



AZERBAIJAN GAS EXPORT POTENTIAL & RELATED INFRASTRUCTURES FOR EU & TR ENERGY SECURITY ISSUES (UP TO 2050)

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"Caspian region -where important gas supply potentials exist- has always been directly related to the huge importers' energy security issues, such as EU and Turkey."

ABSTRACT

Due to increasing demand, gas supply is one of the most strategic energy security issues for huge importers. Caspian region -where important gas supply potentials exist- has always been directly related to the huge importers' energy security issues, such as EU and Turkey.

Azerbaijan as an important gas supplier country located in the Western Caspian Region, and her future gas supplies become more important for the importers mentioned above. Consequently, these importers are forming alliances together with long term plans and developing new projects to import the gas resources from Azerbaijan. As a result of this alliance, politically named as "Southern Gas Corridor, SGC" continues to be developed. In the concept of SGC, transportation of the Azerbaijan gas resources to TR & EU, SCPX-TANAP-TAP and related infrastructures are decided to be constructed.

In this paper, after focusing on the Azerbaijan gas supply potential and gas market, the importance of this potential for European and Turkish energy markets will be described by underpinning the annual demand values. Since Southern Gas Corridor is a long term target, 2050 Azerbaijan gas supply and export potential (in huge gas projects base), including the infrastructural limitations, will be estimated.

INTRODUCTION

With 0,9 tcm proved gas reserves of total world share of 0.5% and 16.2 bcma 2013 average gas production,¹ Azerbaijan is the 27th country according to the proved reserves and 34th country according to the average annual production rate in the world.²

Also not having a significant volume of

proved gas reserves and annual production while compared with the huge gas producers in the world and in Caspian Region; some geostrategic, political and commercial issues increased the importance of Azerbaijan in the regional gas politics, mainly for EU & TR.

Main reasons for the increasing importance of Azerbaijan for EU & TR are:

- Azerbaijan resources are convenient for commercially meeting some portions of the increasing gas demand of EU & TR markets (Which is the first step of Southern Gas Corridor Project³). Those resources are important for TR's & EU's energy resource diversification strategies.
- EU based professional companies are operating the huge gas fields in Azerbaijan, such as BP in Shah Deniz & Shafag-Asigman, and Total in Absheron.
- Azerbaijan government and gas export strategies are supported by EU, US, TR and her transit neighbor Georgia.
- Azerbaijan is thought to be the first step to transport Caspian resources to TR & EU.
- Due to stable political structure, legislative and security issues, there is a suitable environment in Azerbaijan for investment. In addition to this environment there are also international investors dealing with the future opportunities.
- There are no important technical, technological and logistical risks for the development of new gas projects.

AZERBAIJAN: BEING A MORE POPULAR GAS SUPPLIER

Due to the increasing importance of Azerbaijan for EU & TR, her popularity in being a gas supplier is increasing more than that of



Name	Type	Location	Avr. Water Depth (m)	Operator	Situation	GIP (bcm)
Shah Deniz	Gas/Cond.	Offshore	50-550	BP	Production	1000 (proved)
Umid & Babek	Gas/Cond.	Offshore	50-100	SOCAR	Exploration	200 (discovered) + 400 (estimated)
Absheron	Gas/Cond.	Offshore	450-500	TOTAL	Exploration	350 (discovered)
Shafag Asigman	Gas/Cond.	Offshore	550	BP	Exploration	1000 (estimated)
ACG Deep & Shallow Gas	Oil & Gas	Offshore	120-175	BP	No agreement	No Public Data (discovered)

Table 1: Important gas fields and projects in Azerbaijan.

any other huge suppliers. This fact initially is due to the political support especially by EU & US. Moreover, existing producing projects and coherent steps taken for the future development projects are important for Azerbaijan to be successful in gas politics game.

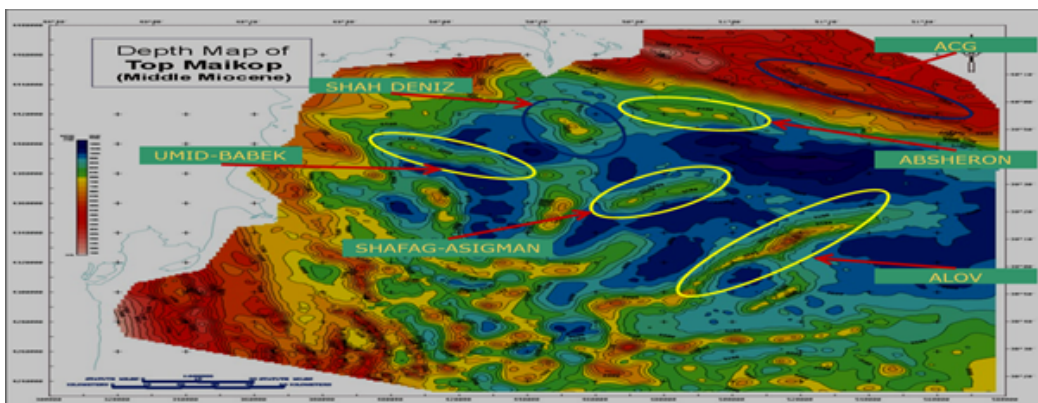
Before focusing on the future gas production and export estimations, current ongoing projects and future gas prospects of Azerbaijan have to be understood. Table below gives brief information about Azerbaijan's important gas fields & projects. The prospects and

the fields' locations are shown on Map 1.

Notes:

- Nakhichevan, Bahar Gum Deniz, Bulla Deniz gas – condensate fields and other smaller dry gas / gas-condensate fields will be considered as “other gas resources of Azerbaijan” in the paper.
- Associated gas produced in oil fields are not taken into consideration. Gas produced from such fields are re-injected - flared or used as additional supply for

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Map 1: Locations and structures of important gas resources of Azerbaijan.



		GAS EXPORT PIPELINES				
		Name of Pipeline	From (Supply Country)	Through (Countries)	To (Markets)	Capacity (bcm/a)
AZERBAIJAN	EXISTING	SCP	AZERBAIJAN	AZ-GEO	TURKEY	8
		GAZI-MAGOMED-MOZDOK	AZERBAIJAN	AZ-RUS	RUSSIA	1
		BAKU-ASTARA	AZERBAIJAN	AZ-IRAN	NAKCHIVAN	0,5
	FUTURE	SCPX	AZERBAIJAN	AZ-GEO	TURKEY-EU	16
		TANAP	AZERBAIJAN	TR	TURKEY-EU	16
		TAP	AZERBAIJAN	GR-IT	ITALY	10

Table 2: Existing and planned gas export pipelines of Azerbaijan.⁴

"Azerbaijan's oil and gas fields: Shah Deniz Project with 3 phases, Umid-Babek Fields, discovered Absheron gas-condensate field, Shafag Asigman exploration block, and possible shallow and deep gas resources in ACG oil production license.

- Azerbaijan in winter seasons.
- Fields which have political conflicts with Iran and Turkmenistan due to status of Caspian are also not taken into consideration.

In addition to these fields and projects, infrastructures to transport the gas are also important for coherent export scenarios. Table 2 shows the general properties of Azerbaijan (and Azerbaijan gas export related) gas pipeline system.

AZERBAIJAN GAS EXPORT POTENTIAL ESTIMATION (UP TO 2050)

In order to estimate the gas export potential of Azerbaijan to TR & EU up to 2050, initially the existing gas producing and important existing licenses, which are on exploration or development period and expected to be taken into production up to 2050, are taken into consideration. These are Shah Deniz Project with 3 phases, Umid-Babek Fields, discovered Absheron gas-condensate field, Shafag Asigman exploration block, and possible shallow and deep gas resources in ACG oil production license. Additionally, other smaller proved and possible reserves, which are already are in production or planned to be taken into production are taken into consideration as the "other gas resources of Azerbaijan".

Moreover, to be able to make coherent estimations, possible risks for development of the related future projects are also commented. Which are mainly;

- Having not enough drill ships in Caspian to continue offshore exploration, pre-well drillings and subsea completion operations. This may result in delays in the development periods of some resources.
- Due to general unconsolidated sand structure of AZ reservoirs, a big volume of sand is produced. In gas fields, initially this is not an important concern, but for the maturity period of the field, sand management issues have to be considered.
- Due to general expected PVT properties, condensate blockage issues have to be taken into consideration.
- There are high pressure reservoirs and high pressure water zones that might result in drilling and completion problems.
- Oil prices will affect the project economics. Low prices will result in delay in investment for AZ government and foreign companies.
- Gas sales to EU may not be economic due to the unit production and transportation costs.

Additionally, less than 30% of the claimed reserves are proved. Being more than 70% of the future gas resources can be accepted as possible or probable reserves. This fact has to be taken in account for the estimations.

After mentioning the issues above, estimated production profiles of the due gas projects of Azerbaijan and assumptions made in the estimation process are given below:

ASSUMPTIONS TABLE:



Topics/ Related Gas Projects	Assumptions
Shah Deniz	<ul style="list-style-type: none"> Shah Deniz is estimated to be developed in 3 stages. (One additional stage added to have more recovery.) Production periods are taken up to the life of field (LoF). Hence current PSA's are thought to be extended and abandonment production is assumed as 1 bcma for SD1.
Umid / Babek	<ul style="list-style-type: none"> Reserves in Umid field are discovered and probable and in Babek field reserves are possible. Not discovered yet. It is assumed that, enough expected volume of resources exist in place. For the reservoir properties, production capacities, decline rates, development schedules and strategies, public data taken from Shah Deniz1 and SOCAR's management performance in her other offshore gas fields are benchmarked.
Absheron	<ul style="list-style-type: none"> Reserves in Absheron field are discovered and probable. Not proved. It is assumed that, enough expected volume of resources exist in place. For the reservoir properties, production capacities, decline rates, development schedules and strategies, public data taken from Shah Deniz1 and TOTAL's management performance in her other offshore gas fields are benchmarked. Some delays for the development of the field are assumed due to the lack of enough drill ships in Caspian, low oil prices and decreasing interest of TOTAL in AZ oil & gas market. Absheron is estimated to be developed in 2 stages.
Shafag Asigman	<ul style="list-style-type: none"> Reserves in Shafag Asigman field are not discovered and all possible. It is assumed that, enough expected volume of resources exist in place. For the reservoir properties, production capacities, decline rates, development schedules and strategies, public data taken from Shah Deniz1 and BP's management performance in her other offshore gas fields are benchmarked. Some delays for the development of the field are assumed due to the lack of drill ships and subsea technologies in Caspian and low oil prices. Shafag Asigman is estimated to be developed in 2 stages.
ACG Deep & Shallow	<ul style="list-style-type: none"> Reserves in Deeper and Shallower sections of ACG field are discovered and probable. But not proved. More tests have to be completed in order to model the structures better. It is assumed that, enough expected volume of resources exist in place. For the reservoir properties, production capacities, decline rates, development schedules and strategies, public data taken from Shah Deniz1, ACG's oil bearing sections and BP's management performance in her other offshore gas fields are benchmarked. Hence there is not an existing agreement with SOCAR and ACG partners to develop and produce gas from shallow and deep sections of ACG, a service or a PSA agreement is assumed to be signed as soon as possible. According to the assumed agreement, shareholders will not change and BP will remain the operator. Some delays for the development of the field are assumed due to the lack of drill ships and subsea technologies in Caspian and low oil prices.
Other Gas Fields Production	<ul style="list-style-type: none"> All other smaller offshore-onshore gas producing fields are taken under consideration together. Hence most of the existing fields are mature and there are important production problems (such as, sand production, low pressure, old wells and completions) a soft decline in the total gas production of Azerbaijan from other fields is assumed. New discoveries, developments of fields in the border of conflicted areas, unexpected increase in oil prices and by this effect new investments in current resources will change the scenarios.
AZ Consumption	<ul style="list-style-type: none"> Gas consumption in Azerbaijan is assumed as to increase 1% annually.
Nakhchivan Consumption	<ul style="list-style-type: none"> Gas consumption in Nakhichevan is assumed as to increase 1% annually.
Russia Export Volume	<ul style="list-style-type: none"> According to the increasing demand in Russia Caucasian region, export is assumed to be increased up to 3 bcm levels and will continue up to 2050.

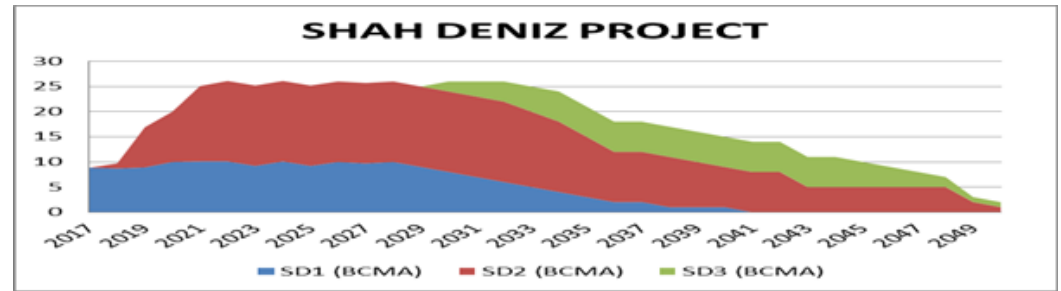
Table 3: Assumptions for production estimations.



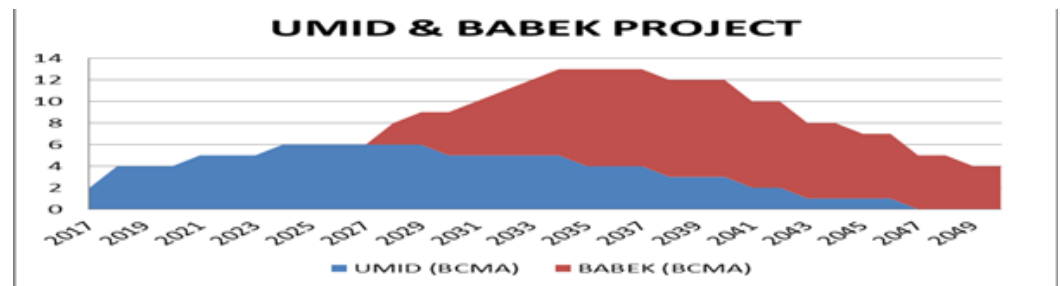
Table 3 below shows the general assumptions taken into consideration, before estimating the future production profiles of the due fields and the consumptions and other related issues to calculate Azerbaijan export potential.

Note that all estimated production profiles given in the following graphs are technically and economically producible volumes, to the end of LoF. Production profiles are extracted by evaluating due assumptions given in the Table 3.

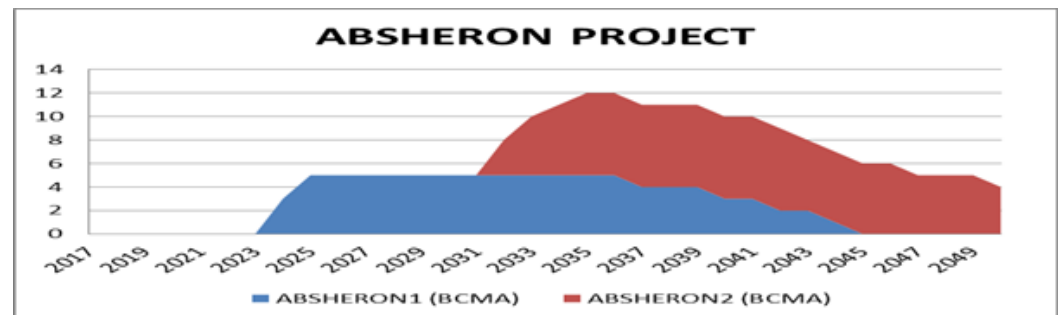
PRODUCTION PROFILES:



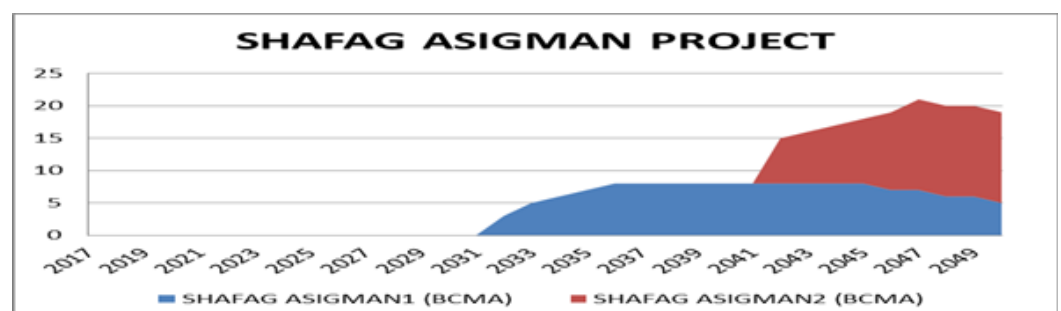
Graph 1: Estimated Shah Deniz Project production profile up to 2050.



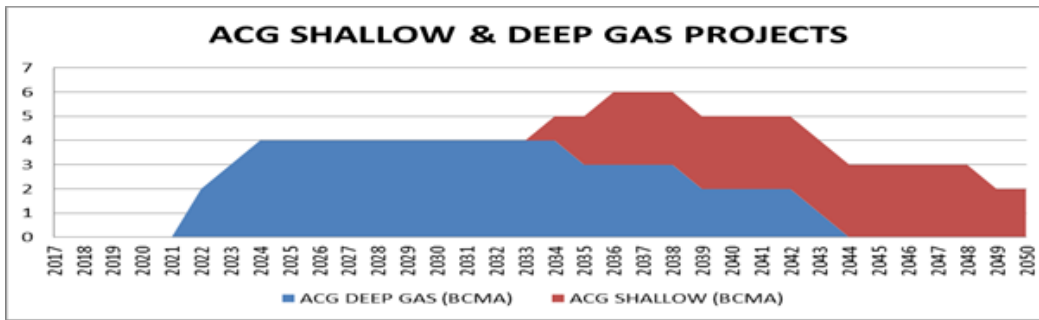
Graph 2: Estimated Umid & Babek Projects production profiles up to 2050.



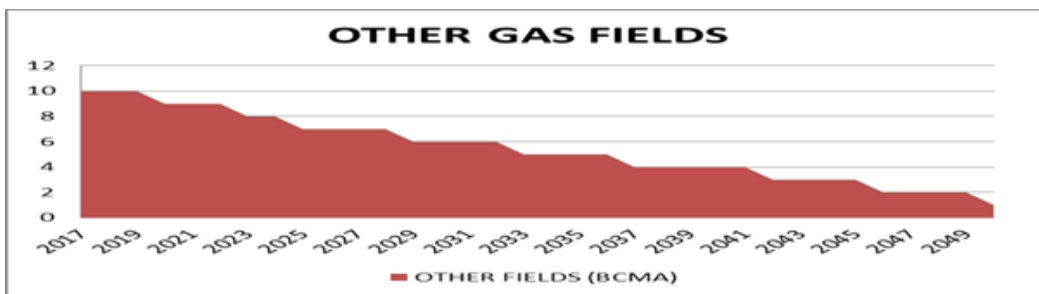
Graph 3: Estimated Absheron Project production profile up to 2050.



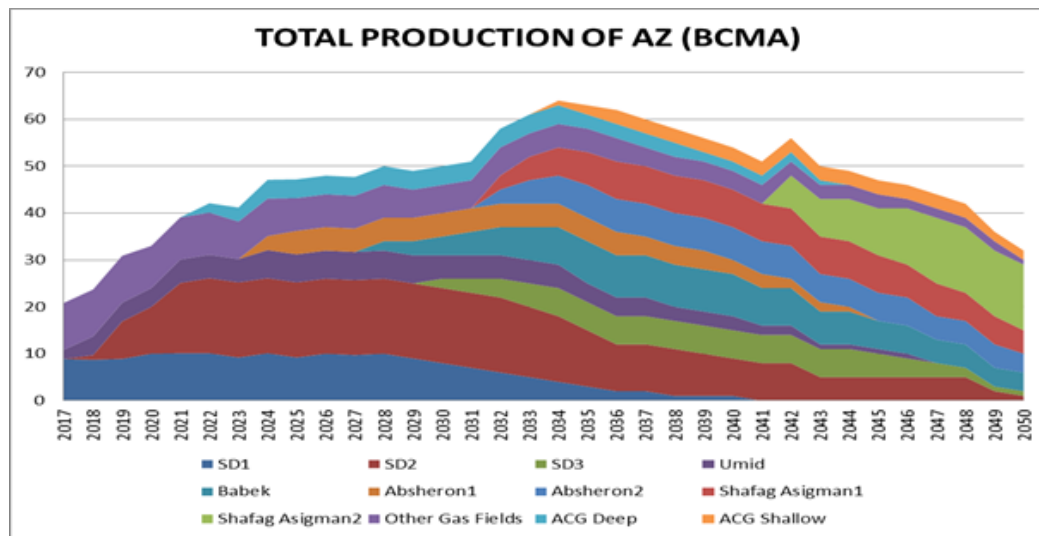
Graph 4: Estimated Shafag Asigman Project production profile up to 2050.



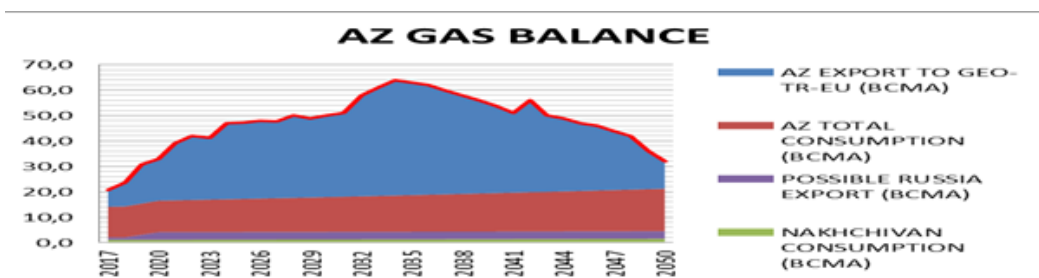
Graph 5: Estimated ACG deep and shallow gas projects production profiles up to 2050.



Graph 6: Estimated Azerbaijan's all other gas fields' production profiles up to 2050.



Graph 7: Estimated total gas production profile of Azerbaijan up to 2050.



Graph 8: Estimated Azerbaijan's gas balance including production, exports, imports and consumptions up to 2050.

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FUTURE INFRASTRUCTURE LIMITATIONS AND EVALUATIONS (UP TO 2050)

Having only the resource export potential and the market demand is not enough for gas projects to be actualized, therefore commercial transportation structures have to be planned and constructed. After estimating the future production profiles and export potentials of Azerbaijan in the section above, in this section, by considering the technical and commercial issues, existing capacities and possible capacity extensions of the export structures will be evaluated.

To start with the initial step of the root, (which is SCP and expanded SCP: SCPX) as seen in the graph below;

- SCP has a capacity of 8 bcma and is enough up to the first commercial production of SD2. Then SCP's capacity will be expanded up to 24 bcma to handle additional 16 bcma of SD2 gas.
- With the new developments and new resources SCPX capacity will not be enough after 2023. Then, a new upgrade of the capacity up to 34 bcma is assumed to be done in 2023. Totally 60 bcm gas will not be able to be transported due to lack of extra capacity of expanded SCPX (SCPFx) between years 2032-2039. However, hence the production expectations are declining after 2034 and it will not be economic to construct a bigger capacity expansion for only 7 years, 34 bcma is assumed to be commercially the best selection. For those 7 years, Azerbaijan may decrease the production in her own operating fields or other export op-

tions to Iran or Russia can be put on the table.

- The purpose of selection SCPFx capacity as 34 bcma, while TANAP Expansion is announced as 31 bcma (by SOCAR), is the additional gas will be exported to Georgia.

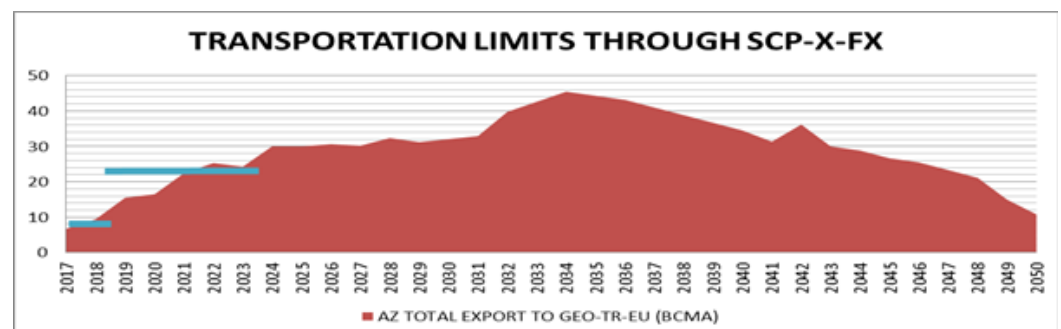
After recalculating the gas volume on Azerbaijan border to export her gas to GEO & TR & EU, including the limitations of SCPX, Graph 10 below is prepared.

According to the Graph 10;

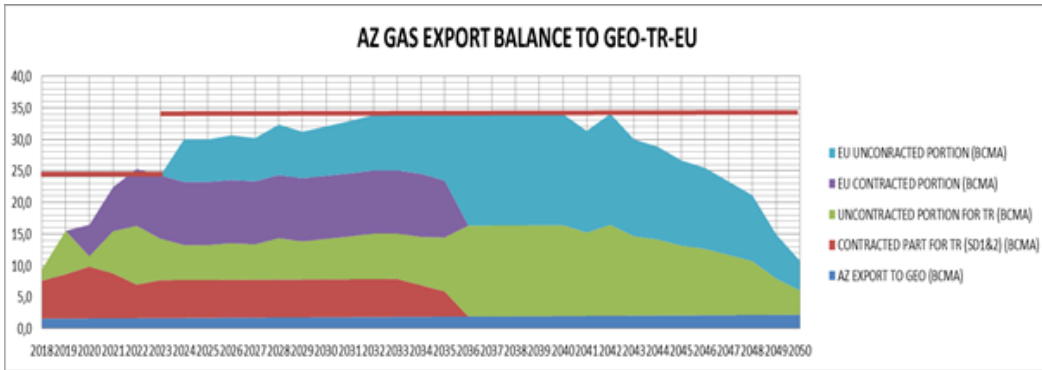
- Georgia sales are assumed to start with 1,6 bcma in 2018 and increase up to 2,2 bcma in 2050. (Moreover, there will be some little free portion in SCPFx for extra supplies to Georgia)
- Again, the red lines show the limitations of SCPX and SCPFx.
- Contracted parts of EU & TR are the public announced data. Additionally, due to the nature of development of gas projects, an increase at start volumes and a decrease at the end volumes are assumed.
- For the uncontracted portions to EU & TR, after benchmarking with announced SD2 sales, 45% of the extra volume (which is equal to total export minus GEO sales minus contracted volumes of TR and EU) is assumed to be sold to TR and 55% portions is assumed to be exported to Italy market.

While the gas is now in the eastern border of Turkey, as shown on the graph 11 below;

- 16 bcma capacity of TANAP and around (estimated after due maintenance and



Graph 9: Transportation limits of expanded SCPX to future AZ export to GEO-TR-EU.



Graph 10: New AZ gas export balance to GEO-TR-EU after the limitations of SCPX and SCPFX capacities.

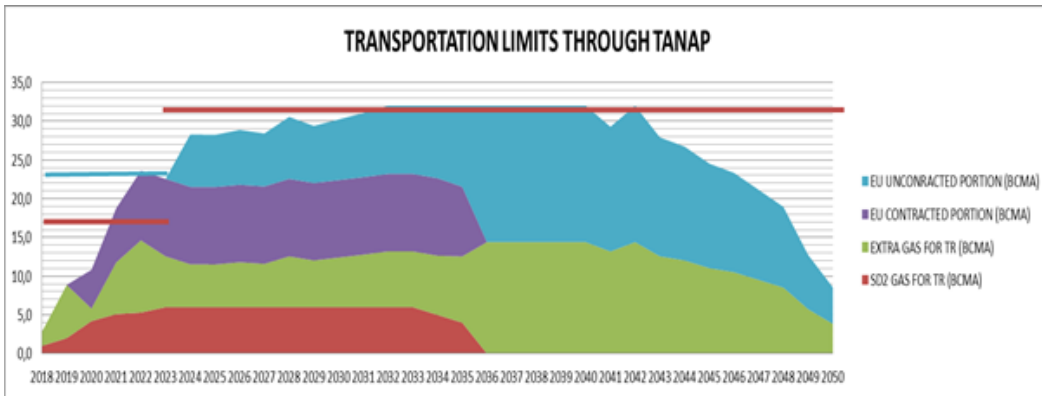
small expansions) 8 bcma capacity of Eastern Turkish gas pipeline system will be enough for transportation of Azeri gas to mid-Turkey and EU border up to 2023's.

- Then in 2023 the announced plan of SO-CAR to expand TANAP capacity up to 31 bcma has to be completed.

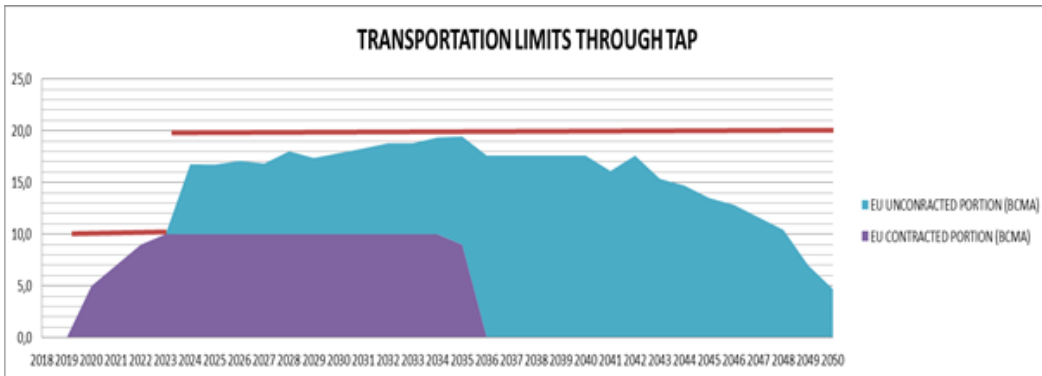
of Turkey for EU, as shown on the Graph 11 above:

- 10 bcma capacity of TAP is enough to transport Azeri gas to Italy market up to 2023.
- In 2023, as announced by the authorities of EU to increase TAP capacity up to 20 bcma, capacity of TAP will have to be expanded up to 20 bcm. Then there will

While the gas is now in the western border



Graph 11: Transportation limits of TANAP, Turkish gas network and expanded TANAP for Azeri gas export to TR & EU.



Graph 12: Transportation limits of TAP and TAP expansion for future Azeri gas exports to Italy.



"Long term gas planning is an important issue, which has many effective criteria to consider. Reserves, structures, agreements, politics, pipeline capacities, economics, markets and other regional factors have to be analyzed together."

PIPELINE	CAPACITY	EXPANDED CAPACITY	EXPANSION TIME
SCPX	16	34	2023
TANAP	16	31	2023
TAP	10	20	2023

Table 4: Estimated expanded capacities of AZ export pipelines to GEO-TR-EU.

be no capacity limitations for the future export potentials.

As a result of these capacity limitations, estimated capacity expansion years and the new capacities are given in the Table 4.

RESULTS & ANALYSIS

As seen on the graphs and evaluations above, long term gas planning is an important issue, which has many effective criteria to consider. Reserves, structures, agreements, politics, pipeline capacities, economics, markets and other regional factors have to be analyzed together.

As a result of this study, while focusing on the Azerbaijan gas supplies to TR & EU up to 2050, these items below can be listed.

- For Azerbaijan:
 - Azerbaijan has to develop new resources and increase the planned gas production volumes from due projects.
 - Initially, she has to successfully complete the SD2 project and gas export roots with her partners.
 - She has to make plans to organize the expansion of SCPX and TANAP in 2023.
 - She has to resolve current export capacity issues as it limits transportation via SCPFX due to lack of free capacity, between years 2032 and 2039.
 - She has to focus on the exploration and development of new fields to continue to be a gas supplier after 2050. (Gas export potential to GEO-TR-EU root and Russia will be below 15 bcma after 2050 and this will continue to decrease, if there will be no new additional supplies added).

- She has to find additional resources to infill the free capacities of SCPFX (after 2043), TANAPX (after 2043) and TAPX (after 2036). (The expected free capacities can be seen on the graphs above).
- For Turkey:
 - She has to focus on the possible extra uncontracted volumes of Azeri gas up to 2050.
 - She has to make estimations for additional supplies from Russia - Iran - Iraq - Eastern Mediterranean and LNG options up to 2050.
 - She has to make agreements with Azeri gas supplier companies by considering these scenarios.
 - For price negotiations, she has to keep in mind that, some portion of Azeri gas has to be sold in Turkey for economic considerations. This clue and other possible supplies will strengthen her hand in the due deals.
- For EU:
 - She has to continue to support politically Azeri gas export to EU.
 - Hence, there is an increasing demand for gas in EU; there will be no market problem.
 - Azeri gas volume will be so small while considering the total EU demand scenarios however, for diversification of resources, this root has to be successful.

ABBREVIATIONS

- EU: European Union
- RUS: Russia
- TR: Turkey
- AZ: Azerbaijan
- SCP: South Caucas Pipeline

"For price negotiations, Azerbaijan has to keep in mind that, some portion of Azeri gas has to be sold in Turkey for economic considerations. This clue and other possible supplies will strengthen her hand in the due deals."



SCG: Southern Gas Corridor

TS: Turkish Stream Pipeline

TANAP: Trans Anatolia Pipeline

GEO: Georgia

GR: Greece

IT: Italy

TAP: Trans Adriatic Pipeline

“X” after pipeline name: Means extension of the related pipeline (Ex: SCPX: Expansion of SCP)

“FX” after pipeline name: Means forward extension of the related extended pipeline (Ex: SCPFX: Expansion of SCPX)

Tcm: Trillion cubic meters

Bcma: Billion cubic meters annually

SOCAR: National Oil Company of Azerbaijan

BP: British Petroleum

SD: Shah Deniz Gas Project

LoF: Life of Field

GIP: Gas in Place

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