ASSESSMENT OF RISK ASSOCIATED WITH THE SECURITY OF GAS SUPPLY IN GREECE

In accordance with the provisions of Article 9 of Regulation (EU) No 994/2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC

(Unofficial Translation)

ATHENS

December 2011

REGULATORY AUTHORITY FOR ENERGY

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Foreword

This Study of Assessment of Risk associated with the Security of Gas Supply in Greece (Study) is submitted in accordance with the provisions of Article 9 of Regulation (EU) No 994/2010 of the European Parliament and of the Council, of 20 October 2010, concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC (Regulation).

The Study has been elaborated by the Regulatory Authority for Energy (RAE), in the context of its competences as a Competent Authority, in accordance with Article 12 of Law 4001/2011 (Government Gazette, Series I, No 179, , 22.08.2011) “On the operation of Electricity and Natural Gas Energy Markets on Research, Production and Hydrocarbon Transmission Networks and other arrangements".

To elaborate the Study, RAE has established a working group formed by Hellenic Gas Transmission System Operator S.A. (DESFA), Hellenic Electricity Transmission System Operator S.A. (DESMIE), Public Gas Corporation (DEPA), in its quality of supplier to protected consumers under long-term gas import agreements, and representatives of the Ministry of Energy, Environment and Climate Change (MEECC).

Interim results of the Study have been presented to representatives of the electricity production (E.P.) sector and the industry, as well as to the Natural Gas Undertakings (NGU) that supply minor consumers connected to the Greek transmission systems. Remarks submitted by the participants have been taken into account in formulating the final Study.

The first section of the Study presents the background of the Greek gas market and, specifically, the National Natural Gas System (NNGS), the historical evolution of gas demand in Greece and an estimate of the evolution of the supply and demand balance in the short and in the medium-term. The second section presents the supply security crisis scenarios examined and the results of the assessment of risks and their potential impacts on the gas supply of Greece.

Please note that this risk assessment analyses the risks and their impacts on the security of gas supply in Greece. This analysis is conducted at national level and any infrastructure or demand data at regional level are not taken into account. The analysis is based on the assumption that any analysis at regional level would hardly reverse the conclusions of the previous analysis, at least as regards Greece.

Any analysis at regional level would necessarily have to take into account the fact that the natural gas delivered at the “Sidirokastro” Entry Point is transmitted from Russia to Greece through, inter alia, the transit networks of Romania and Bulgaria. Therefore, any disruption of the transit in any of the aforementioned networks and at least in these two EU Member States directly affects the delivery of natural gas quantities in Greece, alongside with the two other Member States. Namely, one would expect high correlation of the impacts of such a disruption on all three Member States.

Therefore, any expansion of the analysis at regional level may show an improvement as to the capacity to manage crises affecting each Member State individually. However, in the cases of high correlation scenarios, the impact on Greece may be serious and it is possible that a respective conclusion is reached through the risk assessment of Bulgaria and Romania in particular since the dependence of these Member States on a single gas supplier is very high. One of the conclusions that may be deduced from expanding the analysis at regional level is that, in order to mitigate the consequences of such a crisis, it would be necessary to interconnect at least one of the three Member States with another region or to implement a new large infrastructure having large entry capacity within the region of Greece-Bulgaria-Romania. Such projects, apart from the other projects of the Southern Corridor, could be one of the proposed pipelines for interconnecting Greece with Italy or a new LNG terminal station in Northern Greece, both of which are projects under design and development.

I. Hellenic Gas Market Data

1. Natural gas demand

1.1 Natural gas share in the energy balance

Renewable energy sources, energy saving actions and the use of natural gas are some basic tools for attaining the targets of Greece relating to greenhouse gas emission reduction. The significance of the renewable energy sources and natural gas for covering a large share of the increase in the primary energy consumption in the last decade in Greece is presented in Chart 1. (Source: EUROSTAT).

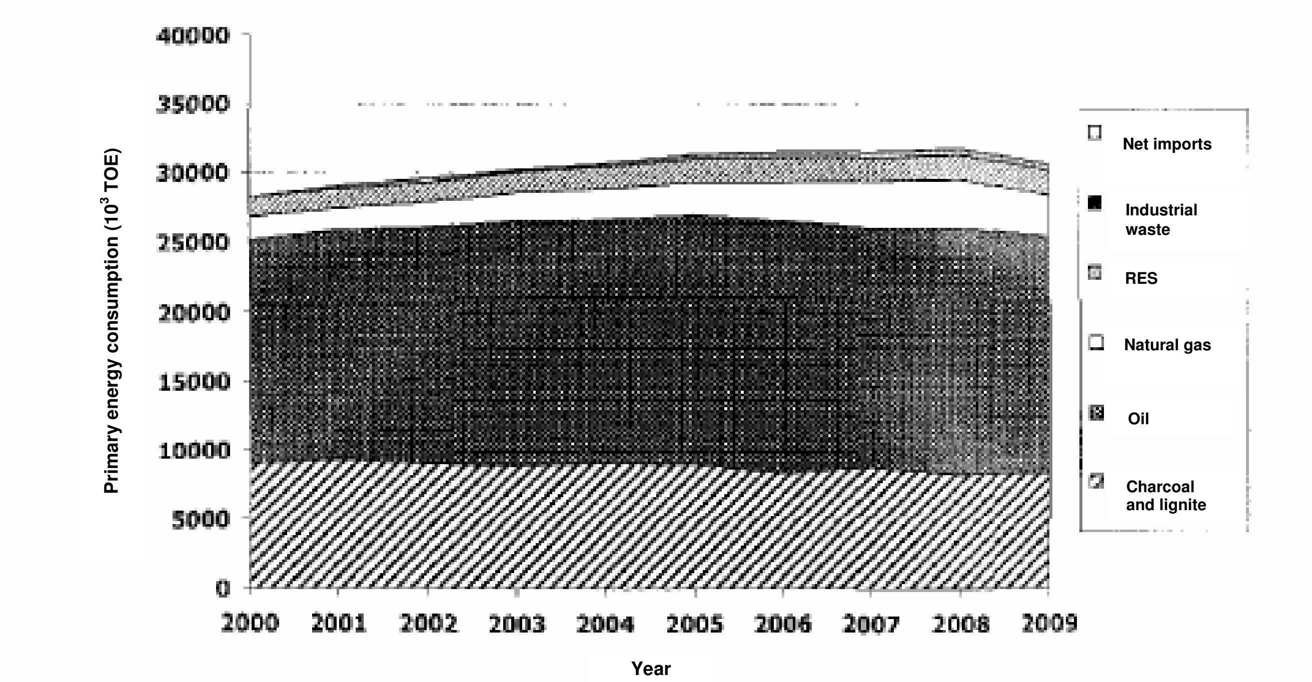
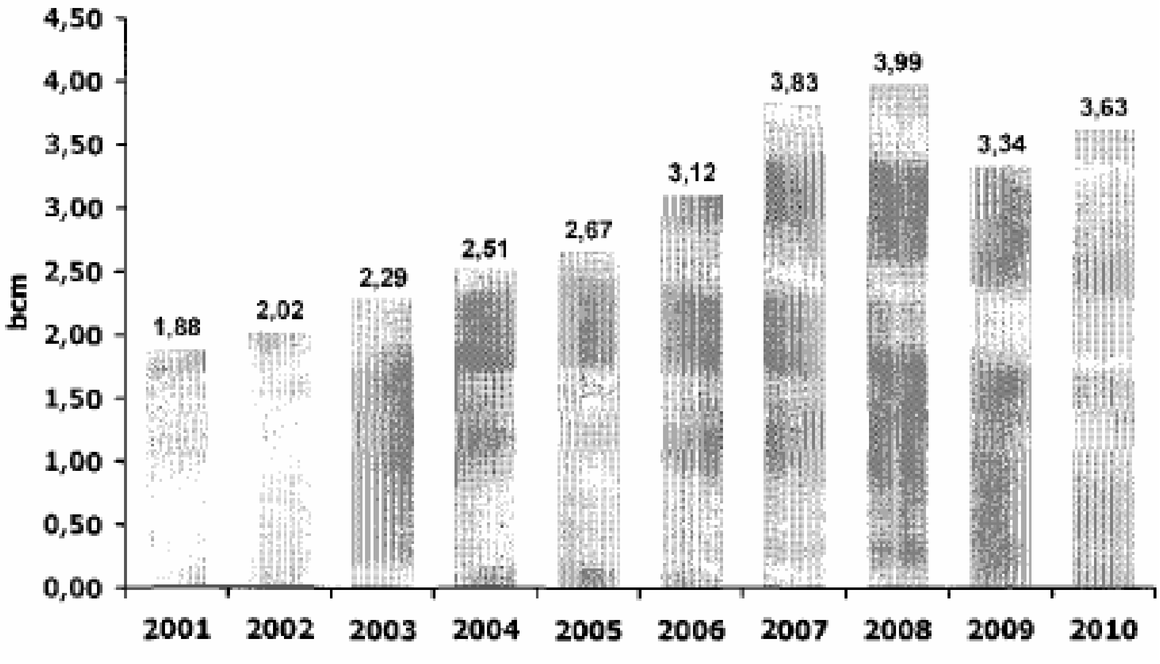


Chart 1: Evolution of natural gas share in the primary energy consumption in Greece

Natural gas share in the primary energy consumption amounted in 2009 to 10%.

1.2 Historical demand data

Natural gas demand in the period 2001-2007 increased annually by more than 12% on an average, as presented in Chart 2. Therefore, in 2007, the demand was almost twice as that of 2001. The stabilisation observed in 2008 and the sensible decrease in 2009 are partially due to the economic crisis that was escalating in 2008 and 2009, on one part, and the reduced demand for natural gas for electricity production, as a result of the hydrological features of 2008 and 2009, the electricity market operation conditions and the high natural gas prices in 2008 and in the first half of 2009, on the other part.



Year

Chart 2: Historical evolution of natural gas demand

1.2.1 Qualitative features – Demand per sector

Chart 3 below presents demand per sector, as a percentage of the total demand in 2007 and 2010. It is observed that the increase in the share of the household-commercial sector in the total demand for natural gas continues, due to the continuous development of natural gas distribution networks by the three Natural Gas Undertakings.

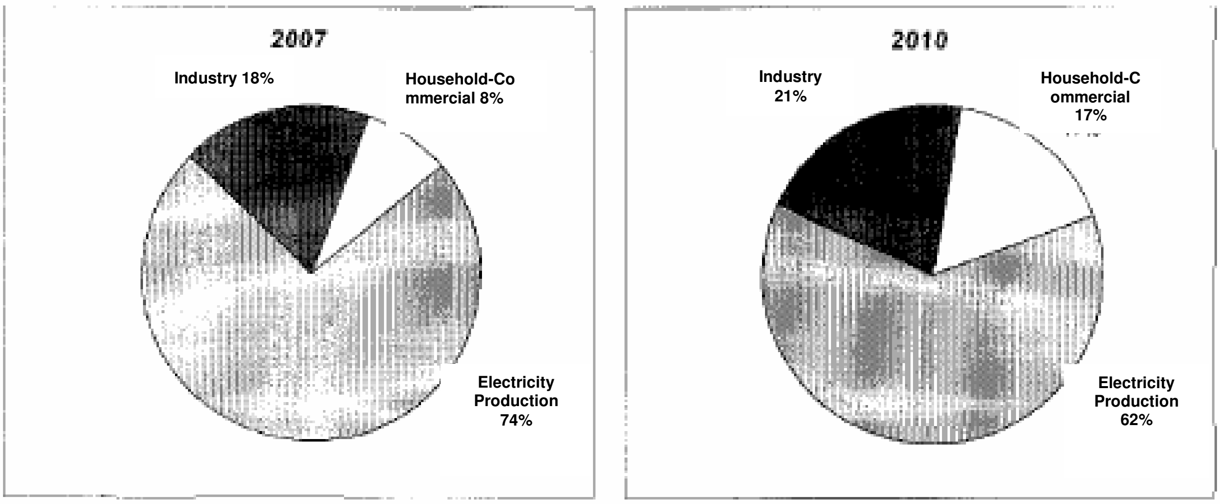


Chart 3: Demand per consumer category in 2007 and 2010

1.2.2 Qualitative features – Peak demand for natural gas

Peak demand significantly increased in the period 2004-2010, as presented in Table 1 below. The share of the electricity production sector in the peak demand fell during the last five years from 70% down to 60%.

Table 1: Daily peak demand for natural gas

Year	Peak demand (Nm^3 χ $1O^6$) / day	Consumption rate of the electricity production sector during the maximum-demand day (peak)
2004	9.9	73%
2005	12.2	70%
2006	13.5	71%
2007	16.1	67%
2008	15.2	61%
2009	16.3	63%
2010	16.9	57%

The fall in the share of the electricity production sector in the peak demand is consistent with the data presented in the previous paragraph relating to the penetration of natural gas in the household-commercial consumption.

1.3 Demand evolution forecast (2012-2020)

The demand for gas in the following years until 2020, according to estimates made by DESFA, is expected to increase, as shown in Chart 4.

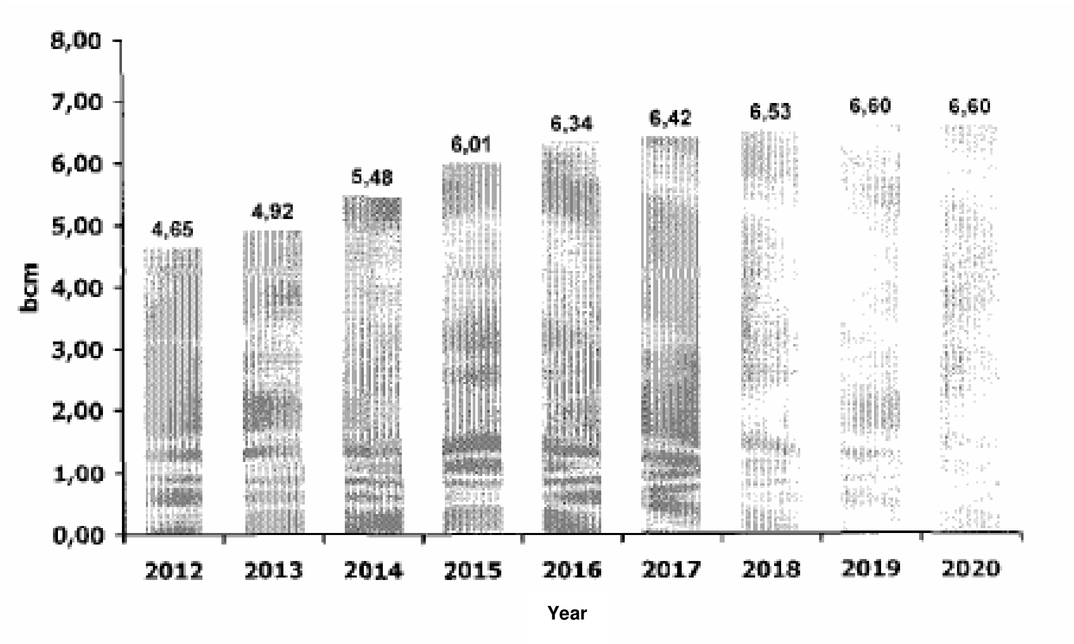


Chart 4: Estimated demand evolution

The aforementioned forecast of demand has been based on the following data:

- The forecasts of the annual natural gas market, as communicated by the NNGS Users to the Operator, in accordance with Article 90 of Chapter 12 of the Management Code.
- The historical data on daily natural gas deliveries at each Exit Point of the NNGS, as drawn from relevant records kept by the Operator.

1.3.1 The role of the electricity production sector

The electricity production sector has been the milestone for the introduction of natural gas into the energy mix of Greece, providing the necessary anchor loads for concluding long-term gas supply agreements and for developing infrastructure. As mentioned above, the sector's share in the total demand for natural gas is currently about 60%.

The participation of natural gas plants in the electricity production balance has been increasing at strong pace since 2005, covering a significant part of the increase in the demand for electricity. Such an increase temporarily stopped in 2009 and, to a certain extent, in 2010. Such two-year period coincided with the economy falling into recession, while the weather conditions have favoured the high inflow of water in hydroelectric power station reservoirs. Chart 5 presents the evolution of the natural gas share in the centrally-allocated electricity production in Greece from 2005 to 2011.

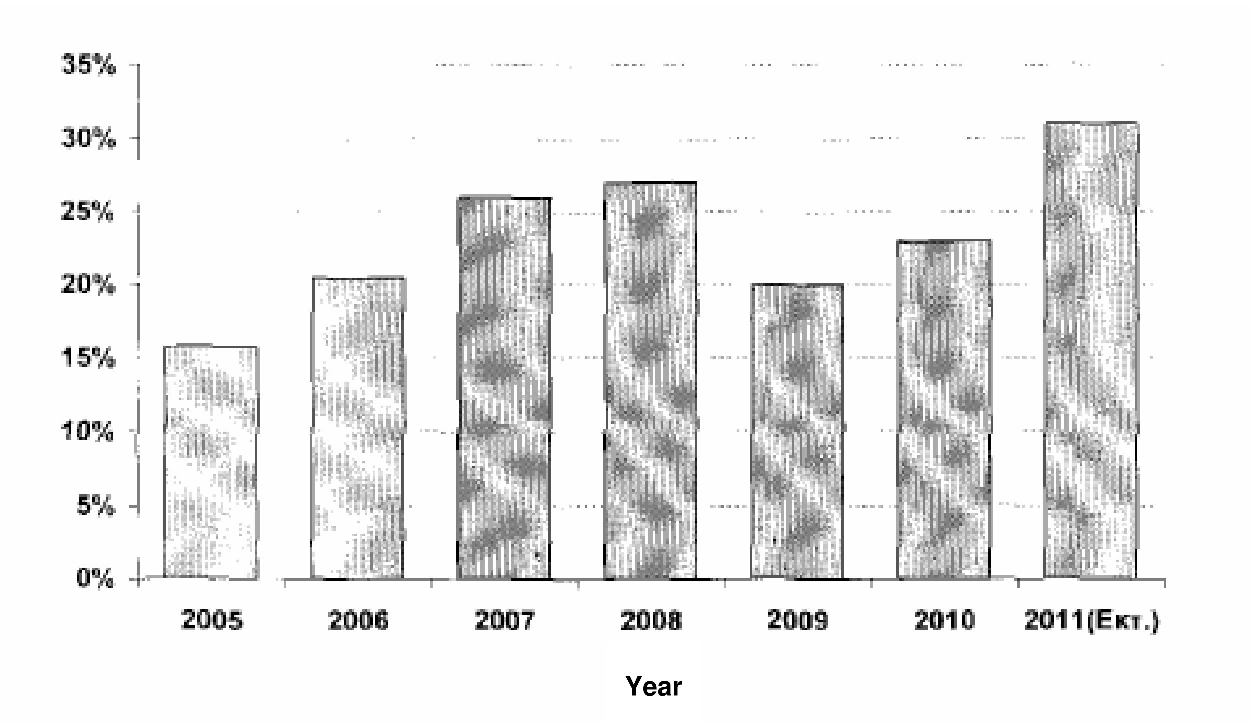


Chart 5: Natural gas share in the centrally-allocated production of electricity in Greece.

It is deduced from the above that the generation of electricity from plants fuelled with natural gas is soon expected to exceed 1/3 of the energy produced from centrally-allocated potential in the interconnected system.

2. Natural gas supply

The natural gas consumed in Greece is imported either under long-term agreements or under short-term agreements for the purchase of LNG loads or additional gas through pipelines. To date, DEPA S.A. is the only gas supplier having concluded long-term gas supply agreements. The gas is supplied under long-term agreements from Russia, Algeria and Turkey.

2.1 Current long-term agreements

The evolution in time of the natural gas supply under the aforementioned long-term agreements is displayed in Chart 6, presenting the total annual contractual quantities until 2021, when the last current agreement expires.

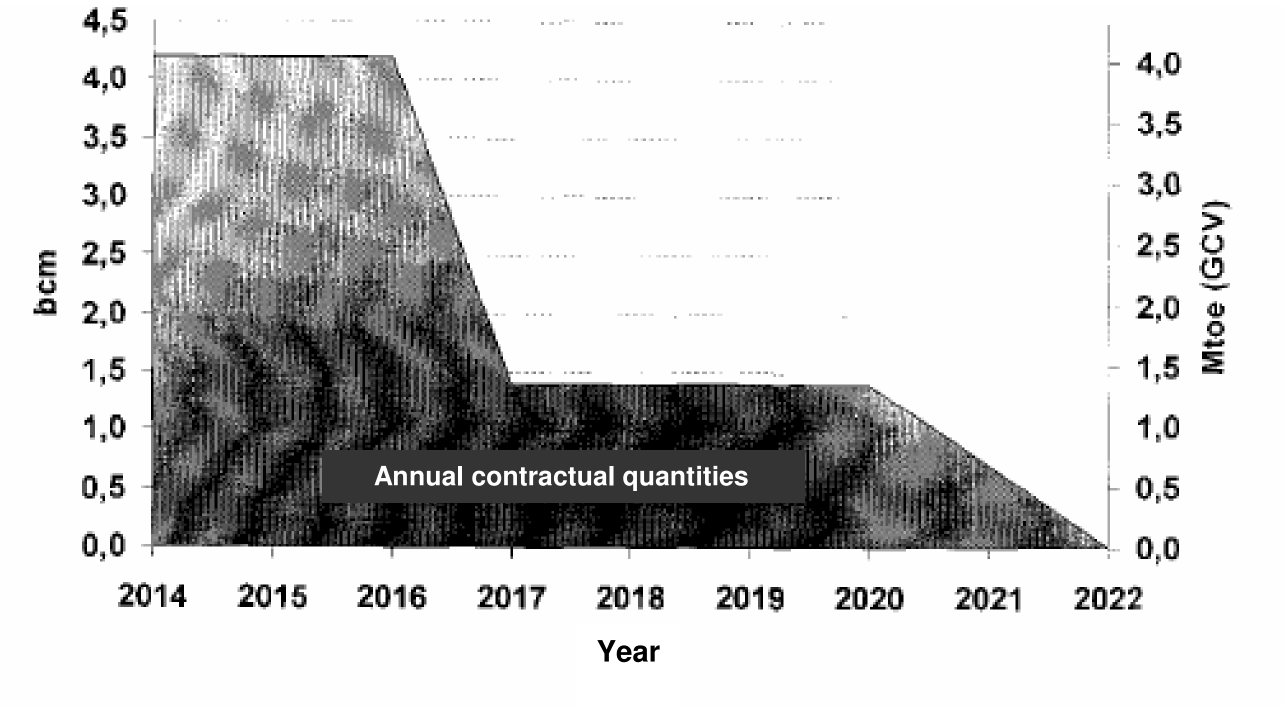


Chart 6: Natural gas supply under current long-term supply agreements

2.2 Sources of supply to the Greek market in the period 2007-2010

During the last three years, the sources of natural gas supply in Greece have been diversified. This development has taken place alongside the interconnection with Turkey and the realization of extensive LNG imports by NNGS Users. These imports have been performed under short-term supply agreements both by DEPA S.A. and by other NNGS Users.

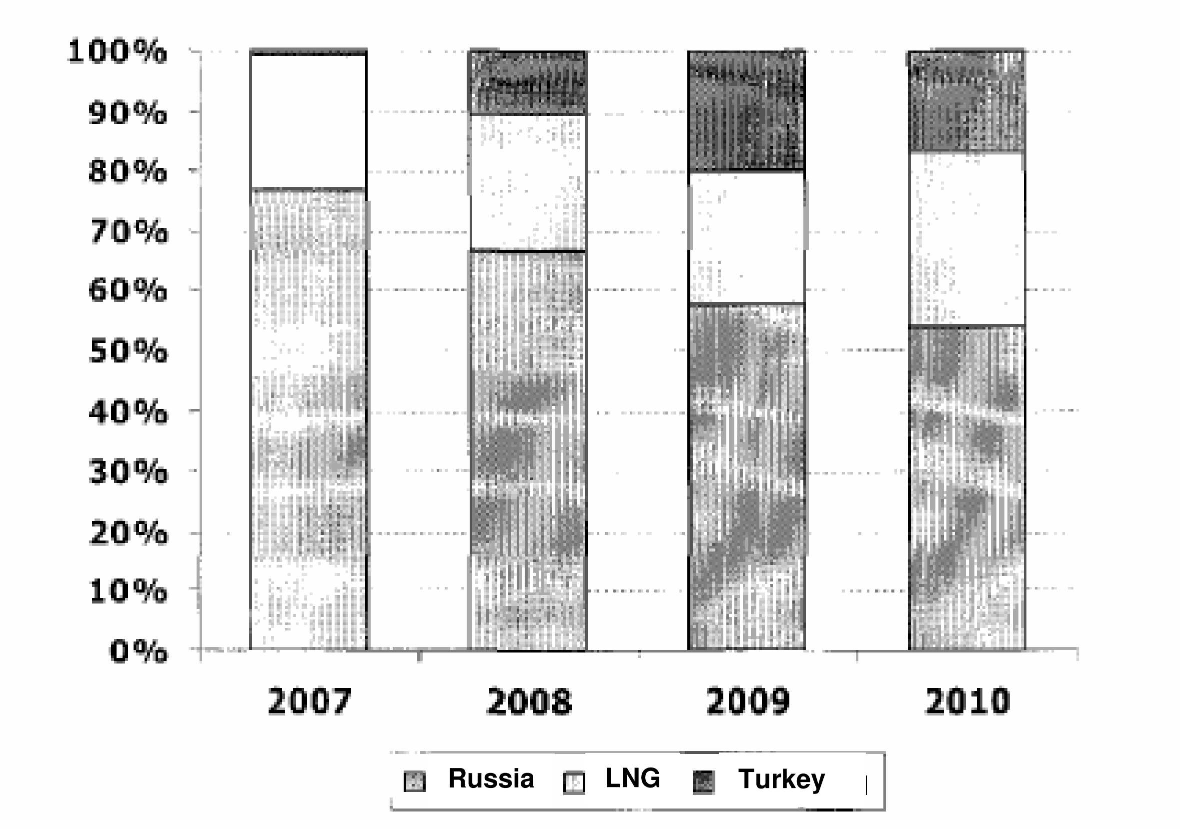


Chart 7: Evolution of natural gas mix in Greece in the period 2007-2010

2.3 Supply and demand balance

2.3.1 Supply and demand balance until 2014

Table 2 presents the potential natural gas deficit until 2014, based on the current long-term agreements and the demand estimate as per paragraph 1.3.

Table 2: Assessment of the sufficiency of natural gas quantities until 2010 based on current long-term agreements

	2012		2013		2014	
	bcm	**Mtoe**	**bcm**	**Mtoe**	**bcm**	**Mtoe**
Demand	4.64	4.46	4.92	4.73	5.48	5.26
Annual contractual quantities	4.2	4.04	4.20	4.04	4.20	4.04
Expected deficit	**0.44**	**0.42**	**0.72**	**0.69**	**1.28**	**1.22**

The aforementioned data of the Table present a deficit in the natural gas supply which varies from 0.4 bcm in 2012 to 1.2 bcm in 2014. That deficit may be compensated by the conclusion of new short-term or long-term agreements that will use the available capacity of the existing and of any new infrastructures, in accordance with the applicable framework.

2.3.2 Supply and demand balance until 2020

Chart 8 presents the balance of supply and demand based on the existing data of the current agreements until 2020, as well as long-term estimates.

The data in the Chart show an imperative need to replenish the quantities that will cease to exist due to the gradual expiration of the current agreements after 2017, on the one hand, and the need to find additional quantities of at least 2 bcm per year from 2015 and afterwards by concluding long-term agreements, on the other hand.

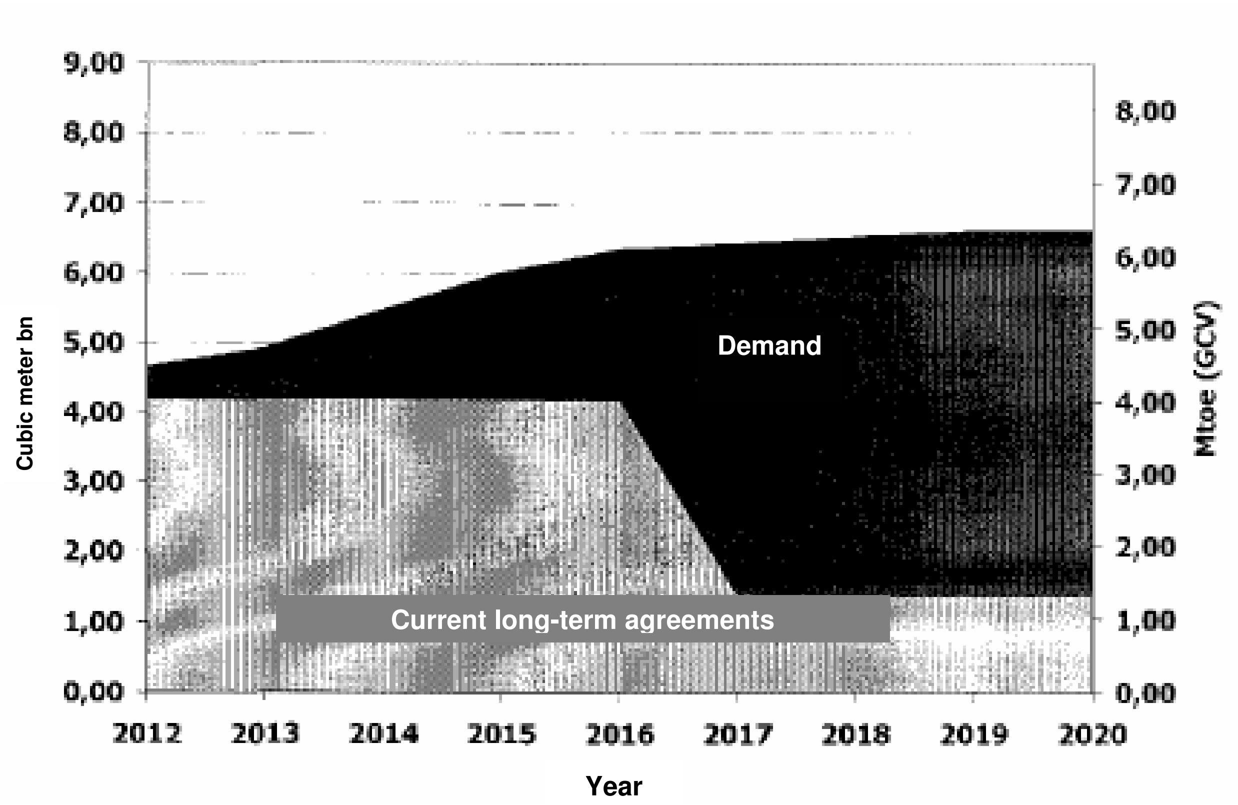


Chart 8: Long-term estimate of requisite natural gas quantities under different demand scenarios

3. National Natural Gas System and Use of Infrastructure

3.1 General description

The National Natural Gas System consists of the main high-pressure gas transmission pipeline from the Greek-Bulgarian borders to Patima, Elefsina, the high-pressure transmission branches that connect the various regions of Greece with the main pipeline, including the branch connecting the main pipeline to the Greek-Turkish borders, the Liquefied Natural Gas (LNG) Facility at Revythoussa Island, as well as the additional facilities and infrastructures serving the Transmission System.

3.1.1 National Natural Gas Transmission System (NNGTS)

Natural gas enters the NNGTS through three Entry Points, i.e. Sidirokastro, on the Greek-Bulgarian borders, Kipi, Evros, on the Greek-Turkish borders, and Agia Triada, opposite to the Revythoussa Island. Table 3 presents the capacity of the Entry Points before and after the installation of a compression station at Nea Mesimvria, which is expected to be completed during 2012.

Table 3: Existing and future capacity of the NNGTS Entry Points in m. of Nm^3/day

Entry Point	Without compressor	With compressor (20120)
Sidirokastro	9.77	12.00
Kipi, Evros	2.72	5.16
Agia Triada	12.47	12.47

3.1.2 LNG facility on the Revythoussa Island

The LNG Revythoussa facility is interconnected to the National Transmission System via the "Agia Triada" Entry Point at the southern end of the network and substantially contributes to the security of supply both through its storage facility and through the capacity it provides for diversifying the origin of the natural gas imported in the Greek market. It consists of:

1. Two storage tanks of total capacity of 135 000 m^3 LNG, approximately 127 000 m^3 of which can be pumped.
2. LNG gasification installations of total capacity of 1 000 m^3/hour or approximately 14 million Nm ^{3}/day and standby gasification capacity of 250 m^3/hour.
3. A twin subsea pipeline of 600m length and 24" diameter connecting the terminal station to the NNGTS.
4. Installations enabling unloading of vessels having maximum total length of 290 m. and capacity of 180 000 m^3.

3.2 Use of infrastructures and agreements

Third party (User) access to the National Natural Gas System is provided in accordance with the terms and provisions of the NNGS's Management Code and the Measurement Regulation, in the context of relevant Transmission Agreements and LNG Facility Usage Agreements concluded with the System Operator.

3.2.1 Transmission Agreements

Under the Transmission Agreements, entered into by and between Users (individuals or entities registered in the Register of Users of the Regulatory Authority for Energy) and the Operator, on the basis of the standard Transmission Agreement, issued by Decision ref. 611/2010 of the Regulatory Authority for Energy (Government Gazette No 480, 20.04.2010), the latter provides the Users with the following services:

A) Off-take by the Operator of a Natural Gas Quantity from one or more Entry Points.

B) Transmission of the Natural Gas Quantity through the NNGTS.

C) Delivery of the Natural Gas Quantity by the Operator to one or more Exit Points.

D) Performance of necessary measurements through the metering installations at the Entry and Exit Points.

The aforementioned services are provided continuously and for a minimum period of one day. In the period from 20.04.2010 to 31.10.2011, 43 Transmission Agreements were entered into by and between the Operator and NNGS Users, three of which had a contractual term exceeding three hundred sixty five (365) days. In the same period, the shares of Natural Gas Quantities off-taken from the NNGTS by DEPA S.A. and by third party Transmission Users were as follows (*Source: DESFA).*

Natural Gas Quantity Off-Takes/ Period: 20.04.2010-31.10.2011

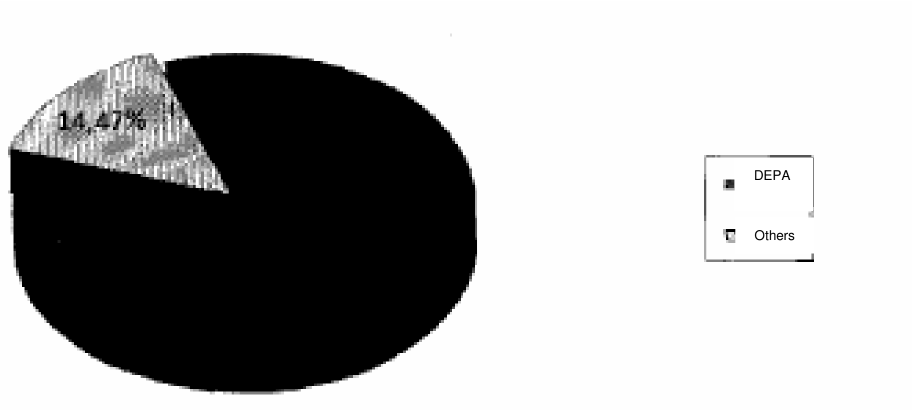
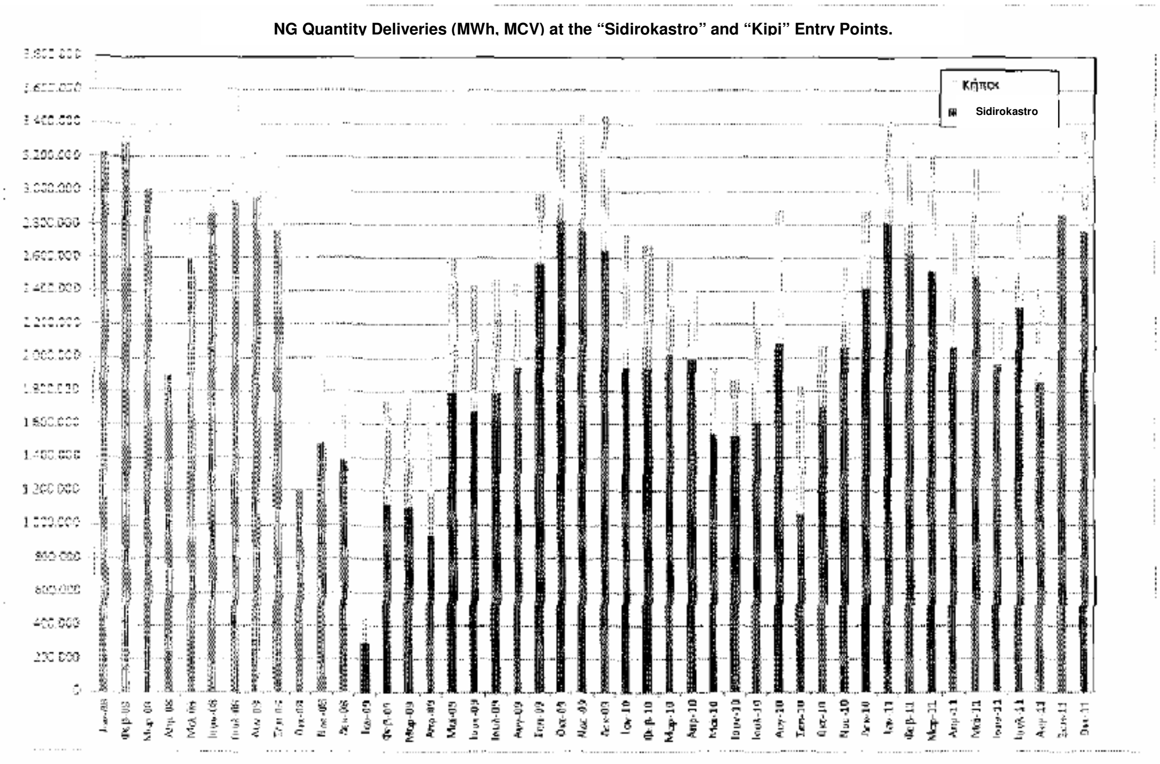


Chart 9

3.2.2 Use of interconnections

The charts below present the NG quantity delivered on a monthly basis at the "Kipi" and "Sidirokastro" Entry Points, expressed in MWh (Maximum Calorific Value) in the period 01.01.2008 - 31.10.2011, as well as the daily peak against the booked and technically available capacity, respectively, in the same period.



Period	Sidirokastro	Kipi
01.01.2008 - 31.12.2008	29 596 864.57	4 646 398.98
01.01.2009 - 31.12.2009	21 476 004.84	7 553 270.44
01.01.2010 - 31.12.2010	21 927 021.65	6 915 034.15
01.01.2011 - 31.10.2011	24 262 299.88	6 178 142.10

Chart 10: NG Quantity Deliveries at the "Sidirokastro" and "Kipi" Entry Points expressed in MWh (MCV) *Source: DESFA*

Period 01.01.2008 - 31.10.2011

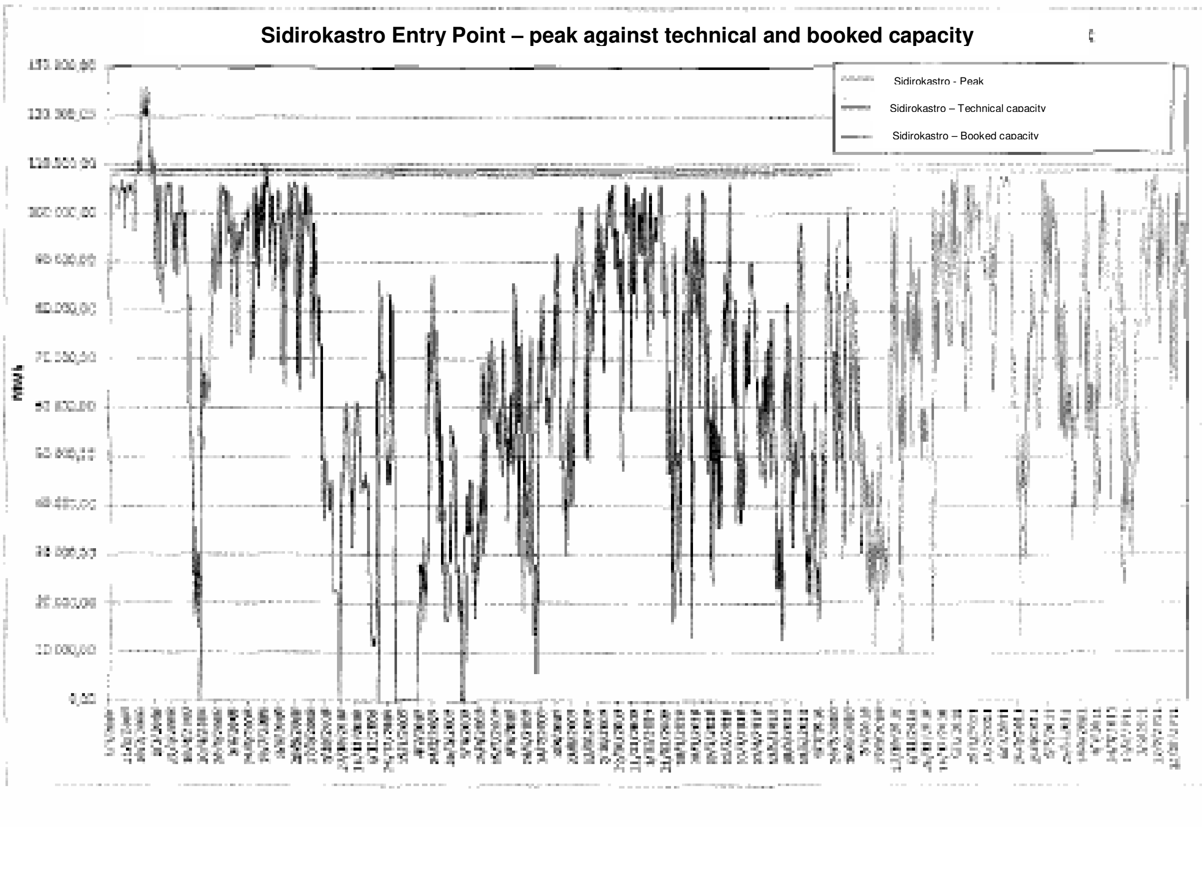


Chart 11: Use of "Sidirokastro" Entry Point. Quantities expressed in MWh (MCV) *Source: DESFA*

Table 4: Average and maximum daily quantities compared to the technical capacity

Period	Average Daily NG Quantity Delivered (MWh MCV)	Maximum Daily NG Quantity Delivered (MWh MCV)	Technical capacity (MWh MCV)
01.01.2008-31.12.2008	80 865.75	125 936.80	109 000.00
01.01.2009 -31.12.2009	58 838.37	106 528.60	109 000.00
01.01.2010-31.12.2010	60 074.03	107 186.99	109 000.00
01.01,2011 -31.10.2011	78 567.30	107 846.49	109 000.00

Period 01.01.2008 - 31.10.2011

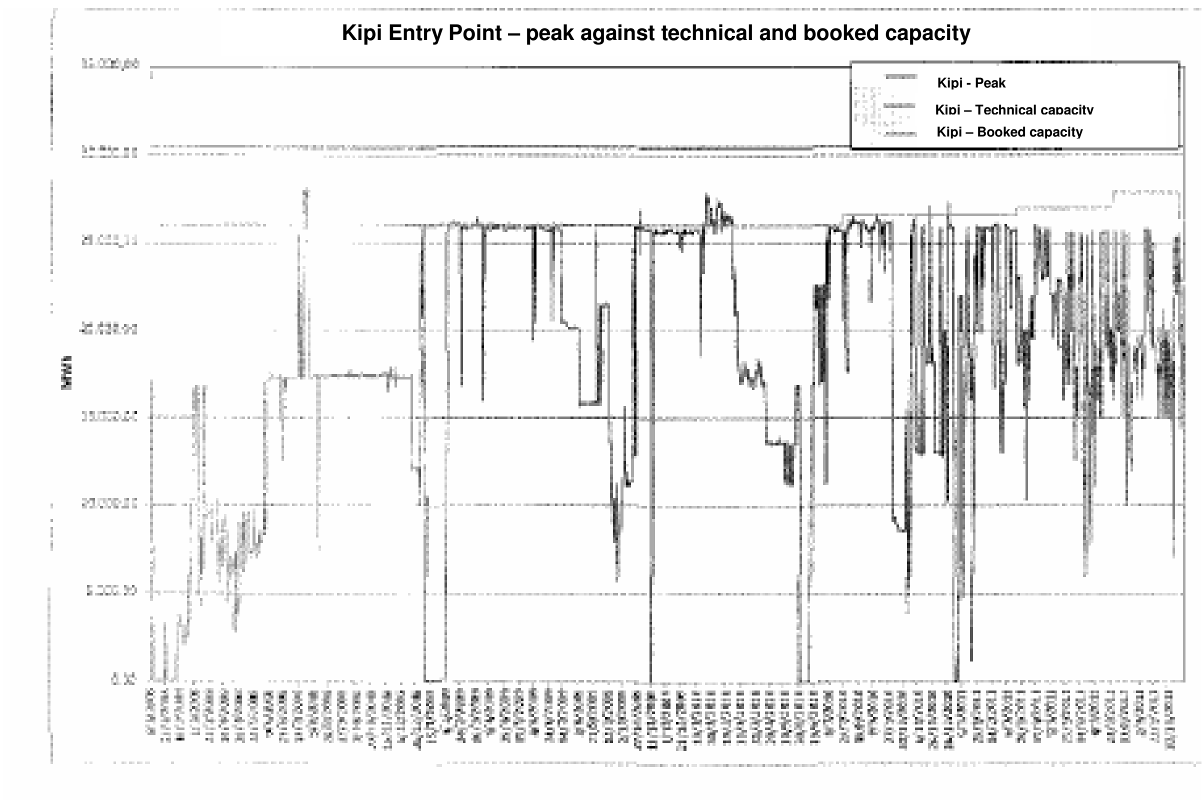


Chart 12: Use of "Kipi" Entry Point. Quantities expressed in MWh (MCV) *Source: DESFA*

Table 5: Average and maximum daily quantities compared to the technical capacity

Period	Average Daily NG Quantity Delivered (MWh MCV)	Maximum Daily NG Quantity Delivered (MWh MCV)	Technical capacity (MWh MCV)
01.01.2008- 31.12.2008	12 695.08	28 033.15	30 400.00
01.01.2009- 31.12.2009	20 693.89	26 940.02	30 400.00
01.01.2010- 31.12.2010	18 945.30	27 849.83	30 400.00
01.01.2011 - 31.10.2011	20 428.76	26 077.83	30 400.00

3.2.3 Use of the LNG terminal

The LNG Revythoussa terminal safeguards the normal operation of the National Natural Gas Transmission System, on one part, since it is, for the time being, the only infrastructure through which gas is sent out to balance the National Gas Transmission System and, on the other part, since, given that it ensures diversification of the sources of LNG supply, it enables the supply of the Greek market in periods of pipeline gas supply crises. Moreover, its use significantly contributes to promoting competition in the Greek natural gas market, since it is the only point of import of NG quantities through the spot market, as well as the only, for the time being, point of NG import that has free access to diversified upstream sources of supply and suppliers. The chart below presents the daily NG quantity that is gasified and sent out to the NNGTS (via the Agia Triada Entry Point), expressed in MWh (MCV) in the period 01.01.2008 – 31.10.2011, compared to the booked and the technical available capacities, respectively.

Period 01.01.2008 - 31.10.2011

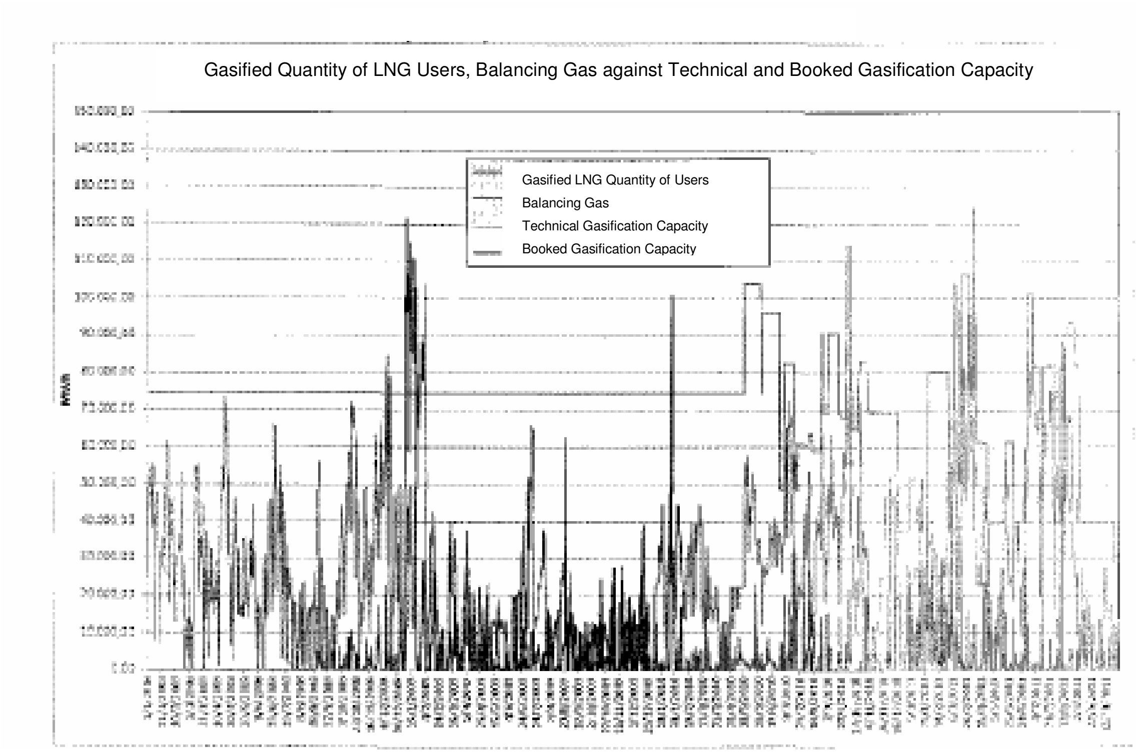


Chart 13: Use of "Kipi" Entry Point. Quantities expressed in MWh (MCV) *Source:DESFA*

Table 6: Average and maximum daily quantities compared to the technical capacity

Period	Average Daily NG Quantity Delivered (MWh MCV)	Maximum Daily NG Quantity Delivered (MWh MCV)	Technical capacity (MWh MCV)
01.01.2008 -31.12.2008	29 411.10	103 643.20	139 656.15
01.01.2009 -31.12.2009	24 539.31	143 643.89	139 656.15
01.01.2010 -31.12.2010	34 625.26	150 041.12	139 656.15
01.01.2011 -31.12.2011	36 742.07	111 054.28	139 656.15

II. Risk Assessment

This section presents the assumptions, the methodology and the results of the risk assessment.

The risk assessment consists of the following steps:

1. Identification of potential risks for the natural gas supply
2. Elaboration of scenarios of natural gas supply crises, representative of the risks identified at the previous step.
3. Simulation of the crisis scenarios and calculation of the demand share that cannot be served.
4. Assessment of the impact on each consumer category from the non-service of the demand, for each scenario.
5. Risk assessment based on the combination of each scenario's probability with its impact on each consumer category.

The following chart presents the successive steps we have made in order to assess the risks for the natural gas supply security.

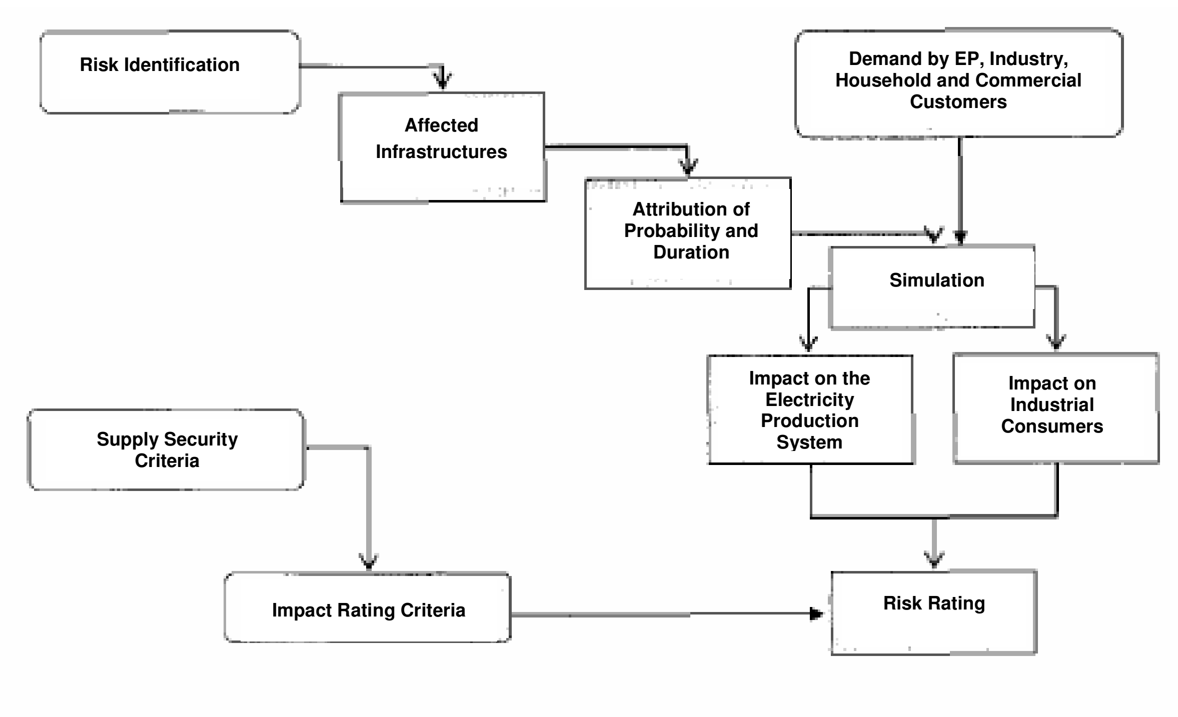


Figure 1 – Risk Assessment Procedure

In addition to the aforementioned procedure, in accordance with the Regulation, we have examined whether the principle relating to the sufficiency of infrastructures for managing supply crises is successfully applied.

The paragraphs below present the aforementioned procedure in five sections:

1. Supply security criteria.
2. Risk identification and elaboration of representative crisis scenarios.
3. Scenario analysis, simulation and impact assessment.
4. Risk rating for each crisis scenario examined according to the criteria determined.
5. N-1 calculation.

4. Supply Security Criteria

4.1 Criteria laid down in Regulation (EU) No 994/2010

Member States are obliged pursuant to the Regulation to take necessary actions to meet the following criteria relating to the security of natural gas supply.

4.1.1 Criterion relating to infrastructures (N-1 standard)

Pursuant to the Regulation, Member States shall ensure that the necessary measures are taken so that by 3 December 2014 at the latest, in the event of a disruption of the single largest gas infrastructure, the capacity of the remaining infrastructure, determined according to the N – 1 formula as provided in point 2 of Annex I to the Regulation, is able, without prejudice to paragraph 2 of Article 6, to satisfy total gas demand of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years.

The N – 1 formula describes the ability of the technical capacity of the gas infrastructure to satisfy total gas demand in the calculated area in the event of disruption of the single largest gas infrastructure during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years.

If, in the event of disruption of the single largest gas infrastructure, the capacity of the remaining infrastructure in the “calculated area" ensures the satisfaction of the total natural gas demand, N-1 is calculated using the formula:

$$N-1[\%] = \frac{EP_m + P_m + S_m + LNG_m - I_m}{D_{max}} \times 100, \quad N-1 \geq 100\% \qquad (1)$$

where:

“"Calculated area" means a geographical area for which the N – 1 formula is calculated, as determined by the Competent Authority.”
“"Dmax" means the total daily gas demand (in mcm/d) of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years.”

""EP_m": *technical capacity of entry points (in mcm/d), other than production, LNG and storage facilities covered by Pm, Sm and LNGm, means the sum of the technical capacity of all border entry points capable of supplying gas to the calculated area.”*

"“P_m": *maximal technical production capability (in mcm/d) means the sum of the maximal technical daily production capability of all gas production facilities which can be delivered to the entry points in the calculated area.”*

""S_m": *maximal technical storage deliverability (in mcm/d) means the sum of the maximal technical daily withdrawal capacity of all storage facilities which can be delivered to the entry points of the calculated area, taking into account their respective physical characteristics.”*

""LNG_m": *maximal technical LNG facility capacity (in mcm/d) means the sum of the maximal technical daily send-out capacities at all LNG facilities in the calculated area, taking into account critical elements like offloading, ancillary services, temporary storage and re-gasification of LNG as well as technical send-out capacity to the system.”*

""I_m": *means the technical capacity of the single largest gas infrastructure (in mcm/d) with the highest capacity to supply the calculated area. When several gas infrastructures are connected to a common upstream or downstream gas infrastructure and cannot be separately operated, they shall be considered as one single gas infrastructure.”*

In case that "*a supply disruption can be sufficiently and timely covered with market-based demand-side measures*", N-1 is calculated using the formula:

$$N-1[\%]=\frac{EP_m+P_m+S_m+LNG_m-I_m}{D_{max}-D_{eff}}\times 100,\ N-1\geq 100\% \quad \textbf{(2)}$$

where:
"Deff" means the part (in mcm/d) of Dmax that in case of a supply disruption can be sufficiently and timely covered with market-based demand-side measures."

The assumptions used for applying the N-1 standard, as well as the results of the calculations until 2014, without taking into account the capability to manage demand using market-based measures, are presented in point 7.3.

4.1.2 Unserved demand by protected consumers

In accordance with Article 8 of the Regulation, the Competent Authority shall require the natural gas undertakings, that it identifies, to take measures to ensure gas supply to the protected customers of the Member State in the following cases:

(a) extreme temperatures during a 7-day peak period occurring with a statistical probability of once in 20 years;

(b) any period of at least 30 days of exceptionally high gas demand, occurring with a statistical probability of once in 20 years; and

(c) for a period of at least 30 days in case of the disruption of the single largest gas infrastructure under average winter conditions.

When this analysis was elaborated, no decision had been taken to expand the definition of protected consumers to the categories referred to in Article 2(a) and (b) of the Regulation. However, it has been considered expedient to assess, in the context of the risk assessment, the capability to satisfy this criterion for all potentially protected consumers, i.e. household consumers and small and medium-sized enterprises connected to a distribution network, as well as district heating installations that are not able to switch to alternative fuels. Hereinafter, wherever a reference is made to "protected consumers", this shall refer to the definition given in Article 2 of the Regulation expanded to include categories (a) and (b).

4.2 Additional risk assessment criteria

Member States may set additional criteria regarding the supply with natural gas. The said criteria must be based on the risk assessment and be identified in the preventive action plan. The particular features of the NNGS, as well as the structure of the Greek gas market have led us to examine the risk also with regard to the security of supply to electricity consumers and the security of industrial facilities. We present below the rationale of examining the risks for complying with the two additional criteria.

4.2.1 Security of supply to electricity consumers

The gradually increasing share of the natural gas in the primary energy balance of the electricity production sector, as presented in point 1.3.1, imposes the need to examine the impact on the adequacy of production capability of a sudden disruption of the natural gas supply. The desirable criterion must secure the sufficiency of alternative sources of primary energy in order to serve the total demand for electricity. This criterion is directly related to securing the supply to household consumers and small and medium-sized enterprises, since the supply with electricity is in any case necessary for the operation of the heating or water heating systems.

The criterion examined is as follows: Sufficiency of alternative primary energy sources for serving the total demand for electricity. Unserved demand for electricity: 0 MWhe

4.2.2 Security of industrial facilities

The consultation with major industrial gas clients has resulted in highlighting the significance, for most processes using natural gas, of early warning, so that they can ensure the safe operation of their facilities. Most persons questioned have answered that if a 48-hour prior warning is given, the risk of a significant and permanent damage being caused to their facilities is prevented. The criterion examined is as follows: Maintenance of supply during the first 48 hours of any crisis to the Industry.

4.2.3 Significance of additional criteria

The aforementioned criteria have been introduced in the elaboration of the risk assessment in order to assess the risk of their not being met. The potential alternative ways to meet these criteria, as well as the means and the resources required to mitigate the risk will be examined via a cost-benefit analysis when the preventive action plan will be elaborated.

5. Risk Identification - Scenarios

5.1 Extrinsic risks

The risks coming from factors extrinsic to the NNGS may be grouped into risks due to technical causes and risks due to contractual or political causes.

5.1.1 Technical failure at the upstream transit systems

“Sidirokastro” Entry Point.

The natural gas delivered at the “Sidirokastro" Entry Point is transferred from Russia to Greece via the transit networks of Ukraine, Moldova, Romania and Bulgaria. Therefore, any disruption of the transit procedure in one of the aforementioned networks directly affects the delivery of natural gas quantities in Greece as well.

“Kipi” Entry Point.

The natural gas is delivered at the "Kipi" Entry Point via the Turkish transmission system and a pipeline section of 36’’ diameter crossing the Evros river and terminating at the entrance of the Kipi metering station. Based on historical data, any major disruption of the Russian gas transit procedure affects the neighbouring Turkey, equally affecting the “Kipi” Entry Point.

"Agia Triada” Entry Point

The Agia Triada Entry Point is exclusively supplied with gas from the LNG station at Revythoussa and is subject to all restrictions applicable to that station. It is the third Entry Point in the NNGS and substantially contributes to the security of supply both with its storage facility and with the capacity it provides for diversification of the origin of the natural gas imported in the Greek market.

For the time being and due to the limited storage space (130 000 m^3 LNG), the Facility is made available to third parties only for provisional storage (i.e. for offloading from vessels and subsequent gasification of the LNG and send-out to the Transmission System), while a small part of the storage space is exclusively used by the Operator for the preservation of permanent reserves in order to cover the security of NNGS supply in the short-term (to cover peak demands, to address emergencies of disruption of the gas supply from pipelines and to perform gas balancing of the Transmission System).

Any delay in the arrival of LNG loads for any reason entails possible reduction of the LNG gasification rate at the “Agia Triada” Entry Point. The limited storage space of the terminal station requires regular arrival of vessels transporting LNG (every 4 days approximately, if the gasification rate reaches the maximum capacity of the station) and, therefore, the smooth supply to the network is directly related to the availability of LNG vessels, technical problems (e.g. explosion in the LNG station in Algeria-Skida), economic data (LNG price), weather conditions prevailing both at the LNG vessel loading facilities and at the terminal station, while, at the same time, the current technical capacity of the port facilities does not allow landing of tankers of capacity exceeding 180 000 m^3. Nevertheless, the incidents of reduced supply to the NNGS from the “Agia Triada” Entry Point that are due to the late arrival of LNG loads are limited due to the high differentiation of the sources of supply with liquefied natural gas (LNG Spot Market).

5.1.2 Incidents of reduced supply to the NNGS in the period 1/2008-10/2011 (Availability of National Natural Gas System)

The Tables below present historical data of delivery disruptions at the Sidirokastro and Kipi Entry Points in the period 01/2008-10/2011. The incidents related to these Entry Points are classified into three (3) categories cited in an order of decreasing significance (Total disruption of deliveries > Partial disruption of deliveries > Entry pressure lower than the minimum contractual pressure):

Table 7. Incidents of reduced deliveries at the SIDIROKASTRO Entry Point in the period 1/2008 to 11/2011

SIDIROKASTRO		Total disruption of deliveries (hours)	Partial disruption of deliveries (hours)	Pressure lower than the minimum contractual one (days)
2008	Total	103	314	1 1
	Maximum duration	48	197	4
	Average duration	5.4	104.7	1.8
2009*	Total	228	252	5
	Maximum duration	191	41	5
	Average duration	57	21.87	5
2010	Total	49	329	4
	Maximum duration	23	75	3
	Average duration	7	12.2	2
2011	Total	38	188	4
	Maximum duration	1 9	12.5	4
	Average duration	6	40	4

*** The period of Russian-Ukrainian crisis – January 2009 – has not been taken into account.*

Table 8. Incidents of reduced deliveries at the KIPI Entry Point in the period 6/2008 to 11/2011

KIPI		Total disruption of deliveries (hours)	Partial disruption of deliveries (hours)	Pressure lower than the minimum contractual one (days)
2008	Total	29	60	3
	Maximum duration	20	16	2
	Average duration	1.71	15	1.5
2009*	Total	8	63	1
	Maximum duration	5	24	1
	Average duration	4	12	1
2010	Total	25	6	4
	Maximum duration	25	6	1
	Average duration	' 25	6	1
2011	Total	133	71	17
	Maximum duration	23	11	3
	Average duration	12	9	2

*** The period of Russian-Ukrainian crisis – January 2009 – has not been taken into account.*

5.2 Contractual disputes/ problems

The second category of risks are risks due to contractual or political causes. A recent example is the crisis in January 2009, during which the flow of natural gas from Sidirokastro and, then, from Kipi was fully disrupted.

Table 9. Incidents of reduced deliveries at the SIDIROKASTRO Entry Point during the Russian-Ukrainian crisis in January 2009

SIDIROKASTRO		Total disruption of deliveries (hours)	Partial disruption of deliveries (hours)	Pressure lower than the minimum contractual one (days)
2009	Total	363	28	16

Table 10. Incidents of reduced deliveries at the KIPI Entry Point during the Russian-Ukrainian crisis in January 2009

KIPI		Total disruption of deliveries (hours)	Partial disruption of deliveries (hours)	Pressure lower than the minimum contractual one (days)
2009	Total	340	5	26

Political instability resulting in riots in a country of origin is another potential source of risk. A recent example that has, though, not affected our country in relation to the natural gas, is the riots in Libya that have caused disruption of gas supply to Italia for more than six months.

5.3 Intrinsic risks

5.3.1 Technical failure in a domestic infrastructure

The supply to the National Natural Gas Transmission System via three Entry Points located at the ends of the main pipeline (Sidirokastro, Kipi, Agia Triada) and at the extremity of the Komotini branch enable alternative supply to consumers, even in cases where it is required to isolate a section of a pipeline in order to address emergencies or due to scheduled maintenance. At this point, it has to be stressed out that the design and construction both of the Entry and Exit Points and of the ancillary systems of the NNGS ensure an adequate amount of standby equipment, so that an error does not lead to disruption of the gas supply or partial or total loss of surveillance of the normal operation of the system. Additional networks supplying household and/or small commercial consumers, such as the networks of Athens, Thessaloniki and Larissa (except than Volos) are supplied from two or more different and operationally-independent measuring and regulating stations of the NNGS, so that their incessant supply with gas is safeguarded in all cases.

The secure and normal operation of the NNGS is safeguarded through the constant monitoring and control of its facilities by the Load Control and Dispatching Centre of DESFA using a reliable supervisory control and data collection system (SCADA). Moreover, the established on-call mechanism for engineers and field technicians ensures the timely (within 2 hours from the time the incident occurs) addressing of any emergency or serious malfunction in the system's equipment, on a 24-hour basis.

Moreover, the LNG station operates staffed on a 24-hour basis, while its supply with electricity is secured by:

1. The combined heat and power station at the Revythoussa Island, which ensures the autonomy of the terminal station as regards its supply with electricity, and, alternatively;

2. Two independent (one surface and one underground) distribution lines (20kV), each of which is able to fully cover the needs of the facility. Therefore, former disruptions of the gasification of the LNG station due to disruption of the electricity supply have almost been eliminated.

The absence of alternative routes of supply to areas supplied via NNGS branches other than the Karperi-Kipi (Komotini branch) system entails failure to supply these areas in cases of incidents requiring disruption of the natural gas flow to these branches or even de-compression of sections thereof. These branches are:

1. Plati branch
2. Volos branch (a section of the Thessaly NGU)
3. Oenofita branch
4. Lavrio branch
5. Keratsini branch
6. Antikira branch
7. Thisvi branch
8. Agioi Theodoroi branch (Corinth)
9. Karditsa branch

Of the aforementioned branches, branches 2 and 9 supply gas to distribution networks which protected consumers are connected to. In case of potential disruption of the NG flow, due to technical problems, the restoration of the system's normal operation, according to the Operator, is achieved within two (2) hours from the occurrence of the incident, due to the timely addressing of the matter by the on-call engineer and field technician mechanism. In the meantime, until the failure is restored, the affected areas are expected to be supplied with the natural gas quantity stored in the high-pressure transmission branch, which is sufficient to serve the protected consumers until the incident lapses. Based on historical data, no disruption of NG supply to any household or commercial consumer due to disruption of supply in any branch has been observed to date.

5.3.2 Act of God/ disaster

No emergencies have occurred in the NNGS in the past due to an act of God or a disaster that have resulted in the restriction or total disruption of the natural gas supply.

5.4 Crisis scenarios

A gas supply crisis in Greece may occur when the supply is restricted in the gas transmission system from Russia which entails concurrent restriction of natural gas supply at both "Sidirokastro" and

“Kipi” Entry Points. Supply restriction at the Entry Points is considered to include three cases: (a) Total disruption of supply at both Entry Points, (b) supply equal to 25% of the technical capacity of the “Sidirokastro” Entry Point and 50% of the technical capacity of the “Kipi” Entry Point and (c) supply equal to 50% of the technical capacity of both Entry Points respectively.

Moreover, the security of gas supply in Greece is affected in case of delay in the arrival of LNG loads, which entails possible reduction in the send-out of gasified LNG to the NNGTS. However, limitations in the gas supply at the “Agia Triada” Entry Point are also observed when a technical problem arises at the LNG Facility and the cases in which the supply is regarded to amount to

50% and 25% of the technical capacity of the point, as well as the cases of total disruption of supply, are taken into account.

The aforementioned scenarios are presented below, classified according to the affected infrastructure. The impact of reduced availability of plants that can be fuelled with alternative fuel (sub-case Xb) is examined for all scenarios.

5.4.1 Crises due to restriction of the NG supply via the system of transmission from Russia

- Scenario 1: Total disruption of supply at the “Sidirokastro” and “Kipi” Entry Points due to restricted supply in the NG transmission system from Russia for one month, This scenario assumes regular supply to the NNGS with LNG from the LNG spot market.
- Scenario 2: It is a repetition of scenario 1, assuming that the LNG market is tight and it is difficult to find LNG spot loads.
- Scenario 3: Total disruption of supply at the “Sidirokastro” and “Kipi” Entry Points due to restricted supply in the NG transmission system from Russia for seven (7) days during the week of maximum demand in winter.
- Scenario 4: Restricted supply at the “Sidirokastro” and “Kipi” Entry Points equal to 25% and 50% of the technical capacity of the points, respectively, due to restricted supply in the NG transmission system from Russia, for thirty (30) days during a typical winter month of high demand.
- Scenario 5: Restricted supply at the “Sidirokastro” and “Kipi” Entry Points equal to 25% and 50% of the technical capacity of the points, respectively, due to restricted supply in the NG transmission system from Russia, for seven (7) days during the week of maximum demand in winter.
- Scenario 6: Restricted supply at the Sidirokastro” and “Kipi” Entry Points equal to 50% and 50% of the technical capacity of the points, respectively, due to restricted supply in the NG transmission system from Russia, for thirty (30) days during a typical winter month with high demand.
- Scenario 7: Restricted supply at the Sidirokastro” and “Kipi” Entry Points equal to 50% and 50% of the technical capacity of the points, respectively, due to restricted supply in the NG transmission system from Russia, for seven (7) days during the week of maximum demand in winter.

5.4..*2 Scenario of delay in the arrival of LNG load*

- Scenario 8: Delay in the arrival of LNG load for 7 days.
- Scenario 9: Delay in the arrival of LNG load for 20 days.
- Scenario 10: Delay in the arrival of LNG load for 30 days.

The aforementioned scenarios are simulated under conditions prevailing during a standard winter month of high demand.

5.4.3 Scenarios related to a technical problem at the LNG facility

- Scenario 11: Total disruption of supply at the “Agia Triada” Entry Point, because of a technical problem at the LNG facility, for seven (7) days during the week of maximum demand in winter.
- Scenario 12: Total disruption of supply at the “Agia Triada” Entry Point, because of a technical problem at the LNG facility, for one month.

- Scenario 13: Restricted supply at the “Agia Triada” Entry Point, equal to 25% of its technical capacity, because of a technical problem at the LNG facility, for seven (7) days during the week of maximum demand in winter.
- Scenario 14: Restricted supply at the “Agia Triada” Entry Point, equal to 25% of its technical capacity, because of a technical problem at the LNG facility, for one month.
- Scenario 15: Restricted supply at the “Agia Triada” Entry Point, equal to 50% of its technical capacity, because of a technical problem at the LNG facility, for seven (7) days during the week of maximum demand in winter.
- Scenario 16: Restricted supply at the “Agia Triada” Entry Point, equal to 50% of its technical capacity, because of a technical problem at the LNG facility, for one month.

5.4.4 Scenarios related to a technical problem in a branch of the transmission pipeline

- Scenario 17: Disruption at the section of the main pipeline connecting Karperi to Serres, for seven (7) days during the week of maximum demand in winter.
- Scenario 18: Disruption at the section of the main pipeline connecting Karperi to Serres, for a period of seven (7) days for one month.

5.4.5 List of scenarios elaborated for simulation

A table presenting the crisis scenarios to be examined and an assessment of their occurrence frequency is cited below.

Table 11 – Scenarios for simulation

Supply crisis outside the NNGS				
Scenario Number	***Cause***	***Impact on the supply to the NNGS***	***Duration***	***Occurrence Probability***
1&2	Restricted supply in the NG transmission system from Russia	Qsid=0&Qkipi=0	1 month	2
3			1 week	3
4		Qsid=25%&Qkipi=50%	1 month	2
5			1 week	4
6		Qsid=50%&Qkipi=50%	1 month	3
7			1 week	4
8	Delay in the arrival of LNG load	Possibility of reduction in the LNG gasification rate Qyfa	up to 7 days	5
9			20 days	4
10			30 days	2
Technical problem in the NNGS				
11	Technical problem at the LNG facility	Qyfa=0	1 week	3
12			1 month	2
13		Qyfa=25%	1 week	4
14			1 month	2
15 16		Qyfa=50%	1 week	4
			1 month	2
17	Disruption at the Karperi-Serres section	Supply of eastern branch only from Turkey	1 week	3
18			1 month	1

Qsid : Maximum daily quantity from the “Sidirokastro” Entry Point on the basis of current long-term agreements

Qkipi : Maximum daily quantity from the “Kipi” Entry Point on the basis of current long-term agreements

Qyfa : Maximum gasification capacity of the LNG terminal

The occurrence probability rating used is as follows:

1 : Extremely improbable	once every 50 years or less
2 : Rather improbable	once every 20 years or less
3 : Less probable	once every 10 years or less
4 : Probable	once every 3 years or less
5 : Very probable	Annual or more frequent occurrence

6. Crisis simulation for assessing impacts

6.1 Demand data

The demand data used in the analysis presented in this section have occurred from historical time series of very high and standard demand in winter, which have been properly modified considering the new consumer connections and the expected production balance per fuel type in the electricity production (EP) sector. No statistical analysis has been performed to determine the stochastic value of demand, since, according to DESFA, the correlation of demand to weather conditions is low. It is assessed that the above fact is due to the following reasons:

- The Greek natural gas market is still under development and, hence, the rate of connections with new clients determines the evolution of annual demand, as well as peak demand.
- 60% of the total demand comes from the EP and is formulated, on the long-term, according to the balance of various forms of primary energy used in that sector.

  The demand share of the household and commercial sector, which is significantly dependent on weather conditions, is lower than 20%.

The demand data refer to the following periods:

(A) Day of maximum demand in winter,

(B) Week of maximum demand in winter, which includes the day of maximum demand in winter.

(C) A standard month of high-demand in winter.

Demand has been estimated for three categories of natural gas consumers: (a) Household consumers and small and medium-sized enterprises connected to distribution networks, (b) Individual and industrial consumers, (c) Electricity production sector. The calculations have been performed by DESFA according to the following assumptions:

The data provided by Users who are serving or will serve customers other than electricity producers (other customers) in the context of the elaboration of the Development Study accompanying the approved NNGS Development Programme have been used to assess annual demand in the aforementioned categories (a) and (b). The aforementioned data have been grouped into two main categories: i) Industrial use (small and large industry and co-generation) and ii) Urban use (household and commercial use).

The daily consumption data of NGUs and individual consumers, as these occur from the application of the calculation method described in points 6.1.1 and 6.1.2, have been used to calculate the maximum weekly demand. Specifically, the seven (7) consecutive days in which the highest demand during the period of one year for all NNGTS Entry Points has been recorded have been calculated (concurrent maximum demand). The period from 14/1 to 12/2 of 2010 has been set as the period for calculating standard demand in winter for thirty (30) consecutive days.

6.1.1 Demand by household customers and small and medium-sized enterprises connected to distribution networks

Specific profiles of household, commercial and industrial use of natural gas have been adopted to assess the qualitative features of the daily demand for natural gas per usage category (household, commercial, industrial) for each Exit Point serving an existing Natural Gas Undertaking or a NGU under incorporation (Central Greece, Central Macedonia, Eastern Macedonia & Thrace). These have occurred from the historical consumption data in cities, the profile of which is not expected to materially change in the next years and the climatic conditions in which are similar. Therefore, for example, in areas such as Alexandroupoli, Komotini, Drama, the average consumption profile of Thessaloniki in the period 2008-2010 has been used for determining the household and commercial use profile. Similarly, the profile of Komotini in 2010 has been used for determining the industrial use profile of Komotini.

6.1.2 Demand by industrial and individual consumers

Individual consumers include consumers that are connected to NNGTS Exit Points that do not serve NGUs or power production plants, or to points that, even though serving NGUs, correspond to an individual metering station that is supplied from the high-pressure transmission system and, therefore, each of them has a distinctive daily consumption profile.
To find the daily consumption of each individual consumer of the NNGTS, its daily profile for the year 2010 has been used, since it has been regarded as representative of the years to come.

6.1.3 Demand by the electricity production sector

Demand by power production plants has been assessed taking into account historical data regarding the plants' operation and reducing them to the expected balances of the years 2011-2014. The assumptions made regard a scenario with medium to low hydraulicity. The reduced lignite production capability due to the decommissioning of Ptolemaida 1 and Megalopoli 1 and 2 plants is taken into account. Regarding the 2010 period, new production capabilities fuelled with natural gas, of 1260 MW power, which will cover the deficit caused by reduced hydraulic and lignite production, exist already or are under test operation.

With regard to the demand for electricity in 2011, DESMIE expects a small decrease compared to 2010. A potential increase in the period 2012-2014 will be marginal, at the level of production of new RES production capability, which potentially means stabilisation of the demand for natural gas by the electricity production sector.

The monthly RES production is assessed at 400 GWh, while electricity imports amount to 420 GWh.

The main assumptions used for determining gas demand for electricity production are presented in Table 12.

Table 12 – Summary of assumptions for determining the natural gas demand for electricity production

	Historical base	Demand for EP
Standard month of high demand in winter	15 Jan – 14 Feb 2010	Hydraulic prod. : -49% Imports: +24% Lignite prod. : - 9% Demand : +0%
Week of maximum demand in winter	5-11 March 2011	Hydraulic prod. in March 2011 decreased by 35%

6.2 Simulation of scenarios

6.2.1 Simulation of actions taken by Operators

The flowchart below displays the simulation of actions taken by the Natural Gas and Electricity System Operators in each crisis scenario.

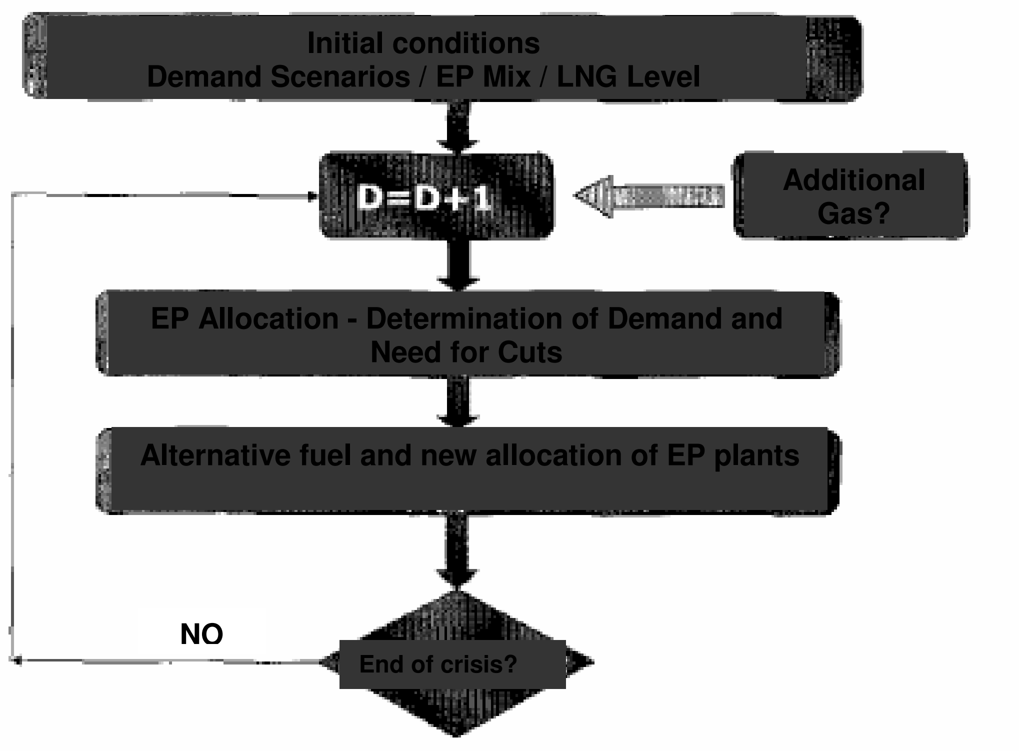


Figure 2 – Simulation of actions taken by Operators in each crisis scenario

6.2.2 Initial conditions of scenario simulation

The initial simulation conditions of the crisis scenarios are presented below.

A) Initial conditions applied in all scenarios:

Supply from Sidirokastro (Qsid):	Maximal daily quantity from the "Sidirokastro" entry point based on current long-term agreements in Nm^3/day.
Supply from Kipi (Qkipi):	Maximal daily quantity from the "Kipi" entry point based on current long-term agreements in Nm^3/day.
Gas-fuelled electricity production plants which can switch to alternative fuel	It is assumed that 4 combined-cycle electricity production plants of total power of 1800 MWe and one open-cycle electricity production plant of power of 150 Mwe fuelled with natural gas can also operate if fuelled by oil.
Availability of gas-fuelled electricity production plants fuelled with natural gas, which can switch to alternative fuel:	- Scenarios (a): One gas-fuelled electricity production plant of 400 MWe power which can switch to alternative fuel is out of order - Scenarios (b): Two gas-fuelled electricity production plants (of 800 MWe total power) which can switch to alternative fuel are out of order (The other plants are assumed to be available without any restrictions relating to fuel supply).

(B) Initial conditions relating to the LNG facility (used in the scenarios examining disruption of supply with pipeline gas, in which the LNG facility operates):

LNG tank level:	- 70% for a 7-day crisis under maximum demand conditions - 25% in the scenarios of delay in the arrival of

	vessel - 50% in all other scenarios
Arrival of first vessel:	- No vessel arrives during the 7-day crisis. - 6 days after the crisis for all other scenarios, with the LNG station operating.
Frequency of arrival of LNG vessels following the arrival of the first vessel:	- 8 days in the scenario of LNG market tightness - 4 days in the scenario of LNG sufficiency.
LNG load:	75 000 m^3 LNG.

6.2.3 Methodology for calculating unserved demand

Crisis scenarios are simulated by calculating the balance of mass in semi-stable conditions using a daily step.

If a daily deficit occurs in the balance of mass, cuts are performed to ensure continuous supply to protected consumers until the crisis ends.

Cuts are made based on the following principles:

- The following order of cut is applied:
  1. EP plants that can switch to alternative fuel
  2. Other EP plants
  3. Industry
  4. Distribution networks supplying household customers and small and medium-sized enterprises
- Cuts are uniformly divided in the days between two arrivals of LNG loads.
- No natural gas deliveries to industrial and individual consumers are cut during the first 48 hours.

The figure below displays the data considered in calculating the amount of cuts in deliveries for the scenarios in which the LNG terminal is operating.

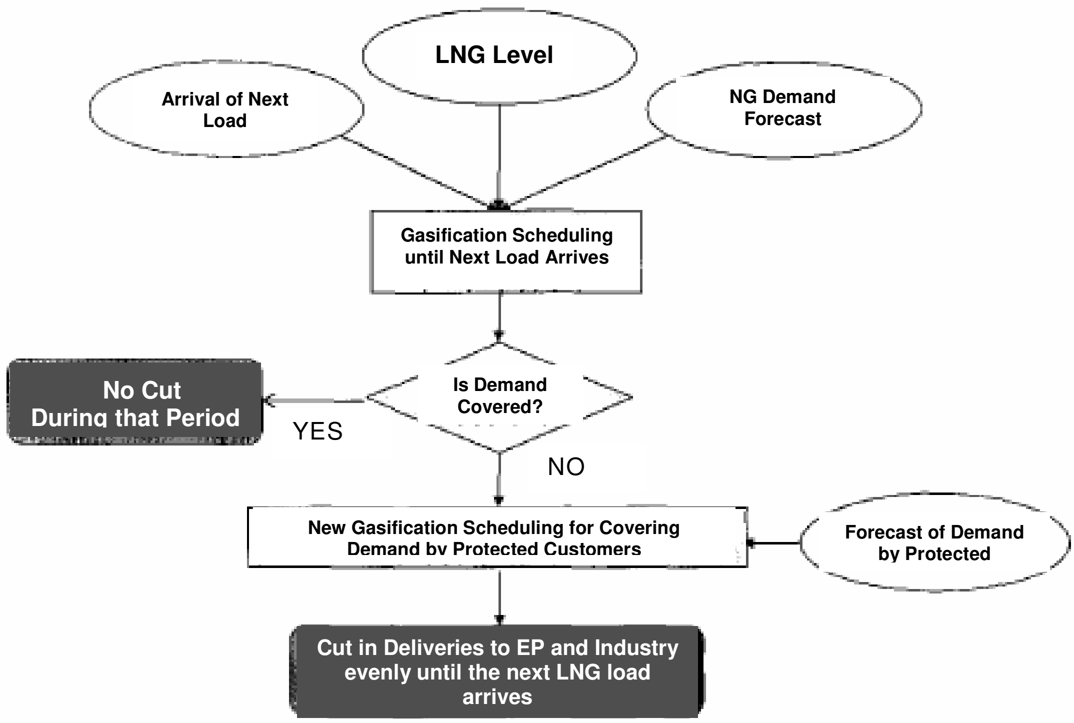


Figure 3 – Procedure for assessing NG delivery cuts

6.2.4 Calculated indicators

As mentioned above, unserved demand per day for each category of consumers is calculated under each scenario. Moreover, the following qualitative indicators are calculated for each category of consumers:

<u>Qualitative indicators of cuts in the Industry</u>

- Number of days subject to cut
- Number of days subject to cut > 20%
- Number of days subject to cut > 50%
- Average value of cut
- Maximum value of cut

<u>Qualitative indicators of cuts in the EP</u>

- Equivalent full-load days of the production capability using the alternative fuel.
- Deficit of electric power (maximum value, average value, number of days) from natural gas plants following full load, in the following order:
    1. Natural gas plants that can switch to alternative fuel
    2. Hydroelectric power stations
    3. Backup oil stations

6.3 Impact ranking

The following 5-step scale is used for ranking impacts.

A. Low impacts

B. Medium impacts

C. Significant impacts

D. Serious impacts

E. Very serious impacts

6.3.1 Gravity of impacts on electricity production

The gravity of the impacts referred to in the previous paragraph can be translated for the EP sector as follows:

A. Limited economic impacts

B. Medium economic impacts, impacts on the market

C. Extensive use of alternative sources to cover the deficit

D. Need to put standby capacity in operation

E. Deficit of power – energy and extensive cuts

Each of the aforementioned categories A-E may be expressed via the qualitative indicators presented in paragraph 6.2.4 according to the criteria laid down in the table below:

Table 13 – Classification of impacts on EP

	A	B	C	D	E
Cut in deliveries to plants with alternative fuel (a.f.) for 5 days maximum	✓				
Cut in deliveries to plants without a.f. or to plants using alternative fuel for more than 5 days		✓			
Power deficit from NG plants > 400 MW for more than 2 days or use of a.f. for more than 6 days of equivalent full-load days			✓		
Power deficit from NG plants > Backup hydroelectric power stations (HPS) for more than 2 days				✓	
Power deficit from NG plants > Backup HPS and oil-fuelled plants for more than 2 days					✓

6.3.2 Gravity of impacts on the industry

The gravity of the impacts referred to in paragraph 6.3 can be translated for the Industry as follows:

A. Economic loss that is recovered.
B. Significant economic loss that is recovered.
C. Economic or other loss having impact on the year
D. Economic or other loss having impact beyond the year
E. Loss putting the survival of the company or lives at risk.

DEPA has proposed, for the industry, the approach presented in the table below. According to this approach, the impact of cuts is not examined horizontally but per type of process supplied with NG.

Table 14 – Classification of impacts on Industry

	A	B	C	D	E
Customers performing process (kilns, etc.)				✓	✓
Customers using NG as a raw material		✓	✓		
Customers using NG for production of calorific fluids (e.g. steam)		✓			
Combined heat & power (CHP)			✓		

The allocation of consumptions to the four types of process can demonstrate the gravity of the impacts depending on the total size of the cut. This assessment shows that a cut of up to 40% is regarded as of B, C level, while a cut above 60% is of D or E level. However, this approach gives no picture of the impact of the duration of the cut.

In order to assess the gravity of the impacts on industrial facilities caused by the potential cut in their supply with NG, a questionnaire has been sent to major industrial consumers. The seven questionnaires filled in show that 2 and 5 days separate medium - serious impacts to serious – very serious ones. The following chart presents the classification of a potential crisis with cut escalation during its progress.

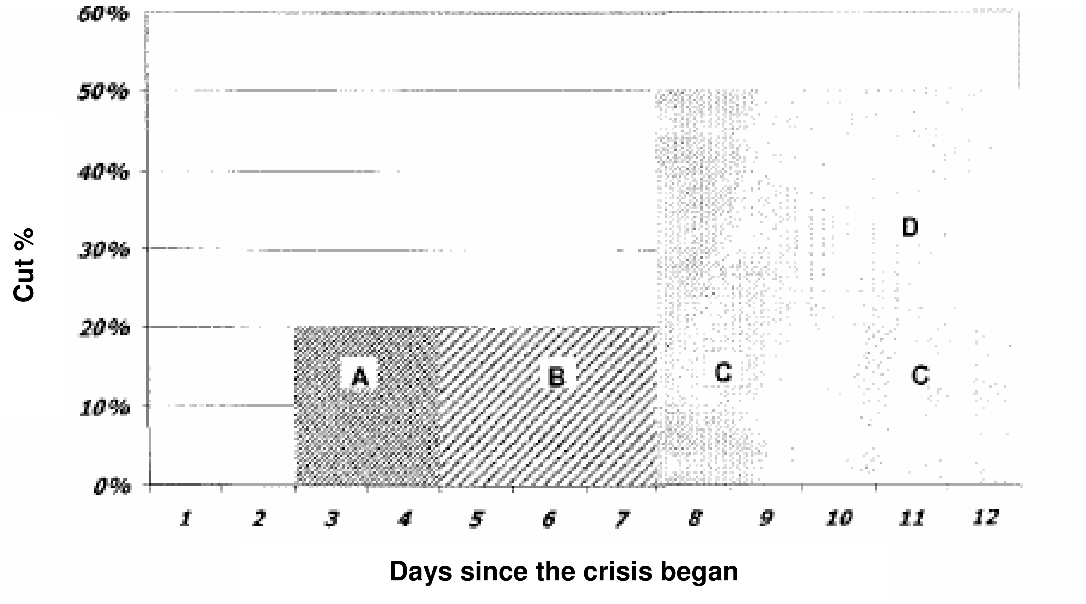


Figure 4

Based on the above, the following table is drafted, presenting the criteria applied for determining the gravity of the impacts of cuts cumulatively in industrial facilities

Table 15 – Classification of impacts on Industry

	A	B	C	D	E
Cut in deliveries to the industrial sector lower than 20% for less than 48 hours.	✓				
Cut in deliveries to the industrial sector lower than 20% for less than 5 days.		✓			
Cut in deliveries to the industrial sector lower than 20% for more than 5 days.			✓		
Cut in deliveries to the industrial sector up to 50% for less than 2 days.			✓		
Cut in deliveries to the industrial sector by 20-50% for less than 5 days				✓	
Cuts of higher extent or with longer duration					✓

The issue of impacts on the industry will be further explored while elaborating the preventive action and emergency plans. During such elaboration, it will be examined whether it is possible to apply interruptible agreements in the industry.

6.3.3 Risk matrix

Based on the aforementioned classification of impacts in conjunction with the ranking of scenarios relating to their occurrence probability, the following risk matrix is drafted.

Probability	**Very or extremely probable**					
	Probable					
	Less probable					

	Rather improbable					
	Extremely improbable					
		Low A	**Medium B**	**Significant C**	**Serious D**	**Very serious E**
		Impacts				

Figure 5 – Risk matrix

Each scenario, according to the gravity of impacts and its probability is put into one of the 25 positions of the matrix. Positions located below the diagonal are regarded as high-risk positions, while those located above the diagonal are regarded as low-risk ones. Intermediate positions, on either side of the diagonal, are regarded as medium-risk positions.

7. Results

7.1 Impacts in the scenarios examined

Table 16 - Impact classification and description per scenario

No	Scenario description	Impacts		Impact description
		EP	Industry	
1	Total disruption for 30 days of pipeline gas supply (Bulgaria and Turkey) a : Basic assumption as to the availability of dual-fuel plants	C	C	Extensive use of oil by dual-fuel plants (14 full-load days) Disruption in units without a.f. One day of cuts > 50% in the Industry
	b : Increased unavailability of dual-fuel plants	C	C	Extra limited use of other energy sources (HPS)
2	Scenario 1 assuming tight LNG load market a : Basic assumption as to the availability of dual-fuel plants	D	E	Extensive use of oil by EP plants (23 full-load days). Extensive use of other energy sources (HPS and oil-fuelled Thermal Power Stations) Extensive cuts in the Industry – 19 days > 20% and 11 days > 50%
	b : Increased unavailability of dual-fuel plants	E	E	Seven extra days with insufficient production capability to cover the demand.
3	Total disruption of supply from pipelines (Bulgaria and Turkey) for a week of maximum demand	D	C	Extensive use of oil by OP plants (6 full-load days). Extensive use of other energy sources (HPS and oil-fuelled TPS) Readiness of oil-fuelled TPS to respond within a week (with a question mark) Potential E.
4	Partial disruption for 30 days by 75% from Sidirokastro and by 50% from Kipi a : Basic assumption as to the availability of dual-fuel plants	C		Extensive use of oil by dual-fuel plants (19 full-load days) Disruption of operation of units without a.f.
	b : Increased unavailability of dual-fuel plants	D		4 days with need to use other energy sources (HPS and oil-fuelled TPS)
5	Scenario 4 for a week of maximum demand a : Basic assumption as to the availability of dual-fuel plants.	B		Extensive use of oil by dual-fuel plants (6 full-load days) Disruption of operation of units without a.f. The deficit may be almost completely covered by dual-fuel plants.
	b : Increased unavailability of dual-fuel plants	C		Extensive use of other primary energy sources (Hydro)
6	Partial disruption for 30 days by 50% from Sidirokastro and Kipi a : Basic assumption as to the availability of dual-fuel plants	C		Extensive use of oil by dual-fuel plants (9 full-load days)
	b : Increased unavailability of dual-fuel plants	C		Extra limited disruption of operation in plants without a.f. The deficit may be completely covered by dual-fuel plants.
7	Scenario 6 for a week of maximum demand a : Basic assumption as to the availability of dual-fuel plants	B		Extensive use of oil by dual-fuel plants
	b : Increased unavailability of dual-fuel plants	B		Extra limited disruption of operation in units without a.f. The deficit may be completely covered by dual-fuel plants.

8	Delay in the arrival of a vessel for one week Common results under both assumptions relating to the availability of dual-fuel plants	A		Minimal use of oil by dual-fuel plants (1 full-load day)
9	Delay in the arrival of a vessel for 20 days Common results under both assumptions relating to the availability of dual-fuel plants	B		Significant use of oil by dual-fuel plants (4 full-load days)
10	Delay in the arrival of a vessel for 30 days Common results under both assumptions relating to the availability of dual-fuel plants	B		Significant use of oil by dual-fuel plants (5 full-load days)
11	Cessation of operation of the LNG terminal for a week of maximum demand a : Basic assumption as to the availability of dual-fuel plants	B		Extensive use of oil by dual-fuel plants (5 full-load days) and cuts in units without a.f. The deficit may be completely covered by dual-fuel plants.
	b : Increased unavailability	C	-	Extra deficit that must be
	of dual-fuel plants			covered by other sources (HPS)
12	Cessation of operation of the LNG terminal for 30 days of demand in winter Common results under both assumptions relating to the availability of dual-fuel plants	C		Extensive use of oil by dual-fuel plants (8 full-load days)
13	The capacity of the LNG terminal is limited to 25% for a week of maximum demand Common results under both assumptions relating to the availability of dual-fuel plants	B		Medium use of oil by dual-fuel plants (2 full-load days)
14	The capacity of the LNG terminal is limited to 25% for 30 days of demand in winter Common results under both assumptions relating to the availability of dual-fuel plants	≤A		Minimal use of oil by dual-fuel plants (0.5%)
15, 16	The capacity of the LNG terminal is limited to 50%			No cuts need to be made
17	Disruption in the pipeline section between Karperi and Serres for a week of maximum demand	B		Potential use of oil by the Komotini plant (1 full-load day)
18	Disruption in the pipeline section between Karperi and Serres for 30 days of demand in winter	A		Potential minimal use of oil by the Komotini plant (1/2 full-load day)

7.2 Risk matrix

The crisis scenarios are placed into the risk matrix according to the probability attributed to them and the extent of the impacts calculated. To place the scenarios unto the matrix, the worst category of impact, between Industry and EP, is used.

Probability	Low A	Medium B	Significant C	Serious D	Very Serious E
5- Very or extremely probable	8				
4- Probable	15*	7,9,13,5a	5b		
3- Less probable		11a,17	6,11b	3	
2- Rather improbable	14,16*	10	1,4a,12	*4 b*	*2*
1- Extremely improbable	18				
	Impacts				

** No impact has been calculated for scenarios 15 and 16. Nevertheless, these have been placed into the matrix for completeness reasons.*

Figure 6 – Scenarios on the risk register

7.3 N-1 calculation

7.3.1 Assumptions - Data

The assumptions and data used for applying the N-1 formula are as follows:

Calculated area is the National Natural Gas System (NNGS) that includes the National Natural Gas Transmission System within the Greek territory and the LNG facility at the Revythoussa Island.

EP_m: The technical capacities of the Sidirokastro and Kipi Entry Points

P_m=0: Zero natural gas production

S_m=0: There is no underground natural gas storage facility

LNG_m: the technical capacity of the Ag. Triada Entry Point

I_m: The technical capacity of the single largest gas infrastructure having the highest supply capacity (Ag. Triada Entry Point) ; **equal to LNG_m**

D_{max}: The maximum daily demand of the Greek market.

To convert MWh into Nm^3 the following ratio has been used: 1 000 Nm3 = 11.16 MWh.

The aforementioned data with their respective values (in m. Nm^3/day), for the calculation years 2011 to 2014, are displayed in the table below:

	Year 2011	Year 2012	Year 2013	Year 2014
EP_m	12.49	17.16	17.16	17.16
I_m	12.47	12.47	12.47	12.47
P_m	-	-	-	-
Sm	-	-		-
D_{max}	19.32	20.19	21.01	22.10

7.3.2 Results

The application of the N-1 standard based on formula (1) produces the following results:

	Year 2011	Year 2012	Year 2013	Year 2014
N-1 (o/o)	65%	85%	82%	78%

7.3.3 Assessment of Deff level that is required to meet N-1 standard.

Pursuant to Article 6(2) of the Regulation, the Member States may consider that N-1 standard has been satisfied, as long as the capacity to manage demand by applying market-based measures is proven in the preventive action plan. The N-1 standard based on formula (2) is applied below, determining the minimum D_{eff} that can be sufficiently and timely covered using market-based demand-based measures, to satisfy N-1 standard.

	Year 2011	Year 2012	Year 2013	Year 2014
D_{efF} (m. Nm^3)	6.83	3.03	3.85	4.94

7.4 Conclusions

The analysis above results in the following conclusions:

1. Under the current conditions, household consumers, small and medium-sized enterprises connected to a distribution network, as well as district heating installations that are not able to switch to alternative fuels, are not expected to suffer impacts on their supply, in any of the scenarios examined, as long as proper measures for managing the demand by EP and Industry are applied.
2. The analysis of 18 scenarios and of their sub-cases (a, b), entailing different impacts (21 in total), shows that 2 scenarios will have no impact at all, 8 scenarios are considered as low-risk, 10 scenarios are considered as medium-risk and one is considered as high-risk.
3. The maximum daily and weekly demand may be satisfied by the current infrastructures.
4. The N-1 standard is not met by the current infrastructures. It is expected that this standard could be satisfied through the application of market-based measures demand side management measures in the range of 3-5 mcm per day during the next three years.