiya edilə bilər.

Bu hesabatın əsas nəticələrindən biri ondan ibarətdir ki, Azərbaycanda kənd təsərrüfatı sektoruna, xüsusilə də fermer təsərrüfatlarına daxil olduqda kiçik ölçülü PV sistemləri artıq yüksək gəlir əldə edir. Bununla belə, 2021-ci ildə günəş enerjisi cəmi 48 MVt, yəni ümumi quraşdırılmış gücün 0,6%-ni təşkil edən yeni PV bazarının digər sahələrində investisiya üçün əhəmiyyətli maneələr qalır. “Elektrik Enerjisi İstehsalında Bərpa Olunan Enerjidən İstifadə” kitabı 2021-ci ildə nəşr olunub və bərpa olunan enerji layihələrinin inkişafı üçün etibarlı hüquqi mexanizmin təmin edilməsində ilk addımdır. Bununla belə, bərpa olunan enerjilər üçün dəstək mexanizmləri yalnız elan edilib, lakin hələ ətraflı şəkildə işlənib hazırlanmayıb və təfərrüatlı şəkildə həyata keçirilməyib.

Hesabat aşağıdakı kimi strukturlaşdırılıb: 1-ci bölmədə quraşdırılmış güc, elektrik enerjisi istehlakı və tələbat, maraqlı tərəflər və enerji bazarının strukturu, eləcə də PV-nin cari vəziyyəti

haqqında əsas məlumatlar daxil olmaqla, Azərbaycanın enerji bazarının icmalı verilir. bazar. Bölmə 2 Azərbaycanda bərpa olunan enerjilər üçün mövcud tənzimləyici və biznes çərçivəsini təsvir edir. 3-cü bölmə bu hesabatın əsas diqqət mərkəzində olan Azərbaycanın irriqasiya və kənd təsərrüfatı sektoru haqqında əsas məlumatları təqdim edir. 4-cü bölmə Azərbaycanda günəş enerjisi ilə işləyən suvarma üçün rentabellik təhlili ilə biznes nümunəsini təqdim edir. 5-ci bölmədə Azərbaycanda PV bazarının qiymətləndirilməsi və Azərbaycanda bərpa olunan enerjinin gələcək inkişafı üçün lazım olan addımlar verilir.

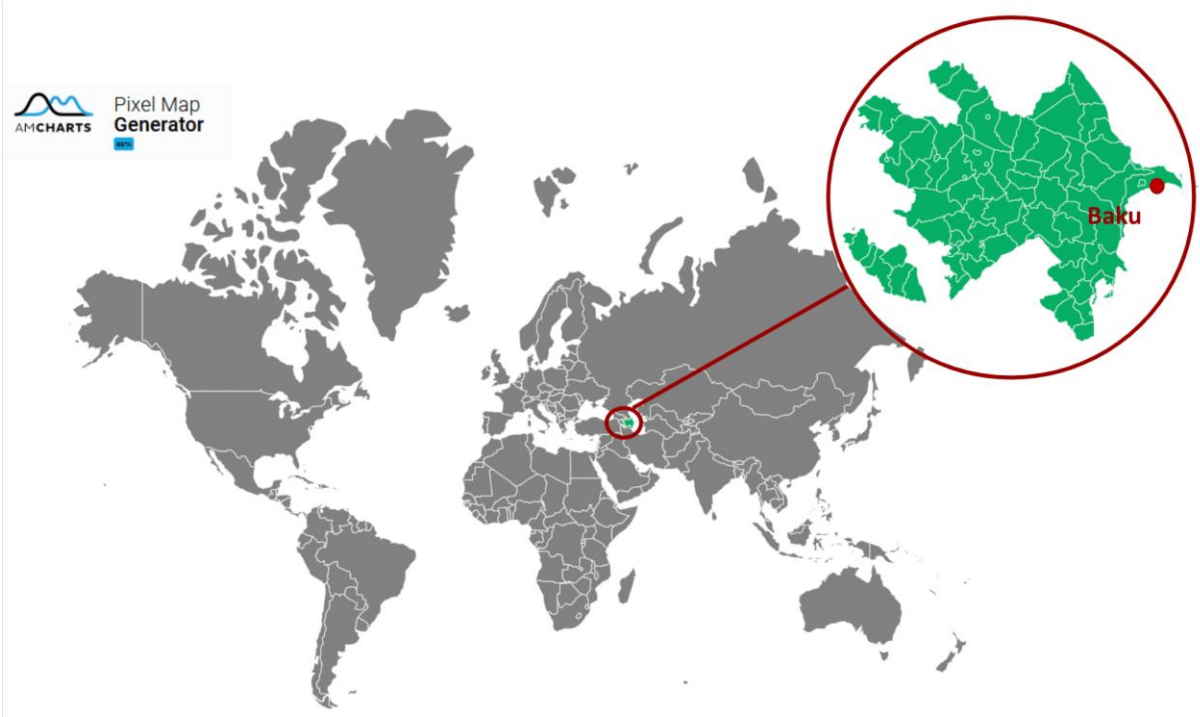
1. Introduction to the Energy Sector in Azerbaijan

1.1. Country overview

The Republic of Azerbaijan is located in the Southern Caucasus region, with an area of 86,573 square kilometers and a population of 10.2 million. Following the collapse of the Soviet Union, the country regained its independence in 1991 [1]. As a result of the prolonged Nagorno-Karabakh conflict, the country is divided into two parts: the landlocked exclave of Nakhchivan is separated from the main area of the country. Azerbaijan borders Russia and Georgia to the north, Turkey to the west, Iran to the south, and has a sea border to the east.

Azerbaijan has a moderate climate with mild winters and hot summers. Mean annual precipitation is 463.24 mm and average temperature is 13.37°C [2]. However, the climate varies greatly across the regions, with semi-arid zones in the center and east of the country, temperate zones in the north, and continental and tundra zones in the west.

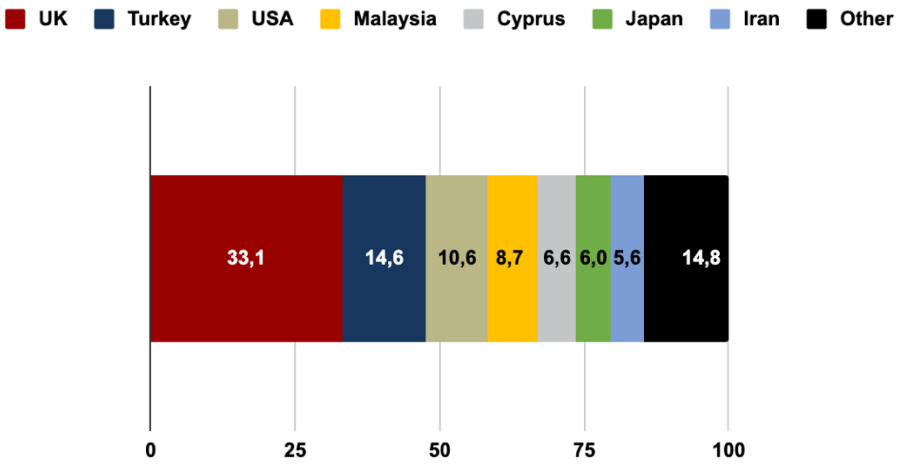
Figure 1: Azerbaijan in the world



Source: eclareon 2022; map generated with the help of Pixel Map Generator, amCharts

Azerbaijan is one of the most dynamic economies in the Caucasus and former Soviet bloc countries. In 2021, Azerbaijan was ranked the 50th economy according to the ranking of GDP in constant prices and 82nd in current prices [6]. Azerbaijan's GDP (current prices) in 2021 amounts to USD 54.62 billion, a tenfold increase since 2000. Industrial activity, particularly oil and gas production, is the predominant economic activity in Azerbaijan. It amounted to, on average, 52% of the country's GDP between 2010 and 2020 [7]. In 2020 oil and natural gas production provided for 60% of the state budget [8]. Historically, the oil and gas industry has also attracted most of foreign investment into the country [9]. According to the Central Bank of Azerbaijan, the main countries investing in the region are the United Kingdom (33.1% of all foreign investments), Turkey (14.6%), the United States (10.6%) and other countries such as Malaysia (8.7%), Cyprus (6.6%), Japan (6%) and Iran (5.6%) [10].

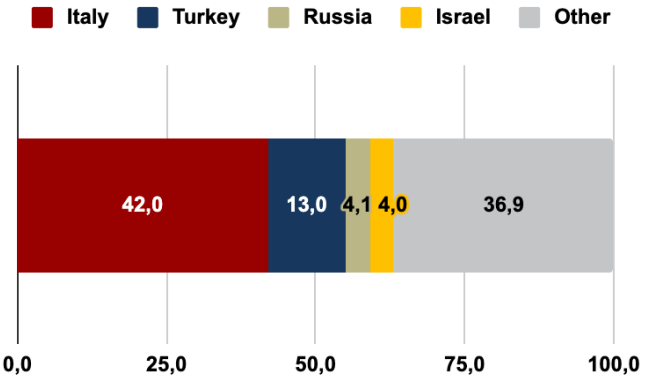
Figure 2: Foreign Investment in Azerbaijan by Country in 2021



Source: eclareon 2022; based on materials of the Central Bank of Azerbaijan

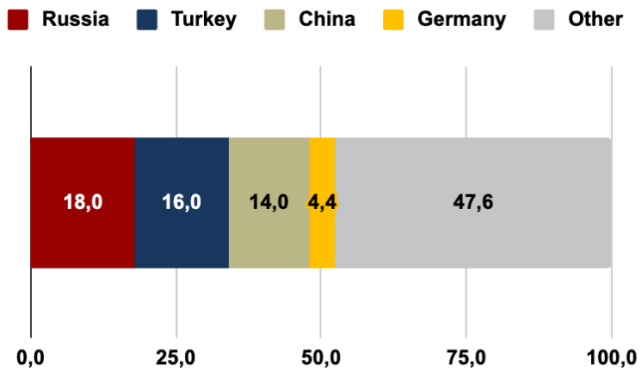
In 2021, Azerbaijan exported mainly to Italy (42%), Turkey (13%), Russia (4.1%) and Israel (4.0%) [11]. Oil and gas products account for almost 90% of Azerbaijan's export revenues, other exports such as plastics (2%) and cotton (1.2%) playing a marginal role [11]. Azerbaijan's imports are dominated by machinery (15%), vehicles (10%) and electrical equipment (8.4%) [12], with imports stemming mainly from Russia (18%), Turkey (16%), China (14%) and Germany (4.4%) [12].

Figure 3: Azerbaijan's Exports by Country in 2021



Source: eclareon 2022; based on materials of Trading Economics [11]

Figure 4: Azerbaijan's Imports by Country in 2021

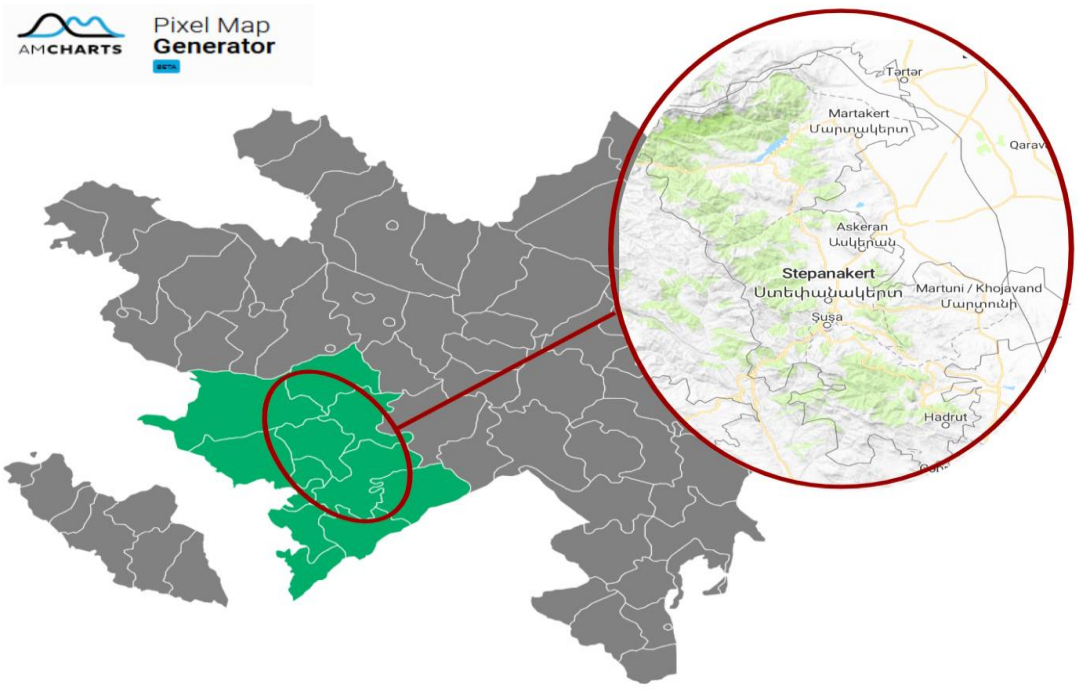


Source: eclareon 2022; based on materials of the Central Bank of Azerbaijan [12]

Azerbaijan's exports to the European Union are likely to increase significantly in the following five years, in light of a Memorandum of Understanding (MoU) on a Strategic Partnership in the Field of Energy signed by the European Commission and the Azerbaijani government in July 2022. The agreement foresees an increase in deliveries of natural gas from Azerbaijan to the European Union from 8.1 billion cubic meters (bcm) in 2021 to an expected 12 bcm in 2022. According to the MoU, Azerbaijani exports to the EU through the Southern Gas Corridor are set to more than double in the following five years, with deliveries expected to reach at least 20 bcm annually by 2027 [13]. The rising use of gas for exports is likely to encourage the government to develop additional capacities for renewable energy, which could be used as a replacement for natural gas to meet internal energy demand. The MoU confirms the ambition to reap synergies between the EU's energy transition and Azerbaijan's renewable energy potential.

In July 2020, Azerbaijan entered an armed conflict with its neighbouring country Armenia about the territorial ownership of Nagorno-Karabakh (see Figure 5). An official armistice started in November 2020, foreseeing the return of several of the territories in Nagorno-Karabakh to Azerbaijan [3]. However, the latent conflict between Armenia and Azerbaijan about the Nagorno-Karabakh region (see Figure 5) has periodically flared up again, as testified by the latest incident on the border near the village of Sotk in September 2022. The European Council hosted Azerbaijan and Armenia in Brussels in October 2022 to normalize the relationship [4]. Negotiation talks were pursued in Geneva on October 4th, 2022, under the auspices of the USA. This succession of negotiations suggests the converging interests of the countries in a peaceful settlement of the conflict [4]. The renewed interest of Western actors in this hydrocarbon-rich region may facilitate appeasement. Meanwhile, the economic development of the Nagorno-Karabakh region is one of the key priorities of the Azerbaijani government. Currently, a series of rehabilitation works are being carried out in Nagorno-Karabakh, with USD 1.6 billion of the current state budget allocated towards the reconstruction of formerly war-torn territories [5]. However, the following study focuses on areas of Azerbaijan, not directly related to the Nagorno-Karabakh region and the conflict with Armenia.

Figure 5: The Nagorno-Karabakh region within Azerbaijan



Source: eclareon 2022, map generated with the help of Pixel Map Generator, amCharts and scribblemaps

Building on revenues generated from oil and gas exports and a steady inflow of foreign capital, Azerbaijan has undergone a modernization of its industrial, educational, health and housing sectors in the last two decades. The recent economic boom is evidenced by a more than fivefold increase of average GDP per capita in the last 20 years, with average GDP per capita amounting to USD 4,221 in 2020 [14]. However, due to the volatility of oil prices, a rentier state like Azerbaijan depends on the volatility of global market prices for fossil fuels: while Azerbaijan's average annual GDP grew by 15% from 2000 to 2009, the GDP growth rate was only 1% from 2010 to 2020. The oil price shocks in 2014-2015 and in 2020 had a major negative impact on Azerbaijan's GDP, which decreased by 3.1% in 2016 and by 4.3% in 2020 [21].

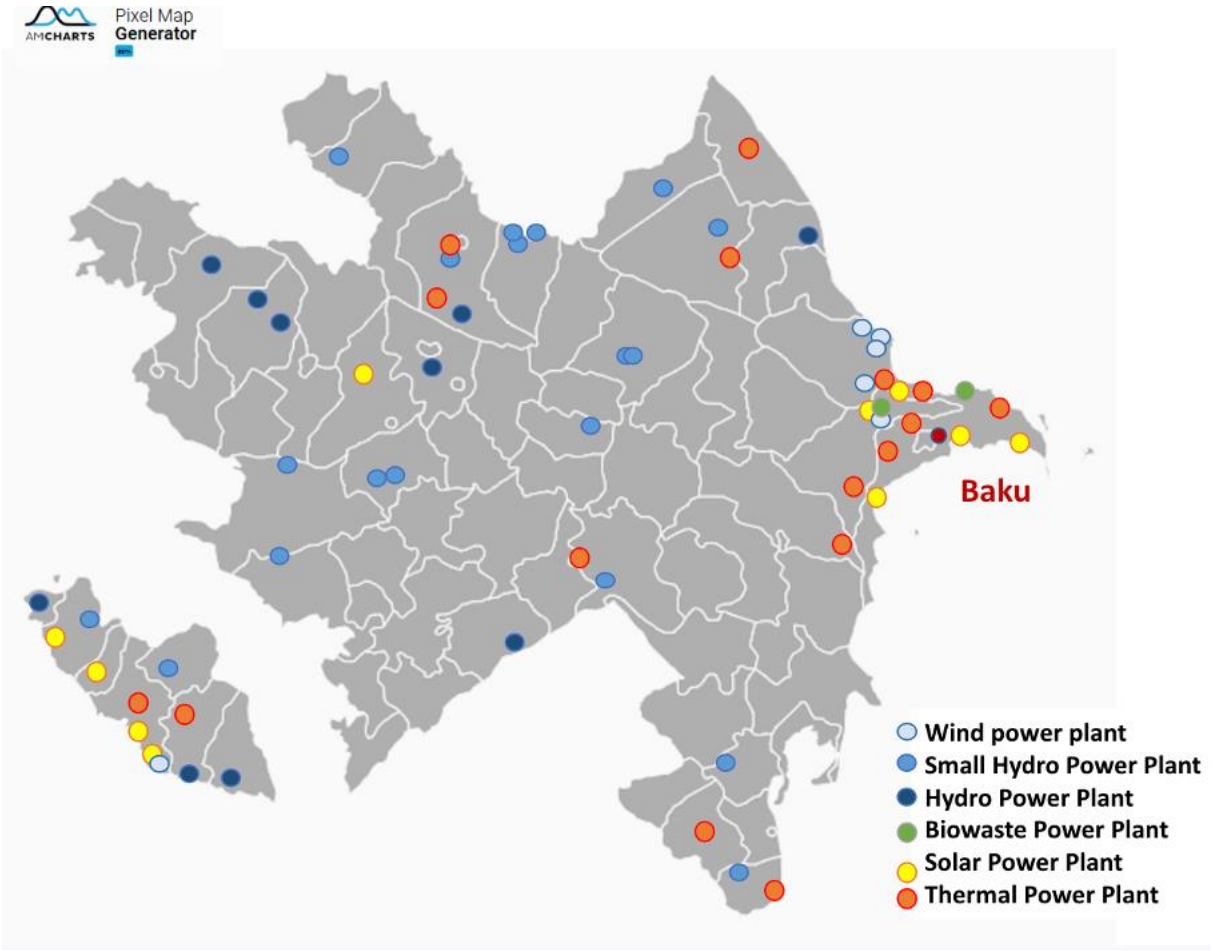
These numbers show, that the boom of Azerbaijan's oil and gas industry has come as a double-edged sword, increasing the dependency of the economy on fossil fuel exports. In order to tackle this problem, in 2016, the Azerbaijani government designated agriculture, tourism, logistics and information/communication technology as the four priority sectors for diversifying Azerbaijan's economy [88]. Agriculture already plays a key role in the Azerbaijani economy, with 37% of Azerbaijan's working population employed in agriculture [16]. However, the share of agriculture of total economic output has remained low ever since the collapse of the Soviet Union – in 2020, only 7% of Azerbaijan's total GDP was derived from the agricultural sector [15]. The agricultural sector has been selected as the main focus area of the present study – with high potential both for economic growth and the deployment of renewable energies.

1.2. Installed Capacity and Electricity Generation

Azerbaijan's energy sector is nearly self-sufficient. In 2020, Azerbaijan imported merely 0.5 petajoule (PJ) of electricity and 10.8 PJ of oil. Besides, 98% of the primary energy production and 90% of electricity generation in 2019 were attributed to oil and gas production [8]. However, most of the energy produced from oil and gas is not used for domestic consumption: in 2020, 40% of Azerbaijan's annual natural gas production and 90% of the country's annual oil production were exported [23]. At the same time, and in correlation with the economic growth since the collapse of the Soviet Union, domestic energy demand has increased by almost one third (30%) since 1996 [24]. Nevertheless, in 2021, energy use per capita remained below the global average, amounting to 17,924 kWh [90]. In 2020, more than half of the energy was consumed by the residential (37%), transport (21%) and industrial sectors (13%) [28].

Azerbaijan's installed electricity generation capacity reached almost 8 GW (7,965.2 MW) in 2021 [27], which represents an increase of 61.7% as compared to 2000 (see Figure 7 below). Since 2000, most of the total installed capacity is represented by gas-fired thermal power plants [27].

Figure 6: Electricity Power Plants in Azerbaijan in 2021

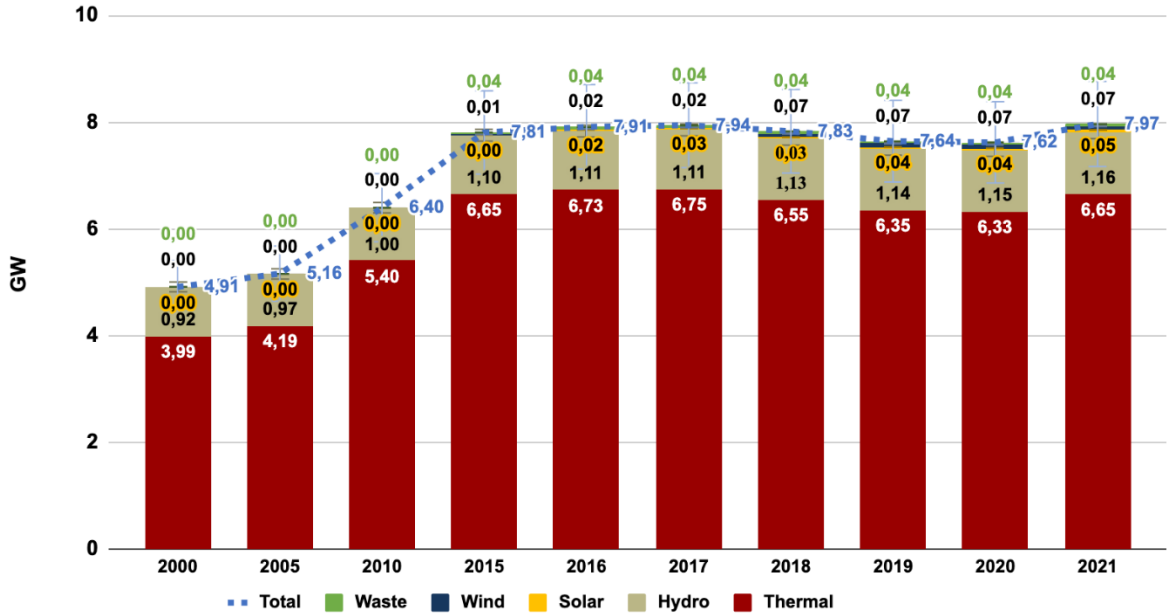


Source: eclareon 2022, non-exhaustive list, map generated with the help of Pixel Map Generator, amCharts; based on data of the Ministry of Energy of Azerbaijan [31]

In total, there are 70 installed power plants with a total installed capacity of 7,927.2 MW in 2021. This includes 19 thermal power plants, 10 hydro power plants, 20 small hydro power plants, 12 solar power plants (including two hybrid ones), 7 wind power plants (including two

hybrid ones) and 2 biomass power plants (including one hybrid one) in 2020 (see Figure 6 above) [31]. The hybrid Gobustan power plant, in close proximity to Baku, combines solar, biomass and wind.

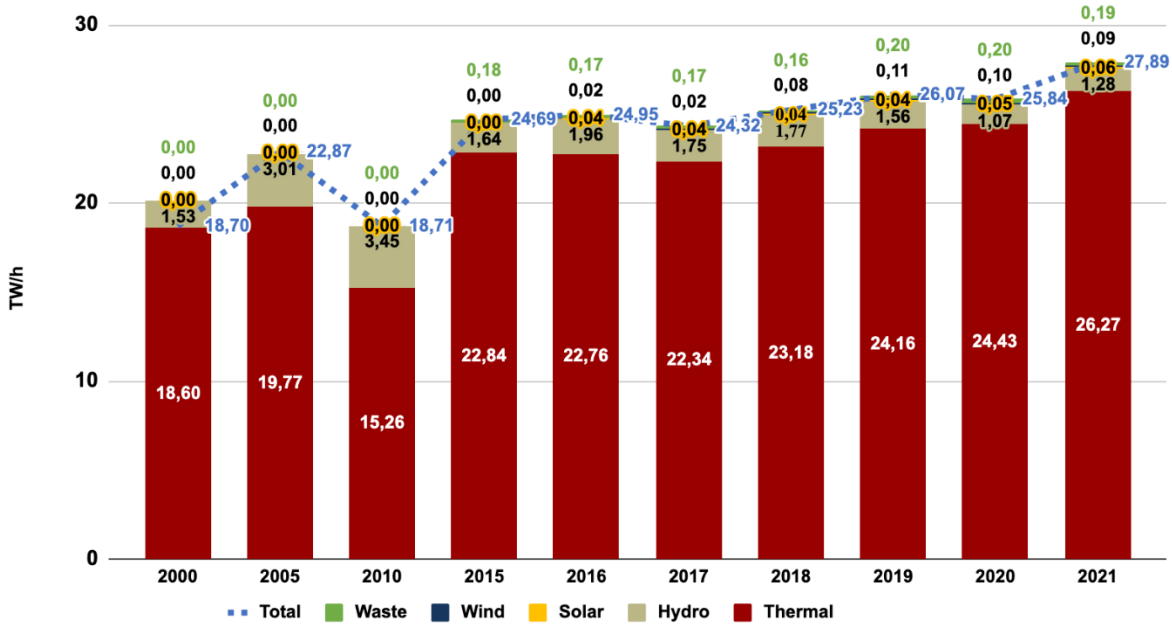
Figure 7: Total installed capacity by sources of energy in GW (from 2000 to 2021)



Source: eclareon 2022, based on the materials of SSC [26].

As Figure 7 shows, the installed capacity has been stable since 2015, after the surge of the 2000s. Total capacity has increased by 2.7 GW since an energy policy introduced in 2005 (see Section 1.5.1).

Figure 8: Electricity Generation by source of energy in TWh (from 2000 to 2021)

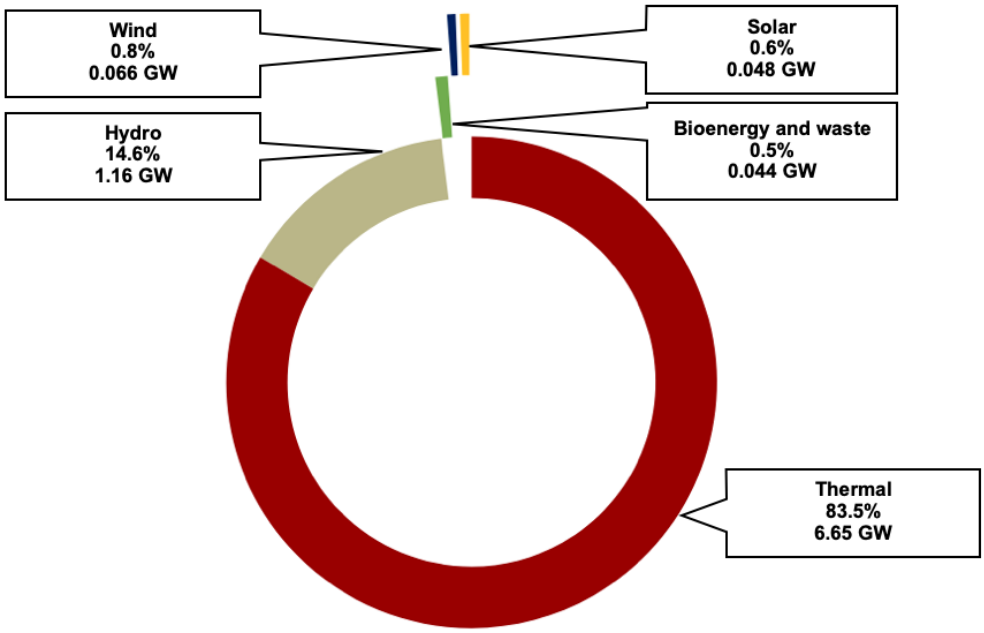


Source: eclareon 2022, based on the materials of SSC [33].

In 2021, Azerbaijan produced 27.89 TWh, mainly from thermal power plants (26.27 TWh), as Figure 8 shows. Electricity generation has increased by 49% since 2000. It dropped in 2010 (see Figure 8 above) due to the global financial crisis which also hit Azerbaijan's economy. As the local production was affected by the fall of oil prices and an outflow of foreign investments.

In Azerbaijan thermal power plants are mainly fueled by gas and oil. In 2000, oil accounted for 13.45 TWh of electricity generation compared to 3.71 TWh for gas. With the energy reforms initiated by the Government to ensure energy security (See Section 1.5), the generation of electricity by oil dropped in 2010 to 0.023 TWh whereas the electricity generation by gas increased to 15.24 TWh in 2010 and 24.38 TWh in 2020 [115]. Today, oil-fired generation has nearly disappeared and is only used occasionally in times of economic crisis, as it was the case in 2016 or 2021 [121] [122] [123].

Figure 9: Shares of installed electricity capacity by type of energy source in 2021

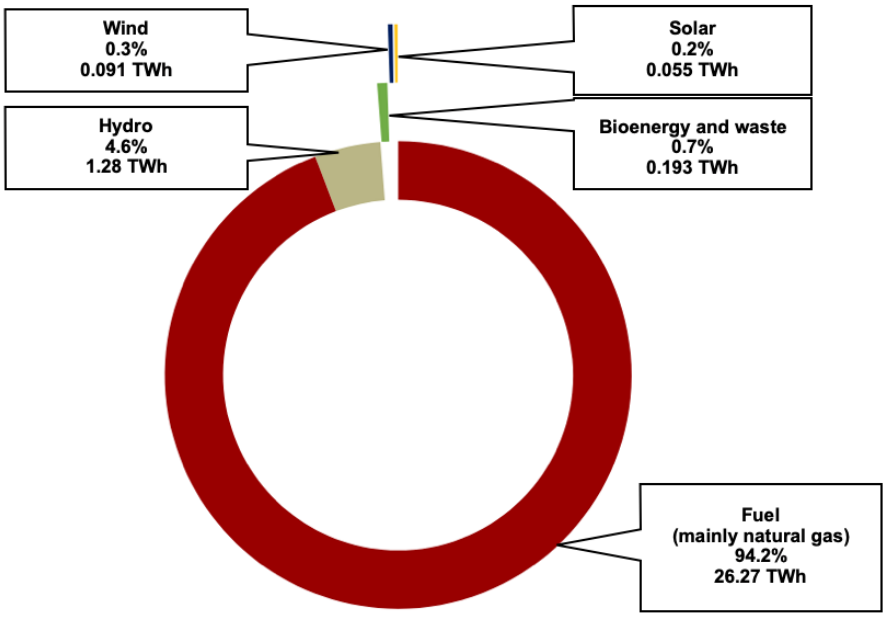


Source: eclareon 2022, based on the materials of SSC [26].

In 2021, thermal power plants represented 83.5% of total installed capacity. The hydropower plants accounted for 1.16 GW (14.6%). Renewable energies (wind, solar and biomass) totaled only 157.9 MW, the equivalent of less than 2% of total installed capacity.

As depicted in Figure 10, fuel accounted for 93.76% (26.27 TWh) of generated electricity in 2021. Natural gas constituted the largest type of electricity generator in 2021. Power plants (electricity, CHP, heat) were predominantly fueled by 5,893 thousand TOE of natural gas, followed by 136 thousand TOE of oil fuel and 15 thousand TOE diesel fuel [121] [122] [123]. Hydroelectric energy represented only 4.6% (1.28 TWh); bioenergy and waste 0.7% (0.193 TWh); wind 0.3% (0.091 TWh) and solar energy 0.2% (0.055 TWh) of the generated electricity in 2021 [33].

Figure 10: Shares of different energy sources by generated electricity in 2021



Source: eclareon 2022, based on the materials of SSC [33]

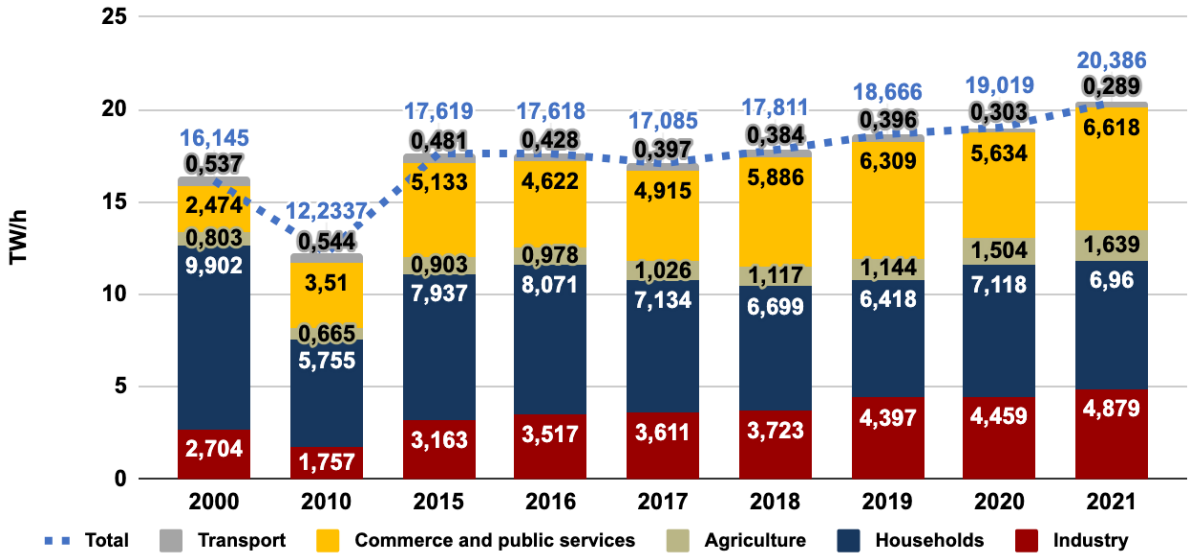
Despite the launch of new initiatives, the role of renewables (excluding hydro power) is still very limited with less than 2%, i.e. 0.343 TWh of generated electricity and 168.36 MW of installed capacity in 2020. However, its geographic location, the proximity to the Caspian Sea and a diverse climate with mountainous relief provide Azerbaijan with large potential for both solar and wind energy development. According to official sources, the renewable energy potential amounts to 26,900 MW [37], comprising mainly solar (23,000 MW) and wind (3,000 MW) energy, followed by hydro power (500 MW) and biomass (400 MW). Nonetheless, some factors hinder the development of renewable energy, such as low oil prices, lack of legal incentives, the disinterest of political and economic decision-makers or public neglect [38]. In comparison, for the other two Caucasian states, Armenia and Georgia, renewables represented 9% and 6% of total installed capacity (excluding large hydropower plants) [22].

Azerbaijan plans to install more capacity in the following years [13]. This is linked to a growing population and hence increasing electricity consumption. At the same time, Azerbaijan has set a target for renewable energy to provide 30% of the total installed capacity by 2030 (including hydropower) [52]. According to the German consulting company VPC, at least 1,500 MW of RE must be additionally installed by 2030 to achieve this goal [29].

1.3. Electricity Consumption and Demand

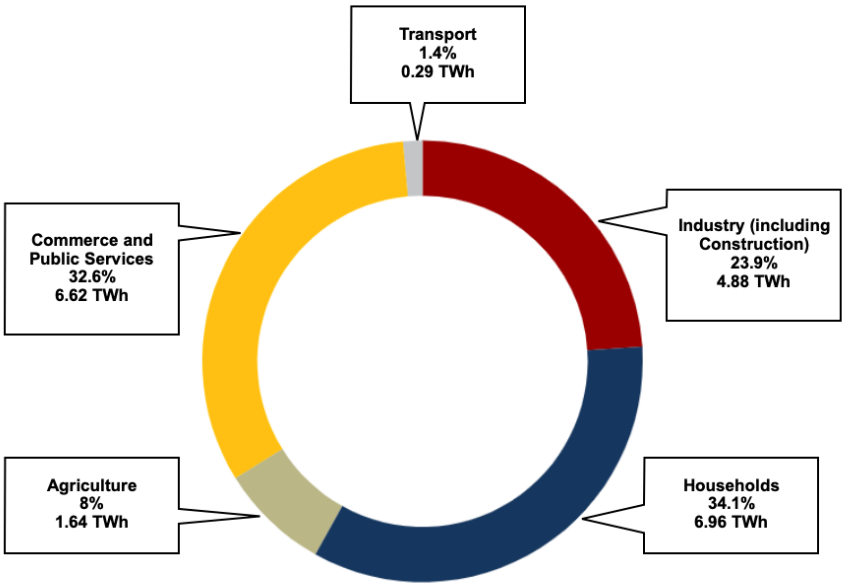
Electricity consumption in Azerbaijan reached 20.38 TWh in 2021. Households, industry (including construction), and public services are mainly responsible for this consumption. Overall electricity consumption increased by more than 26.3% since 2000. As Figure 11 shows, the electricity demand from the service and industry sectors has increased since 2000, whereas household consumption has substantially declined in the last two decades.

Figure 11: Electricity consumption by sector in GWh from 2000 to 2021



Source: eclareon 2022, based on the materials of SSC [39]

Figure 12: Electricity consumption by sector in 2021



Source: eclareon 2022, based on the materials of SSC [39]

Azerbaijan produced 27.89 TWh in 2021 [33] of which 25.72 TWh were consumed, including final consumption (20.39 TWh), net exports (1.52 TWh) and the energy industries' own

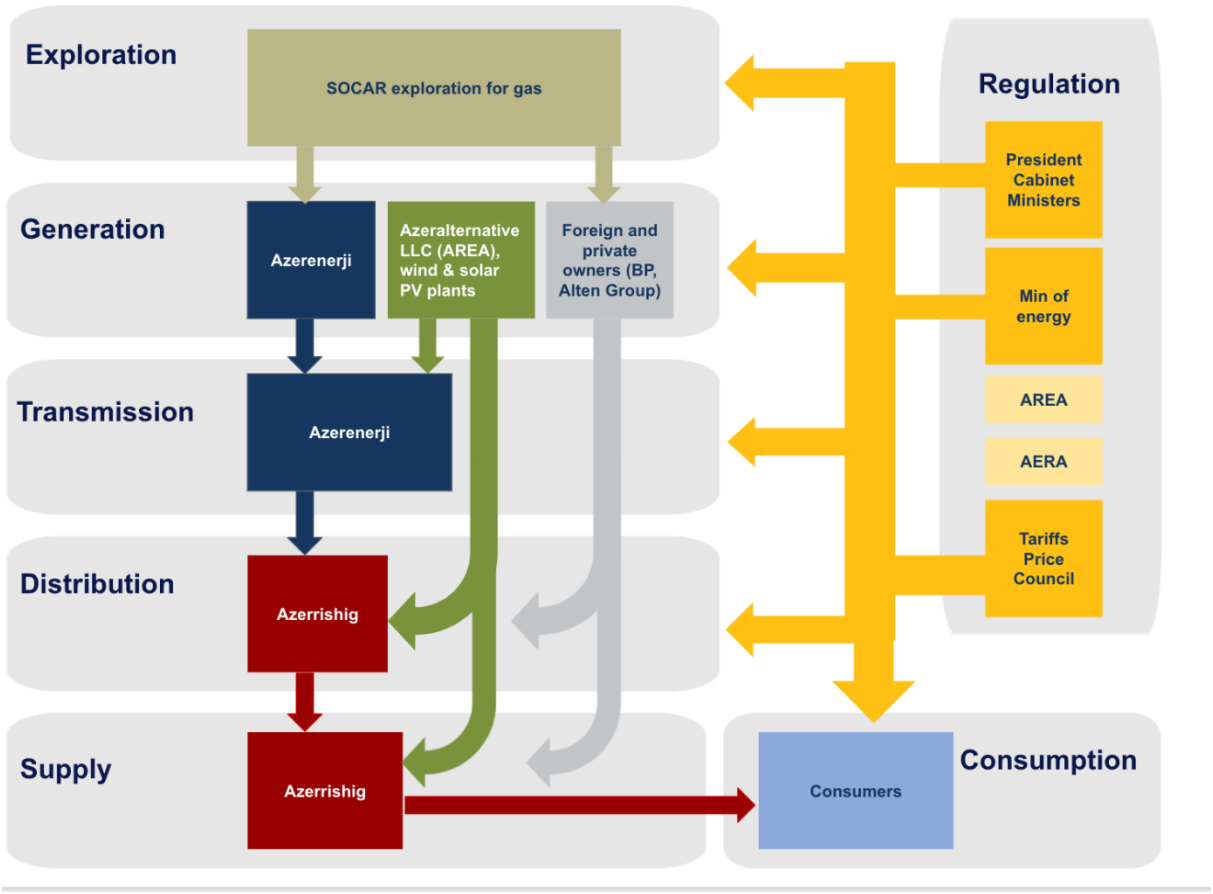
consumption (3.81 TWh). Final consumption includes the consumption of all industries (except the energy industries' own consumption) including construction, transport, agriculture, trade and public institutions, and households. While the agricultural sector accounted for only 8% of the electricity consumption, the electricity demand from the agricultural sector has increased more than twofold between 2010 and 2021.

The network electricity losses in 2021 reached 2.15 TWh, including 0.39 TWh in transmission and 1.76 TWh in distribution networks [39].

1.4. Structure and Stakeholders of the Electricity Market in Azerbaijan

Azerbaijan's energy sector is controlled by monopolistic state-owned companies, a legacy of the Soviet Union.

Figure 13: The Electricity Market in Azerbaijan



Source: eclareon, based on the materials of IDEER [32].

The entities of the electricity market in Azerbaijan can be divided into the following categories:

- **Supervising bodies of the electricity sector:** the Presidential Administration, the Cabinet of Ministers and the Ministry of Energy (MoE)
- **Institutional infrastructure organizations:** the Tariff Council, the Azerbaijan Energy Regulatory Agency (AERA), the Agency for Renewable Energy Sources (AREA) and the State Statistical Committee of the Republic of Azerbaijan (SSC)
- **Technology infrastructure organizations:** the Central Dispatch Administration (CDA), the Azerenerji Management, Science and Laboratory Complex
- **Electricity producers:** Azerenerji, State Oil Company of Azerbaijan Republic (SOCAR, oil and gas exploration)
- **Electricity supplier:** Azerishig (supplier and distributor)

1.4.1. Supervising bodies of the electricity sector

The Cabinet of Ministers of the Republic of Azerbaijan is the central governing body in the power sector. The Cabinet of Ministers establishes the general principles of the energy policy, its development and determines the financing. The Ministry of Energy supervises the implementation of state policies, regulations and decrees adopted by the government in the energy sector. The MoE also oversees various entities as well as commercial institutions. Several agencies are under its authority, including AREA and AERA.

1.4.2. Institutional infrastructure organizations

The Tariff Council is mainly responsible for determining the tariffs of electricity, gas and renewable energy. The Tariff Council is chaired by the Minister of Economy [8] [118].

Based on the decree "On Approval of the Strategic Roadmap for the National Economy and Major Economic Sectors", the Azerbaijan Energy Regulatory Agency (AERA) was established in December 2017. The functions of AERA correspond to the analysis and drafting of the electricity price proposal. The chairman of AERA and its two deputies are appointed by the Ministry of Energy. AERA monitors the compliance of producers, transmission operators, distributors, suppliers and consumers with energy laws, and conducts energy market analyses. For liberalization purposes, the calculation and approval of energy price functions will be transferred from the Tariff Council to AERA [8] [117].

In September 2020, the Azerbaijan Renewable Energy Agency (AREA) was created under the Ministry of Energy. The Agency reports on and regulates the market for the development of the renewable energy sector [8] [116]. As with AERA, the Minister of Energy of the Republic of Azerbaijan appoints and dismisses the Director of AREA and his two deputies. It supports the state in the development of its policies, organizes the regulation of renewable energy activities and enhances the feasibility of renewable energy activities. The Agency also manages the state-owned enterprise Azalternative Energy. The Agency has been developing dynamically and has publicly expressed a desire to modernize [42].

The State Statistical Committee of the Republic of Azerbaijan (SSC) is responsible for providing official accurate and reliable energy data to improve the energy sector [8] [119].

1.4.3. Technology infrastructure organizations

The Central Dispatch Administration (CDA) is responsible for the control of Azerbaijan's energy system. It manages, controls and optimizes all activities carried out to ensure uninterrupted management of power generation and transmission [8]. The telecommunications system used for this purpose is SCADA. It provides real-time network visualization, monitoring and continuous management of the status, supply processes and changes in power plants, substations and transmission lines [73] [124]. The Azerenerji Management, Science and Laboratory Complex in Baku was inaugurated by the president in 2020, who stressed the importance of such a facility after the 2018 black-out, as well as the need for a monitoring and control system [125]. The power system in the Nakhchivan Autonomous Republic is managed by the Nakhchivan Autonomous Republic Energy Agency [32].

1.4.4. Electricity producers

The energy system comprises five main stages: exploration, production, transmission, distribution and supply.

As mentioned before, electricity generation in Azerbaijan largely depends on oil and gas exploration and production [126]. Founded in 1992 by the government, SOCAR is the leading national company for oil and gas production [8]. Its functions include oil and gas exploration and exploitation as well as refining, negotiating contracts for the state and supplying natural gas to Azerbaijan's industry and population. It controls the entire oil and gas energy value chain with the exception of retail oil supplies. Holding a monopoly in the domestic market, the company also has a substantial presence abroad. It operates in Turkey, Georgia, Romania, Switzerland, Germany and Ukraine. SOCAR receives financial support and strategic guidance from the government of Azerbaijan [25]. As for electricity generation and transmission, Azerenerji owns nearly all power plants, apart from minor renewable energy installations. Established in 1996, it is the only player in the generation and transmission segments in the entire country except in the Nakhchivan administrative region. In 2017, the monopolistic system was split in two. Along with the former one, a new system, the State Energy Service, was created in Nakhchivan administrative region to manage generation, transmission, distribution, and supply in this autonomous republic [43].

Since 1992, the state-owned company Azerenerji has dominated the entire generation and transmission market. The company owns 86% of all installed power plants in Azerbaijan, amounting to 6.46 GW (as of 2020) [31]. Alongside Azerenerji, the state-owned companies Nakhchivan, Azerishig and Azalternative Energy, respectively owned 244.4 MW (3.3%); 55.3 MW (0.7%); and 16.9 MW (0.2%) of total capacity in 2020 [34]. Officially, private independent power producers control 738.06 MW (9.8%) of total installed capacity. In practice, real private companies controlled 7 power plants in 2019, i.e. 604.6 MW (8%) [32]. SOCAR, established by a decree of former President Heydar Aliyev, owns a thermal power plant (133 MW) and the Balakhani biomass plant (37 MW). It falls into the category of private independent power producers for official statistics because it has internationalized and is now headquartered in Geneva [26].

These independent power producers mainly specialize in renewable energy. Nakhchivan AR dominates and controls 27 MW of solar (67.5% of all solar capacity installed) and 5.9 MW of small hydropower plants (24%) [26]. Azerishig OJSC owns 55.3 MW (95.3%) of all wind power capacity. Azalternative Energy LLC possessed 13 MW (32.35%) of solar capacity in 2020. Independent companies hold 37 MW of capacity from biomass sources (98.1% of the biomass market) and 9.2 MW from small hydropower plants (37.4%). The independent companies dominate biomass power generation capacity. Nonetheless, they receive their revenues mainly from their 683.8 MW of thermal power plants. BP is the main foreign actor in the energy market of Azerbaijan. Other foreign players such as the Middle-Eastern companies Masdar or ACWA Power International have recently entered the market [45] [46].

1.4.5. Electricity suppliers

Azerishig is the responsible institution for electricity distribution and supply. Azerishig emerged in 2015, when the government transferred the distribution assets and functions of Azerenerji to this new company as a first step toward market reform. Its goal is to ensure a quality distribution system by maintaining and building a network that meets international norms and standards [47]. For example, following the instructions of the state, the company undertook the renovation of the network of 13 villages in the Jalilabad and Bilasuvar districts [48].

1.5. Grid Infrastructure of the Electricity Market in Azerbaijan

The grid system in Azerbaijan officially provides universal access to electricity. The total length of Azerbaijan's high voltage networks is approximately 7,800 km: 1,505 km at 220 kV, 31 km at 230 kV, 1,542 km at 330 kV and 477 km at 500 kV. There are 93 high-voltage substations on the grid. However, the capacity of the network is generally below 110 kV [29].

Azerbaijan is connected via transmission lines to Russia (330 kV), Georgia (300 to 500 kV), Turkey (200 up to 330 kV) and Iran (154 to 330 kV) [32].

1.5.1 On-Grid power generation

After the disintegration of the USSR Azerbaijan's authorities undertook reforms to modernize the infrastructure and to increase power capacity. The aim was to ensure the country's energy independence and energy security. Only eight power plants were working in 1990. The State Program for the Development of the Fuel and Energy Sector of the Republic of Azerbaijan (2005-2015) increased the capacity of power plants by 54% in 2015 as compared to 1990 [49].

Apart from the construction of new power plants, the 2002 presidential decree ordered to fire thermal power plants with natural gas instead of oil, which used to be the dominant fuel during Soviet times [29]. This decision solidified the energy independence of Azerbaijan, which disposes of significantly more gas than oil reserves. In 2021, Azerbaijan's oil reserves were estimated at 7 billion oil barrels and gas reserves at 60 trillion cubic feet (1.7 billion bcm) [112]. After the introduction of the new energy policies in the beginning of the 2000s the country transformed from being an importer to an exporter of hydrocarbons in 2007.

Despite the reforms, serious issues with regards to the stable supply of electricity remained since many of the most powerful power plants have been in operation since Soviet times. For instance, the thermal power plant TPP Azerbaijan with an installed capacity of 2,400 MW has been in operation since 1981 [51]. Similarly, the main hydro-power plants – Mingachevir HPP and Shamkir HPP with an installed capacity of respectively 424 and 380 MW – were built in 1953 and 1982 [56]. In general, the obsolescence of the domestic electricity infrastructure, non-compliance with technical regulations and lack of diversification of energy supplies has continuously led to short circuits, outages, and energy losses [29].

On July 3rd 2018, an electricity blackout in 39 regions of the country, including the capital Baku, caused serious issues in hospitals, strategic centers and industrial enterprises. According to the official investigation, the accident was caused by obsolete equipment, false risk assessments, negligence in safety rules and a lack of employees. Following this incident, the most obsolete power plant, the Srivan TPP (built in 1962) was decommissioned in May 2019. The dominance of state ownership of the electricity market is seen as one of the key factors of this energy instability and the main cause of these grid-related issues [50] [51].

1.5.2 Off-Grid power generation

According to official statistics, 100% of Azerbaijan's population has access to electricity. However, the actual level of electrification may differ from official figures, particularly in some

isolated regions, especially along the borders[1]. Outages are more frequent in these peripheral areas.

Three less well-served areas can be identified. Firstly, the installation of adequate infrastructure is hindered in the districts located in the mountainous area on the eastern border, comprising the districts of Gadabay, Dashkhasan and Lachin. Secondly, in the north full coverage is not ensured due to the terrain in the districts of Oghuz (north) and Shamakhi (north). The southern Azerbaijan districts of Jalilabad and Lankaran also partly suffer from a lack of physical infrastructure [132].

[1] Information provided in an interview with the Azerbaijan France Chamber of Commerce on 28 June 2022.

1.6. Electricity markets, prices, tariffs and costs

1.6.1 Wholesale and retail markets

As the liberalization of the Azerbaijani electricity market has only started in recent years, the Tariff Council and AERA are still setting prices. This system provides cheaper electricity for households. The electricity market is divided into three main segments:

- the purchase of electricity from renewable sources,
- the wholesale market,
- and the retail market.

The state-owned monopolies received USD 397 million in capital for Azerenerji and USD 601 million for Azerishıq from the government between 2015 and 2019. This financial support from the state can be explained both by very low tariffs for consumers and by the fact, that the number of employees is far above the level of optimal efficiency [29].

The Asian Development Bank and IEA suggest improving market efficiency, introducing competition, restoring high levels of service, reforming tariffs and abolishing the role of state-owned companies in social and employment policies [29] [50].

Prompted by the gas and oil price decline, the Azerbaijani government has undertaken reforms. To expand capacity, improve efficiency and attract investors, the government began to liberalize the market. The draft law “On Electricity” opened the power plant market to independent power producers, facilitating the acquisition of power plants. The “Strategic Roadmap for the Development of Utilities” (electricity, heating, water and gas), adopted in 2016, envisioned a gradual transition to a liberal market [52].

According to the World Economic Forum's energy transition index, transition readiness and system efficiency have improved in Azerbaijan since the last decade, ranked 44th in the overall index in 2021 [53]. Although generation efficiency is improving, market barriers remain and the monopoly status of state-owned energy companies hinders a successful energy transition [54].

1.6.2 Formation of electricity prices

In Azerbaijan the price of electricity is not directly set by the market. Instead, the Tariff Council sets electricity prices for different categories in such a way that energy services shall be affordable for the population. In line with the Decree of the Cabinet of Ministers "On Approval of Rules Ensuring State Control over Formation and Application of State Regulated Tariffs (Prices)" from 2005, the tariffs have to be set according to the cost-plus methodology [37]. This pricing method involves adding a fixed percentage to the costs required to produce one volume of output.

The price of electricity is one of the lowest in the region and the world (0.041 USD/kWh), compared to electricity prices for households in Armenia (0.041 USD/kWh), Georgia (0.086 USD/kWh), Belarus (0.062 USD/kWh) and Turkey (0.061 USD/kWh) [55].

Table 1: Electricity tariffs in Azerbaijan

Electricity tariffs in Azerbaijan		
	Groups	**Tariffs** **AZN/kWh, including VAT** **(EUR/kWh, including VAT - as of July 2022)[2]** **November 2021[3]**
1.	**Purchase**	
1.1	**Private small hydro power stations**	0.05 (0.029)
1.2	**Wind power stations**	0.055 (0.032)
1.3	**Other renewable energy sources**	0.057 (0.033)
1.4	**Other alternative energy sources**	0.066 (0.038)
2.	**Wholesale**	
2.1.1	**Day**	0.064 (0.037)
2.1.2	**Night**	0.037 (0.021)
3.	**Transmission**	0.002 (0.0012)
4.	**Retail**	
4.1	**Households**	-
4.1.1	**Households with monthly consumption less than 300 kWh**	-
4.1.2	**Households with monthly consumption more than 300 kWh**	-

[2] The numbers in brackets represent the converted EUR/kWh equivalent of AZN/kWh according to the exchange rate of 31 July 2022.
[3] The electrcity tariffs indicated in Table 1 are as of November 2021 as this was the last time the rates were changed by the Tariff Council (status: February 2023).

Electricity tariffs in Azerbaijan		
Groups		Tariffs AZN/kWh, including VAT (EUR/kWh, including VAT - as of July 2022)[2] November 2021[3]
4.1.3	**Households with monthly consumption less than 200 kWh**	0.08 (0.046)
4.1.4	**Households with monthly consumption between 200 and 300 kWh**	0.09 (0.052)
4.1.4	**Households with monthly consumption more than 300 kWh**	0.013 (0.075)
4.2	**Non-residential**	-
4.2.1	**Trade and Service**	0.011 (0.064)
4.2.2	**Other**	0.010 (0.058)

Source: eclareon, based on the materials of IDEER [32] and Tariff Council [74].

As shown in Table 1, there are four main categories for electricity tariffs in Azerbaijan:

1. the price of renewable electricity sold by private and public players,
2. the price on the wholesale market,
3. the price for transmission,
4. and the price on the retail market.

In November 2021, the transmission price amounted to AZN 0.002 the equivalent of EUR 0.001. The purchase price of renewable energy varies depending on the source of the renewable energy, i.e. from AZN 0.05 to 0.066 (equivalent to EUR 0.029 - 0.038).

On the retail market block tariffs apply to households residing in the country and a flat-rate tariff for non-residents, who are not registered as a VAT payer. Three subcategories were created for the former. The cost of the subscription depends on the household's consumption. In November 2021, new rates were introduced. Three new categories were created in the retail market based on household consumption. Households with consumption up to 200 kW per month pay AZN 0.08 (the equivalent of EUR 0.046) per kWh. Households with a monthly consumption from 200 kWh to 300 kWh (inclusive) pay AZN 0.09 (the equivalent of EUR 0.052) per kWh. As for households with a monthly consumption of more than 300 kWh the price per kWh rises to AZN 0.13 (the equivalent of EUR 0.075).

Electricity tariffs were stable until 2017 [56]. The subsequent introduction of new block prices based on different usage categories and the introduction of purchase prices from generators using RES led to an increase in prices [56]. Despite these increases, electricity prices remain under the cost of generation [56].

2. The PV market in Azerbaijan

Azerbaijan has a high potential for the deployment of solar energy: the Ministry of Energy estimates that the solar energy potential is 23,040 MW with between 2,400 and 3,200 hours of sunshine annually. The global horizontal insolation is estimated at 1,500 kWh/m2 - 2,000 kWh/m2 [58]. Located in the central river valleys, in the north and north-west of the country [59], Guba-Khachmaz, Kalbagar-Lachin, Daghlig-Shirvan and Nakhchivan are the most well-disposed regions for solar development. Due to the rise of domestic energy consumption, Azerbaijan is likely to increase the energy capacity for renewables to meet domestic energy demand [52].

Azerbaijan's total installed capacity for solar energy amounted to a meagre 48 MW with 11 large-scale solar power plants in 2021. The four most significant photovoltaic installations include Suraklany, Sungait, Piralki with an installed capacity of 2.8 MW and the "Nakhchivan Solar Power Plant", which was by far the country's largest PV power plant with a capacity of 20 MW [64][65]. It must be pointed out that solar energy only constituted 0.6 % of the total installed capacity in Azerbaijan in 2021.

Figure 14: Annual global solar irradiance on the sloping surface of Azerbaijan (GTI)

Source: Global Solar Atlas

Since 2017, a significant number of companies, including BP, Masdar, Tekfen Construction, and Avelar Solar, have signed Memoranda of Understanding with the Ministry of Energy on the large-scale development of renewable energies in Azerbaijan. In line with Azerbaijan's commitments under the Paris Agreement, Azerbaijan approved the draft law "On the Use of Renewable Energy Sources in Electricity Production" and "On Accelerating Reforms in the

Energy Industries of the Republic of Azerbaijan" in 2020. In cooperation with the Asian Development Bank, the MoE has agreed to conduct a pilot project on "Knowledge Exchange and Technical Assistance for the Development of Floating Solar Panels" in 2019 [30].

In accordance with the implementation of the Strategic Roadmap (December 6th, 2016), several projects for the installation of photovoltaic parks in the Hajigabul district, the Absheron Peninsula and the settlement of Alant were presented in December 2020. Masdar's 230 MW photovoltaic park located in the Garadagh and Absheron districts is expected to start commercial operation in 2023. Noticeably, Masdar's utility-scale solar PV is the first Azerbaijan's foreign investment PV project structured as a public-private partnership [62][66]. Moreover, Masdar signed an agreement to add 10 GW of capacity (in the first stage 4 GW and 6 GW in the second stage) of clean energy installations in Azerbaijan without indicating the specific timeline [67].

Regarding PV module or hardware manufacturing, currently, no local module production exists and, to the best of our knowledge, no module manufacturing site is currently planned. For the 230 MW photovoltaic park in the Garadagh and Absheron districts mentioned above, the required components were entirely imported from abroad [145].

As can be seen from the mere numbers of total installed PV capacity, the PV market in Azerbaijan is still in the very initial development phase, with a high potential for growth in the years to come if Azerbaijan's government is willing to deliver on its goals to reach 30% of renewables in the national energy mix until 2030.

3. Regulatory and Business Framework

3.1. Regulation and support schemes for renewable energy projects

It must be pointed out, that Azerbaijan is still a fledgling renewable energy market, not only with regards to the sheer numbers of installed capacity. Specific renewable energies-related legislation, necessary to provide a reliable framework for investors, has only emerged in recent years. The publication of the Law "On the Use of Renewable Energy Sources in the Production of Electricity" (No. 339-VIQ) in 2021 can be considered the very first step in creating a legal framework for the development of renewable energy projects. Detailed support mechanisms for renewable energies, such as feed-in-tariffs and net metering, still need to be defined, implemented and tested in practice in the coming years. Therefore, this section can only outline the provisions, formally written down in recently published legislation on renewable energies, but not give a full assessment of its actual implementation.

The following laws can be regarded as crucial for the overall energy sector in Azerbaijan: firstly, the Law "On Energy" (Law No. 541-IQ) from 1998, which regulates the exploration, exploitation, production, storage, distribution and transportation of oil and gas products. The law also affirms Azerbaijan's intention to minimize the carbon footprint of energy generation. Secondly, the Law "On Electrical Power" (Law No. 459-IG), published in 1998, and the Law "On Electricity and Thermal Power Plants" (Law No. 784-IQ), published in 1999, target the liberalization of the energy market and the participation of private actors in the energy sector.

Regarding legislation for the development of the renewable energy sector, until recently, Azerbaijan had only adopted action plans or roadmaps: In 2004, the "State Program on the Use of Alternative and Renewable Energy Sources", was published. For the first time, it estimated Azerbaijan's renewable energy potential, recommending the establishment of a regulatory framework for renewable energies. In line with this, the "Strategic Roadmap for the Development of Utilities", first published in 2016, re-iterated Azerbaijan's political will to develop the renewable energy industry. Despite having the status of legal acts, these documents merely outlined the government's intentions without following-up on the drafting and implementation of support mechanisms in practice [70].

In recent years, however, the drafting of renewable energy legislation has gained new momentum in Azerbaijan. Since 2019, the European Bank for Reconstruction and Development (EBRD) has been supporting the Government of Azerbaijan to develop a legal framework related to RES and to design a transparent and detailed legal process for the development of RES projects with the corresponding support mechanisms. As part of the first step of this process, the Order "Azerbaijan 2030: National Priorities for Socio-Economic Development", published in February 2021, and the Law "On the Use of Renewable Energy Sources in the Production of Electricity" (No. 339-VIQ), published in May 2021, introduced the concepts of feed-in tariffs, net-metering and other relevant support mechanisms for the development of renewable energies in Azerbaijan. However, how these support mechanisms are going to be implemented in practice was not defined in the law [68][71]. Hence, further action by the government is needed to determine and elaborate the auction system for RES, the processes for net-metering and feed-in-tariffs, the prerequisites for getting specific certificates to connect to the grid and the details for Power Purchase Agreements.

In addition, the government has also committed to introduce energy efficiency legislation [40]: In August 2021, the president of the Republic of Azerbaijan approved the new law “On Alternative Use of Energy Resources and Energy Efficiency” (No. 359-VIQ), which was developed with the support of the EU4energy initiative and European experts [41]. Entering into force in July 2022, the effectiveness of this law has yet to be evaluated.

3.1.1 Key regulatory incentives for renewable energy projects

The main regulatory incentives for renewables announced in the Law “On the Use of Renewable Energy Sources in the Production of Electricity" (No. 339-VIQ) from 2021, are guaranteed tariffs and off-take of the generated electricity as well as net-metering [68]. The law also specifies, that the selection of a developer for a renewable energy project is conducted by the Ministry of Energy. The selection is supposed to take place either by means of an auction (whereby the winner is determined based on the lowest electricity-generation price per kWh), or by means of direct negotiations (in case of pilot projects or projects of strategic importance). After being selected in either an auction or direct negotiations, the producer needs to conclude the following three agreements:

- 1) Investment Agreement with the Ministry of Energy
- 2) Power Purchase Agreement with the guaranteed buyer (Azerenerji)
- 3) Connection Agreement with the State Electric Power Enterprise (either Azerenerji or Azerishig, depending on the network)

It must be noted, that, according to Article 16 of the Law “On the Use of Renewable Energy Sources in the Production of Electricity” (No. 339-VIQ), apart from these three agreements project developers selected for a renewable energy project need an additional formal certificate. So far, the law only specifies, that a formal certificate is required, without providing concrete information on how it can be obtained. As of yet, no public information has been made available on the concrete requirements and content of this certificate. According to AREA, the specifications for obtaining this certificate have been submitted to the government for approval and will be made public in the foreseeable future.[4]

According to AREA, detailed rules of the auction mechanism have already been drafted and submitted to the government in October 2022, but, as of February 2023, still need to be approved by the government of Azerbaijan. These new auction rules are then supposed to be applied to auctions for new solar power plants, starting in 2023.[5]

Apart from this relatively recent legislation related to renewable energies, several incentives to attract foreign investment are already in place and implemented: By obtaining a so-called “investment incentive certificate”, granted by the Ministry of Economy, investors can benefit from partial exemptions in income tax and profit tax and full exemptions on VAT, property tax and land tax for a period of seven years. These general incentives for investors also cover renewable energy projects [72].

[4] Information provided by AREA in an email exchange from 25 January 2023.
[5] ibid.

3.1.2 Regulations on the electricity trade and purchase for private PV systems

The Law “On the Use of Renewable Energy Sources in the Production of Electricity” (No. 339-VIQ) from 2021 also introduced the “active consumer” concept, which closely resembles a net metering mechanism [114]. Depending on the balance between consumption and production, active consumers can sell their produced electricity at the wholesale tariff and buy grid electricity at the applicable retail tariff [136]. “Active consumer” refers to “*a legal or natural person producing electricity from renewable energy sources up to the power limit fixed by the President.*”

It is possible to install renewable energy capacity below 150 kW without a formal permit [141]. However, active consumers are legally obliged to install a meter at their own expense [144]. Given the short time frame between the introduction of the “active consumer” concept and the writing of this report, the effectiveness of this mechanism has yet to be evaluated.

3.2 Codes and Standards

3.2.1 Electricity transmission rules and technological grid connection

Currently, there is no precise regulation on the transmission rules and technological grid connection for RE installations. In accordance with Article 17 of the Law “On the Use of Renewable Energy in the Production of Electricity” (No. 339-VIQ), the producer benefits from the advantage of the prioritized transmission and distribution of electricity from RES. In parallel, producers of electricity should conclude the aforementioned Connection Agreement with the State Power Engineering Enterprise on the connection to the power grid (either Azerenerji or Azerishig, depending on the network) [73].

3.2.2 Electricity Standards

At the time of writing this report, the distribution system operator (DSO) is coordinating the draft of a new network code for the electricity sector as a whole intending to define the rules and technical requirements for ensuring stability, quality and reliability of the electricity system [73]. The code shall define the technical rules for the transmission and distribution of electricity and, by doing so, facilitate the coordination of all electricity market stakeholders. This code will also be of high relevance for the development of renewable energy in the country [68].

3.3 Terms of trade, investments and imports

3.3.1 Trade, investments and import conditions

As in the case of most other post-Soviet countries, Azerbaijan's economy underwent a series of reforms, which transformed and liberalized also the financial system. This transformation entailed the restructuring of the banking sector and the establishment of the State Oil Fund (SOFAZ) in 1999.

After the construction of the Baku-Tbilisi-Ceyhan oil export pipeline in 2006 and after a rapid increase in oil product prices foreign investments increased rapidly and went primarily into the oil and gas market. Foreign direct investment (FDI) inflows reached 16% of GDP in 2016, which was the highest rate in the Caucasus region. However, in the past FDI in Azerbaijan has often been subject to the volatilities of the oil and gas market [75].

In Azerbaijan the import of equipment, facilities and tools related to RES is exempt from VAT and customs duty [80]. Apart from that, for investors residing in technological parks, additional advantages are granted. The Tax Code of the Republic of Azerbaijan exempts residents of industrial parks from corporate income tax, property tax and land tax for 10 years and VAT for imported machinery, technological equipment and devices in industrial parks for 7 years, starting from the year of registration [80].

3.3.2 Inflation and interest rates

Inflation rates in Azerbaijan have fluctuated between 2% and 7% since 2018. In 2021, the inflation rate was 6.7%, which was the lowest among all CIS countries. Due to the current tense geopolitical situation, the average inflation in Azerbaijan from January to May 2022 has been surging and reached 12.4% [76]. Prices for energy and food, especially for flour and meat, are likely to remain high [77].

Azerbaijan's key interest rate changes frequently, but in recent years has remained in the range between 6% and 8%. From September 2021 to March 2022, the key interest rate changed five times and rose from 6.25% to 7.75%. This has been linked to a tightening of monetary policy by Azerbaijan's central bank, which started in September 2021 [79].

3.4 Financing of PV power plants

The financial market in Azerbaijan is modestly developed and so far, local banks' support for RES projects has been limited. The banking sector is underdeveloped, as evidenced by the ratio of banking assets to GDP, which amounts to only 47%. Among the 29 banks operating in Azerbaijan in 2020, four hold more than 60% of the market. Industry (16% of the bank credit portfolio in 2020) and agriculture (4%) are sectors that are not prioritized by local banks. Renewable energy projects are mainly financed by the government and by foreign financial institutions according to AREA [81].

In 2015, for the purpose of improving the financing of the agricultural sector, the Agribusiness Credit and Development Agency (AKIA) was created. Noticeably, the fund is fueled by international donors such as the European Union, the Korean International Cooperation Agency and the Union Nations Development Program [113].

The European Union is the most active contributor to RES projects in Azerbaijan. Through the European Investment Bank (EIB), the EU4Energy and the Technical Assistance and Information Exchange instrument the EU helps to develop financing solutions and to advise on the regulatory framework via the European Neighborhood Policy (ENP) or via other bilateral agreements. The EU has helped Azerbaijan to shape a long-term sustainable energy strategy, to encourage energy efficiency and to develop energy labels [82] [83].

The European Bank for Reconstruction and Development (EBRD) is the most active actor among foreign banks in financing RES projects. It has already spent EUR 716 million (88% of its current portfolio allocation in Azerbaijan) to implement sustainable infrastructure [84]. The EBRD allocated EUR 51 million to Masdar's Alat Solar industrial park. Beyond financial assistance, the EBRD supports the implementation of renewable energy auctions and policy framework for small-scale renewable energy projects [85].

The Asian Development Bank (ADB) planned to commit USD 35.7 million to the Alat solar park. In addition, it completed two pilot projects and provided technical assistance for the development of floating solar projects [86].

The World Bank also cooperates by supporting the development of offshore wind parks. Noticeably, other organizations such as USAID or IFC have been assisting Azerbaijan in the expansion of renewable energy [87].

4. Irrigation and agriculture in Azerbaijan

4.1. Overview of the water and irrigation situation in Azerbaijan

Efficient water management poses one of the major environmental challenges in Azerbaijan given the intermittency and spatial variability of the availability of water resources. Average renewable water supply fluctuates between 23 billion cubic meters (bcm) and 32 bcm during dry years [91]. The largest rivers Kura and Arak - which play a crucial role as they provide 80% of total water resources - rise and mostly flow outside of Azerbaijan's borders. Hence, 70-75% of total water (appr. 10 bcm) is forming outside of Azerbaijan [92]. Water resources per capita have been dropping by 40% since 1990 [93]. They are sevenfold less in Azerbaijan than in water-rich countries such as, for example, Georgia. Water extraction in Azerbaijan in 2021 totaled 13.7 bcm. Excluding 3.2 bcm of water losses during transportation, the water available for consumption was equivalent to 10.5 bcm [93]. Uncertain and unequal distribution of water creates regional imbalances in access, for example in rural areas and particularly on the Absheron Peninsula [91].

Climate change has already significantly impacted Azerbaijan's water resources. The country's annual rainfall has decreased by 14.5% over the period 2012-2021 compared to 2002-2011 [128]. Locally, climate change disruptions are reflected in desertification around the Baku region and frequently occurring flash floods in the north of the country. Rising temperatures cause an increase in evaporation, which exacerbates water scarcity and soil degradation [127]. As the risks associated with climate change, including the risk of desertification, remain high, the authorities are striving to tackle the lack of water efficiency. One of the ways to reduce water consumption is through the use of solar energy as suggested in our business case [69].

Several measures have been taken to improve water efficiency. The rate of water loss during transport has been reduced from 33% in 2010 to 23% in 2021 [93]. The Water Users Association Development Support Project has contributed to improve the efficiency of irrigation water distribution. Investments in rehabilitating the water canal networks help to reduce water losses [100]. Apart from that, in 2020 the government of Azerbaijan launched an Action Plan [94], which foresees the creation of additional reservoirs, the modernization of irrigation canals and the securing of drinking water supplies in several small towns and rural areas [95]. In official declarations**,** president Ilham Aliyev emphasized the need to solve the water problem using the most advanced technology [97] and the authorities have announced their willingness to involve German companies [63].

In 2021, 72% of total water consumption in Azerbaijan was related to agriculture and irrigation, which amounted to 7.6 bcm [93]. Irrigated crops account for 80% of the value of agricultural food production. Officially, 55% of the total area of Azerbaijan is dedicated to agriculture but only 1.4 million of these 4.7 million hectares are irrigated [96]. These facts as well as high solar potential ensure a suitable environment for using solar energy in irrigated crops to boost water and energy efficiency.

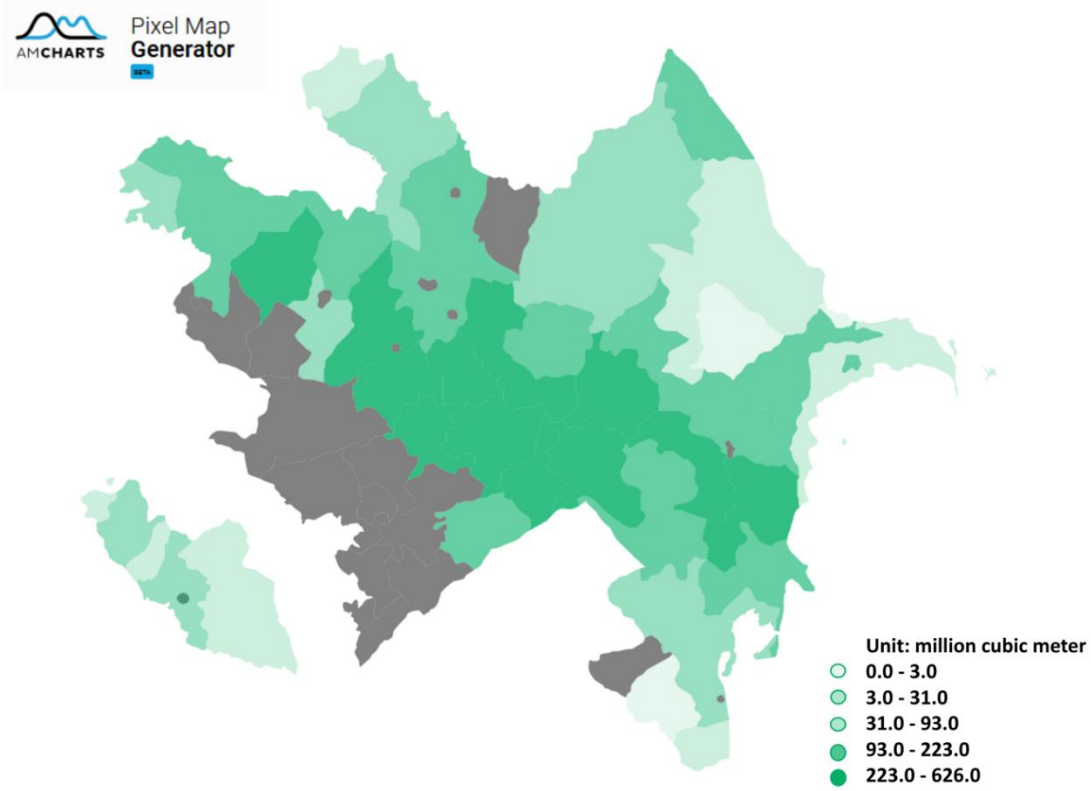
4.2. Structure of the agricultural sector and irrigated lands in Azerbaijan

In 2021, the agricultural sector contributed only 5-6% to GDP while 36.3% of the total employed population (1.8 million persons) was working in the agriculture, forestry and fishing sectors [15]. As a result, workers' incomes are lower in these economic sectors than in the rest of the economy [129]. The main agricultural outputs of Azerbaijan are cotton, grain, fruits and vegetables (primarily grapes, tomatoes and cucumbers), livestock and tea [107].

Following the disintegration of the USSR, the collective lands in Azerbaijan were re-distributed. As a result, Azerbaijan's agricultural sector is currently extremely fragmented and dominated by small-sized farms: In 2018, 88% of the farms in Azerbaijan were below 5 ha, which corresponds to 85% of all agricultural lands [78]. However, the minimum size of subsistence is 10 ha [98]. Due to the small size of these farms, many rely on subsidies. Only 1.4% of the total number of farms are larger than 20 ha and only 0.4% are larger than 50 ha [98]. The business case presented in Section 5 of this study is most relevant for the larger agricultural entities, that are most likely to be able to invest in solar pumps suitable for large-scale irrigation.

Of the 4,780.6 thousand ha cultivated lands only 31% were irrigated [130] [131]. The five districts using the most irrigation for agriculture are Shamkirn in the northwest of the country (360.9 million cubic meter, mcm), Banda (495.6 mcm), Adjabedi (624.2 mcm) and Kurdamir (332.3 mcm) in the center and Sabirabad (444.6 mcm) in the southeast. Notably, all these districts in the Aran economic region benefit from a substantial level of insolation (see Figure 14 above).

Figure 15: Irrigated lands in 2021 (million cubic meter)



Source: eclareon 2022, map generated with the help of Pixel Map Generator, amCharts and SSC's materials

Different irrigation techniques and equipment are used in Azerbaijan today, encompassing for example mechanical and electrical pump stations, sub-artesian wells, and diesel-powered pumps. Mechanical irrigation dominates and accounts for 40% of total irrigated land, electrical pump stations for 25%, sub-artesian wells for 10.56% and diesel generators for 4.85%[6] [99].

Since 2016, the government of Azerbaijan has launched a series of measures to both modernize outdated machinery and remove structural barriers in agriculture. The agricultural sector is supported through grants, tax exemptions and subsidies on machinery, fertilizers, and pesticides [88]. At the same time, the digitalization of the agricultural sector has been pushed forward. The launch of the e-Agriculture Information System (EAIS) in 2019 was one of the most far-reaching initiatives in this regard, allowing farmers to digitize their activities and giving them access to government subsidies for crops, seeds and animal breeding. As of 2022, more than 600,000 farmers are registered in the system [89]. In addition, a pilot project for the construction of a smart village in Agali has been underway since 2020 [19].

[6] For 270 thousand hectares or 19.27% of total irrigated lands, the type of irrigation is not specified in official statistics.

5. Selected business case

This section is dedicated to the profitability analysis of one PV business model in Azerbaijan. It includes sample calculations such as cash-flow modelling and sensitivity analyses and provides an outlook of profitability changes related to changes in energy yield and fuel costs.

The water scarcity, the need to increase the efficiency of agriculture as well as the plan of the government to increase renewable energy capacity suggest the economic assessment of an exemplary PV business case for solar-powered irrigation systems in Azerbaijan. This business model is described in the following section.

A solar water pump is an electric pumping system, that includes a set of solar panels that power an electric motor, which is used to operate a pump, that draws water from groundwater or a surface-water resource such as a pond, a river or a lake.

Given the high levels of water stress in Azerbaijan, a need for efficiency in water management has been identified, particularly in agriculture. The business case in this study focuses on the profitability of a solar-powered irrigation pump. The target group refers to farms from 20 ha to more than 50 ha, which represents 1.4% and 0.4% of all agricultural holdings. In absolute numbers, this would correspond to between 2,400 and 8,400 farms.

According to official statistics, the most profitable farms in Azerbaijan are based in the districts of Baku, Absheron, Samukh, Fuzuli, Tovuz and Gusar [108]. It is important to mention, that a large share of the irrigated areas of Azerbaijan is located in these districts [100] [109].

For the business case presented in this section, the district of Baku was selected for at least four reasons. First, farms in Baku tend to be wealthier than in other regions and hence have more financial capacity for investing in solar-powered irrigation systems. Second, the issues of desertification and more frequent droughts in Absheron and Baku increase the need for efficient water usage, that can be facilitated by solar-powered irrigation [101]. Third, the regions of Absheron and Baku are politically stable and hence offer a favorable environment. Finally, RES projects have already been implemented in these districts, which facilitates the implementation of other projects [132].

For the business case the solar radiation values of Baku city were used. According to data taken from the Global Solar Atlas, the solar radiation in the region corresponds to 1,700 kWh/m^2 (global tilted irradiation (GTI) at optimum angle) per year. After applying a performance ratio of 0.80 to this irradiation the specific yield used (and shown in the graphs and figures) is 1,440 kWh/kWp/a. It must be noted, that the specific annual PV yield in Azerbaijan varies substantially between different locations: The solar irradiation (again GTI at optimum angles) varies in Azerbaijan between approx. 1,241 kWh/m^2 in the north and in the east to 1,826 kWh/m^2 in Nakhchivan.

5.1 Methodology of the profitability analysis

An Excel-based discounted cash flow analysis (DCF) was used for the profitability analysis. The DCF methodology evaluates a project using the concept of the time value of money.

All future cash flows are estimated and discounted to their present values. The net present value (NPV) is the sum of all positive and negative cash flows, including the initial investment. The NPV allows for the comparison of investments with different durations and cash flow profiles over their lifetime at the present point in time. Besides NPV, the internal rate of return (IRR) for both the equity and the entire project were calculated as well as the amortization period (payback time) for the invested capital. These parameters give an indication of the attractiveness of a PV investment. Please note, that we have used discounted cashflows for the calculation of the amortization period, but that we also show an undiscounted payback period in the project overview charts. By definition, these undiscounted payback periods are always shorter than the discounted payback periods, because the time value of money concept is ignored which basically means that AZN 1 today will still be worth AZN 1 at any time in the future.

Another key parameter calculated is the levelized cost of electricity (LCOE), which makes it possible to compare power plants of different generation technologies and cost structures.

Finally, ratios such as the debt service coverage ratio (DSCR) and loan life (-cycle) coverage ratio (LLCR) provide information about whether the project cash flows suffice to reimburse the debt invested in a project. These values should be at least > ,1 which would mean that free project cash flows would suffice to pay back debt.

5.2 A 20kW solar powered irrigation system with a water storage tank

A 20kW photovoltaic system provides the electricity to run a water pump. With the extracted water, the owner of the system can irrigate land used for agricultural purposes. The exact amount of water to be pumped depends on the groundwater resources in the area and the efficiency of the pump. This cost-benefit analysis assumes, that the water pump is already in place, but is powered by a private diesel generator (genset). The PV system replaces the generator and, therefore, the revenues are based on fuel savings. A chemical battery is not part of the PV system configuration, but a physical storage unit such as a water tank is already in place. Thus, the fields could also be irrigated at night to reduce evaporation losses. As a result, the overall efficiency of the PV system is increased as it can operate during periods, when no irrigation is required. In addition, a water pump can only be installed in areas with sufficient and sustainable water resources, as the system calculated here does not include water resource monitoring. The potential problem of over-extraction of groundwater should be closely monitored.

Several PV companies in Azerbaijan were contacted as part of the research for this report. According to the above information on the energy sector in Azerbaijan, as well as information confirmed by companies in the renewable energy sector, the key projects in the use of PV energy are projects in the agricultural sector with energy-efficient irrigation solutions. These companies mainly focus on the implementation of small multi-kilowatt photovoltaic systems by

the rules and requirements stipulated in the document "On the Use of Renewable Energy Sources in the Production of Electricity" (No. 339-VIQ).

The following Figure 16 summarizes the key parameters and results for the base case calculations of the business case:

Figure 16: Project Overview – 20 kWp solar water pump

PV System		
Project Duration	Years	25
PV System Size	**kWp**	**20,0**
Nominal storage capacity	kWh	-
Total PV system costs /kWp	**AZN/kWp**	**1.700**
Total PV System Cost	AZN	34.000
Performance Factor	%	80%
Degradation	% p.a.	0,70%
Applied Solar Yield	kWh/kWp/a	1.440
Average Yearly Generation	kWh/a	26.338
Fixed Operation Costs PV	% p.a.	2,00%
Battery Replacement Interval	Years	-

Financing			
Debt (Gearing)	**50%**	**AZN**	**17.000**
Loan Tenor		**Years**	**3**
Debt Interest Rate		**%**	**16%**
Initial Equity		AZN	17.000
Additional Equity		AZN	7.765
Discount Rate		%	7,0%
Longterm Inflation Rate		%	6,0%
Investment Subsidy-PV		AZN	-

System Operation - Savings		
Applied Direct PV Consumption	%	65,00%
Applied Battery PV Consumption	%	-
Genset Efficiency	kWh/ltr	3,0
Average Replaced Fuel Consumption p.a.	ltr/year	5.706
Fuel Price (1st Ops Year)	AZN/ltr	0,80
Oil costs as % of fuel costs	%	10,00%
Fuel Price Escalation	**% p.a.**	**8,00%**
Genset CAPEX fee saved	AZN p.a.	-
Genset OPEX fee saved	AZN p.a.	-
Generator related savings (average)	AZN/kWh	0,54

Results		
Net-Present Value	AZN	75.948
Equity IRR	%	21%
Project IRR	%	20%
Amortization - discounted payback period	Years	8,41
Undiscounted payback period	Years	6,89
LCOE (no subsidy)	AZN/kWh	0,20
Min DSCR**	x	0,62 x
Min LLCR***	x	0,66 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Source: eclareon, 2022

About the assumptions for this PV Business Case

The size of a PV system for an application like this depends heavily on the depth of the water resources, the size and efficiency of the pump and the demand for water which depends on the crop, the surface to be irrigated and the local rainfall patterns. Solar water pump systems can range from single digit kWp to several 100 kWp, but systems around 20 kWp are common and mostly sufficient.

The applied direct PV consumption, which determines what proportion of solar radiation can be efficiently converted into 'useful' electricity, has been set at 60%, thanks to a system supplying electricity to a single unit. This value can be increased by increasing the storage volume (water storage pond) or other efficiency measures. It is assumed, that the capacity of the PV system will decrease by 0.7% per year, which is a consequence of the deterioration of the system.

The lifetime of the system has been set to 25 years. A PV module lifetime of 25 years is possible if the system is installed professionally and with "sufficiently high" quality. These two factors can be implemented throughout Azerbaijan with the help of local and foreign PV companies.

The total turn-key cost of the PV system (capital cost, capex) for the PV system has been calculated to be about 1,700 AZN/kW (936 EUR/kW)[7] without storage. The total cost of the

[7] Conversion into EUR according to the official exchange rate as of 13 February 2023.

system is AZN 34,000 (EUR 18,728).[8] The operating costs of the PV system amounted to about 2% of the system cost.

In the business model, the PV system is financed with 50% equity provided by the owners of the PV system. The remaining 50% is financed by a loan, which is provided through the Agribusiness Credit and Development Agency (AKIA) [113].

The loan period is 3 years. The loan has an interest rate of 16% and the equity is discounted at 7%. This is a rather low rate and reflects the fact that the client's main goal is not to make money on fuel savings, but to be able to irrigate his fields and improve the quality of his crops, which is a more important source of income for him. The farmer does not want to lose money either, so the discount rate for his equity investment was higher than the long-term inflation rate of 6%. If this were a pure “project finance”- investment case, it would be illogical, that debt is more expensive than equity, which carries a higher proportion of investment risk.

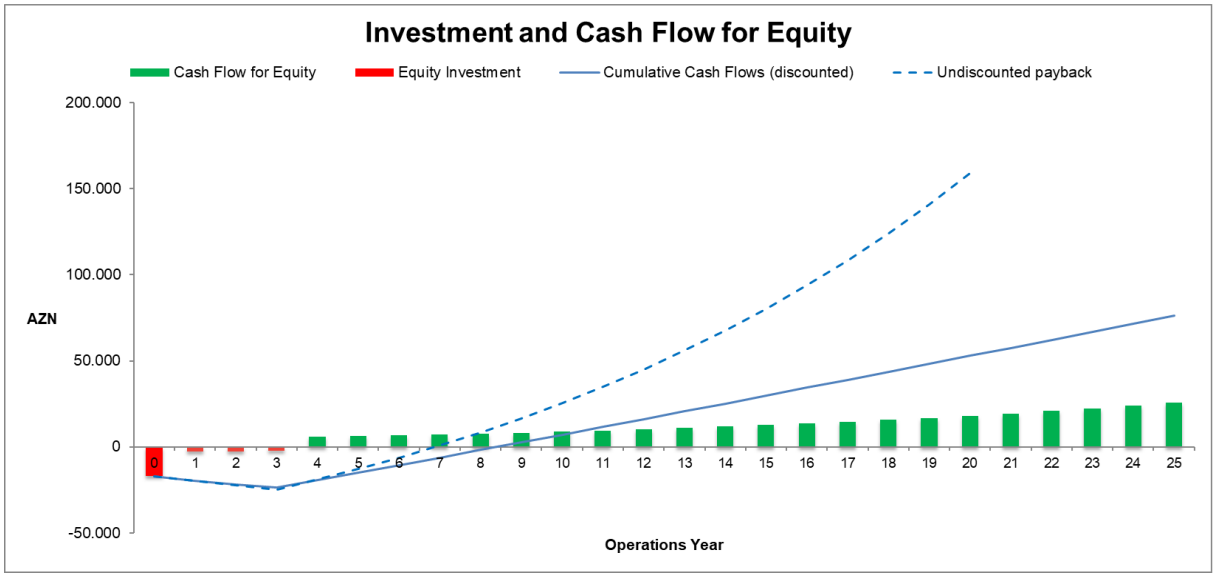
In this case, however, the assumption was made, that the bank would lend to such a system not only based on the expected cash flows of the project (as in the case of pure project finance), but also on the creditworthiness of the borrower, in this case, the farmer. In this way, the bank will be able to compensate the loan even if the PV system financed generates fewer savings than planned, provided that the creditworthiness of the farmer proves to be sustainable. Nevertheless, the motivation for the farmer to take out a loan may be a lack of cash, combined with the possibility of deducting the interest payments on the loan from his taxable income.

Financial results for this PV Business Case

As Figure 17 shows, the undiscounted payback period for the equity investment is about 6.9 years (8.4 years if cashflows are not discounted). Therefore, the amortization is reached during the duration of the PPA contract. The equity IRR is 21% and the project IRR is around 20 %.

The equity cash flow for the case is as follows:

Figure 17: Equity Cash Flow - Baku city

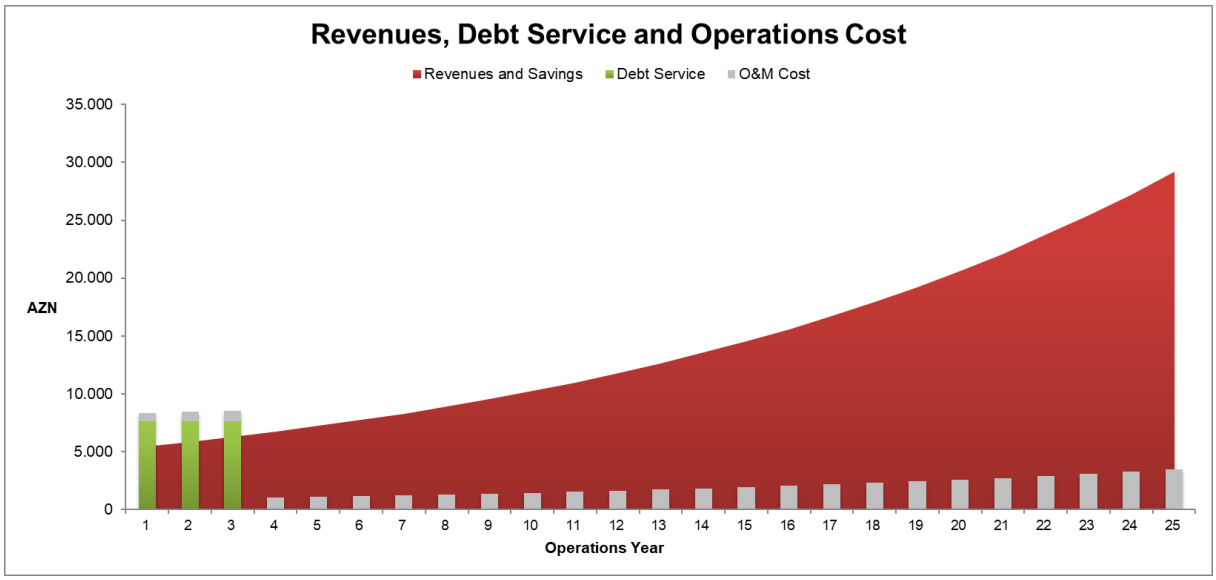


Source: eclareon, 2022

[8] Conversion into EUR according to the official exchange rate as of 13 February 2023.

As can be seen (Figure 18), the cash flow for equity is decreasing for the three first years due to the investments. Then, after year 4, it is growing each year due to the end of the debt tenor and the full reimbursement of the loan.

Figure 18: Project Cash Flows – Baku city



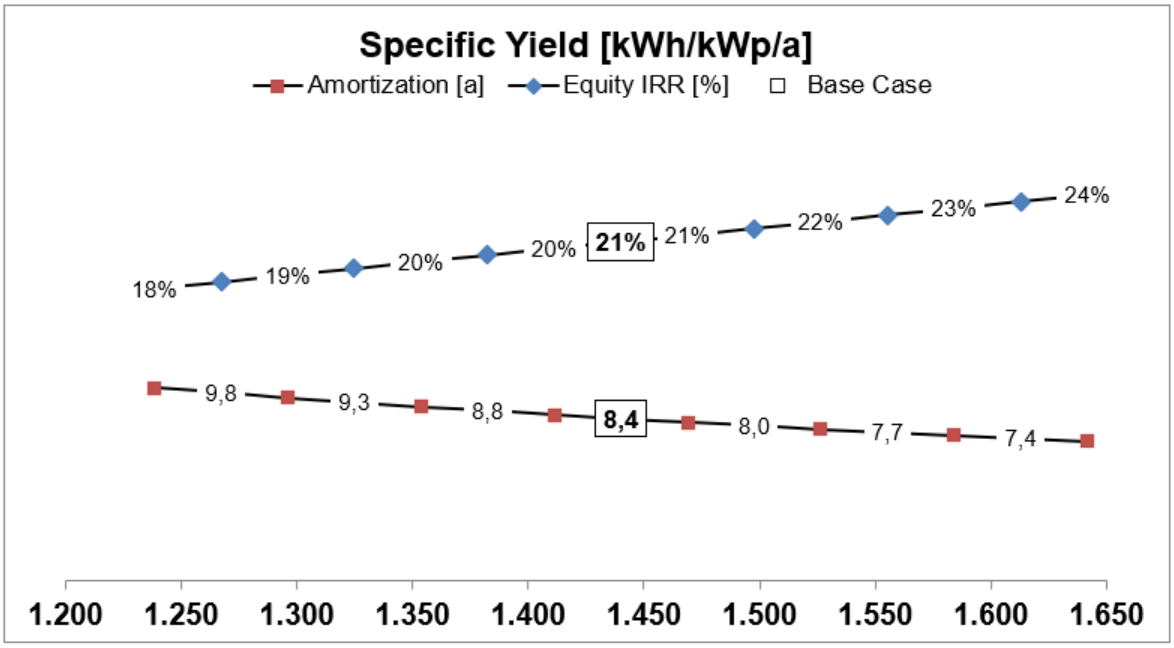
Source: eclareon, 2022

Sensitivity of results for this PV Business Case

The following figures show how two key economic performance indicators of the investment, the discounted payback period (amortization) and return on equity (Equity IRR), change when certain of the assumptions described above are modified.

The specific yield shows the kilowatt hours produced by a PV system per kWp of capacity and per year. It is calculated based on the solar radiation multiplied by the performance factor of the PV system. This factor includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules and possible shadowing among other factors. Logically, a system built in an area with higher irradiation contributes to higher financial results. The equity IRR increases and the payback period decreases when more electricity can be harnessed.

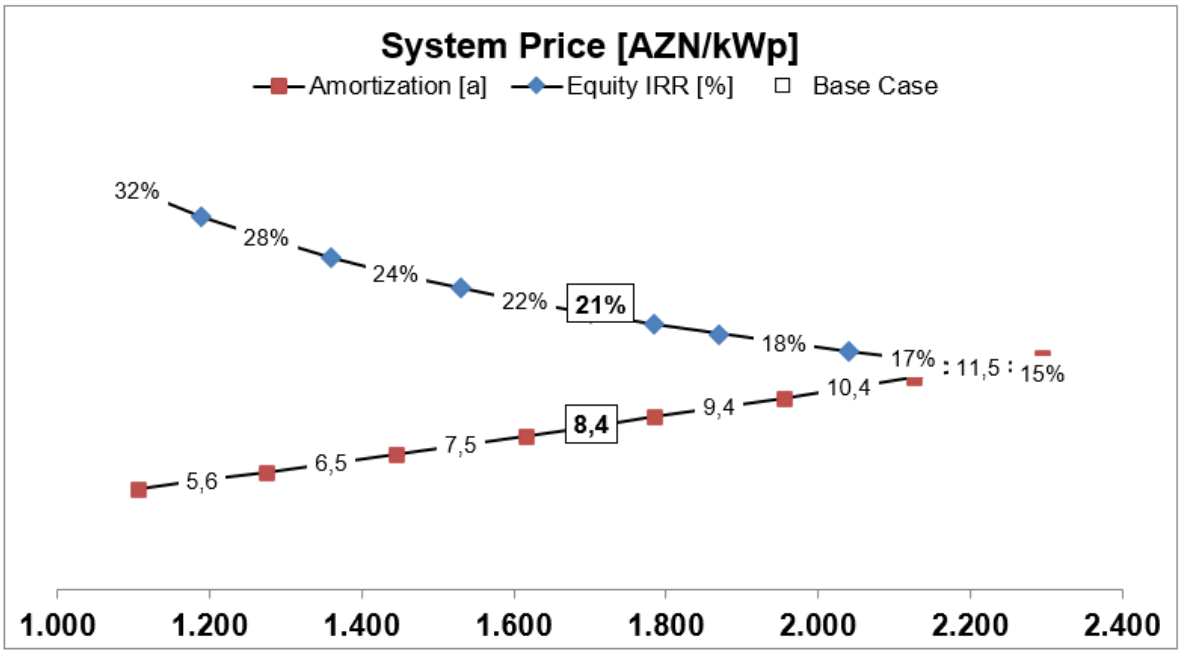
Figure 19: Specific Yield Sensitivity - Baku city



Source: eclareon, 2022

In a selected specific yield area, where the solar irradiation reaches 1,641 kWh/kWp/a, it requires only 7.2 years instead of 8.4 years to achieve the payback. In this case, the equity IRR improves to 23.70% compared to 20% for the baseline situation, as Figure 19 shows.

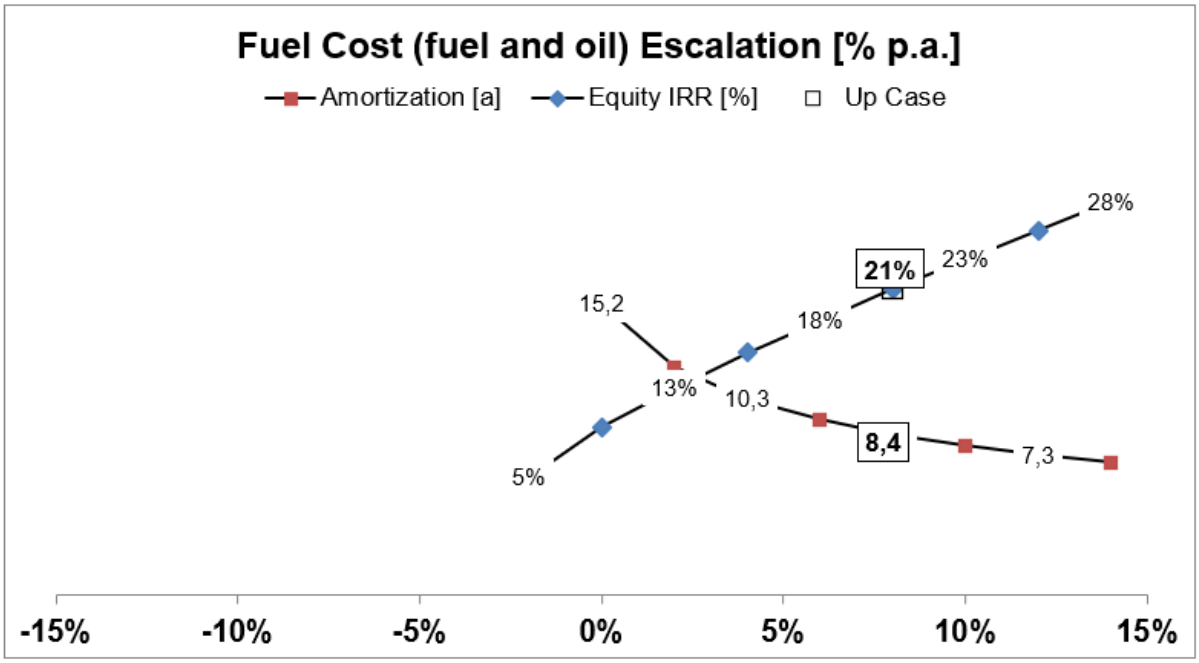
Figure 20: System Price Sensitivity – Baku city



Source: eclareon, 2022

As Figure 20 shows, the installation costs determine the financial results of PV systems. The equity IRR is growing, when the installation costs are decreasing. If the installation costs decrease from 1700 to 1105 AZN/kWp, the equity IRR is significantly more advantageous 32.12% (compared to 20.77% in our base case). Amortization is completed in 5.18 years and not 8.4 years.

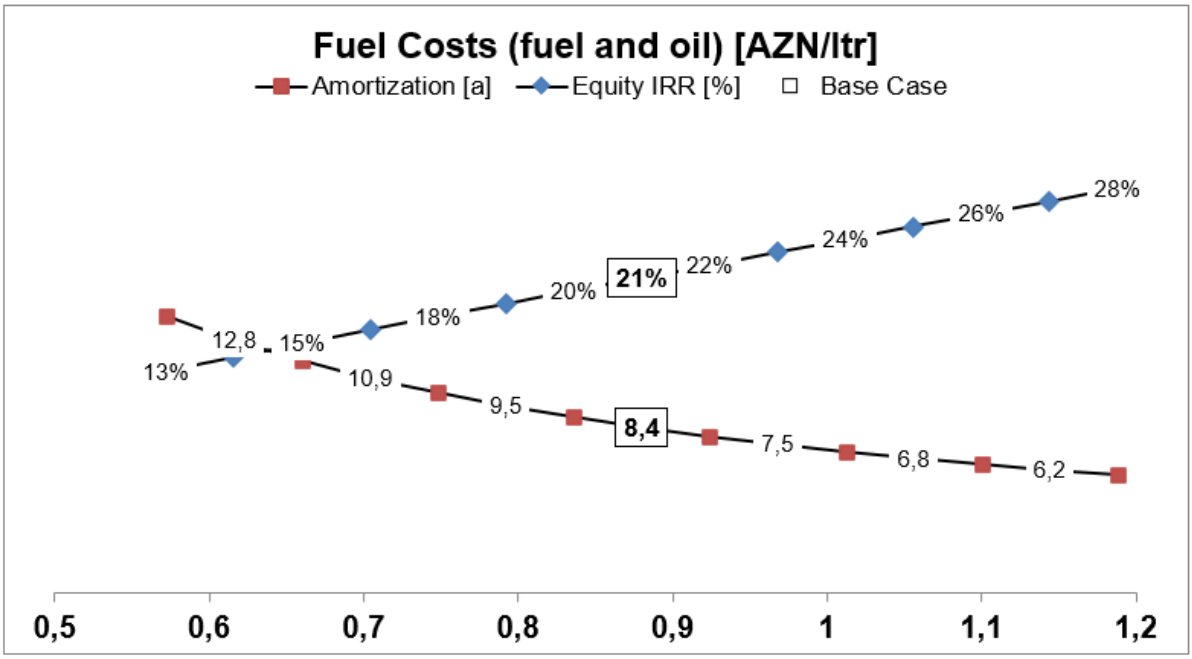
Figure 21: Fuel Costs Escalation Sensitivity – Baku city



Source: eclareon, 2022

Regarding the fuel price, it goes without saying, that the PV investment will be economically viable, if the fuel price is high. The higher the fuel price, the higher the savings and the faster the return on investment. As shown in Figure 21 and Figure 22 below, an 14% fuel costs escalation - including fuel and oil - will allow for a faster payback. Amortization will be achieved over **6.9 years.** As a result, the returns for the shareholders of the farmer, after the debt has been paid off will improve (corresponding to **28.12%**).

Figure 22: Fuel Costs Sensitivity in AZN/ltr – Baku City



Source: eclareon, 2022

6. Conclusion

Endowed with significant oil and gas resources, Azerbaijan has only recently initiated measures to develop renewable energies and improve energy efficiency. In recent years, efforts in market liberalization and modernizing the country's transmission, distribution and generation infrastructure have been undertaken to attain energy independence and downsize network losses.

With regards to renewable energies, despite favorable natural conditions, Azerbaijan is still a fledgling market with installed capacity for wind (0.8%), solar (0.6%) and biomass (0.5%) amounting to a meagre 1.9% of total installed capacity in 2021. Substantial renewable energy legislation has only emerged in 2021 and certain crucial support mechanisms, such as detailed rules for the auction mechanism, have yet to be further elaborated and implemented in practice. Apart from that, keeping end-user tariffs low for social welfare reasons represents a substantial market barrier and makes it challenging to increase the share of renewables in the country's energy mix.

In line with the Paris Agreement engagement, Azerbaijan's officially stated goal is to increase its share of renewable energy in total installed capacity to 30% by 2030. The political will, evidenced by the announcement and launch of large-scale PV projects, and the heightened interest of European countries in the region suggest, that Azerbaijan is eventually embarking on the green energy transition in this decade. However, the speed of this transition is yet unclear as revenues from the oil and gas sector will continue to play a major role in the country's economy in the foreseeable future. Besides, investors interested in the PV market should also remain vigilant with regards to the unresolved latent conflict in Upper-Karabakh, which potentially constitutes a geopolitical risk. Apart from that, improvements with regards for eradicating corruption in Azerbaijan are needed, which represents a major impediment for foreign investment.

Despite efforts to digitize procedures and make information on regulatory procedures on RES available to investors, data transparency of government websites could be improved by enhancing methods of data organization and extending web services to English language versions. As the transparency of government websites is still lacking, international organizations such as the German-Azerbaijani Chamber of Commerce can serve as a relevant platform not only in order to connect with local stakeholders, but also to keep up-to-date with any relevant development regarding the dynamically evolving renewable energy legislation.

This report has demonstrated that large-scale solar irrigation is already economically viable in Azerbaijan, providing a potential solution to many of the economic and environmental challenges that the country is facing. Azerbaijan faces a growing water scarcity, and the use of solar energy for irrigation can significantly reduce water usage and improve water management. Solar irrigation systems can increase agricultural productivity by providing consistent and reliable access to water for crops. This can lead to higher yields and improved food security in the country. Besides, by using solar energy for irrigation Azerbaijan can reduce its reliance on fossil fuels, improve its energy efficiency and significantly reduce carbon emissions in the agricultural sector. Finally, solar irrigation can play a crucial role in the development of rural areas in Azerbaijan by providing farmers with access to water, energy and increased agricultural productivity, leading to economic growth and job creation in rural areas, which are often underdeveloped as compared to the economic centers of Baku and the

Absheron peninsula. In conclusion, large-scale solar irrigation has the potential to address multiple challenges faced by Azerbaijan, including water scarcity, agricultural productivity, energy efficiency, decarbonization and rural development.

As the oil and gas era is soon to be replaced by a green and sustainable future of renewables, it is becoming increasingly important for the country to diversify its economy and find new sources of growth. Education and training in the field of renewable energy can help to achieve this by providing the skills and knowledge necessary for the development and implementation of renewable energy projects, creating new jobs and businesses, and boosting local economic activity. By investing in renewable energy education and training, Azerbaijan can tap into a rapidly growing industry with strong growth potential and help to ensure its long-term economic viability. By developing the skills and expertise of its workforce in the field of renewable energy, Azerbaijan can position itself as a regional leader in this area, attracting foreign investment and helping to drive sustainable economic growth.

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