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Western Balkans Investment Framework Infrastructure Project Facility Technical Assistance 4 (IPF 4)

WB11-ALB-ENE-01

Gas Master Plan for Albania & Project Identification Plan

Gas Infrastructure Master Plan

Final

Nov 2016

COWI | IPF

*) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

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The technical assistance operation is financed under the Western Balkans Investment Framework (WBIF) which is a joint initiative of the EU, International Financial institutions, bilateral donors and the governments of the Western Balkans which supports socio-economic development and EU accession across the Western Balkans through the provision of finance and technical assistance for strategic investments, particularly in infrastructure, energy efficiency and private sector development.

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List of Abbreviations

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
bcm	Billion cubic meters
BVS	Block valve station
CAD	Computer-aided Design
CAPEX	Capital expenditures
CCGT	Combined cycle gas turbine
CNG	Compressed natural gas
CP	Connection point
CTMS	Custody transfer measuring station
DC	Dispatch centre
DCF	Discount Cash Flow
DCVG	Direct current Voltage Gradient
EBRD	European Bank for Reconstruction and Development
EF	Electrofusion
EIB	European Investment Bank
ELBC	Electronic Line Break Control
EN	European Standard
ESCo	Energy Service Company
ESIA	Environmental Social Impact Assessment
EU	European Union
FCRT	Full Cost Recovery Tariff
FS	Feasibility study
FYRoM	Former Yugoslavian Republic of Macedonia
GHG	Greenhouse gasses
GIS	Geographic information system
GMP	Gas master plan
HDD	Horizontal directional drilling
HDPE	High-density polyethylene
HP	High pressure
IAP	Ionian Adriatic Pipeline
IP	Intersection point
ISO	International Organization for Standardization
LGU	Local Government Unit
LNG	Liquefied natural gas
LP	Low pressure
LPG	Liquefied petroleum gas
mcm	Million cubic meter
MP	Medium pressure
NDT	Non-destructive testing
NPV	Net Present Value
NRA	National Regulatory Authority
OPEX	Operational expenditures
OS	Odorizing station
PE	Polyethylene
PMRS	Pressure reducing and metering station
PSP	Private Sector Participation
RER	Renewable Energy Resources
RES	Renewable Energy Source
SEE	South-eastern Europe

TAP	Trans Adriatic Pipeline
TPP	Thermal power plant
WB	World Bank
WBIF	Western Balkans Investment Framework

1 Executive Summary

COWI-IPF Consortium has been commissioned to elaborate the Gas Master Plan for Albania (hereafter "GMP") and the Project Identification Plan aiming to the development of a sustainable natural gas system that makes a balanced contribution to the energy system, the security of natural gas supply, to competitiveness and environmental protection. Albania is today, along with Montenegro and Kosovo, the only country in Europe, not linked to interstate gas transmission systems and has a completely isolated, national gas distribution system.

The present report relates specifically to IPF project reference WB11-ALB-ENE-01, Gas Master Plan for Albania and Project Identification Plan (hereafter the "Project") and it is the main deliverable according to the TOR approved by the beneficiaries and the no-objection of EBRD as the lead IFI, on March 20th 2015.

In the past Albania had a significant gas sector, but there is virtually no gas now. Domestic gas production has declined from 1 bcm in 1982 to 0.01 bcm in recent years. The very small remaining gas activity is concentrated in the southern part of the country supplying the oil refinery industry with limited volumes of domestic produced gas from the fields of Divjaka and Frakull and associated gas from the oil fields near Ballsh. The total pipeline network has a length of 498 km and connects all the previously operational gas fields. Except for the refurbished pipeline from Delvina gas field to the refinery in Ballsh, the gas infrastructure is non-operational and would require rehabilitation before coming operational. Generally, it can be concluded that the majority of the existing gas pipelines are old and/or in poor condition, which make it not feasible to repair these pipelines and almost an entirely new or rebuilt gas transmission and distribution system is required.

Demographic characteristics of Albanian settlements are very unfavourable for the development of gas distribution networks: Albania has a relatively large number of settlements (approx. 3,000) with a relatively small number of inhabitants per settlement. The total useful energy consumption for entire Albania was forecasted by sector and was modelled with the IAEA MAED model (*Model for Analysis of Energy Demand*). The model evaluated future energy demand by sector based on medium to long term scenarios of socio-economic, technological and demographic developments[1].

The basis for the forecasts in households and services was the forecasted number of inhabitants and households. The indicator used in measuring the economic development was the gross domestic product per capita (GDP/cap). Population projection for Albania by 2040 is taken from the World Bank database for population estimates and projections up to 2050, and the distribution of the total population by prefectures and then by regions or zones is made by considering the

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[1] For more information about the IAEA MAED model and a detailed potential natural gas demand and supply assessment, please refer to the report "WB11-ALB-ENE-01, Gas Demand and Supply Assessment", June 2015

shares of each prefecture in total population projected for Albania by INSTAT. The potential natural gas consumption by sector was forecasted as follows:

- Forecasted total useful thermal energy demand in households, services and industry of Albania that can be replaced by natural gas is distributed by prefectures and then by LGU´s of Albania as future potential natural gas consumption (about 2,167 mcm in 2040, including agriculture and transport sector);
- Future potential natural gas consumption for electricity generation could be around 770 mcm in 2040, and forecasted natural gas consumption in refineries in 2040 could be around 89 mcm.

Building gas distribution networks involves substantial economies of scale. A principal measure for benefiting from economies of scale is the average volume of gas demand per kilometre (km) of the distribution grid which, in turn, depends greatly on a country's (or region's) settlement density. The principal drivers of gas demand as well as the degree of the penetration of gas usage are the following:

- Population density and its distribution:
- Level of urbanization
- Type of dwelling:
- Presence of Anchor Consumers:

Based on the above criteria, a realistic potential area to develop the gas distribution network includes 85 LGUs whose gas consumption corresponds to 77% of the total forecasted demand in Albania for the year 2020 and the 82% for the year 2040. To find out how much of the total potential gas demand in the 85 LGUs could be distributed economically, a technical and a financial analysis was carried out. The technical analysis is focused to the calculation of the required capital investment size for each distribution area and it was based on four LGUs, (Tirana, Kamez, Gjirokaster and Zall-Herr), which serve as reference. The goal of the financial analysis was to determine whether the investment in gas distribution networks for individual LGUs was cost-effective in relation to the potential natural gas consumption in the area observed. The evaluation process focused to the calculation and assessment of the Full Cost Recovery Tariff (FCRT), which is the tariff that covers the capital expenditure and the operating expenses. The analysis revealed that the lower FCRTs were observed in Fier, Pogradec, Tirana, Shijak, Durres, Elbasan and Fushe-Kruja (below 0.10 euro/km). Finally, by applying the principle that consumption centres with adequate gas consumption can support less attractive areas, the potential gas distribution areas were defined.

From the gas distribution analysis, the main points concluded were the following:

- The area of Fier – Vlora and Ballsh represents a significant gas consumption triangle where most of the anchor gas consumers are located.
- The area of Tirana and Durres represents the main gas area in Albania with significant potential gas consumption. The contribution of each gas

consumption sector to the total gas consumption counts for 32%, the industrial sector being the largest with 37% and therefore, it is recommended, this area to be considered as one gas distribution centre.

- The gas connection rates affect remarkably the expected expansion rate of the distribution networks and therefore it should be supported with a number of administrative policies and financial supporting schemes in order to facilitate the end consumers to switch to gas usage. It is recommended these schemes to be accompanied by regulatory policies and administrative enforcement actions.

- Due to the demographic characteristics of Albania (large number of settlements with low population density), the total gas volume is not significantly affected by increasing the distribution tariff. It should be noted that higher distribution tariff will enable the development of larger distribution systems, assuming that this increase does not impact the natural gas position within the competing fuels. In more details, a 10% tariff increase led to a marginal increase of the gas consumption (around 2.5%) due to the small size of the additional LGUs, except for cases where consumption centres with adequate gas consumption became eligible. On the other hand, the CAPEX size is more affected by adding areas when they become feasible in a tariff increase. A 10% tariff increase led to an equal increase of the capital investment requirements.

- The proposed gas transmission network to be assessed can be in divided into five main branches:

    - North branch, starting from connection point with TAP (near Fier) and going towards Shkodra and the MNE border crossing point,

    - Elbasan branch, starting from connection point with TAP (near Fier) and going to Elbasan through Lushnja and Dumrea,

    - South branch, serving the areas of Fier, Vlora, Ballsh, Tepelena and Gjirokastra,

    - East branch, connecting the areas of Korca, Pogradec, Prrenjas and FYRoM,

    - Kosovo branch, starting from Milot and ending at the Albanian – Kosovo border point near Kukes.

For the technical design of the proposed transmission route and the technical pipeline specification, official national topographic maps 1:25,000 were used together with GIS software to design the pipeline routes. The corridor selection was influenced by the presence of major seismological and geological risks in the area. The areas, which are prone to seismic, geological, hydrological, and environmental risks, were identified for the whole Albania and they were transposed on top of preliminary pipeline corridors. Consequently, whenever it was technically possible the preliminary corridors were shifted or modified properly to avoid going over these risky areas as much as feasibly possible. Working pressures and basic hydraulic optimizations have been carried out. In addition, for each of the sections of the transmission gas pipeline elaboration of environmental conditions were assessed and recommendations and mitigations were given. Finally, the CAPEX for each section was calculated for the following four scenarios:

Scenario 1, which considered the construction of IAP with its determined diameter plus the gas transmission pipelines to Kosovo and FYRoM.

Scenario 2, which considered the construction of IAP with its determined diameter

Scenario 3, which considered the construction of a national gas network plus the gas transmission pipelines to Kosovo and FYRoM.

Scenario 4, which considered the construction of a national gas network.

Based on the above scenarios, the financial analysis evaluated three development options:

(a) The Albanian Gas Transmission System,

(b) International Pipeline to Kosovo and

(c) International Pipeline to Kosovo and FYRoM.

In order to identify the impact of IAP to the development of the national gas network, three variants were further analysed. **Variant A (without IAP)**, which assumes that the common pipeline sections with IAP would be designed based on domestic gas demand, **Variant B (with IAP technical specs)**, which assumes that the common pipeline sections with IAP would follow IAP's technical requirements and **Variant C (with IAP)**, which assumes that IAP exists.

Assuming that a uniform regulatory tariff regime is applied, the range of the transmission tariff resulted from the gradual development of the Albanian gas transmission network is presented in the table below:

Table 1-1: Range of the transmission tariff for Albanian gas network (in eur/m^3)

	Variant A	Variant B	Variant C
From:	0.0148	0.0148	0.0148
To:	0.0423	0.0597	0.0267

The main points concluded from the analysis were the following:

- The presence of anchor loads during the early construction period will provide the necessary gas volumes to the Project and hence will contribute to the development of a sustainable gas network throughout the country.

- The post stamp regulatory regime tariff where all transmission system users pays the same tariff is actually subsidizing other tariffs for the transportation of gas in the country and gives substantial support for the development of the gas network throughout the country.

- IAP as a private pipeline will boost the gasification of Albania, since significant lower CAPEX will be needed resulting in low gas transmission tariff.

- Assuming that the total gas tariff (transmission and distribution) is 0.20 eur/cm and that the distribution tariff is 0.15 eur/cm, the development of a network covering the main LGUs tends to be feasible for Variant A and C and therefore a more detailed analysis is recommended. Regarding Variant B, the gas transmission network could be expanded up to Tirana and Durres area in the north and Fier – Ballsh and Vlore area in the south. The gasification of the area north of Tirana is related to the possibility of connecting MNE with adequate gas quantities.

The natural gas storage has an important impact on the security and dependability of the natural gas supply for consumers. The salt dome of Dumrea is a large rock salt diapir covering a surface area of approximately 250 km². There are two options of Dumre salt dome development:

- Dumre Alternative 1 storage option is of sufficient volume but without enough withdrawal capacity.

- Dumre Alternative 2 storage option is of too big volume, but has sufficient withdrawal capacity for the gas consumption storage needs.

Due to the fact that the Albanian gas market will be relatively small, and that the peak shaving needs will be relatively small (amounting 184 mcm, just a fraction of the expected transmission volumes of IAP for third countries) the virtual storage sub-lease option should be implemented. This option together with other load management options that does not require any investment (dual fuel, tariff incentives, line pack and similar) would represent the most feasible and recommended load management option for Albania. In case that there is sufficient interest from other countries, the large underground gas storage option could be developed.

2 Introduction

Project Title:	Gas Master Plan for Albania & Project Identification Plan
Project Number:	WB11-ALB-ENE-01
Contractor:	COWI IPF Consortium
Beneficiary:	Ministry of Energy and Industry (Lead), Albpetrol and ERE
Project start date:	02 June 2015
Project Duration:	16.5 months
Anticipated completion:	December 2016

2.1 Scope and objectives of the GMP report

This Project consists of preparation of a comprehensive natural Gas Master Plan for Albania and a Project Identification Plan. The project will include:

(1) Gas demand and supply scenarios;

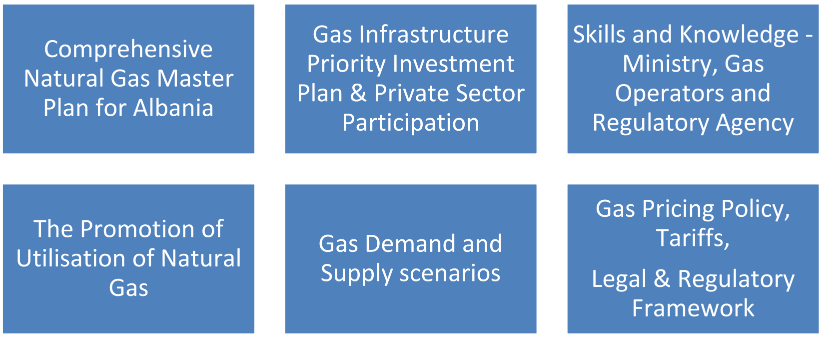
(2) Gas pricing policy, tariffs and regulations;

(3) Promotion of the utilisation of natural gas in Albania;

(4) Development of local knowledge and skills within the Ministry of Economy, Gas System Operator(s) and the Regulatory Agency for Energy;

and

(5) Development of a Project Identification Plan comprising of the priority gas investment projects and including a prefeasibility level analysis of potential infrastructure projects, together with the means of attracting investment, particularly from the private sector.



This Project is a subproject within the overall WBIF-IPF4 project.

This report is using the approved Terms of Reference as agreed by the Government of Albania and EBRD (March 20th, 2015) and the methodology (comments on the ToR) agreed by EBRD (May 13th, 2015) as a basis.

The overall objectives of the Project are the following:

- Enhancement of the utilisation of gas in and for the benefit of the national economy;
- Diversification of energy sources and supply routes to increase energy security in Albania;
- Introduction of advanced gas supply technologies through virtual pipelines, floating LNG, CNG, etc.;
- Consolidation and improvement of the legal and institutional framework governing the gas sector and the energy sector as a whole, as well as the strengthening of relevant institutions in the field;
- Establishment of new institutions where deemed necessary; and
- Developing competition between energy suppliers

Specific objectives of the Project are to:

- Address the existing national institutional framework of the gas sector and make recommendations with respect to its development as well as support the knowledge and skills development in the beneficiaries;
- Estimate the potential for stimulating future private sector participation (PSP);
- Identify and resolve key impediments to increasing national gas delivery;
- Assess existing relevant studies on gas market development and take stock of what has emerged from those;
- Review current market conditions, including existing and predicted system bottlenecks, with a view to addressing these against a projection of the medium-term gas supply/demand balances. Assessing the present and future average and peak demand requirements taking into account growth in industrial production, power generation, transport, commercial and household sectors;
- Assess the existing institutional framework related to gas, energy and other related sectors that are, or will be, influenced by the creation of a gas market in Albania;
- Assess the existing gas network in Albania, and make appropriate recommendations on its possible integration with the future Albanian gas system; and

- Make recommendations on the inclusion of the priority gas projects, and of the potential LNG terminal / underground gas storage sites, into the Detailed Spatial Planning and the consenting process in Albania

- Develop the Strategic Environmental Assessment (SEA) in respect of the gasification of Albania.

Following the successful implementation of the Project, and the definition of the Project Identification Plan, the Project deliverables will be used as a basis for the Government of Albania, International Financial Institutions (EBRD, EIB, WB etc.) and other investors (PSP) to make infrastructure investment decisions.

Under a separate program, Capacity building, as well as consultancy support in developing the gasification policy, legal, regulatory and institutional framework will be performed in order to facilitate the development of the gas sector in Albania, in line with the Albanian Gas Law and Albania’s obligations under the Energy Community Treaty.

3 The General Context

3.1 The socio-economic environment

Albania is a country in South-eastern Europe with a total area of 28,371 square kilometres. It is bordered by Montenegro to the northwest, Kosovo to the northeast, the FYRoM to the east, and Greece to the south and southeast. It has a coast on the Adriatic Sea to the west and on the Ionian Sea to the southwest. The total coastline is about 476 km long.

Albania is considered as an upper-middle income economy, with a GDP of US $13.21B in 2014, representing the 0.02% of the world economy. GDP in Albania averaged US $5.65B from 1984 until 2014, reaching an all-time high in 2014 (as reported by the World Bank Group). Recent free-market reforms have opened the country to foreign investment, especially in the development of energy and transportation infrastructure, with the service sector dominating the country's economy (68.5%), followed by the industrial sector (12%) and agriculture (19.5%).

According to the 2011 Census, the total population of Albania was 2,800,138 with a low fertility rate of 1.49 children born per woman. After the fall of the Communist regime in 1990, Albania was affected by massive external migration, which was later followed by a massive internal migration, which resulted in population decrease in the North and South of the country while it increased in Tirana and Durres centre districts.

The country's capital, Tirana, represents its financial and industrial centre, with a metropolitan population of almost 600,000 people.

Table 3-1: The largest cities in Albania

Cities	Population
Tirana	622,190
Durrës	203,917
Vlora	135,032
Elbasan	124,179
Shkodra	111,686
Korça	86,994
Fier	84,638
Kamëz	81,688
Berat	63,132
Lushnja	53,507

3.2 The context within the sector and relevant strategies

The construction of TAP, and the reports of FS and ESIA for IAP[2] and Perspectives and Challenges for developing the gas market in Albania were considered the main sources relating to the economic and technical elaboration of the development of transmission and distribution gas system and use of natural gas in the region of Albania.

Trans Adriatic Pipeline

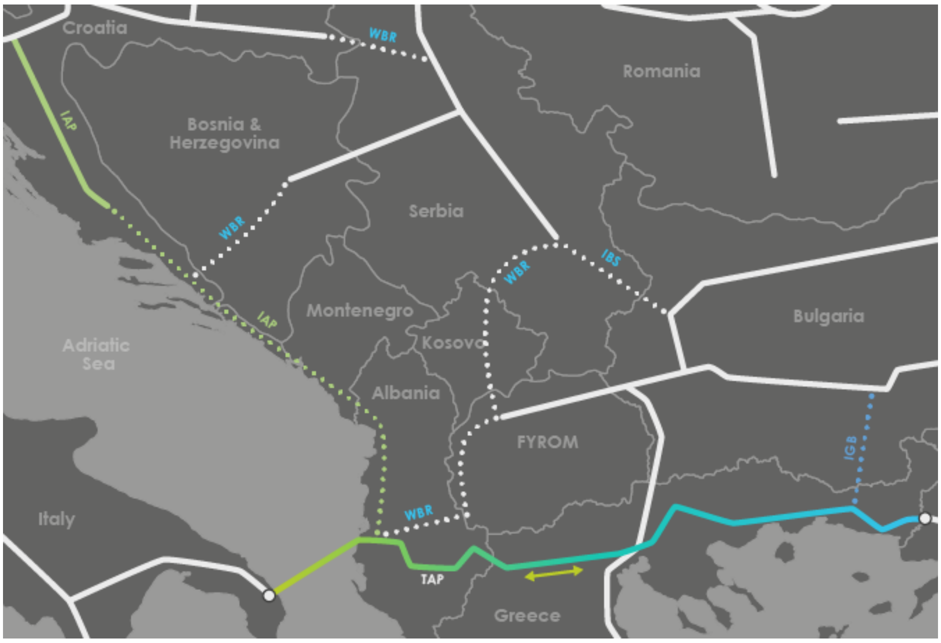


Figure 3-1 TAP route

TAP is a regional natural gas pipeline project which will transport natural gas from Shah Deniz II deposit in the Caspian Sea (Azerbaijan) to European markets. It will pass through Greece, Albania and the Adriatic Sea, and come ashore in the south of Italy. The European Union, under the TEN-E guidelines, has recognised TAP as “Project of Common Interest” for its overall energy policy objectives.

TAP will be approximately 870 km long, with approximately 215 kilometres onshore and 37 km offshore in Albania. It starts at the Albanian border with Greece at Bilisht Qender in Korça region, and arrives at the Adriatic coast 17 km north-west of Fier, 400 metres inland from the shoreline.

The pipeline will initially have a capacity of 10 bcm/year and 1.35 mcm/h maximum flow rate. In a second stage, this capacity can be doubled to 20 bcm/year by scaling up the installed capacity of compressor stations.

TAP is considered important for Albania because it will connect Albania to the Southern Gas Corridor, providing an option for natural gas supply to the Albanian

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[2] *FS and ESIA for the Ionian – Adriatic Pipeline (IAP) – Feasibility Study Report, January 2014*, COWI-IPF

market. The TAP Project will be one of the largest foreign direct investments in Albania and, as such, will generate significant benefits and prospects to the Albanian industry and local communities.

TAP AG will construct, own and operate the TAP pipeline. Albania, Greece and Italy have signed an Intergovernmental Agreement on TAP. Based on the Joint Decision of Albanian, Greek and Italian energy regulators of June 2013 (TAP Exemption), TAP AG is required to construct and operate at least one bidirectional exit point in Albania (located in Fier) with a capacity of 2-10 mcm/day (0.73-3.65 bcm/year). In addition to Fier, a second exit point in Kuçova is under discussion.

According to Joint Opinion’s point 4.7.6.the on TAP has obligation to “construct and operate” an exit point [of the capacity mentioned above] “from its commercial operation date. It is to be noted, however, that according to the Gas Market Development Commitment Agreement (GMDCA) concluded with the Albanian Government, TAP will “design, procure and construct pressure reduction and fiscal metering facilities at a single exit point” only if three conditions are fulfilled. The conditions are that (1) in no circumstance the minimum capacity for the Initial Albanian Exit Facility shall fall below 0.3 bcm/yr, (2) there exists, or there will exist by no later than two years after the commercial operation date of TAP, an Albanian local gas distribution network and/or direct connection lines; and (3) there exists an appropriate capacity booking subject to TAP tariff methodology. Once these conditions are fulfilled, TAP will also finance the construction of the exit point.

Ionian – Adriatic Pipeline

Figure 3-2 IAP Route – Albanian Section

IAP will be approximately 511 km long, with approximately 168 km in the Albanian section. The route starts at compressor station on the TAP system near Fier and runs north towards Shkodra. Near Torovica a BVS and Custody Transfer Metering Station (CTMS) Bushat will be placed. From Torovica the route runs toward the border between Albania and Montenegro at Shkodra. At the border the pipeline route crosses Buna River.

The FS and ESIA for the IAP, elaborated in 2014 under the WBIF umbrella, evaluated the economics of the development of the Ionian – Adriatic Pipeline. Comprehensive technical, economic and financial analyses were carried out with the main purpose to evaluate the financial and profitability aspects of the project, under the assumption that the required IRR of the Project is 8%. Using three separate country TSO's model, the IAP project in Albania, within the envisaged transmission and investment conditions, results in an exceptionally low gas transmission tariff of around 0.9 EURcts/m^3.

Perspectives and Challenges for developing the gas market in Albania

The presentation elaborated in 2012 by Prof. As. Dr. Stavri Dhima gives a comprehensive outlook of the current status of the Albanian gas market as well as the challenges, which will face once it will be opened. The main points presented were:

- The current limited gas production is used mainly for oil and refining operations by two oil companies ARMO and Albpetrol, to fulfil part of their own technological needs.
- The LPG annual consumption in household and services nearly 100,000 tons/year
- The “National Strategy of Energy, (updated)”, estimates the gas consumption by year 2030 to be at the level of 1.5 to 1.8 bcm/year, with the main consumers expected to be:
    - First priority, power generation sector and industrial consumers,
    - Second priority, service sectors, which will use the natural gas for heating,
    - Third priority, residential sector for using of natural gas for heating, cooking and hot water.

Underground Gas Storage potentials of Albania. Albania has several suitable sites for gas storage, including, a salt dome in Dumrea (up to 2 bcm) and the depleted Divjaka gas field (up to 1 bcm). Based on a preliminary feasibility study, presented on the 3rd Gas Forum in Ljubljana, the possible UGS at Dumrea Salt Dome could have the cheapest cost for gas storage (76 $/mcm). By connecting its gas storage into regional gas network (including Energy Community) Albania could provide regional storage facilities for other Balkan countries.

3.3 Basic institutional, legislative and political aspects

3.3.1 Institutional aspects

Albania proclaimed that the State will retain an important strategic role of being: 1) the bearer of the energy policy and 2) the regulator of the sector. In that context, the responsibility for various aspects of the energy sector is split amongst a number of different public institutions/agencies with a direct and indirect impact on the development of the gas sector:

- *National Assembly of Albania (NAoA).* Conducts the legislative process that consists in the approval of the laws and the approximation of Albanian legislation with the EU acquis. Oversees the activity of the GoA and of ministers in particular. Oversees not only the executive institutions, but also the constitutional ones or the ones created by it pursuant to the law, in order to monitor the enforcement of the legal framework. Approves the members of the ERE Board and the organisational chart;

- *President of Albania*. Declares all primary legislation, investors' agreement approved by the NAoA or international treaties ratified by the NAoA. Has a right to exercise a veto on a bill, whenever he/she does not agree, and only once for a particular bill;

- *Government of Albania (GoA)*. Defines the principal direction of the general state policy and of specific strategies, such as the Energy Development Strategy. Defines the rules on the terms and conditions for granting permits to construct and operate natural gas system pipelines and infrastructure. Approves special permit for the construction and operation of natural gas pipeline infrastructure for the transmission and distribution of natural gas, natural gas storage facilities, direct lines and interconnection lines with neighbouring systems. Administers the petroleum sub-sector and takes care of production sharing agreements;

- *Ministry of Energy and Industry (MEI)*. Develops policies for the development of the natural gas sector, in accordance with the requirements laid down in the Treaty of the Energy Community, the principal directions of general state policy and specific strategies, such as Strategy national Development and Integration and the national Energy Strategy and the objectives set in the national Plan of Implementation of the Stabilization and Association Agreement. MEI approves new infrastructure plans of natural gas; Issues building permits and authorizations of new gas infrastructure; Technical designs and safety regulations and proposes the Albanian government for approval. MEI plays a crucial role in the harmonization and interoperability of the Albanian natural gas systems with standards and regulations of EU gas sector. and the interaction of the Albanian natural gas systems;

- *Other Ministries*. Fulfil duties and issue orders relating to the natural gas sector to implement the National Energy Strategy (National Plan of Implementation of the Stabilization and Association etc.). Provide opinions, comments and/or suggestions, and recommendations on the issues of the natural gas sector. The environmental permits are issued by the Ministry of Environment and National Licensing Centre;

- *Energy Regulatory Entity (ERE)*. Adopts and issues rules and regulations required to fulfil obligations under the Law on Natural Gas Sector of 2015. Issues licenses for the operation in the natural gas activities. Sets tariffs and prices pursuant to the terms under the Law on Natural Gas Sector of 2015. Monitors, controls and enforces compliance with terms from the laws and licenses. Ensures consumer protection with respect to tariffs;

- *Albpetrol SH.A.* Has the exclusive rights, as the State-owned company, for the development of all oil and gas fields under its management. Signs contracts with organisations and persons according to the laws and regulations. Involved in production and supply of natural gas. Owns all gas infrastructures in Albania, i.e. cca. 500 km of pipelines, which are mostly not operational or partially missing. Has Hydrocarbon Agreements with a number of companies, including PHOENIX Petroleum which is operating existing gas fields. Licensed by the ERE (since 22 August 2012) to perform transmission and distribution activities in the area where it owns the pipelines. Operates currently only some 10 km of transmission and distribution networks, supplying small entrepreneurs and households in the areas of Kucova and Patos-Marinez;

- *National Agency of Natural Resources*. Drafts the strategy in the energy sector, monitors its implementation, plans the needs for energy in the future, issues recommendations, as well as implements policies of the GoA in the field of minerals, petroleum and hydro-energy. Negotiates and signs production sharing agreements. Consults, proposes and cooperates with relevant governmental structures to design its policies in the field of hydrocarbons;

- *National Technical and Industrial Inspectorate*. Monitors the natural gas activities and technical safety in the design, construction, and the use of various types of gas infrastructure;

- *Province and Municipal Authorities*. Fulfil duties and issue orders regarding gas investments within the geographical area of the authority; and

- *Other organisations/institutions*. Civil society organizations and cultural institutions play a role in the gas sector through advocacy, mobilization and dialogue with communities.

According to the Law on Natural Gas Sector of 2015, the majority of duties and responsibilities in the gas sector is distributed between the GoA, the MoEI, the AKBN, the ERE, and Albpetrol SH.A as the gas TSO and the gas DSO.

Albania has the corresponding ministry responsible for energy (the MoEI) and the independent NRA (the ERE). The two derive their competences from the Law on Natural Gas Sector of 2015 transposing Directive 2009/73/EC from the Third Energy Package which has become mandatory in Albania from 2015.

Duties of the gas TSO and the gas DSO are defined in the Law on Natural Gas Sector of 2015 too, but no further regulations have been adopted in that direction. The gas TSO (presumably Albpetrol SH.A) awaits its further development along the requirements of the Third Energy Package. It needs to be properly unbundled, and then certified and licensed by the ERE before the GoA/MEI can designate it as the gas TSO. Apart from Albpetrol SH.A, no other specific gas undertakings are recognised as the most promising candidates for the gas DSO(s) which would develop natural gas distribution network(s) in Albania. However, it is necessary to ensure all institutional, legal and regulatory prerequisites in order to have the gas DSO(s) properly unbundled and licensed by ERE too.

The competence of the MEI, the ERE and the gas TSO (Albpetrol SH.A) shall be built by further training to this purpose. Development of knowledge and skills within these institutions, authorities and operators with respect to development of the gas system is a major aspect of the technical assistance being provided to Albania´s energy sector.

3.3.2 Legislative aspects

The legal and regulatory framework for the gas market in Albania is currently defined by the Law on Natural Gas Sector of 2015 which was adopted by the NAoA on 23 September 2015. With the Law on Natural Gas Sector of 2015, Albania has transposed its obligations arising from the Third Energy Package (Directive 2009/73/EC and Regulation (EC) No. 715/2009) of EU legislation.

The transposition of the Third Energy Package is currently followed by adopting necessary bylaws in the gas sector, as defined by this gas related Law, within the deadlines agreed with the Energy Community institutions. The legal and regulatory framework needs to achieve adoption of the secondary regulations required firstly for the transmission and distribution system operation and secondly for the gas market operation.

For the needs of the gasification Project, the provisions of the Law on Natural Gas Sector of 2015 sufficiently and satisfactorily cover the key issues:

- Terms such as control, TSO certification, and vertically integrated undertaking are correctly defined;
- Requirements for the unbundling of the gas TSO, as well as of the gas DSO, are fully transposed;
- ERE is tasked to adopt the Regulation on the Certification of the TSO determining rules on procedure and timelines for the certification (including for the certification of the exempted gas TSO) – accomplished;
- The certification and designation of the gas TSO is prescribed;
- Licences to perform the activities of natural gas distribution, and operation of storage and LNG facilities simultaneously present acts on designation of respective operators;
- ERE is tasked to inform relevant international bodies on gas TSO’s designation; and
- The certification of the gas TSO with regards to third countries is required too.

Further progress in the implementation of the Energy Community's Acquis Communautaire is linked with the adoption of detailed rules and regulations necessary for the gasification. Albania still needs to adopt the necessary acts concerning the functioning of the gas sector. In terms of the legal and regulatory framework, it is necessary to draft and approve specific rules envisaged under the primary legislation, such as the Market Code, Transmission Grid Code, Distribution Grid Code, Capacity Allocation and Congestion Management Rules, Quality of Service Rules etc. Preparation of these rules needs specialised expertise. Strengthening of the administrative capacity of the institutions and market players is a prerequisite.

The Law on Territory Planning and Development will have to be applied during the development of the gas infrastructure. Gas infrastructure is to be developed with application of not only the provisions of the Law on Territory Planning and Development but also based on the adoption of appropriate planning documents with public participation and the enactment of permits authorising the construction and use of gas distribution system facilities. Application of this Law ensures assessment and planning of measures in order to avoid or mitigate adverse impacts on the environment. This Law also stipulates real estate property rights in order to use the land for construction of the gas infrastructure and associated facilities.

The legal framework for environmental and nature protection comes from the provisions of the Law on Environmental Protection, the Law on Environmental Impact Assessment, the Law on Air Protection from Pollution, the Law on Protected Areas, the Law on Environmental Protection from Trans-Boundary Impact, the Law on Environmental Permits, and the Law on Forest.

Regulations regarding the organisation and registration of property rights are contained in the Civil Code, the Law on the Restitution and Compensation of the Property to the ex-owners, the Land Law, the Law on State Property, the Law on Expropriation, and the Law on Registration of Real Estate (RE). The Civil Code of Albania, in Chapter II, regulates the methods for acquisition of property rights. There are several ways for acquiring the property rights, through i.e. Contract, Inheritance, Good Faith acquisition, Adverse Possession, Expropriation and few other methods. Use and management of the State Property (movable and RE belonging to the state or to local self-governments) is regulated by the Law on Strategic Investments. General rules regarding property rights apply to the acquisition and cessation of ownership rights and other property rights regarding State Property. The Law on Expropriation defines the basic terms concerning expropriation, the procedure of establishing public interest, preparation of actions necessary for expropriation, the procedure of expropriation and compensation for it. Expropriation means dispossession or limitation of the ownership right on property, when required so by public interest, with a compensation based on market value. In accordance with the Law on RE Registration, RE property should be registered in the RE property register. This register is open to the public and is administrated by local RE Property Registration Offices, which report to the central RE Property Registration Office, which, in turn, is governed by a Board of Directors and the Chief Registrar.

The current legal framework regarding RE will apply to the planning, development and construction of any gas network, and does not need to be amended – there are enough legal institutions in the Albanian legislation that can apply to a gas infrastructure. All procedures are defined in current laws. Any impediments in these legal procedures are known and not necessarily related to the development of a gas infrastructure.

3.3.3 Political aspects

The Albanian energy sector has been identified as one of the strategic growth sectors; often referred to as the enabler for the country's economic recovery. A number of reforms within the energy sector have been implemented during the past period. However, there still remains significant efforts to be made in the gas component, which include the gasification of the country.

Albania, as the Contracting Party to the EnC Treaty, has assumed international legally binding obligations to align its legal and regulatory framework with the respective EU Acquis Communautaire. In other words, irrespective of the country's status in relations to the EU integration process, the gas sector is already bound to adopt the corresponding EU Acquis Communautaire in line with implementation dynamics determined by the Energy Community institutions according to the EnC Treaty’s provisions.

Albania currently disposes only of limited natural gas reserves and does not have access to international natural gas markets yet. Depending on the results of exploration in the next 5-10 years, as well as on the development of TAP, Albania will consider the possibility of exploiting and transporting natural gas more widely. Albania should also consider the distribution of natural gas throughout the country, but this cannot be expected before 2020, even in the most favourable conditions.

Due to such uncertainties and long lead times (if connection to TAP is delayed and/or results of further exploration in Albania indicate lack of commercially viable reserves), the best approach would be to focus on unbundling, certifying, licensing, and designating the gas TSO first and the gas DSO(s) next – establishing the operators is essential for the development of gas infrastructure. Such focus is motivated by the clear commitment of Albania towards EU integration and its active role in international cooperation in the field of natural gas, within the EnC Treaty. Alternatively, the activities related to the gas TSO and the gas DSO(s) can be realised in a ‘dry-run’ mode (to become ready if and when the gas sector emerges, i.e. establishing the TSO and DSO businesses and performing related energy activities in practice once gas systems are operational).

The planned connection to TAP (not earlier than 2020) and possible finding and exploitation of domestic gas would determine the specifics of natural gas market later on. Therefore, preparation of bylaws in this area (the detailed model, design and structure of the natural gas market in Albania) is seen as the medium-term priority since there are more urgent issues to be resolved in the short-term period, as described above. Organisation and development of a competitive natural gas market will be put in focus after resolving issues linked with regulation of the gas sector, such as access to and use of natural gas network and the methodology for determining tariffs.

Please refer to "*Institutional Review and Organisational and Institutional Assessment Report*" for more detailed legal and institutional aspects of project implementation.

3.4 Potential gas demand basis

3.4.1 Albania

Total useful energy consumption for entire Albania was forecasted by sector and was modelled with the IAEA MAED model (*Model for Analysis of Energy Demand*). The model evaluated future energy demand by sector based on medium to long term scenarios of socio-economic, technological and demographic developments[3].

The basis for the forecasts in households and services was the forecasted number of inhabitants and households. The indicator used in measuring the economic development was the gross domestic product per capita (GDP/cap). Population projection for Albania by 2040 is the taken from the World Bank database for population estimates and projections to 2050, and the distribution of the total population by prefectures and then by regions or zones is made by considering the shares of each prefecture in total population projections for Albania made by INSTAT.

Based on the data available from the Census 2011, carried out by INSTAT, the thermal energy consumption was distributed to the households by regions of Albania. The same way as for the household and service sector, further distribution of the forecasted useful energy consumption in industry by LGUs is made based on the statistical data about the shares of number of business entities by their location within prefectures (only in urban LGU´s) and then by the shares of the number of inhabitants of each urban LGU in total number of inhabitants in all urban LGU´s in prefecture in 2011.

The MAED model was applied to each region/LGU and the potential natural gas consumption by sector was forecasted as follow:

- Forecasted total useful thermal energy demand in households, services and industry of Albania that can be replaced by natural gas is distributed by prefectures and then by LGU´s of Albania as future potential natural gas consumption (about 2,167 mcm in 2040, including agriculture and transport sector), but excluding anchor consumers.

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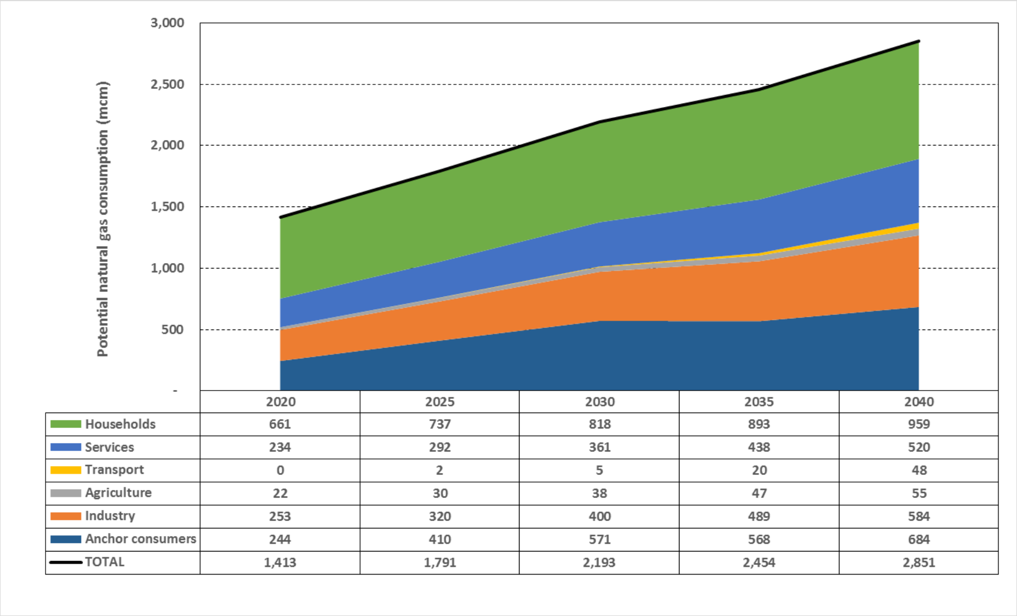
[3] For more information about the IAEA MAED model and a detailed potential natural gas demand and supply assessment, please refer to the report "WB11-ALB-ENE-01, Gas Demand and Supply Assessment Draft", November 2015

- Future potential natural gas consumption for electricity generation could be around 437 mcm in 2040, and forecasted natural gas consumption in refineries and other anchor consumers in 2040 could be around 247 mcm.



	2020	2025	2030	2035	2040
🟩 Households	661	737	818	893	959
🟦 Services	234	292	361	438	520
🟨 Transport	0	2	5	20	48
⬜ Agriculture	22	30	38	47	55
🟧 Industry	253	320	400	489	584
🟦 Anchor consumers	244	410	571	568	684
— TOTAL	1,413	1,791	2,193	2,454	2,851

Figure 3-3 Total potential natural gas consumption in Albania by consumption sectors

Demographic characteristics of Albanian settlements are very unfavourable for the development of gas distribution networks. Albania has a relatively large number of settlements (approx. 3,000) with a relatively small number of inhabitants per settlement. In more details, Albania is divided into 12 administrative counties, 36 districts, 61 municipalities (and previous 373 Local Government Units (LGU)). There are 74 cities overall and 2,972 town and villages[4] covering a total area of 28,371 km2.

Building gas distribution networks involves substantial economies of scale. A principal measure for benefiting from economies of scale is the average volume of gas demand per kilometre (km) of the distribution grid which, in turn, depends greatly on a country's (or region's) settlement density. The factors influencing the principal drivers of gas demand as well as the degree of the penetration of gas usage are the following:

- Population density and its distribution,
- Level of urbanization,
- Type of dwelling,
- Presence of Anchor Consumers.

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[4] Source: INSTAT, A New Urban –Rural Classification of Albanian Population, May, 2014

With regard to rural areas in general, it is not expected that rural LGU´s will be considered among the priority areas for the development of local natural gas distribution networks, since economies of scale would be difficult to be achieved.

A forecast of the potential gas consumption profile of the rural area in Albania is presented below.

Table 3-2: Total Forecasted Gas Consumption Profile of the Rural Areas in Albania

	No of LGU's	**Population**	**Area km2**	**Gas Consumption (in '000 m3)**							
				Residential		**Services**		**Industrial**		**Total**	
				2020	**2040**	**2020**	**2040**	**2020**	**2040**	**2020**	**2040**
Rural Areas	308	1,339,173	25,899	298,120	384,868	39,771	82,324	0	0	**337,891**	**467,193**
Total Albania	373	2,800,138	28,371	660,525	958,705	234,050	520,398	274,985	687,577	**1,169,560**	**2,166,680**
%	82.57%	47.83%	91.29%	45.13%	40.14%	16.99%	15.82%	0.00%	0.00%	**28.89%**	**21.56%**

Note: Industrial gas consumption figures include transport, agriculture and industry subsectors

The main characteristics of these areas are the lack of industrial gas demand and, for the majority of them, the low population density and the limited level of the gas demand. The total potential gas consumption represents only the 29% of the total Albania in 2020. It is forecasted that in 2040 natural gas consumption will reach 470 mcm and represent 21% of total Albania, while for urban areas the growth rate is higher. The range of the forecasted gas consumption for the year 2040 varies from 0.079 mcm to 474.28 mcm, the average being 5.75 mcm and the median 1.19 mcm. For the year 2020, the minimum gas consumption is forecasted 0.075 mcm and the maximum one 235.18 mcm, the average being 3.11 mcm and the median 0.91 mcm.

As opposed to the rural areas, the total gas consumption profile for the urban LGU´s is presented in the following table:

Table 3-3: Total Forecasted Gas Consumption Profile of the Urban Areas in Albania

	No of LGU's	**Population**	**Area km2**	**Gas Consumption (in '000 m3)**							
				Residential		**Services**		**Industrial**		**Total**	
				2020	**2040**	**2020**	**2040**	**2020**	**2040**	**2020**	**2040**
Urban Areas	65	1,460,965	2,472	362,405	573,835	194,279	438,073	274,985	687,577	**831,669**	**1,699,485**
Total Albania	373	2,800,138	28,371	660,525	958,705	234,050	520,398	274,985	687,577	**1,169,560**	**2,166,680**
%	17.43%	52.17%	8.71%	54.87%	59.86%	83.01%	84.18%	100.00%	100.00%	**71.11%**	**78.44%**

Note: Industrial gas consumption figures include transport, agriculture and industry subsectors

Based on the above, a realistic potential area for developing the gas transmission and distribution pipeline system includes 85 municipalities and it is presented in the map below (see Figure 3–4*)*. The following points should be mentioned:

- The gas consumption of the 85 municipalities corresponds to the 77% of the total Albania for the year 2020 and the 82% for the year 2040.
- The area covers the 13% of the total Albania area, while, in terms of the population level, it covers the 65% of total Albania population,
- Some municipalities are under consideration due to the presence of anchor consumers or potential gas storage facilities (ie. Divjaka etc.)
- The municipalities Berat, Kozarë, Kuçovë, Kutalli, Otllak, Perondi, Poshnjë and Urë Vajgurore of Berat Prefecture are supplied by a gas distribution network developed directly from TAP,

- For the case of Korca Prefecture, two options are available related to the possibility of developing the international pipeline to FYRoM. The distribution network can be developed directly from TAP or from an exit point from the transmission pipeline to FYRoM, in case that the latest proved to be feasible,
- The case of Kukes municipality. The municipality of Kukes, although gives sustainable distribution network, is linked to the international transmission pipeline to Kosovo.

Table 3-4: Expected municipalities for gasification

	No of Municipalities	Population	Area	Gas Consumption (in '000 m3)							
				Households		Services		Industrial		Total	
				2020	2040	2020	2040	2020	2040	2020	2040
Proposed Municipalities	85	1,813,521	3,469	455,900	709,898	195,671	437,807	246,316	615,892	**897,887**	**1,763,597**
Total Albania	373	2,800,138	28,371	660,525	958,705	234,050	520,398	274,985	687,577	**1,169,560**	**2,166,679**
%	22.79%	64.77%	12.23%	69.02%	74.05%	83.60%	84.13%	89.57%	89.57%	**76.77%**	**81.40%**

Finally, it should be noted that in Section 4.5, a more detailed feasibility evaluation of the 85 municipalities is presented.

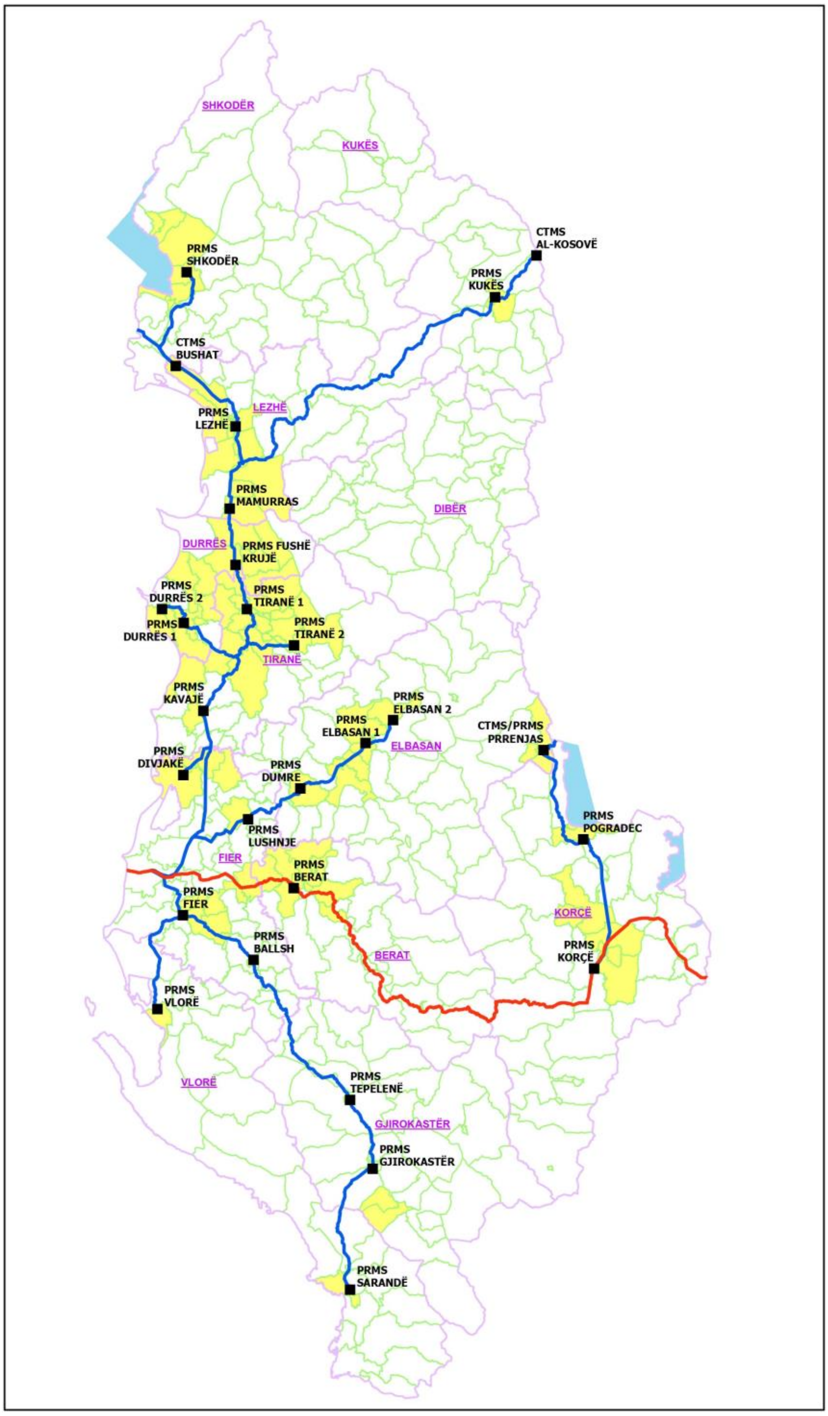

Figure 3–4: Municipalities viable for further screening for gasification

3.4.2 Kosovo and FYRoM

The forecasted total gas consumption in Kosovo and FYRoM are taken from the "*Study on the Implementation of the new Regulation (EU) 994/2010 Concerning Measures to Safeguard Security of Gas Supply in the Energy Community*".

Currently, there is no use of natural gas in Kosovo and according to Energy Community Study, it might be expected that natural gas consumption in Kosovo will grow up to 1.1 bcm within 2040. It was assumed that the gas might be supplied from the neighbouring countries (Former Yugoslav Republic of Macedonia, Serbia and in long term from Montenegro or Albania).

In scenarios 1 and 3 of Albania's transmission system, additional quantity of 1 bcm/year is provided near Kukes for the supply of Kosovo.

Forecasted gas consumption in Kosovo is shown in the table and figure below.

Table 3-5: Forecasted total natural gas consumption in Kosovo

(mcm)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Final consumption	66	101	137	172	207	242	288	334	380	426	472	516	560	604	648	692	739	786	833	880	927
Transformation	-	12	24	36	48	60	69	78	86	95	103	107	110	113	117	120	121	123	124	126	127
Rafineries and non-energy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Losses	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	10
Total	**67**	**114**	**163**	**210**	**258**	**305**	**361**	**416**	**471**	**526**	**581**	**629**	**677**	**724**	**773**	**820**	**869**	**918**	**967**	**1,016**	**1,064**

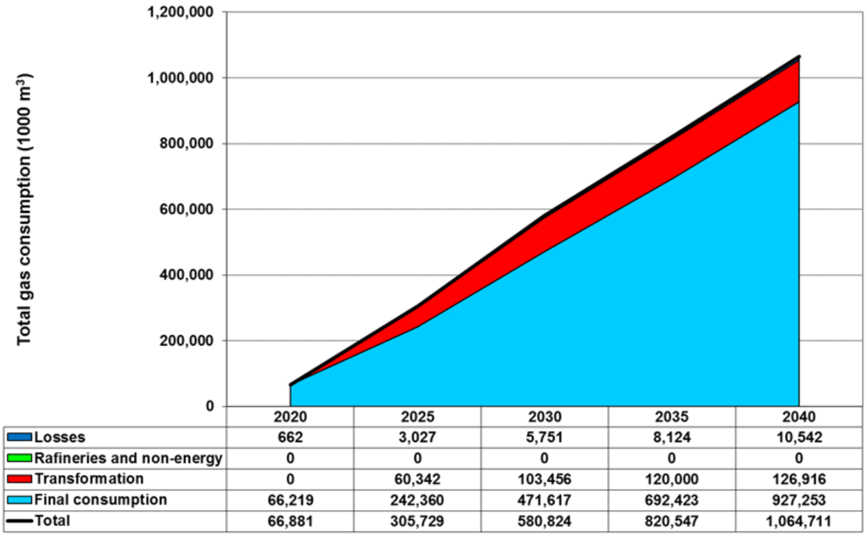

Figure 3-5 Forecasted total natural gas consumption in Kosovo

Currently, the share of natural gas in total primary and total final energy consumption in Former Yugoslav Republic of Macedonia is pretty small, as well as for electricity and heat production.

Total natural gas consumption in Former Yugoslav Republic of Macedonia in 2014 was 157 million cubic meters. There is no production or proven reserves of natural gas in Former Yugoslav Republic of Macedonia. Although all natural gas is imported, the import pipeline's capacity of 0.8 bcm/y is far from being fully used and could even be extended to up to 1.2 bcm/y.

Total gas consumption in Former Yugoslav Republic of Macedonia is forecasted to increase to 2.3 bcm in 2040, of which 1/3 or 0.756 bcm/y could be supplied from Albania (according to scenarios 1 and 3 of Albania's transmission system, additional quantity of 0.756 bcm/year is provided near Prrenjas for the supply of FYRoM).

Forecasted gas consumption in FYRoM is shown in the table and figure below.

Table 3-6: Forecasted total natural gas consumption in FYRoM

(mcm)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Final consumption	254	293	333	372	411	451	496	541	586	631	676	718	760	801	843	885	921	958	994	1,031	1,067
Transformation	775	850	925	1,000	1,075	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Rafineries and non-energy	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Losses	11	12	13	14	15	16	17	17	18	18	19	19	19	20	20	21	21	21	22	22	22
Total	**1,070**	**1,185**	**1,301**	**1,416**	**1,531**	**1,647**	**1,693**	**1,738**	**1,784**	**1,829**	**1,875**	**1,917**	**1,959**	**2,001**	**2,043**	**2,086**	**2,122**	**2,159**	**2,196**	**2,233**	**2,269**
1/3 supplied from Albania	**356**	**395**	**433**	**472**	**511**	**549**	**564**	**579**	**595**	**610**	**625**	**639**	**653**	**667**	**681**	**695**	**707**	**720**	**732**	**744**	**756**

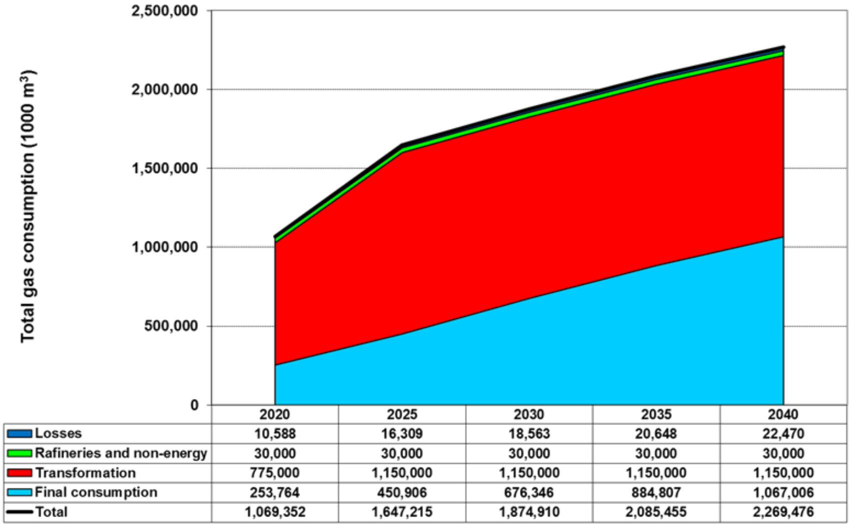

Figure 3-6 Forecasted total natural gas consumption in FYRoM

4 Gas Distribution System - Technical and Economic Assessment

4.1 Assessment of existing gas infrastructure

In the past Albania had a significant gas sector, but there is virtually no gas now. Domestic gas production has declined from 1 bcm in 1982 to 0.01 bcm in recent years, and almost an entirely new or rebuilt gas transmission and distribution system is required.

Albania is today, along with Montenegro and Kosovo, the only country in Europe, not linked to interstate gas transmission systems and has a completely isolated, national gas distribution system. The very small remaining gas activity is concentrated in the southern part of the country supplying the oil refinery industry with limited volumes of domestic produced gas from the fields of Divjaka and Frakull and associated gas from the oil fields near Ballsh. There are two oil refineries at Ballsh and Fier with a combined capacity is 1 Mt/y, but both are presently running at 40-50% of capacity. Other industries, such as the Fier fertilizer plant that used to be a major natural gas consumer in the 70's, have either shut down or have reduced their production volumes.

Due to the location of gas and oil fields and the availability of pipeline infrastructure, the use of gas was focused on the area of Fier, which represented about 70% of the gas market in Albania over the past years.

Gas fields already have some pipeline infrastructure in place from Durres to Delvina. The total pipeline network has a length of 498 km and connects all the previously operational gas fields (Povelca, Divjaka, Frakulla, Panaja and Delvina) with consumers located in Fier, Vlora, Elbasan, Lushnja, Ballsh and Durres (see Figure 4-1). Except for the refurbished pipeline from Delvina gas field to the refinery in Ballsh, the gas infrastructure is non-operational and would require rehabilitation before coming operational. Much of the network needs to be totally replaced, but rights of way can be useful.

During the preparation of this study, through contacts and meetings with Albpetrol Sh.a, relevant information on the status and the condition of the existing gas pipeline network in Albania was obtained. Albpetrol Sh.a. described the actual condition of existing pipelines and proposed some pipelines having the potential for rehabilitation.

Based on available data, an analysis of the potential to integrate the existing pipelines in Albania into the new transmission system was performed.

Determination of the rehabilitation options of the pipeline to be used as a future transmission line would require detailed inspection and analysis related to the integrity of the pipeline and wall thickness (capability of the wall to withstand transmission system design pressures).

The basic criteria used for the analysis of the integration potential of the existing pipelines were: pipeline diameter, design pressure, year of construction, existing and planned purpose, corridor acceptability etc.

It is also important, in order to integrate the existing gas pipeline within the new gas transmission system, that the corridor for the existing pipelines meets the required conditions of safety, such as the distance from existing populated buildings, etc. Hence, the changes in population density were considered, and the potential development of landslides, road slides etc.

The majority of the existing gas pipelines do not meet the requirements of the transmission system due to the year of construction, their condition and diameter. They additionally do not follow the shortest way to consumption centres.

For instance:

- the existing gas pipelines Frakulla – Fier, Cakran–Ballsh, Povelca–Fier are not in the direction for supply of gas to LGU´s that have large gas consumption.

- the pipeline Divjaka-Fier, section Divjaka-Bubullima does not correspond to the system configuration. The shortest route of a pipeline from Fier (the connection point to TAP) to Tirana is also the most feasible option considering also the shortest connection from Divjaka to the transmission system.

Generally, it can be concluded that the majority of the existing gas pipelines are old and/or in poor condition, which makes their repair not viable. In such cases, the use of the existing pipeline corridor was considered. Given the available information on the existing pipeline routes and the required development level of GMP, the wider corridors for the use of existing pipeline RoW (Right-of-Way) are considered. Only by examining the actual situation at the site, it will be possible to accurately determine the extent to which the particular RoW is usable or should be abandoned along some sections in order to avoid existing housing, other existing underground infrastructures etc. This is handled in the subsequent phases of project development. (Basic / Detailed design).

Following corridors were considered:

Fier to Elbasan - the pipeline itself is damaged and practically unusable. The corridor was considered, but eventually the shorter route was chosen to reach potential consumers (in Lushnja and Elbasan) and the potential location of UGS Dumrea. The gas pipeline route follows existing pipeline corridor from Shalesi to place Cerik, at length of about 7 km.

Fier to Vlora - the existing pipeline is very old, the diameter is inadequate and most of pipes are missing. Rehabilitation would mean the construction of a new pipeline in the existing corridor. The corridor was considered, but at some sections more appropriate route considering population and terrain was chosen. The gas pipeline route follows existing pipeline corridor from the point in the vicinity of village Levan to Novoselë at a length of 3.5 km, and also from the settlement Aliban to Skrofotinë at a length of 4 km.

Fier to Ballsh - the existing pipeline should generally be in good condition. Based on available data, during planning of the new transmission system, the existing corridor was used to the maximal extent. However, the existing pipeline is not included in the transport system because it does not meet applicable safety requirements and standards (eg, distance from inhabited buildings). Detailed determination of the potential of the corridor will require a more detailed study. Along the section Fier to Ballsh the pipeline route for the most part follows the existing pipeline corridor at approximate length of 11.5 km. At the sections near the settlements Porteza (3.5 km), Criq (1 km), when bypassing the settlement Visoka (4 km) and approaching the city of Ballsh (3 km), the route follows the wider existing pipeline corridor, meaning the use of RoW can still be considered during Basic Design phase.

Ballsh to Delvina - Despite the fact that a good portion of the pipeline is repaired or replaced, it is predominantly an old pipeline with different diameters of sections, which do not meet the needs of planned gas consumption. The corridor does not entirely meet the European safety standards (eg, distance from inhabited buildings). Therefore, the new transmission system includes the construction of a new gas pipeline with a maximal use of the existing corridor. The pipeline route follows the corridor of the existing gas pipelines in Ballsh in length of about 0.6 km, near the settlement Bejari 8 km, from Toci to Qesariti 6.7 km, from the town Memailaj to the vicinity of Gjirokastër about 21.5 km with just a small divergence near Tepelenë and from Prongji to Vergo in a length of 12 km.

The route of the existing pipeline passes also places with unsuitable terrain, with potential landslides. Therefore, the new route is in some parts laid in more favorable terrain. A detailed determination of the potential use of the existing corridor will require a detailed study, which should be done in connection with the Main Design.

In conclusion it can be stated that existing corridors were partially used in the development of the future transmission system, such as: the pipeline Fier to Vlora, a pipeline going southeast to Fier through Ballsh toward Delvina and a small section of the pipeline from Fier to Elbasan.

Within **SEE Regional Gasification Study – Albania Market**, the City Distribution Demand Studies for Tirana and Elbasan were prepared. Currently there are no existing city distribution networks in Albania, except for the existing pipelines to large consumers.

Figure 4-1 Existing Pipelines as of December 2014, Source: Albpetrol Sh.a

4.2 Gas distribution systems basics

Gas distribution systems of cities and villages usually consist of the following unities (looking in the direction of gas flow):

- odorising station with connecting pipeline from PRMS;
- the high pressure (HP) distribution pipeline
- medium-pressure (MP) gas network
- low pressure (LP) gas network
- MRS of low pressure (LP) gas network

The permitted range of working gas pressure in the distribution system (limited by minimum and maximum working pressure) at which gas distribution takes place is divided into three classes:

- low pressure (up to and including 0,1 bar),
- medium pressure (0.1 bar up to and including 5 bar) and
- high pressure (more than 5 bar)

The distribution system starts from a pressure reduction and metering station (PRMS), which normally is the property of the transmission system operator (TSO).

The PRMS owned by the TSO generally has two outputs to the gas distribution systems: one at which the pressure is reduced to 5 bar (for MP gas network supply) and another at which the pressure is reduced to 16 bar (for HP distribution pipeline supply).

The odorizing station (OS) normally owned by the gas distributor (DSO) is built at an appropriate location, often near a metering and regulation station (MRS). The purpose of having an OS is gas odorizing because natural gas is colourless, odourless and tasteless, so an odorant of characteristic smell is added, to enable the detection of gas presence by sense of smell. Gas odorizing is to be performed in accordance with the technical regulation G 280-1 "Odorizing of gas”.

MP and LP gas supply system enables full gasification (gas as fuel for heating, hot water, cooking and cooling) of existing and future objects, while HP distribution pipelines typically are used for gas supply of large, mainly industrial consumers, or to transport gas to the MRS in remote parts of the city or village.

MP and LP gas pipelines are made from the polyethylene pipes manufactured and tested according to applicable standards such as: EN 1555 Plastics piping systems for the supply of gaseous fuels -- Polyethylene (PE) -- Part 2: Pipes (EN 1555-2) Standard pipes and fittings are quality PE 100, while section sizes and classes (SDR) comply with the working and test conditions.

HP distribution pipelines are made of steel pipes manufactured and tested according to applicable standards: SSH EN 10208-2 Steel pipes for pipelines for combustible fluids -- Technical delivery conditions -- Part 2: Pipes of requirement class B (EN 10208-2). The quality and thickness of the wall comply with the working and test conditions.

The final dimensions of the gas distribution pipelines are determined by hydraulic calculations in the main design stage.

Gas distribution pipelines are mainly laid in public roads, parallel with other utility infrastructure.

MP and LP pipelines are typically buried with minimal ground cover of 0.80 m while HP gas pipelines are buried with minimal ground cover of 1.0 m. The width of the pipeline trench is typically from 0.40 to 0.70 m. Gas distribution pipes are laid on a sand bed, cca 15 cm thickness.

After laying and testing the pipeline, the trench is backfilled with fine sandy material to a certain level above the pipe. Above the sand backfilling are done with gravel in layers until the surface sub base. Surfaces, such as pavement, sidewalk and green areas are then restored to its original state.

The pipeline distance from buildings, other above ground structures and parallel underground utility installations, as well as crossings of other utility installations, complies with the rules and standards for the pipeline installation, such as: Technical rules G 463 Steel pipelines for maximum operating pressure over 16 bar , S SH EN 1594 Gas infrastructure -- Pipelines for maximum operating pressure over 16 bar -- Functional requirements (EN 1594) , Technical rules G 466-1 Steel pipelines for maximum operating pressure over 5 bar – Maintenance and S SH EN 12007-1 Gas infrastructure -- Pipelines for maximum operating pressure up to and including 16 bar -- Part 1: General functional requirements.

Pipeline crossings of railways and main roads are usually performed by methods of drilling at a prescribed depth while typical technical solutions of pipeline crossings with watercourses include open trench methods, i.e. burying the pipeline at the proper depth below the bottom of the watercourse with some concrete protection.

Distribution pipelines are almost exclusively installed underground, which further increases the level of operating safety.

4.3 Layout development basics

4.3.1 System layout

The future gas distribution systems will be supplied from the PRMS’s, which are planned near the centres of large consumption areas of Albania. PRMS’s are either planned as future additions to TAP above ground facilities such as block valve stations (BVS), as provided in the National Sectoral Plan for TAP Project and ESIA for TAP in Albania, or additions to above ground facilities on the planned IAP and other transmission pipelines. Including PRMS Fier three (3) TAP off- take points are planned.

The number and locations of the PRMS’s satisfy the technical requirements for gasifying the 85 LGU´s described in Section 3.4.

The layout of the distribution pipelines is designed with the focus to supply major consumers such as industrial consumers, larger public / service facilities, and large market centres, while the pipelines continues to reach other consumers afterwards. The distribution systems can be either capillary or ring shaped. Distribution gas networks are further designed to enable the network construction in individual settlements and districts, so it is possible to separate the parts of the network using closing valves.

The layout of the HP distribution system is designed to reach larger industrial consumers requiring working pressure higher than the operating pressure a MP gas network can provide. In addition, the HP distribution system is used in city outskirts where the pressure of MP gas network is not satisfactory.

The construction of the MP gas distribution system allows for full gasification of peripheral parts of towns and villages of the selected 85 LGU´s in the future by ensuring a satisfactory level of system pressure. Industrial zones are also supplied from the MP system to ensure supply of sufficient quantities of gas and a satisfactory pressure level required for operation of equipment installed at major consumers.

LP gas network is supplied with gas from a PRMS which is located at the MP distribution network. They measure gas quantities and reduce the pressure to the LP gas network operating pressure.

4.3.2 Consumer connections

Consumer connections starts at the connection to the street pipeline.

In LP gas network the connection ends either with an external main isolation valve and a built-in facade cabinet (meter and pressure regulator) or a basement connection isolation valve located immediately upon connection entering the basement.

LP gas networks can be provided in old city centres and inner parts of towns, when the dominating building structure (such as townhouses) prevents the gasification with medium pressure because of the specific installation of façade cabinets. The cabinets could come in immediate vicinity of the pavement and the edge of the public road surfaces, and could be in immediate danger of damage. In addition, culture-protective requirements could prevent installation of façade cabinets.

For MP gas network, consumer connection ends with the external main isolation valve and a surface-mounted facade cabinet with pressure reducer.

4.4 Potential gas distribution systems

As a part of the elaboration of the future potential gas market a technical assessment of the distribution networks was done.

To estimate the cost of the distribution systems four (4) reference LGU´s were identified and the CAPEX for these LGU´s estimated based on the pipeline length in the distribution system. The Identification process included a division of the selected 85 LGU’s in four groups based on the population density (population per km2). In each group one reference LGU was selected having the average population density within the group and at the same time largest potential gas consumption. As shown in Table 4-2 below, these are Zall-Herr, Gjirokastër, Kamëz and Tirana.

Table 4-1: Selection of Reference LGU´s

Group	Number of LGU's	Population	Total area	Average area	Average population density	Average potential gas consumption		LGU	County	Population	Area	Population density	Potential gas consumption	
						2013	2040						2013	2040
			km²	km²	pop/km²	mcm	mcm				km²	pop/km²	mcm	mcm
1	50	393,214	2,639.96	52.8	162.1	2,186.4	4,137.0	Prezë	Tirana	4,727	28.96	163.24	1,202.7	2,771.5
								Maminas	Durrës	4,463	27.62	161.61	1,389.7	2,304.5
								Zall-Herr	**Tirana**	**9,389**	**58.30**	**161.06**	**2,083.8**	**4,826.3**
								Gostimë	Elbasan	8,116	50.20	161.69	1,690.3	2,325.8
2	18	309,894	535.11	29.73	601.5	6,053.7	14,585.8	Cërrik	Elbasan	6,695	10.97	610.35	3,880.0	11,081.1
								Gjirokastër	**Gjirokastër**	**19,836**	**29.74**	**667.07**	**9,667.4**	**25,699.8**
								Bërxullë	Tirana	9,883	15.56	634.99	2,293.7	5,303.2
3	24	608,301	215.27	15.38	2,783.7	18,940.1	51,756.0	**Kamëz**	**Tirana**	**66,841**	**24.78**	**2,697.04**	**25,078.7**	**68,144.5**
								Lezhë	Lezhë	15,510	5.41	2,864.32	4,691.3	11,633.0
4	3	495,188	55.68	18.6	7,763.5			**Tirana**	**Tirana**	**418,495**	**40.00**	**10,462.69**	**177,635.0**	**474,276.7**

For the remaining 81 LGU´s the lengths were calculated by using average calculated length of the distribution network per inhabitant for each of four groups.

4.4.1 Reference LGU´s

For these four LGU's the distribution systems were developed by hand using Google Earth software, Open Street View, relevant topographic maps and other available documents with the intent to enable the gasification of all objects within a settlement (LGU). The priority is supply of major consumers such as industrial consumers, larger public and service objects, and large market centres which are in the path of the route. After that, the route continues to reach other consumers (residential)

Table 4-2: Representative LGU´s and the average city distribution network length per inhabitant

Group	LGU	Population	Pipeline Length (m)	Meter per inhabitant
1	Zall-Herr	9,389	99,761	10.63
2	Gjirokaster	19,836	77,294	3.90
3	Kamez	66,841	226,671	3.39
4	Tirana	418,495	481,149	1.15

The distribution networks in the four reference LGU´s are presented in below Table 4-3 , Table 4-4 , Table 4-5 and Table 4-6 .

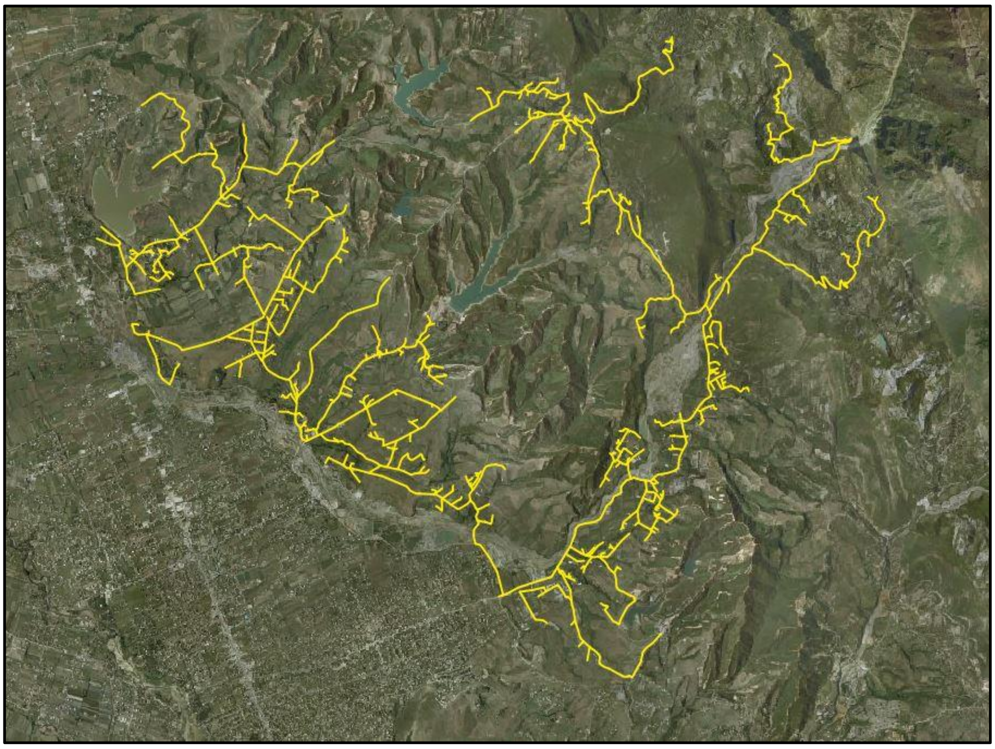

Table 4-3 Proposed city distribution network of Zall-Herr

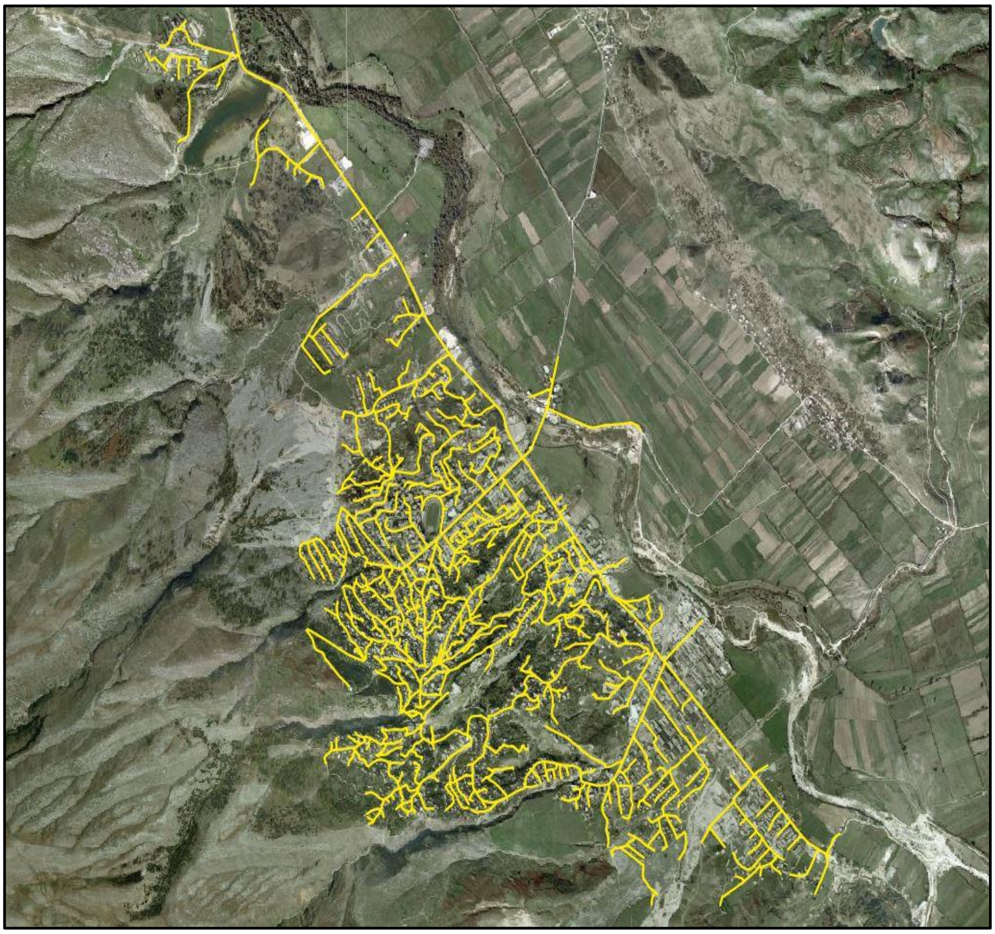

Table 4-4 Proposed city distribution network of Gjirokaster

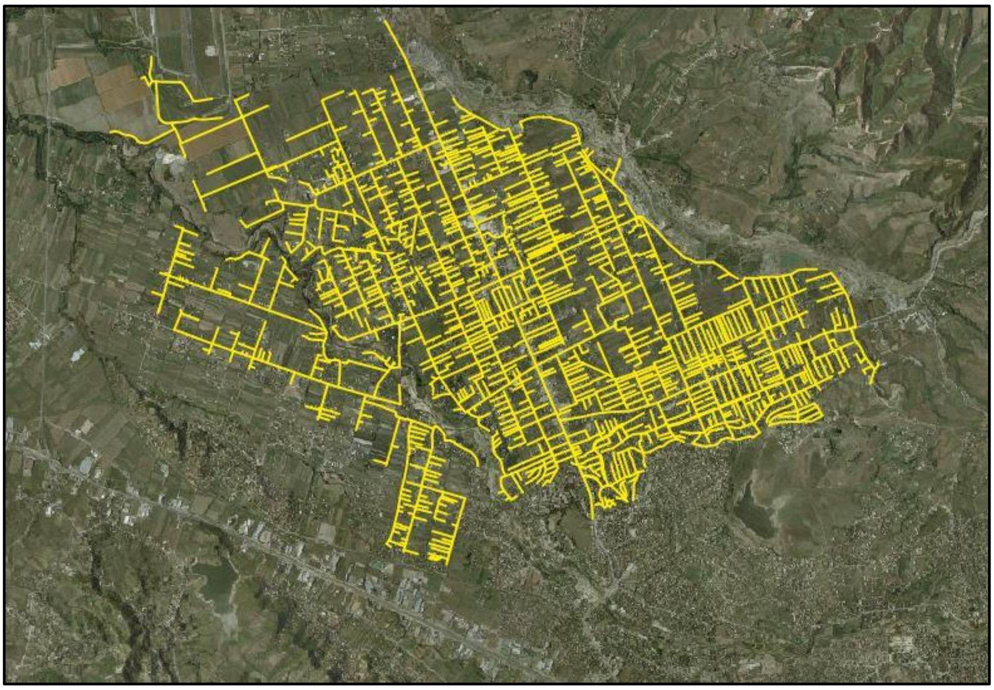

Table 4-5 Proposed city distribution network of Kamez

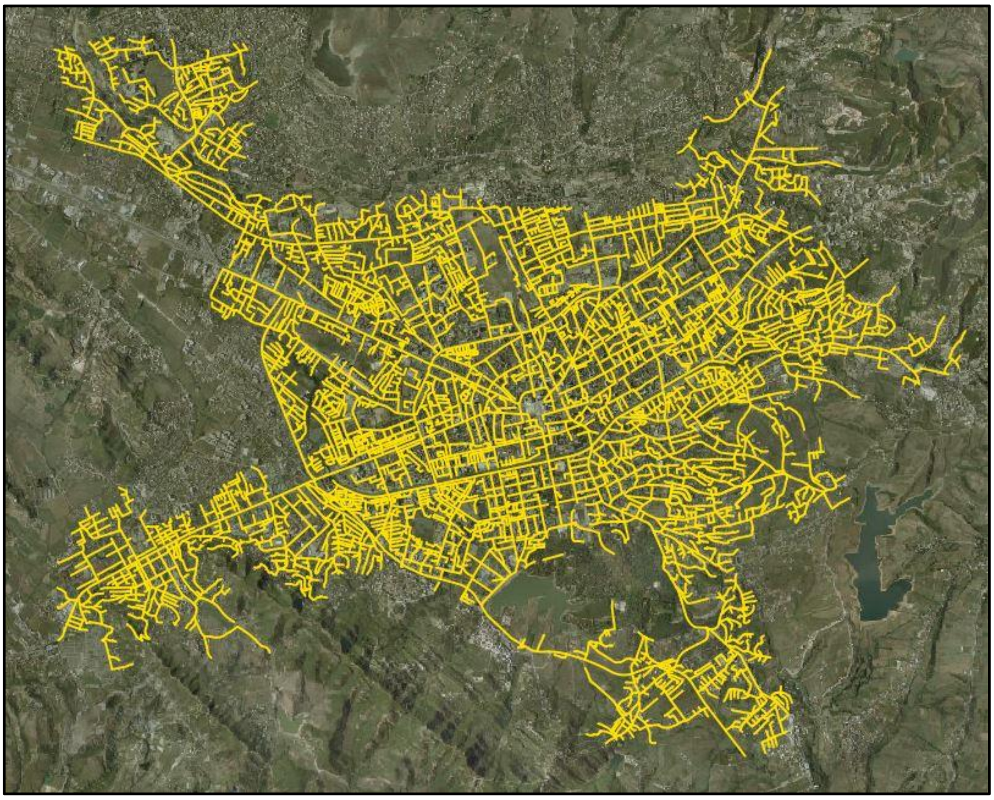

Table 4-6 Proposed city distribution network of Tirana

4.4.2 Pipeline lengths and CAPEX estimates

Based on result from the 4 reference LGU´s the following Table 4-7 presents the unit prices used in the assessment of CAPEX for distribution, while Table 4-8 present the estimated pipeline length and CAPEX networks in all 85 LGU´s.

Table 4-7 Unit prices for distribution networks

Material	Mechanical installation works	Construction works	Total
25 €/m	18 €/m	85 €/m	128 €/m

Table 4-8 Lengths and CAPEX estimates of distribution networks in 85 LGU´s

PRMS	Municipalities	LGU	Population	Pipeline Length (meter)	CAPEX (mill. EUR)
Ballsh	Mallakastra	Ballsh	7,657	25,966	3.3
Berat	Berat	Berat	36,496	123,765	15.8
Berat	Kuçova	Kozarë	5,622	59,735	7.6
Berat	Kuçova	Kuçova	12,654	42,912	5.5
Berat	Ura Vajgurore	Kutalli	9,643	102,460	13.1
Berat	Berat	Otllak	9,218	31,260	4.0
Berat	Kuçova	Perondi	9,005	30,538	3.9
Berat	Ura Vajgurore	Poshnja	7,375	78,362	10.0
Berat	Ura Vajgurore	Urë Vajgurore	7,232	28,181	3.6
Divjaka	Divjaka	Divjaka	8,445	89,731	11.5
Divjaka	Lushnjë	Dushk	7,872	83,642	10.7
Divjaka	Divjaka	Tërbuf	10,201	108,389	13.9
Dumrea	Belsh	Belsh	8,781	93,301	11.9
Durrës	Durrës	Durrës	113,249	384,050	49.2
Durrës	Shijak	Maminas	4,463	47,421	6.1
Durrës	Durrës	Manëz	6,652	70,680	9.0
Durrës	Durrës	Rrashbull	24,081	93,835	12.0
Durrës	Shijak	Shijak	7,568	25,665	3.3
Durrës	Durrës	Sukth	15,966	169,644	21.7
Durrës	Shijak	Xhafzotaj	12,381	48,244	6.2
Elbasan (1+2)	Elbasan	Bradashesh	10,700	36,286	4.6
Elbasan (1+2)	Cërrik	Cërrik	6,695	26,088	3.3
Elbasan (1+2)	Elbasan	Elbasan	78,703	266,897	34.2
Elbasan (1+2)	Elbasan	Gjergjan	5,126	54,465	7.0
Elbasan (1+2)	Cërrik	Gostima	8,116	86,235	11.0
Elbasan (1+2)	Elbasan	Labinot-Fushë	7,058	74,993	9.6
Elbasan (1+2)	Elbasan	Shirgjan	7,307	28,473	3.6
Fier	Fier	Fier	55,845	64,206	8.2

PRMS	Municipalities	LGU	Population	Pipeline Length (meter)	CAPEX (mill. EUR)
Fier	Patos	Patos	15,397	59,997	7.7
Fier	Roskovec	Portëz	8,259	28,008	3.6
Fier	Roskovec	Roskovec	4,975	19,386	2.5
Fier	Fier	Strum	7,538	80,094	10.3
Fier	Patos	Zharrëz	5,236	17,756	2.3
Fushë-Kruja	Kruja	Bubq	5,951	63,231	8.1
Fushë-Kruja	Kruja	Fushë-Kruja	18,477	71,998	9.2
Fushë-Kruja	Kruja	Kruja	11,721	124,539	15.9
Fushë-Kruja	Kruja	Nikël	9,518	101,132	12.9
Gjirokastra	Gjirokastra	Gjirokastra	19,836	77,294	9.9
Gjirokastra	Gjirokastra	Lazarat	2,801	29,761	3.8
Kavaja	Kavaja	Golem	5,243	55,708	7.1
Kavaja	Kavaja	Kavaja	20,192	68,475	8.8
Kavaja	Kavaja	Luz i Vogël	4,735	50,311	6.4
Korça	Korça	Drenovë	5,581	59,300	7.6
Korça	Korça	Korça	51,152	173,467	22.2
Korça	Maliq	Libonik	8,922	94,799	12.1
Korça	Maliq	Maliq	4,290	45,583	5.8
Korça	Korça	Qendër Bulgarec	9,022	95,862	12.3
Kukës	Kukës	Kukës	16,719	65,148	8.3
Kukës	Kukës	Shtiqën	3,438	36,530	4.7
Lezha	Lezha	Balldren i Ri	6,142	65,261	8.4
Lezha	Lezha	Kolsh	4,228	44,924	5.8
Lezha	Lezha	Lezha	15,510	52,597	6.7
Lezha	Lezha	Shëngjin	8,091	85,969	11.0
Lezha	Lezha	Shënkoll	13,102	139,213	17.8
Lezha	Lezha	Zejmen	5,660	60,139	7.7
Lushnja	Lushnja	Lushnja	31,105	121,205	15.5
Mamurras	Kurbin	Kodër-Thumana	12,335	131,063	16.8
Mamurras	Kurbin	Laç	17,086	66,578	8.5
Mamurras	Kurbin	Mamurras	15,284	162,397	20.8
Mamurras	Kurbin	Milot	8,461	89,901	11.5
Pogradec	Pogradec	Buçimas	15,687	53,198	6.8
Pogradec	Pogradec	Pogradec	20,848	23,969	3.1
Prrenjas	Prrenjas	Prrenjas	5,847	22,784	2.9
Prrenjas	Prrenjas	Rrajcë	8,421	28,557	3.7
Saranda	Saranda	Saranda	17,233	67,151	8.6
Shkodra	Malesia e Madhe	Gruemira	8,890	30,148	3.9
Shkodra	Malesia e Madhe	Koplik	3,734	39,675	5.1

PRMS	Municipalities	LGU	Population	Pipeline Length (meter)	CAPEX (mill. EUR)
Shkodra	Malesia e Madhe	Qendër	4,740	50,364	6.4
Shkodra	Shkodra	Rrethinat	21,199	71,890	9.2
Shkodra	Shkodra	Shkodra	77,075	261,377	33.5
Tepelena	Tepelena	Tepelenë	4,342	14,725	1.9
Tirana 1	Kamëz	Kamëz	66,841	226,671	29.0
Tirana 1	Tirana	Kashar	43,353	168,932	21.6
Tirana 1	Kamëz	Paskuqan	37,349	126,658	16.2
Tirana 1	Vora	Preza	4,727	50,226	6.4
Tirana 1	Vora	Vora	10,901	115,826	14.8
Tirana 1	Tirana	Zall-Herr	9,389	99,761	12.8
Tirana (1+2)	Tirana	Tirana	418,495	481,149	61.6
Tirana 2	Vora	Bërxullë	9,883	38,511	4.9
Tirana 2	Tirana	Dajt	20,139	213,983	27.4
Tirana 2	Tirana	Farkë	22,633	88,193	11.3
Tirana 2	Tirana	Ndroq	5,035	53,498	6.8
Tirana 2	Vora	Peza	6,272	24,440	3.1
Tirana 2	Tirana	Vaqarr	9,106	35,483	4.5
Vlora	Vlora	Vlora	79,513	269,644	34.5

4.5 Economic evaluation and system development options

4.5.1 Methodology

To find out how much of the total potential gas demand in the 85 LGUs could be feasible, an economic evaluation was carried out. The goal was to determine whether the investment in gas distribution networks for individual settlements/LGU´s was cost-effective in relation to the potential natural gas consumption in the area observed.

The evaluation process focuses on the calculation and assessment of the Full Cost Recovery Tariff. The FCRT is calculated by dividing the NPV of the capital expenditure and the operational and maintenance costs by NPV of the gas volumes. It should be noted that gas volumes were adjusted by the relevant penetration rate of each consumer category.

$$\text{FCRT} = \frac{\text{NPV(CAPEX + OPEX)}}{\text{NPV (gas volume)}}$$

Finally, the estimation of the cash flows used for calculating the NPV values of the above indicator is based on the following basic assumptions:

- Time perspective: The cash-flow forecasts cover an operating time period of 21 years (i.e. from 2020 to 2040),
- Construction period: Construction works start in 2019 and last for 6 years (year 1 = 40%, year 2 = 20% and year 3 to 6 = 10%)
- Inflation: The analysis is in fixed term. Any inflation effects have not been considered in the calculations,
- Depreciation rate: The depreciation amount is determined by a straight-line method of fixed assets write-off on the basis of their expected economic life, which is assumed 20 years,
- VAT is not included,
- Discount rate: The reference discount rate is 7%

4.5.2 Estimate of cash outflows

Cash outflows are related to the costs needed to developed and maintain the operational activity of the investment and include the capital and the O&M costs.

CAPEX: include the initial CAPEX plus any replacement costs planned in distant years. Regarding the estimation of CAPEX items, an analysis of the methodology used was presented in Section 4.4.2.

Replacement costs are related to capital costs required for the replacement of assets that are fully depreciated during the reference time period. As it was assumed that the average lifetime of the assets is 20 years, no replacement costs will be occurred during the reference time period.

OPEX: includes all costs to operate and maintain the new service (cost forecasts are based on historic unit costs). The main elements of operating costs and the underlying assumptions are presented below:

- labour costs – 1 employee per 1 mcm of gas distributed with a minimum number of 5 employees at an average salary at 9,600 eur. per year[5]
- maintenance costs – 0.5% of capital investment
- insurance costs – 0.5% of capital investment
- distribution losses – 1.5% of distributed gas (price of gas 0.3 eur/m^3)

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[5] 9,600 eur per year correspond to an average monthly rate of 500 eur/months plus indirect labour costs, such as external advisors

4.5.3 Assessment of financial performance indicators

The annual gas consumption derives from the potential annual consumption volumes, as it was forecasted and presented in the Demand and Supply Analysis Report, by applying a network penetration rate. For the purpose of the present evaluation, it was assumed the connection rate by sector will have the following dynamics:

- Industrial sector: the penetration rate will gradually increase from 10% in first year of the project to maximum of 80% after 10 years of operations. It is assumed that 20% of the potential end users will never switch to or use the natural gas,

- Service sector: the penetration rate will gradually increase from 5% in first year of the operations to a maximum of 70% after 15 years of operations. It is assumed that 30% of the potential end users will never switch to or use the natural gas,

- Residential sector: the penetration rate will gradually increase from 3% in first year of operations to a maximum of 70% after 25 years of operations. It is assumed that 30% of the potential end users will never switch to or use the natural gas.

It should be pointed out that connection rates affect remarkably the expected expansion rate of the distribution network and it can easily jeopardize the viability of the investment. For this reason, it is common that such kind of projects are supported with a number of financial supporting schemes in order to facilitate the end consumers to switch to gas usage. In some cases, they are accompanied by administrative enforcement regulations (i.e. obligation to install natural gas equipment to new buildings etc.)

Table 4-9 Estimated FCRT by LGU

No	PRMS connected	Prefectures	LGUs	FCRT *(eur/cm)*	Avg Gas Consumption 2020-2040 *('000 cm)*	CAPEX *(mil. euro)*
1	Ballsh	Mallakastra	Ballsh	**0.15**	2,940	3.3
2	Berat	Kuçovë	Kuçovë	**0.26**	2,816	5.5
3	Berat	Berat	Berat	**0.27**	7,878	15.8
4	Berat	Ura Vajgurore	Ura Vajgurore	**0.31**	1,542	3.6
5	Berat	Kuçova	Perondi	**1.27**	422	3.9
6	Berat	Berat	Otllak	**1.30**	422	4
7	Berat	Kuçova	Kozarë	**4.06**	256	7.6
8	Berat	Ura Vajgurore	Kutalli	**4.14**	429	13.1
9	Berat	Ura Vajgurore	Poshnja	**4.15**	327	10
10	Divjaka	Divjaka	Divjaka	**0.48**	3,138	11.5
11	Divjaka	Divjaka	Tërbuf	**3.56**	531	13.9
12	Divjaka	Lushnjë	Dushk	**3.70**	393	10.7
13	Dumrea	Belsh	Belsh	**0.30**	5,127	11.9

No	PRMS connected	Prefectures	LGUs	FCRT (eur/cm)	Avg Gas Consumption 2020-2040 ('000 cm)	CAPEX (mil. euro)
14	Durrës	Shijak	Shijak	**0.09**	5,077	3.3
15	Durrës	Durrës	Durrës	**0.09**	73,928	49.2
16	Durrës	Durrës	Rrashbull	**0.92**	1,826	12
17	Durrës	Shijak	Xhafzotaj	**0.97**	882	6.2
18	Durrës	Shijak	Maminas	**2.47**	340	6.1
19	Durrës	Durrës	Sukth	**2.59**	1,158	21.7
20	Durrës	Durrës	Manëz	**2.65**	471	9
21	Elbasan (1+2)	Elbasan	Elbasan	**0.10**	45,781	34.2
22	Elbasan (1+2)	Cërrik	Cërrik	**0.11**	3,942	3.3
23	Elbasan (1+2)	Elbasan	Bradashesh	**1.36**	470	4.6
24	Elbasan (1+2)	Elbasan	Shirgjan	**1.50**	335	3.6
25	Elbasan (1+2)	Cërrik	Gostima	**3.91**	385	11
26	Elbasan (1+2)	Elbasan	Gjergjan	**3.98**	240	7
27	Elbasan (1+2)	Elbasan	Labinot-Fushë	**4.58**	287	9.6
28	Fier	Fier	Fier	**0.05**	21,966	8.2
29	Fier	Patos	Patos	**0.17**	5,878	7.7
30	Fier	Roskovec	Roskovec	**0.18**	1,879	2.5
31	Fier	Roskovec	Portëz	**1.18**	414	3.6
32	Fier	Patos	Zharrëz	**1.19**	262	2.3
33	Fier	Fier	Strum	**3.91**	355	10.3
34	Fushë-Kruja	Kruja	Fushë-Kruja	**0.10**	12,136	9.2
35	Fushë-Kruja	Kruja	Kruja	**0.27**	7,822	15.9
37	Fushë-Kruja	Kruja	Bubq	**2.63**	424	8.1
36	Fushë-Kruja	Kruja	Nikël	**3.06**	583	12.9
38	Gjirokastra	Gjirokastra	Gjirokastra	**0.15**	9,070	9.9
39	Gjirokastra	Gjirokastra	Lazarat	**4.37**	118	3.8
40	Kavaja	Kavaja	Kavaja	**0.22**	5524	8.8
41	Kavaja	Kavaja	Luz i Vogël	**1.83**	494	6.4
42	Kavaja	Kavaja	Golem	**3.39**	288	7.1
43	Korça	Korça	Korça	**0.14**	14,513	14.9
47	Korça	Maliq	Maliq	**0.65**	1,198	5.8
44	Korça	Maliq	Libonik	**3.20**	523	12.1
45	Korça	Korça	Drenova	**3.21**	326	7.6
46	Korça	Korça	Qendër Bulgarec	**3.24**	521	12.3
48	Kukës	Kukës	Kukës	**0.28**	3,900	8.3
49	Kukës	Kukës	Shtiqën	**6.73**	94	4.7
50	Lezha	Lezha	Lezha	**0.25**	3,547	6.7
51	Lezha	Lezha	Shëngjin	**3.32**	457	11

No	PRMS connected	Prefectures	LGUs	FCRT (eur/cm)	Avg Gas Consumption 2020-2040 ('000 cm)	CAPEX (mil. euro)
52	Lezha	Lezha	Balldren i Ri	**3.49**	328	8.4
53	Lezha	Lezha	Kolsh	**3.50**	225	5.8
54	Lezha	Lezha	Zejmen	**3.64**	290	7.7
55	Lezha	Lezha	Shënkoll	**3.79**	640	17.8
56	Lushnjë	Lushnjë	Lushnjë	**0.15**	12,036	13.5
57	Mamurras	Kurbin	Laç	**0.28**	4,017	8.5
58	Mamurras	Kurbin	Mamurras	**0.77**	3,513	20.8
59	Mamurras	Kurbin	Milot	**0.78**	1,946	11.5
60	Mamurras	Kurbin	Kodër-Thumana	**2.76**	838	16.8
61	Pogradec	Pogradec	Pogradec	**0.08**	5,865	3.1
62	Pogradec	Pogradec	Buçimas	**1.08**	876	6.8
63	Prrenjas	Prrenjas	Prrenjas	**0.12**	3,421	2.9
64	Prrenjas	Prrenjas	Rrajcë	**1.38**	365	3.7
65	Saranda	Saranda	Saranda	**0.31**	3,863	8.6
66	Shkodra	Shkodra	Shkodra	**0.12**	25,152	22.4
67	Shkodra	Malesia e Madhe	Koplik	**0.53**	1,257	5.1
68	Shkodra	Malesia e Madhe	Gruemira	**1.03**	516	3.9
69	Shkodra	Shkodra	Rrethinat	**1.06**	1,191	9.2
70	Shkodra	Malesia e Madhe	Qendër	**3.14**	281	6.4
71	Tepelena	Tepelena	Tepelena	**0.13**	1,997	1.9
72	Tirana 1	Kamëz	Kamëz	**0.16**	17,270	19.4
73	Tirana 1	Kamëz	Paskuqan	**0.69**	3,298	16.2
74	Tirana 1	Vora	Vora	**0.70**	2,891	14.8
75	Tirana 1	Tiranë	Kashar	**0.76**	4,015	21.6
76	Tirana 1	Vora	Preza	**2.06**	438	6.4
77	Tirana 1	Tirana	Zall-Herr	**2.27**	786	12.8
78	Tirana (1+2)	Tirana	Tirana	**0.08**	113,707	61.6
79	Tirana 2	Tiranë	Farka	**0.76**	2,093	11.3
80	Tirana 2	Vora	Peza	**0.80**	558	3.1
81	Tirana 2	Tiranë	Vaqarr	**0.81**	791	4.5
82	Tirana 2	Vora	Bërxulla	**0.81**	855	4.9
83	Tirana 2	Tiranë	Ndroq	**2.02**	476	6.8
84	Tirana 2	Tirana	Dajt	**2.12**	1,808	27.4
85	Vlora	Vlora	Vlora	**0.18**	17,290	23.1

4.5.4 Assessment of the potential gasification area

In order to find out how much of total gas demand could be serviced to end users by gas distribution systems, an economic optimization of the gas network development was carried out. It proved that only main gas consumption centres have adequate consumption to reach the required distribution margin (ie. LGUs with low FCRT). However, by combining these LGUs with other less attractive areas at PRMS level, additional LGU´s (ie. LGUs with high FCRT) could be supplied with gas at an affordable tariff level. By applying this concept, the list of the LGUs suitable to be gasified is presented in below Table 4-10.

Table 4-10 Potential gasification area by tariff level

PRMS	LGUs	Tariff =<0.10 euro/cm		Tariff =<0.11 euro/cm		Tariff =<0.12 euro/cm		Tariff =<0.13 euro/cm		Tariff =<0.14 euro/cm		Tariff =<0.15 euro/cm	
		Gas Consumption 2040	CAPEX	Gas Consumption 2040	CAPEX	Gas Consumption 2040	CAPEX	Gas Consumption 2040	CAPEX	Gas Consumption 2040	CAPEX	Gas Consumption 2040	CAPEX
		('000 cm)	*(mil. Euro)*	*('000 cm)*	*(mil. Euro)*	*('000 cm)*	*(mil. Euro)*	*('000 cm)*	*(mil. Euro)*	*('000 cm)*	*(mil. Euro)*	*('000 cm)*	*(mil. Euro)*
Fier	Fier Patos Roskovec Portëz Zharrëz Strum	64,447	22.0	65,127	24.2	65,127	24.2	65,127	24.2	65,127	24.2	66,041	34.5
Vlorë	Vlorë											40,100	23.1
Ballsh	Ballsh											6,223	3.3
Tepelenë	Tepelenë							4,084	1.9	4,084	1.9	4,084	1.9
Gjirokastër	Gjirokastër											18,418	9.9
Lushnjë	Lushnjë											25,550	13.5
Elbasan	Elbasan Cërrik Bradashesh Shirgjan Gostimë	99,646	37.5	100,945	42.1	101,872	45.8	101,872	45.8	101,872	45.8	102,941	56.8
Tirana	Tirana Kamëz Paskuqan Vorë Kashar Farkë Pezë Vaqarr Bërxullë	326,941	97.2	326,941	97.2	333,881	112.1	345,752	133.7	353,559	148.1	358,338	157.6
Durrës	Shijak Durrës Rrashbull Xhafzotaj Maminas	160,821	52.4	166,382	64.5	168,981	70.6	169,988	76.7	169,988	76.7	169,988	76.7
Fushë-Krujë	Fushë-Krujë	24,684	9.2	24,684	9.2	24,684	9.2	24,684	9.2	24,684	9.2	24,684	9.2
Shkodër	Shkodër Koplik Gruemirë					53,221	22.4	53,221	22.4	55,909	27.5	57,383	31.3
Korçë	Korçë									32,915	14.9	32,915	14.9
Pogradec	Pogradec	13,263	3.1	13,263	3.1	13,263	3.1	13,263	3.1	13,263	3.1	13,263	3.1
Prrenjas	Prrenjas					6,872	2.9	6,872	2.9	6,872	2.9	6,872	2.9
Total		**689,802**	**221.4**	**697,342**	**240.3**	**767,901**	**290.3**	**784,862**	**319.9**	**828,272**	**354.2**	**926,799**	**438.7**

The future gas market will depend on the economics of the distribution network as well as on the feasibility of the gas transmission development. The final aim is to provide end users with gas at a competitive price compared to other competing fuels at the distribution level.

4.5.5 Regulatory and financing arrangements

In greenfield gasification projects the market penetration rate plays a significant role because it affects the expected expansion of the distribution network and therefore it can easily jeopardize the viability of the investment. For this reason, it is common that such projects are supported with a number of regulatory policies and financial supporting schemes in order to create a growing and competitive gas market and to facilitate the end users to switch to gas usage.

This section outlines the policies and measures which can be adopted in order to facilitate the gasification and to increase the probability of a rapid gas penetration. The available policies and measures can be divided into two main categories: regulatory measures and direct financial supporting packages for the building interior network installations and for the necessary appliances (boiler, kitchen etc.).

The regulatory measures are public policies aiming to promote the required investment and to eliminate barriers that discourage the involved stakeholders from the usage of gas. To this extend, policies and measures that can be implemented are the following:

- the obligation included in the license of the distribution companies to connect all consumers willing to use natural gas, if they are located in a region where it is economically and technically feasible.

- the obligation of implementing energy codes to the residential and commercial buildings. Energy codes are recognized as a simple and cost-effective way to reduce energy consumption and lower energy bills. Even more these codes can be used as possible selection criteria in implementing any financial supporting package.

- when energy building codes cannot be implemented, standards that establish minimum, mandatory energy-efficiency requirements for building components and equipment can be used.

- gas utilities are generally in a favourite position to advise their clients on the gas usage and other energy efficiency measures in their homes through demand side management programs. To use this advantage, various countries have made it mandatory or created incentives for energy utilities to promote energy efficiency to their customers.

- Finally, a more specific measure can be the obligation to place in the new buildings heating installation and hot water supply system which support the use gas.

The best results are reached when these measures and policies are combined with financial supporting packages and/or other information. Generally speaking, financial support can be in the form of grants and subsidies, cheap loans and replacement programs which are the most frequently available schemes in most countries. In some cases, direct fiscal incentives, such as tax credit to the end users or to the manufacturers, can be applied, although they are much less used in the EU. The above programs are usually coming along with awareness campaigns and free based energy saving advice offered by the local DSOs.

Common financial programs that can be used for the renovation of the building can summarized as follow:

- Supporting schemes by co-financing programs from the EU
  These are co-funded programs which are managed by commercial banks and provides incentives to improve the energy efficiency in residential buildings. Eligible homes are apartment buildings or individual apartments and detach houses that satisfy some pre-set criteria such as the land zone, building category etc. The financing sources are a mix of grant and a free-interest loan (interest rate subsidy 100%). The level of the grant can vary from 15% to 75% of the total investment size while the loan has a repayment period of 4/5/6-year. For both products, the specific terms are subject to the annual income of the bearer.

- Supporting schemes by the DSO
  This funding scheme can be offered by the DSOs and concerns loans carrying no interest and covers the conversion costs of internal heating installations. The size of the loan and the repayment period is determined by the installed boiler capacity according to market characteristics, while the repayment obligation is included in the gas bill.

- Discount schemes to connection fees
  A discount between 50% and 100% on the connection fees for new connections to the existing natural gas network depending on the consumer income level and the installed boiler capacity can be offered by the DSOs.

The above packages are applied to residential gas users and usually they are coming in a revolving pattern, which means that they are valid for a limited time and they are launched again at a later stage.

Finally, the concept of an “Energy Service Company” can be introduced in order to facilitate the gasification process. ESCo is a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user’s facility or premises, and accepts some degree of financial risk in so doing. The payment for the delivered services is based (either wholly or in part) on the achievement of energy efficiency improvements and on meeting other agreed performance criteria. The models of offering these services can take various forms and result in diverse contract models and financing arrangements. In fact, the ESCo service package does not automatically need to include financing, which can be provided by the building owner, the ESCo or a third financing partner. In any case, the ESCo can be used as a vehicle and facilitator for financing.

4.5.6 Conclusions

The aim of this chapter was to define and evaluate the possible area in which the gas can be distributed economically. For this purpose, a technical analysis was carried out in order to calculate the required capital investment size for each distribution area, followed by an economic assessment. Finally, by applying the principle that consumption centres with adequate gas consumption can support less attractive areas, the potential gas distribution areas were defined. From the analysis, the following points can be concluded:

- The area of Fier – Vlora and Ballsh represents a significant gas consumption triangle in which most of the anchor gas consumers are located.

- The area of Tirana and Durres represents the main gas area in Albania with significant potential gas consumption. The contribution of each sector to the total gas consumption counts for 32%, the industrial sector being the largest with 37% Therefore, it is recommended this area to be considered as one gas distribution centre.

- The gas connection rates affect remarkably the expected expansion rate and the economics of the distribution network and it can easily jeopardize the viability of the investment. Therefore, it is necessary, in parallel with the network development, to introduce financial supporting schemes in order to facilitate the end consumers to switch to gas. It is recommended these schemes to be accompanied by regulatory policies and administrative enforcement actions.

- Due to Albania demographic characteristics (large number of LGUs with low population density), the total gas volume is not significantly affected by increasing the distribution tariff. A 10% tariff increase led to a marginal increase of gas consumption (around 2.5%) due to the small size of the additional LGUs, except for cases where a consumption centres with adequate gas consumption became eligible. On the other hand,, the CAPEX size is affected more by adding areas which become feasible in a tariff increase. A 10% tariff increase led to an equal increase of the capital investment requirements.

  It should be pointed out that, as the distribution tariff is one element of the gas retail price, any increase will enable the development of larger distribution system, assuming that the natural gas position within the competing fuels is not affected.

5 Gas Transmission System - Technical and Economic Assessment

5.1 Gas transmission system basics

5.1.1 Routing

As a part of initial development of a gas master plan, the gas transmission network throughout Albania is developed with the goal to reach major consumption centres, with economically acceptable consumption density, and neighbouring countries in a most economical way and with the minimal impact on the environment. The proposed concept relays on the identified corridor for the IAP infrastructure.

Official national topographic maps 1:25,000 were used along with publicly available QGIS Val software to design the pipeline routes. Suitable corridors/routes are selected for pipelines, minimizing the length and environmental impacts of the proposed pipeline system. Working pressure and basic hydraulic optimisation has been carried out.

In general, the pipeline route assessment shall confirm that the developed routes are feasible to construct using well-established pipeline construction practices. These practices are described in this report and special construction techniques have been specified, for example, the techniques which apply at major crossings.

The pipeline routes cross diverse landscapes, varying from flat and arable land to mountainous and rocky regions. The pipeline routes cross several rivers, railways, highways and smaller roads. For each crossing the suitable crossing technique shall be assessed and confirmed for the routes chosen in the Project Identification Plan comprising of the priority investment projects.

5.1.2 Safety requirements

When developing gas transmission pipelines special attention should be given to the route selection. Route selection shall take into account the design, construction, operation, maintenance and disposal of the pipeline, and should also take into consideration anticipated urban and industry developments.

Factors that shall be considered during route selection include:

- public safety, and safety of the personnel working on or near the pipeline;
- environmental protection;
- other property and facilities;
- third-party activities;

- geotechnical, corrosion and hydrogeological conditions;
- construction requirements, operation and maintenance requirements;
- national and/or local requirements;
- future exploration.

Pipeline materials shall have the mechanical properties, such as strength and toughness, necessary to comply with the design requirements and the requirements for corrosion control. Materials shall be suitable for the intended fabrication and/or construction methods.

The technical requirements and standards for safeguard of people and property and protection of oil and gas pipelines, plants and equipment, that are an integral part of the pipeline system, must be observed.

Examples of defined safety requirements applied in practice are given in Annex 10.

Safety requirements are prescribed and regulated by applicable Laws, Standards and Technical Regulations.

5.1.3. Standards and Technical Regulations for the gas sector in Albania

Local regulations such as the new Law on Natural Gas Sector No. 102/2015 and international norms and standards, were taken in to account in preparation of this report. ISO and EN standards are international and European standards. Many are adopted as Albanian standards by the General Directorate of Standardization of Albania. (GDS).

The Albanian Technical Regulations for Natural Gas recently adopted with two decisions of the Council of Ministers (decision no. 1030, dated 27.11.2013, and decision no. 104, dated 02.04.2015), are taken in account in this report as well as European and American / ISO standards. A detailed list is presented in Section 10.

Based on the proposed routes, their characteristics, technological and technical requirements and methods of construction, the investment costs were determined.

5.2 Pipeline route description including environmental and social factors and mitigations

Following paragraphs present the geographical descriptions of gas pipeline corridors and other environmental and social data related to these corridors. An overall depiction of prospective pipeline corridors is shown in Figure 5–1 below. In this figure the path of the TAP and IAP are also shown.

TAP route is already determined and the pipeline is in the process to be constructed, therefore the description for this corridor is not necessary.

IAP route is also determined from a previous feasibility study, but a description of the IAP sections is, nonetheless, included, because IAP route (actual dimensions of that pipeline still to be determined) is foreseen to be part of the Albanian natural gas system.

The gas transmission system of Albania is laid in a way to enable the supply of selected 85 LGU´s, with the ability to provide the supply of Kosovo and Macedonia.

It is assumed that the gasification of Albania is starting and developing further from TAP as a primary infrastructure for gasification. Since the most LGU´s with higher consumption are located in the coastal, western part of Albania, the territory through which part of the planned IAP runs, this route was used as a main backbone of the Albanian gas transmission system. The remaining pipelines are laid in a way to reach the LGU´s and large "anchor" consumers using the shortest possible route, taking into account geological, topographical, environmental and social considerations. In this regard, the LGU´s near Berat, and near Korce will be supplied directly from facilities located close to TAP.

The pipeline routes towards Kosovo and Macedonia are laid in accordance with previously made studies (Study on the Implementation of the Regulation (EU) 994/2010 concerning measures to safeguard security of gas supply in the Energy Community, and South East Europe: Regional Gasification Study Final Report January 2009), in such a way as to enable the supply of LGU´s in those directions as well. Part of the planned gas transmission system uses the existing pipeline corridors. Part of the route towards Elbasan is located in a way to allow direct connection of the underground gas storage in Dumrea with the transmission system of Albania, assuring the least possible dependence on TAP. In addition, a part of the existing pipeline corridor is used.

These prospective pipeline corridors are divided into smaller sections based on the points where pipelines branch out into new pipelines or based on hydraulic sections that were analysed as part of the pipeline design. The intention of the information about pipeline corridors is to provide input to CAPEX and OPEX calculations by highlighting terrain features and environmental and social impacts that can impact construction costs. The pipeline corridors are divided into numbered sections (see Figure 5–1 and Table 5-1) and their particular geological, environmental and social features for each section are described in the sub-chapters below. This description was based on the following official materials:

- Geological hazards Map of Albania. Shkupi et al., 2000;
- Geological map of Albania, 1:200,000. Xhomo et al, 2002;
- Hydrogeological map of Albania, 1:200,000. 2015; and
- Map of Protected Areas in Albania. MoE, 2015;

In addition, the description also contain review and use of:

- Indicative flood map of Albania with 100 years return period. UNDP, Albania, 2003;
- Indicative archaeological map of Albania. Ministry of Culture, 2014;
- Albania's Second National Communication on the Climate Changes. MoE. 2009;
- Roads and railways network;
- Existing oil and gas pipelines RoW;
- Terrain map; and
- Existing land use.

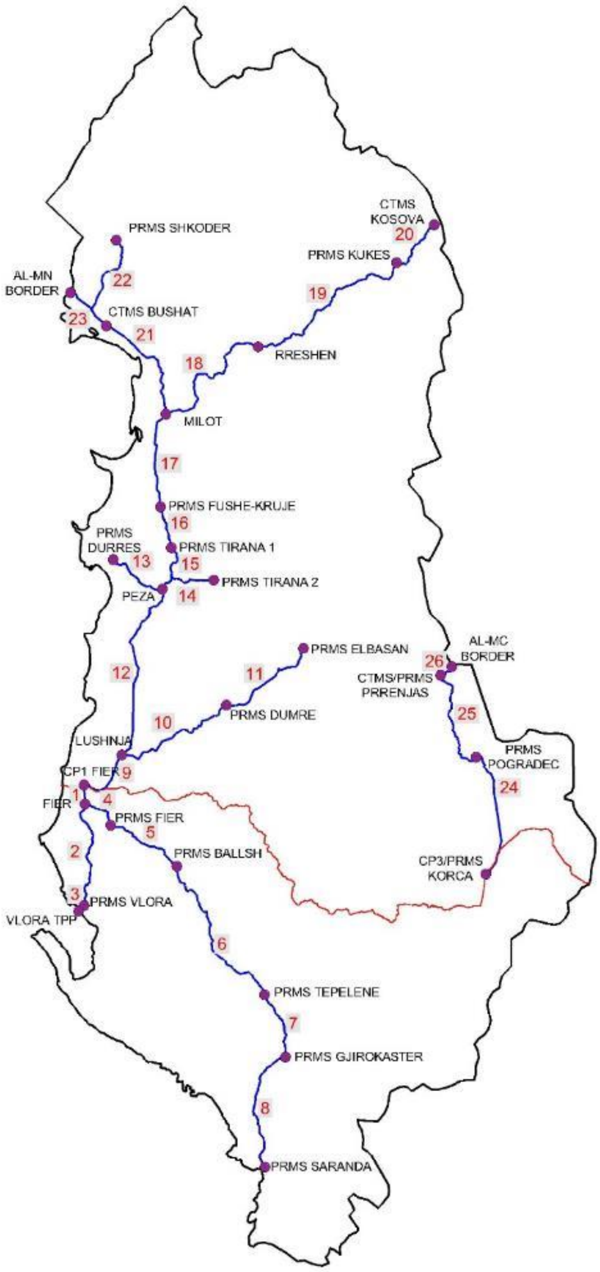

Figure 5–1: Pipeline sections

The lengths of planed branches of the Albanian gas transmission system as well as the descriptions related to the construction difficulty are given in Table 5-1 below.

Table 5-1: Information about the planned Albanian gas transmission system

Section No.	Begin – End	Length (km)	Main Characteristics
1	CP1 FIER – FIER	5.1	Flat agricultural lands; soft geological formations; a few populated areas.
2	FIER - PRMS VLORA	31,6	Passes flat-to-hilly terrain; Soft geological formations; Partly populated areas; Crosses Vjosa River; Vjosa-Narta Protected Landscape (18 km); Several crossings with highways and railways

Section No.	Begin – End	Length (km)	Main Characteristics
3	PRMS VLORA – VLORA TPP	3.1	Flat wetland area of Narta Lagoon; Crosses Railway; Goes through Soda Forest.
4	FIER - PRMS FIER	10.3	Flat agricultural lands; soft geological formations; a few populated areas.
5	PRMS FIER - PRMS BALLSH	23.1	Passes hilly terrain; Soft geological formations; Several crossings with state roads as well as with Gjanica River;
6	PRMS BALLSH - PRMS TEPELENA	48.6	Passes different terrains, mostly hilly, followed by the significant areas of hard rock and mountains, as well as the populated areas of Memaliaj and Tepelena. Crosses Drino and Vjosa River; Infringes upon Kardhiq Strict Natural reserve.
7	PRMS TEPELENA - PRMS GJIROKASTRA	19.4	Passes along Vjosa River Valley; Infringes upon Kardhiq Natural Reserve.
8	PRMS GJIROKASTRA – PRMS SARANDA	35.7	Infringes upon Kardhiq Natural Reserve.
9	CP1 FIER – LUSHNJA	15,7	Flat lands; Soft geological formations; Some populated sections. Crosses Seman River
10	LUSHNJA - PRMS DUMRE	35	Flat-to-hilly agricultural lands, Soft geological formations Some populated sections
11	PRMS DUMRE - PRMS ELBASAN	32.3	Hilly agricultural lands, Soft geological formations; Sinkhole formations of Dumrea some urban areas at outskirts of Elbasan. Crosses Shkumbin River.
12	LUSHNJA - PEZA	51.7	Flat agricultural lands, Soft geological formations; Some short populated sections. Crosses Shkumbin River.
13	PEZA - PRMS DURRËS	17,7	Passes flat-agricultural lands, partly passes low hills and partly populated areas. Some relatively hard formations; Crosses Erzen River
14	PEZA - PRMS TIRANA 2	16,8	Hilly and rugged terrain, Relatively hard soils; Some populated areas near outskirts of Tirana; Crosses Erzen River; Crosses two national roads and the new highway Tirana - Elbasan
15	PEZA - PRMS TIRANA 1	14,8	Hilly agricultural lands; Relatively hard soils; Some populated areas near outskirts of Tirana; crossing Tirana-Durres Highway
16	PRMS TIRANA 1 – PRMS FUSHE-KRUJA	39,2	Flat agricultural lands; soft geological formations; Passes populated areas; Crossing Mat River.
17	PRMS FUSHE-KRUJA – MILOT	39,2	Flat agricultural lands; soft geological formations; Passes populated areas; Crossing Mat River.
18	MILOT - RRESHEN	42.5	Mainly passes flat narrow Mat River Valley and Fan River Valley. Difficult terrain. A few hard geological formations Crosses the rivers several times; Rocky, hilly and mountainous terrain; hard geological formations, Crosses Big Fan River 3x.
19	PUKA - PRMS KUKËS	51,5	Rocky, mountainous terrain; hard geological formations, Crosses Little Fan River several times, Crossing Durres –Kukes highway 3x, Crossing Fierza Lake.
20	PRMS KUKES - CTMS AL KOSOVË	16,8	Passes mostly hilly terrain and agricultural lands; some relatively hard geological formations. Crosses Luma River.
21	MILOT - CTMS BUSHAT	33,2	Mainly passes flat agricultural lands, some low hills. Relatively soft geological formations; Crosses Smaller Drin River.
22	CTMS BUSHAT - PRMS SHKODRA	29,8	Passes flat agricultural lands; Relatively soft geological formations; Passes some densely populated area at the vicinity of Shkodra; Crosses the larger Drin River (the branch connecting with Buna River); Buna-Velipoja Protected Landscape (10 km)

Section No.	Begin – End	Length (km)	Main Characteristics
23	CTMS BUSHAT – MONTENEGRO BORDER	13,5	Mainly passes flat-agricultural lands Relatively soft geological formations, Buna-Velipoja Protected Landscape (9 km)
24	CP3/PRMS KORCA - PRMS POGRADEC	35.3	Flat agricultural lands; the other part, Crosses several major transportation infrastructure objects.
25	PRMS POGRADEC - CTMS/PRMS PRRENJAS	31.4	Rocky hills and mountains; Hard geological formations; Crosses the highway to FYRoM,
26	CTMS/PRMS PRRENJAS - FYRoM BORDER	5	Partially flat agricultural lands and part rocky mountain, some hard geological formations; Crosses some densely populated villages. Crossing the national road to FYRoM.

5.2.1 Section 1: CP1 Fier - Fier

This section is 5.1 km and is situated within the flat agricultural lands of Little Myzeqea Plain. The superficial soil layers at this portion of the corridor are composed of Pleistocene and Holocene sands, gravel, and conglomerates, which are of alluvial origin (Class E or D, according to Eurocode Soil Classification). As such these soils are soft and easy to excavate. Based on the Diggability Classification these are expected to be Class I or Class II.

The corridor goes mainly across agricultural lands, far from human settlements. As for the environmental impact, there are no protected areas or nature monuments near this section of the prospective pipeline. As far as major geological hazards, there is a tectonic fault near the corridor of this section, as it can be seen in the figure below to the right.

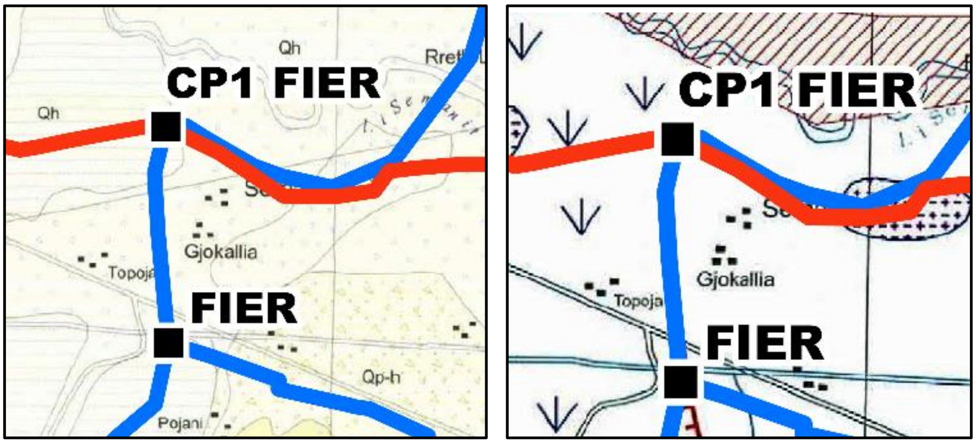

Figure 5-2 Geological map and Hazard map of the Section 1

The corridor crosses a few local roads and most importantly Hoxhara Canal, which runs perpendicular to the direction of the pipeline.

5.2.2 Section 2: Fier – PRMS Vlora

This section is 31.6 km long and similarly as the previous two sections goes through flat agricultural lands. The geologic formations are Pleistocene and

Holocene sands, gravel, and conglomerates, which are of alluvial origin and consequently not hard to excavate (Class I-II). The last section (nearly 18 km) goes through Vjosa-Narta Protected Landscape (see Figure 5-3 below to the right). The geological formations are again sandy and clayey, but the difference is that these deposits are rather of marine origin.

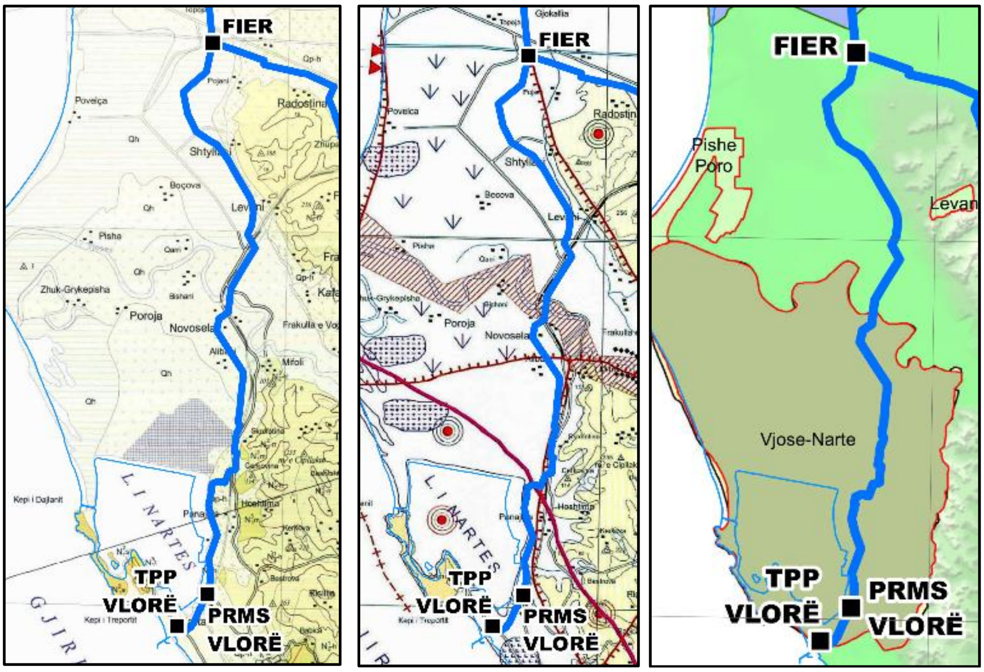

Figure 5-3: Geological, Hazard, and Protected Areas maps of Sections 2 and 3

This particular section is also within an area with high earthquake intensity (level IX MSK or about 7-8 Richter). Additionally, in this section there is a tectonic fault that goes parallel to the pipeline corridor for almost 20 km and two other tectonic faults cross the pipeline corridor in a perpendicular fashion. Since the thickness of the Quaternary deposits is considerable, there is no any risk from tectonic faults in case of earthquake.

The pipeline corridor crosses Vjosa River and its quaternary gravel aquifer, which is an area that is susceptible to intermittent floods when heavy rainfalls occur. Otherwise the pipeline corridor goes along the old national road from Fier to Vlora and then along the new Fier-Vlora highway. Most of the time the corridor is parallel to these roads but occasionally it crosses them over.

From the social point of view, the corridor runs relatively far from human settlements, with only a couple of exceptions at the areas where it comes in close proximity to some commercial properties. Meanwhile from the archaeological perspective the corridor passes near the ancient city of Apollonia. Even at considerable distances around this area are reported artefacts, therefore due to this fact, a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary to be conducted prior and during construction works. This survey should be carried out also close to Vlora TPP because of the possible archaeological remains close to the coastline.

Similarly, the construction works affecting the areas that fall inside the Vjosa-Narta Protected Landscape should be effectuated by taking into account the provisions of the Albanian law 10431 of June 06.2011 “On environmental protection”, as well as the CMD no 680/2004 related to this protected area.

In order to avoid, as much as possible the potential environmental and social impacts, the selection of the prospective gas corridor from Fier to Vlora should take into consideration, the railway and the new road Fier-Vlore, as well as the findings of the Integrated Coastal Zone Management and Clean-Up Project.

5.2.3 Section 3: PRMS Vlora – Vlora TPP

This section is only 3.1 km long and connects PRMS Vlora to Vlora Thermal Power Plant. For nearly 2 km the pipeline corridor of this section goes through the wetlands between Narta Lagoon and Narta Village. This area gets inundated by water during times of heavy rains and it is part of the lagoon’s buffer zone. The geological formations are again sands and clays of marine origin and in addition are rich with organic materials (Class E according to Eurocode Soil Classification). These soils are soft and easy to excavate (Class I or Class II), but on the other hand the water table is very shallow, which may require special measures during construction.

For the last 0.5 km just before reaching Vlora TPP, the pipeline corridor passes through Soda Pine Forest. This forest was planted in the seventies with the intention to protect the coastline from sea erosion. This forest is very dense and is composed by large, mature, marine species of pine trees, which with require proper machineries to cut the pipeline way through this forest.

5.2.4 Section 4: Fier – PRMS Fier

This section is 10.3 km long and mostly flat. It passes mostly through terrain (with the exception of the area just before reaching PRMS Fier, which is characterized by gentle hills). The soils in this part are the same sands, gravels, and conglomerates of alluvial origin as in the previous section. Their consistency is similar to Class E or D soils, according to Eurocode Soil Classification. Similar with previous sections, these soils are expected to be of low diggability (Class I or Class II). As it is evident in the figures below, there are no major geographical and geological hazards within this section of the pipeline.

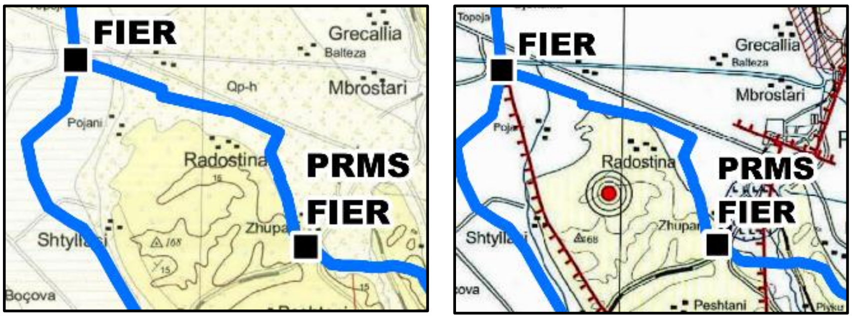

Figure 5-4: Geological map and Hazard map of the Section 4

5.2.5 Section 5: PRMS Fier - PRMS Ballsh

This section is around 23.1 km long and goes through mostly hilly terrain, which is covered by olive groves and agricultural lands. The geological layers that outcrop at the surface are represented by flysch formations of the Mesinian and Tortonian geologic periods, which consist of sandstones, clays, and conglomerates (Class B, C, and D soils). The superficial soil layers are generally soft and easy to excavate (Diggability Class I-II), except for the rare segments where sandstones formations emerge to the surface (Diggability Class III-IV). Furthermore, the area is marked by a few small landslides, which are generated mainly from road earthworks and deforestation. The small landslides, which are located within the hilly sides, may be avoided by locating the pipeline route at the flat portions of the hills.

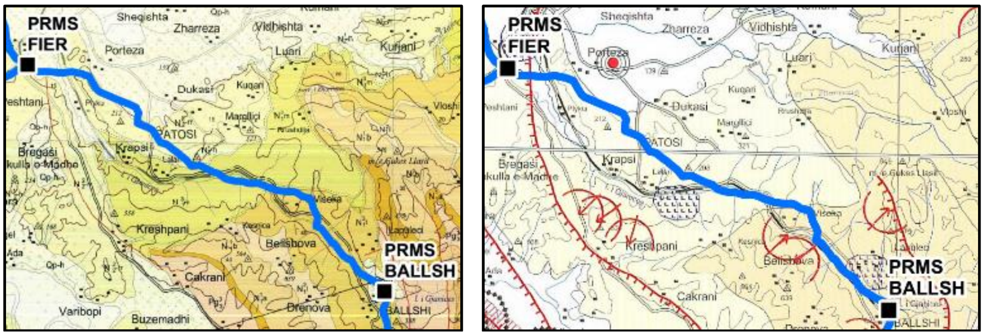

Figure 5-5: Geological and Hazard Map of Section 5

The prospective corridor crosses a few times the national road Fier-Ballsh and other local roads of minor importance. The corridor also crosses Gjanica River; once near Fier and another two times near Visoka Village.

In this portion of the pipeline there is also a tectonic fault that runs perpendicular to the corridor, which does not represent any risk for the pipeline. There are no particular protected areas or nature monuments near this section, but however; in order to avoid, as much as possible the potential environmental and social impacts, the selection of the prospective gas corridor should take into consideration the railway Fier-Ballsh.

5.2.6 Section 6: PRMS Ballsh - PRMS Tepelena

This section is around 48.6 km long and because of the considerable length is diverse from the geological and environmental point of view. For the first 30 km (from Ballsh to Qesarat Village) the terrain is similar in altitudes and hilly predisposition with the previous section (Class B, C, or D soils). Therefore, the ground is relatively easy to excavate (Diggability Class I-III) with the exception of some small areas where limestone and sandstones may outcrop near the surface and have Class III or Class IV diggability. Furthermore, the area is marked by many previous small landslides, which indicate the susceptibility of this area to this phenomenon. A few landslides are recorded in the area south of Ballsh and they extend for nearly 15 km.

The next 18 km (from Qesarat Village to PRMS Tepelena) is characterized by the geologic profiles related to Vjosa River Valley. In fact, the corridor crosses Vjosa River five times. The geologic formations are composed of flysch or depending how close they are to the river valley, of alluvial deposits. The superficial soils are composed of a mixture of clay, sand, and gravel (Soil types B or C according to Euro Code Soil Classification).

In this subsection there is one area, which is located near the town of Memaliaj, which is relatively more seismically active (intensity of earthquake IX MSK or approximately 7-8 Richter) with presence of some tectonic faults and landslides nearby. In this same area there are also a few sites where gravel is extracted for construction purposes.

From the social point of view, the pipeline corridor goes through the town of Memaliaj and infringes upon the inhabitants of this town. Meanwhile, the rest of the sections are far from human settlements.

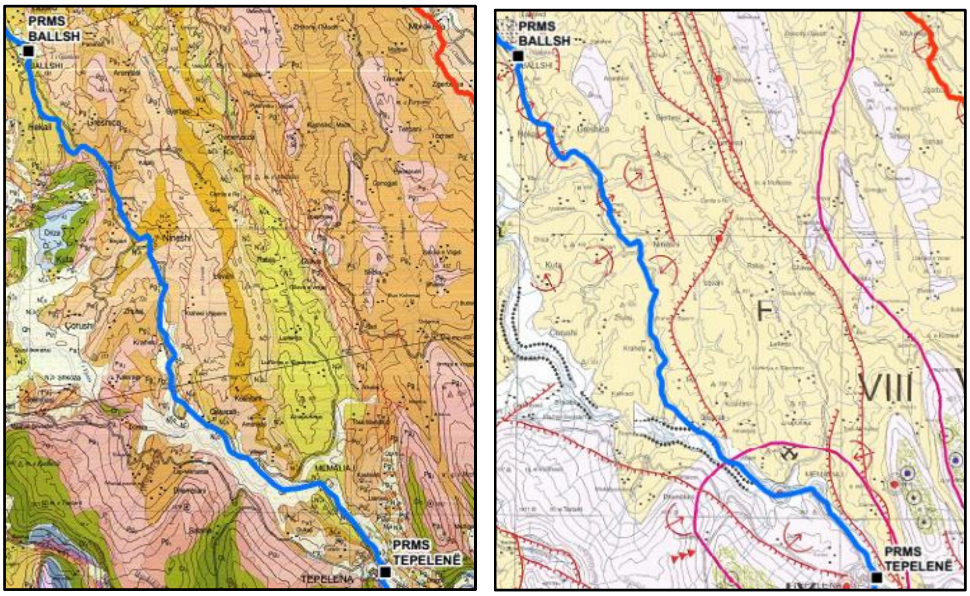

Figure 5-6: Geological and Hazard Map of Section 6

5.2.7 Section 7: PRMS Tepelena – PRMS Gjirokastra

This pipeline is 19.4 km long and it is located in its entirety within Drino River Valley. The corridor crosses Drino River nine times. The geologic formations are flysch or alluvial deposits, depending how close they are to the river valleys, which are composed of a mixture of clay, sand, and gravel (Soil types B or C according to Euro Code Classification). A small part of the Drino River valley, at the left side of the Drino River, is affected by landslides, which are generated from the construction earthworks of Gjirokastra-Tepelena motor road. There are no infringements upon local settlements within this section.

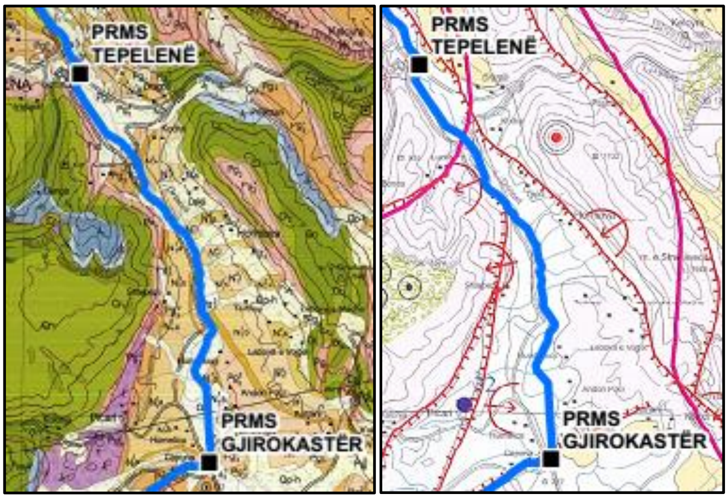

Figure 5-7: Geological and Hazard Map of Section 7

5.2.8 Section 8: PRMS Gjirokasta – PRMS Saranda

Meanwhile, some segments of the portion of the prospective pipeline from PRMS Gjirokastra to PRMS Saranda (around 25 km) are characterized by hard rock formations composed by limestone and sandstone that are in the shape of layers or tiles that outcrop too close to the surface (Type A soils). This particular terrain is also marked by high altitudes (mountains) and it reaches almost 800 m above sea level near Kardhiq Village. Consequently, the ground is hard and very difficult to excavate (Diggability Class IV-VI).

From Kalasa Village to Gjashta mountain pass the prospective pipeline (nearly 8.5 km) runs through Delvina Plain, and consequently the soil formation are again of alluvial origin. These formations are made of silts, sands and gravels, which are very easy to excavate (Type D, or type E soil and Class I-III diggability).

The last segment of the prospective corridor (nearly 1.5 km long), traverses again limestone formation, which are very hard to excavate (Diggability Class IV-VI).

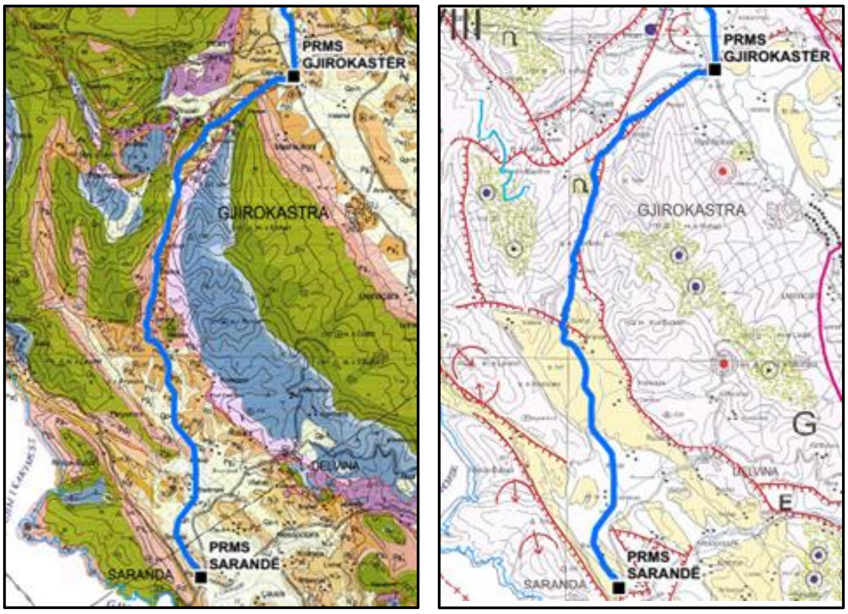

Figure 5-8: Geological and Hazard Map of Section 8

There are also considerable geological hazards, in this portion of the corridor since tectonic faults run parallel to the corridor for nearly 15 km, and another one crosses the corridor perpendicularly as it shown in Figure 5-8 to the right above.

Within this section there is also a protected area, which is classified as a Strict Natural Reserve (Kardhiq Natural reserve). The corridor goes through the western edge of this protected area for nearly 5 km as it is shown in Figure 5-9 below.

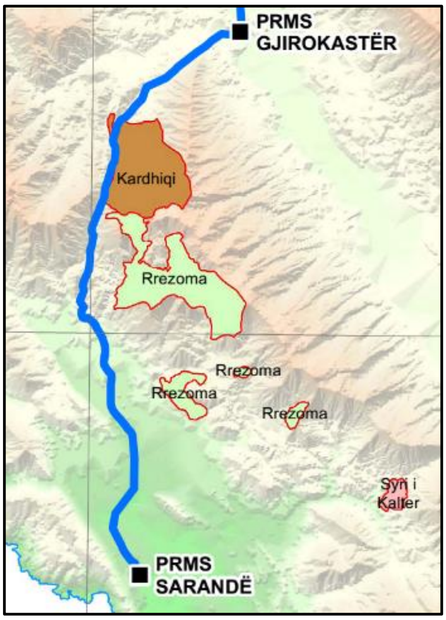

Figure 5-9: Protected-Areas Map of Sections 8

In order to avoid, as much as possible the potential environmental and social impacts, the selection of the prospective gas corridor should take into consideration, the existing new road from Krahes (Tepelena district) to Kardhiq , as well as the road under construction from Kardhiq to Delvina to Saranda. The location of the actual pipeline should also be based on the findings of the Integrated Coastal Zone Management and Clean-Up Project.

From the archaeological perspective, a detailed survey, in compliance with the Albanian Law “On cultural heritage”, is necessary prior and during construction works, because of possible archaeological artefacts close to the ancient settlements around Finiq. This survey should be carried out overall in the area between Delvina and Gjashta Mountain pass (close to Saranda).

5.2.9 Section 9: CP1 Fier - Lushnja

This section is 15.7 km and it is part of IAP route. This section is situated completely within flat lands that are part of Myzeqea Plain, which is a major agricultural area. The geologic formations overwhelmingly are typical of Pleistocene and Holocene sandy, and clayey alluvial formations (Type E soils) that are present throughout Western Albanian Plain, which are very easy to excavate (Class I-II). Part of these formations constitute the Quaternary gravel aquifer of Lushnja Area.

The corridor passes for a short distance through some densely populated sections. In addition, the section of the corridor crosses Seman River, and a few local roads. With the exception of some regions that are sensitive to flooding (see shaded areas in the Figure 5-10 below to the right) there are no other geological hazards. Additionally there are no protected areas within this section.

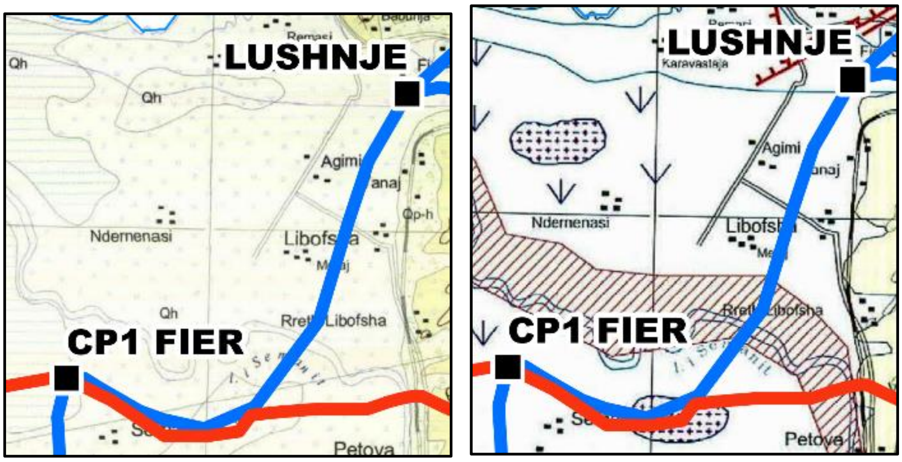

Figure 5-10: Geological and Hazard Maps Section 9

5.2.10 Section 10: Lushnja - PMRS Dumre

This section is 35 km long and for the first half it is flat and similar to the easy-to-excavate formations characteristic of Western Plains of Albania (Type E soils). However, in the second half, some different formations emerge. Firstly, some sandy-clayey formations of the Mesinian, Tortonian, appear (the areas depicted with brown in the figure below). The relief is hilly and its altitude rises from 30-40 m above sea level in the plains below to 130-140 m. These formations are loose-to-medium cohesion less soils (Type D soils) that coupled with abrupt elevation changes lead to increased landslide risk.

Figure 5-11: Geological Map of Section 10

The last section (the area in purple) is composed of evaporates, which are composed of gypsum or rock salts. This is a very specific geologic formation of Albania, that is well-known for its pronounced subsidence, and sinkhole phenomena, which is attributed to karst activity within the evaporate formations. These formations are part of a diapir with trans-extensional transverse tectonics. This is demonstrated by the circular tectonic fault that corresponds so closely to the extents of this area (see Figure 5-12 below).

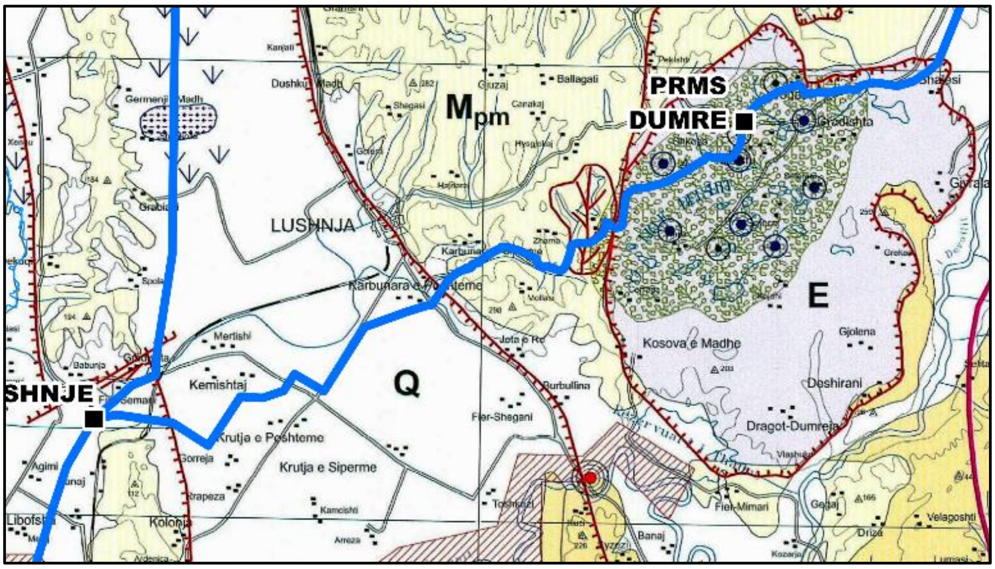

Figure 5-12: Geological Hazards map of Section 10

Within Dumrea Region there are 83 small and medium-size natural karst lakes. About 20 of them get dry in the summer. Two of these lakes, namely Dega and Seferan have the status of nature monuments, which means they are protected areas of the 4th category. Lakes in Dumrea Region are created from large sinkholes (see the dotted area in the Figure 5-12 above). Sinkhole formation is attributed to the presence of thick deposits of residual clays, limestone, and rock salts. The prospective corridor runs through Dumrea diapir for nearly 18 km.

Sinkhole and subsidence phenomena has been exacerbated by deforestation for agricultural purposes. The consistency of soils, however, is soft and very comparable to other agricultural areas (Diggability Class I-II).

From social perspective, Dumrea Region is rich in archaeological findings, therefore; a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary prior and during construction works.

5.2.11 Section 11: PRMS Dumrea - PRMS Elbasan

This section is 32.3 km long and for the first 8 km it is situated within Dumrea Region, which was described in the previous section.

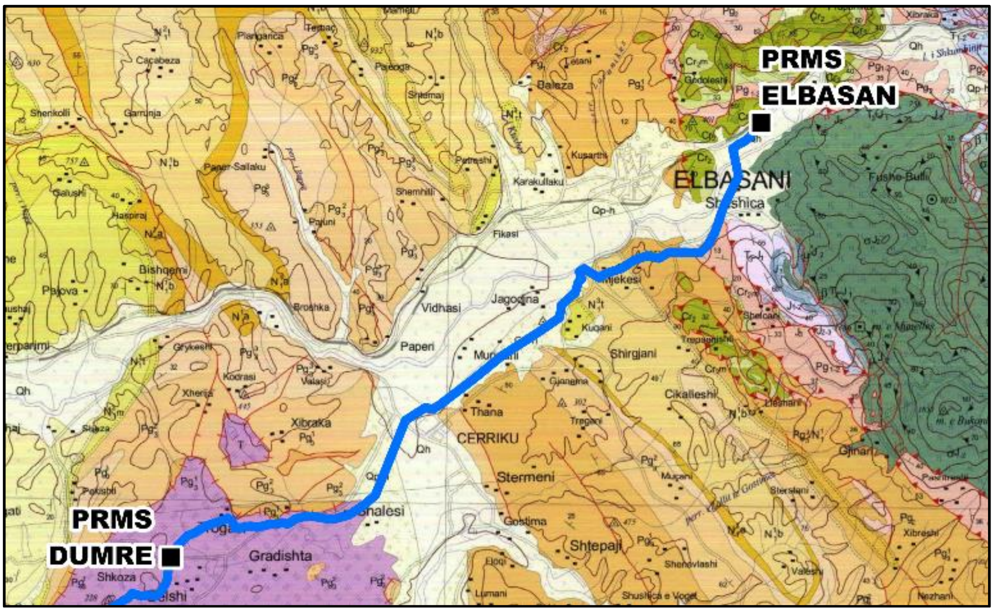

Figure 5-13: Geological and Hazard Map of Section 11

The rest of the section is located almost entirely in the alluvial valleys created by Devoll River and Shkumbin River (light coloured areas in the figure above). The geological formations are composed of sands and gravels (Type E soils), which are easy to excavate (Class I-III). These formations constitute, also, the Quaternary gravel aquifer of Elbasan. Only a small section near Elbasan (the darker area near Elbasan) is composed of hilly terrain, which consists of Eocene flysch (Type B, or C soils). The flysch is composed of silts, marls, and sands. It must be noted that marl formations do not outcrop in superficial layers, therefore these soils are easy to excavate (Class I-III).

Meanwhile, the section has some relatively small geological hazard. Tectonic fault lines run parallel and cut across the corridor near Elbasan Area for almost 10 km as it can be seen in Figure 5-13gure 5-14 below. Apart from these hazard, the prospective corridor crosses only minor local roads and does not impact residential settlements.

Similar to the previous section, a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary prior and during construction works, because of possible impacts to the ancient Egnatia Road and other potential archaeological sites, including a burial site (tumulus) close to Cerrik.

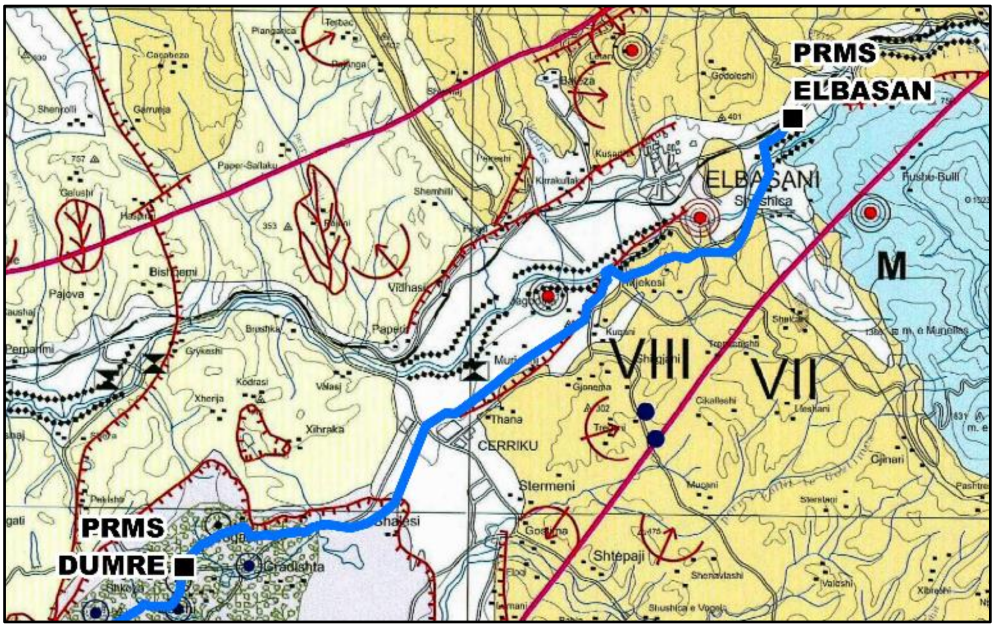

Figure 5-14: Geological hazards for Pipeline Section 11

5.2.12 Section 12: Lushnja - Peza

This section has a length of about 51.7 km and can be divided into two subsections. The first 23 km of this section is located within the Myzeqe Plain and it is mostly flat. The soils in this area, as mentioned earlier, are made of Pleistocene and Holocene alluvial formations, which consist of clays and sands and gravels, which are easy-to-excavate (Type E soils and Diggability Class I-II). As far as geotechnical hazards are concerned, there are not many such hazards identified in this area. The only hazards are some flood prone areas near Shkumbin River, which is crossed by this section. The corridor does not infringe upon any human settlements, or protected areas in this section.

Meanwhile, the other subsection (28.1 km long) is mostly hilly and rugged. The terrain altitudes reach 350 m above sea level. The formations are a mixture of Pliocene, and Miocene (Tortonian, and Serravalian) geologic periods, which consist of sands, clays, sandstones and limestones (Type B, C, or D soils). Therefore, the soils are hard to excavate (Diggability Class II-IV) and the ground profile goes through some abrupt altitude variations at certain portions.

In addition, there are numerous landslide areas in the hilly part of this section. The corridor does not run through any human settlements, but crosses the national road between Kavaja to Durres, a few other local roads and a few rivers (Erzen, Darci and Peza). Therefore, no infringements occur on any settlements within both subsections.

It must be noted that the prospective gas corridor from Lushnja to Peza has been assessed in depth during the feasibility study of the IAP project, and the conclusions of this study should be taken into consideration, in order to avoid, as much as possible, the environmental and social impacts.

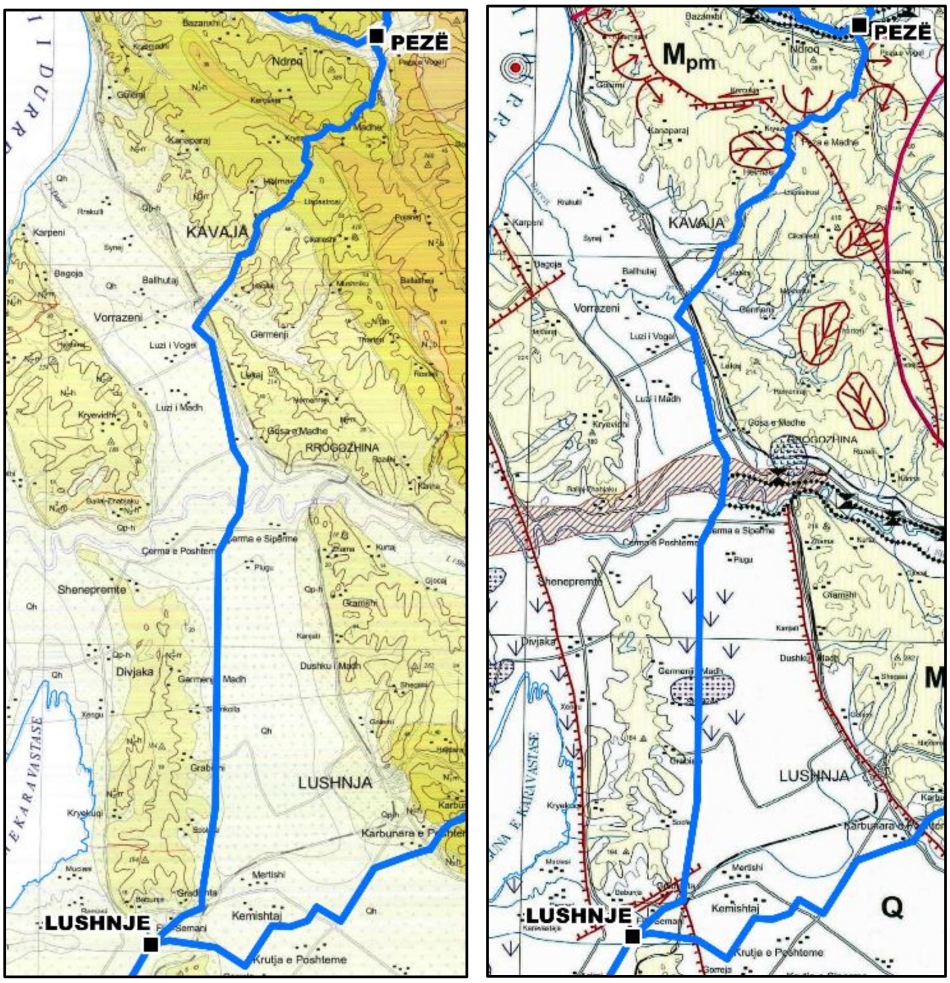

Figure 5-15: Geological, Hazard, and Protected-Areas Maps of Section 12

5.2.13 Section 13: Peza - PRMS Durres

This section is 17.7 km long and starts at IAP exit point near Peza and ends at PRMS Durrës. The prospective pipeline corridor runs along the northern side of the Valley of Erzen River for nearly 14 km, and then crosses the river and proceeds through the plain of Shijak. Therefore, the geologic formations are composed of clays, sands and gravels of alluvial origin, which are reasonably easy to excavate (Type E, or D, and Diggability Class I-III). These constitute also the Quaternary gravel aquifer of Erzen River.

The geological hazards are not pronounced in this area. The only two hazards are floods, and high earthquake intensity. Floods are pronounced at the point where the prospective corridor crosses Erzen River. Similarly, the area of high earthquake intensity is situated at the portion where the section crosses the river.

As far as infringement on settlements, there are no major intrusions of the pipeline on the human settlements along the way.

Figure 5-16: Geological map of Sections 13, 14, and 15

The selection of this pipeline within the corridor should also be based on the findings of Durana spatial plan. Durana is a term for the future integrated urban area between Tirana and Durres. In addition, the possibility for archaeological artefacts near Durres, requires that a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary prior and during construction works.

5.2.14 Section 14: Peza - PRMS Tirana 2

This section is 16.8 km long and runs from the IAP exit point near Peza Village to Sauk Village at the outskirts of Tirana. The terrain of this section is overwhelmingly hilly and rugged. The altitudes vary from 50 – 350 m above sea level. The geological formations are represented by a mixture of Pliocene, and Miocene deposits that consist of sands, clays, and limestones (Type B, or C). In some very limited areas, sandstones and limestones outcrop close to the surface and this makes these formations relatively hard to excavate (Class III-IV diggability).

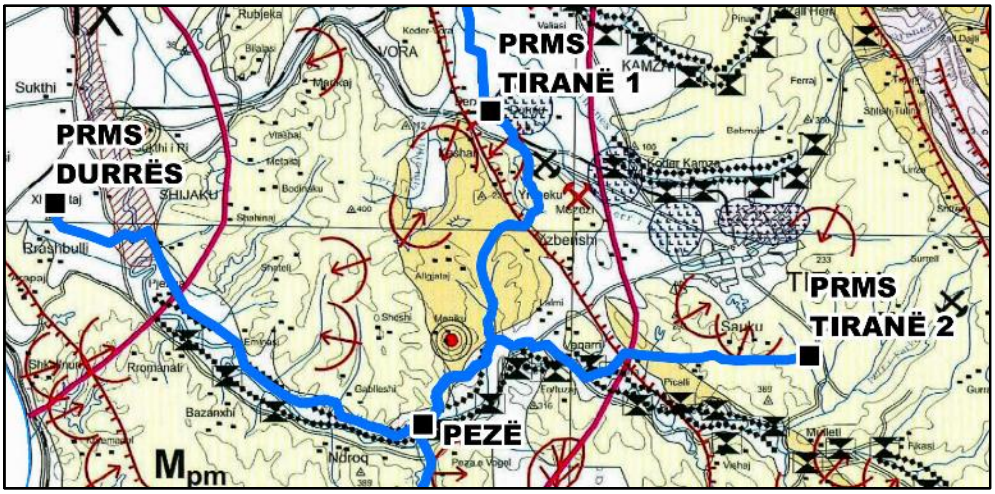

Figure 5-17: Hazard map of Sections 13, 14, and 15

The prospective corridor crosses Erzen River, which is used by the construction industries for the extraction of construction materials throughout large portions of its length. In addition, there are some areas of documented landslides and a tectonic fault that cuts perpendicular to the corridor as it can be seen in Figure 5-17 above.

From the social perspective, there are no significant intrusions to human settlements at this section of the pipeline network. Only in one occasion the pipeline cuts through the village of Vaqar, which is a large village at the outskirts of Tirana. The prospective pipeline runs also through two important national roads, and the new highway Tirana-Elbasan.

5.2.15 Section 15: Peza - PRMS Tirana 1

This section is 14.8 km and for the first 12 km the geologic formations are the same as the previous section. The altitudes are lower and reach only 150-200 m above sea level. The rest of the corridor, is flat and composed of sands, clays, and gravels, and other easy-to-excavate geological formations (Class II-III).

The geological hazards are relatively minor. Only a few landslide prone areas are identified, and a tectonic fault (see Figure 5-17 above). However, these hazards are relatively far from the prospective corridor.

The prospective gas corridor Peza - Tirana 1 has been assessed in depth during the feasibility study of the IAP project, therefore; this study should be taken into consideration, in order to avoid, as much as possible, the environmental and social impacts.

5.2.16 Section 15: PRMS Tirana 1 – PRMS Fushe-Kruja

This section is 39.2 km long and passes through soft alluvial formations (Type E soils) of Pleistocene-Holocene, similar to those encountered in other areas that fall within Western Albanian Plains (light coloured area in Figure 5-18 below to the left). The corridor passes mostly through agricultural lands (Diggability Class I-II) and through some of the most densely populated regions in the country. As a consequence, there are infringements upon residential and commercial properties, especially in the outskirts of Tirana, where there is the greatest density of settlements.

Meanwhile, the area has a considerable large number of small rivers and streams, but Ishmi River is the most important of these water bodies. Flood risk is the major hazard in this area (depicted with hatched pattern in the Figure to the right below). In addition, the gas corridor in this section runs across Tirana-Ishmi Quaternary Aquifer.

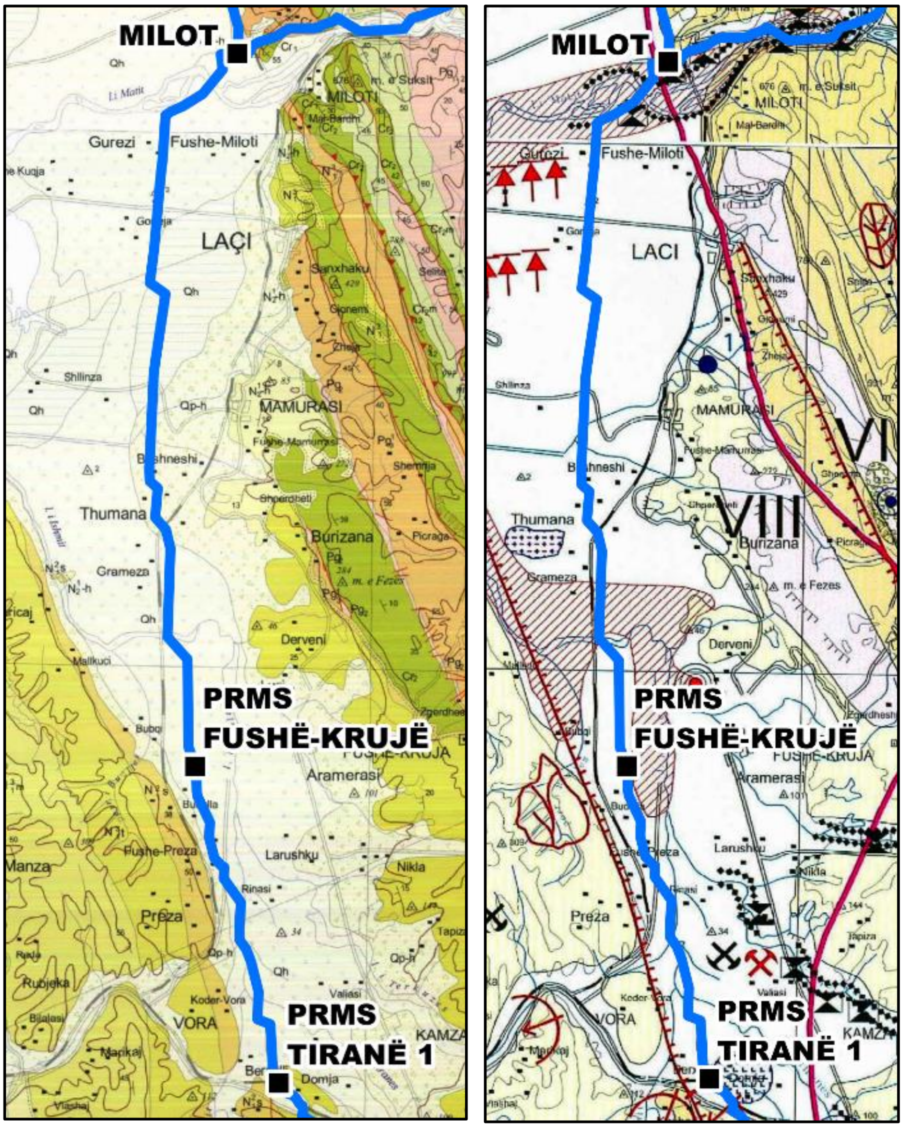

Figure 5-18: Geological and Hazard Maps of Sections 15 and 16

Similar to the previous section, this prospective gas corridor has been assessed in depth during the feasibility study of the IAP project, therefore; this study should be taken into consideration, in order to avoid, as much as possible, the environmental and social impacts.

5.2.17 Section 17: PRMS Fushe-Kruja – Milot

This section (27.2 km long) is very similar to the previous one with regard to terrain characteristics and geological formations. It is important to mention that in this section there are numerous areas, where the corridor comes in close proximity to individual residential and commercial buildings, since settlements are very much dissipated throughout the agricultural lands in this part of the country.

Meanwhile, the most important natural hazard in this section is the flood risk. Floods are most likely to happen around Ishmi and Mat River Valley (see the shaded areas in the Figure 5-18).

Similarly to other sections that fall within IAP route, the feasibility study for IAP should be considered for review in order to avoid, as much as possible, the environmental and social impacts.

5.2.18 Section 18: Milot – Rreshen

This section is almost 42.5 km long and runs along Mat River and then through Fan River Valleys, which are relatively narrow. In fact, the corridor crosses these rivers ten times. The geologic formation within the valleys are composed of gravel with smaller amounts of sand. These are part of the Quaternary gravel aquifer of Mati River. The diggability remains acceptable within the valley limits (Class II-III), however; since the valleys are narrow, there are parts of the corridor that cut through mountainous slopes, which are composed of harder formations. These formations are depicted with the various colours in the figure below. The formations alternate between limestones, ultrabasic rocks, and igneous rocks (Type A soil). In addition, topsoil, if present, is shallow (Type B soils), therefore; the diggability of these formations is very low and they are very hard to excavate (Class IV-V diggability).

Figure 5-19: Geological map for Section 18

This particular section has no major geological hazards apart from flood risk within the narrow river valley of Mat River, and the extraction of gravel for the purpose of being used as construction material. In addition, rock falls and erosions are prone to occur in steep slopes as the result of the weathering of ultrabasic rocks, but these are not of great concern for the buried pipeline.

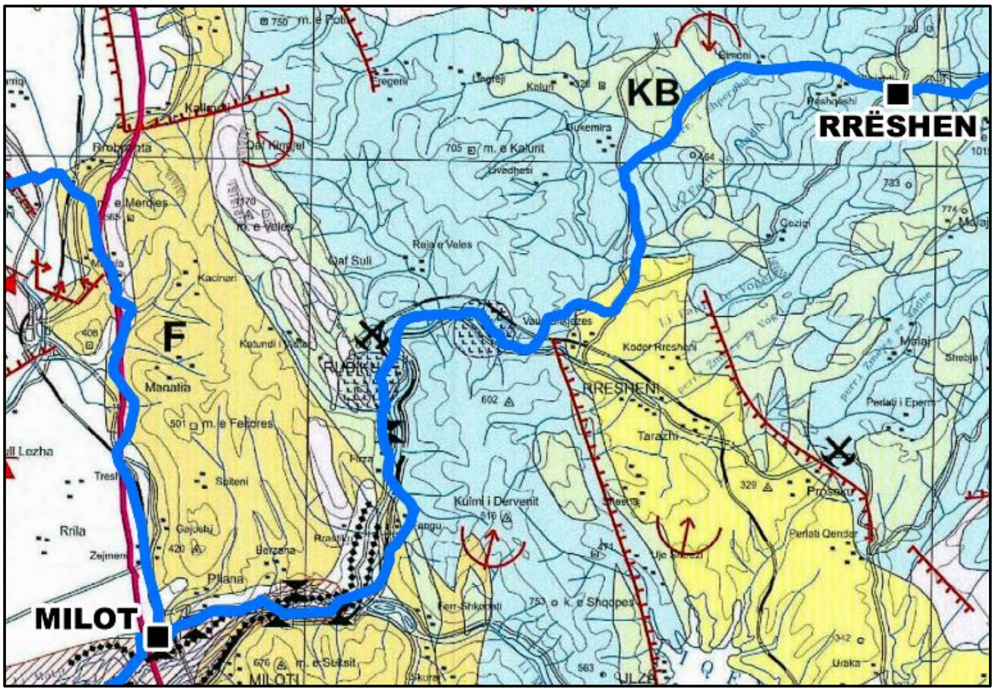

Figure 5-20: Geological hazards for Section 18

Similarly, there are no impacts on protected areas within this section and the corridor runs reasonably far from human settlements. The prospective corridor, in addition, crosses a few times the new highway to Kosovo within this section.

5.2.19 Section 19: Rreshen – PMRS Kukes

This is a long section (51.5 km) and similarly to the previous section passes through some difficult hilly, mountainous terrain (Diggability Class IV-VI). The corridor follows somewhat the Little Fan River Valley (another tributary of Fan River) and it ends by crossing Fierza Lake south of Kukes (as shown in Figure 5-21).

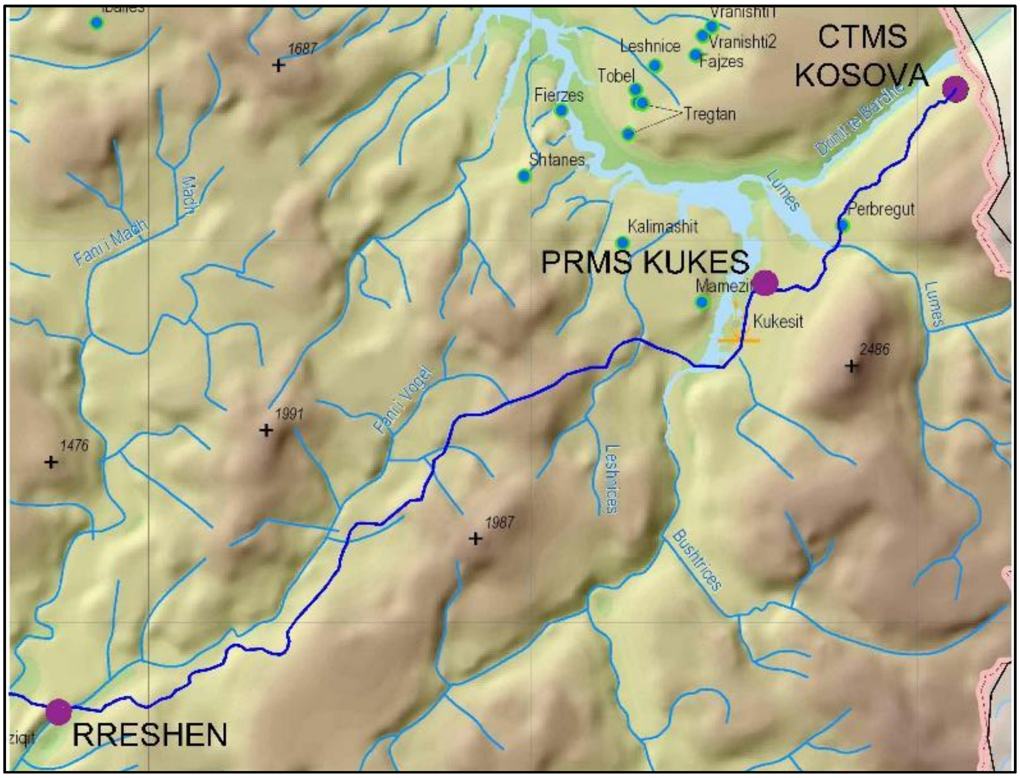

Figure 5-21: River network map for sections 19, and 20

The geologic formation are again variations of hard ultrabasic rocks (Type A). Near the Town of Kukes, however, the basaltic rocks dissipate into the Pleistocene-Holocene alluvial deposits (light coloured area) from Black Drin river (tributary of Drin River), which are composed of sand and gravel, and therefore much more easy to excavate (Class III-IV).

The corridor crosses also numerous rivers and streams that are tributaries of Little Fan River and the rivers of Leshnica, Black Drin, and Luma as is depicted in Figure 5-21.

5.2.20 Section 20: PRMS Kukes - CTMS AL-Kosova

This is a relatively short section (16.8 km), which is mostly hilly terrain, and has also some flat and urban areas near the Town of Kukes. The section ends at Albanian-Kosovo border.

The geological formations are composed of sandstones, which do not outcrop too close to the surface and consequently are not as hard to excavate as the previous sections (Type B soils and Diggability Class II-IV). This last section constitutes also the Karst aquifer of Korabi-Koritnik.

The geological hazards are pronounced only in the last portion of this section. As it is evident from the figure below, there are two tectonic faults that cross the prospective corridor in a perpendicular fashion, while another tectonic line runs just along the corridor for nearly 10 km.

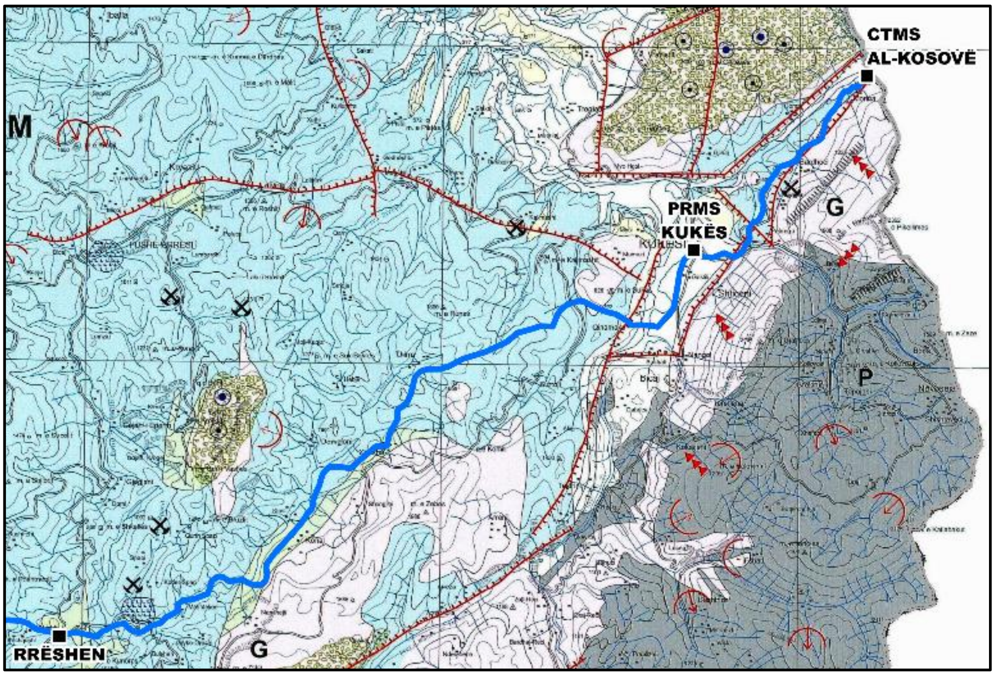

Figure 5-22: Hazard Map of Sections 19 and 20.

Meanwhile, the intrusion upon human settlements is very minimal since the area is sparsely populated. Only at the last portion, the corridor goes in vicinity of the villages of Gostil, Bardhoc, and Morina.

5.2.21 Section 21: Milot – CTMS Bushat

This section is 33.2 km long and passes mainly flat, agricultural areas (Type E soils). However, the area around the town of Lezha is somewhat different (areas in dark brown and green in Figure 5-23). This area is relatively mountainous and its geologic formations, in contrast to both the previous and subsequent sections, are composed of limestone and silicate formations of the Cretacious period and are alternated by silt, and marl formations of the Eocene (Type A, or B soils). These formations are relatively harder than the flat areas depending on the presence of the hard limestone and sandstone near the surface (Diggability Class IV-V).

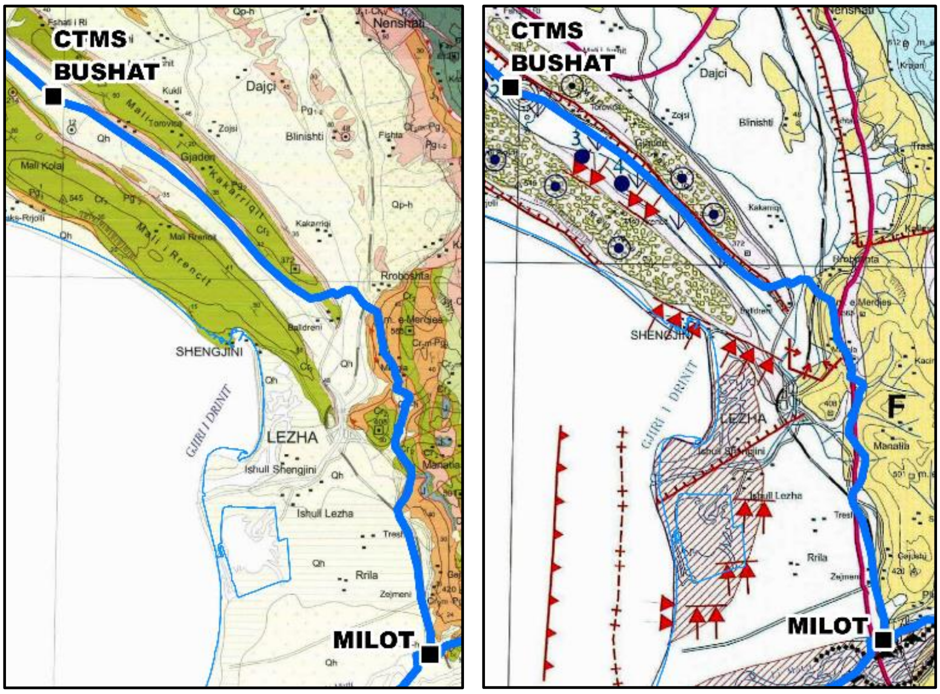

Figure 5-23: Geological and Hazard Maps of Section 20

About geological hazards in this section, it is important to mention the tectonic fault along Kakariq Plain. This tectonic fault runs in parallel with the corridor for almost 15 km.

The prospective gas corridor Milot-Bushat has been assessed during the FS of IAP project, which should be reviewed. In addition, a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary prior and during construction works, because of potential archaeological sites/monuments, near Lezha archaeological park and its surroundings.

5.2.22 Section 22: CTMS Bushat - PRMS Shkodra

This section is around 29.8 km long and runs through low-lying plains of alluvial origin. The geologic formations, especially around Shkodra are typically alluvial, and are composed of fine sands and conglomerates (Type E, or D). These formations are easy to excavate (Class II-III). These formations constitute also the quaternary gravel aquifer of Lower Shkodra.

Meanwhile, in relation to geological hazards, the prospective corridor is situated within an area of high intensity of earthquakes (IX MSK or 7-8 Richter). In addition, a few tectonic faults cross the corridor as indicated in Figure 5-24. The corridor crosses also the largest river in Albania (Drin River), which is the source of the largest flood risk in the country.

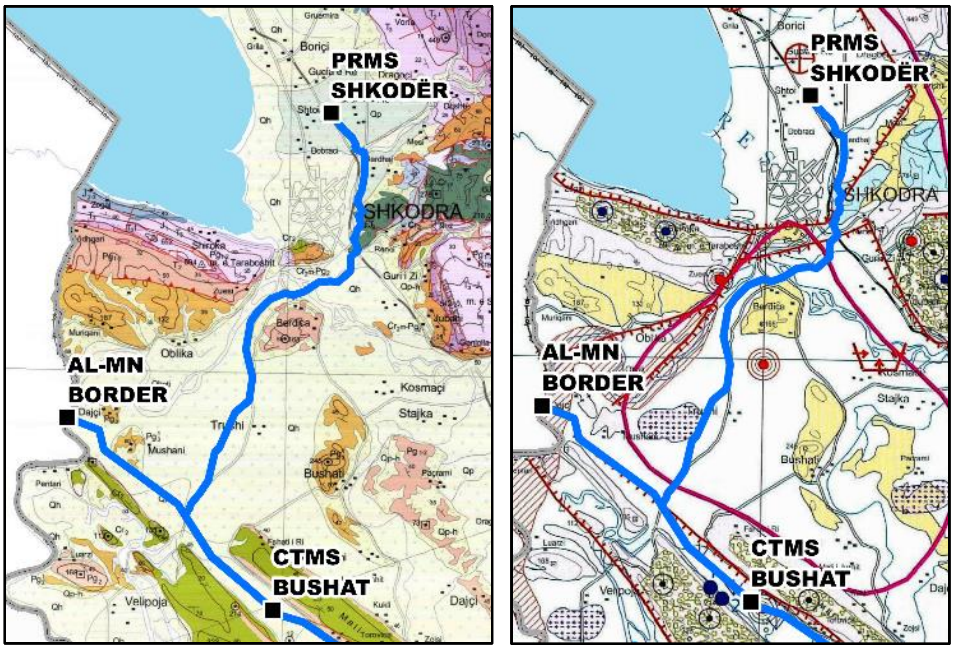

Figure 5-24: Geological and Hazard Maps of Sections 21, and 22.

Meanwhile, proximity to residential settlements is very significant. The corridor approaches near Shkodra City and runs between its suburbs and surrounding villages in very close proximity to individual houses or commercial buildings.

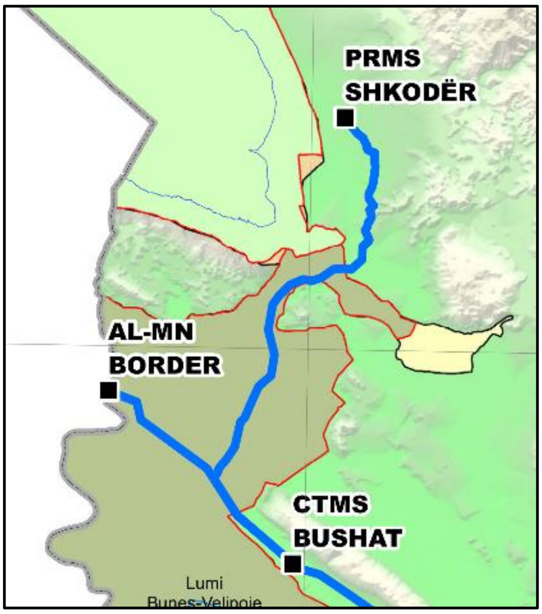

Figure 5-25: Protected-Areas Map of Sections 21, and 22.

From the environmental point of view, there is a Protected Landscape Area that is crossed by the prospective pipeline corridor, which is situated at the north near the border with Montenegro (the dark area in the figure above). The pipeline corridor runs through this protected area (Buna-Velipoja Protected Landscape) for more than 10 km. The crossing of this protected landscape should be effectuated by taking into account the provisions of the Albanian law 10431 of June 06.2011 “On environmental protection”, as well as the CMD no 682/2005 related to this protected area.

In addition, a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary prior and during construction works. This survey should be carried out because of the possibility to cross potential archaeological sites/monuments, near Shkodra archaeological park and its surroundings.

5.2.23 Section 23: CTMS Bushat - Montenegrin Border

This section is only 13.5 km long and has the same characteristics as the previous section. The corridor infringes upon Buna-Velipoja Protected Landscape for almost 8 km as shown in Figure 5-25. The crossing of the protected landscape should be effectuated by taking into account the provisions of the Albanian law 10431 of June 06.2011 “On environmental protection”, as well as the CMD no 682/2005 related to this protected area.

5.2.24 Section 24: CP3 Korçe - PRMS Pogradec

This section is around 35.3 km long and for the major part runs through Korca Plain The terrain within Korça Plain is generally very flat and the soils here are composed of Pleistocene-Holocene clays, sands, and gravels (Type E or D soils), which are all of alluvial origin from the deposits of Devoll and Dunavec River. They constitute also the Quaternary gravel aquifer of Korça and of surrounding villages. These formations are soft and easy to excavate (Diggability Class I-II). A part of this area used to be swampy, but proper drainage works have turned it into a productive agricultural area. Nevertheless, there are a few limited areas (which are depicted with hatched pattern in the Figure 5-26ure below) that persist to have shallow water tables or get intermittently flooded.

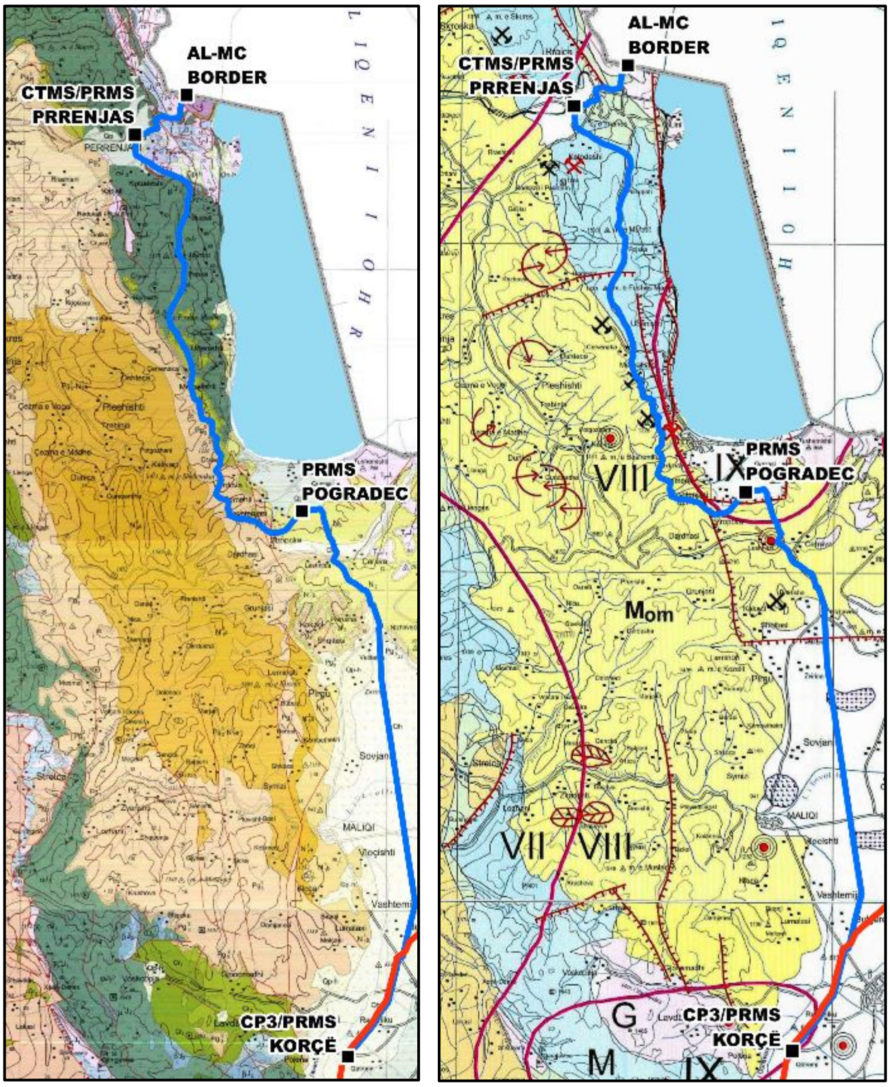

Figure 5-26: Geological and Hazard Maps of Sections 24, 25, and 26.

5.2.25 Section 25: PRMS Pogradec – CTMS/PRMS Prrenjas

This section is 31.4 km long and in contrast to Korça Plain is mountainous and reaches heights up to 1300 m above sea level. The soils are also diverse in their compositions. Part of the section consists of Oligocene flysch, which is composed of clays and sands at the superficial layer and limestone at layers below the superficial layers (Type B soils). The other portion of the pipeline section (the area with greyish colour in Figure 5-26) consists of ultrabasic rocks of the Jurassic Period (Type A soils). As a consequence, this portion is hard to excavate (Diggability Class V-VI).

There are only few geologic hazards near the pipeline corridor. Two tectonic faults are near the pipeline corridor; one is parallel to the corridor (nearly 8 km), while the other one is perpendicular to the pipeline corridor as shown in the figure above. In addition, the prospective pipeline corridor infringes upon the Protected Landscape around Lake Pogradec, as it is illustrated in Figure 5-27. The corridor runs through this protected landscape for nearly 30 km. The crossing of the Protected

Landscape should be effectuated by taking into account the provisions of the Albanian law 10431 of June 06.2011 “On environmental protection”, as well as the CMD no 80/1999 related to this protected area.

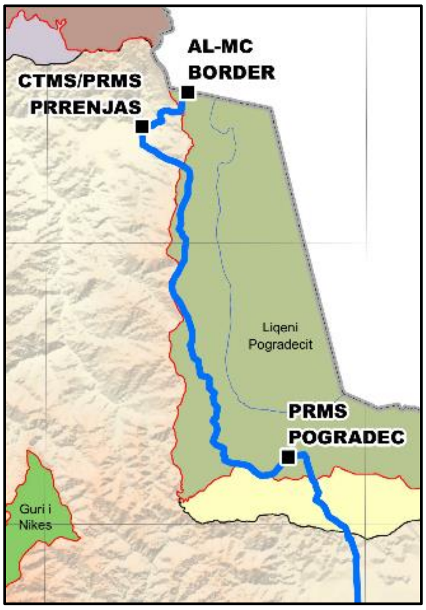

Figure 5-27: Protected-Areas Map of Sections 25, and 26.

As for other land features, the pipeline corridor, crosses Dunavec River, Devoll River, and other smaller rivers, as well as the national road Korça-Pogradec. The selection of the prospective gas corridors should also take into account the planned new road Korça-Qukes, in order to avoid, as much as possible, the environmental and social impacts.

In addition, a detailed archaeological survey, in compliance with the Albanian Law “On cultural heritage” is necessary prior and during construction works. This survey should be carried out because of the possibility to cross potential archaeological sites/monuments.

5.2.26 Section 26: CTMS/PRMS Prrenjas - FYRoM Border

This is a very short section (only 5 km) and runs from Prrenjas to the FYRoM border. It is very similar in its characteristics with the latter portion of the previous section (Type A, or B soils and Class IV-V diggability).

Meanwhile, the corridor crosses the national road to Korça and the national road towards the border with FYRoM. In addition, this pipeline section infringes upon some individual residential homes in the town of Prrenjas.

5.3 Pipeline throughput scenarios

Based on previous studies and energy strategies of the gasification of Albania, it is assumed that the transmission system of Albania will be supplied with the natural gas from TAP. The National Sectorial Plan for TAP (May 2013) as well as the ESIA for TAP in Albania and the FS and ESIA for the IAP in Albania, provide information of above ground pipeline facilities, including block valve stations (BVS) and pressure reduction and metering stations (PRMS), which can serve the purpose to enable the natural gas supply of Albania. The transmission system of Albania is planned with three take-off points from TAP (near Korça, Kuçova and Fier.

In the two scenarios that include IAP, the transmission system of Albania will have branches connected to IAP, PRMS's provided by the TSO and PRMS's provided by IAP.

Four scenarios of Albania's transmission system were considered:

Scenario 1:

- provides for the supply of gas for the selected LGU´s and the anchor consumers in Albania;
- considers the construction of IAP with its determined diameter (gas transmission toward Montenegro, Bosnia & Herzegovina and Croatia);
- supply of Kosovo from the direction of Kukes and the supply of former Yugoslav Republic of Macedonia (FYRoM) from the direction of Prrenjas;

Scenario 2:

- provides for the supply of gas for the selected LGU´s and the anchor consumers in Albania;
- considers the construction of IAP with its determined diameter (gas transmission toward Montenegro, Bosnia & Herzegovina and Croatia);

Scenario 3:

- provides for the supply of gas for the selected LGU´s and the anchor consumers in Albania;
- supply of Kosovo from the direction of Kukes, as well as the supply of FYRoM from the direction of Prrenjas;

Scenario 4:

- provides for the supply of gas for the selected LGU´s and the anchor consumers in Albania;
- The transmission system is optimized for the 80% of potential gas demand in selected LGU´s in Albania, total demand of potential large gas consumers (thermal power plants, refineries etc.) plus expected gas consumption in Kosovo and FYRoM in accordance with good pipeline planning practices.

The planned amounts of gas for supply is presented in Table 5-2 and Table 5-3 below.

*Table 5-2**:** Design gas quantities for supply of consumers on an annual basis in 2040*

Albania	Anchor Consumers [mcm/year]	Residential sector [mcm/year]	Service sector [mcm/year]	Industrial sector [mcm/year]	Total consumption [mcm/year]	Total capacity [m3/h]
CTMS/PRMS PRRENJAS		2.6	1.5	5.2	9.3	3,439
PRMS BALLSH	72.0	2.1	1.5	3.8	79.4	21,908
PRMS BERAT	125.0	15.6	12.6	12.2	165.4	58,438
PRMS DUMRE		1.7	1.7	7.8	11.2	4,732
PRMS DURRES		62.1	26.4	119.4	207.9	74,325
PRMS ELBASAN1	28.0	11.4	9.6	40.9	89.9	26,048
PRMS ELBASAN2		12.0	8.9	34.9	55.8	18,716
PRMS FIER	147.0	27.0	16.3	37.6	227.9	65,949
PRMS FUSHË-KRUJË		15.6	6.6	29.8	52.0	18,593
PRMS GJIROKASTËR		3.7	4.5	12.7	21.0	7,764
PRMS KAVAJË		12.3	7.0	3.1	22.4	12,233
PRMS KORÇË	125.0	23.3	14.9	14.2	177.4	64,043
PRMS KUKES		3.2	2.3	4.9	10.3	4,163
PRMS LEZHË		10.3	3.9	4.2	18.4	8,447
PRMS LUSHNJE		9.1	6.2	15.3	30.6	12,010
PRMS MAMURRAS		12.4	6.1	11.0	29.6	12,526
PRMS POGRADEC		10.0	5.9	5.3	21.2	9,931
PRMS SARANDË		5.2	4.4	2.5	12.1	6,007
PRMS SHKODËR		27.0	16.9	32.6	76.5	31,689
PRMS TEPELENE		0.9	0.9	2.8	4.6	1,695
PRMS TIRANA 1		154.8	97.6	44.3	296.7	149,528
PRMS TIRANA 2		119.2	71.4	32.3	222.9	112,160
PRMS VLORE	187.0	20.2	20.2	11.6	239.0	82,769
TOTAL	**684.0**	**561.7**	**347.4**	**488.6**	**2,081.6**	**807,113**
Neighbouring Countries						
KOSOVO (Scenario 1, 3)		1,000.0			1,000.0	120,000
FYR of MACEDONIA (Scenario 1,3)		756.0			756.0	86,000
MNE, BiH, CRO (Scenario 1, 2)		4,000.0			4,000.0	480,000
Scenarios						
Scenario 1					7,837.6	1,493,113
Scenario 2					6,081.6	1,287,113
Scenario 3					3,837.6	1,013,113
Scenario 4					2,081.6	807,113

Table 5-3: Consumption of the potential large consumers in 2040

Consumer	mcm
Vlora TPP	62
CCGT 1 (Vlore)	125
CCGT 2 (Korce)	125
CCGT 3 (Kucove)	125
Ballsh refinery	72
Fier refinery	17
Bankers Petroleum	130
Kurum	28
TOTAL	**684**

5.4 Block flow diagrams

The block flow diagrams of the 4 transmission system scenarios are presented in Annex 1, 2, 3 and 4.

5.5 Standard conditions

For the gas quality and throughput related calculations the following standard conditions were taken in account:

- Standard Pressure: 1.01325 bar
- Standard Temperature: 15°C

Design Gas Quality

Natural gas composition shown in Table 5-4 corresponds to the gas composition of the Trans Adriatic Pipeline (TAP) according to C205/ILFM-AD-0000/Rev. B IAP (Ionian Adriatic Pipeline) – Hydraulic study and cost comparison (step 1). The process calculations are based on this composition.

Table 5-4: Design Gas Quality

Component		Mole %
Methane	C1 (CH_4)	87.78
Ethane	C2 (C_2H_6)	2.72
Propane	C3 (C_3H_8)	1.54
Iso-Butane	C4 (C_4H_{10})	0.5
N-Butane	C4 (C_4H_{10})	0.51
Iso-Pentane	C5 (C_5H_{12})	0.24
N-Pentane	C5 (C_5H_{12})	0.24
Hexane	C6 (C_6H_{14})	0.03
Nitrogen	N2	4.43
Carbon Dioxide	CO2	2.01
Total		**100**

5.6 Pipeline related data

General parameters of the transmission pipeline through Albania:

- Pipeline Maximum Allowable Operating Pressures:
  - 82 barg, for IAP section of transmission system of Albania and 50 bar for rest of transmission system of Albania
  - 50 barg, for transmission system of Albania when IAP is not included

- Pipe wall thickness determination as per S SH EN 1594 in acordance with SSH EN 10208-2.
- Material standard:
    - L245NB / L245MB ; (8”-12”)
    - L360NB / L360MB; (16”-24”)
    - L415NB / L415MB; (32”-40”)
- Pipe Wall Conductivity: 45 W/m/K
- PE Coating Thickness: 3.5 mm
- PE Coating Conductivity: 0.35 W/m/K
- The soil temperature at laying depths: 10°C

5.7 Hydraulic calculations

5.7.1 Methodology

To make decision about optimal pipeline diameters for transmission system the hydraulic calculations have been conducted.

The process calculations have been conducted using the GASWorkS software 9.0 by Bradley B. Bean, PE.

GASWorkS™ provides Windows based steady-state network modelling tools. It is designed to assist the engineering professionals analyse and design distribution, gathering, transmission, and plant piping systems containing natural gas or other compressible fluids. Support is provided for systems made up of fittings, compressors, pipes, regulators, valves, and wells. A robust set of import and export routines allows data exchange with a variety of CAD, GIS, and Database applications.

The gas transmission system should be hydraulically optimized to enable supply of the Albanian gas market for three different development options:

- Supply of the Albanian gas market
- Supply of the Albanian and regional gas market - evacuation of the expected domestic production toward the neighbouring countries
- Supply of the Albanian and regional gas market with the final goal to reach the regional N-1 criterion (all related to the implementation of Regulation (EU) no 994/2010 of the European Parliament and of the Council of 20

October 2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC)

In relation to above mentioned development options four different models have been developed and Hydraulic calculations have been conducted for four different scenarios described in Section 5.3.

Individual pipeline system configurations are compared to each other with respect to investment cost and maintenance cost.

5.7.2 Wall thickness calculation

Pipe wall thickness calculations have been performed per S SH EN 1594 in accordance with SSH EN 10208-2.

S SH EN 1594 is applicable to gas supply systems - Pipelines for maximum operating pressure over 16 bar and defines functional requirements. SSH EN 10208-2 defines technical delivery conditions of steel pipes for pipelines for combustible fluids and defines applicable safety factors.

5.7.3 Design pressure

Design pressure calculation has been performed on the basis of pipeline diameter and throughput of the system and according to inlet and outlet pressure of the system.

For transmission pipeline system of Albania (Scenarios 3 and 4) the calculations are based on a maximum supply pressure of 50 barg at a temperature of 10°C from the pressure reduction stations at TAP pipeline.

When IAP is part of the transmission pipeline system of Albania (Scenarios 1 and 2), the calculations are based on a maximum supply pressure of 82 barg at a temperature of 10°C from the pressure reduction station at TAP pipeline (CP1 Fier). This is considered for the IAP section of transmission system and section toward Dumrea. For the rest of transmission system the calculations are based on a maximum supply pressure of 50 barg.

The minimum delivery pressures for all scenarios are considered as follows:

- To centres with potential large gas consumers equal to 35 barg (power plants in Vlore, Kuçova, and Korça, and refineries in Fier, Ballsh and Bankers Petroleum)

- To the most far LGU´s (at the system's endpoints) equal to 16 barg.

5.7.4 Hydraulic results

Results of hydraulic calculations for determination of optimal transmission system pipeline diameters, for different scenarios as mentioned in methodology chapter are shown in Table 5-6 and Annexes 5, 6, 7 and 8.

When IAP is included in the transmission system of Albania, the hydraulic calculations for Scenario 1 result in a larger pipeline diameter along the route from Milot to Kukës compared to Scenario 2, due to the increase in gas transmission for the supply of Kosovo from the direction of Kukës.

In the same way, the hydraulic calculations for Scenario 1 result in a larger pipeline diameter along the route from Korça to Prrenjas compared to Scenario 2 due to the increase in gas transmission for the supply of FYR of Macedonia from the direction of Prrenjas.

For the Scenarios 3 and 4, when IAP is not part of transmission system of Albania, results of hydraulic calculations show that, the Scenario 3 calculations result in a larger pipeline diameter along the route from Lushnja to Kukës compared to Scenario 4, due to the increase in gas transmission for the supply of Kosovo from the direction of Kukës.

The increase in gas transmission for the supply of FYR of Macedonia from the direction of Prrenjas (Scenario 3) results in a larger pipeline diameter along the route from Korça to Prrenjas compared to the Scenario 4.

For Scenarios 1, 2 and 3 the route section from CP1 Fier to Peza has the same pipeline diameter. In Scenario 4 the pipeline diameter of the section from Lushnja to Peza becomes smaller compared to Scenarios 1, 2 and 3.

Section toward Dumrea is dimensioned to enable transmission for the purpose of underground storage.

For all scenarios, the sections from CP1 Fier toward Vlora and Saranda do not differ in pipeline diameter and hydraulic results.

Table 5-5: Transmission pipelines sizes per scenario

Section		Pipeline length	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		km	inch	inch	inch	inch
1	CP1 FIER - FIER	5.1	16	16	16	16
2	FIER - PRMS VLORE	31.6	12	12	12	12
3	PRMS VLORE - TPP VLORE	3.1	8	8	8	8
4	FIER - PRMS FIER	10.3	12	12	12	12
5	PRMS FIER - PRMS BALLSH	23.1	8	8	8	8
6	PRMS BALSH - PRMS TEPELENE	48.6	8	8	8	8
7	PRMS TEPELENE - PRMS GJIROKASTËR	19.4	8	8	8	8
8	PRMS GJIROKASTËR - PRMS SARANDË	35.7	8	8	8	8
9	CP1 FIER - LUSHNJE	15.7	32	32	32	32
10	LUSHNJE - PRMS DUMRE	35.0	20	20	20	20
11	PRMS DUMRE - ELBASAN	32.3	8	8	8	8
12	LUSHNJE - PEZE	51.7	32	32	32	24
13	PEZE - PRMS DURRES	17.7	8	8	12	12
14	PEZE - PRMS TIRANA 2	16.8	12	12	12	12
15	PEZE - PRMS TIRANA 1	14.8	32	32	24	20
16	PRMS TIRANA 1 - PRMS FUSHE-KRUJE	12.0	32	32	24	12
17	PRMS FUSHE-KRUJE - MILOT	27.2	32	32	24	12
18	MILOT - RRESHEN	42.5	20	8	24	8
19	RRESHEN - PRMS KUKES	51.5	16	8	20	8
20	PRMS KUKES - CTMS AL-KOSOVO	16.8	16		20	
21	MILOT - CTMS BUSHAT	33.2	32	32	8	12
22	CTMS BUSHAT - PRMS SKHODRA	29.8	8	8	8	12
23	CTMS BUSHAT - AL-MN BORDER	13.5	32	32		
24	CP3 KORCE - PRMS POGRADEC	35.3	16	8	16	8
25	PRMS POGRADEC - CTMS/PRMS PRRENJAS	31.4	16	8	16	8
26	CTMS/PRMS PRRENJAS - AL-MC BORDER	5.0	16		16	

5.8 CAPEX and OPEX estimate

Based on the proposed routes, their characteristics, technological and technical requirements and methods of construction, the investment costs were determined.

Specific construction cost of the pipeline is defined on the basis of contractor's market prices for similar (comparable concept) pipeline projects, which are built on a terrain of similar configuration. Prices are adjusted in accordance with the market conditions in the past 3-6 years, and the state of the market in Albania.

Specific construction cost of pipeline and pipeline facilities includes engineering, construction, electrical works, instrumentation and control system construction, expropriation, land acquisition, design, supervision and operating costs.

The pipeline investment is presented in tabular form below.

Table 5-6: Pipeline investment costs for Scenario 1

	Pipeline Section	Scenario 1				
		Investment costs				Amount of gas for initial fill up
		Pipeline diameter	Pipeline length	Specific investment cost pipeline	Investment costs pipeline	
		inch	km	€/"m	Mio €	m^3
1	CP1 FIER - FIER	16	5.1	19.5	**1.6**	35,400
2	FIER - PRMS VLORE	12	31.6	20.6	**7.8**	140,400
3	PRMS VLORE - TPP VLORE	8	3.1	24.6	**0.6**	6,000
4	FIER - PRMS FIER	12	10.3	19.6	**2.4**	44,100
5	PRMS FIER - PRMS BALSH	8	23.1	21.2	**3.9**	44,800
6	PRMS BALSH - PRMS TEPELENË	8	48.6	20.3	**7.9**	94,400
7	PRMS TEPELENË - PRMS GJIROKASTËR	8	19.4	21.4	**3.3**	37,600
8	PRMS GJIROKASTËR - PRMS SARANDË	8	35.7	26.0	**7.4**	69,300
9	CP1 FIER - LUSHNJE	32	15.7	26.4	**13.3**	689,700
10	LUSHNJE - PRMS DUMRE	20	35.0	26.3	**18.4**	594,600
11	PRMS DUMRE - ELBASAN 2	8	32.3	20.6	**5.3**	62,700
12	LUSHNJE - PEZË	32	51.7	27.4	**45.3**	2,271,500
13	PEZË - PRMS DURRES	8	17.7	20.3	**2.9**	34,400
14	PEZË - PRMS TIRANA 2	12	16.8	20.5	**4.1**	71,900
15	PEZË - PRMS TIRANA 1	32	14.8	27.0	**12.8**	650,200
16	PRMS TIRANA 1 - PRMS FUSHE-KRUJE	32	12.0	26.3	**10.1**	527,200
17	PRMS FUSHE-KRUJE - MILOT	32	27.2	26.2	**22.8**	1,195,000
18	MILOT - RRESHEN	20	42.5	22.4	**19.0**	461,000
19	RRESHEN - PRMS KUKES	16	51.5	26.7	**22.0**	357,200
20	PRMS KUKES - CTMS AL-KOSOVË	16	16.8	20.3	**5.5**	267,200
21	MILOT - CTMS BUSHAT	32	33.2	26.4	**28.0**	1,458,600
22	CTMS BUSHAT - PRMS SKHODËR	8	29.8	22.5	**5.4**	57,800
23	CTMS BUSHAT - AL-MN BORDER	32	13.5	26.2	**11.3**	593,000
24	CP3 KORCE - PRMS POGRADEC	16	35.3	20.2	**11.4**	244,900
25	PRMS POGRADEC - CTMS/PRMS PRRENJAS	16	31.4	25.6	**12.9**	217,800
26	CTMS/PRMS PRRENJAS - AL-MC BORDER	16	5.0	25.1	**2.0**	34,600

Table 5-7: Pipeline investment costs for Scenario 2

	Pipeline Section	Scenario 2				
		Investment costs				Amount of gas for initial fill up
		Pipeline diameter	Pipeline length	Specific investment cost pipeline	Investment costs pipeline	
		inch	km	€/"m	Mio €	m^3
1	CP1 FIER - FIER	16	5.1	1.6	**1.6**	35,400
2	FIER - PRMS VLORE	12	31.6	7.8	**7.8**	140,400
3	PRMS VLORE - TPP VLORE	8	3.1	0.6	**0.6**	6,000
4	FIER - PRMS FIER	12	10.3	2.4	**2.4**	44,100
5	PRMS FIER - PRMS BALSH	8	23.1	3.9	**3.9**	44,800
6	PRMS BALSH - PRMS TEPELENË	8	48.6	7.9	**7.9**	94,400
7	PRMS TEPELENË - PRMS GJIROKASTËR	8	19.4	3.3	**3.3**	37,600
8	PRMS GJIROKASTËR - PRMS SARANDË	8	35.7	7.4	**7.4**	69,300
9	CP1 FIER - LUSHNJE	32	15.7	13.3	**13.3**	689,700
10	LUSHNJE - PRMS DUMRE	20	35.0	18.4	**18.4**	594,600
11	PRMS DUMRE - ELBASAN 2	8	32.3	5.3	**5.3**	62,700
12	LUSHNJE - PEZË	32	51.7	45.3	**45.3**	2,271,500
13	PEZË - PRMS DURRES	8	17.7	2.9	**2.9**	34,400
14	PEZË - PRMS TIRANA 2	12	16.8	4.1	**4.1**	71,900
15	PEZË - PRMS TIRANA 1	32	14.8	12.8	**12.8**	650,200
16	PRMS TIRANA 1 - PRMS FUSHE-KRUJE	32	12.0	10.1	**10.1**	527,200
17	PRMS FUSHE-KRUJE - MILOT	32	27.2	22.8	**22.8**	1,195,000
18	MILOT - RRESHEN	8	42.5	8.0	**8.0**	82,500
19	RRESHEN - PRMS KUKES	8	51.5	12.3	**12.3**	100,000
20	PRMS KUKES - CTMS AL-KOSOVË	0	0.0	0.0	**0.0**	0
21	MILOT - CTMS BUSHAT	32	33.2	28.0	**28.0**	1,458,600
22	CTMS BUSHAT - PRMS SKHODËR	8	29.8	5.4	**5.4**	57,800
23	CTMS BUSHAT - AL-MN BORDER	32	13.5	11.3	**11.3**	593,000
24	CP3 KORCE - PRMS POGRADEC	8	35.3	5.9	**5.9**	68,500
25	PRMS POGRADEC - CTMS/PRMS PRRENJAS	8	31.4	6.5	**6.5**	61,000
26	CTMS/PRMS PRRENJAS - AL-MC BORDER	0	0.0	0.0	**0.0**	0

Table 5-8: Pipeline investment costs for Scenario 3

Pipeline Section	Scenario 3				
	Investment costs				Amount of gas for initial fill up
	Pipeline diameter	Pipeline length	Specific investment cost pipeline	Investment costs pipeline	
	inch	km	€/"m	Mio €	m^3
1 CP1 FIER - FIER	16	5.1	1.6	**1.6**	35,400
2 FIER - PRMS VLORE	12	31.6	7.8	**7.8**	140,400
3 PRMS VLORE - TPP VLORE	8	3.1	0.6	**0.6**	6,000
4 FIER - PRMS FIER	12	10.3	2.4	**2.4**	44,100
5 PRMS FIER - PRMS BALSH	8	23.1	3.9	**3.9**	44,800
6 PRMS BALSH - PRMS TEPELENË	8	48.6	7.9	**7.9**	94,400
7 PRMS TEPELENË - PRMS GJIROKASTËR	8	19.4	3.3	**3.3**	37,600
8 PRMS GJIROKASTËR - PRMS SARANDË	8	35.7	7.4	**7.4**	69,300
9 CP1 FIER - LUSHNJE	32	15.7	9.9	**9.9**	437,900
10 LUSHNJE - PRMS DUMRE	20	35.0	13.9	**13.9**	379,700
11 PRMS DUMRE - ELBASAN 2	8	32.3	5.3	**5.3**	62,700
12 LUSHNJE - PEZË	32	51.7	34.1	**34.1**	1,442,000
13 PEZË - PRMS DURRES	12	17.7	4.3	**4.3**	75,700
14 PEZË - PRMS TIRANA 2	12	16.8	4.1	**4.1**	71,900
15 PEZË - PRMS TIRANA 1	24	14.8	7.2	**7.2**	231,100
16 PRMS TIRANA 1 - PRMS FUSHE-KRUJE	24	12.0	5.7	**5.7**	187,400
17 PRMS FUSHE-KRUJE - MILOT	24	27.2	12.9	**12.9**	424,900
18 MILOT - RRESHEN	24	42.5	22.7	**22.7**	663,900
19 RRESHEN - PRMS KUKES	20	51.5	26.9	**26.9**	558,700
20 PRMS KUKES - CTMS AL-KOSOVË	20	16.8	6.8	**6.8**	182,200
21 MILOT - CTMS BUSHAT	8	33.2	5.3	**5.3**	64,500
22 CTMS BUSHAT - PRMS SKHODËR	8	29.8	5.4	**5.4**	57,800
23 CTMS BUSHAT - AL-MN BORDER	0	0.0	0.0	**0.0**	0
24 CP3 KORCE - PRMS POGRADEC	16	35.3	11.4	**11.4**	244,900
25 PRMS POGRADEC - CTMS/PRMS PRRENJAS	16	31.4	12.9	**12.9**	217,800
26 CTMS/PRMS PRRENJAS - AL-MC BORDER	16	5.0	2.0	**2.0**	34,600

Table 5-9: Pipeline investment costs for Scenario 4

Pipeline Section	Scenario 4				
	Investment costs				Amount of gas for initial fill up
	Pipeline diameter	Pipeline length	Specific investment cost pipeline	Investment costs pipeline	
	inch	km	€/"m	Mio €	m^3
1 CP1 FIER - FIER	16	5.1	1.6	**1.6**	35,400
2 FIER - PRMS VLORE	12	31.6	7.8	**7.8**	140,400
3 PRMS VLORE - TPP VLORE	8	3.1	0.6	**0.6**	6,000
4 FIER - PRMS FIER	12	10.3	2.4	**2.4**	44,100
5 PRMS FIER - PRMS BALSH	8	23.1	3.9	**3.9**	44,800
6 PRMS BALSH - PRMS TEPELENË	8	48.6	7.9	**7.9**	94,400
7 PRMS TEPELENË - PRMS GJIROKASTËR	8	19.4	3.3	**3.3**	37,600
8 PRMS GJIROKASTËR - PRMS SARANDË	8	35.7	7.4	**7.4**	69,300
9 CP1 FIER - LUSHNJE	32	15.7	9.9	**9.9**	437,900
10 LUSHNJE - PRMS DUMRE	20	35.0	13.9	**13.9**	379,700
11 PRMS DUMRE - ELBASAN 2	8	32.3	5.3	**5.3**	62,700
12 LUSHNJE - PEZË	24	51.7	25.7	**25.7**	807,500
13 PEZË - PRMS DURRES	12	17.7	4.3	**4.3**	75,700
14 PEZË - PRMS TIRANA 2	12	16.8	4.1	**4.1**	71,900
15 PEZË - PRMS TIRANA 1	20	14.8	6.0	**6.0**	160,500
16 PRMS TIRANA 1 - PRMS FUSHE-KRUJE	12	12.0	2.9	**2.9**	51,400
17 PRMS FUSHE-KRUJE - MILOT	12	27.2	6.6	**6.6**	116,400
18 MILOT - RRESHEN	8	42.5	8.0	**8.0**	82,600
19 RRESHEN - PRMS KUKES	8	51.5	12.3	**12.3**	100,000
20 PRMS KUKES - CTMS AL-KOSOVË	0	0.0	0.0	**0.0**	0
21 MILOT - CTMS BUSHAT	12	33.2	8.0	**8.0**	142,000
22 CTMS BUSHAT - PRMS SKHODËR	12	29.8	7.7	**7.7**	127,500
23 CTMS BUSHAT - AL-MN BORDER	0	0.0	0.0	**0.0**	0
24 CP3 KORCE - PRMS POGRADEC	8	35.3	5.9	**5.9**	68,500
25 PRMS POGRADEC - CTMS/PRMS PRRENJAS	8	31.4	6.5	**6.5**	61,000
26 CTMS/PRMS PRRENJAS - AL-MC BORDER	0	0.0	0.0	**0.0**	0

5.9 Economic evaluation and system development options

5.9.1 Methodology

Having define the gas distribution areas with adequate gas consumption, the next step focuses on the assessment of the gas transmission system. The starting point of the development of the gas transmission system was assumed TAP exit point near the city of Fier (CP FIER). From this point, the gas network was assumed to be expanded towards the large gas consumption centres in a way that the additional pipeline sections would result to the lowest possible transmission tariff. Other criteria taken into account for the selection of the next consumption centres were the presence of anchor loads, the size of CAPEX and the market gas consumption profile.

The methodology applied was the DCF method. Two are the main features of the DCF:

- Only cash flows are considered, i.e. the actual amount of cash being paid out or received by the project. Cash flows must be considered in the year in which they occur and over a given reference period.

- At comparison (i.e. adding or deducting) of cash flows occurring in different years, the time value of money has to be considered. Therefore, future cash flows are discounted back to present using a factor whose magnitude is determined by the choice of the discount rate to be used in the DCF analysis.

- The discount rate is defined as the rate that produces a zero NPV, i.e. and is given by the following equation:

$$0=\sum\{St|(1+r)^{t}\}$$

where: S_t is the balance of net cash flow at time *t*.

For each section under consideration, the cash flows from the gas transmission activity were calculated and the transmission tariff was estimated based on the reference IRR. The basic assumptions were the following:

- <u>Time perspective</u>: The cash-flow forecasts covered an operating period of 21 years (i.e. from 2020 to 2040),

- <u>Construction period</u>: Construction works were assumed to last four years at equal annual construction phases (2016-2019),

- <u>Uniform regulatory tariff regime</u> according to which all transmission system users pays same tariff,

- Depreciation rate: The depreciation amount is determined by a straight-line method on the basis of the expected economic life of the fixed assets, which was assumed to be 25 years,

- Inflation: The analysis is in fixed term. Any inflation effects have not been considered in the calculations,

- VAT is not included,

- IRR: The reference IRR was assumed 8%.

5.9.2 Options under consideration

For the purpose of the current evaluation of the gas transmission system, three options were considered:

- **Option A: Albanian Gas Transmission System**

  This option evaluates the viability of the Albanian gas transmission network and defines the priority order in which the gas consumption centres will be connected to the network. International pipeline connections to neighbouring countries (ie. KOS, FYRoM and the MNE) were not considered. The criteria applied to define the order by which the PRMSs will be connected were: (a) the transmission tariff, (b) the gas consumption profile by sectors and (c) the CAPEX size.

- **Option B: International Pipeline Branch to Kosovo**

  This option assessed the impact to the transmission tariff of the development of an international transmission pipeline between Albania and Kosovo. The starting point of the pipeline branch is located in Milot and the cross border point near Kukës. The total length is estimated to 301.7 km and based on the present analysis, there is no domestic gas demand alongside the pipeline (therefore the branch will transport gas only for the Kosovar market). It was assumed that the gas pipeline towards Kosovo will be constructed after the development of the gas transmission network in the areas of Fier, Vlore, Ballsh, Elbasan, Tirana and Durrës.

- **Option C: International Pipeline Branch to FYRoM**

  This option assessed the impact to the transmission tariff of the development of an international transmission pipeline between Albania and FYRoM.The connection border point to FYRoM is located at the municipality of Prrenjas near the village of Rrajca and will be connected to TAP pipeline through a regional transmission pipeline starting from Korça (CP Korça). The pipeline will transport gas to areas of the LGU of Korça and Pogradec and to a 200 MW CCGT, planned for 2035. It was assumed that the connection to FYRoM will be realized after the connection to Kosovo.

In addition to the above options, the impact of the ownership scheme of IAP to the economics of the Project was assessed by evaluating three variants per option:

- **Variant A: Without IAP**

  This variant assumes that the common pipeline sections with IAP would be designed based on domestic gas demand requirements and the gas transmission system would be developed and operated by the national TSO.

- **Variant B: With IAP technical specifics**

  This variant assumes that the common pipeline sections with IAP would follow IAP’s technical requirements. The gas transmission system was designed taking into account forecasted gas volumes of 4 bcm per year transmitted to countries at the north of Albania (CRO, MNE and BiH) . This development scenario resulted to the highest investment costs. The system will be developed and operated by the national TSO.

- **Variant C: With IAP**

  This variant assumes that IAP is constructed and managed by a private TSO and the regional transmission pipelines will be developed and operated by the national TSO. This development scenario resulted to the lowest capital investment needs.

5.9.3 Estimate of the cash flows

Investment Costs

These costs include the initial investment costs, the costs for the gas quantities needed to fill up the pipelines and the costs associated with the replacement of fully depreciated assets.

The initial investment cost for the analysed options was based on the technical characteristics of each specific section of the gas transmission branch as presented in Section 5.8 (see Table 5-6 to Table 5-9). In addition, a 10% contingencies were considered.

The capital investment costs were increased by the costs of gas quantities needed for the initial fill up of gas pipelines at a price of 0.3 Euro/m^3. It was assumed that these costs occur during the last year of construction works

Finally, the reinvestment costs needed for the replacement of devaluated assets were not taken into account since their economic life was assumed that exceeds the reference period.

Operating expenses

These expenses were based on historic unit costs and they were estimated by applying the following assumptions:

- Labour cost: It was assumed a minimum number of 80 employees plus 10 employees for every PRMS connected to the transmission pipeline. The average salary was estimated at 10,800 EUR per year[6].
- Maintenance costs: They were calculated as percent of the investment costs, starting from a minimum value of 0.5% at the beginning of the operation year and ending to a maximum value of 1.5%. The annual growth step was assumed 0.05%
- Insurance costs: They were calculated at the level of 0.5% of total investment size.
- Right of way costs: The cost of the annual right of way can be paid in two different ways: one is for the building period when the damages happen on the crops, land, and forest or similar, and the other part is paid for the pipeline protection area. It is forbidden to build objects, or plant orchard, forest or similar in that area. This restriction applies for the entire life of the pipeline and therefore some sort of compensation should be paid. For the purpose of this assessment, the unit cost of this variable was assumed at 0.17 Euro/m^2 (the necessary route width was assumed to be 10 m from each side of the pipeline).
- Transmission losses: These are typical losses in natural gas transmission systems and were assumed to be 1% of transmitted gas (price of gas 0.3 Eur/m^3)
- Energy costs: The cost of gas that facilities use to preheat the gas before metering and pressure reduction: this cost is assumed to be 0.4% of transmitted gas (price of gas 0.3 Eur/m^3).
- Overheads: They were estimated at 20% of total operating expenses.

Revenues

The natural gas transmission activity would be regulated by the National Energy Authority so as to allow the TSO to recover the justified costs and earn a return on the Regulatory Asset Base according to the contracted transmission capacity and the expected transmitted volumes. For simplicity, in the financial analysis the Project revenue is calculated based on an average transmission charge which

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[6] 10,800 eur per year correspond to an average monthly rate of 600 eur/months plus indirect labour costs, such as external advisors

results to an investment IRR of 8%, multiplied by gas flows associated with a gas distribution tariff of 0.15 Eur/m^3 (as identified in Section 4.5).

Working Capital

The basic assumptions and key parameters for the estimation of the required working capital were:

- average time outstanding for the account receivables, 90 days.
- average time of payment for the account payables, 45 days.

5.9.4 Transport tariff tendency projection

Option A: Albania

The tables below present the tendency of the transmission tariffs for each pipeline section and variant under consideration. The transmission tariffs derived from the gradual development of the domestic gas transmission system are within acceptable range and, in the same time, are resulting to sustainable operating cash flows. Variant C, which assumes IAP as a private pipeline, lead to low gas transmission tariffs, since significant lower CAPEX will be needed. In the contrary, Variant B, which assumes that the design of the domestic network is based on IAP technical specs, resulted to a transmission tariff, the level of which lead to low possibility for gasification of the areas north of Tirana.

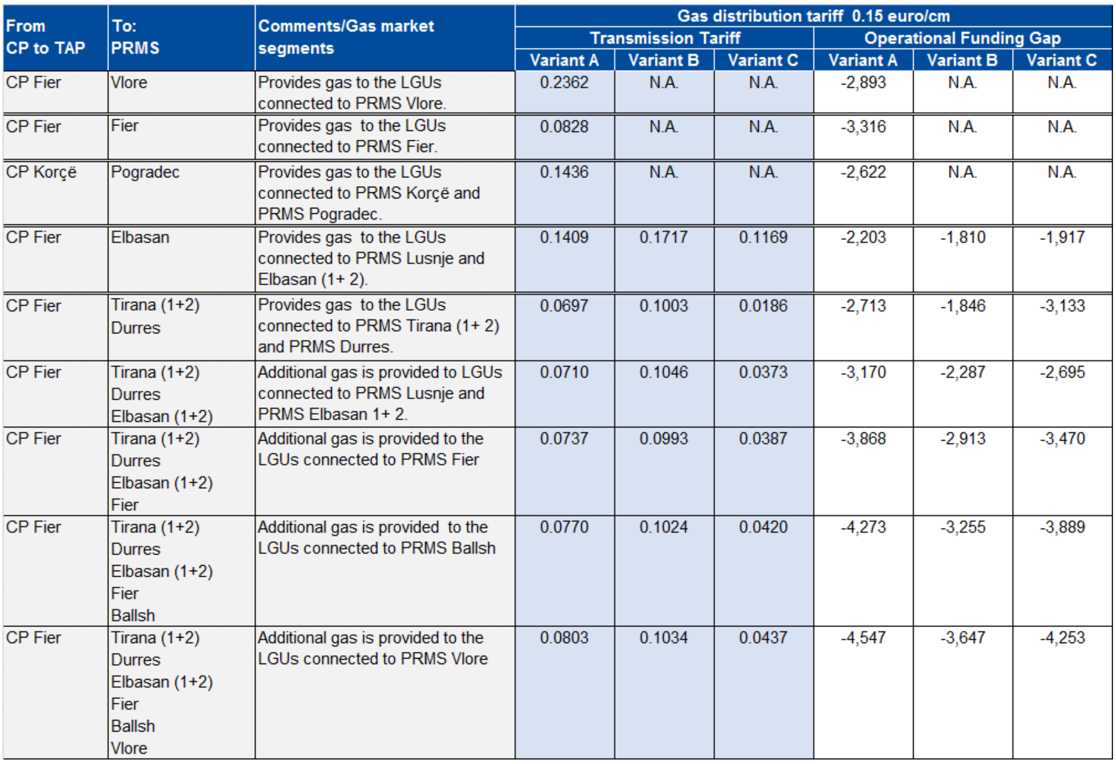
Generally speaking, the presence of significant anchor loads at the early stage of the construction of the gas transmission system gave the necessary input to a sustainable development of the gas market. Due to this reason and in order to identify the impact of the anchor loads to the present evaluation, a scenario without the anchor consumers was analysed. The analysis revealed that the gas transmission activity without the gas quantities of the anchor loads would require significant additional funding to cover operational expenses.

Table 5-10: Gas transmission tariff tendency

From CP to TAP	**To: PRMS**	**Comments/Gas market segments**	**Gas transmission network (in klm)**	**Gas distribution tariff 0.15 euro/cm**									**Cumulative CAPEX (in mil. Euro)**		
				Cumulative Gas Consumption in 2040		**Transmission Tariff (in Euro/cm)**			**Levelised Cost (in Euro/cm)**						
				Market (in '000 cm)	**Anchor Loads**	**Variant A**	**Variant B**	**Variant C**	**Variant A**	**Variant B**	**Variant C**	**Variant A**	**Variant B**	**Variant C**	
CP Fier	Vlore	Provides gas to TPP Vlore and to the LGUs connected to PRMS Vlore.	39.8	40,100	187,438	**0.0230**	**0.0230**	**0.0230**	0.0213	0.0213	0.0213	11,063	11,063	11,063	
CP Fier	Vlore Fier	Additional gas is provided to Fier Refinery, Banker Petroleum and to LGUs connected to PRMS Fier.	50.1	106,141	334,301	**0.0149**	**0.0149**	**0.0149**	0.0140	0.0140	0.0140	13,718	13,718	13,718	
CP Fier	Vlore Fier Ballsh	Additional gas is provided to Ballsh Refinary and to LGUs connected to PRMS Ballsh.	73.2	112,364	406,438	**0.0148**	**0.0148**	**0.0148**	0.0139	0.0139	0.0139	18,021	18,021	18,021	
CP Fier	Vlore Fier Ballsh Elbasan (1+2)	Additional gas is provided to CURUM Steel Industry and to LGUs connected to PRMS Elbasan 1 and Elbasan 2.	156.2	240,855	434,438	**0.0251**	**0.0279**	**0.0228**	0.0231	0.0256	0.0210	50,349	59,151	44,340	
CP Fier	Vlore Fier Ballsh Elbasan Tirana (1+2) Durres	Additional gas is provided to LGUs connected to PRMS Tirana 1, Tirana 2 and Durres.	257.2	769,181	434,438	**0.0321**	**0.0410**	**0.0205**	0.0293	0.0371	0.0189	94,780	131,709	52,082	
CP Fier	Vlore Fier Ballsh Elbasan Tirana (1+2) Fushe Kruje	Additional gas is provided to LGUs connected to PRMS Fushe-Kruje.	269.2	793,865	434,438	**0.0328**	**0.0434**	**0.0203**	0.0299	0.0393	0.0187	97,987	142,989	52,082	
CP Fier CP Korçë	Vlore Fier Ballsh Elbasan Tirana (1+2) Durres Fushe Kruje Pogradec	Additional gas is provided to LGUs connected to PRMS Korçë and PRMS Pogradec.	304.5	840,043	559,397	**0.0325**	**0.0422**	**0.0209**	0.0296	0.0381	0.0192	105,048	150,050	59,143	

From CP to TAP	To: PRMS	Comments/Gas market segments	Gas transmission network (in klm)	Gas distribution tariff 0.15 euro/cm								Cumulative CAPEX (in mil. Euro)		
				Cumulative Gas Consumption in 2040		Transmission Tariff (in Euro/cm)			Levelised Cost (in Euro/cm)					
				Market (in '000 cm)	Anchor Loads	Variant A	Variant B	Variant C	Variant A	Variant B	Variant C	Variant A	Variant B	Variant C
CP Fier CP Korçë	Vlore Fier Ballsh Elbasan Tirana (1+2) Durres Fushe Kruje Shkodër Pogradec	Additional gas is provided to LGUs connected to PRMS Shkodër.	394.7	897,426	559,397	**0.0377**	**0.0553**	**0.0220**	0.0342	0.0498	0.0202	129,615	212,866	65,062
CP Fier CP Korçë	Vlore Fier Ballsh Elbasan Tirana (1+2) Durres Fushe Kruje Shkodër Tepelenë Pogradec	Additional gas is provided to LGUs connected to PRMS Tepelenë.	443.3	901,509	559,397	**0.0399**	**0.0575**	**0.0241**	0.0362	0.0517	0.0221	138,328	221,578	73,775
CP Fier CP Korçë	Vlore Fier Ballsh Elbasan Tirana (1+2) Durres Fushe Kruje Shkodër Tepelene Gjirokastër Pogradec	Additional gas is provided to LGUs connected to PRMS Gjirokastër.	462.7	919,927	559,397	**0.0407**	**0.0581**	**0.0251**	0.0369	0.0523	0.0229	141,993	225,244	77,440
CP Fier CP Korçë	Vlore Fier Ballsh Elbasan Tirana (1+2) Durres Fushe Kruje Shkodër Tepelene Gjiroktasra Pogradec Prrenjas	Additional gas is provided to LGUs connected to PRMS Prrenjas.	494.1	926,799	559,397	**0.0423**	**0.0597**	**0.0267**	0.0383	0.0537	0.0244	148,723	231,974	84,170

Table 5-11: Gas transmission tariff tendency without anchor consumers for the main LGUs



From CP to TAP	To: PRMS	Comments/Gas market segments	Gas distribution tariff 0.15 euro/cm					
			Transmission Tariff			Operational Funding Gap		
			Variant A	Variant B	Variant C	Variant A	Variant B	Variant C
CP Fier	Vlore	Provides gas to the LGUs connected to PRMS Vlore.	0.2362	N.A.	N.A.	-2,893	N.A.	N.A.
CP Fier	Fier	Provides gas to the LGUs connected to PRMS Fier.	0.0828	N.A.	N.A.	-3,316	N.A.	N.A.
CP Korçë	Pogradec	Provides gas to the LGUs connected to PRMS Korçë and PRMS Pogradec.	0.1436	N.A.	N.A.	-2,622	N.A.	N.A.
CP Fier	Elbasan	Provides gas to the LGUs connected to PRMS Lusnje and Elbasan (1+ 2).	0.1409	0.1717	0.1169	-2,203	-1,810	-1,917
CP Fier	Tirana (1+2) Durres	Provides gas to the LGUs connected to PRMS Tirana (1+ 2) and PRMS Durres.	0.0697	0.1003	0.0186	-2,713	-1,846	-3,133
CP Fier	Tirana (1+2) Durres Elbasan (1+2)	Additional gas is provided to LGUs connected to PRMS Lusnje and PRMS Elbasan 1+ 2.	0.0710	0.1046	0.0373	-3,170	-2,287	-2,695
CP Fier	Tirana (1+2) Durres Elbasan (1+2) Fier	Additional gas is provided to the LGUs connected to PRMS Fier	0.0737	0.0993	0.0387	-3,868	-2,913	-3,470
CP Fier	Tirana (1+2) Durres Elbasan (1+2) Fier Ballsh	Additional gas is provided to the LGUs connected to PRMS Ballsh	0.0770	0.1024	0.0420	-4,273	-3,255	-3,889
CP Fier	Tirana (1+2) Durres Elbasan (1+2) Fier Ballsh Vlore	Additional gas is provided to the LGUs connected to PRMS Vlore	0.0803	0.1034	0.0437	-4,547	-3,647	-4,253

Option B: International gas pipeline to Kosovo[7]

As mentioned before, this option evaluates the impact to the gas transmission tariff when a connection pipeline to Kosovo is added to the national gas system.

The connection to Kosovo is assumed to be near the existing Morina - Vërmica border crossing, 22 km from the town of Kukës. The pipeline branch is expected to have 110.8 km length from the CP Milot and the capital investment requirements were estimated at 56.4 mil. Euro. Due to the additional quantities planned to be transmitted through the pipeline, the pipe resizing of the national gas transmission system was deemed necessary, in case that the later does not follow the IAP technical specification. This led to an additional Capex of 10.4 mil. Euro.

For the purpose of the present evaluation, it was assumed that the pipeline section to Kosovo would be developed after the construction and operation of the gas transmission system to Fushe-Kruja and before connecting PRMS Shkodra. The table below shows the impact of this development to the transmission tariff.

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[7] It should be pointed out that for the Option B and Option C the above analysis was based on gas consumption forecasts that were not elaborated in the context of the present study and therefore no data validation was done. In addition, the development of the two pipeline sections on both sides of the border requires that all the necessary actions should be taken in coordination by the national authorities of the two countries.

Table 5-12: Gas transmission tariff tendency with Kosovo interconnection

	Transmission Tariff *(in Eur/cm)*			CAPEX *(in '000 Euro)*		
	Variant A	**Variant B**	**Variant C**	**Variant A**	**Variant B**	**Variant C**
Without Kosovo Pipeline	0.0321	0.0410	0.0205	94,780	131,709	52,082
With Kosovo Pipeline	0.0349	0.0395	0.0219	188,723	220,450	103,968

Option C: International Gas Pipeline to FYRoM[8]

The gas pipeline branch to FYRoM will cross the Albanian – FYRoM border near Qafë Thana border crossing point and it was assumed that it would be developed after the construction of the domestic gas network and the connection to Kosovo.

The table below presents the impact of the Kosovo / FYRoM gas connection to the domestic transmission tariff.

Table 5-13: Gas transmission tariff tendency with Kosovo & FYRoM interconnection

	Transmission Tariff *(in Eur/cm)*			CAPEX *(in '000 Euro)*		
	Variant A	**Variant B**	**Variant C**	**Variant A**	**Variant B**	**Variant C**
Without Kosovo & FYRoM Pipeline	0.0321	0.0410	0.0205	94,780	131,709	52,082
With Kosovo & FYRoM Pipeline	0.0373	0.0305	0.0180	215,602	262,190	133,067

5.9.5 Conclusions

Given the expected volume of transported natural gas for the reference period and the capital investment requirements, the following can be concluded:

- The presence of anchor loads during the early construction period will give the necessary gas volumes to the Project and hence will contribute to the development of a sustainable gas network.

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[8] The same as footnote No 7

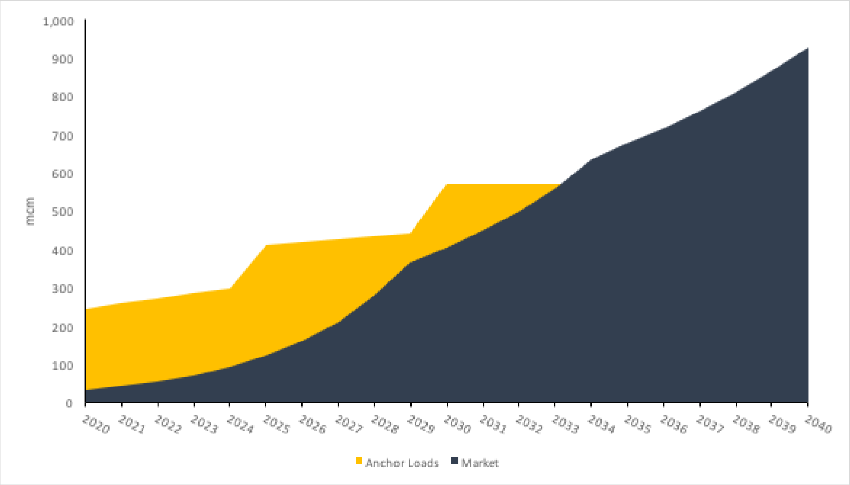

Figure 5-28 Anchor Loads vs. Market Gas Volume 2020-2040

- The uniform regulatory tariff regime (i.e. all transmission system users pays the same tariff) is actually subsidizing other tariffs for the transportation of gas and gives substantial support for the development of the gas network throughout the country.

- IAP as a private pipeline will boost the gasification of Albania, since significant lower CAPEX will be needed to develop the national transmission network resulting to a low gas transmission tariff.

- Gas transmission development toward Kosovo will allow lower transmission tariff for the LGUs connected to the transmission network under a post stamp tariff regime.

- Gas transmission development toward Kosovo and FYRoM will allow lower transmission tariff for the LGUs connected to the transmission network under a post stamp tariff regime.

Finally, the feasibility of the gas network system can be assessed by evaluating its ability to provide end users with gas at a competitive retail price compared to other forms of energy, mainly electricity and diesel. It might be difficult to compete with the price of fuel wood, the primary energy source in rural areas, due to its low price and, therefore, gas penetration to these areas might not be currently feasible.

Benchmark natural gas retail price

For the purpose of the present analysis, it can be assumed that a gas retail price at a 20%-25% discount to the electricity price for medium size industries and households would be applicable. Based on EUROSTAT data, this discount is considered among the lowest one in the observed countries (EU, Liechtenstein, FYRoM, Serbia, Turkey, Bosnia and Herzegovina and Moldova) [9]. Given that the current average electricity price for Albania is at the level of 10.7 ALL/kWh (0.08 eur/kWh)[10], a gas retail price of 0.0578 eur/kWh (0.511 eur/cm) might be feasible. This price leads to a total network cost of around 0.20 eur/cm, assuming that the gas supply price is 0.364 eur/kWh (0.322 eur/cm)[11].

Assuming that the total gas network tariff is 0.20 eur/cm and that the gas distribution tariff at 0.15 eur/cm, the development of a network covering the main LGUs tends to be feasible for Variant A and C and therefore a more detailed analysis is recommended. Regarding Variant B, the gas transmission network could be expanded up to Tirana and Durres area in the north and Fier – Ballsh and Vlore area in the south. The gasification of the area north of Tirana is related to the possibility of connecting MNE with adequate gas quantities.

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[9] Based on EUROSTAT data for 2015, the difference between gas retail price and electricity price for middle industrial and residential users varies between 20% and 70%.

[10] Based on ERE data

[11] TAP wholesale price at the border=0.0364 eur/kWh (based on WB11-ALB-ENE-01: Demand and Supply Assessment Report)

6 Gas Storage

The natural gas storage has an important impact on the insurance and securing of the natural gas supply and covering the requests of consumers. There is gas storage potential in Albania: Albpetrol develops two alternative salt formation projects in Dumre and a depleted gas field in Divjaka (SeeNews, 2010) (TAP, na). All projects are in conception status.

The salt dome of Dumre is a large diapir covering a surface area of approximately 250 km². The salt mirror is mostly at depth 2,000 m. The overburden is karstic to a large extent and consists of gypsum and anhydrite. The salt reaches down to 6,000 m. The salt volume is estimated to amount 1,400 km³. There are two options of Dumre salt dome development, as follows:

Dumre Alternative 1

Supposed to have a working capacity of 260 to 300 million cubic meters and a withdrawal rate of 1.29 mcm/day. The investment for this alternative is estimated to be EUR 68 million.

Dumre Alternative 2

Much larger than alternative 1, it may have a working capacity of 1 to 1.2 billion cubic meters and a withdrawal rate of 6 mcm/day. With an estimated investment of EUR 73 million, the alternative 2 would have the lowest cost per cubic meter. The start-up of gas storage facilities in Dumre are estimated for the end of 2019.

Divjaka

Divjaka was exploited between 1960 and 1980, it produced approx. 1.3 bcm of natural gas and is practically empty. The Divjaka field consists of 25 different reservoir layers, each 4 to 6 meters thick, in the depth interval from 2,000 to 2,600 m, with no water drive.

With estimated 60 Mmcm working gas volume, Divjaka is of a rather smaller scale. The withdrawal rate is 0.5 mcm/day. The storage could secure the supply for 120 days. With an investment of EUR 39 million (IBRC, 2010), Divjaka would have relatively high cost per cubic meter.

6.1 Consumption analysis

The total potential thermal demand in Albania, represented in natural gas consumption is described in detail in Gas Demand and Supply Assessment. According to that, total potential natural gas consumption in Albania rises from 1.5 bcm in 2020 to around 3 bcm in 2040 (Table 6-1).

Table 6-1: Total potential thermal demand represented in natural gas (mcm)

mcm	2020	2025	2030	2035	2040
Households	661	737	818	893	959
Services	234	292	361	438	520
Industry	275	351	444	555	688
TOTAL	**1,170**	**1,381**	**1,623**	**1,886**	**2,167**
Refineries	82	103	103	96	89
Power generation	270	333	416	598	770
TOTAL	**352**	**436**	**519**	**694**	**859**
TOTAL	**1,522**	**1,817**	**2,142**	**2,580**	**3,025**

The above table shows the potential, but the actual expected gas consumption is the result of the economical optimization of the development of the gas transmission and distribution network since the gas network will be realised only in the areas where it is economically feasible, and resulting gas demand will be much lower than total thermal demand represented in the above table.

As previously explained in Gas Demand and Supply Assessment, connection to the gas network may only be available to those in the areas where it is feasible to develop natural gas network, and if the final price of gas for the end users is competitive in comparison with other energy sources. Therefore, the procedure of forecasting future gas consumption is first to determine the heat and electricity market, and then to determine which part of the heat market gas can cover, and what part of the electricity generation could be gas powered.

The next step is to determine whether the investment in gas distribution networks for individual settlements/ LGU´s is cost-effective in relation to the potential natural gas consumption in the area observed. In doing so, the eligibility criteria is determined, and a big part of the settlements/ LGU´s is ejected in this first round.

Building gas distribution networks involves substantial economies of scale. A principal measure for benefiting from economies of scale is the average volume of gas demand per kilometre (km) of the distribution grid which, in turn, depends greatly on a country's (or region's) settlement density.

The second round is to determine the possible dynamics and direction of the gas transmission network development taking into account gas consumption of the large industrial consumers, power plants and refineries.

From the time when gas network is constructed in some area, in scenarios of development of the future gas consumption in the area observed, a rate of penetration of the gas to the heat market is predicted. The penetration rate is based on experience from the already gasified countries in Southeast Europe.

The final result of the economic optimization is a realistic expected natural gas consumption in Albania, which is expected to grow from 0.276 bcm in 2020 to 1.611 bcm in 2040 (Figure 6-1).

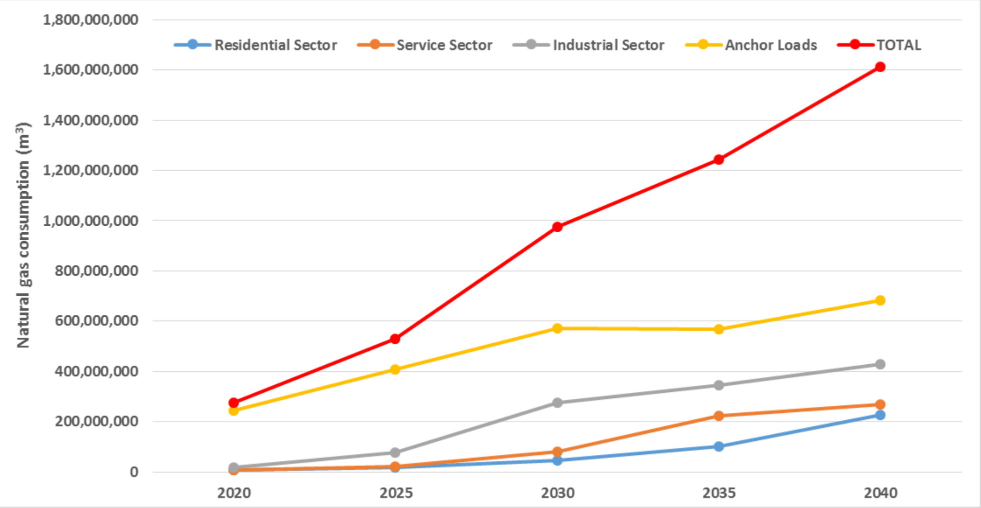

Figure 6-1 Expected natural gas consumption in Albania

6.2 Meteorological data analysis and load duration curve calculation

In order to analyse potential need for storage, optimization of required storage volume and the daily withdrawal capacity has been carried out for the average cold and coldest year in the last twenty years. Optimization is carried out assuming that the gas supply will be contracted at a level of expected annual gas consumption evenly throughout the year.

Peak daily gas demand is based on the annual gas demand forecast and the load duration curves data for households and services. Peak daily demand usually occurs in winter times in January or February.

The average and high gas demand will depend on the volume of the temperature dependent gas consumption (households and services), their temperature dependent load duration curve, average and daily temperature occurring once in 20 years, and the structure of the current and expected future gas consumption. Due to the availability of data the average year and daily consumption occurring with a statistical probability of once in 20 years of the temperature dependent gas customers is calculated from the Croatian temperature dependent gas consumers load duration curve and average year daily temperature and temperatures of year with a statistical probability of once in 20 years of the Tirana area, which is expected to be the largest market of country.

Other sectors than households and services, particularly industry, transformation, refineries and non-energy consumers have relatively constant gas consumption during the year.

Table 6-2: Total thermal demand represented in natural gas (mcm)

Consumption (10^6 m^3)	2020	2025	2030	2035	2040
Seasonal	15	43	126	327	497
Constant	261	489	848	916	1,115
Total	276	531	974	1,243	1,611

The share of constant gas consumption in the Albania is relatively high and declines from 95% share in 2020 to the level of around 69% of total Albanian gas consumption.

6.3 Storage needs

In the year of average temperature the storage needs for total thermal demand of Albania will grow from volume of 5 mcm in 2020 to 181 mcm in 2040. The required peak daily capacity will grow from 0.1 mcm/day in 2020 to 3.3 mcm/day in 2040.

Table 6-3: Storage needs in the year with average temperature (mcm)

		2020	2025	2030	2035	2040
CONSUMPTION (mcm)		**276**	**531**	**974**	**1,243**	**1,611**
	Seasonal	15	43	126	327	497
	Constant	261	489	848	916	1,115
STORAGE NEEDS	Volume (mcm)	5	16	46	119	181
	Capacity (mcm/day)	0.1	0.3	0.8	2.1	3.3

In the year of 1 in 20 temperature the storage needs for total thermal demand of Albania will grow from volume of 6 mcm in 2020 to 184 mcm in 2040. The required peak daily capacity will grow from 0.2 mcm/day in 2020 to 5.9 mcm/day in 2040.

Table 6-4: Storage needs in the year with 1 in 20 temperature (mcm)

		2020	2025	2030	2035	2040
CONSUMPTION (mcm)		**276**	**531**	**974**	**1,243**	**1,611**
	Seasonal	15	43	126	327	497
	Constant	261	489	848	916	1,115
STORAGE NEEDS	Volume (mcm)	6	16	47	121	184
	Capacity (mcm/day)	0.2	0.5	1.5	3.9	5.9

Dumrea 1 is a storage option with sufficient volume but without enough withdrawal capacity. Dumrea 2 storage option is of too big volume, but have sufficient withdrawal capacity for the gas consumption storage needs.

Albania can developed its own storage or rent storage capacity in Croatia when IAP pipeline is developed and if it will be supplied from gas from Croatia.

When TAP is in operation, primarily Italy but also Greece could provide similar storage services to the Albanian market, by the use of the flexibility tools existing in the corresponding networks.

6.4 Load management recommendations

A screening of different peak shaving and seasonal storage measures has been carried out. Albania can develop its own storage or rent storage capacity in neighbouring countries, as explained above.

One of the solutions for peak shaving is a propane-air system in larger consumption centres. Propane-air, also called LPG-Air or SNG, is essentially synthetic natural gas that is formed by mixing vaporized propane or LPG with air. Once mixed it forms a homogeneous mixture that can be used as a direct replacement for natural gas in combustion applications. A typical propane-air peak shaving plant consists of LPG storage facilities, truck unloading station, transfer pumps, propane vaporizers, air compressors, propane-air mixer, gas flow rate and calorific value measurement device, and system controls.

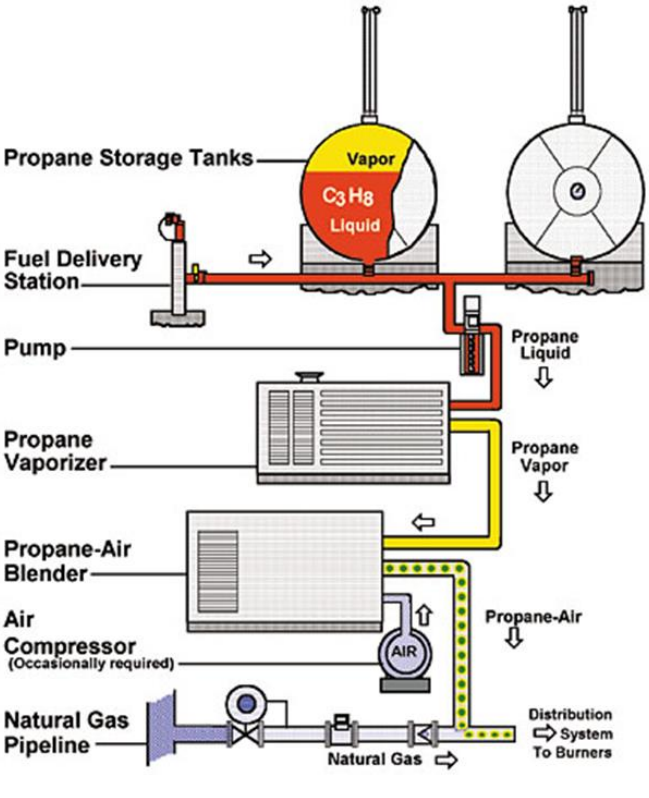

Figure 6-2 Propane-air peak shaving plant schematics

Any kind of LPG gas network infrastructure that potentially could be integrated into the new natural infrastructure does not exist in Albania. At this point of the study development it is not known in which cities the gas distribution system will be developed, and what will be actual gas demand, so any recommendations related to the facilities sizes or investment are not possible.

It can be expected that natural gas will at the first instance replace LPG as most expensive heating fuel in the areas where gas distribution network is developed, followed by other fossil fuels. The related LPG tanks/storages in industry and bigger services could be used as the dual fuel capability and it will often be a simplest solution for peak shaving. Also, solutions like CNG and/or small scale LNG storage facilities could be considered for peak-shaving, depending on the economic feasibility of the available options, on a case-by-case basis.

Use of dual fuel capability for boiler houses in industry and larger services will often be the simplest solution for peak shaving. One of the barrier in the use of dual fuel is the difference in prices. Hence, the use of interruptible consumers' needs to be regulated on a contractual level to clarify the obligations of the gas company. In order to fully utilise the dual fuel capability it is recommended that the gas company be responsible for delivery of second fuel to the boiler houses and that the prices for oil delivered should be the same as the price for gas delivered. This would naturally mean an increase in the average gas price or the introduction of increased prices during the winter to meet this extra cost. Gas company shall have to decide when and where to initiate the change to alternative fuels.

Line packing of IAP and related Albanian transmission system until the pipeline reach full potential in the later stages of the project utilisation would be from the investment point of view the cheapest solution (the price of balancing gas is another issue). It might be a solution for the fast daily peak shaving. It would mean that Transmission Company can use the internal storage of the pipeline by reducing the pipeline pressure from working 50/80 bar to a minimal level. To control the line packing a SCADA system needs to be implemented.

LNG can be used for peak shaving, either based on import of LNG or based on local LNG storage where gas is condensed during the summer period. Eagle LNG can be potential storage site.

The use of a tariff structure with high incentives to use gas during periods with low consumption and high prices respectively during peak periods will normally be the least cost solution for reducing peak loads. For individual consumers, a higher tariff during winter would encourage energy savings, either as reduced temperature or comfort or by investing in insulation and new windows.

6.5 Conclusions

Peak daily gas demand is based on the annual gas demand/temperature history of Croatia (load duration curve), the temperature data of three distinctive areas of Albania and forecast of gas demand for Albania.

In the year of average temperature the storage needs for total thermal demand of Albania will grow from volume of 5 mcm in 2020 to 181 mcm in 2040. The required peak daily capacity will grow from 0.1 mcm/day in 2020 to 3.3 mcm/day in 2040.

In the year of 1 in 20 temperature the storage needs for total thermal demand of Albania will grow from volume of 6 mcm in 2020 to 184 mcm in 2040. The required peak daily capacity will grow from 0.2 mcm/day in 2020 to 5.9 mcm/day in 2040.

Due to the fact that the Albania gas market will be relatively small, and that the peak shaving needs will be relatively small amounting 184 mil.m3, which is just a fraction of the expected transmission volumes of IAP for the third countries, the virtual storage sub-lease option[12] should be implemented. This option together with

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[12] Virtual storage sub-lease option would mean that the local supplier should create sub-lease storage agreement with suppliers using existing storages in Croatia and Austria or future storages in Albania, and take required volume from IAP pipeline flows. The price of that gas will be a gas market price enhanced for the expected storage costs. The suppliers benefit in that deal is the fact that the gas is sold at the market price increased by the storage fee, but realized without the actual storage use and transportation cost toward and of the storage facility

other load management options that does not require any investment (dual fuel, tariff incentives, line pack and similar) would represent most feasible and recommended load management option for Albania. In case that there is sufficient interest from the other countries, then large underground gas storage option could be developed.

7 Concluding Remarks and Recommendations

Demographic characteristics of Albania settlements are very unfavourable for the development of gas distribution networks. Albania have a relatively large number of settlements (approx. 3,000) with a relatively small number of inhabitants per settlement.

The potential natural gas consumption by sector was forecasted as follow:

- Forecasted total useful thermal energy demand in households, services and industry of Albania that can be replaced by natural gas is distributed by prefectures and then by LGU´s of Albania as future potential natural gas consumption (about 2,167 mcm in 2040, including agriculture and transport sector);

- Future potential natural gas consumption for electricity generation could be around 770 mcm in 2040, and forecasted natural gas consumption in refineries in 2040 could be around 89 mcm.

A realistic potential area to develop the gas distribution network include 85 LGUs with gas consumption corresponds to 77% of the total Albania for the year 2020 and the 82% for the year 2040. To find out how much of the total potential gas demand in the 85 LGUs could be distributed economically, a technical and a financial analysis was carried out. The evaluation process focus to the calculation and assessment of the Full Cost Recovery Tariff (i.e. the tariff which covers the capital expenditure and the operating expenses). The analysis revealed that the lower FCRT were observed in Fier, Pogradec, Tirana, Shijak, Durres, Elbasan and Fushe-Kruja (FCRT below 0.10 Euro/m^3). Finally, by applying the principle that consumption centres with adequate gas consumption can support less attractive areas, the potential gas distribution areas were defined.

7.1 Gas distribution system

From the gas distribution analysis, the main points concluded were the following:

- The area of Fier – Vlora and Ballsh represents a significant gas consumption triangle in which most of the anchor gas consumers are located.

- The area of Tirana and Durres represents the main gas area in Albania with significant gas consumption. The contribution of each sector to the total gas consumption counts for 32%, the industrial sector being the largest with 37% Therefore, it is recommended this area to be considered as one gas distribution centre.

- The gas connection rates affect remarkably the expected expansion rate and the economics of the distribution network and it can easily jeopardize the viability of the investment. Therefore, it is necessary, in parallel with the network development, to introduce financial supporting schemes in order to facilitate the end consumers to switch to gas. It is recommended these schemes to be accompanied by regulatory policies and administrative enforcement actions.

- Due to Albania demographic characteristics (large number of LGUs with low population density), the total gas volume is not significantly affected by increasing the distribution tariff. A 10% tariff increase led to a marginal increase of gas consumption (around 2.5%) due to the small size of the additional LGUs, except for cases where a consumption centres with adequate gas consumption became eligible. However, the CAPEX size is affected more by adding areas which become feasible in a tariff increase. A 10% tariff increase led to an equal increase of the capital investment requirements.

7.2 Gas transmission system

The proposed gas transmission network, as it is presented in Figure 7-1 can be in divided in five main branches:

- The **North branch**, starting from connection point with TAP (near Fier) and going towards Shkodra and the MNE border crossing point,
- The **Elbasan branch**, starting from connection point with TAP (near Fier) and going to Elbasan through Lushnja and Dumrea,
- The **South branch**, serving the areas of Fier, Vlora, Ballsh, Tepelena and Gjirokastra,
- The **West branch**, connecting the areas of Korça, Pogradec, Prrenjas and FYRoM,
- The **Kosovo branch**, starting from Milot and ending at the Albanian – Kosovo border point near Kukes.

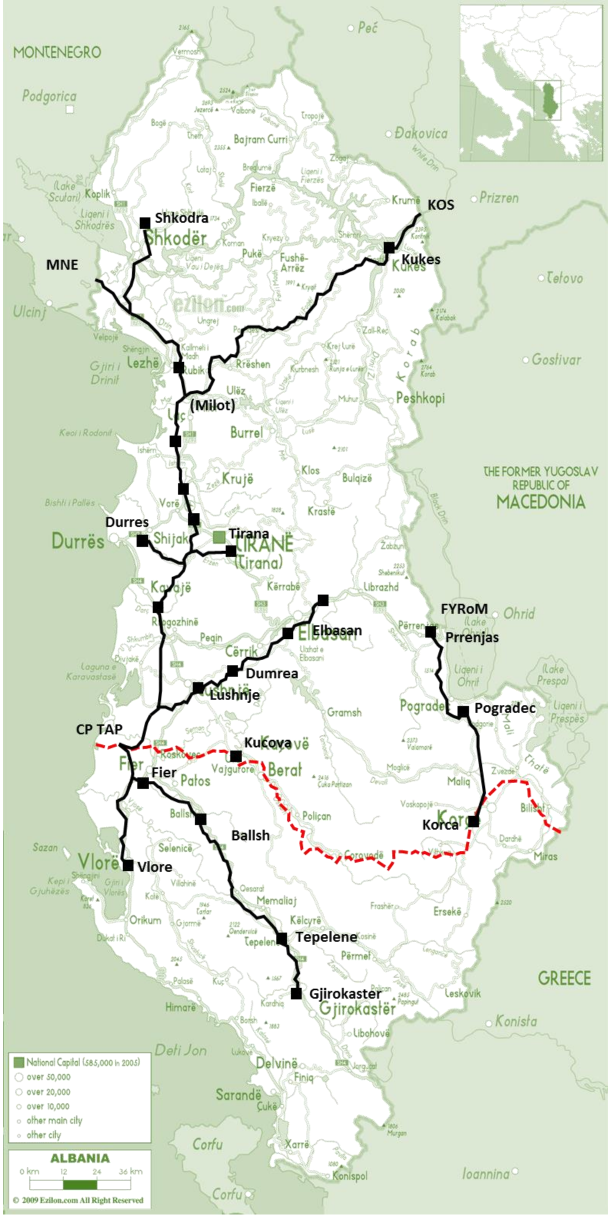


Figure 7-1: Proposed gas transmission network

The CAPEX for each section was calculated for the following four scenarios:

Scenario 1, which considered the construction of IAP with its determined diameter plus the gas transmission pipelines to Kosovo and FYRoM.

Scenario 2, which considered the construction of IAP with its determined diameter

Scenario 3, which considered the construction of a national gas network plus the gas transmission pipelines to Kosovo and FYRoM.

Scenario 4, which considered the construction of a national gas network.

Based on above scenarios, the financial analysis evaluated three development options:

(a) The Albanian Gas Transmission System,

(b) International Pipeline to Kosovo and

(c) International Pipeline to Kosovo and FYRoM.

In order to identify the impact of IAP to the development of the national gas network, three variants were further analysed. **Variant A (without IAP)**, which assumes that the common pipeline sections with IAP would be designed based on domestic gas demand, **Variant B (with IAP technical specs)**, which assumes that the common pipeline sections with IAP would follow IAP's technical requirements and **Variant C (with IAP)**, which assumes that IAP exists.

Assuming that a post stamp regulatory tariff regime is applied, the range of the transmission tariff resulting from the gradual development of the Albanian gas transmission network is the following;

Table 7-1: Range of the transmission tariff for Albanian gas network (in eur/cm)

	Variant A	Variant B	Variant C
From:	0.0148	0.0148	0.0148
To:	0.0423	0.0597	0.0267

From the analysis, the main points concluded were the following:

- The presence of anchor loads provided the Project with the necessary gas volumes during the early period and hence contributed to the development of a feasible and sustainable gas development throughout the country.
- The post stamp regulatory regime tariff where all transmission system users pays the same tariff is actually subsidizing other tariffs for the transportation of gas in the country and gives substantial support for the development of the gas network throughout the country.
- IAP as a private pipeline will boost the gasification of Albania, since significant lower CAPEX will be needed resulting in low gas transmission tariff.
- Assuming that the total gas network tariff is 0.20 eur/cm and that the gas distribution tariff at 0.15 eur/cm, the development of a network covering the main LGUs tends to be feasible for Variant A and C and therefore a more detailed analysis is recommended. Regarding Variant B, the gas transmission network could be expanded up to Tirana and Durres area in the north and Fier – Ballsh and Vlore area in the south. The gasification of the area north of Tirana is related to the possibility of connecting MNE with adequate gas quantities.

7.3 Gas storage

The natural gas storage has an important impact on the insurance and securing of the natural gas supply and covering the requests of the consumers. The salt dome of Dumrea is a large diaper covering a surface area of approximately 250 km². There are two options of Dumrea salt dome development; Dumrea Alternative 1 and 2.

- Dumrea 1 is a storage option with sufficient volume but without enough withdrawal capacity.

- Dumrea 2 storage option is of too big volume, but have sufficient withdrawal capacity for the gas consumption storage needs.

Since the Albanian gas market will be relatively small, and that the peak shaving needs will be relatively small (amounting 184 mcm, which is just a fraction of the expected transmission volumes of IAP for the third countries) the virtual storage sub-lease option should be implemented. This option together with other load management options that does not require any investment (dual fuel, tariff incentives, line pack and similar) would represent the most feasible and recommended load management option for Albania. In case that there is sufficient interest from the other countries, then the large underground gas storage option could be developed.

8 Potential Future Energy Mix in Albania

The present and future Energy Mix for Albania has been evaluated with reference to the implementation schedule, assuming full implementation, of the Gas Master Plan for Albania and is presented below.

8.1 Existing Base Line data

The foundation for a reasonable evaluation of the potential future Energy Mix in Albania is the existing energy mix in past years.

This information was collected from different sources such as AKBN and IEA. Albania Energy Balance for 2013 is found in the recently approved NREAP (National Renewable Energy Action Plan) for Albania and was provided by AKBN, while data from IEA is found on the web-site www.iea.org.

Table 8-1 Total Final Energy Consumption (TFEC) in Albania by 2013, ktoe

	solid fuels	oil products	natural gas	geothermal, solar etc.	biomass	electricity		derived heat	TOTAL
						hydro	imported		
Total final	**93**	**1,200**	**8**	**12**	**193**	**253**	**308**	**5**	**2,071**
Households	**1**	**79**	**0**	**5**	**160**	**136**	**165**	**0**	**546**
Service etc.	**5**	**36**	**0**	**6**	**11**	**53**	**65**	**0**	**176**
Industry	**87**	**183**	**8**	**0**	**10**	**57**	**69**	**5**	**419**
Transport	**0**	**816**	**0**	**0**	**0**	**0**	**0**	**0**	**816**
Agriculture	**0**	**86**	**0**	**0**	**12**	**7**	**9**	**0**	**114**

Source: NREAP, May 2015 (AKBN 2013 energy balance)

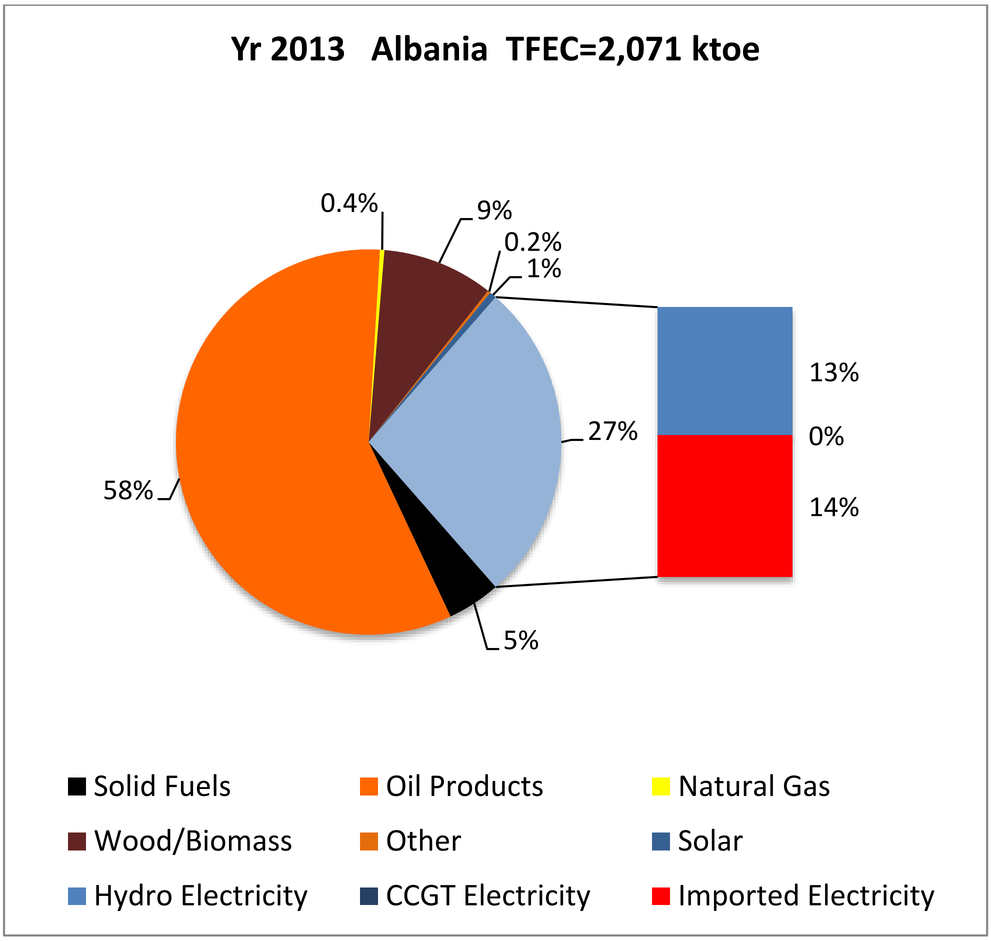


Figure 8-1: TFEC 2013. Source: AKBN

The primary energy supply, also presented in the NREAP for 2013, is indicated in below Table 8-2.

Table 8-2 Total Primary Energy Supply in Albania by 2013, ktoe

	solid fuels	oil products	natural gas	geothermal, solar etc.	biomass	electricity	derived heat	TOTAL
TOTAL Final	**92.6**	**1,339.1**	**27.60**	**12.1**	**193.2**	**670.1**	**5.1**	**2,339.8**
Primary production	**0**	**1,368.2**	**27.60**	**12.1**	**202**	**406.3**	**5.1**	**2,021.4**
Recovered products	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Imports	**92.8**	**1,515.2**	**0**	**0**	**10.4**	**279.5**	**0**	**1,898**
Stock change	**0**	**307.5**	**0**	**0**	**0**	**0**	**0**	**307.5**
Exports	**0.3**	**1,209.8**	**0**	**0**	**19.2**	**15.8**	**0**	**1,245**
Bunkers	**0**	**27**	**0**	**0**	**0**	**0**	**0**	**27**

Source: NREAP, May 2015 (AKBN 2013 energy balance)

For the preparation of the energy mix baseline, the Primary Energy values of the above table were proportionally distributed across sectors according to Final Energy Consumption, supplied in the same report, and with the assumed transmission & distribution efficiencies of respective fuel types.

The following assumptions were made regarding fuel transportation & distribution efficiencies:

Table 8-3 Assumed Efficiencies for Transport & Distribution of fuels in 2013

	solid fuels	oil products	natural gas	geothermal, solar etc.	biomass	electricity	derived heat
Efficiency	100%	100%	100%	100%	100%	65%	100%

As a result of above efficiency assumptions, and considering on Total Final Consumed Energy as the most reliable information (as confirmed by both NREAP and IEA), the below Total Primary Energy Supply by sectors (Table 8-4) was obtained:

Table 8-4 Total Primary Energy Supply (TPES) by sector in Albania by 2013, ktoe

	solid fuels	oil products	natural gas	geothermal, solar etc.	biomass	electricity		derived heat	TOTAL
						hydro	imported		
Total final	93	1,200	8	12	193	389	474	5	2,373
Households	1	79	0	5	160	209	254	0	708
Service etc.	5	36	0	6	11	82	100	0	240
Industry	87	183	8	0	10	87	107	5	487
Transport	0	816	0	0	0	0	0	0	816
Agriculture	0	86	0	0	12	11	13	0	122

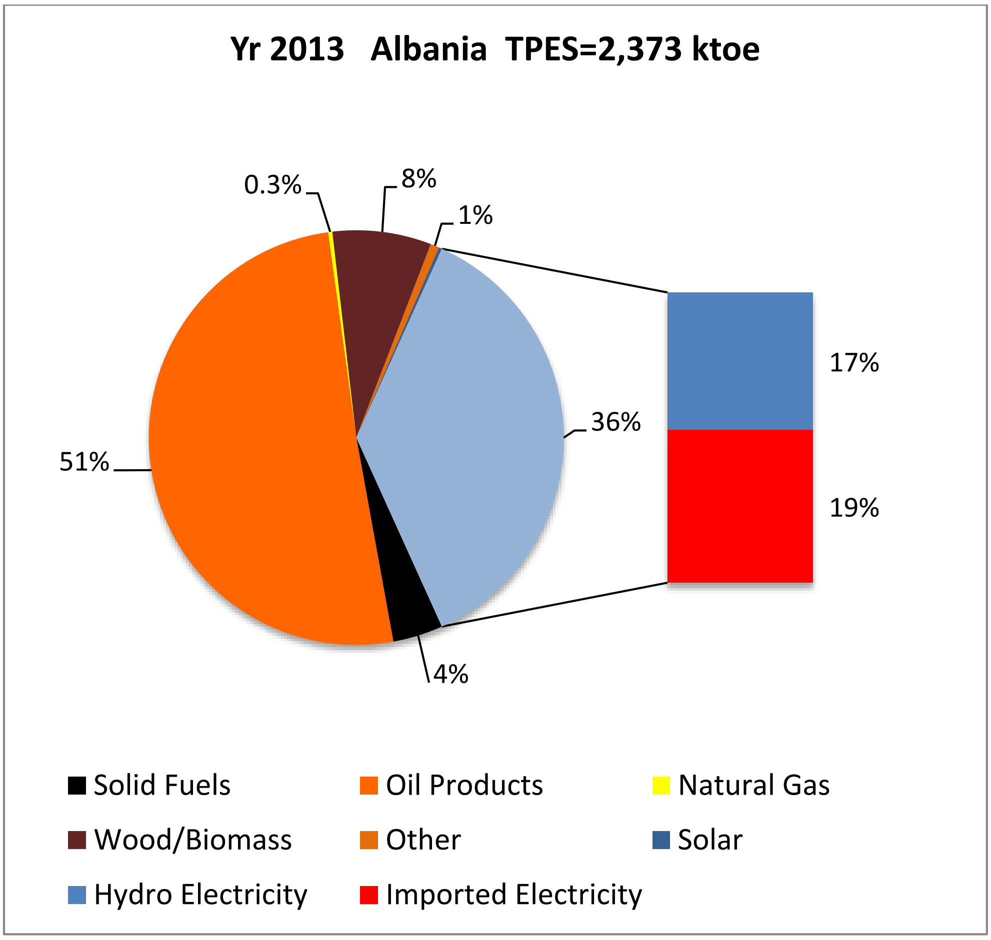


Figure 8-2: Total Final Energy Supply in Albania, 2013. Source: AKBN

8.2 Forecasted Base Line data 2020 to 2040

8.2.1 Base Line data for Energy Consumption

The Albanian Base Line Energy Consumption for 2020 - 2040 is forecasted using the energy model from the Demand and Supply Assessment Report.

Further to the above mentioned energy model, the electric energy was split to hydro, TPP and imported electricity. The consultant used the hydro electricity generation forecast from the energy strategy project, in preparation by USAID, which in combination with transmission and distribution efficiency allowed the calculation of hydro electricity consumption.

Assumptions

It was assumed that the transmission and distribution efficiency of the electric network in Albania will be improved gradually from 2013 to 2040 according to the following Table 8-5:

Table 8-5 Albania Electricity Transmission & Distribution Efficiency, 2020 - 2040

	2013	2020	2025	2030	2035	2040
Efficiency	**65%**	**77%**	**85%**	**87%**	**88%**	**88%**

It was also assumed that the existing Vlora TPP will be working and will run on Diesel during the whole period.

The following Table 8-6 and Table 8-7 summarise the Total Final Energy Consumption in Albania, from 2020 to 2040, by sector and by fuel type.

Table 8-6 Total Final Energy Consumption in Albania by sector, 2020 - 2040, ktoe

	2013	2020	2025	2030	2035	2040
Households	546	649	721	773	827	880
Services	176	231	275	311	359	398
Industry	411	555	661	856	947	1,033
Transport	816	1,081	1,326	1,654	1,859	1,913
Agriculture	114	136	164	207	252	290
Construction and mining	8	22	39	69	114	185
Total	**2,071**	**2,675**	**3,185**	**3,870**	**4,358**	**4,699**

Table 8-7 Total Final Energy Consumption (TFEC) in Albania by fuel type, 2020 - 2040, ktoe

	2013	2020	2025	2030	2035	2040
Solid fuels	93	93	93	93	93	93
Oil products	1,200	1,580	1,971	2,519	2,848	3,042
Natural gas	8	10	12	14	16	18
Geothermal, solar etc.	12	27	41	57	76	99
Biomass	193	232	256	277	306	296
Hydro electricity	253	470	649	711	775	832
Vlora TPP	0	27	21	27	28	28
Imported electricity	308	231	136	165	208	280
Derived heat	5	6	6	7	8	12
Total	**2,071**	**2,675**	**3,185**	**3,870**	**4,358**	**4,699**

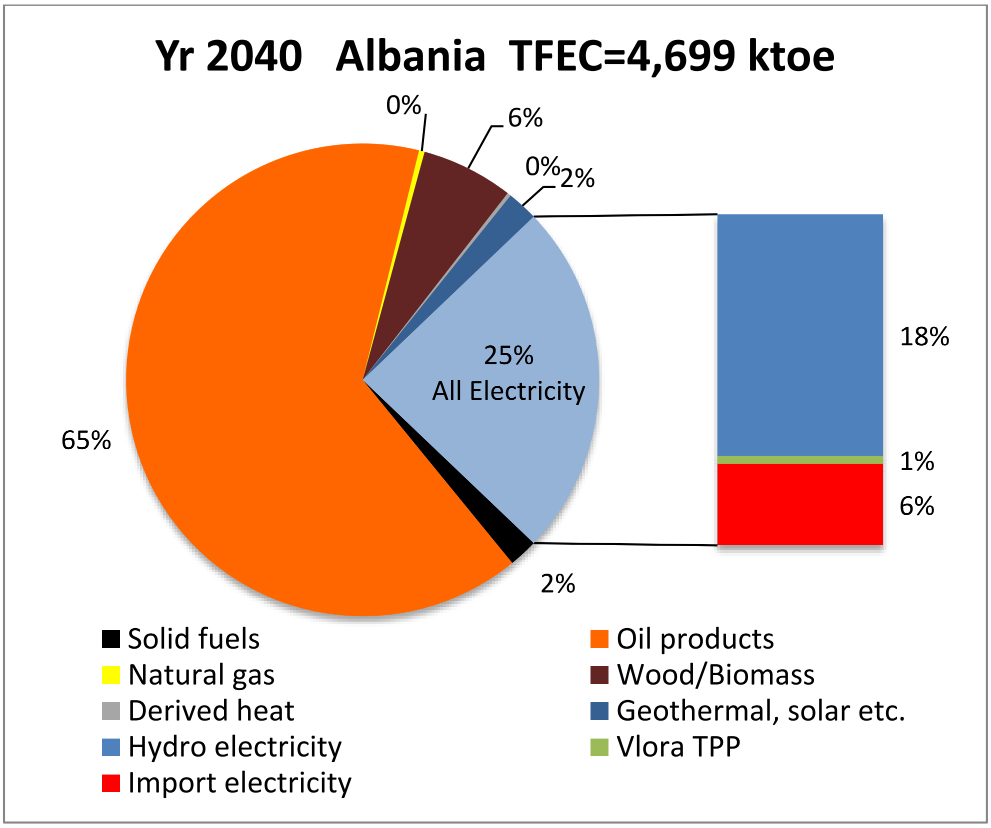


Figure 8-3: Total Final Energy Consumption by fuel type Supply in Albania, 2040.

For TFEC pie-charts, 2020 and 2030, please refer to Annex 12

8.2.2 Base Line data for Energy Supply

The Albanian Base Line Energy Supply for 2020 - 2040 is forecasted using the energy model from the Demand and Supply Assessment Report, while combining it with the hydro electricity generation forecast from the energy strategy project (in preparation by USAID).

Assumptions

It was assumed that the efficiency of the diesel power plant in Vlora is 40%.

Table 8-8 Total Primary Energy Supply (TPES) by sector in Albania, 2020 – 2040, ktoe

	2013	2020	2025	2030	2035	2040
Households	708	776	803	852	902	956
Services	240	297	323	363	411	452
Industry	475	627	706	907	1,003	1,097
Transport	816	1,081	1,327	1,657	1,864	1,922
Agriculture	122	143	169	212	257	295
Construction and mining	12	26	43	73	119	192
Total	**2,373**	**2,950**	**3,370**	**4,064**	**4,555**	**4,914**

Table 8-9 Total Primary Energy Supply (TPES) by fuel type in Albania, 2020 - 2040, ktoe

	2013	2020	2025	2030	2035	2040
Solid fuels	93	93	93	93	92	93
Oil products	1,200	1,667	2,034	2,597	2,927	3,120
Natural gas	8	10	12	14	16	18
Wood/Biomass	193	232	256	277	306	296
Derived heat	5	12	12	14	15	18
Geothermal, solar etc.	12	27	41	57	76	99
Hydro electricity	389	610	764	822	885	950
Import electricity	474	299	159	190	237	320
Total	**2,373**	**2,950**	**3,370**	**4,064**	**4,555**	**4,914**

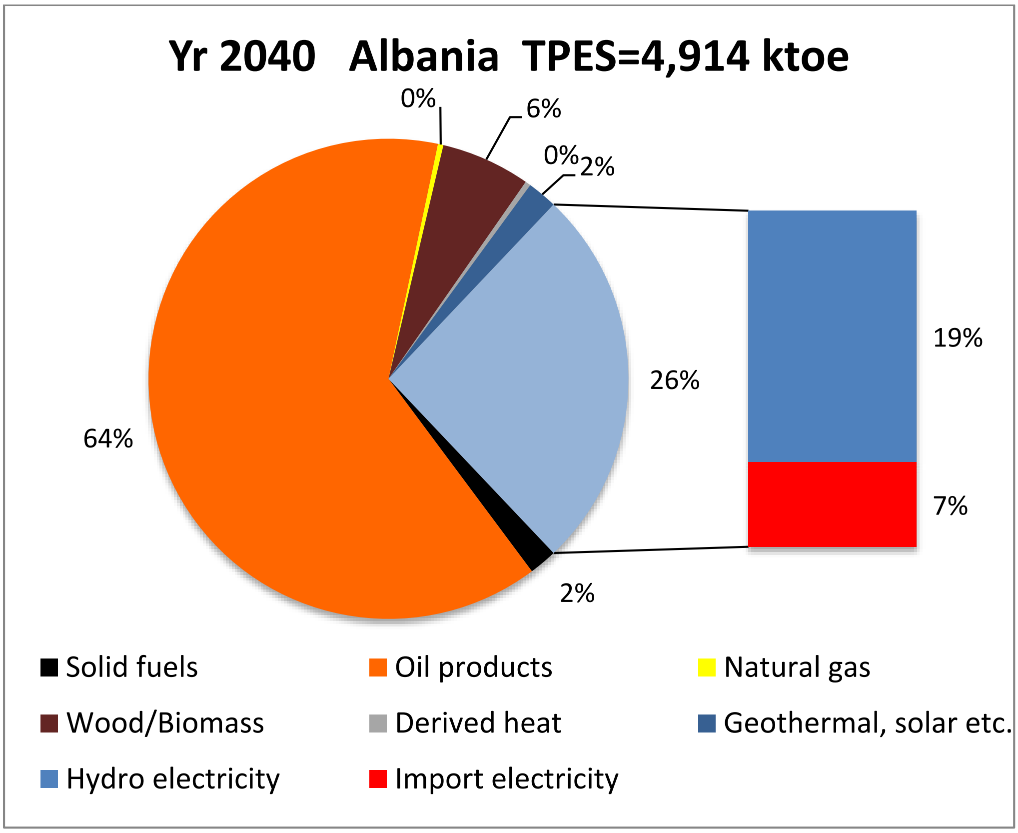


Figure 8-4: Total Primary Energy Supply by fuel type in Albania in 2040

For all TPES pie-charts, 2020 to 2040, please refer to Annex 13

8.3 Natural Gas scenario

8.3.1 Natural gas scenario for Energy Consumption

Implementation of the full GMP for Albania will, as described in chapter 3.4 and further in Table 4-10, lead to a potential gas consumption in Albania by 2040 of total 927 mcm in the residential, service and industrial sectors and 684 mcm for anchor consumers. The gas consumption is presented in below Table 8-10.

Table 8-10 Potential Natural Gas Consumption by 2040

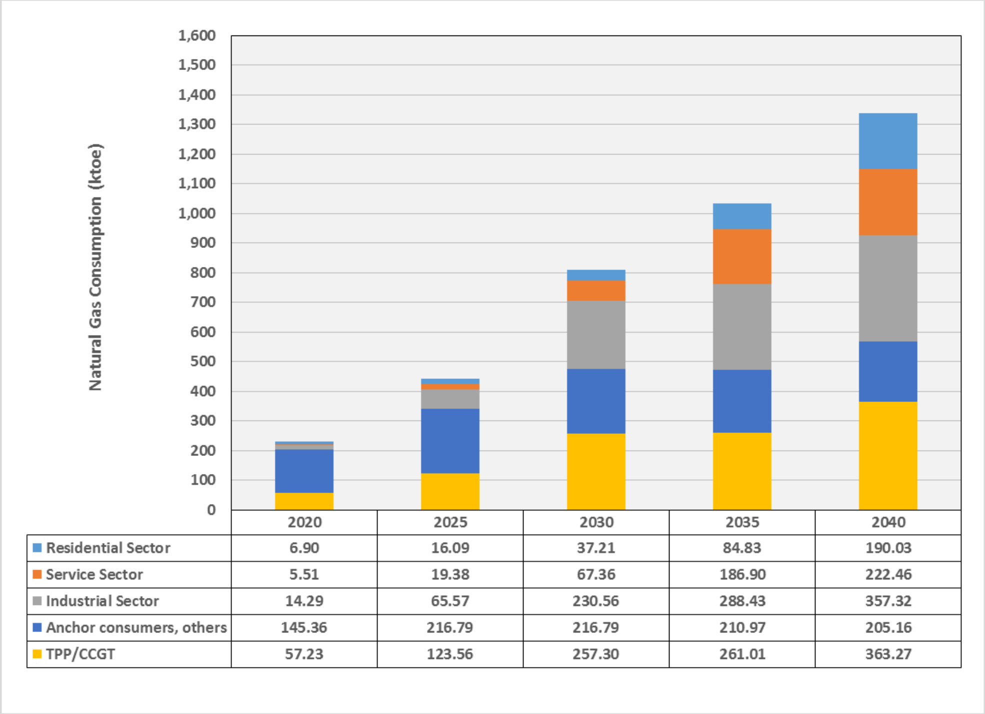
	mcm	**ktoe**
Residential sector	228.8	190.0
Service sector	267.8	222.5
Industrial sector incl. agriculture and transport	430.2	357.3
Total for sectors	**926.8**	**769.8**
Anchor consumers	684.4	568.4
Total	**1,611.2**	**1,338.2**

When talking about “consumption” it is important to split energy sources in 2 categories:

- Energy used to generate other energy sources, i.e. natural gas used to generate electricity;
- Energy used in processes;

For the anchor consumers this will apply for the power plants (new and existing) forecasted in the GMP. Hence, for the total consumption by anchor consumers this split is:

- Natural gas used to generate electricity, 437.4 mcm (363.3 ktoe)
- Natural gas used in process industry, 247.0 mcm (205.2 ktoe)



	2020	2025	2030	2035	2040
■ Residential Sector	6.90	16.09	37.21	84.83	190.03
■ Service Sector	5.51	19.38	67.36	186.90	222.46
■ Industrial Sector	14.29	65.57	230.56	288.43	357.32
■ Anchor consumers, others	145.36	216.79	216.79	210.97	205.16
■ TPP/CCGT	57.23	123.56	257.30	261.01	363.27

Figure 8-5: Potential Natural Gas Consumption according to the GMP

Below Table 8-11 and Table 8-12 present the total final energy consumption by sector and fuel type in Albania for the natural gas scenario.

Table 8-11 Total Final Energy Consumption (TFEC) in Albania by sector, 2020 -2040, Natural gas scenario, ktoe

	2013	2020	2025	2030	2035	2040
Households	546	649	721	773	827	881
Services	176	231	275	316	374	415
Industry	411	546	635	793	882	964
Transport	816	1,081	1,326	1,654	1,860	1,914
Agriculture	114	136	164	207	251	288
Construction and mining	8	22	39	69	114	185
Total	**2,071**	**2,666**	**3,160**	**3,812**	**4,307**	**4,647**

Table 8-12 Total Final Energy Consumption (TFEC) in Albania by fuel type, 2020 -2040, Natural gas scenario, ktoe

	2013	2020	2025	2030	2035	2040
Solid fuels	93	93	79	41	34	30
Oil products	1,200	1,424	1,697	2,054	2,302	2,393
Natural gas	8	184	333	572	796	1,004
Wood, biomass.	193	232	256	272	291	255
Other	5	6	6	7	8	12
Solar	12	27	41	57	76	99
Hydro electricity	266	479	654	673	660	661
CCGT	0	27	64	135	139	193
Imported electricity	295	194	29	0	0	0
Total	**2,071**	**2,666**	**3,160**	**3,812**	**4,307**	**4,647**

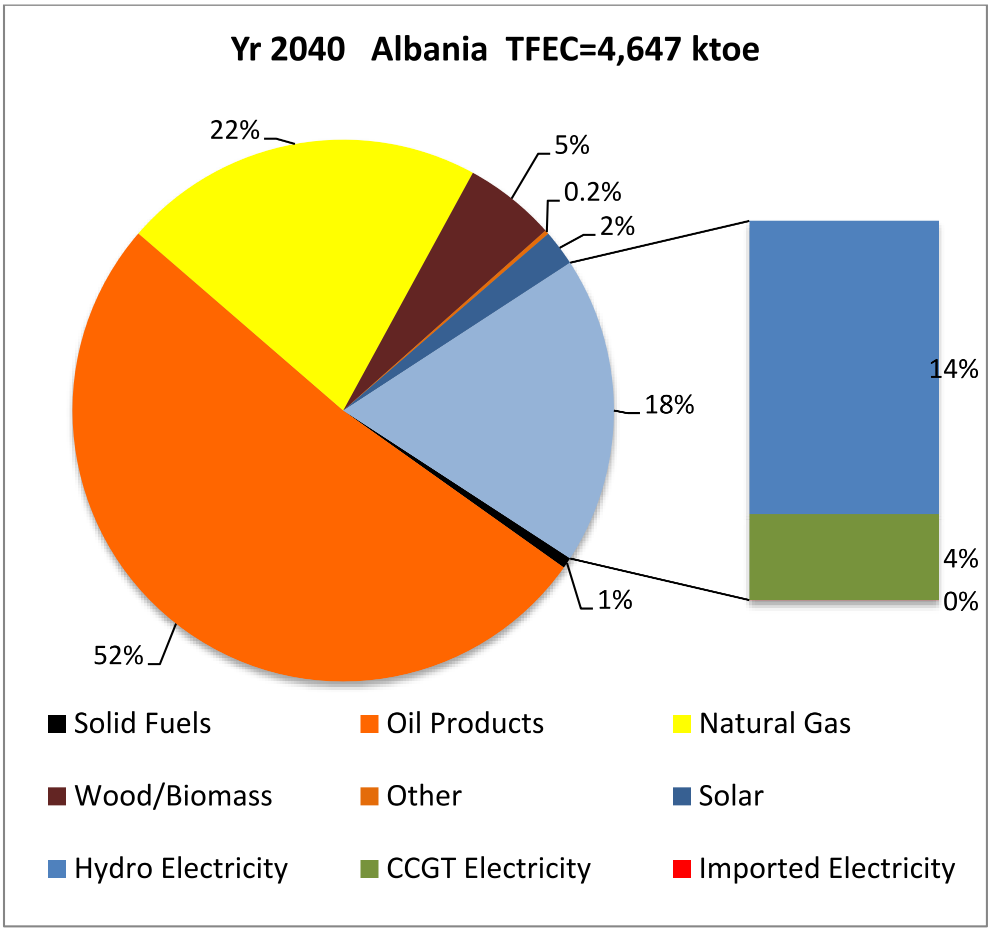


Figure 8-6: Total Final Energy Consumption in Albania, Natural gas scenario, 2040

For TFEC pie-charts, 2020 and 2030 Natural gas scenario, please refer to Annex 14

8.3.2 Natural gas scenario for Energy Supply

Calculation of total energy supply was done with the assumptions that Natural Gas will primarily replace 100% of the imported electricity, the remaining natural gas energy will replace 20% of wood energy and the rest will replace oil products. In the case of heavy industry and anchor loads, such as refineries, it is assumed that natural gas energy will primarily replace oil products.

Furthermore, assumptions were made for the efficiency of CCGT plants in generating electric energy: this efficiency was assumed to be 60%, which is the high end of such power plants in our days.

Based on the above, below Table 8-13 and Table 8-14 present the Total Final Energy Supply by sector and fuel type in Albania for the natural gas scenario.

Table 8-13 Total Primary Energy Supply (TPES) in Albania by sector, 2020 -2040, Natural gas scenario, ktoe

	2013	2020	2025	2030	2035	2040
Households	708	760	805	871	916	978
Services	233	278	307	352	392	467
Industry	475	641	717	889	958	1,055
Transport	816	1,081	1,327	1,658	1,866	1,927
Agriculture	122	142	169	213	257	295
Construction and mining	12	26	43	74	120	195
Total	**2,367**	**2,928**	**3,369**	**4,057**	**4,509**	**4,917**

Table 8-14 Total Primary Energy Supply (TPES) in Albania by fuel type, 2020 -2040, Natural gas scenario, ktoe

	2013	2020	2025	2030	2035	2040
Solid fuels	93	93	79	41	34	30
Oil products	1,200	1,424	1,697	2,054	2,302	2,393
Natural gas incl. CCGT	8	242	458	833	1,060	1,371
Wood, biomass.	182	255	281	290	287	257
Other	16	18	19	18	18	12
Solar	6	22	31	43	55	99
Hydro electricity	409	623	769	778	754	755
Imported electricity	454	252	34	0	0	0
Total	**2,367**	**2,928**	**3,369**	**4,057**	**4,509**	**4,917**

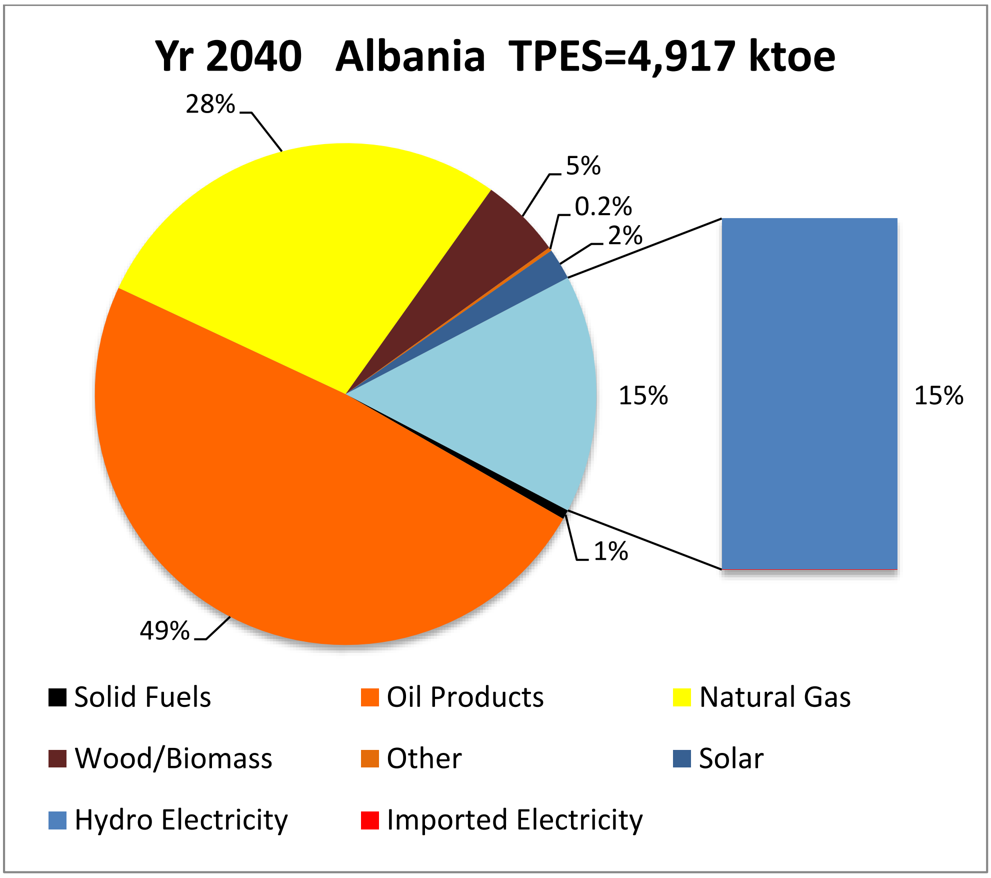


Figure 8-7: Total Final Energy Consumption in Albania, Natural gas scenario, 2040

For TPEC pie-charts, 2020 and 2030 Natural gas scenario, please refer to Annex 15.

For TPES by sector and fuel type for the natural gas scenario, please refer to Annex 16.

8.4 Conclusions on the Albanian Energy Mix

From the data above it can be verified that implementing the Albanian GMP will increase the natural gas component in the Albanian TPES from 0.4% to 28%% in 2040 compared to the Base Line, or expressed in energy from 18 ktoe (210 GWh) in 2013 to 1,371 ktoe (15,950 GWh) in 2040.

Additionally it can be noticed that, starting from 2030, electricity imports are not needed anymore if the planned 3 gas fired CCGT´s (included in the GMP) are implemented, and Albania will have excess capacity for exporting electricity.

9 Gas Infrastructure Project Identification Plan (PIP)

Based on the analyses carried out following development plan and schedule can be recommended, ranked by priority.

Short Term

1. Development of the transmission pipeline from TAP to TPP Vlore. If feasible development of a gas distribution system in Vlore;

2. Development of the transmission system to supply anchor consumers in Fier and Ballsh and if feasible development of gas distribution systems in Fier and Ballsh;

Medium Term

3. Development of the transmission system to supply mainly industrial areas in Elbasan as well as development of gas storage facilities in Dumrea (if feasible);

4. Development of the transmission system to supply mainly industrial / commercial consumers in Durres and Tirana area;

Long Term

5. Development of the transmission system for the interconnector to Kosovo;

6. Development of the transmission system near Korça, to supply the planned CCGT in Korça, and further to Pogradec;

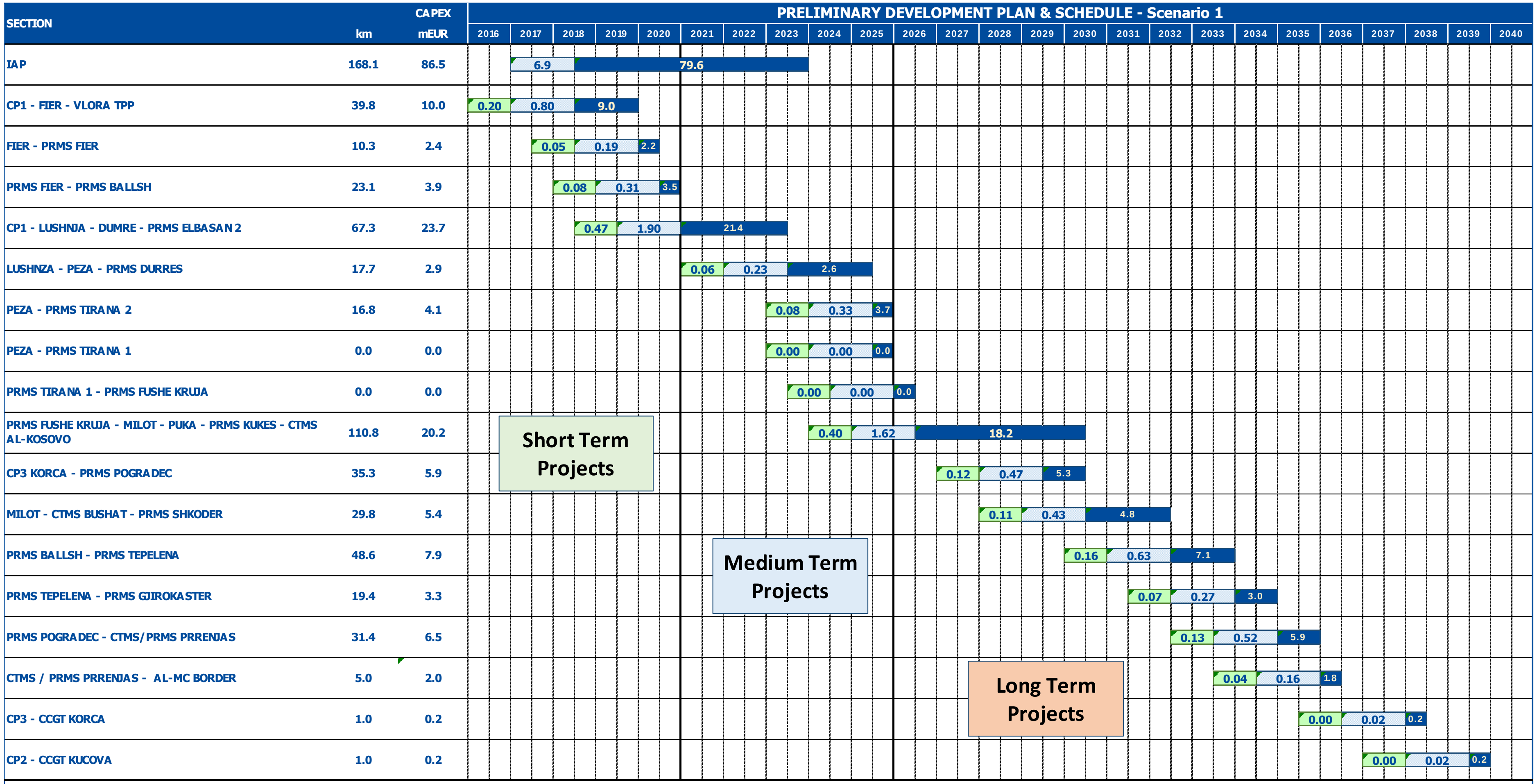
7. Development of the transmission system to Shkodra;

8. Development of the transmission system from Ballsh to Tepelena and Gjirokastra;

9. Development of the transmission system from Pogradec to Prrenjas and further to FYRoM;

10. Development of the transmission system for the planned CCGT in Kuçova;

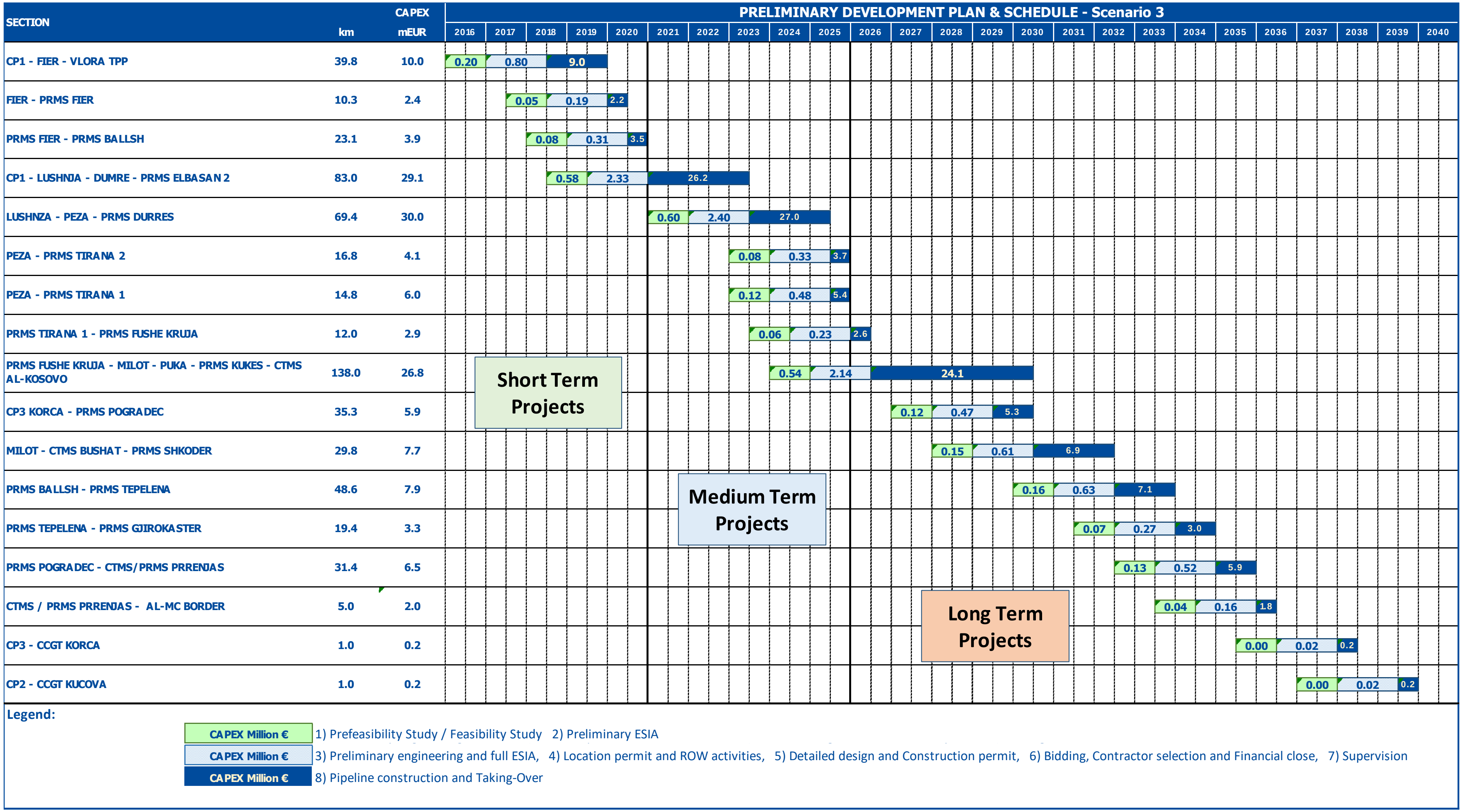
The suggested preliminary development plan & schedule is presented below for Option 1- Variant C (with IAP implemented by third party) and Option 1-Variant A or B (IAP implemented by Albania).



SECTION	km	CAPEX mEUR	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
			PRELIMINARY DEVELOPMENT PLAN & SCHEDULE - Scenario 1																								
IAP	168.1	86.5		6.9	79.6																						
CP1 - FIER - VLORA TPP	39.8	10.0	0.20	0.80	9.0																						
FIER - PRMS FIER	10.3	2.4		0.05	0.19		2.2																				
PRMS FIER - PRMS BALLSH	23.1	3.9			0.08	0.31	3.5																				
CP1 - LUSHNJA - DUMRE - PRMS ELBASAN 2	67.3	23.7			0.47	1.90		21.4																			
LUSHNZA - PEZA - PRMS DURRES	17.7	2.9						0.06	0.23	2.6																	
PEZA - PRMS TIRANA 2	16.8	4.1								0.08	0.33	3.7															
PEZA - PRMS TIRANA 1	0.0	0.0								0.00	0.00	0.0															
PRMS TIRANA 1 - PRMS FUSHE KRUJA	0.0	0.0								0.00	0.00		0.0														
PRMS FUSHE KRUJA - MILOT - PUKA - PRMS KUKES - CTMS AL-KOSOVO	110.8	20.2									0.40	1.62	18.2														
CP3 KORCA - PRMS POGRADEC	35.3	5.9												0.12	0.47	5.3											
MILOT - CTMS BUSHAT - PRMS SHKODER	29.8	5.4													0.11	0.43	4.8										
PRMS BALLSH - PRMS TEPELENA	48.6	7.9															0.16	0.63	7.1								
PRMS TEPELENA - PRMS GJIROKASTER	19.4	3.3																0.07	0.27		3.0						
PRMS POGRADEC - CTMS/PRMS PRRENJAS	31.4	6.5																	0.13	0.52		5.9					
CTMS / PRMS PRRENJAS - AL-MC BORDER	5.0	2.0																		0.04	0.16		1.8				
CP3 - CCGT KORCA	1.0	0.2																				0.00	0.02		0.2		
CP2 - CCGT KUCOVA	1.0	0.2																					0.00	0.02		0.2	

Legend:

- 🟩 CAPEX Million € 1) Prefeasibility Study / Feasibility Study 2) Preliminary ESIA
- ▢ CAPEX Million € 3) Preliminary engineering and full ESIA, 4) Location permit and ROW activities, 5) Detailed design and Construction permit, 6) Bidding, Contractor selection and Financial close, 7) Supervision
- ■ CAPEX Million € 8) Pipeline construction and Taking-Over



PRELIMINARY DEVELOPMENT PLAN & SCHEDULE - Scenario 3

SECTION	km	CAPEX mEUR	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
CP1 - FIER - VLORA TPP	39.8	10.0	0.20	0.80		9.0																					
FIER - PRMS FIER	10.3	2.4		0.05		0.19	2.2																				
PRMS FIER - PRMS BALLSH	23.1	3.9			0.08	0.31	3.5																				
CP1 - LUSHNJA - DUMRE - PRMS ELBASAN 2	83.0	29.1			0.58		2.33		26.2																		
LUSHNZA - PEZA - PRMS DURRES	69.4	30.0						0.60	2.40		27.0																
PEZA - PRMS TIRANA 2	16.8	4.1								0.08	0.33	3.7															
PEZA - PRMS TIRANA 1	14.8	6.0								0.12	0.48	5.4															
PRMS TIRANA 1 - PRMS FUSHE KRUJA	12.0	2.9									0.06	0.23	2.6														
PRMS FUSHE KRUJA - MILOT - PUKA - PRMS KUKES - CTMS AL-KOSOVO	138.0	26.8									0.54	2.14			24.1												
CP3 KORCA - PRMS POGRADEC	35.3	5.9												0.12	0.47	5.3											
MILOT - CTMS BUSHAT - PRMS SHKODER	29.8	7.7													0.15	0.61		6.9									
PRMS BALLSH - PRMS TEPELENA	48.6	7.9															0.16	0.63		7.1							
PRMS TEPELENA - PRMS GJIROKASTER	19.4	3.3																0.07		0.27	3.0						
PRMS POGRADEC - CTMS/PRMS PRRENJAS	31.4	6.5																	0.13		0.52	5.9					
CTMS / PRMS PRRENJAS - AL-MC BORDER	5.0	2.0																		0.04		0.16	1.8				
CP3 - CCGT KORCA	1.0	0.2																				0.00		0.02	0.2		
CP2 - CCGT KUCOVA	1.0	0.2																						0.00	0.02	0.2	

Short Term Projects

Medium Term Projects

Long Term Projects

Legend:

🟩 CAPEX Million € 1) Prefeasibility Study / Feasibility Study 2) Preliminary ESIA
⬜ CAPEX Million € 3) Preliminary engineering and full ESIA, 4) Location permit and ROW activities, 5) Detailed design and Construction permit, 6) Bidding, Contractor selection and Financial close, 7) Supervision
🟦 CAPEX Million € 8) Pipeline construction and Taking-Over

10 References

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- Geological map of Albania, 1:200,000. Xhomo et al, 2002;
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- EUROSTAT data for 2015;
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ALBANIAN TECHNICAL REGULATIONS FOR NATURAL GAS
(Applicable to design of gas pipelines)

- G 463 Steel Pipeline for Operating Pressure above 16 bar - Construction
- G 469 Methods of Testing Under Pressure for Gas Transmission and Distribution
- G 488 Gas Quality Measuring Stations – Design, Construction, Operation
- G 491 Gas Pressure Regulation Stations for Entry Pressures up to 100 bar - Design, Fabrication, Installation, Testing, Commissioning and Operation
- G 492 Gas Measuring Stations for Operating Pressure up to 100 bar - Design, Fabrication, Construction, Testing, Commissioning, Operation and Maintenance
- GW 12 Design and Construction of Cathodic Corrosion Protection for Underground Deposits and Steel Pipelines
- GW 350 Welded Joints of Gas and Water Steel Pipelines - Production, Testing and Evaluation

EUROPEAN AND ADDOPTED EUROPEAN STANDARDS

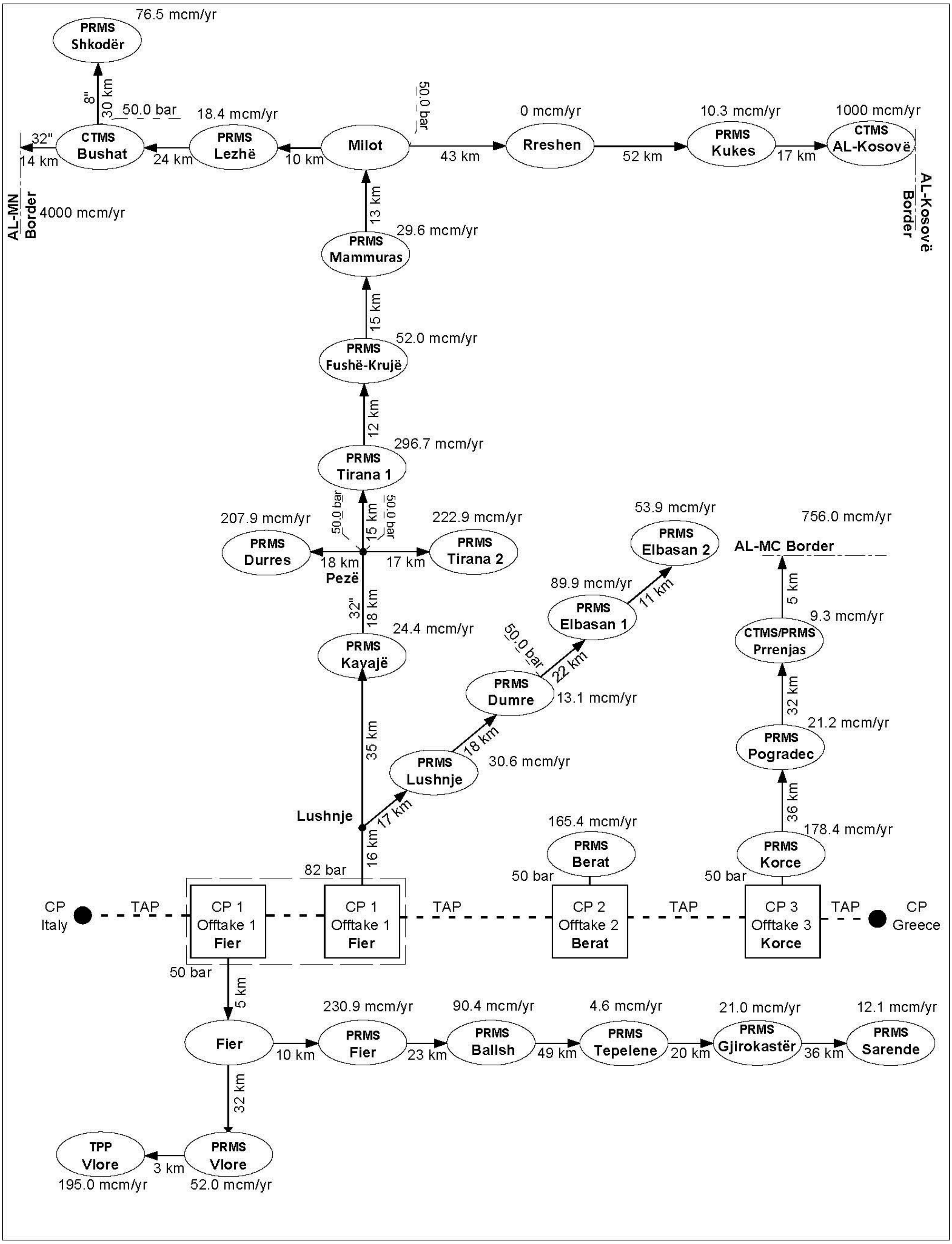
- Standard EN 14161: Petroleum and natural gas industries – Pipeline transportation systems;
- Standard EN 1594: Gas supply systems – Pipelines for maximum operating pressure over 16 bar – Functional requirements;

- Standard EN 1776: Gas supply systems – Natural gas measuring stations-Functional requirements;
- Standard EN 12186: Gas supply systems – Gas pressure regulating stations for transmission and distribution - Functional requirements;
- Standard EN 12327: Gas supply systems – Pressure testing, commissioning and decommissioning procedures - Functional requirements;
- Standard EN 12583: Gas supply systems – Compressor stations - Functional requirements;
- Standard API 5L:2008/: Specification for Line Pipe;
- Standard ISO 3183:2007: Petroleum and natural gas industries – Steel pipe for pipeline transportation systems;

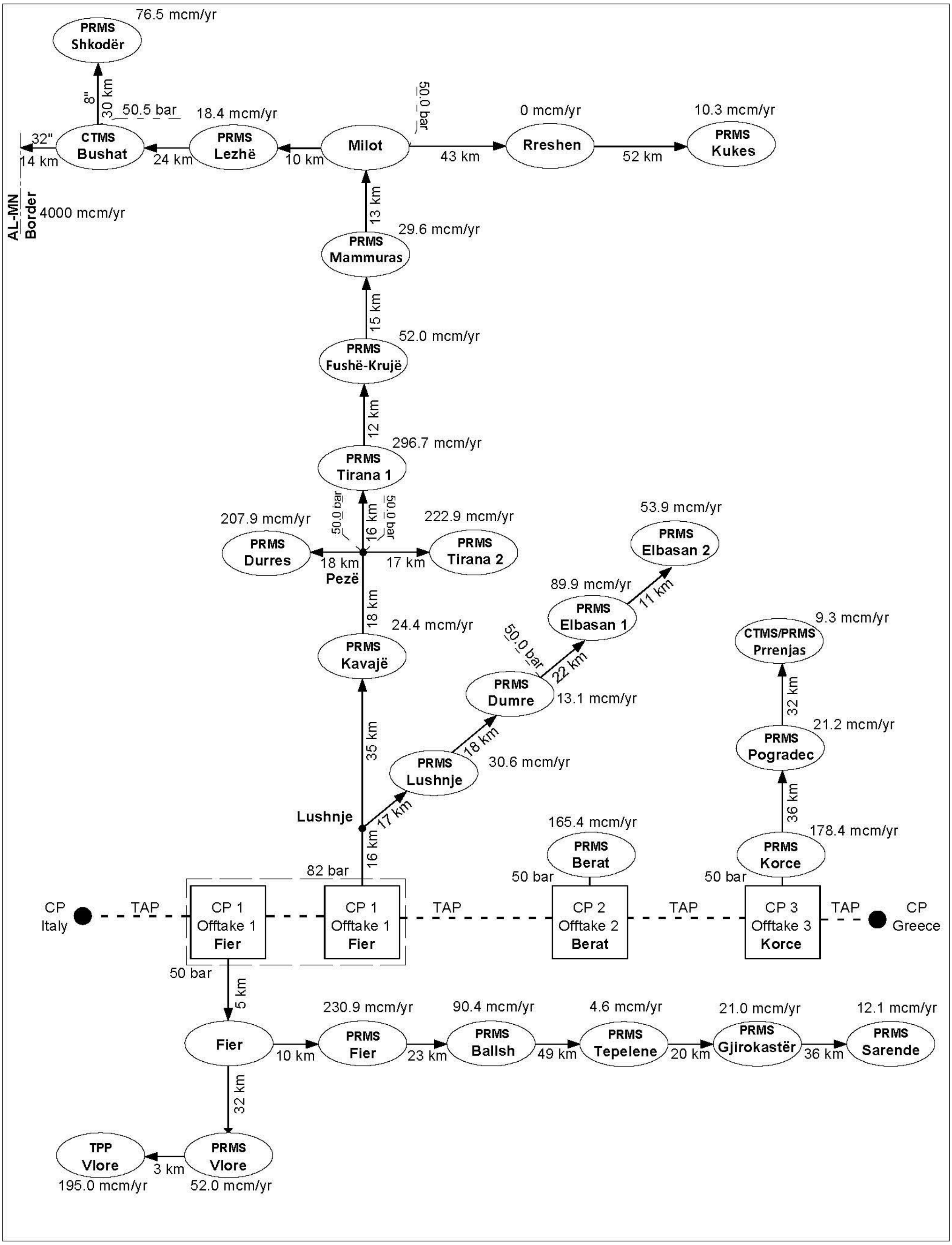
AMERICAN / ISO STANDARDS

- API 5L:2008/: Specification for Line Pipe
- ISO 3183:2007: Petroleum and natural gas industries – Steel pipe for pipeline transportation systems

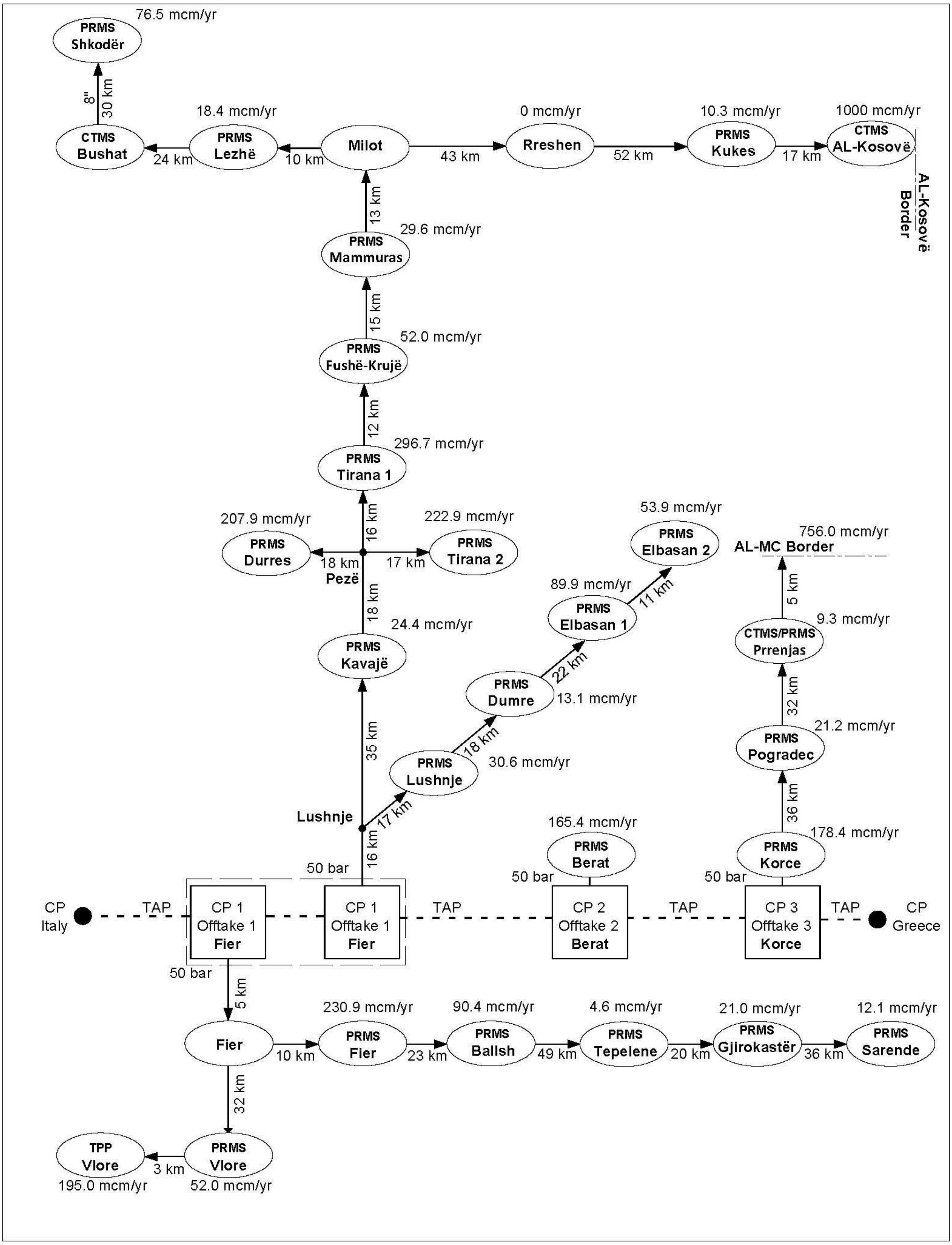
Annex 1 – Block Flow Diagram Scenario 1



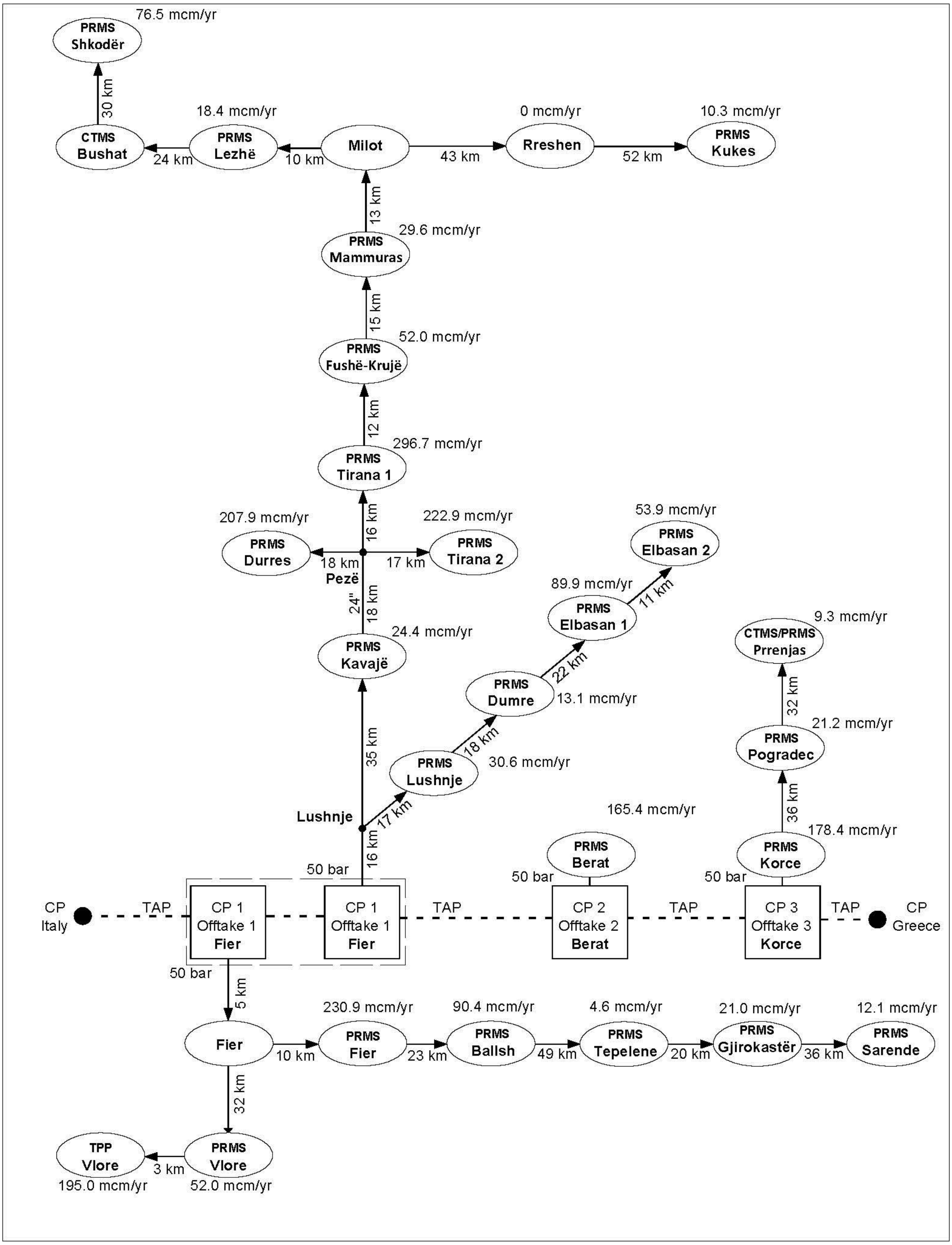
Annex 2 – Block Flow Diagram Scenario 2



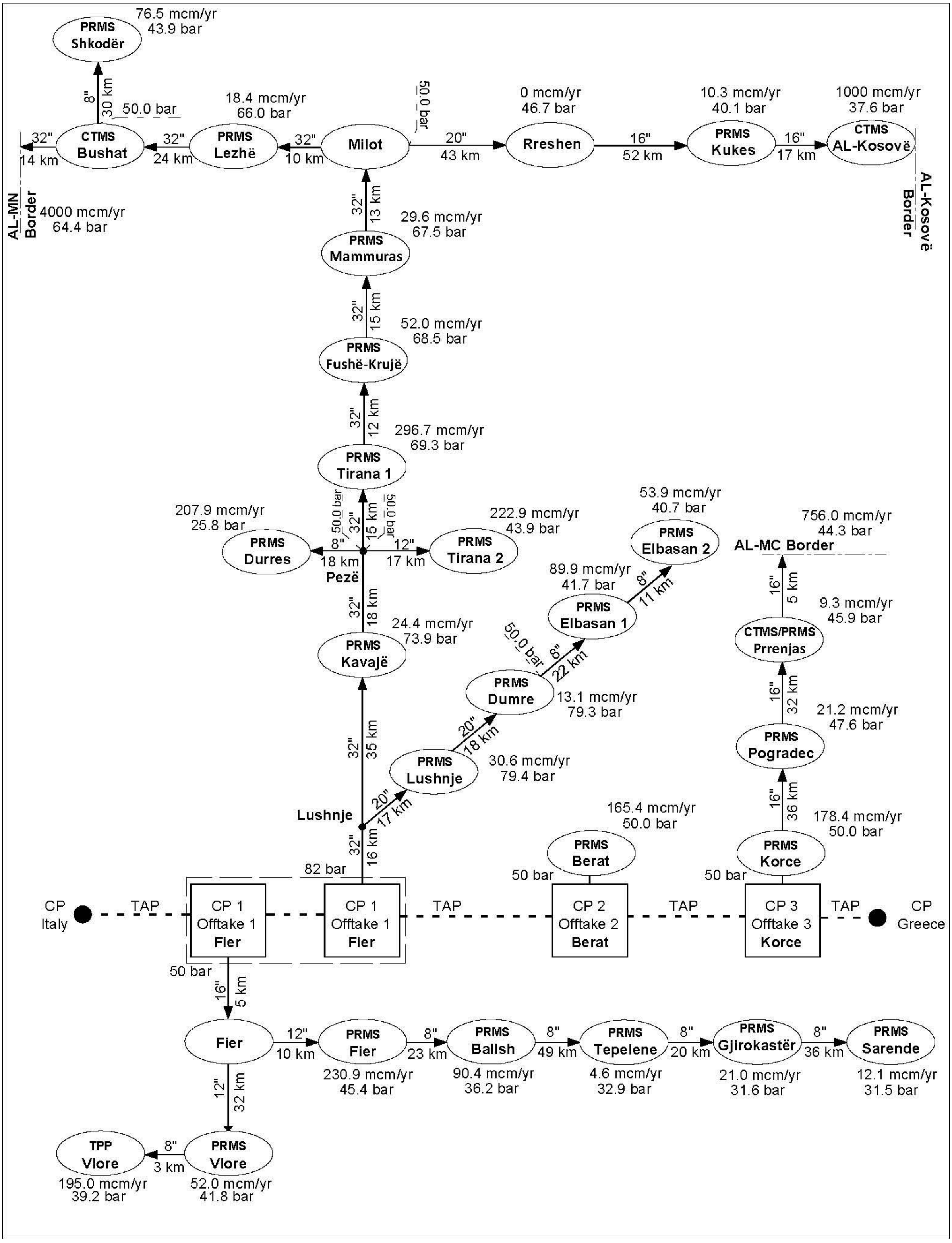
Annex 3 – Block Flow Diagram Scenario 3



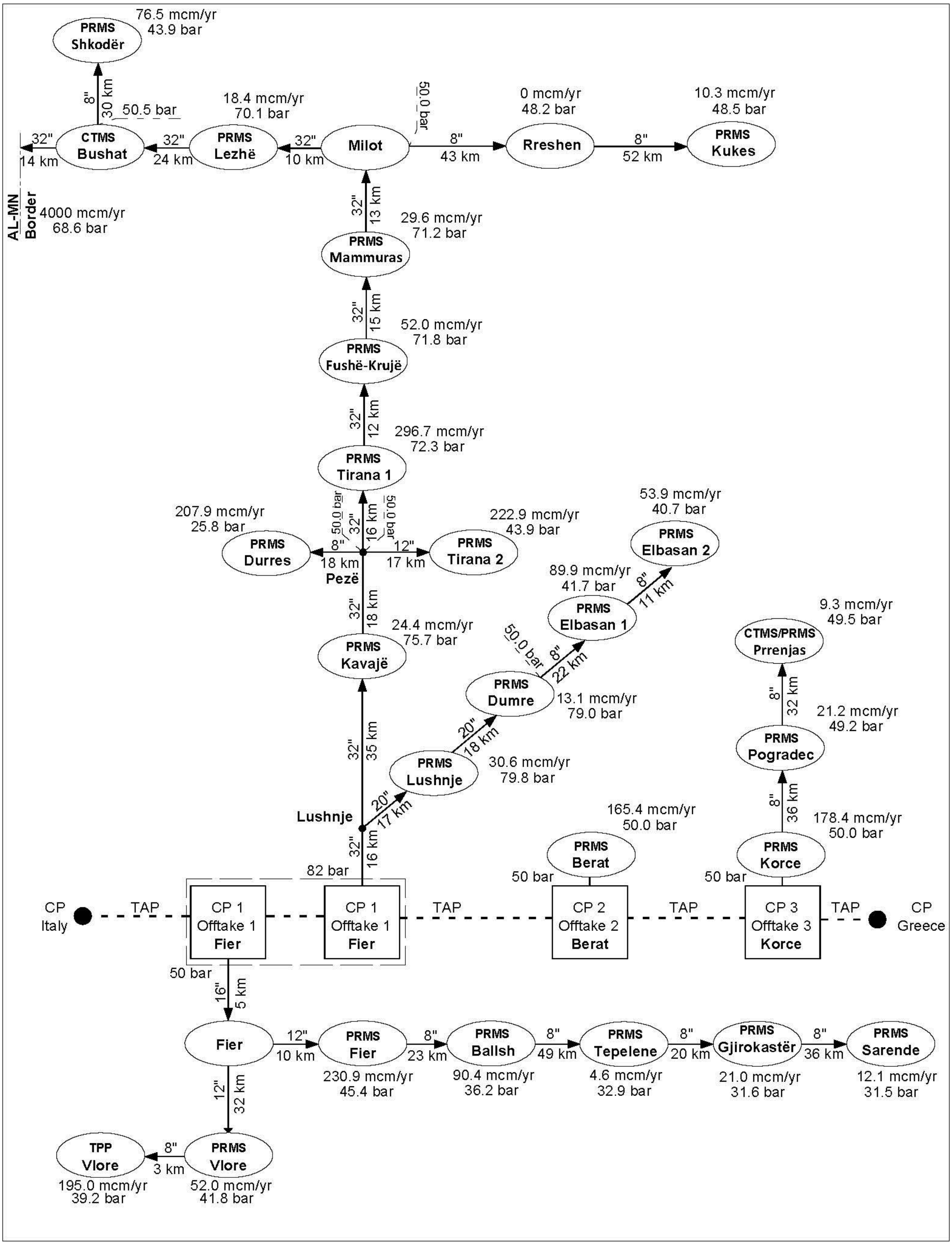
Annex 4 – Block Flow Diagram Scenario 4



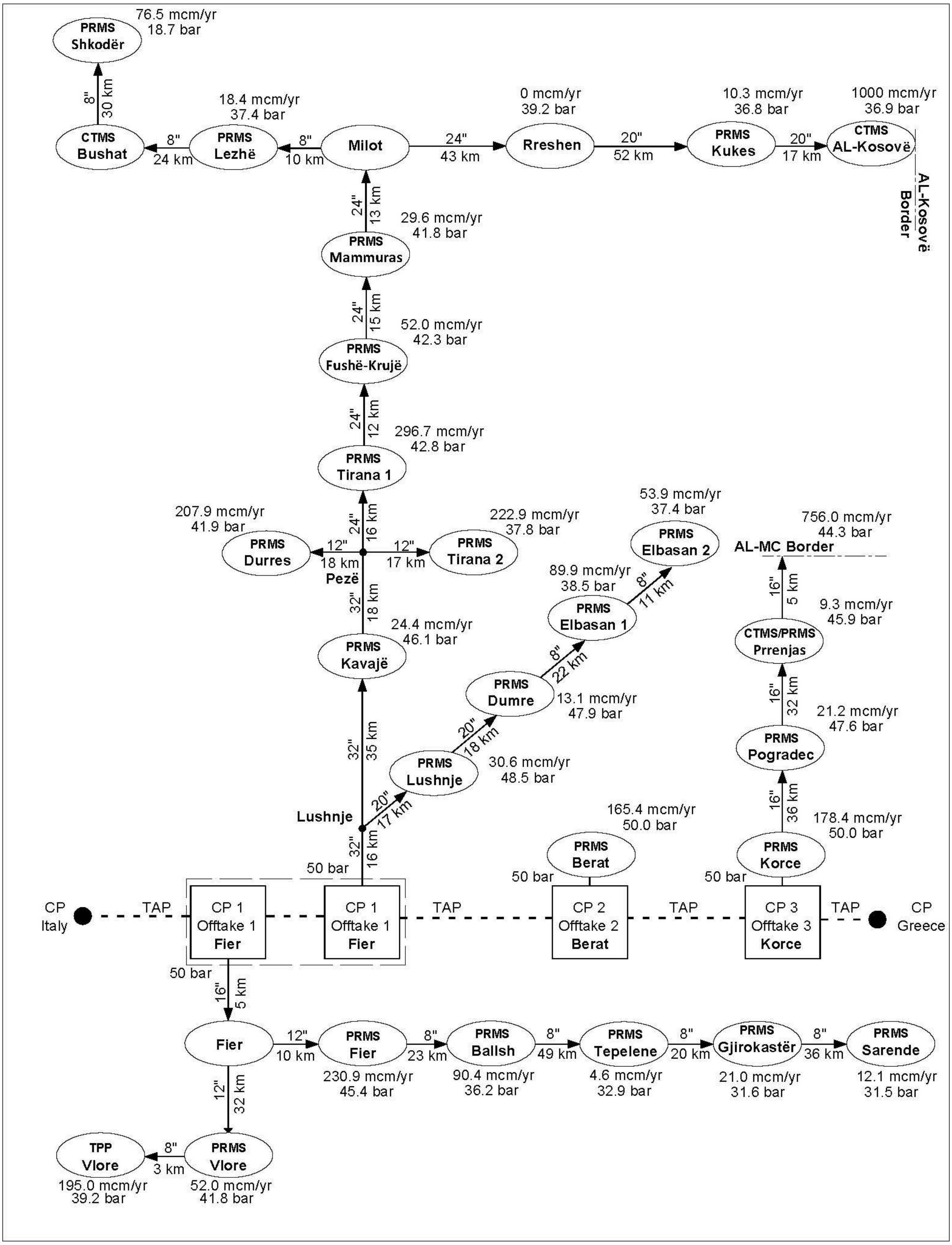
Annex 5 – Hydraulic Calculation Model for Scenario 1



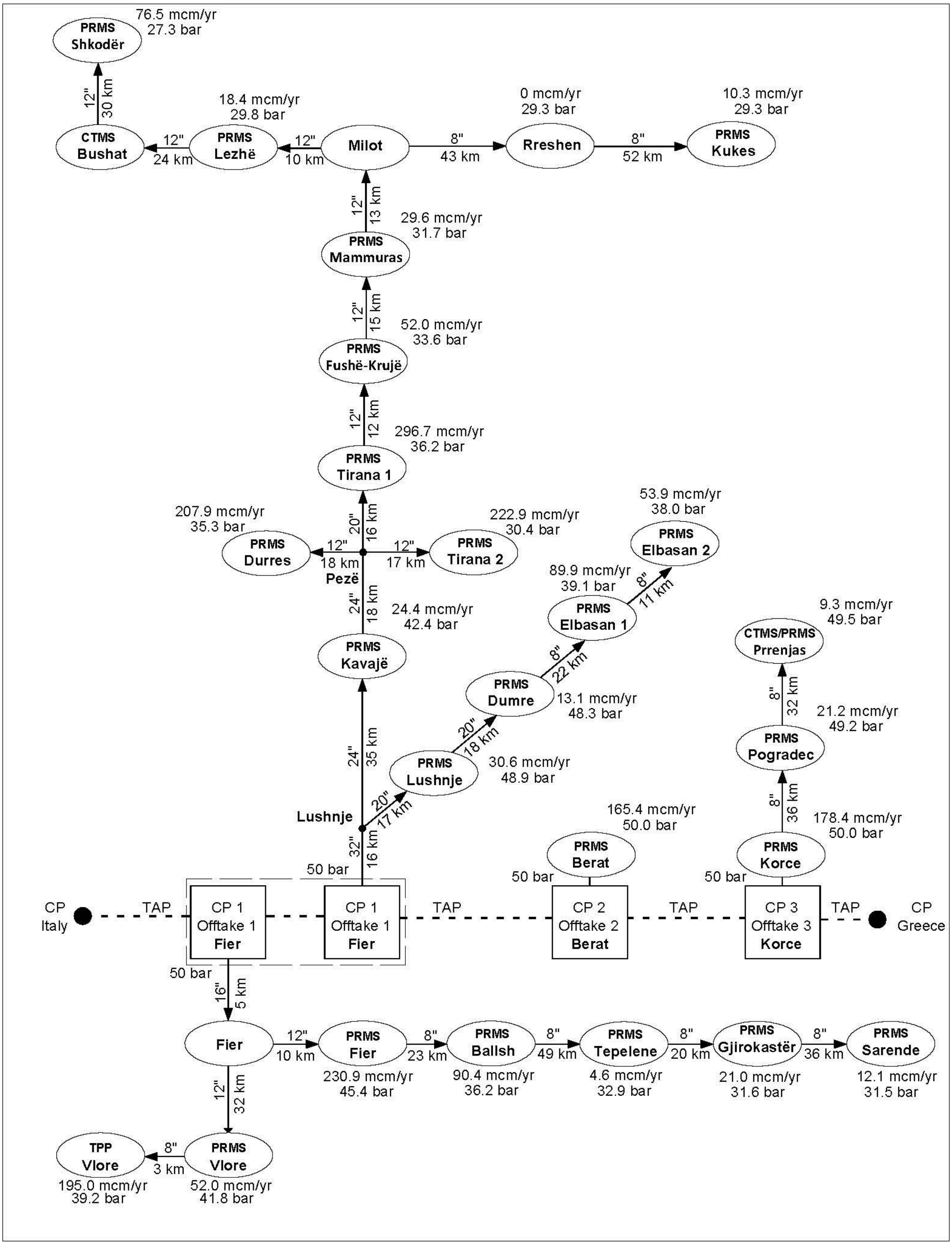
Annex 6 – Hydraulic Calculation Model for Scenario 2



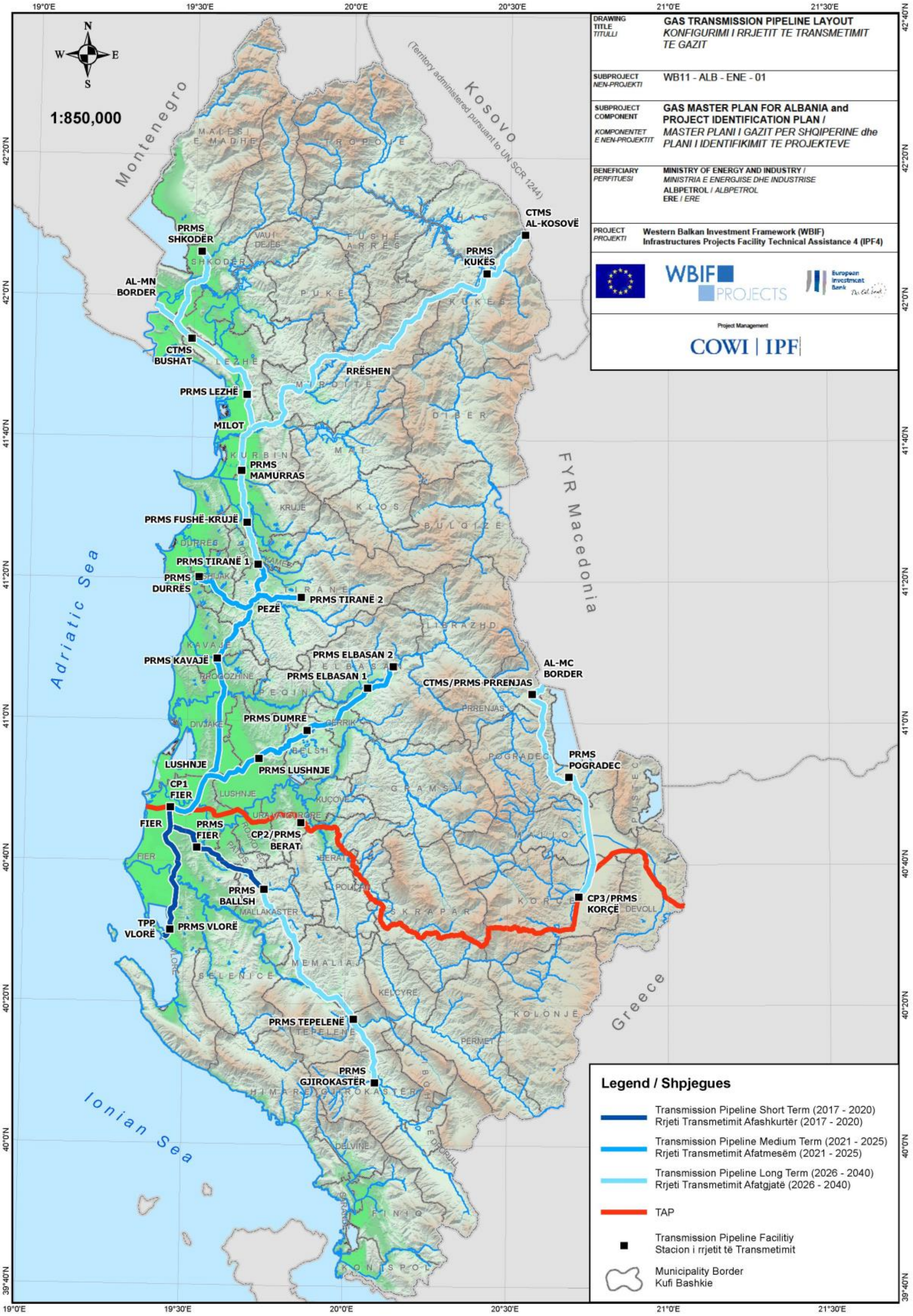
Annex 7 – Hydraulic Calculation Model for Scenario 3



Annex 8 – Hydraulic Calculation Model for Scenario 4



Annex 9 – Maps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GAS TRANSMISSION PIPELINE LAYOUT
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SUBPROJECT
NEN-PROJEKTI
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SUBPROJECT COMPONENT
KOMPONENTET E NEN-PROJEKTIT
GAS MASTER PLAN FOR ALBANIA and PROJECT IDENTIFICATION PLAN /
MASTER PLANI I GAZIT PER SHQIPERINE dhe PLANI I IDENTIFIKIMIT TE PROJEKTEVE
BENEFICIARY
PERFITUESI
MINISTRY OF ENERGY AND INDUSTRY /
MINISTRIA E ENERGJISE DHE INDUSTRISE
ALBPETROL / ALBPETROL
ERE / ERE
PROJECT
PROJEKTI
Western Balkan Investment Framework (WBIF)
Infrastructures Projects Facility Technical Assistance 4 (IPF4)
WBIF PROJECTS
European Investment Bank
Project Management
COWI | IPF
Legend / Shpjegues
Transmission Pipeline Short Term (2017 - 2020)
Rrjeti Transmetimit Afashkurtër (2017 - 2020)
Transmission Pipeline Medium Term (2021 - 2025)
Rrjeti Transmetimit Afatmesëm (2021 - 2025)
Transmission Pipeline Long Term (2026 - 2040)
Rrjeti Transmetimit Afatgjatë (2026 - 2040)
TAP
Transmission Pipeline Facilitiy
Stacion i rrjetit të Transmetimit
Municipality Border
Kufi Bashkie
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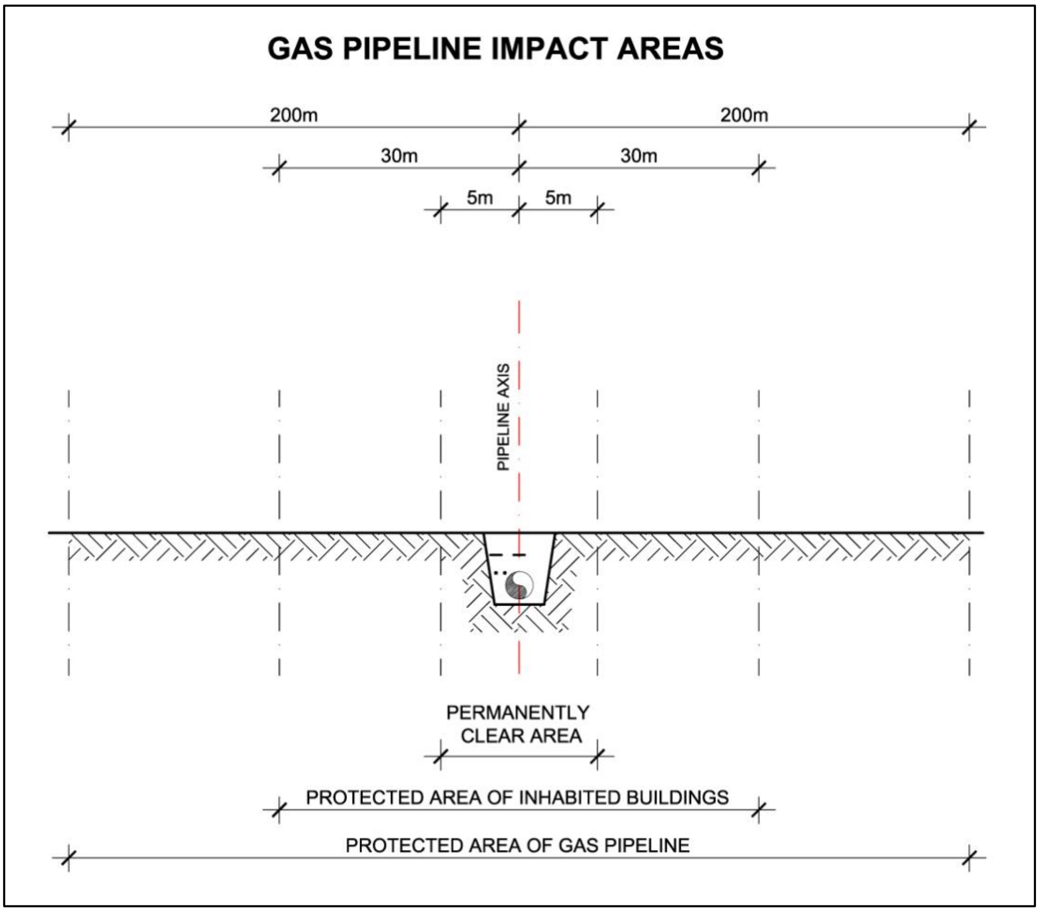
42°20'N
42°0'N
41°40'N
41°20'N
41°0'N
40°40'N
40°20'N
40°0'N
39°40'N
Montenegro
Kosovo
(Territory administered pursuant to UN SCR 1244)
FYR Macedonia
Greece
Adriatic Sea
Ionian Sea
CTMS AL-KOSOVË
PRMS KUKËS
PRMS SHKODËR
AL-MN BORDER
CTMS BUSHAT
RRËSHEN
PRMS LEZHË
MILOT
PRMS MAMURRAS
PRMS FUSHË-KRUJË
PRMS TIRANË 1
PRMS DURRËS
PRMS TIRANË 2
PEZË
PRMS KAVAJË
PRMS ELBASAN 2
PRMS ELBASAN 1
AL-MC BORDER
CTMS/PRMS PRRENJAS
PRMS DUMRE
LUSHNJE
PRMS LUSHNJE
PRMS POGRADEC
CP1 FIER
FIER
PRMS FIER
CP2/PRMS BERAT
PRMS BALLSH
CP3/PRMS KORÇË
TPP VLORË
PRMS VLORË
PRMS TEPELENË
PRMS GJIROKASTËR
MALESI E MADHE
TROPOJE
VAU I DEJES
FUSHE ARRES
SHKODER
PUKE
KUKES
HAS
LEZHE
MIRDITE
DIBER
KURBIN
MAT
KRUJE
KLOS
BULQIZE
DURRES
KAMEZ
SHIJAK
TIRANE
LIBRAZHD
KAVAJE
ELBASAN
RROGOZHINE
PEQIN
PRRENJAS
DIVJAKE
CERRIK
BELSH
POGRADEC
GRAMSH
LUSHNJE
KUCOVE
URA VAJGURORE
ROSKOVEC
PATOS
BERAT
MALIQ
PUSTEC
FIER
POLICAN
SKRAPAR
KORCE
DEVOLL
MALLAKASTER
MEMALIAJ
VLORE
SELENICE
KELCYRE
KOLONJE
TEPELENE
PERMET
HIMARE
GJIROKASTER
LIBOHOVE
DROPULL
DELVINE
SARANDE
FINIQ
KONISPOL

Annex 10 – Examples of defined safety requirements

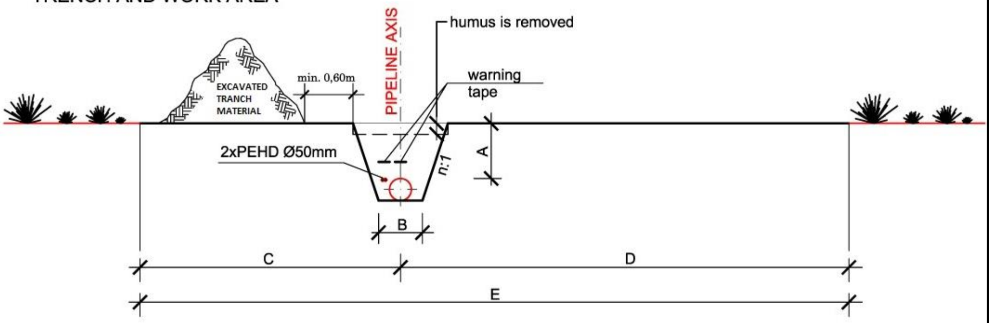
The regulations define the safety zones of the pipelines. The safety zones for gas transmission pipelines are presented in **Error! Reference source not found.** and **Error! Reference source not found.** below.

Priority safety zone 5 m	5 meters on each side of the pipeline axis	It’s forbidden to plant plants with roots longer than 1 meter or plants that are cultivated by digging more than 0,5 meters
Protected zone 30 m	30 meters on each side of the pipeline axis	It is forbidden to build housing objects in the future
Wider safety zone / Protected area 200 m	200 meters on each side of the pipeline axis	Based on the level of population density, additional protection measures should be undertaken



The pipeline working areas depend on the pipeline diameter, as shown in the figure below, and the type of the area. To protect the forests the working areas in the forests are narrower in comparison to the open fields and arable lands.

TRENCH AND WORK AREA



NOMINAL DIAMETER PIPE DN		A (MIN.) METERS				B (m)	C (m)	D (m)	E (m)
INCH	mm	NORMAL SOIL		COMPACT ROCK		NOR. SOIL OR COMP.ROCK	WORK AREA		
4"	100	LOCATION CATEGORY 1 : 1 m	LOCATION CATEGORY 2, 3, i 4 : 1 m	LOCATION CATEGORY 1 : 0,5 m	LOCATION CATEGORY 2, 3, i 4 : 0,65 m	0,40	3	9	12
4"	150					0,45			
8"	200					0,50			
10"	250					0,60	4	10	14
12"	300					0,70			
14"	350					0,75			
16"	400					0,80	5	11	16
18"	450					0,90			
20"	500					1,00			
22"	550					1,00			
24"	600					1,00	6	12	18
26"	650					1,20			
28"	700					1,20			
30"	750					1,30	7	13	20
32"	800					1,30			
34"	850					1,40			
36"	900					1,40			
40"	1000					1,50	7	13	20

LEGEND:

A -minimum overlay material above gas pipelines
B -trench bottom width
C -area intended for the disposal of dredged material and eventually removed humus
D -area for assembly - welding, vehicle and machinery movement
E -total work area width

NOTES:

- trench bottom is flat; sides are slanted depending on quality type
- trench bottom and sides must be without rock and other hard materials that may damage isolation
- excavated soil should not be mixed with other admixtures
- humus is removed on arable areas only above the trench and deposited of separately along with excavation material

Similarly, safety zones are prescribed for the above ground pipeline facilities such as block valve stations, pig trap stations, gas pressure reduction and metering stations and compressor stations:

- The distance of block valve stations or pig trap stations to the edge of roads or railway tracks must be more than 30 m.
- The distance of a compressor station to neighbouring buildings must be more than 100 m and to the edge of roads or railway tracks the distance must be more than 30 m.
- The distance of pressure metering station to neighbouring buildings must be more than 15 m for solid object metering stations or more than 30 m for open space pressure metering stations.

The wall thickness of pipelines must withstand all internal and external loads to which the pipeline is exposed. Safety factors must be taken into account by the calculation of pipeline wall thickness and depends on the population and building density in the 400 m wide protected area of the pipeline.

The Safety factor for different zones is:

- 1st zone – stretch of the pipeline where there is less than six apartment buildings lower than four floors - 1.4;
- 2nd zone - stretch of the pipeline where there is more than six and less than twenty eight apartment buildings lower than four floors - 1.7;
- 3rd zone - stretch of the pipeline where there is more than twenty eight apartment buildings lower than four floors, or where there are commercial, industrial, service, educational, health and other buildings and public areas such as playgrounds, walkways, recreation areas, open stage, sports fields, fairgrounds, parks and similar areas where more than twenty people permanently or temporary resides, and are situated at a distance of 100 m from the axis of the pipeline - 2.0;
- 4th zone - stretch of the pipeline where there are predominantly apartment buildings higher than the four floors - 2.5

The above mentioned safety factors are increased if the pipeline passes under roads, railroads or similar.

The minimal distance between the pipeline and objects that could be located in the pipeline development corridor is also regulated. Usually following apply:

- More than 5 m from outer side of road zone/for regional and local road;
- More than 10 m from outer side of road zone/for 1 level roads;
- More than 20 m from outer side of road zone/for high ways and outer side of train zone/for railways;
- More than 1 m horizontally from construction objects/from the foundation of the object, with condition that stability is not under threat;
- More than 50 cm from other installations;
- More than 10 m from regulated water systems and channels.

Relevant authorities will confirm above-mentioned distances or new ones will be required during the location permit procedure. Each relevant authority will issue conditions related to layout of the pipeline and the infrastructure for which they are responsible for.

The pipeline will be buried along the entire length of the route to the minimum depth, which depends on the type of the soil in which the pipeline is laid:

- in clay soil: at least 1 m measured from the top of the gas pipeline (soil excavation categories I-III);
- in stone soil: at least 0.7 m measured from the top of the gas pipe (soil excavation categories IV-VI).

Minimal burying depth also depends on the pipeline zone. For zone IV the minimal burying depth should be at least 1.1 m. It should be bigger if the pipeline passes below transport facilities (roads, railroads…), rivers or similar.

Burying depth can deviate from the above mentioned, i.e. it may be even bigger if special conditions for the construction are prescribed during the location permit procedure.

Burying depths are also bigger when the pipeline passes through a protected zone of buildings (total zone width of 60 m):

- in clay soil: at least 2 m measured from the upper edge of the gas pipeline (soil excavation categories I-III);
- in stone soil: at least 1.5 m measured from the upper edge of the gas pipeline (soil excavation categories IV-VI).

The pipeline must be equipped with shut-off elements located and spaced in such a way that the maximum distance from any point of the pipeline to the nearest shut-off device for specific pipeline building zone is:

- 1st zone – 16 km;
- 2nd zone – 12 km;
- 3rd zone – 6 km;
- 4th zone – 4 km;

All parts of the pipeline must be protected from corrosion. Above-ground parts of the pipeline, which are not galvanized, shall be protected by anti-corrosion coatings that must be applied in accordance with the provisions of the technical measures and conditions for the protection of steel structures from corrosion. Corrosion protection of underground pipelines should consist of passive protection (insulation) and active protection (cathodic protection).

Examination of welds in the pipeline shall be performed before pressure testing in accordance with ISO 13847. Welds should be examined as follows:

- all welds shall be visually examined. The visual examination shall be conducted by a qualified person by direct or remote viewing, and controls the shape, size, purity of weld. In addition to the visual examination a liquid penetrant or dye penetrant examination, or magnetic particle examination can be carried out. Penetrant testing and magnetic particle examination of branch welds, socket/fillet welds and seal welds must be carried out in the manner and to the extent as required by the norms.

- a minimum of 10 % of the welds completed each day shall be randomly selected for examination by radiography or ultrasonic. The examination shall be increased to 100 % of the welds if lack of weld quality is indicated, but may subsequently be reduced progressively to the prescribed minimum percentage if a consistent weld quality is demonstrated.

- 100 % of the welds shall be examined by radiography or ultrasonic for the special conditions like pipelines within populated areas, transport infrastructure -and river crossings and similar.

Pipelines shall be pressure-tested in place after installation and before being put into operation to demonstrate their strength and leak-tightness. Prefabricated assemblies and tie-in sections may be pre-tested before installation provided their integrity is not impaired during subsequent construction or installation. Minimum test overpressure should be 25% - 50 % higher than calculated overpressure for the pipelines depending on the pipeline safety coefficient or zone or depending on the type of system equipment.

The route of the pipeline must be clearly marked with special marks. The distance between the marks must not be more than 1,000 m on the flat part of the route. At curved portion of the pipeline route, markings are placed at the beginning, in the middle and at the end of the bend.

Marks of the pipeline route are placed at 0.8 m to the right of the flow direction of the gas. Marks should be placed on the both sides of watercourse-, road- and similar crossings.

Annex 11 – Pipe laying, construction requirements and construction methods

Pipe laying and construction requirements

The pipelines are buried in the ground with minimal required cover. The minimal cover requirements are based upon pipeline location class and terrain types as prescribed by applicable laws and regulations (please refer to Section 5.1.2).

The depth of cover must be below the freezing depth as well. This is important in order to avoid freezing of ground water around the pipeline, which can damage the insulation.

To access the pipeline route and the facilities, existing roads will be used predominantly with the approval of the competent authorities. It is necessary to build only local access roads to pipeline facilities, which reduces construction costs and the environmental impact.

To excavate a trench for laying a gas pipeline, it is necessary to provide a work area, often referred to as right-of-way. Width of the work area is in principle depending on the diameter of the gas pipe and other regional and organizational conditions. For the minimal pipeline work area requirements please refer to figures in Annex 10. When the cross-section slopes are greater than 10% (or 10°) the work area expands due to cuts and embankments.

It is often necessary to provide space for deposit of humus, which after pipeline backfilling is to be returned to its original place.

Gas pipeline trench

The pipeline trench excavation is carried out mechanically and manually depending on existing facilities of the route and terrain conditions, with mandatory manual excavation in zones with existing underground installations.

Required trench width at the bottom depends on pipeline diameter.

Excavation for pipelines in different soils (materials of different excavation categories) is to be carried out with proper mechanical equipment.

Excavation and fine digging of trenches in loose soft soil, such as soft ground, pure sand, loose gravel, humus, sand clay, sandy clay, compacted sand and fine gravel and similar soil are performed without use of explosive.

Taking into consideration the gas pipeline diameter, and consequently depth of the trench, excavation is carried out so that lateral sides are sloped. As the trench is not too deep, and the trench sides are properly sloped, no planking and strutting of the lateral sides of the trench are foreseen. This can significantly change at the locations of crossings.

The bottom of the trench must be aligned, planned, without stone impurities that can damage the pipe insulation. Where the ground water is high or the terrain prone to flooding, the contractor will excavate a trench in harsh conditions. In such cases, the most efficient work can be done in the dry season, or by pumping water out of the trench.

Trench backfilling is done with proper mechanical equipment by laying pipes onto a 15 cm thick sand bed layer, and then covering the pipe in sand up to 15 cm above the top of the pipe. In case that the excavation material is sandy or loose to the extent that it does not damage the pipes and pipe coating during backfilling, there is no need to use sand in the trench. The rest of the trench is backfilled with the material from the excavation.

A protective yellow band with an inscription 'DANGER GAS PIPELINE' is incorporated into the trench at the required distance above the pipe. The tape is placed along the whole length of the gas pipeline except at the places of drilling under roads and waterways.

In sections with longitudinal inclination of the gas pipeline greater than 20% it is foreseen that anti-erosion barriers should be set up, made from bags filled with a mixture of sand and cement in order to prevent washing off of the soil.

Protection of the gas pipelines from mechanical damage in sections of rocky and broken stone terrain is foreseen to be carried out by laying the gas pipeline on sandbags placed previously at the bottom of the trench, whereupon the gas pipeline is covered with soft earth or sand 0.3 m above the pipe or the sand bag layer as well.

Pipe laying and bending

The pipelines will be constructed from approximately 14 to 18 m long pre-insulated steel pipes.

The pipes will be transported with vehicles suitable for pipe transportation to the pipeline construction site and positioned along the work area. The pipes will be unloaded with a mounted pipe-layer crane, and side boom, and placed end-to-end alongside the future trench, taking special care not to damage the pipes.

Where the pipeline route changes direction or if there are significant changes in the natural ground contours, hydraulic bending machines shall be used for gradual cold pipe bending. This equipment bends individual pipes to the desired angle. Where the bend cannot be made to meet specific requirements, a prefabricated factory bend will be used.

Welding

Pipes will be connected and welded together so that a pipe section is formed and placed on temporary supports along the edge of the trench. After laying pipe sections in the trench the individual pipe sections will be welded together to form the pipeline. Appropriate welding procedures shall be used.

Welds should be examined as described in Section 5.1.2

Protection against corrosion

After the welds have been checked, tested and approved the exposed steel section at the joint between the pipes, will be cleaned, sand-blasted and protected by applying a protective coating to it (e.g. heat-shrinkable polyethylene sleeves around the pipe). After that the pipeline will be examined for coating damage. The entire pipeline coating will be electronically inspected, using Direct Current Voltage Gradient (DCVG) or any equivalent technique. Before the pipe section is laid on the bottom of the trench, the insulation will be re-tested.

Above-ground parts of pipelines shall be protected by protective paint system.

Next to a passive mechanical anticorrosion protection, the pipelines will be protected by an active cathodic protection and protection from stray currents.

Hydrostatic testing

The entire installation needs to be tested for strength and tightness before it is used. The most common method for testing the integrity of the pipeline and checking for any potential leaks is hydrostatic testing. It is performed by filling the pipeline with water and keeping it under certain pressure to check that the pipeline is not damaged and will not leak during operation. The final test of the installation is performed after the pipeline has been laid into the trench and backfilled.

Monitoring and control of the process, and optical communication system

Monitoring and control include collecting data from the blocking electronic devices (Electronic Line Break Control - ELBC) and other equipment for monitoring and control, and data transfer to the Dispatch Centre (DC). All facilities are linked to the system of remote monitoring and control of the gas network.

The monitoring and control equipment will be installed in a container within facility. The container must be placed outside the hazardous area, which is defined in regard to potential for an explosive atmosphere (Ex zone). The container must ensure appropriate conditions of temperature and humidity (air conditioning, heating, room temperature 15°C to 25°C, and forced ventilation).

Data transfer and Communication to the DC is provided with an optical cable. Along the entire route of the gas pipelines, two 50 mm HDPE pipes can be installed (one active, one spare) for the light-wire signal cable.

Construction methods

The proposed construction methods are described below, including the techniques that will be used to cross roads, railroads and watercourses.

Typically, where there are no other specific requirements, onshore pipeline construction is a sequential process including several distinct operations, and is called:

Spread Technique

The “spread” method of construction for onshore pipelines is normally employed, and involves several groups of construction personnel and equipment that collectively conduct the various stages of the construction operation. Each group of personnel and equipment completes an activity, which picks up where the last one left off, advancing the construction process a step at a time and leaving it ready for the next step to begin. Depending on the timescale for construction, it may be necessary to have multiple spreads working at different locations.

A typical pipeline construction spread will be as follows:

- Route surveying, preparation of the work area, top soil stripping and grading. This activity prepares a continuous running track for the pipeline construction crews.
- Pipe bending and stringing. This involves transporting the line pipes from the pipe dump to the spread and placing them on skids in a continuous string ready to be welded.
- Welding. The individual line pipes are joined into a continuous pipeline string.
- 100% Visual inspection of welds.
- Non Destructive Testing (NDT) usually carried out by radiography.
- Field Joint Coating and checking the pipeline coating for defects.
- Trenching.
- Lowering the pipeline string into the trench.
- Backfilling.
- Hydrostatic Testing.
- Dewatering and drying of the pipeline. This can be followed by nitrogen purging if the commissioning does not shortly follow the drying operation. The purpose of the nitrogen purging is to create a non-corrosive atmosphere within the gas pipeline and prevent the occurrence of

explosive mixture of gas and air by initial release of the gas into the pipeline.

- Coating and corrosion protection surveys to ensure that corrosion protection system works properly and that there are no major defects in the coating.

- Site clean-up and reinstatement. In agricultural land this involves returning the work area to its original condition and re-seeding it.

In addition to the spread team(s), specialist teams will be set up as required to undertake work associated with road, railroad and river crossings and other sections of constricted working, as well as to construct sections through any stretches of particular sensitivity, including conservation areas. In these sections of particularly sensitive environments, modifications are generally made to the standard spread technique aiming to eliminate avoidable environmental damage.

Final construction methods will be determined during the detailed design.

Open-cut Crossings of roads, railroads and watercourses

Open-cutting a crossing is similar to standard pipeline construction but with a greater depth of cover and, where needed, with the installation of concrete slab protection on top of the pipeline. This is normally followed by reinstating the crossing to its original condition.

Open cut crossings are cheaper to construct than trenchless methods and they are therefore used where pipeline construction is not going to have a significant negative impact on the traffic or the environment.

Auger Boring

Auger boring is a trenchless technique for crossing beneath roads, railroads or watercourses and because of the use of specialized equipment has higher initial construction costs than traditional open-cutting. However, taking into account the disruption that open-cut method causes to traffic or to the environment, auger boring becomes the preferred option. It is also a requirement of the highway authorities in most countries that all major road crossings and important watercourses are to be constructed by trenchless techniques. Thus, for all asphalt roads of higher rank or higher traffic load (regional, major, state), boring method is foreseen.

Auger boring provides a safe method of installing pipes and cables while supporting the ground during the bore.

Auger boring is to be carried out by installing a steel casing pipe from a drive pit through the ground while removing the soil inside the encasement by means of the continuous flights (contained within a steel casing pipe) which are rotated and simultaneously pushed into the ground. The casing supports the soil around it as the bore progresses, the ground is cut and the auger flights convey the material back into the work pit. After installation of the casing, a product pipe is installed and the remaining annular space is filled with grout or kept empty and provided with vents. To avoid problems with the pipeline cathodic protection, steel casing pipe can also be included in cathodic protection system. The installation of the casing is often required by the local regulations and standards.

A typical maximum length of an auger bore is approximately 80 m to 100 m.

Pipe Jacking

Pipe jacking involves installing a sleeve, normally made of prefabricated concrete pipe sections, under the crossed feature and then installing the pipeline inside the sleeve. In this method, new pipe sections are jacked from a drive shaft or pit so that the complete string of pipe is installed simultaneously with the excavation. Pipe jacking technique requires workers inside the borehole during excavation and sleeve installation and therefore the sleeve needs to be sufficiently large for man entry. Pipe jacking is more expensive than auger boring, but allows for longer crossing lengths so it is usually recommended for crossing lengths between 100 m and 150 m.

Horizontal Directional Drilling (HDD)

Horizontal directional drilling is a trenchless construction method utilizing equipment and techniques from horizontal oil well drilling technology and conventional road boring. HDD construction is used to install gas pipelines where conventional open trench construction is not feasible or will cause adverse disturbances to the environment, land use or physical obstacles, or the crossing is too long for an auger bore or a pipe jack.

Directional crossings have the least environmental impact of any alternate method. The technology also offers maximum depth of cover under the obstacle thereby affording maximum protection and minimizing maintenance costs. HDD installation involves three main steps: drilling a pilot hole, expanding the pilot hole by reaming and pulling back of pre-fabricated product pipeline section.

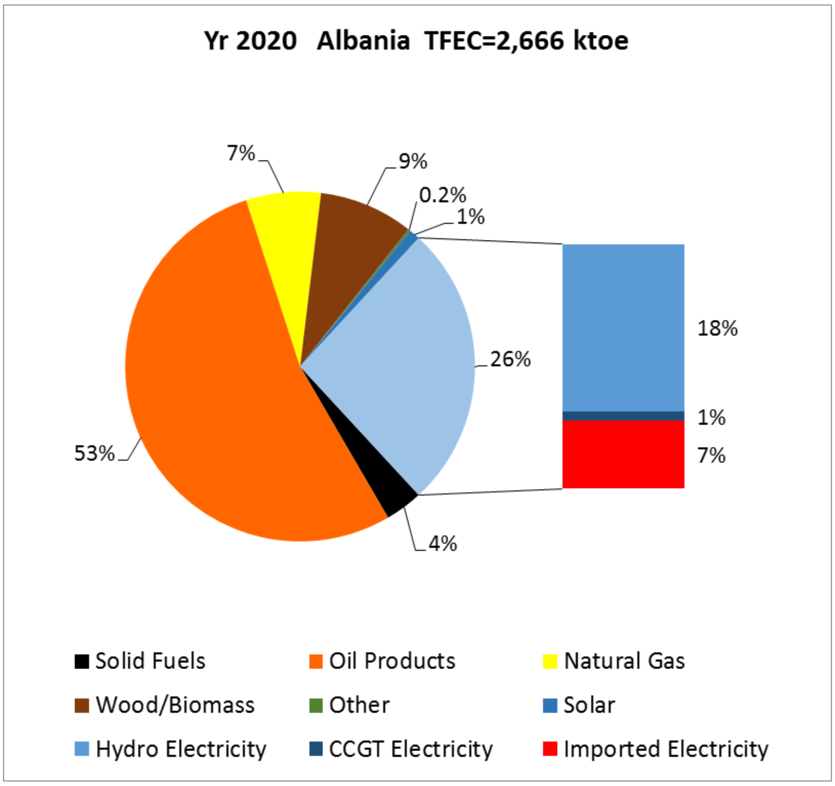
A HDD drill rig and supporting equipment is set-up at the drill entry location determined during the pre-site planning phase. A pilot hole is drilled beginning at a designed angle from horizontal and continues below the obstacle along a designed profile consisting of straight tangents and long radius arcs.

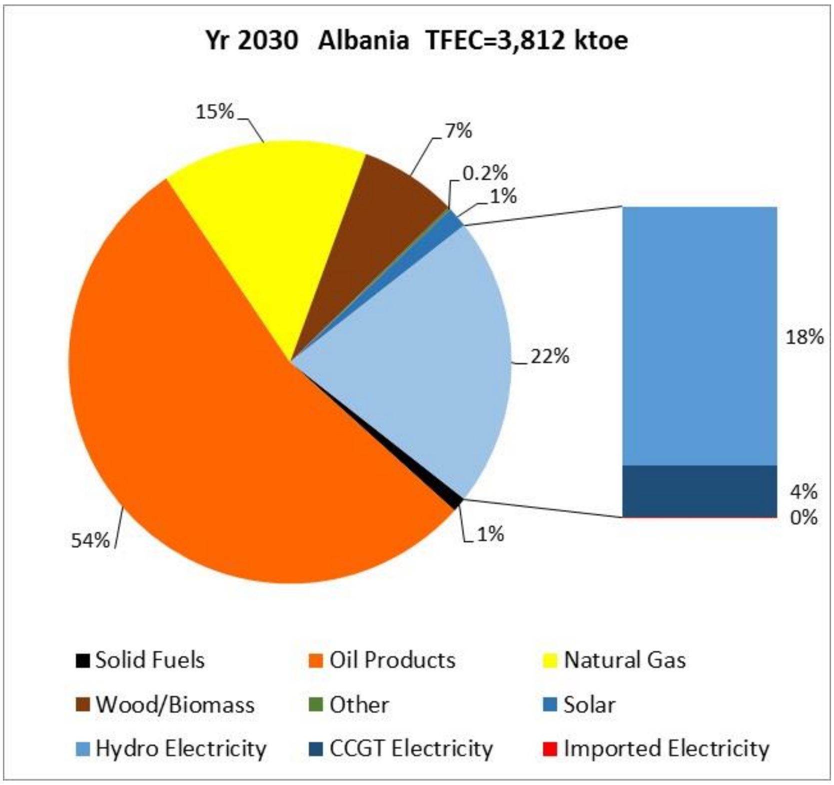
Drilling fluid is injected under pressure ahead of the drill head to transport drill cuttings to the surface, clean build-up on the drill bit, cool the drill bit, reduce the friction between the drill and bore wall, and stabilize the bore hole.

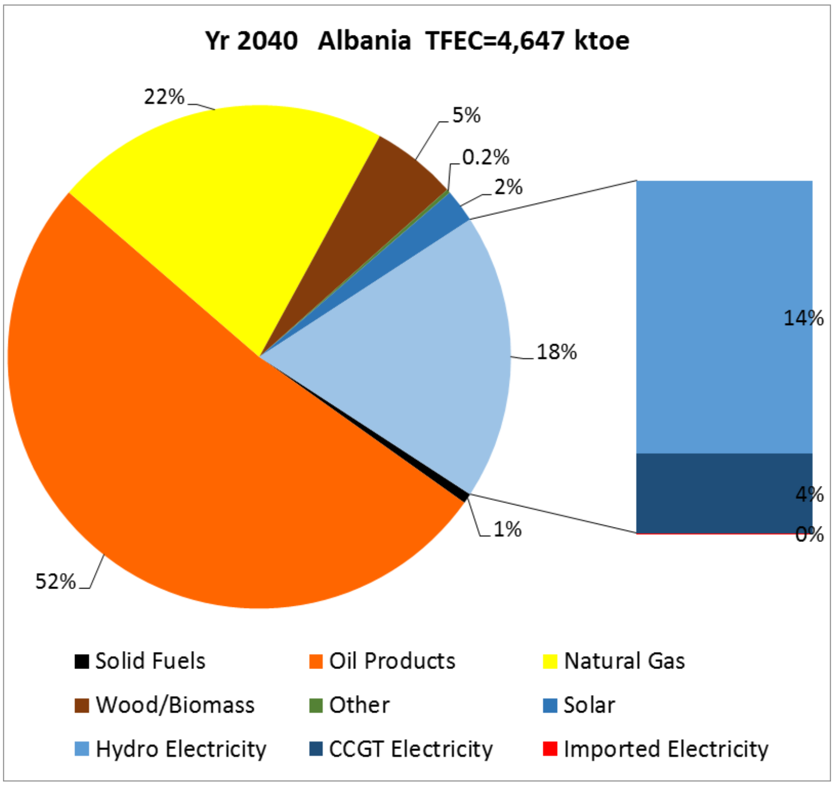
Once the pilot hole is complete, the hole is enlarged to a suitable diameter for the product pipeline. The number of reaming passes is determined by the hardness of the material being reamed and the ability to remove cuttings from the hole.

Geology - geographical conditions are critical for this construction method, depending on which, crossing lengths up to 2 km can be achieved.

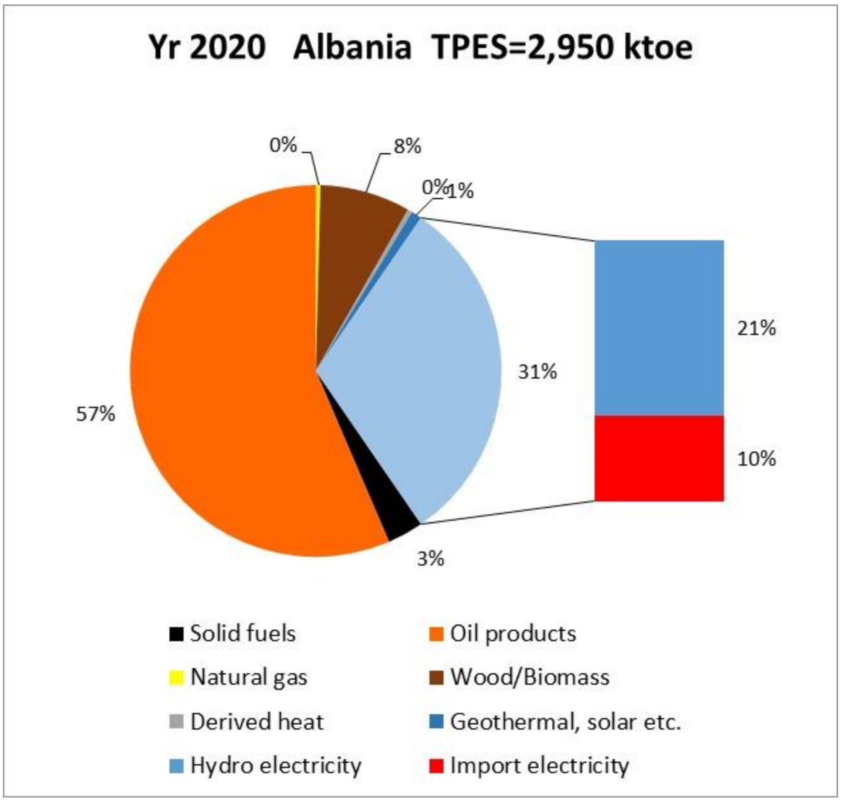
Annex 12 – TFEC Base Line pie-charts

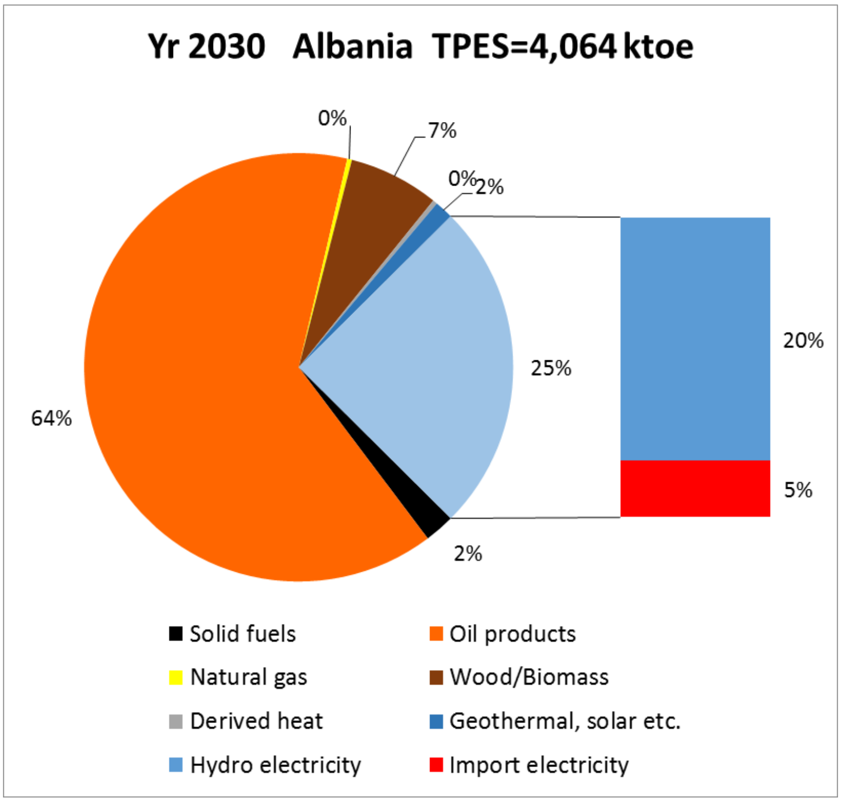


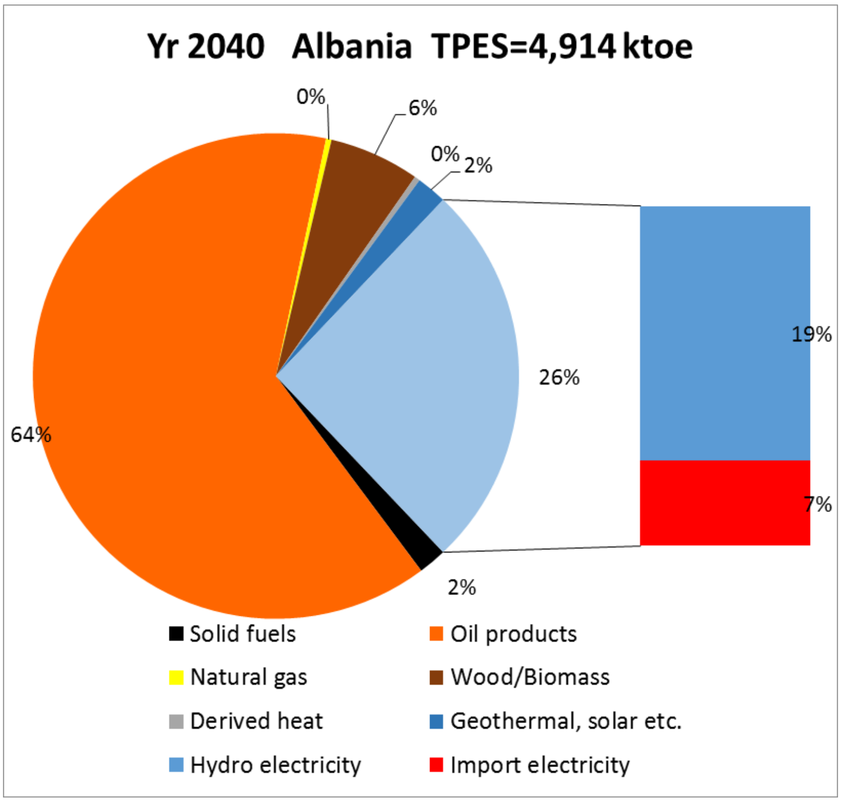



Yr 2040 Albania TFEC=4,647 ktoe
22%
5%
0.2%
2%
18%
1%
52%
14%
4%
0%
Solid Fuels
Oil Products
Natural Gas
Wood/Biomass
Other
Solar
Hydro Electricity
CCGT Electricity
Imported Electricity

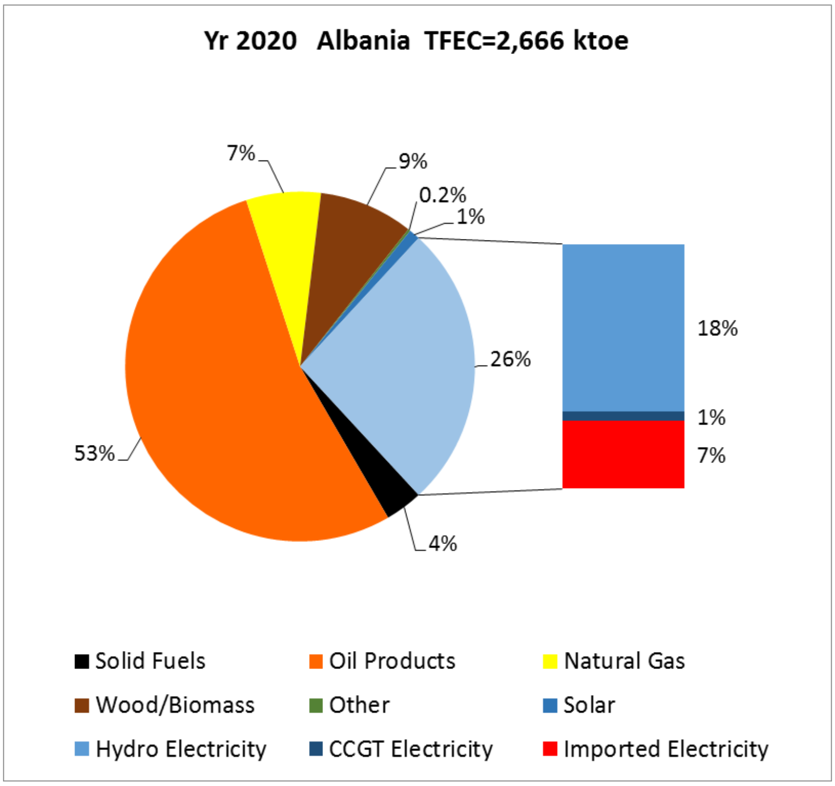
Annex 13 – TPES Base Line pie-charts

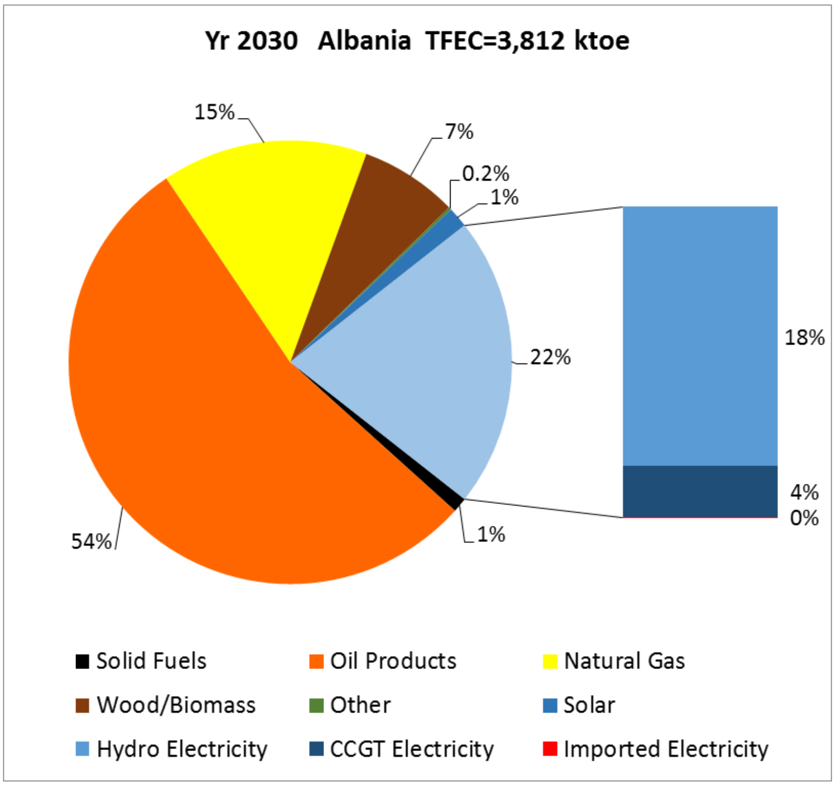




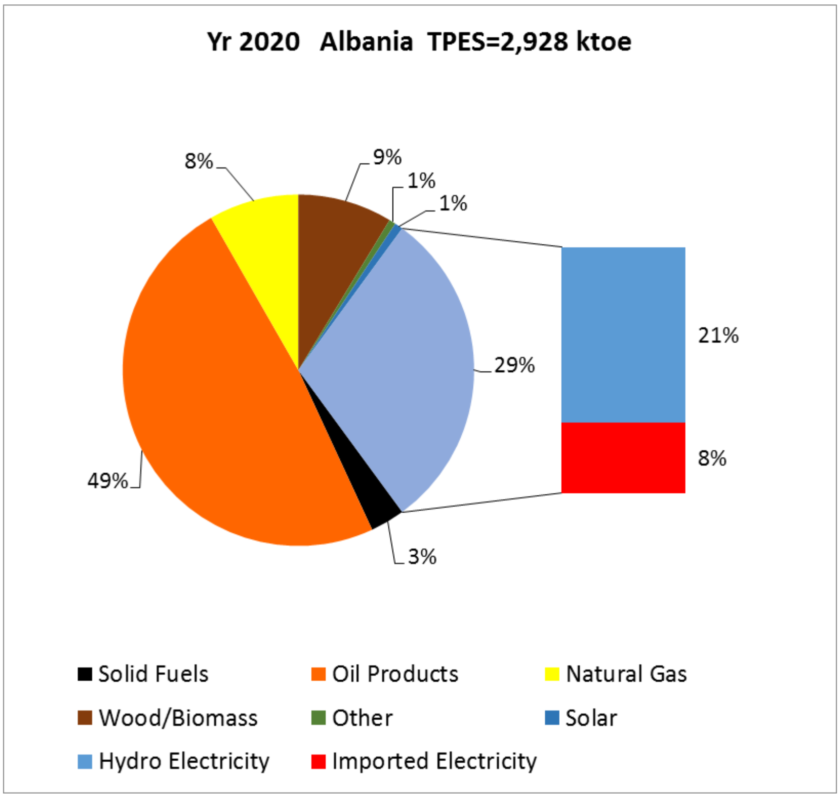

Yr 2040 Albania TPES=4,914 ktoe
0%
6%
0%
2%
19%
26%
64%
7%
2%
Solid fuels
Oil products
Natural gas
Wood/Biomass
Derived heat
Geothermal, solar etc.
Hydro electricity
Import electricity

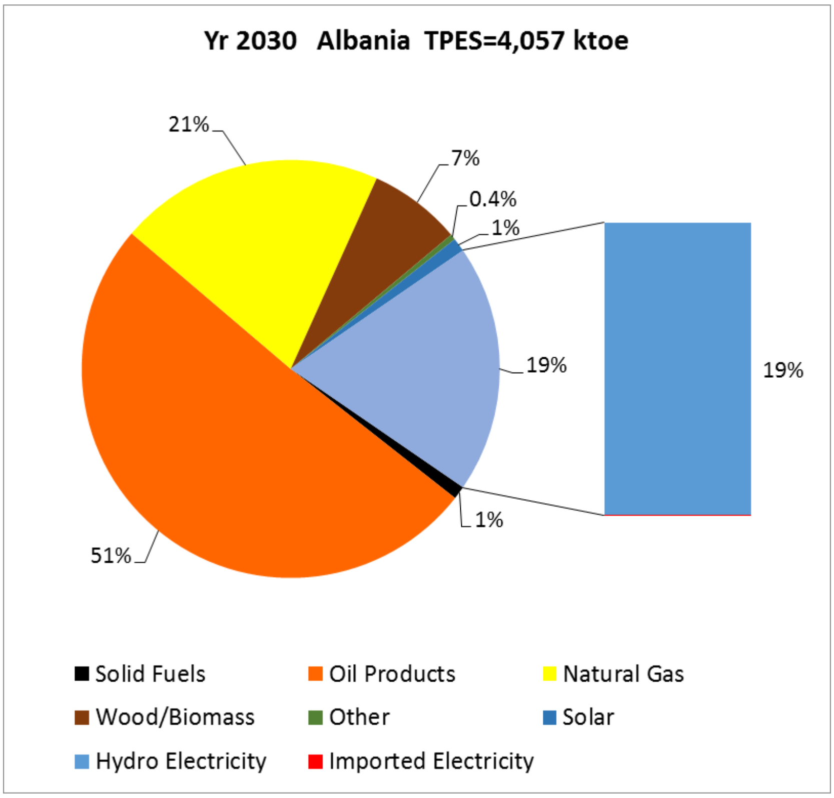
Annex 14 – TFEC Natural Gas scenario pie-charts





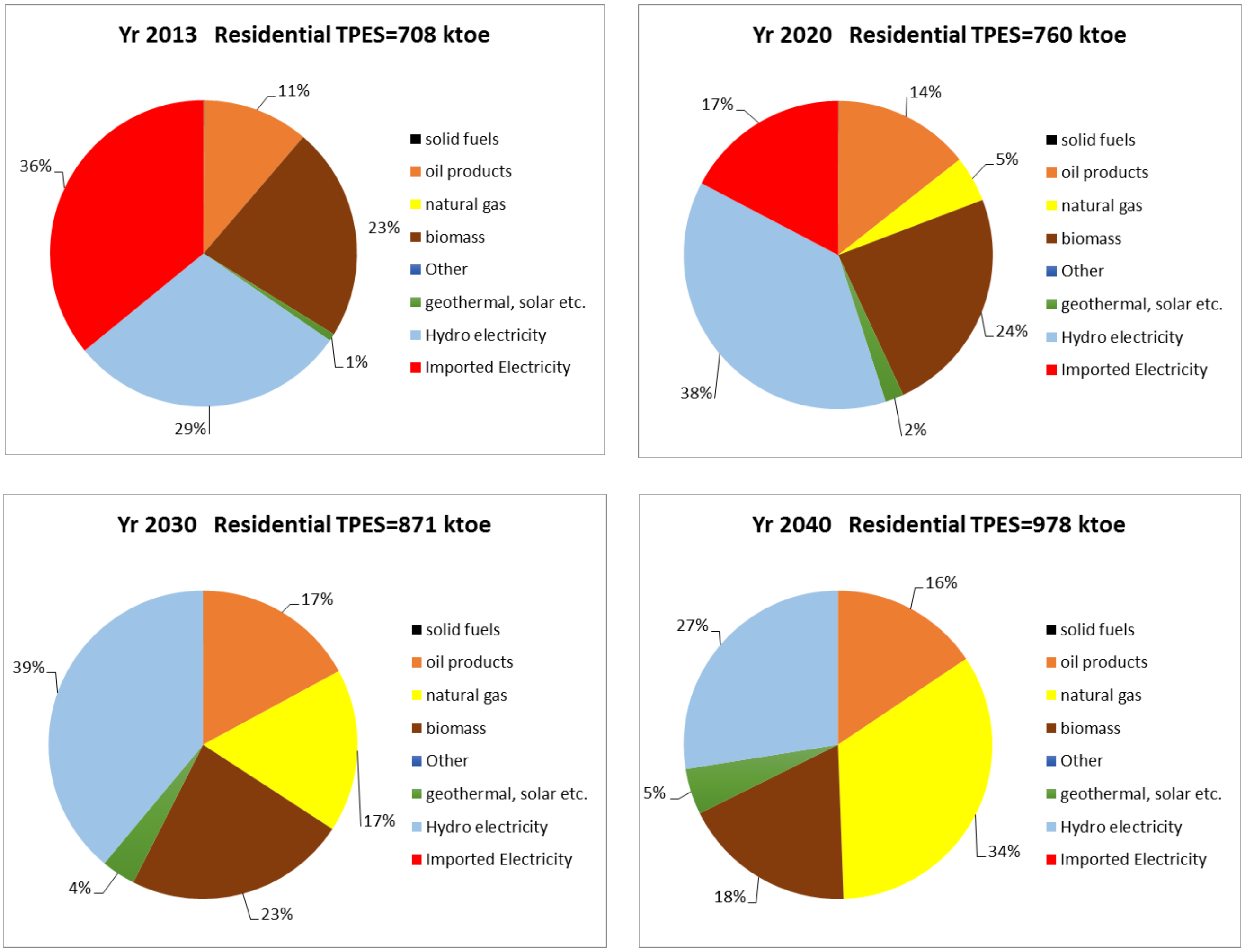
Annex 15 – TPES Natural Gas scenario pie-charts





Annex 16 – TPES Natural Gas scenario pie-charts – by sector

Residential Sector



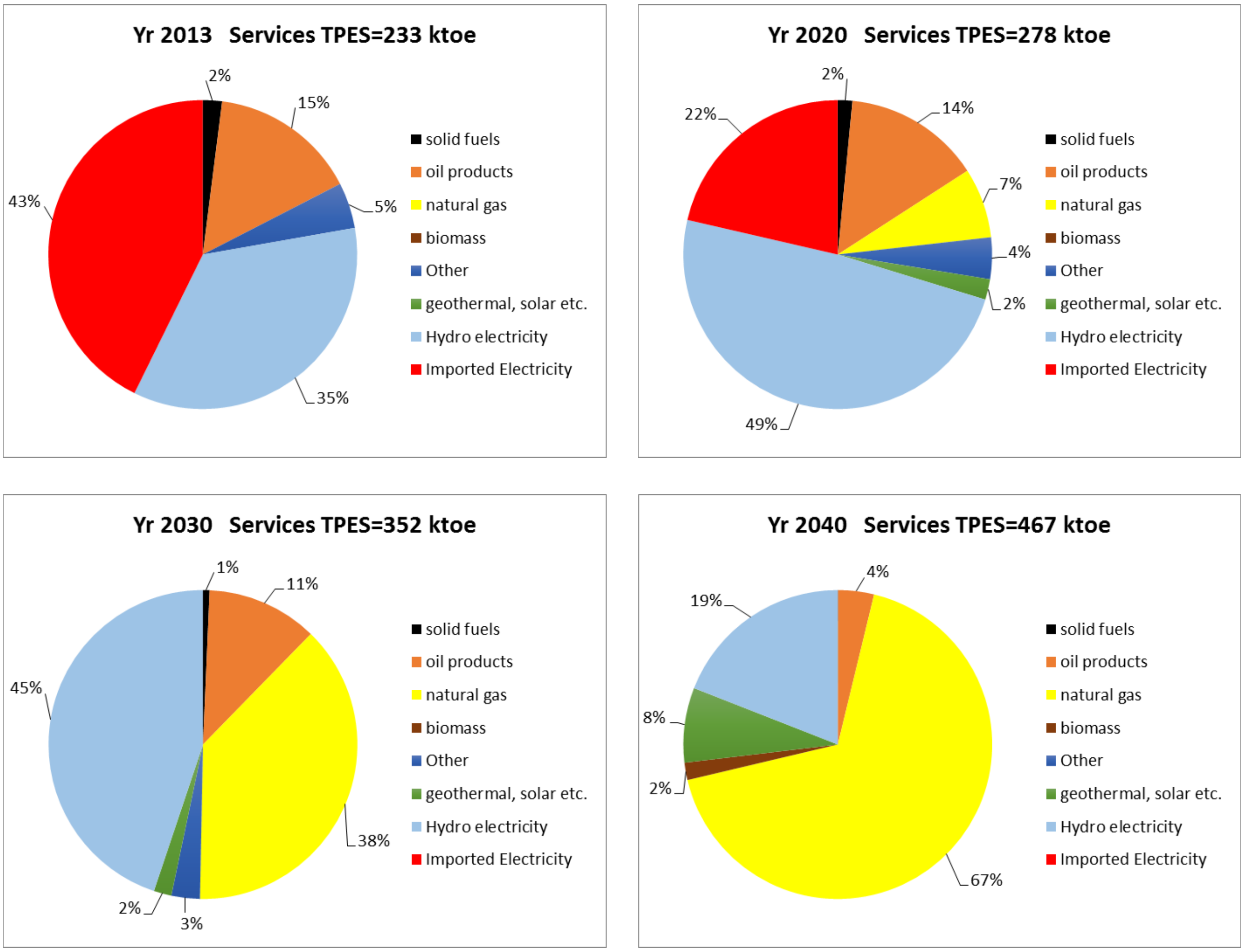
Yr 2013 Residential TPES=708 ktoe

Yr 2020 Residential TPES=760 ktoe

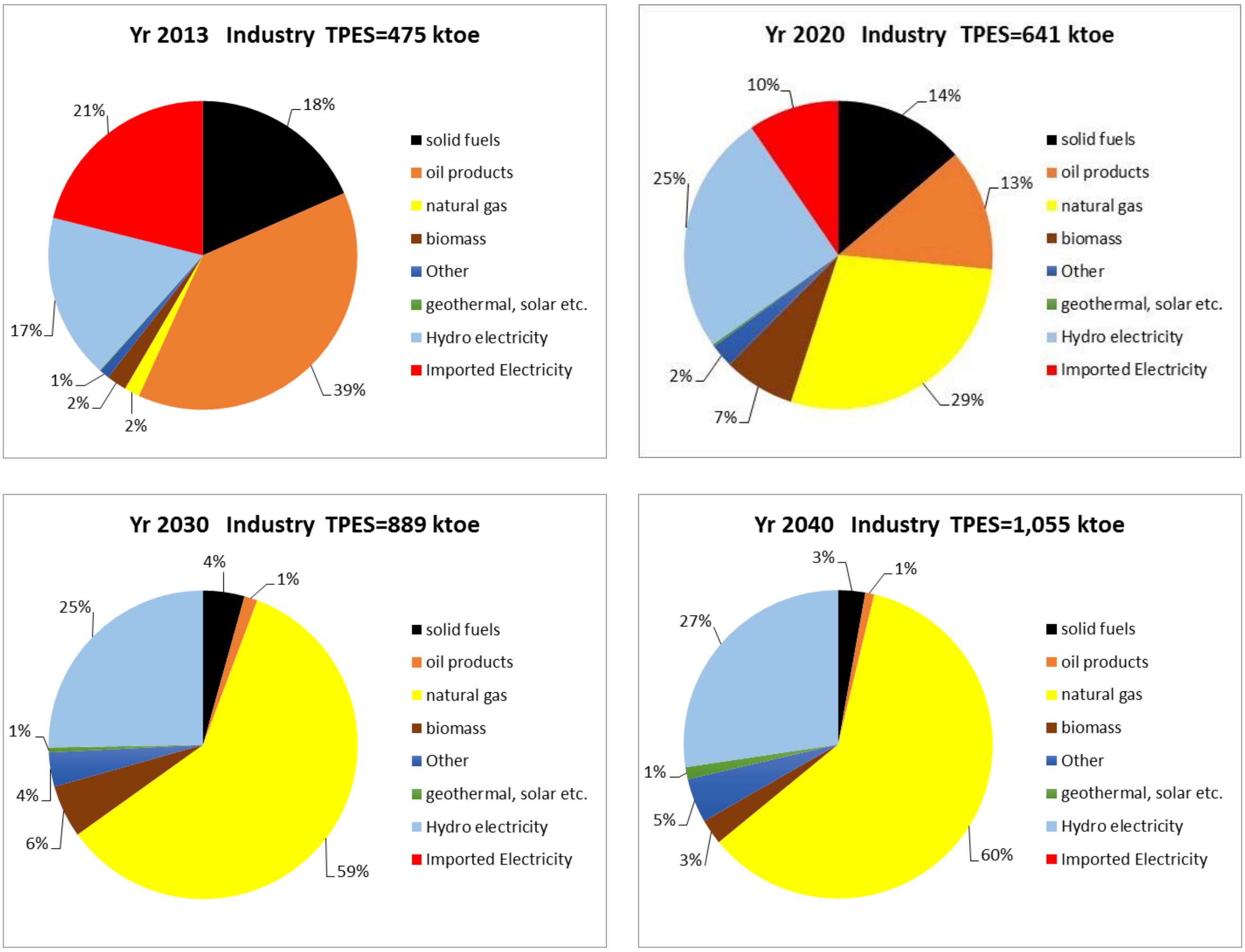
Yr 2030 Residential TPES=871 ktoe

Yr 2040 Residential TPES=978 ktoe

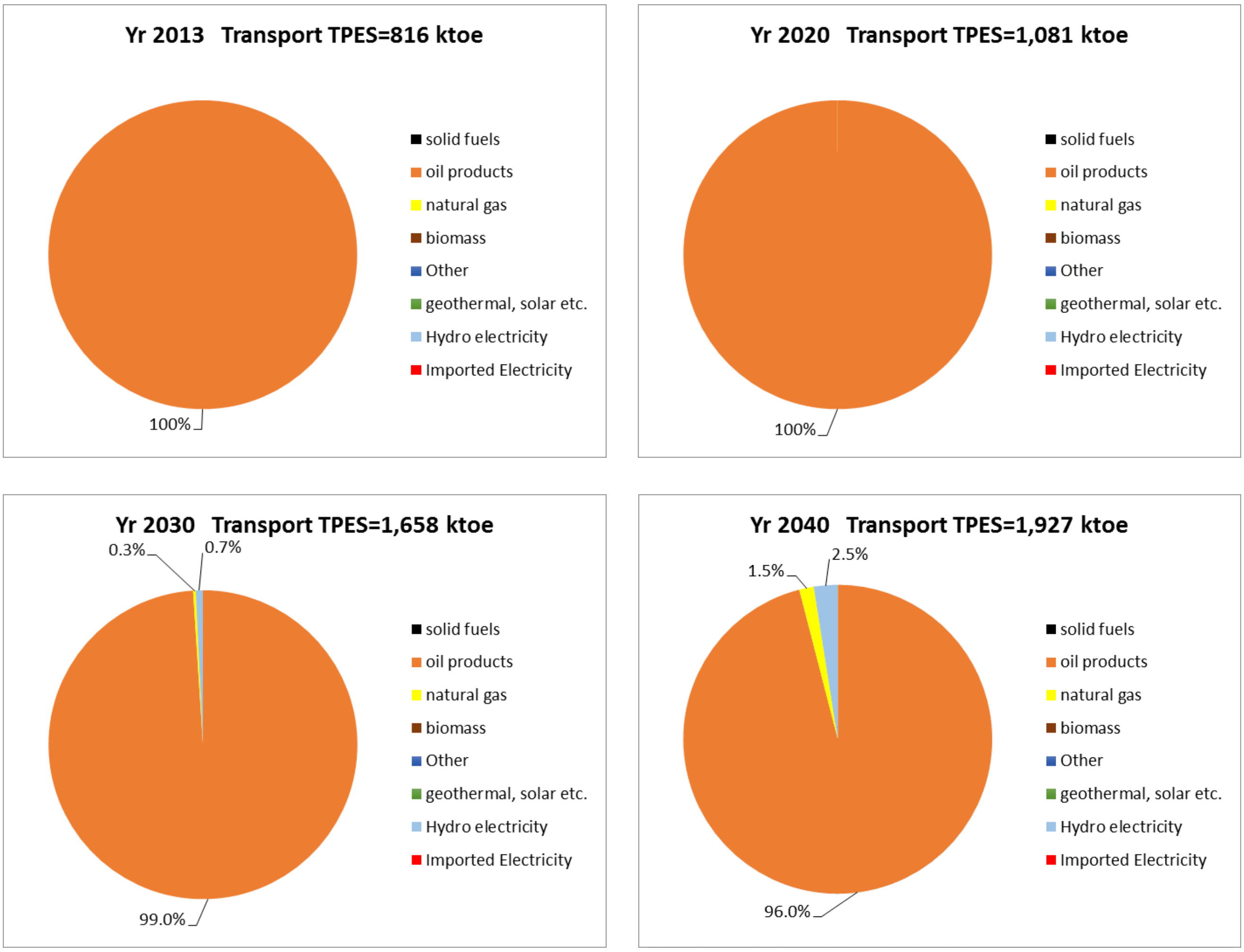
Sevice Sector

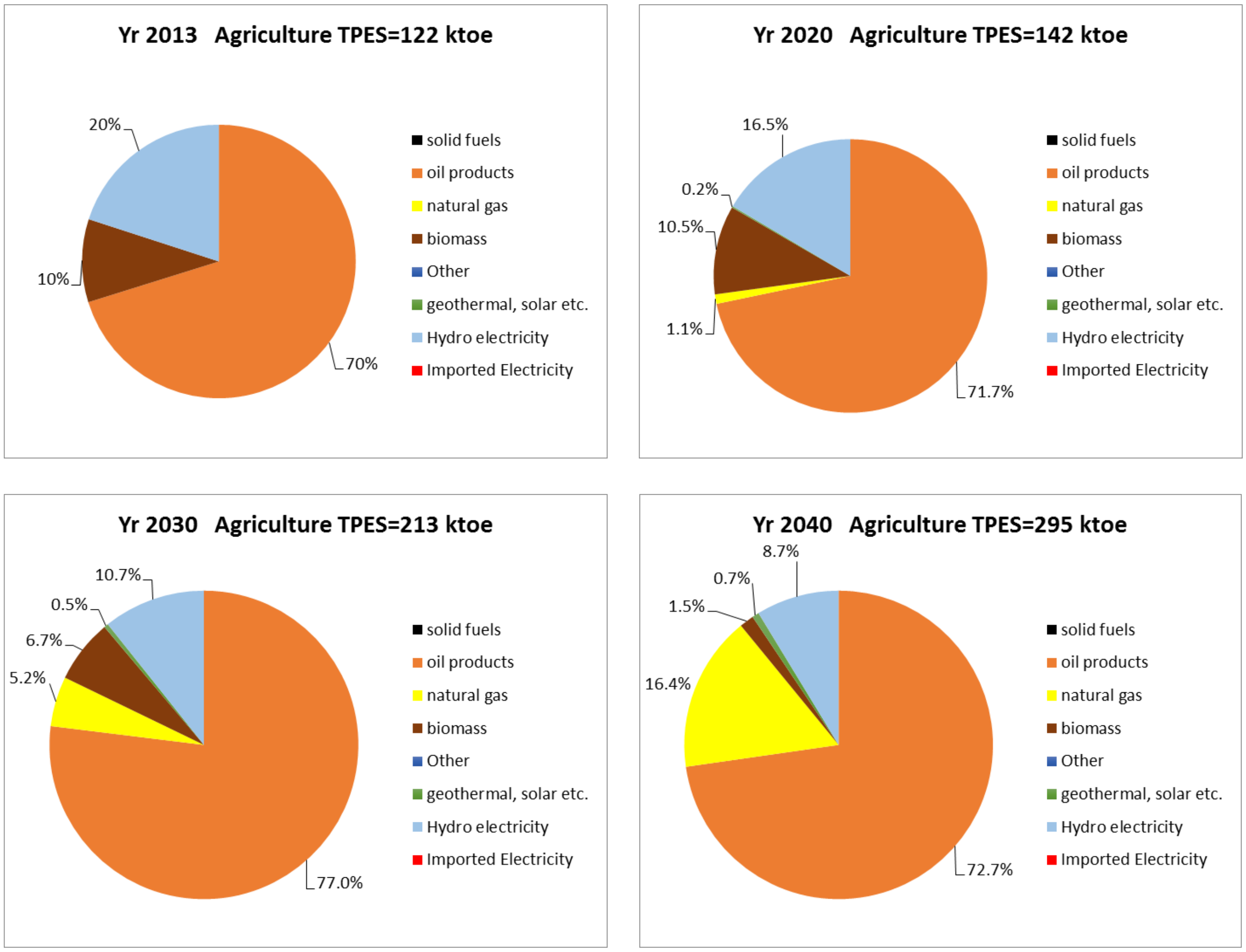


Industrial Sector



Transport Sector





Agriculture Sector