CONSTRUCTION OF A PRIVATE NATURAL GAS NETWORK

Christina Dimitriou

UNIVERSITY CENTER OF INTERNATIONAL PROGRAMMES OF STUDIES
SCHOOL OF SCIENCE AND TECHNOLOGY

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Student Name: Christina Dimitriou

SID: 3303190001
Supervisor: Prof. Theologos Pantelidis

I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Abstract

EL.GAS is a construction company specialized in the natural gas construction sector. It is the market leader in this sector and recently became the first private Distribution System Operator (DSO) in Greece. With this new role EL.GAS will construct and utilize the first private natural gas network in Skydra for a ten-year period. This study asseses on the technological and the financial framework of this pioneer project and presents the technological advancements alongside with any challenges of this project. Furthermore, refers to its financial feasibility and effectiveness by discussing several investment decision-rules. Finally, the study also conducts a scenario and sensitivity analysis to obtain a comprehensive overview of possible investment alternatives and identify critical variables and their operation.

Keywords: Cost Benefit Analysis, Net Present Value, Project Evaluation, Natural Gas

Preface

Usually the preface is used to acknowledge the supervisor, university, family, workplace, and friends. Being true to myself and writing this part honestly, the only person that I would like to thank for is my brother. Writing down this page was the most difficult part of the master's degree journey. What I have become, all my efforts and even this master's degree owes to you. You believed in me more than I did. You pushed me to be better and better and to try even harder. I don't know if you see me or not from somewhere, but I hope you will be proud of me.

Christina Dimitriou
15/12/2021

Contents

ABSTRACT .... **III**

PREFACE .... **I**

CONTENTS **1**

TABLE OF FIGURES **4**

TABLE OF TABLES **5**

TABLE OF GRAPHS **7**

INTRODUCTION **8**

CHAPTER NO.1: NATURAL GAS OVERVIEW **9**

1.1 FUNDAMENTALS 9

1.2 A TRANSITIONAL FUEL 10

1.3 BENEFITS COMPARED TO ALTERNATIVE FUELS 11

1.4 INTRODUCTION TO THE GREEK MARKET 13

CHAPTER NO.2: THE DISTRIBUTION SYSTEM **14**

2.1 DISTRIBUTION METHODS 14

2.1.1 CONVENTIONAL PIPELINE NETWORK *14*

2.1.2 VIRTUAL PIPELINE NETWORK *16*

2.2 DISTRIBUTION OPERATOR SYSTEM (DSO) 18

2.2.1 EDA ATTIKIS *20*

2.2.2 EDA THESS *21*

2.2.3 DEDA *21*

2.3 EL.GAS AS A DSO 22

2.3.1 COMPETITIVE ADVANTAGE OF OUR COMPANY *22*

2.3.2 STRATEGIC EXPANSION *23*

CHAPTER NO.3: CONSTRUCTION OF THE FIRST PRIVATE NATURAL GAS NETWORK . **29**

3.1 LOCATION OF THE PROJECT 29

3.2 TECHNICAL DEVELOPMENT 30
3.3 REVENUES OF THE PROJECT 32
3.3.1 POTENTIAL CUSTOMERS & MARKET PENETRATION LEVEL 33
3.3.2 CAPACITY LEVELS 36
CHAPTER NO.4: ECONOMIC ASPECT OF OUR INVESTMENT 41
4.1 DPOS ECONOMIC REQUIREMENTS 41
4.2 FINANCING OF THE INVESTMENT 42
4.3 INTEREST RATE, TAXATION, INFLATION 42
4.4 COST 43
4.4.1 INVESTMENT COST 43
4.4.2 OPERATION COST 46
4.5 REVENUES 48
CHAPTER NO.5: INVESTMENT EVALUATION 52
5.1 CASHFLOW TIME TABLE 52
5.2 INVESTMENT CALCULATIONS 54
5.2.1 NET PRESENT VALUE RULE (NPV) 56
5.2.2 INTERNAL RATE OF RETURN RULE (IRR) 57
5.2.3 DISCOUNTED PAYBACK PERIOD 58
5.2.4 BOOK RATE OF RETURN (BRR) 58
5.3 SCENARIO ANALYSIS 59
5.3.1 OPTIMISTIC SCENARIO 60
5.3.2 BASELINE SCENARIO 62
5.3.3 PESSIMISTIC SCENARIO 62
5.4 SENSITIVITY ANALYSIS 64
5.5 BREAK EVEN ANALYSIS 66
CHAPTER NO.6: RISKS AND ALTERNATIVES OF THE INVESTMENT 67
6.1 POTENTIAL RISK AND SOLUTIONS 67
6.2 POTENTIAL ALTERNATIVE PROJECT TO COMPARE 68
6.2.1 LOCATION OF APPLICATION 68
6.2.2 TECHNICAL DEVELOPMENT 69

6.2.3 COST AND REVENUE ... *71*
6.2.4 PROJECT EVALUATION ... *75*
6.2.5 COMPRASION WITH SKYDRA ... *75*
CONCLUSIONS ... **77**
BIBLIOGRAPHY ... **78**

Table of figures

Figure 1: Three stages of the natural gas supply chain 10

Figure 2: CO2 savings from coal-to-gas switching in selected regions compared 2010 to 2018 (Source: IAE) 11

Figure 3: The gas pipeline transportation system from production to consumption 15

Figure 4: CNG and LNG process 17

Figure 5: DSO's distribution planning 2020-2024 (Source: www.edathess.gr & www.edaattikis.gr & www.deda.gr) 20

Figure 6: DEDA's Natural Gas Network Development Plan for 2020-2024 24

Figure 7: Development Plan EL.GAS for Central Macedonia 27

Figure 8: Development Plan EL.GAS for Peloponnese 27

Figure 9: Active customers per region 2019 28

Figure 10: Schematic representation of a medium pressure network in the area of Skydra 30

Figure 11: Schematic representation of a low pressure distribution network in the area of Skydra 31

Figure 12: Revenues timeline 50

Figure 13: Schematic representation of a low pressure distribution network in the area of Polygyros 70

Figure 14 Map display of distribution network area of Polygyros 72

Table of Tables

Table 1: DEDA's Natural Gas Network Development Plan for 2020-2024 25

Table 2: EL.GAS License to build natural gas networks 26

Table 3: EL.GAS Applications for license to build and operate natural gas networks...... 26

Table 4: Skydra Permanent Population Census (Source: EL.STAT)................................. 33

Table 5: Detached House and Apartment Buildings in the Municipal Community of Skydra 34

Table 6: Penetration assumptions and household customer calculation 34

Table 7 Penetration assumptions and shop – office customer calculation..................... 35

Table 8 Degree of Consumption Penetration per Customer category 35

Table 9: Skydra Network Capacity Calculation at the end of five years 38

Table 10 : Annual Consumption Calculation of the Skydra Network at the end of the five years.. 39

Table 11: Skydra loan details 42

Table 12: Skydra loan qalqulations 46

Table 13: Skydra 10 years investment plan costs 48

Table 14: Consumers per year (By category).. 51

Table 15: Revenues for 10-Year period 51

Table 16: Skydra Cost - Revenues 10 Year Plan 53

Table 17: Skydra Costs - Revenues 10 year Plan Baseline Calculations........................... 55

Table 18: Skydra Calculations results... 56

Table 19: Discounted Cost and Revenues - Net present Value rule application 57

Table 20: Optimistic Scenario Calculations results 60

Table 21: Skydra Costs - Revenues 10 year Plan Optimistic Scenario Calculations 61

Table 22: Pesimistic Scenario Calculations results 62

Table 23: Skydra Costs - Revenues 10 year Plan Pesimistic Scenario Calculations 63

Table 24: Sensitivity Analysis Calculations results 65

Table 25: Polygyros 10 years investment plan costs 73

Table 26: Polygyros consumers per year (By category) 74

Table 27: Polygyros revenues per year 75

Table 28: Polygyros calculation results 75

Table of Graphs

Graph 1: Fossil fuel price index 1987 to 2015 (Source: BP Statistical Review 2016)........ 12

Graph 2: Greece Inflation Rate (%) 2011-2021 (Source: National Statistical Service of Greece)... 43

Graph 3: Sensitivity analysis Graph.. 65

Graph 4: Break Even Chart.. 66

Introduction

The energy sector is making incremental technological and economic advancements combined with decreased environmental impact. The recent energy law regulations in Greece gave private companies the chance to invest in the energy sector that was till recently dominated by the public sector. EL.GAS decided to be the first private company to construct a private natural gas network. EL.GAS is a construction company based in Thessaloniki with specialization in natural gas projects. In this report will analyze a new investment: the construction of a private natural gas network in the location of Skydra. The goal is to examine the characteristics of this investment and discuss on its feasibility and profitability. The analysis of this investment will start by describing several important aspects of natural gas, its distribution process, and the corresponding Distribution Operator System (DSO) in Greece. This thesis will present the innovative technological infrastructure of this investment and its reduced environmental impact compared to traditional fossil fuels (oil and coal). Briefly will discuss on the demand and supply expectations along with the accompanied tariffs. In the financial study, will present the methodological framework for evaluating this investment. Explicitly will discuss ways of financing this project, the expected revenue, and the corresponding cost. Will use investment criteria tools to evaluate our investment. In the risk management study, will examine potential risks that this investment will have to overcome by applying appropriate solutions. Finally, will provide alternative scenarios and sensitivity analysis to obtain a comprehensive overview of possible investment alternatives and identify critical variables and their operation.

Chapter No.1: NATURAL GAS OVERVIEW

In order to understand the complexity and the width of our investment is important to start from the foundations. Basic elements of natural gas, its origin, evolution, and progress till today.

1.1 FUNDAMENTALS

Natural gas is a fossil fuel, alongside oil (petroleum) and coal, which is formed deep beneath the earth's surface millions of years ago. It is a combustible, gaseous mixture of simple hydrocarbon compounds, usually found in deep underground reservoirs formed by porous rock. It is produced as a result of the decomposition of organic material by the action of anaerobic microbes. In other words, the remains of plants and animals built up in thick layers on the earth's surface and ocean floors over time were buried under sand, silt, and rock (1). Heat and pressure conducted to change some of this carbon and hydrogen-rich material into coal, some into oil (petroleum), and some into natural gas. Analyzing its composition, it comprises several gases, but consists mainly of methane and secondarily from ethane, propane, and butane (2). Burns with a blue flame, producing water and carbon dioxide when completely combusted. It is colorless, odorless, and tasteless. It has a heating value of 800 to 1,200 BTU per cubic foot.

After tracking down the areas with natural gas reserves, there is a process until the consumers take advantage of it. Briefly, the process (Figure 1) includes the stages of production, processing, transmission, storage, and finally distributing it (3). In atmospheric conditions, it exists in a gas form but due to processing technology advances, significant new segments of the natural gas have now evolved. The most important is Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG). In both cases, the gas does not change its chemical state. Mainly is used as a source of energy for heating, cooking, and electricity generation. It is also used as a fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals.

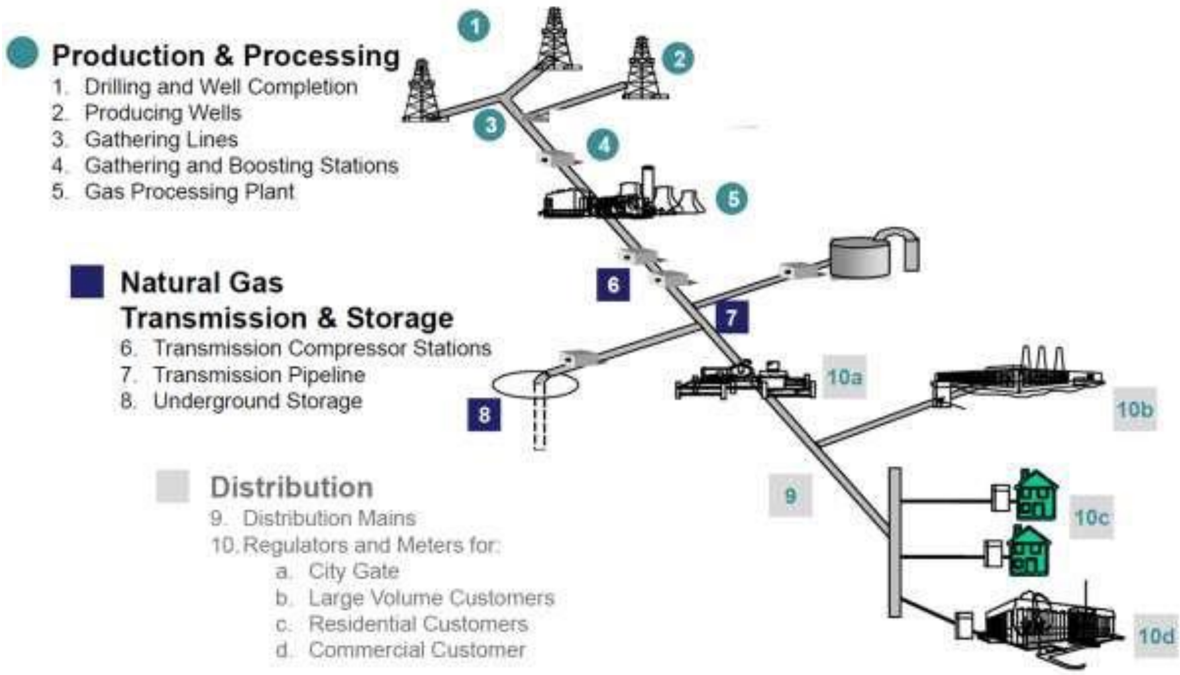


Figure 1: Three stages of the natural gas supply chain

1.2 A TRANSITIONAL FUEL

Reaching the global goals of stabilizing and reducing carbon emissions to mitigate climate change, based on the Paris Agreement (4), natural gas stands out as a bridge fuel between fossil fuels and renewable energy. Because of its economic viability compared to emerging renewable technologies and less polluting effects compared to other fossil fuels, fairly characterized as a transitional fuel. The goal of fuel switching, primarily from coal to natural gas, to reduce emissions of carbon dioxide and air pollutants stands strongly in the last decades. Especially in Greece due to our obligations in the European Union for immediate lignite phase-out till 2028 (5) natural gas stands as the optimum solution.

1.3 BENEFITS COMPARED TO ALTERNATIVE FUELS

Choosing to be the transitional fuel between fossil fuels and renewable energy was not by chance. Natural gas compared to the other fossil fuels outweighs it. It is considered as the "cleanest" and more environmentally friendly fossil fuel as when it is combusted it releases very small amounts of sulfur dioxide and nitrogen oxides. Regarding the CO_2 emissions, when burnt produces half the carbon dioxide (CO_2) and one-tenth of the air pollutants of coal when it goes through this process (6).

Using it instead of coal (Figure 2) could help reach the emissions obligations regarding the Paris Agreement and reduce near-term CO_2 emissions and air pollution, as it produces fewer toxic pollutants and greenhouse gas emissions that contribute to climate change. In power generation is a more efficient fossil fuel (7). Contamination is less likely to happen compared to oil. As it is, a pressurized fuel must be contained within a sealed system and that minimizes the chances to escape into the soil or water through careless handling, spills, or evaporation.

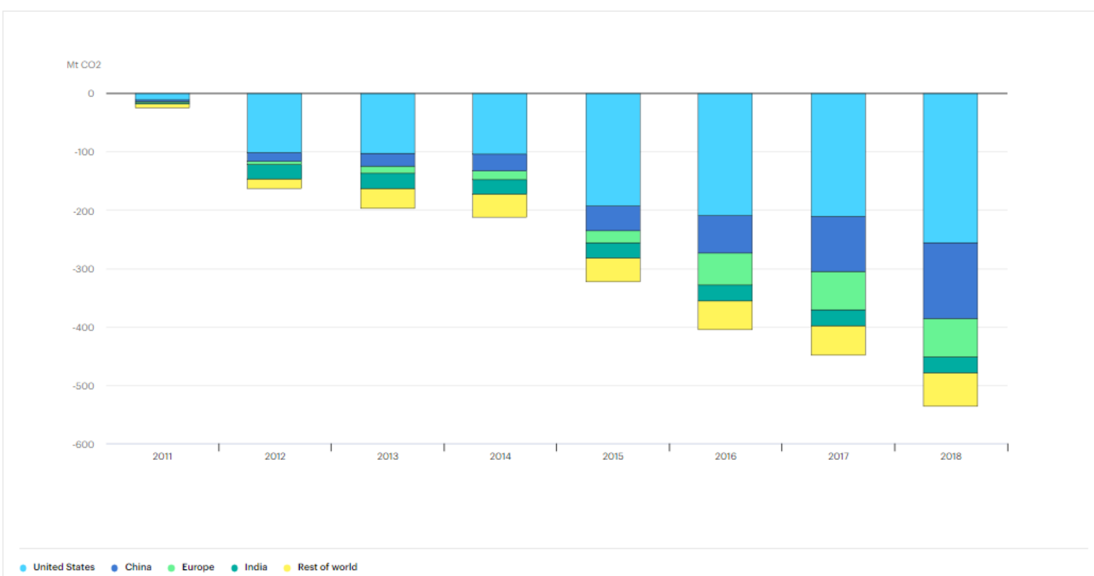
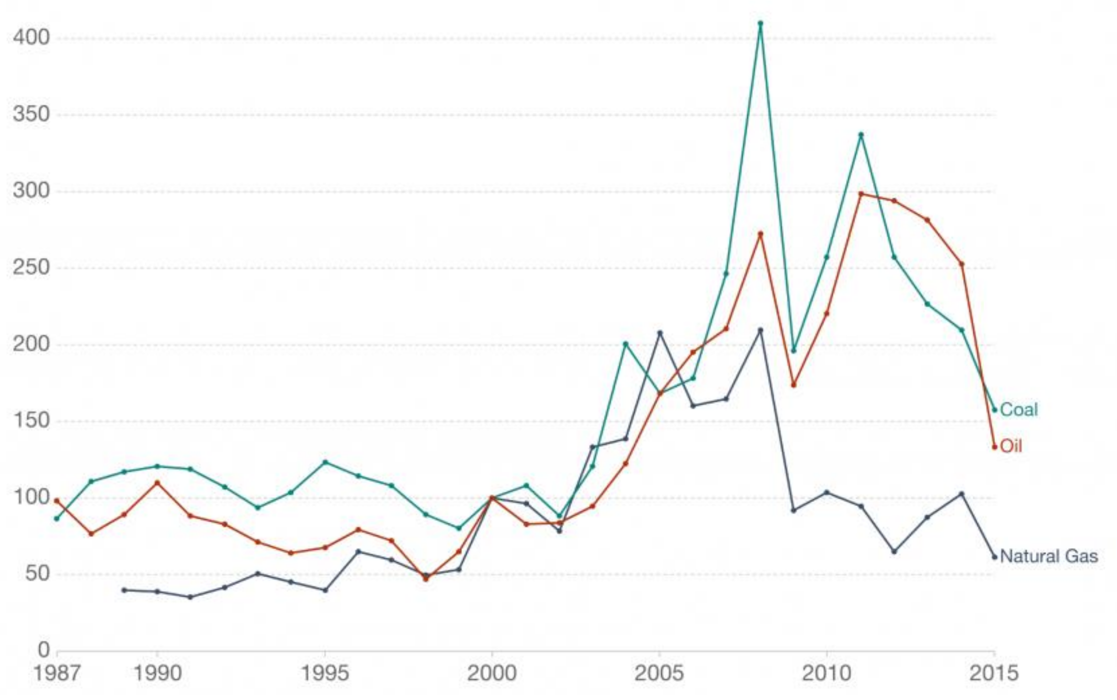


Figure 2: CO_2 savings from coal-to-gas switching in selected regions compared 2010 to 2018 (Source: IAE)

The options of converting it to Compressed Natural Gas (CNG) or Liquefied Natural Gas (LNG) gives a competitive advantage regarding its transportation and its efficiency. CNG seizes less than 1% of the volume it occupies at standard atmospheric pressure, whereas LNG takes up about 1/600th the volume of natural gas (8). These natural gas versions enforce the storage and transportation advantages because it is safer and easier to store than the other fossil fuel, and simultaneously more efficient. If we burn natural gas under perfect combustion circumstances, its light will be blue and there will be minimal to none harmful compounds, whereas other fossil fuels have many more harmful combustion products than natural gas. From an economic aspect, the cost of building a natural gas power plant is cheaper than other power plants. Moreover, it is less expensive (Graph 1) than other fossil fuels (9).



Graph 1: Fossil fuel price index 1987 to 2015 (Source: BP Statistical Review 2016)

1.4 INTRODUCTION TO THE GREEK MARKET

Natural gas was introduced to the Greek Market in 1987 when the Prime Minister of Greece at that time, Andreas Papandreou proceeded with signing an interstate agreement between Greece and Russia regarding a natural gas supply contract. Nevertheless, almost ten years needed till 1996, when the first natural gas customer (Hellenic Sugar Industry) was supplied by the natural gas network.

By that time and till today, the Greek Market faced rapid changes. Due to the lignite phase-out commitment by 2028 and the European Union obligations regarding a revised version of a 10-year National Plan for Energy and Climate (NEPC) submitted to the EU Commission, committing the country to the bloc's wider pledge to a clean energy transition.

The natural gas market by definition consists of a wide range of aspects from extraction and transition to supply and demand. The sides that stand out in this market are the shares regarding the independent natural gas system, system operation, distribution, and supply. In our case,will emphasize in the distribution market.

CHAPTER No.2: THE DISTRIBUTION SYSTEM

Exploting natural gas would be unachievable if we would not leverage its distribution in order to reach the final customers. Distribution technology regarding natural gas has make huge progress the last years and is mentioned below.

2.1 DISTRIBUTION METHODS

Distribution is the last and most essential part of the natural gas supply chain. Through the years, the distribution system has been elevated and developed in order to be more efficient and functional. Further down, we examine the main ways of distributing natural gas and its application.

2.1.1 CONVENTIONAL PIPELINE NETWORK

Pipelines are the most efficient and effective way of distributing natural gas from producing regions to consumption regions (10). In most cases, natural gas produced from a particular well will have to travel a great distance to reach its point of use. The transportation system for natural gas includes a complicated network of pipelines, formed to transport natural gas from its source to areas of raised natural gas demand. Apparently, that needs a large-scale and extensive transportation system.

Constructing natural gas pipelines network demands a great deal of organizing and groundwork, including several authorizations and governing processes (11). Transmission pipelines are wide-diameter pipelines and are usually the long-distance part of natural gas pipeline systems that bring together gathering systems in fertile areas, natural gas processing plants, other pick-up points, and the main end-user service areas. When natural gas reaches the areas where it will be used via large pipelines, it flows into smaller diameter pipelines and then into smaller service lines that go straight to homes or premises. Outlining the main steps that are involved in the process (Figure 3) of transporting natural gas from production areas to consumers, we have the following series:

- Gathering systems, made up of small-diameter, low-pressure pipelines, move raw natural gas from the wellhead to a natural gas processing plant or to an interconnection with a larger mainline pipeline.
- Natural gas processing plants separate hydrocarbon gas liquids, nonhydrocarbon gases, and water from the natural gas before the natural gas is delivered into a mainline transmission system.
- Wide-diameter, high-pressure transmission pipelines that cross the country transport natural gas from the producing and processing areas to storage facilities and distribution centers.
- Local distribution companies deliver natural gas to consumers through small-diameter, lower pressure service lines.

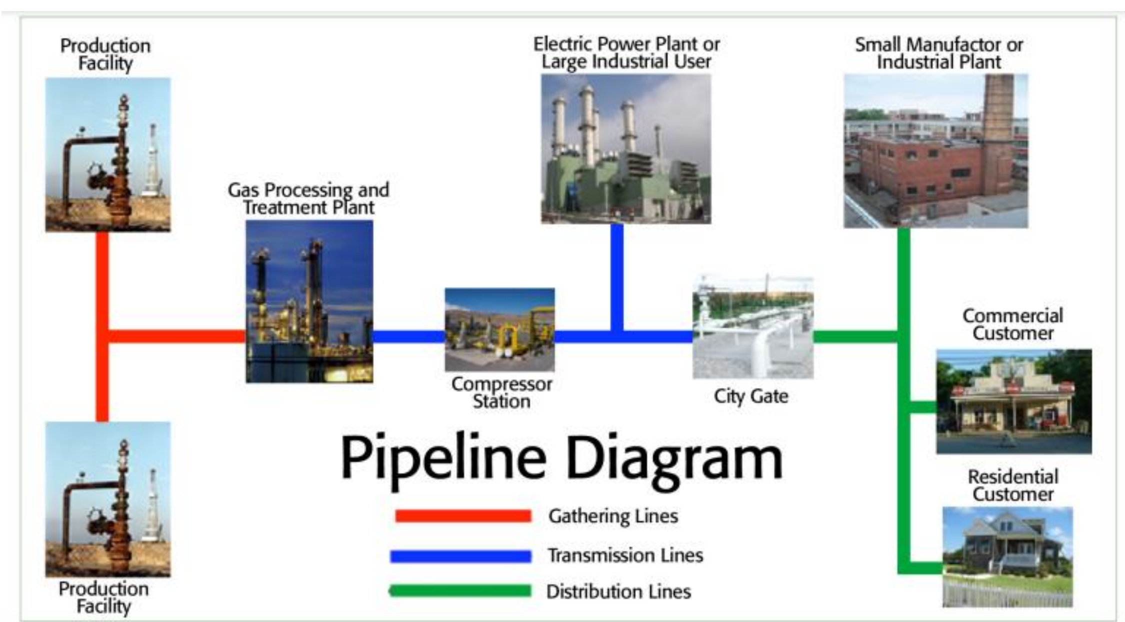


Figure 3: The gas pipeline transportation system from production to consumption

(Source: Pipeline Safety Trust)

2.1.2 VIRTUAL PIPELINE NETWORK

Alternative to a conventional pipeline, a virtual pipeline means that there is no pipe connecting the source and the user of the particular natural gas that is being conveyed. Virtual pipelines permit gas transport where the physical pipeline network is undeveloped or nonexistent. By definition, virtual pipelines are scheduled shipments of natural gas from point A to point B, either by water, in ocean-going or coastal tankers and barges, or overland in containers by rail or road. This operation supply markets that are either too small for normal large-scale carriers or too geographically challenging to justify an investment in pipeline construction (12).

Separating the “virtual pipelines” into two categories based on the mean of transport, then will have virtual pipelines offshore and onshore. For the offshore ones, overwhelmingly Compressed Natural Gas (CNG) is transported. On the other hand in onshore transports, Liquefied Natural Gas (LNG) is preferred.

The procedure of “virtual transporting” CNG inland concisely consists of three basic phases; compression of gas in a compression station, transportation of CNG with tracks, and finally decompression of gas at the decompressor station and channel it to the local network. In most of the cases and also in Greece the sequence of the steps (Figure 4) is the following one:

- A denominated “mother station” is constructed and supplied closed to the main natural gas pipeline network. There takes place the compression of natural gas from 19 to 200 bar.
- Then comes the stage of transportation where specially formed trailers, with a capacity of 200 bars, transport the compressed natural gas from the mother station to the decompression center.
- In that stage there is manufactured a decompression center where the compressed natural gas carried with the trailers is decompressed from 200 bars to 4 bars.
- Since the stage of decompression is completed, the natural gas is ready to pipeline in the local network and to the final customer.

As for the offshore “virtual transporting”, which is often picked for Liquefied Natural Gas (LNG), the operation is simpler. In this case, the main stages (Figure 4) are processing in the liquefaction plant, the sea transport, and last but not least the regasification in the import terminal before pumping it into the customers. With a precise approach the basic stages are:

- Liquefaction process that takes place as a first step where the gas has to be liquefied through the process of refrigeration technology which makes it possible to cool the gas down to approximately -162 °C (-256°F) when it becomes a liquid. In other words, the liquid form seizes a volume 600 times smaller than the same amount of natural gas.
- Using specialized LNG carries specifically designed to contain the cargo at or near atmospheric pressure at a cryogenic temperature of approximately -162°C (-259°F) LNG is transported from the liquefaction plant to the import terminals (usually marine or waterfront facilities) adapted to the stringent international regulations regarding the construction and operation of LNG Carriers at sea and in port.
- Finally, LNG carriers deliver the LNG to a marine terminal where the LNG is stored before undergoing regasification, which converts the LNG back into its gaseous form and is ready to deliver to the customers or stored for later on use.

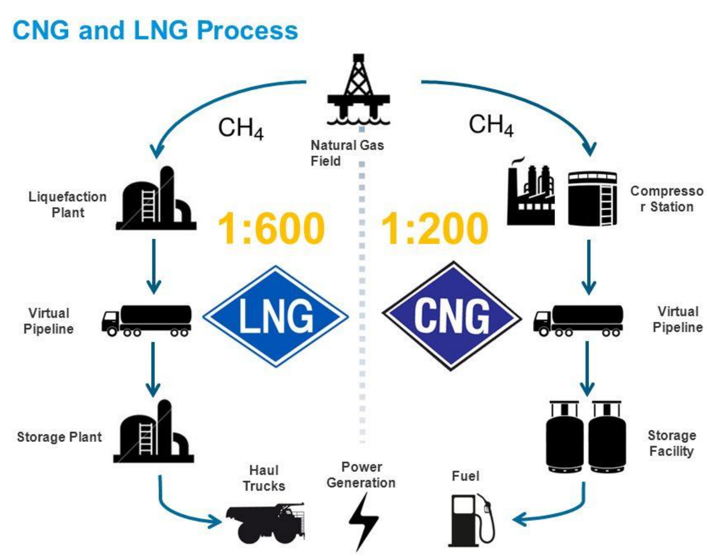


Figure 4: CNG and LNG process

2.2 DISTRIBUTION OPERATOR SYSTEM (DSO)

In Greece until today, the natural gas conventional and virtual pipeline networks were under the jurisdiction of the public sector, which was in charge of its development and operation; in particular the corresponding Distribution System Operator (DSO). As a monopolistic enterprise, the distribution of natural gas was segregated from the supply of natural gas by Law 4336/2015.

RAE (Regulatory Authority of Energy) by the decision 589/2013 (Government Gazette B '487 / 20.07.2017), issued the Distribution Network Operation Code (13). The aim of this code is to set the rights and obligations of the Distribution System Operator as well as issues related to the operation, maintenance, development, and management of the distribution network.

Based on the referred code one of the DSO obligations is to provide the Basic Activity Distribution Services, according to the specific terms and conditions set in the Distribution Network Operation Code, to the distribution system Users and Final Customers, in the most cost-effective, clear, and direct way, without any favoritism between the Users or the Final Customers.

The Basic Activity of the Operator includes, among others:

- Provision of access to the Distribution Users, with objective and impartial criteria, without endangering the smooth and safe operation of the Distribution Network, in accordance with the specific provisions of the Distribution Network Operation Code and the relevant legislation.
- Development (planning and construction) of the Distribution Network.
- Inspection, maintenance, replacement, and upgrade of the Distribution Network.
- Ensuring the security of the Distribution Network, management and immediate response to emergencies, crisis management.

- Approval of Indoor Facilities Studies and inspection conduction in new buildings.
- Promotion of the use of natural gas through market mechanisms for the development of the Distribution Network and the connection of new Final Customers to the Distribution Network.
- Development and operation of easy-to-use and secure information systems, for the execution of his activities.
- Switching shipping carrier process per delivery point.
- Activation of the natural gas meters.

There are three regions in which the natural gas market exists and DSO's are the operators of these three regions. In the area of Attica, EDA Attica is responsible for the operation of the natural gas distribution network as the owner of it. EDA Thessaloniki-Thessaly, as the holder and manager of the natural gas distribution network in the Thessaloniki and Thessaly regions. Finally, DEDA is in charge of the rest of Greece, except for the areas of EDA Attica and EDA Thessaloniki-Thessaly, as the owner and operator of the corresponding distribution networks.

Based on the published planning (Figure 5) of all DSO's for the fore coming period of 2020 – 2024, the expansion of natural gas will face a huge raise alongside the corresponding revenues. All the aforementioned DSO's have come up in 2017 after the unbundling of the previous three EPA (Etaireia Paroxis Aeriou) that served as both the DSO's and the retailers of the market. Taking these projections into consideration, it is surprising that until 2019, no private company had attempted to enter the field of constructing and own a natural gas network.

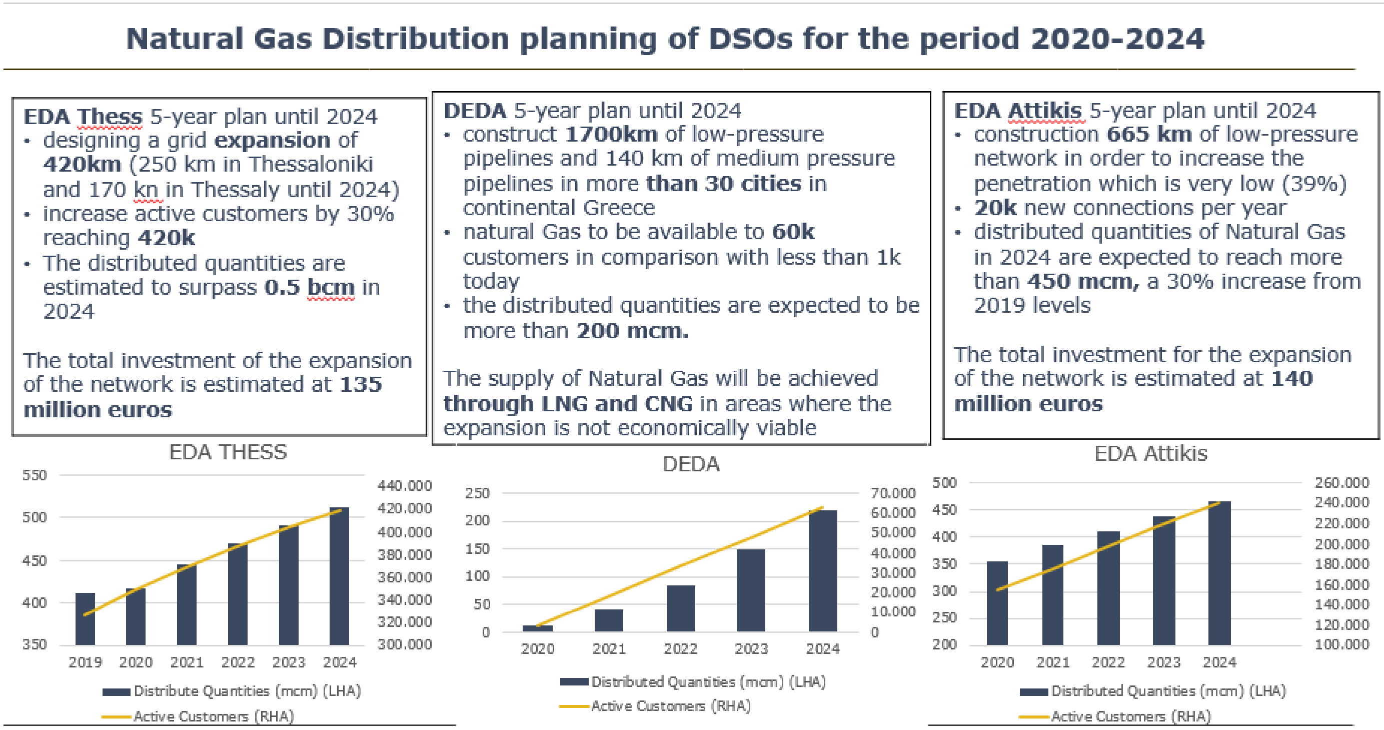


Figure 5: DSO's distribution planning 2020-2024 (Source: www.edathess.gr & www.edaattikis.gr & www.deda.gr)

2.2.1 EDA ATTIKIS

EDA Attikis SA is the responsible DSO for the region of Attica since 2017 when it started its operation with the aim of maintenance, operation, and development of the natural gas networks and the connection of the consumers with it. Till today, EDA Attikis, daily with safety and reliability distributes natural gas to thousands of households and businesses in over 50 municipalities in Attica via a modern network of low and medium pressure pipelines with a length of 3,600 km. The medium pressure and low-pressure distribution network that is operated, maintained, and developed by EDA Attica is the mean of the distribution of natural gas in Attica.

The medium pressure network consists of 330 km of medium pressure pipes, steel pipes with a nominal operating pressure of 19bar or 10bar, to which large industrial consumers are connected as well as the distribution stations that supply the low-pressure networks. Across the low-pressure distribution network, EDA Attikis supplies about 135,000 delivery points, serving a total of almost 385,000 final customers — domestic consumers, commercial consumers, industrial customers, and customers with gas air conditioning. In 2019 the total distributed quantity of natural gas in the distribution network of EDA Attica amounted to 3,981,246 MWh. (14)

2.2.2 EDA THESS

EDA THESS SA or else ETAIRIA DIANOMIS AERIOU THESSALONIKIS THESSALIAS SA started its operation in 2017. Its main activity was planning, design, report, and construction of natural gas networks in the Municipalities and Communities of the geographical region of Thessaloniki and Thessaly. The network of EDA THESS SA, serves thirteen municipalities of the province of Thessaloniki and seventeen municipalities of the region of Thessaly, which already have an activated natural gas network. Through a modern network of pipelines that is constantly developing, and having in mind the needs of the citizens and the environment, EDA THESS SA distributes natural gas safely. Except from the conventional pipeline network that already is developed, with the initiative of EDA THESS SA until this day nine areas are furnishing with natural gas via virtual pipelines. These areas are Lagkadas, Koufalia, Chalastra, Kalampaka, Palamas, Sofades, Elasona, Agia and Tirnavos. In the foreseeable future, it is expected to expand the virtual pipeline network to new remunerative areas.

2.2.3 DEDA

Similar with EDA ATTIKIS and EDA THESS, DEDA was established in 2017 and is a subsidiary of the Public Gas Corporation (DEPA). DEDA is responsible for the areas that are not in the jurisdiction of EDA ATTIKIS and EDA THESS and belong to the Greek territory. It owns, develops, operates and maintains the natural gas distribution networks in different regions of Greece providing economic, reliable, secure and uninterrupted energy supply. The main goal of the company is to operate responsibly, collectively and efficiently the natural gas field with environmentally friendly methods and to upgrade the quality of life of citizens.

In 2020 it reviewed and implemented an ambitious, multiannual development plan which launches the development of natural gas networks in 39 cities in the regions of Eastern Macedonia & Thrace, Central Macedonia, Central Greece, Western Macedonia, Western Greece, Epirus and Peloponnese and aims to construct 1,880 kilometers of network and more than 50,000 connections. This is a large and ambitious project, both in scope and timing, with multiplier benefits for the economy and the local communities of the Greek region. Till 2036 DEDA aims to expand in six regions, to construct 2,372 km of natural gas network, investments close to 450 million euros and 173,562 number of connections. Finally, the network expansion program of DEDA for the period June - October 2021 includes the areas of Alexandroupoli, Komotini, Xanthi and Drama.

2.3 EL.GAS AS A DSO

Areas, where natural gas has not yet implemented, are open to an assertion from any DSO. EL.GAS seizing this opportunity will be the first private competitor to the current DSO’s, constructing the first private natural gas network as a pioneer in the DSO field.

2.3.1 COMPETITIVE ADVANTAGE OF OUR COMPANY

Being the first private company entering a monopolistic, regulated, and till recently, public sector field was not easy since the company had to face the difficulties of a pioneer. The decision to invest in natural gas pipeline network was not by chance; on the contrary, it was based on characteristics and advantages that the company build all these years. Since 2006, is the key constructor for DESFA, the National Transmission Network Operator and the three Distribution Network Operators (DEDA, EDA THESS and EDA ATTIKIS). Currently, is the largest contractor in Greece for all DSO's with an average construction capacity of 10 km and 3,500 gas point connections per month.

Having 15 years of technical knowledge and experience in pipeline construction, operation, gasification, distribution, and transmission of gas systems, inspection, and management systems in natural gas infrastructure is an indisputable qualification. EL.GAS has undertaken all the legal building, development, and operating responsibilities, concerning the natural gas distribution networks. Moreover, provides a wide range of services from a High-Pressure Network at 80bar to the connection of the final customer at 25mbar. Being the first Company in Greece to implement the concept of a 'virtual pipeline', that allows the so-called 'remote networks' to be supplied with gas, a practice that has found ground both abroad and in Greece.

As a contractor for EDA THESS has built CNG infrastructures and simplys natural gas with virtual pipeline networks in six cities. During the past years, has continued to develop by investing in research, personnel, and infrastructure and aims to leverage all the technical know-how and technical experience of its manpower, in order to become the first private DSO. For these reasons, EL.GAS is confident that the business venture will be successful.

2.3.2 STRATEGIC EXPANSION

Recently, EL.GAS was the first private company that obtained licenses to develop and operate distribution networks in cities that were excluded from DEDA's development program. The Regulatory Authority of Energy (RAE) granted DEDA distribution and network management licenses for a number of municipalities. DEDA filed for approval from RAE the "Development Plan" for the following five years which includes the development of the existing gas distribution network, the construction of a new distribution network, new connections, and distributed quantities. The region of Peloponnese considers to have a minor expansion in the 5-year development plan of DEDA (Figure 6 & Table 1). Furthermore, with the governments' decision to close the lignite-fired power plants the cities that used district heating from these plants will have to cover these needs with another method, and natural gas seems to be the best solution. DEDA has not the financial capability to develop the needed infrastructure on time, and this is a great opportunity for EL.GAS's rapid development.

Figure 6: DEDA’s Natural Gas Network Development Plan for 2020-2024

Table 1: DEDA's Natural Gas Network Development Plan for 2020-2024

Centre Greece	**Eastern Macedonia & Thrace**
Lamia	Alexandroupoli
Chalkida	Komotini
Thiva	Drama
Leivadia	Xanthi
Delphi	Orestiada
Karpenissi	Kavala
Western Greece	**Epirus**
Patra	Ioannina
Agrinio	Arta
Pyrgos	Preveza
Western Macedonia	Igoumenitsa
Kastoria	**Central Macedonia**
Grevena	Katerini
Maniakoi	Kilkis
Argos Orestikou	Serres
Amyntaio	Veria
Florina	Giannitsa
Ptolemaida	Alexandreia
Kozani	

In 2019 EL.GAS, leveraged its technical experience and strong financial performance and became the first private company that got the license to build and operate a Gas Distribution Network in Greece. Currently, EL.GAS holds licenses in three out of nine regional units in Greece; Peloponnese, Central and Western Macedonian. These regions have a total population of 2,2 million people. Till today six cities; Paionia, Deskati, Edessa, Polygyros, Tripoli and Korinthos have officially a license to build natural gas networks (Table 2). Within its strategic expansion plans, EL.GAS applied to RAE for the license to build natural gas networks for Skydra, Naousa, and Megalopoli (Table 3). Moreover, licenses to operate the networks of all the aforementioned cities are also in the process of being officially awarded from RAE to EL.GAS (Table 3). In addition, EL.GAS applied for certification to be an administrator of natural gas networks.

Table 2: EL.GAS License to build natural gas networks

Deskati	FEK B 3874-22.10.2019
Paionia	FEK B 3844-17.10.2019
Edessa	FEK B 5096-31.12.2019
Poligyros	FEK B 5212-31.12.2019
Tripoli	FEK B 2778-09.07.2020
Korinthos	FEK B 2779-09.07.2020

Table 3: EL.GAS Applications for license to build and operate natural gas networks

Build	
Megalopoli	I-287350 26/08/2020
Skydra	I-287387 28/08/2020
Naoysa	I-287388 28/08/2020

Operate	
Deskati	I-286020 24.07.2020
Edessa	I-286006 24.07.2020
Korinthos	I-286010 24.07.2020
Paionia	I-286013 24.07.2020
Poligyros	I-286015 24.07.2020
Tripoli	I-286017 24.07.2020
Megalopoli	I-286308 29.07.2020
Skydra	I-286310 29.07.2020
Naoysa	I-286309 29.07.2020

The development plan of EL.GAS includes two clusters in the Northern and Southern Part of Greece (Figure 7 & Figure 8). The strategic focus of the company is to further expand the gas distribution network in the areas of Peloponnese and Western Macedonia, regions that have large potential consumption and the development of gas networks from DEDA is stagnating. Plans to install CNG compressors in Megalopoli for full coverage of Peloponnese with natural gas. In ten years it is expected to have 27,000 new household customers and more than 700 non-household customers.

The total consumption for Central Macedonia, Peloponnese, and Western Macedonia is projected to be 91 mcm per year. For the development of the plan, the total financial needs are about 57,000,000 € of which, the operating costs are almost 21,000,000 €. The revenues from the investments are calculated to be almost 94,000,000 € after ten years.

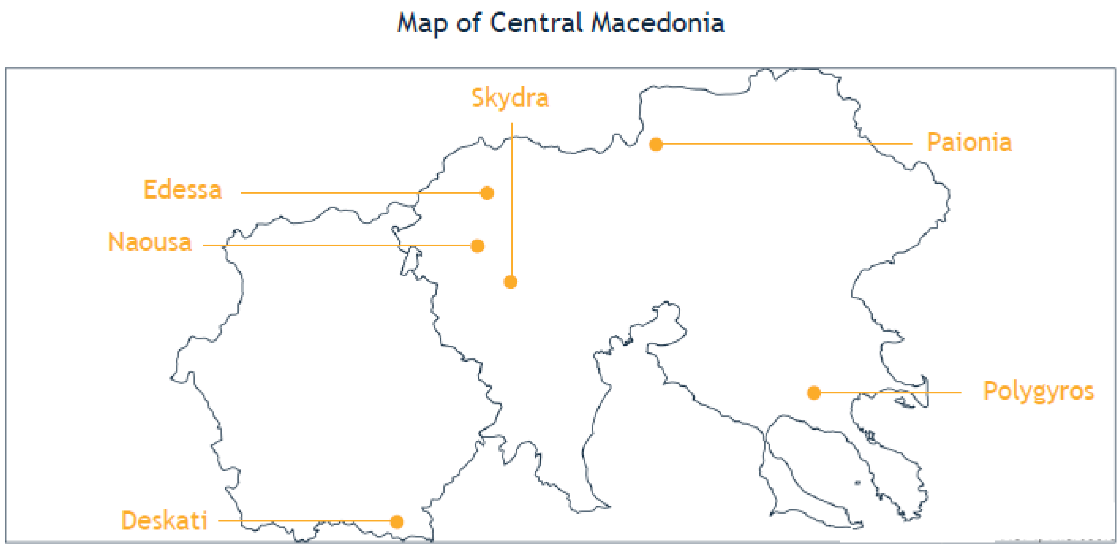


Figure 7: Development Plan EL.GAS for Central Macedonia

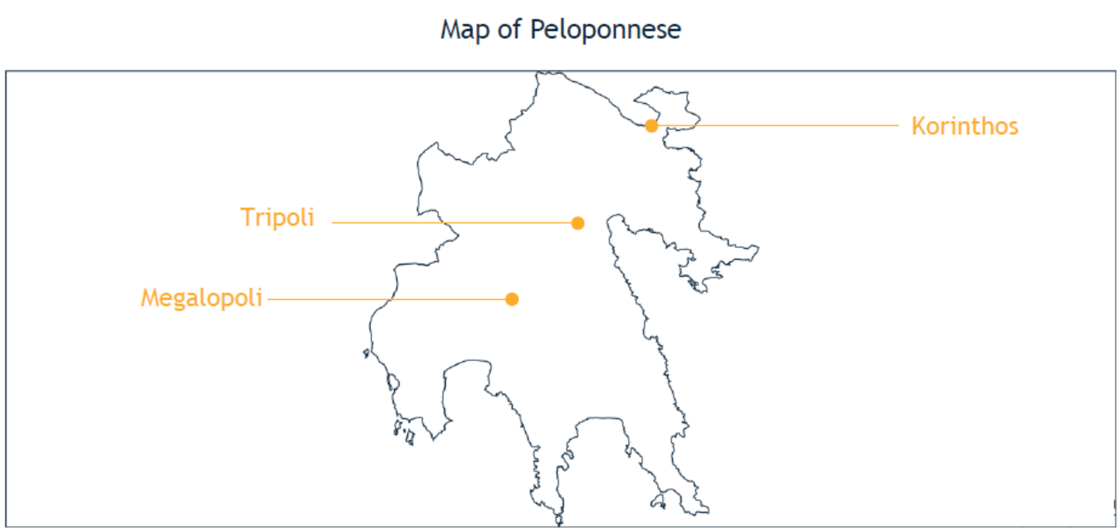


Figure 8: Development Plan EL.GAS for Peloponnese

The number of client connection and the financial approach, cost and revenues, on the business plan seem guaranteed as it is based on data from the rest DSO's. The experience so far from the already developed networks of Thessaloniki, Thessaly and Attica, show a penetration of about 50%. In particular the penetration rate of retail and industrial customers in the region of Thessaloniki reached 51%, in Thessaly 50%, while in Attiki it has reached only 39% in 2019 (Figure 9).

Region	Attiki	Thessaloniki	Thessaly
Active Customer	135k	230k	95k
Network Coverage	55%	53%	55%
Penetration	39%	51%	50%

Figure 9: Active customers per region 2019
(*Source: www.edathess.gr & www.edaattikis.gr)*

CHAPTER No.3: CONSTRUCTION OF THE FIRST PRIVATE NATURAL GAS NETWORK

Skydra will be the first implementation point of EL.GAS duties as a DSO. The first private natural gas network in Greece served by a private company.

3.1 LOCATION OF THE PROJECT

The strategic focus of the company is to penetrate in the field of constructing natural gas networks. Specifically to construct a natural gas distribution network in the area of Central Macedonia, a region that has large potential consumption and the development of gas networks from DEDA is inert. In particular, the investment will take place in Skydra. Skydra is located in Central Macedonia occupying an area of 239,6 km2 and inhabited by 5,406 people with population density 84.3 residents/km2 based on the 2011 permanent residence inventory by the ELSTAT (Greek Statistical Authority) (15). The distribution network concerns the wider area of the municipality of Skydra. An overall development plan of the company for the area is presented, and includes the development of low-pressure networks in the above municipality.

The company's plan is the construction of medium and low-pressure distribution networks in Skydra, according to the company's development plan which includes the construction of a steel pipeline, through the exit of the NNGS (National Natural Gas System) (16) in Aspro. The Low-Pressure network distributes the gas to domestic and commercial consumers in order for the smooth operation of the Distribution network. The supervisory survey of the proposed network is presented in Figure 10. The total length of the steel network is estimated at a total of 8 km for the first 5 years and 930 m for the other 5 years (Figure 10).

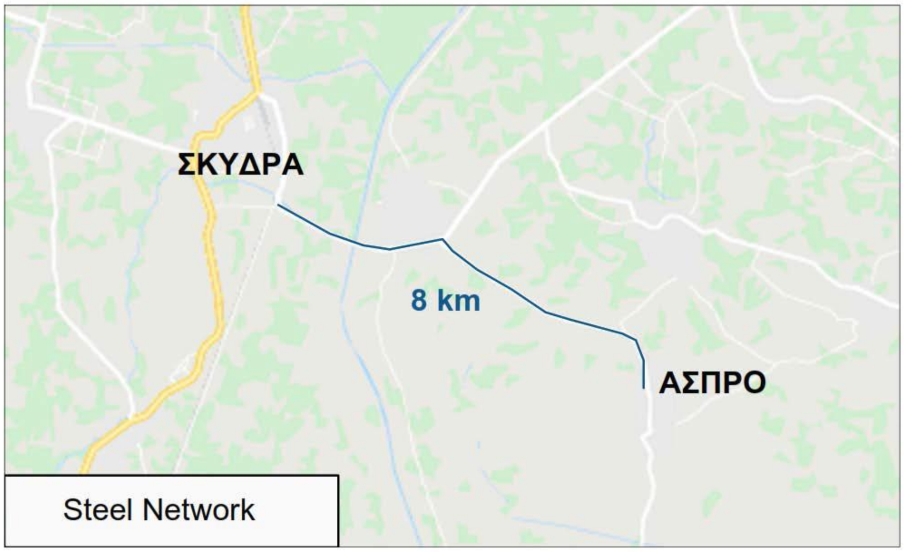


Figure 10: Schematic representation of a medium pressure network in the area of Skydra

3.2 TECHNICAL DEVELOPMENT

The proposed network in the city of Skydra will consist of a system of medium pipes (19 bar) and a system of low-pressure pipes (4 bar). A Medium / Low-Pressure Station (MR 19/4) will be constructed and connect the Skydra distribution network with the NNGS (National Natural Gas System) through a pipeline. The design of the Distribution Network consists of the following two elements:

<u>A. Medium pressure pipeline network</u>

The Medium Pressure Network has a maximum operating pressure of 19 bar and its construction is steel. Connects the High / Medium Pressure Station (MR 50/19) to the Medium / Low-Pressure Stations (MR 19/4). The route follows the route of existing roads and follows a route of rings (inside and outside). The total length of the network of medium pressure pipes is 8,000 meters for the initial stage of the network and 1,080 meters for the second part.

B. Low-pressure pipeline network

The low-pressure pipeline network (4 bar) consists of three separate sectors:

• Network of cross-section pipelines F160, which connects the station MR 19/4 with the distribution network.

• Pipeline network F125, which is the Central Network and serves the main major commercial and industrial consumers.

• Network of cross-sections F63, which is connected to the Central Network and is used for the thickening of the Network and the service of adjacent areas.

The schematic representation of the integrated low-pressure pipeline network is presented (Figure 11).

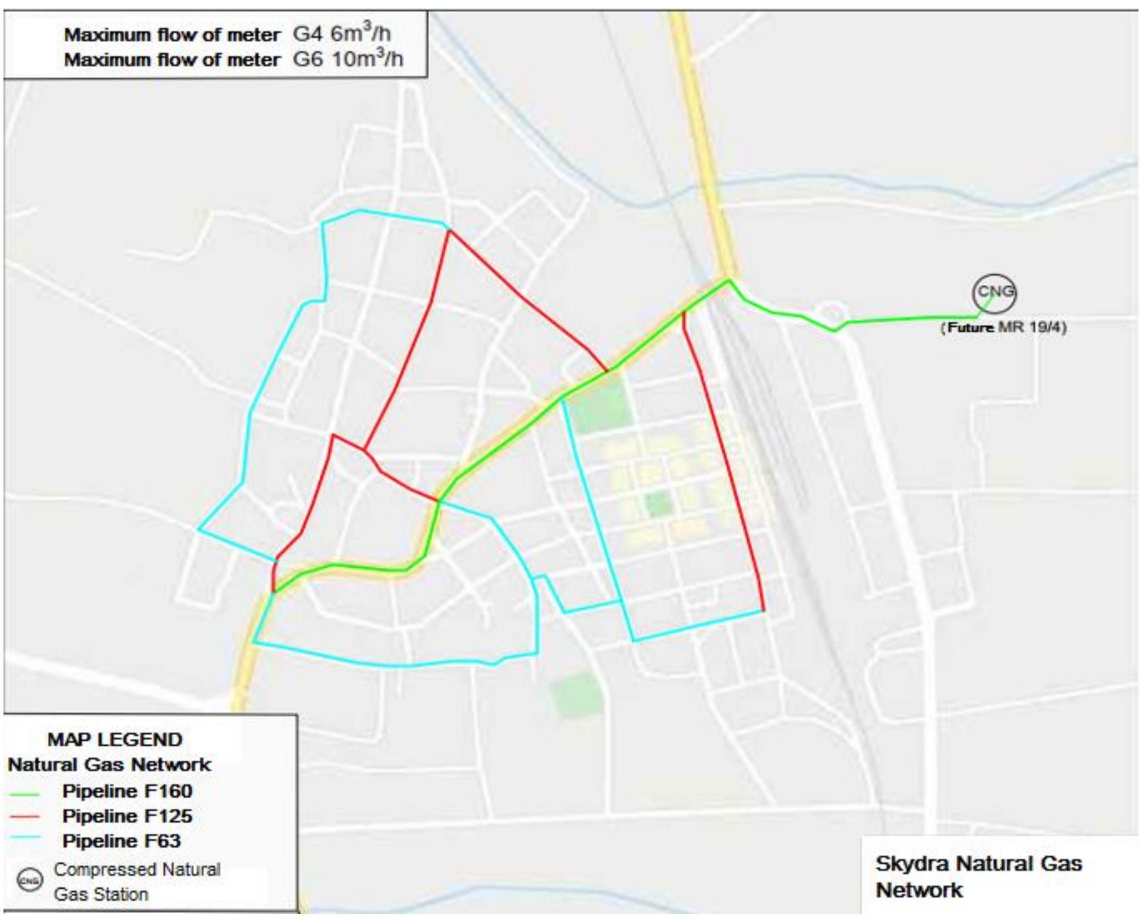


Figure 11: Schematic representation of a low pressure distribution network in the area of Skydra

The selection of materials and the construction of the 4 bar polyethylene network follows the "Regulation of polyethylene gas distribution networks with a maximum operating pressure of 4 bar", Ministerial Decision D3 / A / 14715 (Government Gazette 1530, 19/10/2006). The study of the layout of the distribution network took into account the consumption of the individual areas of the city, the road planning of the area and the positions of the commercial and large consumers. The total length of the main low-pressure distribution network reaches 6,090 meters (at a depth of 5 years) and an extra 390 meters for the next 5 years. In summary, the length of pipeline F160 is estimated at 1,400 meters, the length of pipeline F125 at 1,890 meters and the condensation network (F63) at 2,800 meters.

According to the design of the Five-Year Initial Development Plan, a natural gas distribution network will be constructed firstly in the city of Skydra (Municipal Community of Skydra). Then (after the end of the first five years), and during the validity of the permit, there is provision for expansion of the existing network, either by pipeline or by virtual pipeline via CNG, to the other local communities of the Municipal unit of Skydra as well as to the adjacent Municipal Meneidos Unit and its including local communities which belong to the Municipality of Skydra. These Local communities include, among others, the Municipal Unit of Skydra, the Local Communities of Arseni, Giannakochori, Asprou, Daphne, Kalivia, Lipochori, Mavrovouniou, Nea Zoi, Petraia, Rizou, Sebastianos, and the Municipal Unit of Kalipi, Ani, Kraneas, Mandalou and Profitou Helios.

3.3 REVENUES OF THE PROJECT

The keystone of an innovative investment like this are the revenues. They define the feasibility of our project and are the main driving factor to start this venture.

3.3.1 POTENTIAL CUSTOMERS & MARKET PENETRATION LEVEL

For the estimation of potential consumers, information, and data for the Municipal Community and the Municipality of Skydra were used from the inventory of the Hellenic Statistical Authority (ELSTAT), conducted in 2011 (Table 4). These data were used, by making some logical assumptions, in order to first estimate the potential number of consumers per category and type of connection in the Municipality of Skydra and then calculate the natural gas demand.

Table 4: Skydra Permanent Population Census (Source: EL.STAT)

Resident Population Census 2011 – Permanent Population				
Level of administrative division	**No.**	**Geographical Kallikratis Code**	**Description**	**Permanent Population**
5	2266	1004	Municipality of Skydra	20.188
6	2282	100401	Municipal Unit of Skydra	15.613
7	2283	10040101	Municipal Community of Skydra	5.406
8	2284	1004010101	Skydra	5.406

For the calculation of potential household consumers and their type of connection, data from ELSTAT that lists the number of houses and analyzes their type of building (detached or block house), and their heating type (central or autonomous heating) were used (17). Any normal home can be considered a current or potential household and can be counted on the number of possible connections. However, in order to be as realistic as possible, the estimation of the number of connections in Skydra had to be combined with the above data using a series of assumptions (Table 5).

Table 5: Detached House and Apartment Buildings in the Municipal Community of Skydra

Detached House	Number of houses in apartment buildings	Number of apartment buildings (G6)	Number of normal residences (G4)
519	3,227	486	3,746

These apartments will be potential customers of individual connections with G4 meter, while the apartment buildings with central heating considered to be potential customers of central connection with G6 meter. At the same time, all the houses of Skydra, no matter whether they already have a central heating system or not, will be potential customers with individual connections, therefore with a G4 meter.

Assuming that centrally heated apartment buildings would have lower penetration of atomic natural gas, it was estimated that by the end of five years 20% of centrally heated buildings could be connected to the natural gas network. In contrast to the buildings with individual connections, it was considered that the degree of penetration of natural gas will be significantly higher and that at the end of five years 28% of the respective buildings will be connected to the natural gas network with individual connection (Table 6). Regarding the last 5 years of the decade, was assumed that the penetration level and the number of the estimated customers will face downturn.

Table 6: Penetration assumptions and household customer calculation

Connection Type	Penetration Assumption	Number of estimated customers (5 Year)
Individual connections (G4)	28%	1.057
Central Connections (G6)	20%	98

Except from household customers, the commercial consumers are a determinant factor in order to calculate the penetration level and the final number of customers. Regarding shops - offices that considered to be commercial consumers, we can consider that they have exactly similar needs to residential buildings, they use natural gas only for heating.

The shops or offices that are housed in apartment buildings; with the main use of the house, are considered to be covered by the inclusion of the buildings that constitute them in the list of possible connections of the residential buildings (Table 5). The buildings on the other hand that have main or exclusive use of offices - shops are examined separately (Table 7).

Table 7 Penetration assumptions and shop – office customer calculation

	Possible shop - office connections	**Penetration Assumption (5 Years)**	**Number of estimated customers (5 Years)**
Meter (G4)	70	27%	19
Meter (G6)	100	27%	27

The degree of penetration of consumption (number of connections to number of possible connections) for the first five years in the municipality of Skydra is presented (Table 8).

Table 8 Degree of Consumption Penetration per Customer category

Category	**Natural Gas Meter**	**Penetration level in 5 years**
Autonomous connection	Meter G4	28%
Central connections	Meter G6	20%
Shop - Office: Autonomous Connections	Meter G4	27%
Shop - Office: Central Connections	Meter G6	27%
Church - Monastery	Meter G6	50%
School Building	Meter G10	80%
Other use	Meter G6	39%
Hotel	Meter G10	40%
Industry - Workshop	Meter G10	85%
Hospital, clinic etc.	Meter G25	100%

3.3.2 CAPACITY LEVELS

In parallel with the penetration level, capacity is a key factor for the economic growth and sustainability of the investment. In order to examine the capacity levels of Skydra network, we have to make some assumptions and to take into consideration the data from ESTAT. Dividing into two categories, the natural gas connections, will help us understand the capacity levels of natural gas. First, we have the ones with operating pressure of the indoor installation 25 mbar, and those with operating pressure of the indoor installation greater than 25 mbar. For the calculation of connections where the operating pressure is less than 25 mbar, i.e. for the home sector, the reference unit is the household as defined by the ELSTAT inventory. According to this definition, any normal residence is a valid or a potential household since it is defined as a household when:

a) Two or more persons living together

b) Any person who lives alone in a separate residence or resides with other persons in the same residence

The use of natural gas in households concerns heating, cooking and hot water. The calculation of the average annual gas consumption for each category of consumers is calculated based on the degree of heating days. In the area of Skydra this is calculated for the period October to March. The categorization of household consumers is based on whether it is central or autonomous heating. In the case of central heating connections, a G6 gas meter with a maximum hourly capacity of 10 Nm3 / h is used, while in the case of individual connections, a G4 meter with a maximum capacity of 6 Nm3 / h is used.

For household consumers, it is estimated that natural gas will be used for 6 months a year (180 days) and 5 hours on average each day. In the commercial sector, shops - offices use corresponding meters (G4 and G6) with household consumers while other commercial consumers (hotels, factories-laboratories and school buildings) use G10 meters with a maximum hourly capacity of 16 Nm3 / h with the exception of the hospital units, which use G25 meters with a maximum hourly capacity of 40 Nm3 / h and the churches-monasteries, which use G6 meters with a maximum hourly capacity of 10 Nm3 / h.

Finally, G6 meters with a maximum hourly capacity of 10Nm3 / h are used in commercial consumers with other uses. For the category of shops - offices, it is assumed that natural gas will be used for 6 months a year (180 days) and for an average of 5.5 hours each day. Respectively, for the churches it will be used 6 months a year (180 days) for 1.5 hours a day, the hospital units with 365 days of use (10 hours / day), the factories with 250 days of use (10 hours / day), hotels with 180 days of use (10 hours / day), school buildings with 180 days of use (5.5 hours / day) and finally buildings of other uses with 250 days of use (5.5 hours / day).

In order to calculate the average hourly capacity of each consumer, so as to estimate the capacity of the network, it is assumed that the average hourly capacity of each type of commercial consumer corresponds to 60% (capacity factor) of the respective maximum hourly capacity, excluding hospital units and industrial consumers in which a 85% capacity is assumed. Table 9 summarizes the estimated capacity commitments of the network as a whole but also individually by consumer for the Skydra network.

Table 9: Skydra Network Capacity Calculation at the end of five years

			Natural Gas Meter	Penetration level in 5 years	Customers Number in 5 years	Capacity Factor	Maximum Facility	Average facility for the calculation of capacity	Capacity (Nm3/h)
Non industrial	**Household**	**Autonomous conection**	**Meter G4**	28%	1,057	60%	6	3,6	3,805
		Central conections	**Meter G6**	20%	98	60%	10	6,0	588
			Total		1,155				4,393
	Commercial	**Shop - Office: Autonomous Conections**	**Meter G4**	27%	19	60%	6	3,6	68
		Shop - Office: Central Conections	**Meter G6**	27%	27	60%	10	6,0	162
		Church - Monastry	**Meter G6**	50%	8	60%	10	6,0	48
		School Building	**Meter G10**	80%	12	60%	16	9,6	115
		Other use	**Meter G6**	39%	30	60%	10	6,0	180
			Total		96				574
Industrial	**Big commercial / Industrial**	**Hotel**	**Meter G10**	40%	3	60%	16	9,6	29
		Industry - Workshop	**Meter G10**	85%	2	60%	16	9,6	19
		Hospital, clinic etc.	**Meter G25**	100%	2	85%	40	34,0	68
		Industrial consumers	**Meter G25**	100%	4	85%	650	552,5	2.210
			Total		11				2,326

To calculate the total network consumption, the average hourly consumption of each type of consumer must be calculated, and then, taking into account the annual duration of gas use (number of hours and days per consumer), the individual annual consumption must be calculated. To achieve this, it is assumed that the average hourly consumption of each type of consumer corresponds to 40% of the corresponding maximum hourly capacity of its installed meter. The only exception is the hospital units in which this percentage increases to 80%. The individual calculations are summarized (Table 10) and refer the annual consumption at the end of the five-year period.

Table 10 : Annual Consumption Calculation of the Skydra Network at the end of the five years

						CAPACITY								CONSUMPTION			
		Category	Natural Gas Meter	Penetration level in 5 years	Customers Number in 5 years	Capacity Factor	Maximum Facility	Average facility for the calculation of capacity	Capacity (Nm3/h)	Consumption factor	Average facility for the calculation of consumption	Working days/Year	Hours/Day	Hours/Year	Annual cconsumption / Consumer (Nm3)	Annual consumption at the end of 5 year period (Nm3)	Annual consumption at the end of 5 year period (MWh)
Non industrial	Household	Autonomous conection	Meter G4	28%	1.057	60%	6	3,6	3.805	0,40	2,4	180	5,0	900	2.160	2.283.120	26.028
		Central conections	Meter G6	20%	98	60%	10	6,0	588	0,40	4,0	180	5,0	900	3.600	352.800	4.022
			Total		1.155				4.393						5.760	2.635.920	30.049
	Commercial	Shop - Office: Autonomous Conections	Meter G4	27%	19	60%	6	3,6	68	0,40	2,4	180	5,0	900	2.160	41.040	468
		Shop - Office: Central Conections	Meter G6	27%	27	60%	10	6,0	162	0,40	4,0	180	5,0	900	3.600	97.200	1.108
		Church - Monastry	Meter G6	50%	8	60%	10	6,0	48	0,40	4,0	180	1,5	270	1.080	8.640	98
		School Building	Meter G10	80%	12	60%	16	9,6	115	0,40	6,4	180	5,5	990	6.336	76.032	867
		Other use	Meter G6	39%	30	60%	10	6,0	180	0,40	4,0	250	5,5	1.375	5.500	165.000	1.881
			Total		96				574						18.676	387.912	4.422
Industrial	Big commercial / Industrial	Hotel	Meter G10	40%	3	60%	16	9,6	29	0,40	6,4	180	10,0	1.800	11.520	34.560	394
		Industry - Workshop	Meter G10	85%	2	60%	16	9,6	19	0,40	6,4	250	10,0	2.500	16.000	32.000	365
		Hospital, clinic etc.	Meter G25	100%	2	85%	40	34,0	68	0,80	32,0	365	10,0	3.650	116.800	233.600	2.663
		Industrial consumers	Meter G25	100%	4	85%	650	552,5	2.210	0,80	520,0	320	11,0	3.520	1.830.400	7.321.600	83.466
			Total		11				2.326						1.974.720	7.621.760	86.888

For all the above calculations, some penetration assumptions were used, that take into account the network route as well as the location (urban, non-urban areas) and the specific characteristics of each type of consumer (e.g. greater penetration in shared household connections compared to stand-alone connections). The design of the network especially the first years of the investment takes into consideration the fact that the company wants to give access to natural gas directly to as many consumers as possible.

The degree of coverage of the Distribution Network in the Municipality of Skydra is estimated to reach 100% of the road network of the Municipality. During the first five years, the network will be developed only in the Municipal Unit of Skydra. Therefore the degree of coverage for the other Municipal Units will be zero.

CHAPTER No.4: ECONOMIC ASPECT OF OUR INVESTMENT

The economic parameters are a key aspect of the investment and include cost, revenues, financing of the investment and the financial obligations regarding the role as a DSO.

4.1 DPOS ECONOMIC REQUIREMENTS

After having an overview of the investment both from the technical and developing plan, it is time to delve into the economic aspect of it, starting with its financing. According to the RAE regulation of natural gas permission (Official Government Gazette B' 3430/17.08.2018) (18) in order to apply for a natural gas license you have to fulfill the following economic requirements:

A. For the Natural Gas Distribution License, the applicant must have a share or corporate capital amounting to at least six hundred thousand euros (600,000 €). For the assessment of the financial adequacy of the applicant, the adequacy of the provided own funds is taken into account, the amount of which must be at least twenty percent (20%) of the project budget.

B. For the Management of Distribution Network License, the applicant has a share or corporate capital amounting to at least four hundred thousand euros (400,000 €).

As mentioned, EL.GAS has achieved successfully to receive all the required licenses which means that has the ability to self-finance part of the project. In particular, the investment is estimated to cost approximately 5,000,000€ (without including the financing cost) in a time horizon of 10 years. In this case, 2,000,000€ is going to be financed by the Greek banks in the form of a loan and the remaining 3,000,000€ is going to be self-financed.

4.2 FINANCING OF THE INVESTMENT

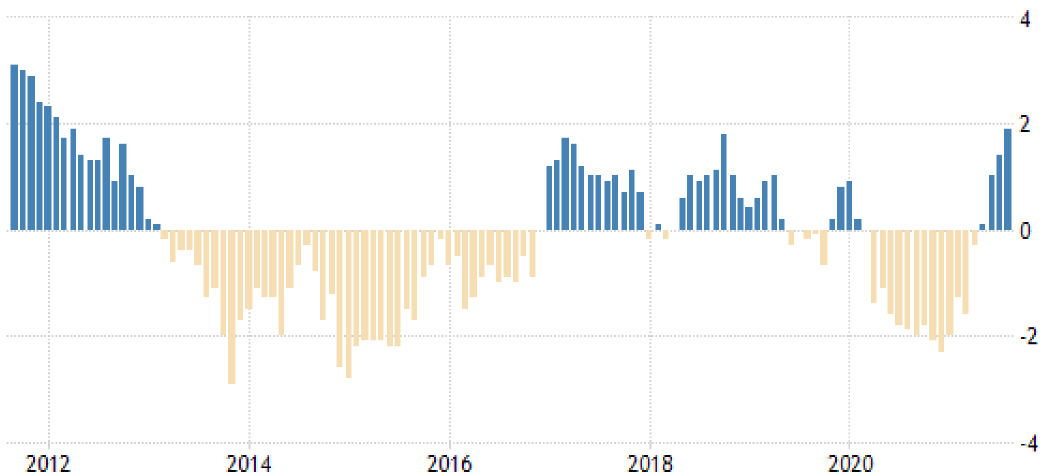
The external financing of this project will be serviced by a loan contract with National Bank of Greece. Taking advantage of the COVID-19 situations and after satisfying the necessary preconditions, the bank will issue a loan with the guarantee of the Business Guarantee Fund COVID-19 of Hellenic Development Bank SA (19). This loan is quite favorable to this project since it has a quite low interest rate. The financing details of the loan are mentioned in Table 11.

Table 11: Skydra loan details

SKYDRA LOAN DETAILS	
Currency	Euro
Form of financing	Loan (amortization) contract
Duration	5 years
Loan amount	2,000,000 €
Guarantee Rate	80%
Grace period	First two years'
Interest rate	2.50%
Dose frequency	Once in a year
Disbursements	One-time

4.3 INTEREST RATE, TAXATION, INFLATION

The investment is strictly monitored, regulated and guaranteed by Energy Regulator Authority (RAE); thus, the required return is 8.00% (as for all other DSO's). Taxation of the project is divided to two major categories: the cost taxation and the revenue taxation. It is assumed that the referred cost in this project includes the tax rate. Particularly in the operating cost of "management staff payroll" the wages are included. The remaining operating cost and most of the investment cost also include the corresponding taxation such as VAT of 24% (20) (except of the de-compressor cost and other material's that we import tax-free from Italy as part of European Union), contractor income tax of 3% and income from business activities of 20%. The revenue corresponding taxation of 24% is included on the Other Expenses. The inflation rate is assumed to be 1%, even though the last decade this rate faced huge fluctuations (Graph 2) in Greece (21).



Graph 2: Greece Inflation Rate (%) 2011-2021 (Source: National Statistical Service of Greece)

4.4 COST

The cost of any investment is a critical factor, especially in pioneer investments like this. Due to the company's experience in the construction of natural gas distribution networks, the construction cost considers to be realistic. In the following paragraphs, is explored in detail the cost of this project and the assumptions that have been made (Table 13).

4.4.1 INVESTMENT COST

We divide cost into two main categories: the investment and the operating costs. The investment cost is significantly higher than the operating cost, as it goes hand in hand with the network construction. The biggest part of this cost is referred to as the fixed assets of the investment and is spent in the first years of the project. Except for the financial cost, it includes the following costs: MR cost, network construction cost, computer cost, cost of other equipment and new customer connection cost. The investment cost of the first two years is almost the same amount of money of the investment cost in the rest eight-year horizon. This is due to the cost of other equipment and network construction costs that are fundamental to the project and are calculated to be paid in the first two years.

MR Cost:

The MR (Metering and Regulation) stations are a critical part of the distribution chain as they are part of the high-pressure system and are used in order to separate the high-pressure network from the distribution network. We are going to use them in order to reduce the pressure before we supply the local network of Skydra with natural gas. MR stations can be purchased or in this case we can construct them since the company has the appropriate know-how and infrastructure. The MR cost that mentioned referees to the total cost (work and materials) for the construction and installation of the required MR stations for the project. The cost of each MR is 40,000€.

Network Construction Cost:

The cost of the network construction is the main expense regarding the operating cost. As mentioned in chapter 3.2 based on the technical expansion of the network, the construction cost is divided into two main categories, the medium, and the low-pressure network. The cost of unit price of medium pressure network construction (€ /m) is 320€ whereas the cost of low-pressure network construction (€ /m) is 140€. According to the construction plan it is estimated that 8,000 meters of medium pressure network and 6,090 meters of low-pressure network are going to be built for the first five years. In line to this, 320€ * 8,000 m = 2,560,000 € will cost the medium pressure network, whereas the low-pressure network will cost 140€ * 6,090 m = 852, 600 €. In total 2,560,00 € + 852,600€ = 3,412,600€ will be the construction cost for the first five years.

After the first five years, the construction cost will be adapted in the network expansion based on the demand of the customers. In particular, it is estimated that an extra 1,080 meters of medium pressure and 390 meters of low-pressure network will be constructed in the following years. The total cost of the remaining 5 years is 1,080 m * 320€ + 390m * 140€ = 400,200€. A total cost for the decade of 3,412,600€ + 400,200€ = 3,812,800€. The material cost is included in the network construction cost per meter, for medium and low-pressure network respectively.

Computer & Software Costs:

It is estimated to be done in two stages; one in the beginning of the project and another in the network expansion stage. It includes buying computers; 6,000€ in the first year and 3,000€ in the expansion stage. Moreover, an annual cost of 2,000€ each year is estimated for renewal of software licenses for SCADA and ERP systems.

Cost of Other Equipment:

It includes all costs that haven't been taken into account and are vital for our project, such as additional spare part cost and extraordinary and non-operating expenses that are related to the equipment.

New Customer Connection Cost:

The network construction cost includes the cost of constructing the main network as it is submitted and accepted from the Regulatory Authority of Energy (RAE). For every new customer that wants to connect to the main network that is going to be constructed, there is the cost of the new customer connection. For that task, the company decided to assign it to external cooperators such as subcontractors. In particular, each subcontractor is responsible for the following works:

1) Construction

2) Electromechanical works

3) Excavations

4) Welding the pipes

5) Drilling

6) Final Connection of Customer

Each Sub-Contractor is responsible for his staff (engineers, workers, economists etc.) in order to be insured and paid by them.

Financial Cost (Loan):

Based on the loan contract that the company is going to sign; the financial cost is estimated. The amount of total year-end payment is calculated and presented in Table 12.

Table 12: Skydra loan qalqulations

YEAR	BEGINNING OF YEAR BALANCE	YEAR END INTEREST ON BALANCE	TOTAL YEAR END PAYMENT	AMORTIZATION OF LOAN	END OF YEAR BALANCE
1	2,000,000 €	50,000 €	430,494 €	380,494 €	1,619,506 €
2	1,619,506 €	40,488 €	430,494 €	390,006 €	1,229,500 €
3	1,229,500 €	30,737 €	430,494 €	399,757 €	829,743 €
4	829,743 €	20,744 €	430,494 €	409,750 €	419,993 €
5	419,993 €	10,500 €	430,494 €	419,994 €	0 €
			2,152,470 €		

4.4.2 OPERATION COST

Compared to construction cost, operating cost faces increases over time since it follows the network expansion and the customer growth. Moreover, it is significantly lower than the investment cost as it focuses more in the maintenance of the existing network. Primarily, management staff payroll and maintenance cost are the ones that are more costly than the remaining operating costs. In detail, operating cost includes the following:

Management Staff Payroll:

Includes insurance and wages for the employees that operate the system. As the network expands, the necessity for staff grows and at the same time the payroll cost increases.

Office Rent:

Cost for 10 years rental contract in Skydra with a monthly rent of €500.

Insurance Costs:

Based on the offers of the insurance companies and the estimation of an average insurance cost for a construction project, we evaluate the insurance cost in proportion with the investment cost. In particular, it reaches 0.14% of the investment cost each year and it varies throughout the 10-year period of our project.

Maintenance Costs:

Following the same path with insurance cost, maintenance cost depends on the investment cost. Particularly, 2% of the investment cost is estimated to be sufficient in order to meet the needs of maintenance costs. This amount of money covers the requirements for extra spare part, staff and whatever is necessary to achieve the operational qualification.

Other Expenses:

Contains expenses such as advertisement, promotion, and spending that have not been included in the initial investment planning.

Table 13: Skydra 10 years investment plan costs

	Cost Category	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Investment Costs	MR Cost	40,000 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00	0,00	0,00
	Network Construction Costs	1,192,000 €	744,600 €	676,000 €	480,000 €	320,000 €	127,400 €	110,000 €	75,200 €	56,400 €	31,200 €
	Computer Costs	8,000 €	2,000 €	2,000 €	2,000 €	2,000 €	5,000 €	2,000 €	2,000 €	2,000 €	2,000 €
	Cost of Other Equipment	15,000 €	5,000 €	5,000 €	5,000 €	5,000 €	3,000 €	3,000 €	2,000 €	2,000 €	2,000 €
	New Customer Connection Cost	110,000 €	100,000 €	95,000 €	92,000 €	75,000 €	70,000 €	62,000 €	35,400 €	27,500 €	24,000 €
	Financial Cost (Loan)	0,00 €	0,00 €	430,494 €	430,494 €	430,494 €	430,494 €	430,494 €	0,00 €	0,00 €	0,00 €
	Total Investment	1,365,000, €	851,600 €	1,208,494 €	1,009,494 €	832,494 €	635,894 €	607,494 €	114,600 €	87,900 €	59,200 €
	Cumulative Investment Cost	1,365,000 €	2,216,600 €	3,425,094 €	4,434,588 €	5,267,082 €	5,902,976 €	6,510,470 €	6,625,070 €	6,712,970 €	6,772,170 €
Operating Costs	Management Staff Payroll	25,000 €	27,000 €	27,000 €	27,000 €	27,000 €	25,000 €	25,000 €	25,000 €	25,000 €	20,000 €
	Office Rent Costs	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €
	Insurance Costs	1,911 €	1,192.24 €	1,691.89 €	1,413.29 €	1,165.49 €	890.25 €	850.49 €	160.44 €	123.06 €	82.88 €
	Maintenance Costs	27,300 €	17,032 €	24,169.88 €	20,189.88 €	16,649.88 €	12,717.88 €	12,149.88 €	2,292 €	1,758 €	1,184 €
	Other Expenses	15,000 €	15,000 €	15,000 €	15,000 €	10,000 €	10,000 €	10,000 €	5,000 €	5,000 €	5,000 €
	Total Operating Costs	75,211 €	66,224.24 €	73,861.77 €	69,603.17 €	60,815 €	54,608.13 €	54,000.37 €	38,452.44 €	37,881.06 €	32,266.88 €
	Cumulative Operating Cost	75,211 €	141,435.24 €	215,297.01 €	284,900.18 €	345,715.55 €	400,323.69 €	454,324.06 €	492,776.50 €	530,657.56 €	562,924.44 €
	TOTAL INVESTMENT COST	1,440,211 €	917,824.24 €	1,282,355.77 €	1,079,097.17 €	893,309.37 €	690,502.13 €	661,494.37 €	153,052.44 €	125,781.06 €	91,466.88 €

4.5 REVENUES

The most crucial part of the project is to examine the revenues, which will define the project's viability. Revenues depend on the number of natural gas suppliers that will be connected to the network. According to the natural gas license register, published by the Regulatory Authority of Energy (22), 45 companies have gas supply licenses. The basic suppliers are Protergia, Zenith, TERNA, Heron, EFA Energy, Watt & Volt, NRG, Elinoil, etc. An important factor for natural gas penetration is the commercial policy of the suppliers and their sales target.

In a new market - network, strong competition and promotions will help the fast penetration of natural gas. State subsidization of natural gas installations is a key factor that will increase the interest for natural gas connection (already applied to Thessaloniki, Thessaly (23) and Attica (24). In the city of Skydra there is an increased interest for natural gas connectivity with more than 800 early applications before we even start building the network, including households, commercial and industrial customers. The relevant subsidies is expected to increase this interest even further.

In our case, it is expected and assumed in the calculations, that the connection fees will be subsidized from the local region of Central Macedonia through ESPA Regional Operational Programs (25). In this way, the company will receive the connection fees that are vital for the revenues and the consumers will get motivated to apply for a natural gas connection. The Revenues for a DSO (Public and Private) are regulated by RAE with two laws (26) (27) (Official Government Gazette B΄ 2093/5.07.2012) (Official Government Gazette B΄ 2385/27.08.2012) and come from 2 charges:

1. Distribution Energy at a fixed price per megawatt hour (Approximately 14.40 €/MWh).

2. Distribution capacity, with charge depending on the hourly maximum consumption for one year (1,123 €/MWh/h).

If we consider for example that a house with G4 meter can burn 67kwh with a yearly consumption of 10Mwh, this results in 217 €/Year. In the calculations it is estimated that on average the household consumers will pay 220€/Year, the commercial consumers 400€/Year and finally the industrial consumers 35,000€/Year for distribution and transit tariffs (Figure 12).

The revenue estimations assume that the level of consumers and penetration will follow the cases of Thessaloniki, Thessaly, and Attica. The consumer category (residential, commercial, and industrial) is also a key factor due to the different consumption volumes. Table 14 and 15 presents the estimated consumers based on which we adapted the revenues. In the calculations is estimated that the connections fees for the household consumers are 1,000€, for the commercial consumers 1,600€ and for the industrial consumers 5,000€. The connection fee is considered to be paid one-off.

Overall, we must keep in mind that the revenues of EL.GAS, depending on the tariffs that the suppliers pay to EL.GAS, are regulated by RAE. This means that the number of consumers is the crucial factor that will define the revenues, and not the price of the tariffs. Additionally, it is assumed that there will be subsidy for natural gas installation connection fees. The reason for this is that the company is already in touch with the local communities and started the necessary bureaucratic process in order to succeed with the subsidy goal.

Figure 12: Revenues timeline

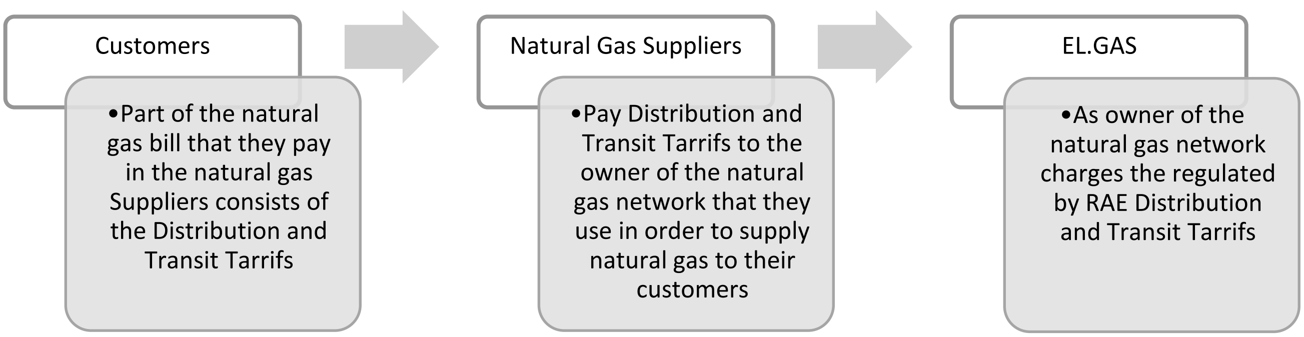


Table 14: Consumers per year (By category)

	Household Consumers per Year									
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Consumers	250	260	230	215	200	160	150	130	100	90
	1.155					630				
	1.785									
	Commercial Consumers per Year									
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Consumers	20	20	20	18	18	15	15	12	12	12
	96					66				
	162									
	Industrial Consumers per Year									
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Consumers	3	3	2	2	1	1	1	1	1	1
	11					5				
	16									

Table 15: Revenues for 10-Year period

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTAL REVENUES	465,000€	645,200€	738,800€	845,100€	911,300€	942,700€	975,000€	1,018,600€	1,050,400€	1,100,000€

CHAPTER No.5: INVESTMENT EVALUATION

The viability of the project is the first priority of the company. Using economic tools, will examine the investment and evaluate whether it is worth proceeding.

5.1 CASHFLOW TIMETABLE

In the previous chapters, we quoted in detail both the costs and the revenues of the investment project. Table 16 reports in aggregate all the economic aspects of the project in order to examine whether the investment is viable or not in a time frame of 10 years. As it was expected the cost, both investment and operating, are inversely proportional with the revenues. In the first years, costs are high in order to lay the foundations of the project and over the years they decrease. Whereas, the revenues, due to the fact that with the years the consumers will grow and the network will expand, indicate a rapid increase.

Table 16: Skydra Cost - Revenues 10 Year Plan

	Cost Category	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Investment Costs	MR Cost	40,000 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00	0,00	0,00
	Network Construction Costs	1,192,000 €	744,600 €	676,000 €	480,000 €	320,000 €	127,400 €	110,000 €	75,200 €	56,400 €	31,200 €
	Computer Costs	8,000 €	2,000 €	2,000 €	2,000 €	2,000 €	5,000 €	2,000 €	2,000 €	2,000 €	2,000 €
	Cost of Other Equipment	15,000 €	5,000 €	5,000 €	5,000 €	5,000 €	3,000 €	3,000 €	2,000 €	2,000 €	2,000 €
	New Customer Connection Cost	110,000 €	100,000 €	95,000 €	92,000 €	75,000 €	70,000 €	62,000 €	35,400 €	27,500 €	24,000 €
	Financial Cost (Loan)	0,00 €	0,00 €	430,494 €	430,494 €	430,494 €	430,494 €	430,494 €	0,00 €	0,00 €	0,00 €
	Total Investment	1,365,000, €	851,600 €	1,208,494 €	1,009,494 €	832,494 €	635,894 €	607,494 €	114,600 €	87,900 €	59,200 €
	Cumulative Investment Cost	1,365,000 €	2,216,600 €	3,425,094 €	4,434,588 €	5,267,082 €	5,902,976 €	6,510,470 €	6,625,070 €	6,712,970 €	6,772,170 €
Operating Costs	Management Staff Payroll	25,000 €	27,000 €	27,000 €	27,000 €	27,000 €	25,000 €	25,000 €	25,000 €	25,000 €	20,000 €
	Office Rent Costs	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €
	Insurance Costs	1,911 €	1,192.24 €	1,691.89 €	1,413.29 €	1,165.49 €	890.25 €	850.49 €	160.44 €	123.06 €	82.88 €
	Maintenance Costs	27,300 €	17,032 €	24,169.88 €	20,189.88 €	16,649.88 €	12,717.88 €	12,149.88 €	2,292 €	1,758 €	1,184 €
	Other Expenses	15,000 €	15,000 €	15,000 €	15,000 €	10,000 €	10,000 €	10,000 €	5,000 €	5,000 €	5,000 €
	Total Operating Costs	75,211 €	66,224.24 €	73,861.77 €	69,603.17 €	60,815 €	54,608.13 €	54,000.37 €	38,452.44 €	37,881.06 €	32,266.88 €
	Cumulative Operating Cost	75,211 €	141,435.24 €	215,297.01 €	284,900.18 €	345,715.55 €	400,323.69 €	454,324.06 €	492,776.50 €	530,657.56 €	562,924.44 €
	TOTAL INVESTMENT COST	1,440,211 €	917,824.24 €	1,282,355.77 €	1,079,097.17 €	893,309.37 €	690,502.13 €	661,494.37 €	153,052.44 €	125,781.06 €	91,466.88 €
	TOTAL REVENUES	465,000 €	645,200 €	738,800 €	845,100 €	911,300 €	942,700 €	975,000 €	1,018,600 €	1,050,400 €	1,100,000 €

Even though a 25-year license has been acquired (maximum possible licensing period by Regulatory Authority of Greece (RAE) is 50 years), both business planning, customer and consumption predictions are based on a ten-year plan. The reason for this decision is the relatively new commercial of natural gas in Greece of only 25 years. Thus, there are not enough historic data or experience to predict how a private network will work on in a time horizon larger than the history of this fuel in the country.

Moreover, we cannot disregard the fact that natural gas is a transitional fuel that will probably be replaced, at least in large scale, in the forthcoming years with a renewable source of energy. For that reason we choose the calculations and predictions to be based on a 10-year period that is more realistic and reasonable. Based on the information of Table 16 using several financial decision-making rules for an investment will present each one of them and argue on the project relevance.

5.2 INVESTMENT CALCULATIONS

The core of the study is to evaluate the financial adequacy of the investment based on the data and the assumptions we have. In order to do that, there are several financial decision-making rules (28). The most popular are:

- Net Present Value (NPV)
- Book Rate of Return (BRR)
- Discounted Payback Period
- Internal Rate of Return (IRR)

In the next paragraphs, will present each one of them and look at the project relevance in detail. Towards to that, Table 18 presents the results of the calculations based on the data presented in Table 17. The Required Return, or else the discount rate, at 8.00% is set as datum. In particular, the required return is considered to be higher than the average for a private investment.

Moreover, 8.00 % was not chosen by chance, but it is regulated and guaranteed from Regulatory Authority of Energy (RAE) and it is common for all the DPO's. Also, the required return is used in the project evaluations in order to apply the Internal Rate of Return rule. All the calculation results presented in Table 18 are explained in detail in the following paragraphs.

Table 17: Skydra Costs - Revenues 10 year Plan Baseline Calculations

	Cost Category	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Investment Costs	MR Cost	40,000 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00	0,00	0,00
	Network Construction Costs	1,192,000 €	744,600 €	676,000 €	480,000 €	320,000 €	127,400 €	110,000 €	75,200 €	56,400 €	31,200 €
	Computer Costs	8,000 €	2,000 €	2,000 €	2,000 €	2,000 €	5,000 €	2,000 €	2,000 €	2,000 €	2,000 €
	Cost of Other Equipment	15,000 €	5,000 €	5,000 €	5,000 €	5,000 €	3,000 €	3,000 €	2,000 €	2,000 €	2,000 €
	New Customer Connection Cost	110,000 €	100,000 €	95,000 €	92,000 €	75,000 €	70,000 €	62,000 €	35,400 €	27,500 €	24,000 €
	Financial Cost (Loan)	0,00 €	0,00 €	430,494 €	430,494 €	430,494 €	430,494 €	430,494 €	0,00 €	0,00 €	0,00 €
	Total Investment	1,365,000, €	851,600 €	1,208,494 €	1,009,494 €	832,494 €	635,894 €	607,494 €	114,600 €	87,900 €	59,200 €
	Cumulative Investment Cost	1,365,000 €	2,216,600 €	3,425,094 €	4,434,588 €	5,267,082 €	5,902,976 €	6,510,470 €	6,625,070 €	6,712,970 €	6,772,170 €
Operating Costs	Management Staff Payroll	25,000 €	27,000 €	27,000 €	27,000 €	27,000 €	25,000 €	25,000 €	25,000 €	25,000 €	20,000 €
	Office Rent Costs	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €
	Insurance Costs	1,911 €	1,192.24 €	1,691.89 €	1,413.29 €	1,165.49 €	890.25 €	850.49 €	160.44 €	123.06 €	82.88 €
	Maintenance Costs	27,300 €	17,032 €	24,169.88 €	20,189.88 €	16,649.88 €	12,717.88 €	12,149.88 €	2,292 €	1,758 €	1,184 €
	Other Expenses	15,000 €	15,000 €	15,000 €	15,000 €	10,000 €	10,000 €	10,000 €	5,000 €	5,000 €	5,000 €
	Total Operating Costs	75,211 €	66,224.24 €	73,861.77 €	69,603.17 €	60,815 €	54,608.13 €	54,000.37 €	38,452.44 €	37,881.06 €	32,266.88 €
	Cumulative Operating Cost	75,211 €	141,435.24 €	215,297.01 €	284,900.18 €	345,715.55 €	400,323.69 €	454,324.06 €	492,776.50 €	530,657.56 €	562,924.44 €
	TOTAL INVESTMENT COST	1,440,211 €	917,824.24 €	1,282,355.77 €	1,079,097.17 €	893,309.37 €	690,502.13 €	661,494.37 €	153,052.44 €	125,781.06 €	91,466.88 €
	TOTAL REVENUES	465,000 €	645,200 €	738,800 €	845,100 €	911,300 €	942,700 €	975,000 €	1,018,600 €	1,050,400 €	1,100,000 €
	PV – COST DISCOUNTED	1,333,528.70 €	786,886.35 €	1,017,975.36 €	793,168.64 €	607,971.35 €	435,133.47 €	385,975.61 €	82,689.47 €	62,921.85 €	42,366.86 €
	PV – REVENUES DISCOUNTED	430,555.56 €	553,155.01 €	586,483.26 €	621,173.73 €	620,215.47 €	594,060.91 €	568,903.14 €	550,317.89 €	525,461.52 €	509,512.84 €
	NPV PER YEAR	-975,211 €	-272,624.24 €	-543,555.77 €	-233,997.17 €	17,990.63 €	252,197.87 €	313,505.63 €	865,547.56 €	924,618.94 €	1,008,533.12 €
	DISCOUNTED PAYBACK PERIOD										PAYBACK PERIOD

Table 18: Skydra Calculations results

Required Return	8.00 %
Net Present Value	11,221.64 €
Internal Rate of Return	8.11%
Book Rate of Return	11,85%
Discounted pay back period	9

5.2.1 NET PRESENT VALUE RULE (NPV)

Will start the project evaluation using the Net Present Value Rule. The Net Present Value considers the time value of money. Net Present Value discounts the expected cash flows of a project to their present value, deducting the investment costs. It is used to evaluate a proposed capital expenditure (29). It is one of the most used factors that determines an investment initiation.

The Net Present Value formula is:

$$NPV = \sum_{i=0}^{n} \frac{c_i}{(1+r)^i}$$

Where:

- NPV: is the Net Present Value.
- Ci: the cash flow at a specific period
- n: the investment years
- r: discount rate

The Net Present Value refers to the difference between the present value of cash inflows and the present value of cash outflows over a specific period of time (30). The decision is obvious: invest in this project if the Net Present Value is greater than zero. For each year in Table 19 the Net Present Value formula for both total costs and revenues of each year was applied.

Subtracting the total discounted present value revenues from the total discounted present value cost gives as result 11.221,64 €. According to the Net Present Value rule, the investment is marginally profitable at 11.221,64 € by the 10th year, signifying the investment acceptance.

Table 19: Discounted Cost and Revenues - Net present Value rule application

DISCOUNTED VARIABLES / YEAR	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
PRESENT VALUE COST	1,333,528.70 €	786,886.35 €	1,017,975.36 €	793,168.64 €	607,971.35 €	435,133.47 €	385,975.61 €	82,689.47 €	62,921.85 €	42,366.86 €	5,548,617.66 €
PRESENT VALUE REVENUES	430,555.56 €	553,155.01 €	586,483.26 €	621,173.73 €	620,215.47 €	594,060.91 €	568,903.14 €	550,317.89 €	525,461.52 €	509,512.84 €	5,559,839.30 €

5.2.2 INTERNAL RATE OF RETURN RULE (IRR)

The internal rate of return (IRR) is the discount rate that makes NPV equal to zero.

$$NPV = \sum_{i=0}^{n} \frac{c_i}{(1+IRR)^i} = 0$$

The IRR rule states that a company should undertake an investment if the IRR is greater than the the required return (31). The required return, is the minimum return an investor expects to achieve by investing in a project. Applying the proper calculations based on aforementioned theory and using the Excel tools, the IRR of the investment reaches 8.11%. According to the IRR rule, the relative indicator of 8.11% greater than the required return of 8, also signifying investment acceptance.

5.2.3 DISCOUNTED PAYBACK PERIOD

The discounted Payback Period is the time duration (number of years) it takes for an investment's cumulative cash flows to equal the initial investment; alternatively, we could state that it is the number of years needed to turn the NPV profitable (32). The applied rule here is to accept an investment if the discounted payback period is less than a specific benchmark or cut of period. This is a rather tricky indicator since it completely ignores cash flows beyond this cut off period.

Some long-term investments are beginning to show net profits after many years, but the cash flows beyond that point could be increasing exponentially. In our case the discounted pay-back period for the investment is 9 years. If the company expects profits at least half the project's lifetime, it would be an important indication of investment rejection. However, we must understand the long-term nature of this investment that will pay back its cost at 9 years, and it will show significant profits from year 10 onwards. This is since for the first 5 years, the investment revenues are paying off the loan. Another factor is the increased infrastructure cost and the increased discounting factor of 8% in relation to the market discounting factors.

5.2.4 BOOK RATE OF RETURN (BRR)

The Book Rate of Return is the ratio of the investment income to the investment assets:

$$BRR = \frac{book\ income}{book\ assets}$$

It is also known as the accounting rate of return, since income and assets used are defined by an accountant. It is not an objective indicator, since it depends on how accountants classify cash flows. The rule states that a company should undertake an investment if its BRR is greater than the company's current BRR (33). It is not a relevant indicator for the project, although for the sake of argument will calculate it.

The BRR indicator of 11.85%, although is not used as already discussed, shows an increased book rate of return, and it should be considered as a positive indication.

5.3 SCENARIO ANALYSIS

Scenario analysis is the process of examining and evaluating possible events or scenarios that could take place in the future and predicting the various feasible results or possible outcomes (34). This process is typically used to estimate changes in the value of our cash flow, especially when there are potentially favorable and unfavorable events that could impact the investment.

There are three different scenarios use in the scenario analysis:

- *Baseline scenario* is the most likely to occur.
- *Optimistic scenario* is the ideal scenario used to set managerial targets.
- *Pessimistic scenario* tries to encapsulate most of the negative outcomes.

In this project, will devise these three scenarios using the COVID-19 pandemic (35) in the following fashion:

- Baseline Scenario:

  Will proceed with the calculations based on the realistic estimations that we mentioned in the previous chapters.

- Optimistic Scenario:

  In this case will assume that the COVID-19 pandemic will be scaled-down giving a positive push in the economy effecting on the revenues that will face a 5% rise.

- <u>Pessimistic Scenario:</u>

  In contrast with optimistic scenario, in this case will assume the opposite regarding the COVID-19 pandemic. The revenues will face a drop-off of 5% due to the negative course of the economy.

5.3.1 OPTIMISTIC SCENARIO

Table 20: Optimistic Scenario Calculations results

Required Return	8.00 %
Net Present Value	289,213.61 €
Internal Rate of Return	10.74%
Book Rate of Return	12,44%
Discounted pay back period	9

Table 21: Skydra Costs - Revenues 10 year Plan Optimistic Scenario Calculations

	Cost Category	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Investment Costs	MR Cost	40,000 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00	0,00	0,00
	Network Construction Costs	1,192,000 €	744,600 €	676,000 €	480,000 €	320,000 €	127,400 €	110,000 €	75,200 €	56,400 €	31,200 €
	Computer Costs	8,000 €	2,000 €	2,000 €	2,000 €	2,000 €	5,000 €	2,000 €	2,000 €	2,000 €	2,000 €
	Cost of Other Equipment	15,000 €	5,000 €	5,000 €	5,000 €	5,000 €	3,000 €	3,000 €	2,000 €	2,000 €	2,000 €
	New Customer Connection Cost	110,000 €	100,000 €	95,000 €	92,000 €	75,000 €	70,000 €	62,000 €	35,400 €	27,500 €	24,000 €
	Financial Cost (Loan)	0,00 €	0,00 €	430,494 €	430,494 €	430,494 €	430,494 €	430,494 €	0,00 €	0,00 €	0,00 €
	Total Investment	1,365,000, €	851,600 €	1,208,494 €	1,009,494 €	832,494 €	635,894 €	607,494 €	114,600 €	87,900 €	59,200 €
	Cumulative Investment Cost	1,365,000 €	2,216,600 €	3,425,094 €	4,434,588 €	5,267,082 €	5,902,976 €	6,510,470 €	6,625,070 €	6,712,970 €	6,772,170 €
Operating Costs	Management Staff Payroll	25,000 €	27,000 €	27,000 €	27,000 €	27,000 €	25,000 €	25,000 €	25,000 €	25,000 €	20,000 €
	Office Rent Costs	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €
	Insurance Costs	1,911 €	1,192.24 €	1,691.89 €	1,413.29 €	1,165.49 €	890.25 €	850.49 €	160.44 €	123.06 €	82.88 €
	Maintenance Costs	27,300 €	17,032 €	24,169.88 €	20,189.88 €	16,649.88 €	12,717.88 €	12,149.88 €	2,292 €	1,758 €	1,184 €
	Other Expenses	15,000 €	15,000 €	15,000 €	15,000 €	10,000 €	10,000 €	10,000 €	5,000 €	5,000 €	5,000 €
	Total Operating Costs	75,211 €	66,224.24 €	73,861.77 €	69,603.17 €	60,815 €	54,608.13 €	54,000.37 €	38,452.44 €	37,881.06 €	32,266.88 €
	Cumulative Operating Cost	75,211 €	141,435.24 €	215,297.01 €	284,900.18 €	345,715.55 €	400,323.69 €	454,324.06 €	492,776.50 €	530,657.56 €	562,924.44 €
	TOTAL INVESTMENT COST	1,440,211 €	917,824.24 €	1,282,355.77 €	1,079,097.17 €	893,309.37 €	690,502.13 €	661,494.37 €	153,052.44 €	125,781.06 €	91,466.88 €
	TOTAL REVENUES	488,250 €	677,460 €	775,740 €	887,355 €	956,865 €	989,835 €	1,023,750 €	1,069,530 €	1,102,920 €	1,155,000 €
	PV – COST DISCOUNTED	1,333,528.70 €	786,886.35 €	1,017,975.36 €	793,168.64 €	607,971.35 €	435,133.47 €	385,975.61 €	82,689.47 €	62,921.85 €	42,366.86 €
	PV – REVENUES DISCOUNTED	452,083.33 €	580,812.76 €	61,.807.42 €	652,232.42 €	651,226.24 €	623,763.95 €	597,348.29 €	577,833.78 €	551,734.59 €	534,988.48 €
	NPV PER YEAR	-951,961 €	-240,364.24 €	-506,615.77 €	-191,742.17 €	63,555.63 €	299,332.87 €	362,255.63 €	916,477.56 €	977,138.94 €	1,063,533.12 €
	DISCOUNTED PAYBACK PERIOD										PAYBACK PERIOD

For the optimistic scenario, we assumed a 5% increase in the revenues in comparison with baseline. This would reflect a moderate revenue increase due to minor favorable parameter change (i.e., increased oil prices, increased customers, etc.). The relevant indicators mentioned in Table 20 are based on the results of Table 21. We can observe an expected increase in all indicators, since we have a long-term investment that is expected to have net profits at maturity. Even a minor increase of 5% in the revenues will have a significant impact in all indicators except discounted payback period that stays stable.

5.3.2 BASELINE SCENARIO

Baseline scenario was the one that was reflecting the most realistic estimations. Table 17 and Table 18 present the data and the calculation results. These estimations include a relatively high required return of 8%. The revenue estimation was quite moderate considering the initial assumption of state subsidy for network installation costs. Therefore, the expected long-term NPV is marginally profitable (11.221,64€). The Internal Rate of Return prevailed over required return as it was expected since we had an indication of that as we had a positive Net Present Value.

5.3.3 PESSIMISTIC SCENARIO

Table 22: Pesimistic Scenario Calculations results

Required Return	8.00 %
Net Present Value	-266,770.32 €
Internal Rate of Return	5.50%
Book Rate of Return	11,26%
Discounted pay back period	10

Table 23: Skydra Costs - Revenues 10 year Plan Pesimistic Scenario Calculations

	Cost Category	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Investment Costs	MR Cost	40,000 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00	0,00	0,00
	Network Construction Costs	1,192,000 €	744,600 €	676,000 €	480,000 €	320,000 €	127,400 €	110,000 €	75,200 €	56,400 €	31,200 €
	Computer Costs	8,000 €	2,000 €	2,000 €	2,000 €	2,000 €	5,000 €	2,000 €	2,000 €	2,000 €	2,000 €
	Cost of Other Equipment	15,000 €	5,000 €	5,000 €	5,000 €	5,000 €	3,000 €	3,000 €	2,000 €	2,000 €	2,000 €
	New Customer Connection Cost	110,000 €	100,000 €	95,000 €	92,000 €	75,000 €	70,000 €	62,000 €	35,400 €	27,500 €	24,000 €
	Financial Cost (Loan)	0,00 €	0,00 €	430,494 €	430,494 €	430,494 €	430,494 €	430,494 €	0,00 €	0,00 €	0,00 €
	Total Investment	1,365,000, €	851,600 €	1,208,494 €	1,009,494 €	832,494 €	635,894 €	607,494 €	114,600 €	87,900 €	59,200 €
	Cumulative Investment Cost	1,365,000 €	2,216,600 €	3,425,094 €	4,434,588 €	5,267,082 €	5,902,976 €	6,510,470 €	6,625,070 €	6,712,970 €	6,772,170 €
Operating Costs	Management Staff Payroll	25,000 €	27,000 €	27,000 €	27,000 €	27,000 €	25,000 €	25,000 €	25,000 €	25,000 €	20,000 €
	Office Rent Costs	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €
	Insurance Costs	1,911 €	1,192.24 €	1,691.89 €	1,413.29 €	1,165.49 €	890.25 €	850.49 €	160.44 €	123.06 €	82.88 €
	Maintenance Costs	27,300 €	17,032 €	24,169.88 €	20,189.88 €	16,649.88 €	12,717.88 €	12,149.88 €	2,292 €	1,758 €	1,184 €
	Other Expenses	15,000 €	15,000 €	15,000 €	15,000 €	10,000 €	10,000 €	10,000 €	5,000 €	5,000 €	5,000 €
	Total Operating Costs	75,211 €	66,224.24 €	73,861.77 €	69,603.17 €	60,815 €	54,608.13 €	54,000.37 €	38,452.44 €	37,881.06 €	32,266.88 €
	Cumulative Operating Cost	75,211 €	141,435.24 €	215,297.01 €	284,900.18 €	345,715.55 €	400,323.69 €	454,324.06 €	492,776.50 €	530,657.56 €	562,924.44 €
	TOTAL INVESTMENT COST	1,440,211 €	917,824.24 €	1,282,355.77 €	1,079,097.17 €	893,309.37 €	690,502.13 €	661,494.37 €	153,052.44 €	125,781.06 €	91,466.88 €
	TOTAL REVENUES	488,250 €	677,460 €	775,740 €	887,355 €	956,865 €	989,835 €	1,023,750 €	1,069,530 €	1,102,920 €	1,155,000 €
	PV – COST DISCOUNTED	1,333,528.70 €	786,886.35 €	1,017,975.36 €	793,168.64 €	607,971.35 €	435,133.47 €	385,975.61 €	82,689.47 €	62,921.85 €	42,366.86 €
	PV – REVENUES DISCOUNTED	409,027.78 €	525,497.26 €	557,159.10 €	590,115.04 €	589,204.69 €	564,357.86 €	540,457.98 €	522,801.99 €	499,188.44 €	484,037.20 €
	NPV PER YEAR	-998,461 €	-304,884.24 €	-580,495.77 €	-276,252.17 €	-27,574.37 €	205,062.87 €	264,755.63 €	814,617.56 €	872,098.94 €	953,533.12 €
	DISCOUNTED PAYBACK PERIOD										

The pessimistic scenario simulates the effect of a 5% decrease in the revenues. The indicators presented in Table 22 and Table 23. This would reflect a moderate revenue decrease due to minor negative parameters change. In this case the investment will not be profitable and will need to find solutions to minimize the negative impact. The investment is marginally profitable under the baseline (realistic) scenario, which means that a marginal increase or decrease in the revenues can have incremental positive or negative impact. Extending the time horizon of the investment will reveal the long -term characteristics of the investment that should have not been ignored and set a cut-off payback period or a cut-off NPV.

5.4 SENSITIVITY ANALYSIS

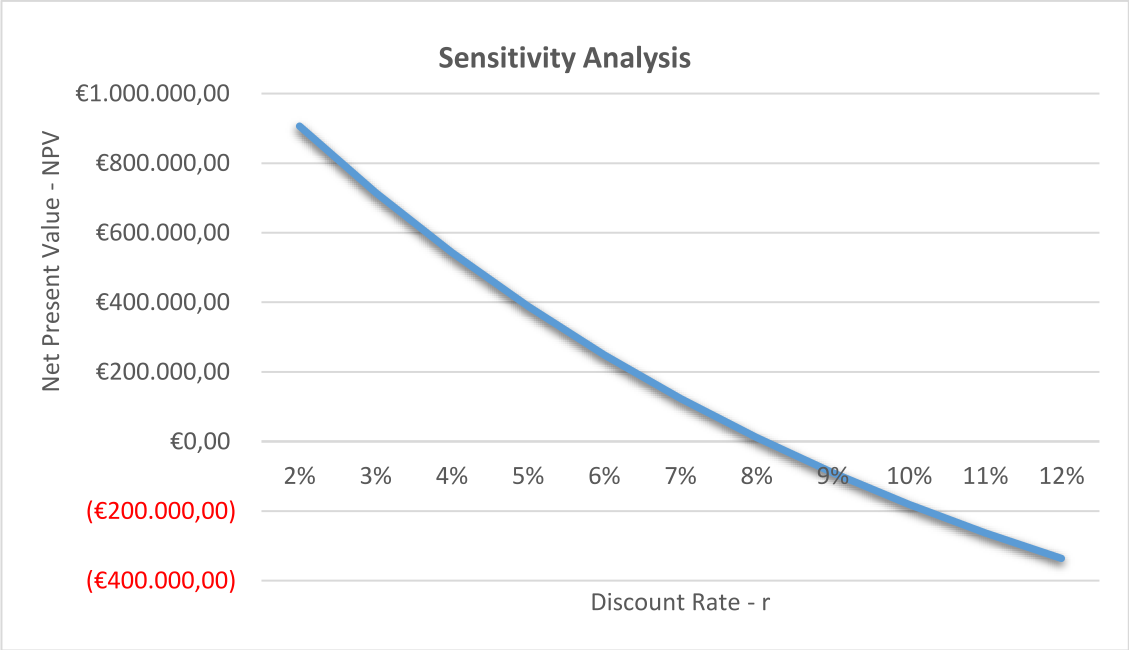
Due to the inherent investment risk that we must face, sensitivity analysis is used to measure the impact of uncertainty of one or more input variables (36). Whenever managers are given a cash-flow forecast, they try to determine what else may happen and the implications of these possible unexpected events. An important distinction between scenario and sensitivity analyses is that sensitivity analysis examines the effect of changing just one variable at a time, whereas scenario analysis assesses the effect of changing all the input variables at the same time.

In this project sensitivity analysis can be expressed by changing the variable of discount rate that is a determining factor of the investment. The projections that we can assume are to examine a range of discount rates between 2% to 12% and examine how it affects the project. To conduct the sensitivity analysis, we examined the effect of a single measurable parameter change, the discount rate. A floating discount rate from 2% to 12% will lead to a variety of NPV mentioned in Table 24. Between 8% and 9% is the turning point where NPV turns from negative to positive (Graph 3). That confirms the baseline calculations where for a discount rate of 8% the NPV is positive (11,221.64€) and the corresponding internal rate of return is 8.11%.

Net present value was decreased rapidly since discount rate was rising. This was to be expected since the discount rate in the Net Present Value formula is in the denominator; an increase in the discount rate leads to a decrease in the Net Present Value.

Table 24: Sensitivity Analysis Calculations results

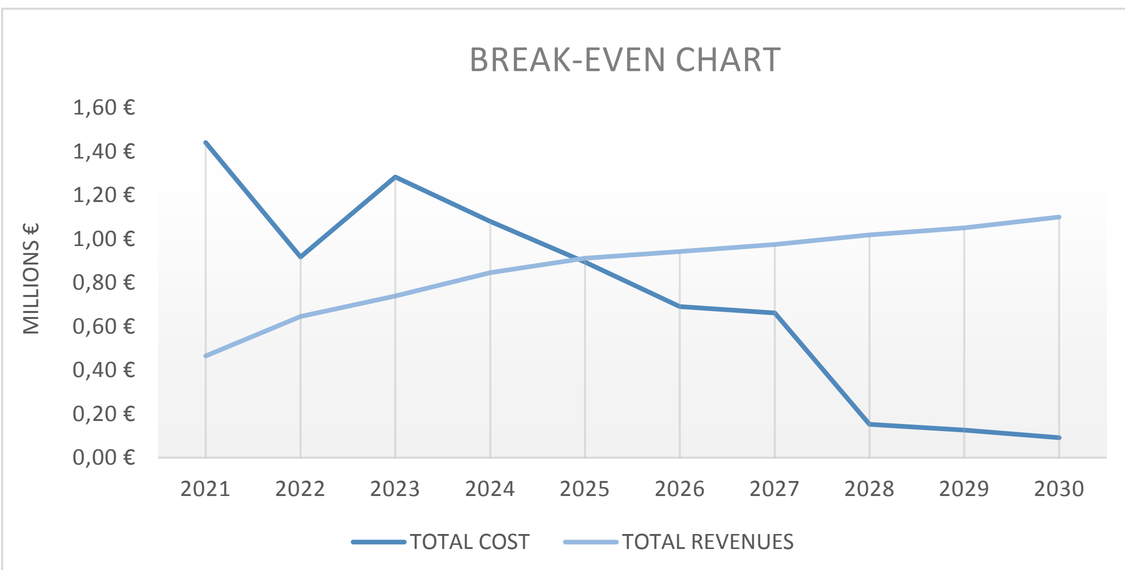
r	NPV
2%	906.420,30 €
3%	714.882,13 €
4%	542.741,92 €
5%	387.994,22 €
6%	248.855,18 €
7%	123.736,35 €
8%	11.221,65 €
9%	-89.952,63 €
10%	-180.915,42 €
11%	-262.676,25 €
12%	-336.138,82 €



Graph 3: Sensitivity analysis Graph

5.5 BREAK EVEN ANALYSIS

Break-even analysis is a method widely known among managers to examine when revenues will be sufficient to cover the investment costs and repay the initial investment. The break-even point can be calculated in terms of Net Present Value (37). The financial break-even occurs at a point when the cash flows are equivalent to the initial investments; this is possible only when the Net Present Value is zero. In our case this occurs just before 2025 when Total Costs and Total Revenues balance.



Graph 4: Break Even Chart

CHAPTER No.6: RISKS AND ALTERNATIVES OF THE INVESTMENT

Risk is an significant factor for any kind of investment. In order to be prepared for it, we have to examine it and find solutions before it becomes imperative.

6.1 POTENTIAL RISK AND SOLUTIONS

Almost any kind of private investment includes risk (38). This risk can be internal from any kind of investment development process or external from all kinds of factors ranging from the economy to extreme situations such as the COVID-19 pandemic. The goal is to identify the most frequent and probably risks for this project and provide the adequate measures that will address the potential risks. In this section will not present all risks but only three special risks that relate to the intrinsic characteristics of this project.

The first risk is the number of estimated natural gas network consumers. This estimation determines the viability of the project, since the consumers define the natural gas network revenue. In case the projections overturn and there are not enough applications, the project is going to face a huge revenue problem because it will not be able to depreciate its investment. In this case the solution would be to ensure adequate connection applications by lobbying the local authorities for state subsidization.

The second risk is the possible depreciation of Regulatory Authority of Energy (RAE) prices. From financial theory, we know that there is an inverted relationship between price and consumption (39). Thus, if the EL.GAS supply commission rise’s abruptly, there will subsequently be an increase in the end customers’ bills that might lead to a reduced consumption. However, this risk is not likely to happen because Regulatory Authority of Energy (RAE) is an independent authority with constitutionally enshrined principles that are difficult to change. In the rare case that this risk might materialize, would have to absorb part of this increase according to relevant demand-price elasticity studies.

The final risk is the "new fuel" risk that is most likely to occur in a small provincial area. Misinformation, the bias for an alternative new fuel and the installation cost are factors that may prevent new customers from connecting to the natural gas network.

In addition, the old technology stakeholders or political interests might lobby against the adoption of this new technology. We must invest in the public information with media campaigns, minimizing the information asymmetry gap and emphasizing on the financial and environmental benefits of the natural gas network.

6.2 POTENTIAL ALTERNATIVE PROJECT TO COMPARE

To assess the project, we should compare it with other similar technology projects that might have different inherent characteristics. In this case the construction of a private natural gas network in Polygyros would be a comparable investment.

6.2.1 LOCATION OF APPLICATION

Polygyros is located in Central Macedonia, occupying an area of 952 km2 and inhabited by 6.121 people with population density 32 residents/km2. Based on the 2011 inventory, there are 5.826 residential and 1.471 commercial/industrial buildings in this area. EL.GAS has received licenses to construct and operate a natural gas network to this town, too. According to estimations, the natural gas penetration will be 28% for residential customers and 11% for commercial/industrial by the end of 10 years. Given the penetration, overall annual consumption is forecast at 4 mcm by the 10^{th} year. Due to Polygyro's long distance from the high-pressure network, natural gas will be supplied differently from Skydra.

In particular, compressed natural gas (CNG) will be loaded at vehicles from compression stations near the high-pressure network and transported to the city gate decompression station owned and operated by the company. Supply to the city gate will be the responsibility of the suppliers. The nearest compression station close to the high-pressure network is in Thessaloniki and will supply natural gas to Polygyros. According to development plan, there are going to be constructed 11.6 km of low-pressure network. Polygyros faces many similarities with Skydra, both in geographic and demographic characteristics. Their investment budget, loan needs and revenues are also similar. Although the technical part and the implementation of the investment face small differences that can give an adequate foundation for comparison. In the following chapter, will discuss this comparison with figures.

6.2.2 TECHNICAL DEVELOPMENT

The distribution network regarding the area of Polygyros refers to an area which is not connected to the National Gas Transmission System, neither within the geographical area of a Distribution Operator. Therefore, the network that will be developed will be isolated. In cities remote from the gas transmission and distribution networks the supply is made with compressed natural gas (CNG) or in the case of very large consumption with liquefied natural gas (LNG). The network will consist of one low-pressure piping system and from a CNG decompression station. The low pressure polyethylene network (4bar), is powered by autonomous compressed gas stations (CNG Stations) and distributes the gas to households, commercial and small industrial consumers by operating sector in order to satisfy the smooth operation of the distribution network. The design of the natural gas distribution network in the area of Polygyros, consists of:

A. Compressed natural gas (CNG) station

For the supply of the distribution network (4bar) of the area of Polygyros, a compressed natural gas decompression station will be installed 1.800m3 / h (CNG Station), which will have the role of the city station (City Gate Station) and will cover the needs of the area.

The compressed natural gas will be transported by special tankers from the gas compression stations at pressures up to 200bar, which will be located within the geographical boundaries controlled by other Distribution System Operators (in this case from the EDA of Thessaloniki - Thessaly).

B. The low pressure network.

The 4 bar low-pressure polyethylene network, which is supplied with gas by 200/4 bar decompression station, and distributes the gas to domestic, commercial, and small industrial consumers, consists of the Basic network (primary network) in the shape of a ring and the branches (secondary networks). The main network is designed to have a minimum pressure of 1.6 bar in all parts of the network. Minimum diameter of polyethylene main pipes is F125mm. Consumer branches and connections are made (as a rule) with pipes with diameters F160mm and F63mm (Figure 13). The choice of materials and the construction of the polyethylene network, 4bar, follows "Regulation of polyethylene gas distribution networks with maximum pressure 4bar operation, Ministerial Decision D3 / A / 14715 (Government Gazette 1530, 19/10/2006) (40).

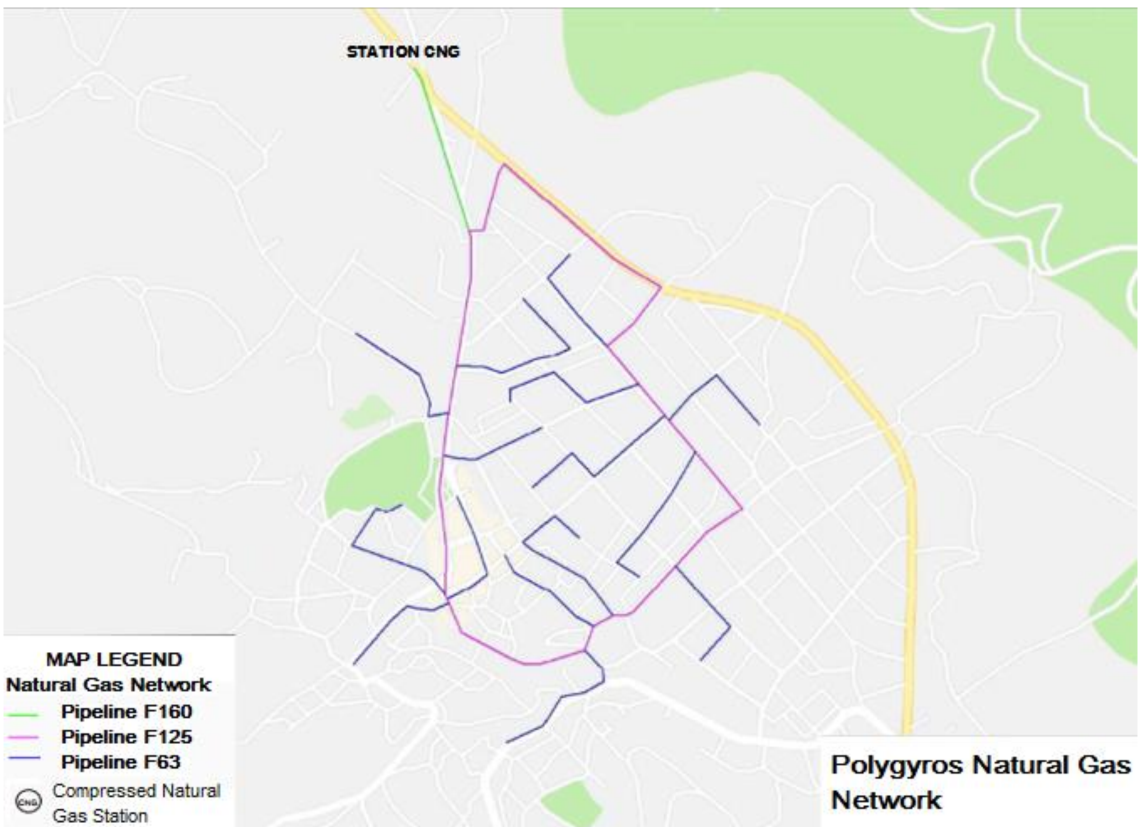


Figure 13: Schematic representation of a low pressure distribution network in the area of Polygyros

6.2.3 COST AND REVENUE

COST

The main reason for choosing Polygyros to be the comparable equivalent of Skydra is the similarities they face as investments, especially in the aspect of cost and revenues. As the main idea of the investment seems identical, but diversifies in the location of applying, the main cost categories, investment and operating costs stay the same. The investment cost also in this case is higher than the operating cost. Regarding the investment cost in the case of Polygyros due to the different technical implementation of the network, using virtual pipeline network with CNG instead of constructing all the steel network leads to redistribution of the investment cost.

In this case the de-compressor cost, that is fundamental for a remote network, is added in the investment cost and at the same time the network construction cost has been minimized as the network that has to be constructed is shorter and has been replaced from the virtual network (Figure 14). The rest elements such as MR cost, computer cost, cost of other equipment and new customer connection cost are approximately the same due to the size of the area and population that are similar. Regarding the financial cost, we assume that it stays the same. As for the operating cost, it is identical to Skydra with a small downward change in the insurance and maintenance cost. The total cost of the investment for a time horizon of ten years is presented in Table 25.

Figure 14: Map display of distribution network area of Polygyros

Table 25: Polygyros 10 years investment plan costs

	Cost Category	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Investment Costs	MR Cost	40,000 €	0.00€	0.00€	0.00€	0.00€	0.00€	0.00€	0.00€	0.00€	0,00
	De-Compressor cost	400,000 €	0.00€	0.00€	0.00€	200,000 €	0,00	0.00€	0.00€	0.00€	0,00
	Network Construction Costs	662,000 €	488,000 €	474,000 €	304,000 €	297,600 €	117,000 €	103,600 €	65,600 €	40,400 €	21,600 €
	Computer Costs	8,000 €	2,000 €	2,000 €	2,000 €	2,000 €	5,000 €	2,000 €	2,000 €	2,000 €	2,000 €
	Cost of Other Equipment	20,000 €	5,200 €	5,200 €	5,000 €	5,000 €	4,000 €	3,000 €	2,000 €	2,000 €	2,000 €
	New Customer Connection Cost	105,000 €	98,000 €	92,500 €	84,000 €	78,600 €	72,500 €	63,200 €	42,600 €	34,500 €	25,000 €
	Financial Cost (Loan)	0.00 €	0.00 €	430.494 €	430,494 €	430,494 €	430,494 €	430,494 €	0.00 €	0.00 €	0.00 €
	Total Investment	1,235,000 €	593,200 €	1,004,194 €	825,494 €	1,013,694 €	628,994 €	602,294 €	112,200 €	78,900 €	50,600 €
	Cumulative Investment Cost	1,235,000 €	1,828,200 €	2,832,394 €	3,657,888 €	4,671,582 €	5,300,576 €	5,902,870 €	6,015,070 €	6,093,970 €	6,144,570 €
Operating Costs	Management Staff Payroll	27,000 €	27,000 €	27,000 €	27,000 €	27,000 €	27,000 €	27,000 €	25,000 €	25,000 €	25,000 €
	Office Rent Costs	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €	6,000 €
	Insurance Costs	1,729 €	830.48 €	1,405.87 €	1,155.69 €	1,419.17 €	880.59 €	843.21 €	157.08 €	110.46 €	70.84 €
	Maintenance Costs	24,700 €	11,864 €	20,083.88 €	16,509.88 €	20,273.88 €	12,579.88 €	12,045.88 €	2,244 €	1,578 €	1,012 €
	Other Expenses	15,000 €	15,000 €	15,000 €	15,000 €	10,000 €	10,000 €	10,000 €	5,000 €	5,000 €	5,000 €
	Total Operating Costs	74,429 €	60,694.48 €	69,489.75 €	65,665.57 €	64,693.05 €	56,460.47 €	55,889.09 €	38,401.08 €	37,688.46 €	37.082,84 €
	Cumulative Operating Cost	74,429 €	135,123.48 €	204,613.23 €	270,278.80 €	334,971.85 €	391,432.33 €	447,321.42 €	485,722.50 €	523,410.96 €	560,493.80 €
	TOTAL INVESTMENT COST	1,309,429 €	653,894.48 €	1,073,683.75 €	891,159.57 €	1,078,387.05 €	685,454.47 €	658,183.09 €	150,601.08 €	116,588.46 €	87,682.84 €

REVENUES

Regarding the part of Polygyros project revenues, we based the projections on the estimations and assumptions for the potential customers and the market penetration level of Skydra due to the similarities that they face. The size of the inhabit area, the weather conditions and the location of interest were kingpins in our estimations. Based on the data from Hellenic Statistical Authority (ELSTAT) we conjectured that in total 1.645 household consumers (of total 5.826) will connect in the network in a time horizon of 10 years. As for the industrial and commercial ones, 162 of 1.471 will proceed with applying for a natural gas connection.

Due to the fact that the charges will be the same as in Skydra the number of consumers will be the determinant factor of the revenues. Table 26 and 27 present the estimated consumers and the total revenues that are expected. It's important to mention that compared to Skydra, Polygyros is considered to have smaller penetration level of customers in all the categories (household, commercial, and industrial). That projection owes to the fact that the network expansion is more restricted in a remote network than in a regular one.

Table 26: Polygyros consumers per year (By category)

	Household Consumers per Year									
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Consumers	230	235	225	200	165	158	122	110	105	95
	1.055					590				
	1.645									
	Commercial Consumers per Year									
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Consumers	20	20	20	16	16	14	12	12	10	8
	92					66				
	148									
	Industrial Consumers per Year									
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Consumers	2	2	2	2	2	1	1	1	1	0
	10					4				
	14									

Table 27: Polygyros revenues per year

YEAR	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTAL REVENUES	400,600 €	535,300 €	652,800 €	741,800 €	819,500 €	879,660 €	907,100 €	959,100 €	1,013,000 €	1,018,900 €

6.2.4 PROJECT EVALUATION

Evaluating the investment is the most crucial part of the project in order to examine whether it is viable or not. Applying the data for Polygyros in all the investment evaluation methods mentioned in Chapter 5 gives the results in Table 28. Also, in this case, it is assumed that the requested return stays the same as in Skydra calculations. Taking into account the evaluation methods and the further down results, the investment seems worth going on. In particular, the positive Net Present Value that reaches 20,919.53€ together with the Internal Rate of Return that exceeds the requested return (8.2236% compared to 8.00%) are positive signs for our investment. Moreover, the discounted pay back period that is smaller than the projects' evaluation time frame alongside with Book rate of Return that reaches 11.8235% support the positive evaluations results.

Table 28: Polygyros calculation results

Requested Return	8.00%
Net Present Value	20,919.53 €
Internal Rate of Return	8.2236%
Book Rate of Return	11.8235 %
Discounted pay back period	9

6.2.5 COMPRASION WITH SKYDRA

The aim of the reference to Polygyros was to compare with a corresponding investment and to identify common features and differences. Location of applying is the main difference of the two projects. Skydra in comparison to Polygyros is located in the regional unit of Pella whereas Polygyros in Chalkidiki regional unit.

The population density of Polygyros is significantly lower than Skydra, even if the polupalation numbers are close. Due to this fact and the estimations for potential customers and penetration level of natural gas, Polygyros investment plan is smaller. Moreover the technical application is a major difference as in Skydra will apply conventional pipeline network, whereas in Polygyros the innovational virtual pipeline network will be implimented.

Regardind the economic evaluation, and in consequence their comparison, both imvestments show possitive features. Polygyros Net Present Value, Internal Rate of Return and Book Rate of Return are higher than the equivalent prices of Skydra. This confirms the fact that both investments are sustainable despite their differences.

Conclusions

This short survey presents the details of a new investment opportunity for EL.GAS; the natural gas network infrastructure construction for the city of Skydra. It is a pioneer project that will utilize state of the technology in order to bring solution to remote areas. This investment is a long-term construction investment, regulated by the Regulatory Authority of Energy (RAE). This implies that it will have increased construction costs and relatively narrow revenue margins. It is also partially financed by a bank loan that will be paid off during its lifetime. Taking into consideration these characteristics, the investment financial indicators have shown marginally profitable investment characteristics. The scenario and sensitivity analysis, and the alternative projects comparison can verify the long-term nature of this investment that is nevertheless preferrable to the requested return. Therefore, we should consider this investment as a favorable investment that will enhance EL.GAS's market value in the natural gas construction sector.

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