



Preventive Action Plan and Emergency Plan Good Practices

A review of EU Member State natural gas preventive action and emergency plans

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1. INTRODUCTION

According to Regulation 994/2010 concerning measures to safeguard security of gas supply (referred to in the rest of this document as the Regulation), Member States with a gas system have to develop a Preventive Action Plan (PAP) and an Emergency Plan (EP) after obtaining the results of a full Risk Assessment (RA), as required by Article 9, and after determining the fulfilment or not of the Infrastructure Standard (Article 6) and the Supply Standard (Article 8). The obligation of establishing a Preventive Action Plan and an Emergency Plan is set out in Article 4, the actual contents of the PAP are set in Article 5, while Articles 10, 11 and 13 contain the requirements for an EP.

The Preventive Action Plan aims at developing the right measures to either completely remove or to at least reduce the risks identified in the Risk Assessment, while the Emergency Plan aims at developing the measures needed to mitigate the adverse effects of a gas disruption, should it occur.

This document is structured as follows. Section 2 puts the PAP and the EP in the context of a Risk Management process, finding their right place as the two key components of the Risk Treatment phase that follows the Risk Assessment phase. Section 3 describes the steps of a PAP performed in line with the Regulation and with the available general purpose Risk Management Standards. Additionally, much attention has been paid to the literature generated in the context of the different Gas Regional Initiatives (GRI) and of the Ten-Year Network Development Plan (TYNDP) and related Gas Regional Investment Plans (GRIP's). Literature produced in some EU research Framework Programme (FP) projects has also been taken into account. Section 4 presents a thorough review of literature in the field of emergency planning and extracts a set of good practices. The literature review covers TSO network codes, relevant legal and regulatory acts, as well as independent research such as that found in relevant FP7 projects and international institutions like the International Energy

Agency (IEA). This information has been buttressed by a survey aimed at 'Competent Authorities' of EU member states designated by EC/994/2010. Circulated and post-processed by JRC-IET, this questionnaire was an instrumental part of the review process. Section 5 contains the conclusions. Section 6 contains the references.

The aims of this document are to provide guidance in the development of a Preventive Action Plan and a collection of best available practices to provide assistance in the design of Emergency Plans, both in line with the Regulation. Nevertheless, this document does not replace in any manner the actual Regulation. In case of doubt or occasional disagreement in the interpretation of both texts, the Regulation prevails.

2. RISK TREATMENT

It is useful to consider the methodology behind both plans in more generic terms, as forming part of a wider framework of Risk Management. Indeed, Article 9 of the Regulation requires each Member State to perform a full Risk Assessment, which should also contain among its components the results of the Infrastructure and Supply standards. Formally, in a Risk Management process, the next step after the completion of the Risk Assessment is the Risk Treatment (see figure 1). The goal of Risk Treatment is to design and implement measures to decrease the risk inherent to the system. The Preventive Action Plan and the Emergency Plan, as considered in the Regulation, corresponds to the Risk Treatment phase in a Risk Management process.

The starting point of the Risk Treatment process is the results of the Risk Assessment as requested by the Regulation. This includes:

- A detailed description of each scenario identified (system boundary and initial conditions).
- The probability / likelihood of each scenario, including a description of the means used for obtaining such estimations.
- The adverse consequences / impacts of each scenario's conditions on the system, including information about the means used for estimating the consequences (indicators, models, expert judgement, etc.)
- The integration of all the previous information into either
 - A Risk Matrix (in case of a qualitative assessment)
 - or a Complementary Cumulative Distribution Function (CCDF) of the impact or consequence variable.
- The results of both the Infrastructure and the Supply Standards.

Once this information is available, different strategies / treatments may be developed for reducing the risk.

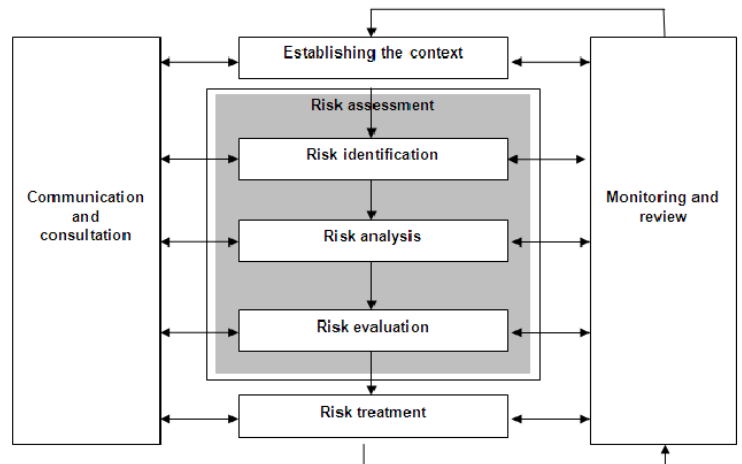


Figure 1.- ISO International Standard Risk Management Framework.

Project EURACOM, in line with ISO 31000 Standard, considers the following options¹

- **Prevention:** putting in place prevention measures directly aimed at reducing the probability / likelihood of scenario occurrence.
- **Protection:** putting in place protection measures in order to reduce the severity of the scenario should it occur.
- **Response:** developing a contingency plan for scenarios that can neither be prevented nor their severity reduced, enabling the involved organisations / institutions to react efficiently should the scenario occur.
- **Recovery:** planning the activation of resources and processes to return to the normal state of operation after the occurrence of the scenario

¹ In fact two more options are considered in EURACOM: risk avoidance and risk transfer. In the opinion of the authors these two strategies overlap partially with the five strategies mentioned in the main text, and where they do not overlap they are not applicable in the Regulation context

and first response procedures have been activated.

- **Risk acceptance:** accepting a risk as it has been identified. This option may apply when the risk level falls below the acceptability level (fulfilment of the risk criterion), or when no further cost-effective, or even feasible measures, to reduce or avoid the risk are available.

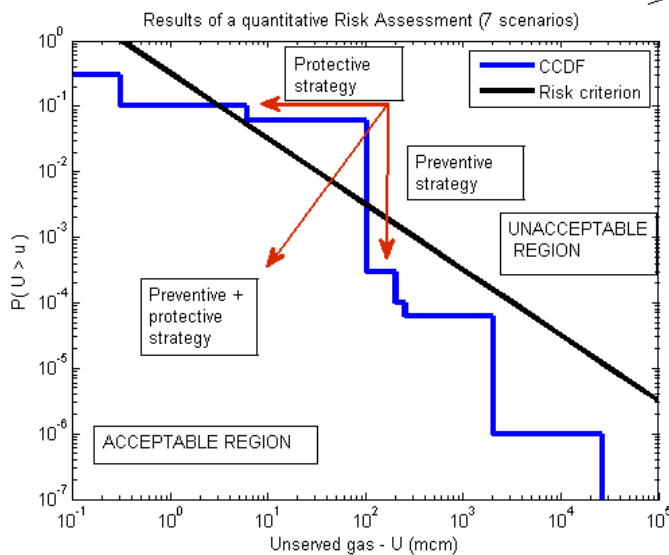


Figure 2.- Typical CCDF of a given output variable U.

Preventive and protective strategies aim at reducing respectively the probability and the severity of the scenarios identified, contributing, if successful, to a reduction of risk. In case a quantitative Risk Assessment has been performed and the results are summarised as a CCDF of the consequences of the different scenarios, as the ones represented in figure 2, preventive strategies will produce a (partial) CCDF shift towards smaller probabilities (downwards), while protective strategies will produce a (partial) CCDF shift towards smaller consequences (leftwards), In general, many potential strategies will have a preventive and a protective component, producing a simultaneous shift in both directions.

Figure 2 shows the results of a hypothetical quantitative Risk Assessment presented in terms of the CCDF (blue line) of a given measure of damage / impact (Unserved gas - U). It shows also a possible risk criterion (black line) and the expected effect of a purely preventive strategy, a purely protective strategy and a simultaneously preventive and protective strategy. Similar effects, although not equal, are expected when a qualitative Risk assessment is performed. Preventive and protective strategies are elements of the Preventive Action Plan.

After all possible cost-effective preventive and protective strategies have been tested, the effect on the global risk is estimated along with the residual risk (risk that remains after implementing the strategies). This is the point where Risk acceptance applies. In case some high risk has to be accepted because unavailability of feasible measures or because of the high cost of reducing it, all the information related to the corresponding scenario(s) is used for informing the Emergency Plan.

Response and recovery are typical elements of an Emergency Plan, which aims at mitigating the impact of gas disruptions on the system and restoring it to its previous state. Both are based on a deep understanding of the functioning of the system and of the risks it may face in the future.

A key conceptual difference between the Preventive Action Plan and the Emergency Plan is their respective time frames; while the former is developed along months or years, in a stepwise manner, producing successive risk reductions, before being fully implemented, the latter is designed to have an immediate effect upon the start of a gas disruption.

3. PREVENTIVE ACTION PLAN

Many Member States of the European Union had already developed Emergency plans before the development of Regulation 994/2010, in accordance with requirements of Directive 2004/67/EC (article 8); by contrast, the Preventive Action Plan is a relatively novel development in the area of security of gas supply, which makes the related literature in the gas sector much scarcer, in fact almost inexistent. Thus, the guidance provided in this section is much more based on the experience incorporated in well established general purpose standards, remarkably ISO 31000, the Regulation itself (especially article 5), the EURACOM FP project and related references. The ENTSO-G Ten-Year Network Development Plan (2011-2020) has also been a valuable source of information, together with the information available about the different Gas Regional Initiatives and the first version of the Gas Regional Investment Plans already published (North West Gas Regional Investment plan (2011 - 2020) and South Gas Regional Investment Plan (2011-2020)).

The goal of the Preventive Action Plan is to reduce the risk associated with the gas system of Member States or regions. This goal necessarily obliges MS to formulate preventive action plans based on the detailed results of a full Risk Assessment, which contains the elements already described in the previous section (description of scenarios, their probabilities and expected consequences and their integration in Risk Matrix or a CCDF plot, together with the results of the Infrastructure and Supply Standards).

Figure 3 is a flow chart of a Preventive Action Plan. It starts by (step 1) Identifying key scenarios contributing to risk. This is part of the Risk Assessment procedure mandated by Article 9 of the Regulation. Useful reference points for carrying out this step, particularly at the regional level, are the ongoing assessments of the EU-wide gas network (e.g. Entso-G's TYNDP, GTE's Reverse Flow study or ACER's framework guidelines on TSO balancing, to name a few). The second step consists

in setting a priority order to reduce risk by selecting the scenarios or groups of scenarios that should be addressed first. Then a loop starts where, according to the order established in the previous step, the potential treatment for each scenario or set of scenarios is analysed. Firstly (step 3), a feasible preventive / protective strategy is designed for each scenario (or groups of scenarios). Then (step 4), the strategy effectiveness is assessed as accurately as possible (via models, indicators, expert judgement or via other means). In step 5, if the strategy is deemed effective, a cost benefit analysis is made in order to check if its adoption is globally justified. The next step (6) consists in estimating the (residual) risk remaining in the system after adopting the last acceptable strategy considered. If this risk is acceptable according to the Risk Criteria set in the 'establishing the context' phase (see figure 1 and reference 2), the loop is exited. The loop is also abandoned if the last scenario or last group of scenarios has already been analysed; otherwise steps 3 to 7 are followed again with the next scenario.

After abandoning the risk reduction loop, the next step in the process (step 8) consists in drafting a preliminary national Preventive Action Plan containing all the information requested in article 5 of the regulation regarding the strategies to decrease the global risk and the fulfilment of the standards. This preliminary national Preventive Action Plan, together with the national Emergency Plan, will be exchanged with neighbouring MS (indicative list in Annex IV of the Regulation) to check potential inconsistencies between plans and decide if a joint PAP is actually needed. If the need of such a joint PAP is agreed, the Joint PAP is developed in step 10 based on a scheme similar to steps 1 to 7 in this procedure, otherwise step 10 should be skipped and go to step 11. This process finishes with the final edition of the PAP, national or joint.

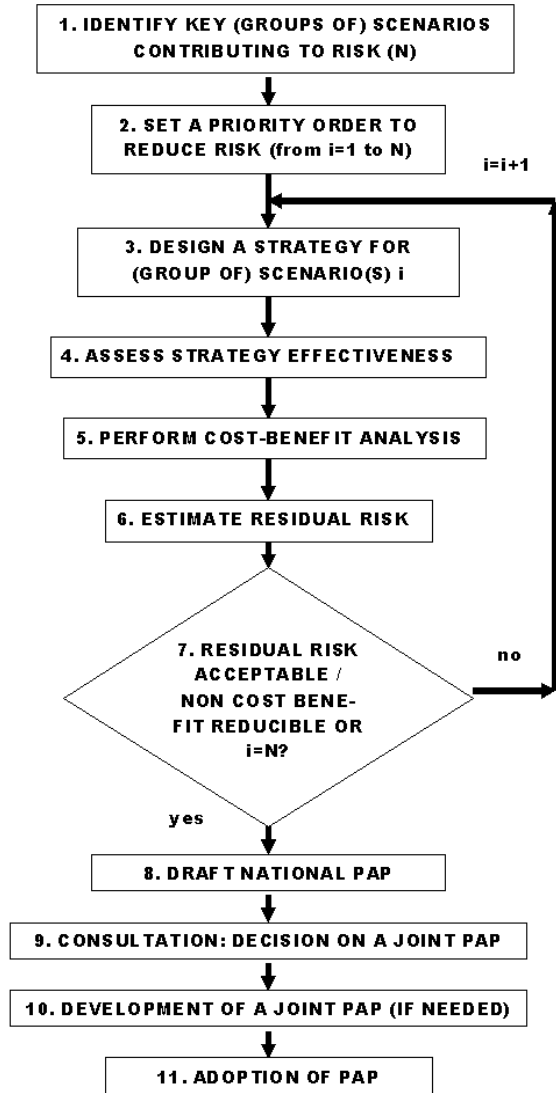


Figure 3.- Flow chart of a Preventive Action Plan.

In the next sections each step of the process is further developed and explained in more depth. In order to make more easily understandable the text concerning some of the steps, two simple examples of hypothetical quantitative and qualitative Risk Assessment results will be used.

The results of the first example are in figure 4 and in table 1. This refers to a quantitative Risk Assessment where the output variable (consequences / impact /

damage) is the quantity of unserved gas in the conditions of a scenario.

Table 1. Results of a hypothetical quantitative RA.

Scenario	Probability (a ⁻¹)	Unserved gas (mcm)	Expected Unserved gas (mcm/a)
SC1	2·10 ⁻¹	3·10 ⁻¹	0.060
SC2	4·10 ⁻²	6·10 ⁰	0.240
SC3	6·10 ⁻²	1·10 ²	6.000
SC4	2·10 ⁻⁴	2·10 ²	0.040
SC5	4·10 ⁻⁵	2.5·10 ²	0.010
SC6	6·10 ⁻⁵	2·10 ³	0.120
SC7	1·10 ⁻⁶	2.6·10 ⁴	0.026
Expected unserved gas			6.496

Seven relevant scenarios have been identified in this study. They have been named and sorted from SC1 to SC7 according to the quantity of unserved gas (from the smallest to the largest). Table 1 provides for each scenario its probability of occurrence per year (a⁻¹), impact in terms of quantity of unserved gas (mcm) and expected impact per year (mcm/a), which is the result of multiplying the probability of occurrence per year of each scenario and its consequence (unserved gas). The expected quantity of unserved gas per year due to all possible scenarios is given in the last row (6.496 mcm/a).

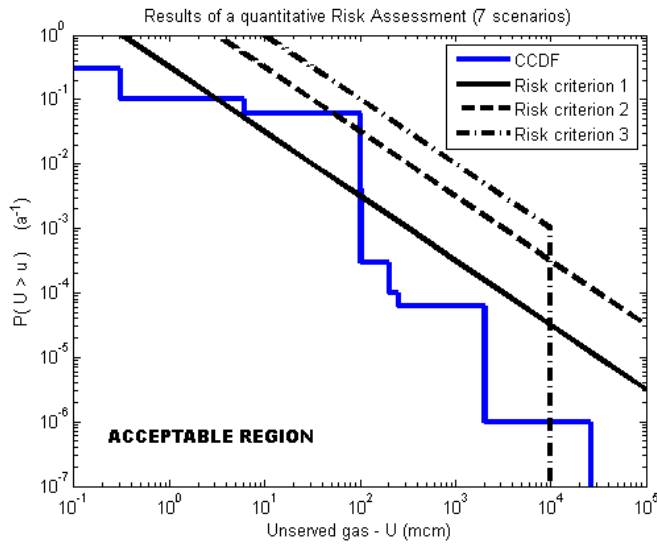


Figure 4.- CCDF of the quantity of Unserved gas in a hypothetical quantitative RA

Figure 4 contains the same information as table 1, but represented as the Complementary Cumulative Distribution Function of the quantity of unserved gas. This figure represents also three possible Risk Criteria (the solid – Risk criterion 1, the dashed – Risk criterion 2, and the solid-dashed black lines - Risk criterion 3). In practical terms it means that the larger the impact the smaller the probability must be in order to be acceptable (in fact, if the impact increases one order of magnitude its probability has to decrease at least one order of magnitude in order to keep their product below the threshold). Risk criterion 1 is more conservative than Risk criterion 2; under the latter, for the same quantity of unserved gas probabilities one order of magnitude larger are allowed. Risk criterion 3 is less restrictive than the other two up to 10 bcm; then any quantity of unserved gas above it is considered unacceptable, independently of its probability. The first vertical segment on the right of the CCDF corresponds to SC7, the second one to SC6 and so on until the first vertical segment on the left, which corresponds to SC1.

The results of the second example are in figure 5. This refers to a hypothetical completely qualitative Risk Assessment (both the likelihood and the severity of all the scenarios are given in qualitative scales). As in the

first example, seven scenarios have been identified as relevant. They have been named SC1, SC2 and so on until SC7. The order does not correspond to any specific sorting rule.

		Severity					
		Insignificant	Significant	Severe	Major	Catastrophic	
Likelihood	Almost Certain	Medium	High	SC2	High	High	
	Probable	Medium	Medium	High	High	High	
	Possible	SC5	Medium	Medium	SC3	SC1	
	Unlikely	Low	SC6	SC4	Medium	High	
	Rare	Low	SC7	Low	Medium	Medium	

Figure 5.- Risk matrix of a qualitative hypothetical RA.

3.1 PREVENTIVE ACTION PLANS IN A EUROPEAN CONTEXT

The risk reduction measures considered in a preventive action plan primarily relate to the construction or upgrading of gas infrastructure, although demand-side measures such as fuel switching or the use of interruptible contracts, typically considered in emergency planning, also play an important role increasing the resilience of the system, making it more robust in crises situations. In many cases cross-border cooperation is required to better integrate gas networks and hence reduce overall risk. In fact, in formulating their preventive action plans member states are encouraged – as per the Regulation – to enhance interconnections with neighbouring countries as well as explore the possibility of enabling cross-border access to storage (article 5). Fortunately there are a number of regional platforms from which such joint investments can be explored.

The first point of reference in developing a regional preventive action plan is ENTSO-G’s Community-wide Ten Year Network Development Plan. This report has

identified potential bottlenecks on the European gas network, the removal of which is synonymous with formulating preventive measures. On the regulator side, the Council of European Energy Regulators (CEER) and the Agency for the Cooperation of Energy Regulators (ACER) both provide a forum with which to assess investments related to the security of gas supply. In particular, these bodies encourage cross-border cooperation through the activities of the Gas Working Group and Gas Regional Initiatives (the latter subdivided into North-West, South, South-South-East regions). Moreover, 'Gas Regional Investment plans' mandated by Regulation 715/2009, and based on the work previously developed within the TYNDP, provide a framework to accommodate joint preventive action planning and the exchange of information amongst MS. In fact, two GRIP's have already been published (Regions North-West and South). Studies are already underway on several cross-border initiatives, such as Baltic Energy Market Interconnection Plan (SE, DK, PL, EE, LV, LT, FI), the North-South plan (PL, CZ, SK, HU, BG, RO) or the Southern Corridor (IT, AT, SI, HU, RO, BG, GR). As the Regulation allows member states to formulate joint preventive action plans (Article 4) and utilise existing regional platforms and suggested regions (Annex IV), such initiatives readily satisfy the Regulation's emphasis on cooperation during the preventive action planning process.

Moreover, the results of national preventive action plans could also crucially inform the EU's ongoing work in reforming the TEN-E guidelines for building energy projects of common interest.² In particular, the Commission's proposal for a new regulation on trans-European energy infrastructure identifies security of supply and system flexibility as central criteria with which to assess whether gas projects be granted the status of 'project of common interest' (PCI). This document even

² see European Commission, Proposal for a Regulation on guidelines for trans-European energy infrastructure, COM(2011) 658, 19-10-2011, at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52011PC0658:EN:NOT>

links these criteria with the fulfilment of the infrastructure standard (N-1) of Regulation 994/2010 at a regional level.³ The document also notes that "the Union's energy infrastructure should be upgraded in order to prevent and increase its resilience to natural or man-made disasters."⁴ This goal is synonymous with that of a preventive action plan as mandated by the Regulation. As such, these plans could form a useful reference in identifying projects of common interest, not least since the proposed regulation promulgates "a harmonised energy system-wide cost-benefit analysis for PCIs in electricity and gas."⁵

Other reference points for exploring risk mitigation and preventive measures at the regional level include the Energy Community Treaty, the European Energy Programme for Recovery (EEPR), and Directive 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. The agendas of all of these bodies are informed by a wider EU energy policy framework addressing security of supply issues (e.g. Energy 2020, the 2050 Roadmap, in addition to energy 'packages' related to infrastructure as well as the second strategic review), and hence are useful for identifying those measures that can reduce overall risk as per the objective of the preventive action plan.

3.2 IDENTIFICATION OF KEY SCENARIOS

The identification of key scenarios contributing to the global risk is a rather simple task when the results of a Risk Assessment are available. It is just a matter of comparing probabilities and severities with Risk criteria.

In the case of a quantitative RA, observing the CCDF gives all the necessary information (supported by results in table form like table 1). In the first example, SC2 and SC3 are the key scenarios that render the system unable to

³ Ibid., Annex IV (d)

⁴ Ibid, p. 10

⁵ Ibid, see Annex V

fulfil Risk criterion 1. SC3 is the only scenario that violates Risk criterion 2. SC7 is the only scenario that violates Risk criterion 3.

In the case of a qualitative Risk Assessment, as shown in example 2, the selection is also straightforward. SC1, SC2 and SC3 are the key scenarios contributing to the global risk of the system, followed by SC4; the other three scenarios are almost irrelevant. The division of the Risk Matrix in three regions is quite similar to establishing Risk criteria.

Additionally, each MS has to identify among the scenarios analysed those that could have a significant impact on neighbouring countries (scenarios producing correlated risks). In principle these scenarios will also have a significant impact on the same MS, although this might not necessarily be true. These types of scenarios are usually related to

- Events or processes that may affect simultaneously more than one MS (natural hazards affecting large regions: earthquakes, floods, severe temperatures, etc., failure of key infrastructures of common use, etc.).
- Events that happen in a MS, whose effect propagates downstream to neighbouring countries, as for example the disruption of gas flow in a main transmission pipeline or failure in accessing cross-border storage facilities.

All the information about these scenarios (likelihood, expected impact on neighbours, dynamic evolution of the scenario, etc.) has to be reported as part of the Risk Assessment results to inform neighbours about the identified risk.

3.3 SET PRIORITY ORDER

Setting priority order consists in sorting the scenarios selected in the previous step according to which contributes more to the global risk and to violating the Risk criteria. This task is simpler in the case of a quantitative RA than in the case of a qualitative RA.

In order to see how to assign priorities in a quantitative RA, let us consider example 1. We already saw that, regarding Risk criterion 3 SC7 is the key scenario and in fact the only one that needs to be treated in order to fulfil the Risk criterion, and regarding Risk criterion 2 SC3 is the only one needing treatment. In the case of Risk criterion 1, both SC2 and SC3 contribute to violating the criterion. A useful tool to establish priorities is to compute the expected quantity of unserved gas per year due to each scenario (the fourth column in table 1), or an equivalent variable, the contribution of each scenario to the expected quantity of unserved gas (quotient between each element in the fourth column in table 4 and the last value in that column). This allows setting the following priority order:

- 1) SC3 (6.0 – 92.4%),
- 2) SC2 (0.24 – 3.7%),
- 3) SC6 (0.12 - 1.8%),
- 4) SC1 (0.06 – 0.9%),
- 5) SC4 (0.04 – 0.6%),
- 6) SC2 (0.026 – 0.4%) and
- 7) SC5 (0.01 – 0.2%).

Formally the order matters only for the first two elements in the list for they are the ones that take the CCDF above the threshold and they contribute circa 96% of the expected damage; the rest are much less important from the point of view of risk. Nevertheless it may be taken into account if further reduction of risk is sought after reducing the risk associated with these two scenarios. The same rule may be applied in the case of Risk criterion 2. In the case of risk criterion 3 it may also be applied except for the need to take SC7 to the first place in the list.

The case of a qualitative RA is more complex and there is no rule applicable to all situations. If we consider example 2, it is obvious that the scenarios may be classified in three groups: 1) SC1, SC2 and SC3, 2) SC4 and 3) SC5, SC6 and SC7, with this order of priority.

Nevertheless, the classification within each group in the absence of more information is not straightforward, especially in the high-risk group. When two scenarios are either in the same row or in the same column, the sorting rule is trivial because only one variable remains (either severity or likelihood). For instance, regarding the high-risk scenarios in example 2, SC1 has to be ranked higher than SC3 (more priority) because their likelihoods are equal / similar, but the severity of SC1 is higher. The comparisons between SC1 and SC2 on one side and between SC2 and SC3 on the other side are more complex. The problem is to determine what is more risky, a scenario that takes the system to a severe condition with near certainty (SC2) or a less likely scenario that produces major consequences. The same problem arises when comparing SC1 and SC2. In principle, with no further information the three priority orders SC2-SC1-SC3, SC1-SC2-SC3 and SC1-SC3-SC2 are equally possible.

In these cases the Competent Authority will have to design a specific ad hoc decision rule to determine the priority order to treat scenarios. A very popular and mathematically sound method available for developing this type of rule is the Analytical Hierarchy Process (AHP). Saaty (1988)⁶ provides the theoretical basis of this method and application examples.

In addition to the normal scenarios arising from the Risk Assessment, both standards have to be properly addressed in the risk reduction loop, should they not be adequately fulfilled. In fact, the standards are the only cases for which the Regulation establishes clear Risk Criteria, not leaving their fulfillment to the criterion of each MS. In principle there are two strategies that could be adopted regarding the priority order to address not accomplished Standards (or cases within the Supply standard):

- Formally insert in the risk reduction loop the cases considered in both standards as scenarios, and

- Address them before any other scenario in the loop.

In the first case, the standards are put in the context of a Risk Assessment where each scenario is addressed according to its probability and severity. These scenarios would have two peculiarities: 1) each one would be linked to a specific risk criterion based on the impact and 2) although preventive and protective measures may be adopted, their compliance with the Regulation has to be assessed according to expected impact (fulfilment of the standards is independent of the probability of each case, only keeping impact below the threshold counts). Additionally, addressing all cases for which the system is not able to fulfil requirements is mandatory.

3.4 THE RISK REDUCTION LOOP

3.4.1 DESIGN A STRATEGY FOR EACH SCENARIO

Each scenario is unique in terms of conditions under which it develops, in terms of system weaknesses / vulnerabilities that it uncovers and in terms of likelihood and consequences, albeit it may share some commonalities with other scenarios.

Actions to reduce the risk contributed by each scenario may involve the development of new infrastructures and improvement / upgrading of existing ones, but also market related measures and agreements with neighbouring countries (Member States and Non-Member States). Among the most typical new infrastructures to improve security are new transmission lines and connections to existing transmission lines, and new LNG and storage facilities. Improvement / upgrading may involve the development of reverse flow capacity and the increase of existing facilities reliability via increased redundancy and replacement of less reliable or aged components by newer ones, among other possibilities. Market related measures are related to the access to new markets (new supply sources under a variety of possible types of contracts), which may involve the simultaneous development of new infrastructures, and the development of contracts and

⁶ T.L. Saaty (1988). Mathematical methods of operations research. Dover

agreements to access cross-border storage facilities. In general, a strategy will consist of a combination of several such actions. The description of the strategy has to be as detailed as possible, indicating the new technical specifications and capabilities of the system after its implementation and the timeframe and steps for its actual deployment.

Actions may be classified as preventive and protective. Typical preventive actions are the replacement of system components by more reliable ones, or the introduction of redundant systems. An example of the latter is the addition of gas-propelled pumps in a compressor station that uses as main pumping devices electricity driven pumps. In case of an electricity blackout the gas-propelled pumps are able to keep the facility running (e.g. a black-start capability). A typical protective action is the increase in sources diversification, which makes the impact of a disruption of gas from a given source less severe. Another typical protective action is the development of storage facilities, which dramatically reduce the impact of gas disruptions.

When developing strategies, it is convenient to optimise them from two points of view:

- Combine several options, seeking for both preventive and protective effects, and
- contribute to reduce the risk associated to more than one scenario.

In general, it is convenient to design strategies that rely on more than one action. The combination of several actions within a strategy may provide it with both protective and preventive components, which will make it more effective. Additionally, some specific actions may incorporate both components.

As it was already mentioned at the beginning of this section, although unique in many senses, different scenarios may share some characteristics. This makes possible the design and deployment of strategies that help reducing simultaneously the risk introduced by different scenarios. For instance, the disruption of gas supply due to geopolitical reasons or because of a severe

damage in a key compressor station may have similar consequences, and also similar remedies. The deployment of reverse flow capabilities will reduce the impact of both scenarios. In fact, according to the Regulation (Articles 6.5 and 6.6), enabling permanent bi-directional capacity at all cross-border interconnections between neighbouring MS, as early as possible and by December 3rd, 2013, at the latest (excluding exceptions), is a protective action that must be considered in each PAP.

The Regulation stresses the importance of basing the measures (actions / strategies) considered in the Preventive Action Plan on market measures, taking into account their economic impact, effectiveness and efficiency, and not putting undue burdens on natural gas undertakings. This provides some light on the best actions to consider when devising preventive strategies. Many studies for developing new infrastructures and upgrading existing ones have already been performed and are available as, either infrastructures for which a Final Investment Decision (FID) has been made, or as infrastructures for which a Final Investment Decision has not been made yet (non-FID). A significant fraction of these studies have been proposed to be partially covered by the EC initiatives EEPR (European energy Program for Recovery) and TEN-E (Trans-European Energy Networks). Most of them have already been considered by different MS and also within different Gas Regional Initiatives and other regional platforms.

These projects have already been screened according different possible criteria (demanded by the market, increased interconnection level, diversification of sources, routes and counterparts, improved market integration, etc.), which make them most attractive. In principle, taking this into account, when thinking of developing infrastructures as actions to reduce risk, FID projects should be considered as first available options, non-FID projects could be considered as next most likely options and completely new projects should only be considered if FID and non-FID proved not to be enough for decreasing risk significantly.

ENTSO-G (2011) provides comprehensive information about infrastructure studies, and has used it in the development of its second TYNDP. The two GRIP's already developed and published under the ENTSO-G umbrella provide further information. Particularly the South Gas Regional Investment Plan (2011-2020) considers not only an inventory of new infrastructures but also a resilience network assessment under four different gas disruption scenarios.

Regarding the Supply Standard (the measures to fulfil it), the Regulation allows that increased standards going beyond the 30 day period considered in article 8.1 points (b) and (c) cases, or any other obligation imposed for reasons of security of gas supply may be considered. Nevertheless, this must be based on the Risk assessment. This means that such a situation (the conditions of the increased standard) should contribute significantly to the global risk in order to be admitted as an acceptable standard. Additionally, measures adopted must comply with points (a), (b), (c) and (d) of article 8.2 and, according to the same article, may be temporarily reduced in case of regional or Union emergency.

3.4.2 ASSESS STRATEGY EFFECTIVENESS

The implementation of a strategy means the introduction of changes in the system. These changes may affect the probability of the targeted scenario and also its associated consequences. Both have to be estimated.

The methods to be used to estimate the new probability of the targeted scenario after applying the strategy are the same that were used when performing the Risk assessment: Classical estimation, Bayesian estimation and expert judgement methods, see Bolado et al. (2011)⁷. The same is valid for the estimation of the new consequences of the scenario; the same models, indicators or expert judgement methods have to be applied in the new conditions.

Nevertheless, three ideas have to be kept in mind when assessing the effect of implementing a strategy; they could not only have a positive impact on the targeted scenario, but they could also:

- produce an impact (either positive or negative) on other scenarios for the same MS,
- induce other scenarios in the same and in other MS (correlated risk), and
- have potential negative or positive impacts on neighbouring MS (correlated risks, if the effect is negative).

In general, the type of actions to be considered within a strategy will have global positive impact on the system. The deployment of a new storage facility together with the flow capacity to take the gas to different regions of the Member State will most likely be beneficial for a wide variety of scenarios. Nevertheless, some specific actions could have negative impacts under some peculiar conditions. These situations have to be carefully scrutinised not to get into a situation of risk underestimation. The same applies to potential negative effects of strategies on neighbouring Member States; they have to be carefully analysed.

As a corollary of the last paragraph, under some specific conditions, some strategies could trigger the creation of new scenarios (which were impossible before the introduction of the strategy). This could be the case, for instance, when a strategy consists in replacing part of the gas supplied by one not very reliable source by another source. If the new source is not very reliable either, a new scenario will have be created and its related risk has to be assessed.

It should be stressed that the application of the Emergency Plan, which typically contains supply and demand side measures, may be one of the components of any strategy developed to reduce risk, and the impact of mitigation actions considered must be taken into account when assessing the effectiveness of the complete strategy. Particularly, the potential negative

⁷ R. Bolado, F. Gracceva, P. Zeniewski, P. Zastera, L. Vanhoorn, A. Mengolini (2011). Best practices and methodological guidelines for conducting gas risk assessments. EC-JRC technical report.

impact of increased supply standards on neighbouring MS, as correlated risks, has to be properly analysed.

Following the same rationale, the effect of any potential internal deficiency of the system, as for instance the existence of any internal bottleneck that produces a departure from optimal gas transmission conditions, has to be adequately taken into account and estimated when assessing the effectiveness of any measure. In fact, the removal of internal bottlenecks may be very effective measures improving the global system performance under different scenarios.

Best practices:

Oxera (2007) is a good example of a cost-benefit analysis in the area of security of gas supply. This consulting company developed a study for the Department of Trade and Industry (DTI) of the UK concerning seven possible measures to promote gas security (1- extension of current supplier obligations, 2- changes to the cash-out obligations, 3- regulation of the use of storage, 4- introduction of some form of capacity mechanism, 5- encouraging additional demand-side response from industrial and commercial consumers, 6- encouraging the installation of back-up fuel capabilities in Combined-Cycle Gas-Turbine – CCGT – power stations and 7- smart metering and increased efforts on fuel efficiency). The study time frame was the period 2007 – 2021. A base case was defined that considered gas infrastructures as per 2007 and indigenous production estimates for the reference period together with selected new infrastructures indicated in the Joint Energy Security of Supply (JESS) Working Group report (2006). The measures were assessed relative to the base case in terms of three variables: the expected cost of forced outages, the impact on wholesale and retail prices and the costs of implementation. Measures that promote greater demand side flexibility (particularly measures 6 and 5, in this order) were identified as the most beneficial for security of supply in this study. Albeit not extensively assessed, uncertainties were at least partially addressed.

3.4.3 PERFORM COST-BENEFIT ANALYSIS

Cost-benefit analysis is a mature and well-known method in the industrial sector. It consists in assessing the (economic) benefit and cost of two or more alternatives in order to make an investment decision. The chosen alternative is the one whose difference between benefit and cost is largest.

Three remarks should be considered regarding cost-benefit analysis. The first one is the difficulty to quantify in economic terms some impacts like the disruption of gas to some protected customer. The second one is the need to properly assess the benefit associated to some strategies. As it has been mentioned, some strategies will have an impact on more than one scenario; the total benefit across all scenarios affected by a strategy has to be estimated. The third remark is related to the treatment of uncertainties. Cost-benefit analyses are most useful when a proper and explicit assessment of uncertainties is done.

3.4.4 ESTIMATE RESIDUAL RISK

Residual risk is easily estimated after having assessed strategy effectiveness. The result of that step is a new probability and / or a new impact of the scenario considered. The implementation of those new values either in the CCDF of the impact (quantitative) or in the Risk Matrix (qualitative) allows the estimation of the residual risk.

Let us consider in example one that, according to the established priority order under Risk criterion 1, and after designing a strategy for scenario SC3, its probability of occurrence decreases to one tenth of its original value (from $6 \cdot 10^{-2}$ to $6 \cdot 10^{-3} \text{ a}^{-1}$) and its impact is reduced by 75% (from 100 to 25 mcm). Under these new conditions, the CCDF of the unserved gas is the one shown in figure 6, which shows a notable partial shift of the CCDF (upper part of the CCDF) towards lower values of probability and impact. Regarding the new expected values of the unserved gas and the unserved gas under scenario SC3 (old values available in table 1), they decrease

respectively from 6.496 to 0.646 and from 6 to 0.15 mcm/a. After the strategy implementation, SC3 would pass to be the second contributor to the global risk, with a much more moderate contribution. In both, the new CCDF and the new expected values of unserved gas, the possible positive impact on other scenarios has been ignored.

In the case of qualitative Risk Assessments the addressed scenarios would have shifted towards the green / yellow region in the Risk matrix.

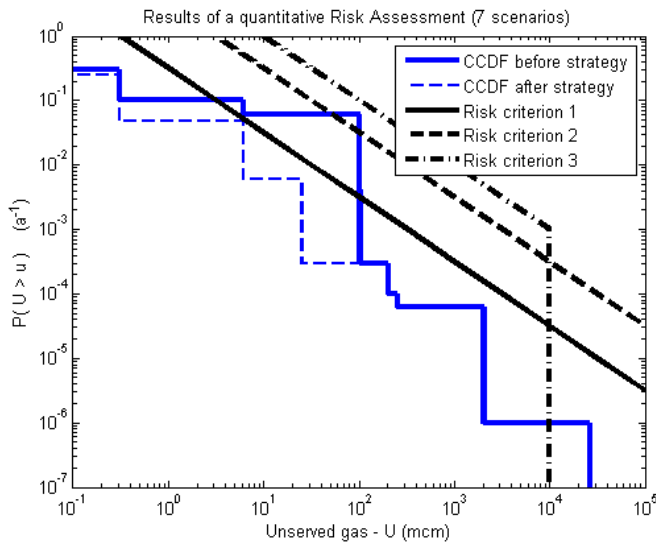


Figure 6.- CCDF of the quantity of Unserved gas in a hypothetical quantitative RA.

3.4.5 COMPARISON WITH RISK CRITERIA / LAST SCENARIO

The risk reduction loop is exited either because the residual risk after the implementation of a strategy is small enough or because the last scenario has already been addressed (in practical cases, the first criterion is the one that is always fulfilled first).

In example 1, the result residual risk after the implementation of the strategy to address scenario SC3 is shown in figure 6. We can see that the reduction in probability and consequences makes the CCDF to fall completely below the curves associated to Risk criteria 1 and 2. Under these conditions, no further scenario needs

to be treated and the loop may be exited. This would not be the case if Risk criterion 3 would be in force.

3.5 DRAFT NATIONAL PREVENTIVE ACTION PLAN

The final result of the risk reduction loop will be: a) a set of strategies to fulfil the standards and to reduce the global risk of the system, and b) the residual risk after the implementation of the strategies. All this information, together with the results of the Risk Assessment, has to be properly documented in line with article 5 of the Regulation.

Regarding the way to report about the Risk Assessment, the key information was already mentioned in section 2 of this report (page 4).

Regarding the fulfilment of standards, all the information requested by article 5, point (b), should be provided (this includes measures, volumes capacities and timing needed to fulfil them, including demand-side measures). Additionally, with respect to the measures to reduce the risk, information about all possible preventive and protective actions, mechanisms to cooperate with other MS and on existing and future interconnections, following article 5, points 1-(d), 1-(e) and 1-(f), including physical characteristics (flows, capacities, etc.), and timing of the deployment of the different actions has to be provided. The PAP must also contain obligations

Recommendations:

Some scenarios identified by a MS may affect other MS, either because of simultaneous occurrence in all of them or because of downstream propagation of effects. Relevant information about these scenarios (nature, list of potentially affected MS, estimated magnitude of the impact on neighbours, etc.) should be duly reported. In the same manner, each MS should estimate the potential impact, positive and negative, of all measures adopted in its PAP and EP on neighbouring MS. The list of potentially affected MS, scenarios induced and positive and negative expected impacts on neighbouring MS should be duly reported.

imposed on the natural gas undertakings and other bodies (article 5, point 1-(c)) and information on all public service obligations (article 5, point 1-(g)).

According to the Regulation, all this information has to be made available by the Competent Authorities to the EC and to other MS not later than June 3rd, 2012.

3.5.1 CONSULTATION (DECISION ON JOINT PAP)

The target of the consultation process is twofold: 1) to make sure that the draft plans (the EP is in fact a contributor to the strategies designed in the PAP) and measures of different MS are not inconsistent and they comply with the regulation and other provisions of the EU and 2) to make a decision about the need of developing joint PAP (and EP).

Having access to the results of the Risk Assessment and the PAP of neighbouring MS is important for identifying scenarios and measures adopted by neighbouring MS that may affect your own country and that could have been initially ignored in the national Risk Assessment and PAP. Each MS is encouraged to do this exhaustive review of neighbouring MS Risk Assessment results and PAP to identify potential correlated risks. The same can be said about the review of neighbour's EP. EP of neighbouring MS must be scrutinised to make sure that cross-border access to contracted gas is guaranteed under non-discriminatory conditions in case of gas supply crisis. This includes also the study of implications of increased supply standards.

The exchange of draft PAP and EP has to be done at the appropriate regional level. Gas Regional Initiatives (South, North-West and South-South-East) and other gas platforms such as BEMIP provide an adequate framework for the exchange of information, but they might not necessarily be the right framework for developing joint PAP and EP. The decision on the development of joint plans has to be addressed taking into account the sets of countries that are systematically affected by correlated risks and the increased capability to decrease risk and to fulfil the standards. As it is mentioned in the Regulation, the list of regions considered in Annex IV is only

indicative and non exhaustive; other alternatives may arise in this process. The Commission may play a role in this decision providing recommendations (Article 4, point 3) to the involved Competent Authorities, who are the ones that are entitled to make the actual decision.

3.5.2 DEVELOPMENT OF A JOINT PAP

If agreed by the affected Competent Authorities in the previous step of the process, they will develop joint plans, which will be based on joint Risk Assessments. Conceptually there is no significant difference between national and joint plans (joint systems instead of national individual systems will be analysed). Specifically, when developing the joint PAP, the first part of the procedure shown in figure 3, up to step 7, and described in the previous pages, may be followed. The same applies to the joint Risk Assessment, which can follow the same approach adopted to develop the national ones, and on which the PAP must be based.

Special care has to be taken to satisfy some of the specific actions requested by the Regulation to the Joint PAP, as for example the fulfilment of the Infrastructure standard at regional level (Article 6, point 3) and the identification of the largest infrastructure of common interest (Annex IV, point 5), the fulfilment of the Supply standard at regional level (Article 8, point 5), or establishing mechanisms and agreements with other MS to implement regional cooperation (Article 4, point 3 and Article 5, point 1-(e)), among others.

3.5.3 ADOPTION OF THE PAP

According to the Regulation, the PAP (and EP), either national or joint, will be adopted and made public not later than December 3rd, 2012. The contents of the PAP should be based on the results obtained in the previous step (section 3.5.2) and will follow the same scheme already described in section 3.5.

The adopted PAP (and EP) will be reviewed by the Commission in consultation with the GCG in order to avoid ineffectiveness, inconsistencies and other undesired situations, according to Article 4, points 6, 7 and 8 of the Regulation.

4. EMERGENCY PLANNING REVIEW AND BEST PRACTICES

The purpose of this section is to document and review existing national gas emergency plans, following the guidelines and requirements set out by Regulation 994/2010 concerning measures to safeguard security of gas supply. The first part of this section will review existing gas emergency planning frameworks, tools and methods. This information has been extracted from TSO network codes, legal and regulatory acts, as well as independent research such as that found in relevant FP7 projects and international institutions (IEA). This information has been buttressed by a survey aimed at 'Competent Authorities' of EU member states designated by EC/994/2010. Circulated by the JRC-IET in July 2011, this questionnaire (attached in the annex) was an instrumental part of the review process.

Before undertaking a comprehensive review of EU member state gas emergency plans it is useful to note the generic standards for emergency management offered by international and multidisciplinary organizations. The first point of reference in this regard is the work carried out via the 7th Framework Programme. For example, the project European Risk Assessment and Contingency Planning Methodologies for Interconnected Energy Networks (EURACOM) carried out an analysis of Contingency Planning as well as Business Continuity Management (BCM) to identify good practices from several domains including the security industry, national guidelines and energy standards.⁸ The EURACOM project discussed emergency preparedness, contingency planning and business continuity management, focusing in particular on the steps and frameworks propagated by various standards at the international, national and sector-specific levels.⁹

⁸ EURACOM WP2, p. 8

⁹ FP7, European Risk Assessment and Contingency Planning Methodologies for Interconnected Energy Networks (EURACOM), *Desktop Study - Contingency Planning and Business Continuity*, Deliverable D2.2, 6-11-2009, at <http://www.eos->

The literature review has been oriented towards national-level contingency plans that encompass the entire gas network. Here the UK definition of a gas supply emergency is instructive, namely "the occurrence of an event or existence of circumstances which has resulted in, or gives rise to a significant risk of, a loss of pressure in the total system or a part of the total system which itself has resulted in or might result in a supply emergency."¹⁰

From this reference point, the principles of emergency management set out by the United States Federal Emergency Management Agency have been adapted to gas contingencies, such that plans must be:

1. Comprehensive – emergency plans take into account all crisis levels, all stakeholders and all impacts relevant to interruptions to gas supply.
2. Progressive – emergency plans are built upon forecast analyses undertaken by risk assessments and preventive action plans.
3. Risk-driven – emergency plans are based on sound risk management principles (hazard identification, risk analysis, and impact analysis) in assigning priorities and resources.
4. Integrated – emergency plans ensure unity of effort among all levels of government and all stakeholders involved in the natural gas supply chain.
5. Collaborative – emergency managers create and sustain broad and sincere relationships among individuals and organizations to encourage trust, advocate a team atmosphere, build consensus, and facilitate communication.

eu.com/LinkClick.aspx?fileticket=cTwMTAwmbL4%3d&tabid=221&mid=1017

¹⁰ UK, Uniform Network Code, TPD Section Q, Emergencies, Version 3.30, 26.03.2010, [1.2.1] By using this definition, this report will not cover emergency planning for individual gas facilities [e.g. pipeline sections, compressor stations, LNG terminals, power plants, etc] despite their important role in managing local supply problems and occasionally affecting national ones.

6. Coordinated – emergency managers synchronize the activities of all relevant stakeholders to achieve a common purpose.
7. Flexible – emergency managers can use creative and innovative approaches in solving supply crises, as long as the consequences of these measures are adequately understood.
8. Professional – emergency managers value a science and knowledge-based approach; based on education, training, experience, ethical practice, public stewardship and continuous improvement.¹¹

In spite of taking due account of national and international standards, the primary method for determining good practices in gas emergency plans is by analyzing their conformity to Regulation 994/2010. This piece of legislation will provide the benchmark with which to assess national and regional emergency planning frameworks, as well as roles, responsibilities and channels of information set out therein. Due account has also been taken of related EU legislation (e.g. Directive 2009/73/EC; Regulation 2009/715/EC) as well as their respective predecessors (in particular, Directive 2004/67/EC concerning measures to safeguard security of gas supply, which explicitly mentions the need to publish national emergency measures). Above all else, the report will be aware of the stipulation in Regulation 994/2010 that “the measures to ensure the security of supply contained in the Preventive Action Plans and in the Emergency Plans shall be clearly defined, transparent, proportionate, non-discriminatory and verifiable, shall not unduly distort competition and the effective functioning of the internal market in gas and shall not endanger the security of gas supply of other Member States or of the Union as a whole.”

¹¹ List adapted from United States, Federal Emergency Management Agency (FEMA), *Principles of Emergency Management*, 11-09-2007
<http://www.iaem.com/publications/documents/PrinciplesofEmergencyManagement.pdf>

4.1 DEFINING CRISIS LEVELS

A fundamental part of an emergency plan is the determination of crisis levels. Already at this stage there is considerable variety amongst EU member states, in terms of both the procedures and criteria under which crisis levels are declared. In fact, the number of crisis levels themselves range from one (France) to five (UK and Ireland), although the Regulation mandates three main crisis levels according to Article 10. Moreover, the declaration of the first phase of a crisis (usually some form of ‘early warning’) is sometimes made by a government actor (France), a transmission system operator (Belgium), a designated crisis manager (Ireland) or a regulator (Germany).¹²

There are also some notable differences in EU states as to the degree to which crisis levels require non-market interventions. In Austria, for example, the prerogatives of the Ministry of Economy and Labour provided by the *Federal Act on intervention measures to safeguard energy supplies* are activated only after market-based measures have been exhausted and the crisis has reached the third and final level of criticality.¹³ The same principle applies in Belgium, although the responsibility to declare an emergency is split between the TSO and competent authority mandated by Regulation 994/2010. By contrast, Poland’s Minister of Economy is authorized to intervene already in the second of four crisis phases, by deciding on the use of compulsory stocks.¹⁴ In the case of France, the government may at any time decide to trigger the National Gas Emergency Plan and thereby take control of the situation, when the exceptional measures undertaken by the gas industry are deemed insufficient or ineffective.¹⁵

¹² Germany, *Gassicherungsverordnung*, 26-04-1982, § 2

¹³ Austria, *Energielenkungsgesetz*, 21-10-1982, as amended in 2006, [Article 2], at <http://www.e-control.at/portal/page/portal/medienbibliothek/recht/dokumente/pdfs/energielenkungsgesetz-1982-idf-106-2006.pdf>

¹⁴ Poland, JRC-IET Questionnaire to Competent Authorities, July 2011

¹⁵ France, *Arrêté du 27 octobre 2006 relatif aux mesures nationales d'urgence visant à garantir la sécurité de*

Few emergency plans offer concrete criteria or thresholds for initiating successive stages of a crisis. In most cases crisis levels are set out in qualitative terms, describing situations where supply is unable to meet demand under various conditions (e.g. when market measures alone are insufficient and intervention in the form of demand restraint or stock withdrawal are necessary). There are, of course, exceptions to this trend; the UK has defined a series of 'triggers' which activate the Joint Response Team. For example, a Gas Balancing Alert (GBA) mechanism provides an early warning to the market when demand-side response or additional supplies are anticipated by National Grid Gas to ensure the physical balance and the future safety of the network. This alert occurs when the forecast day-ahead demand is above a certain 'trigger level', which is based on current capacity and recent reliability of supplies.¹⁶ Thresholds are in place in other countries, as well; for example, Romania defines an urgent situation at the national level if the country loses 20% of gas volumes from import or internal production failure.¹⁷

In the majority of cases, however, the determination of crisis levels are subject to the discretion of the operational actor or competent authority; in case of the latter this is stated explicitly in French legislation, which eschews the use of strict criteria to set crisis levels in favour of modularity, meaning that measures to manage an emergency can be applied without the formal

initiation of an emergency plan.¹⁸ This lends a certain degree of flexibility in deciding on what actions to take during a gas supply crisis. Similar provisions for flexibility in determining crisis levels exist outside the EU. For example, Australia's gas emergency plan classifies emergencies into 5 levels, but notes that these levels "do not constitute an authority for the commitment of resources or...contractual or legal obligations with respect to dealing with an emergency. They are merely an agreed description to contextualise the scale of emergency, expertise and response required to combat the incident."¹⁹ The Regulation contains provisions for declaring a Union-wide or regional emergency for a specifically affected geographical region (this declaration is made by the Commission following requests from at least two Competent Authorities). The matter is then referred to the Gas Coordination Group, and the Commission can coordinate the actions of Competent Authorities to ensure the exchange of information, the consistency and effectiveness of MS responses in relation to the Union level, as well as action with regard to third countries. National gas emergency plans, therefore, should be cognizant of regional/Union crises and ideally accommodate the Regulation's provisions in this regard (French legislation, for example, recognises the role played by the Gas Coordination Group in emergency situations).

l'approvisionnement en gaz naturel en cas de crise, JORF n°259, 8-11-2006 [page 16762, texte n° 7, Article 2] at

<http://textes.droit.org/JORF/2006/11/08/0259/0007> see also <http://www.grtgaz.com/en/home/connection/industrial-customers/reduction-or-suspension/>

¹⁶ See Poyry Consulting, *GB Gas Security Of Supply and Future Market Arrangements*, Report to the Gas Forum, 10-2010, [p. 11] at

http://www.ilenergy.com/pages/Documents/Reports/Gas/528_GB_Gas_Security_&_Market_Arrangements_v1_0.pdf

¹⁷ European Commission, SEC (2009) 978, *Assessment Report of Directive 2004/67/EC on Security of Gas Supply*, 16.7.2009, [p. 51] at

http://ec.europa.eu/danmark/documents/alle_emner/energi/2009_ser2_20090715_assessment_report.pdf

¹⁸ France, *Directive Interministérielle Sur Les Plans Ressources*, n° 30 / SGDN / PSE / PPS du 5 janvier 2001 établie en exécution de la directive générale interministérielle sur la planification de défense et de sécurité, n° 10010, 5-1-2001, at http://www.circulaires.gouv.fr/pdf/2009/04/cir_1224.pdf

¹⁹ Australia, *Emergency Procedures – Gas*, Australian Energy Market Operator (AEMO), Version 6, 109526, 02.2011, [p. 7] at www.aemo.com.au/emergency_public/1092-0009.pdf

To assist in preparing for Union- and regional-level emergencies, there are a number of European bodies that focus on gas emergency planning. Most visibly, the European Network of Transmission System Operators for Gas (ENTSO-G) has set itself the task of adopting common tools to ensure coordination of network operation in normal and emergency conditions, including a common incidents classification scale.²⁰ These tools will respect the EU's principle of subsidiarity and the corresponding emphasis on a three level approach to crisis management set out in Article 3 of the Regulation (e.g. market response, followed by national government intervention and then EU-level measures). An interesting contrast to this 'market-first' approach propagated by the EU and the Regulation can be found in Japan, where the government considers 'resource diplomacy' the cornerstone of Japan's emergency preparedness policy and a crucial instrument for crisis pre-emption.²¹

4.2 CLARIFYING ACTOR ROLES, RELATIONSHIPS AND RESPONSIBILITIES

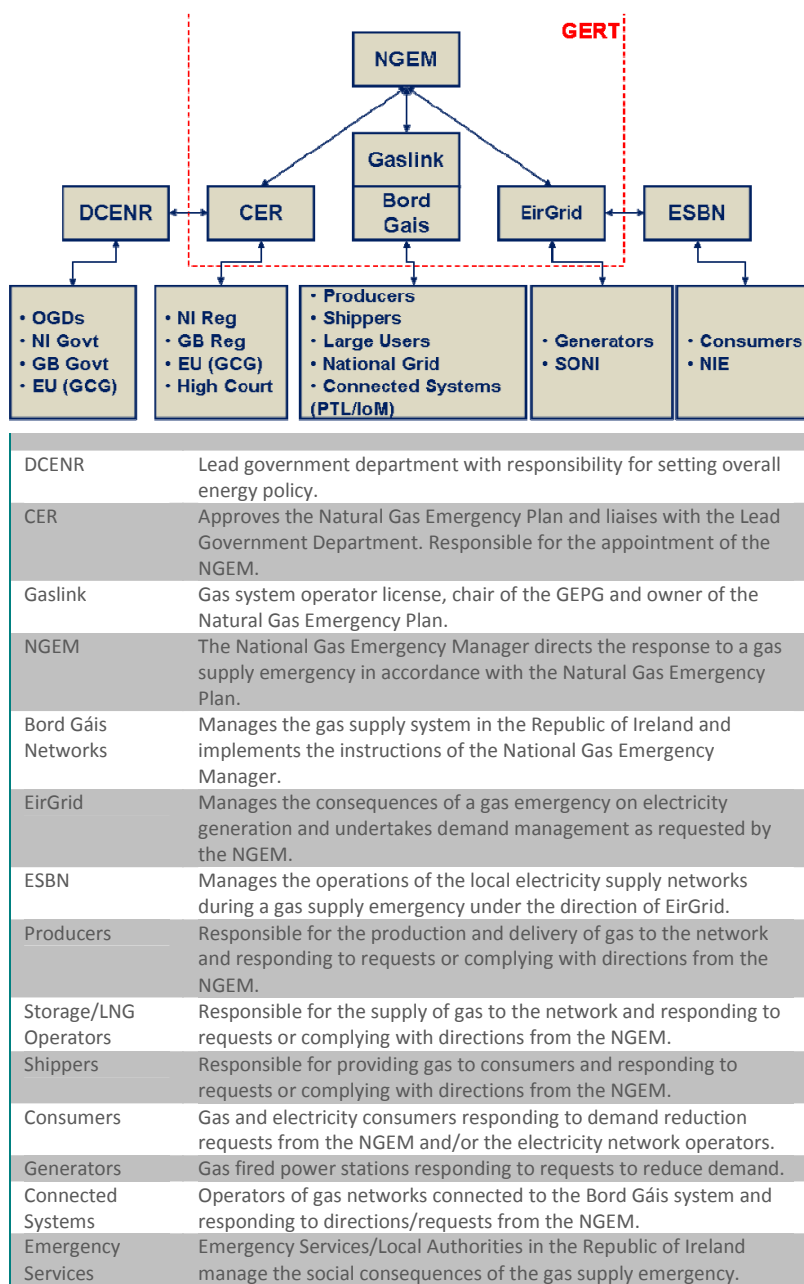
According to the Regulation, the emergency plans must define the roles and responsibilities of gas undertakings, industrial consumers (including electricity producers) and their interaction with competent/regulatory authorities during each crisis level.²² At the industry level, gas network codes are the first point of reference in ascertaining such roles and responsibilities of network users and operators during abnormal conditions; these

²⁰ ENTSO-G, Annual Work Programme 2011, [p. 28] at http://www.entsog.eu/publications/index_awpstat.html ; see also Regulation EC/715/2009, Official Journal of the European Union, L211/36, 14-8-2009, [Article 8] at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0036:0054:EN:PDF>

²¹ International Energy Agency, Energy Policies of IEA Countries, Japan Review, 2008 [pp. 88-89] at www.iea.org/textbase/nppdf/free/2008/Japan2008.pdf

²² Regulation 994/2010, 12-11-2010, [Article 10, 1, b] at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:295:0001:0022:EN:PDF>

Figure 7.- Ireland's 'Top-down' Emergency Planning Framework



Source: Ireland, Gaslink, Natural Gas Emergency Plan, Version 1.0, 02-2009,

contain information sharing and notification procedures as well as obligations to comply with various instructions – such as storage withdrawal or modification of shipping schedules – conferred by the TSO. Network codes become less pertinent as the crisis reaches higher stages of criticality, when government bodies are activated and/or are accorded greater powers of delegation and oversight over the management of national gas supplies. National regulations and legislation provide information on government actors' competencies, and a number of legal acts are usually relevant to the safe operation of natural gas systems.

The IEA has encouraged its member states to produce a publicly available handbook detailing the operational procedures to be taken in the event of a gas supply disruption. Such measures, it has observed, are useful for ensuring an efficient and streamlined decision-making process in the event of a crisis. In a few cases, such as the UK and Ireland, publicly-available gas emergency plans extensively set out the roles and responsibilities of the whole range of actors involved in an emergency situation. In the case of Ireland, for example, the Gas Emergency Planning Group and the Gas Emergencies Response Team (GERT), both overseen by the National Gas Emergency Manager (NGEM), are collectively responsible for Ireland's Natural Gas Emergency Plan. The GERT is composed of Gaslink, Bord Gais, EirGrid and the Irish energy regulator (CER); this body can additionally create an industry-wide consultation group to provide support to the core group when it is required.²³ In the UK, emergency planning and operational response is primarily guided by the Energy Emergencies Executive, which consists of experts drawn from a cross section representing the gas and electricity industries as well as government, agencies, regulators, trade associations and industry bodies. In both the UK and Irish NEPs, the concrete roles and responsibilities of these entities are set out in organigrammes and

²³ Ireland, Gaslink, Natural Gas Emergency Plan, Version 1.0, 02-2009, [p. 6] at http://www.gaslink.ie/files/planning/20090420025342_Public%20NGEP%20Revised.doc.pdf

accompanying tables (see Figures 7 and 8). The UK report provides further details of the composition of each body as well as their operational responsibilities and lines of communication during each alert level and emergency 'trigger.'²⁴

While a clear lead actor is normally identifiable during a gas crisis, there are at least three different ways in which stakeholders can be organized. In 'bottom-up' cases the main gas transmission system operator plays the leading role in managing a crisis and takes on most of the responsibilities for keeping network users and government actors up to date on the emergency measures taken. This is true in the case of Belgium, where Fluxys is responsible for declaring crisis levels and takes on a proactive role in both market and non-market interventions (the latter involving enforced storage withdrawal during the third and final crisis level in order to supply gas to protected customers).²⁵ In other cases, the TSO is part of a wider crisis management structure that is set up in a 'horizontal' framework incorporating a range of stakeholders from government, regulators, industry and end-users. This type of arrangement is captured by the UK example above. Finally, there are 'top-down' frameworks whereby considerable powers of delegation and oversight are given to a single, usually governmental actor. The French and Irish emergency planning procedures follow this type; the former vests authority in the Ministry of Energy, which helms a Crisis Unit that can decide on emergency measures according to the degree of urgency, level of stress (based on the social or political context) and the nature of the measure itself. Similarly, Ireland's Natural Gas Emergency Manager (NGEM) plays the lead role in declaring an emergency, forming the response team and deciding on the appropriate measures in response to a crisis. Outside

²⁴ UK, DECC, National Emergency Plan for Gas and Electricity, Version 13, 04-2010 at http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/resilience/gas_electric/1_20100430123757_e_@@_nationalemergencyplangaselec.pdf

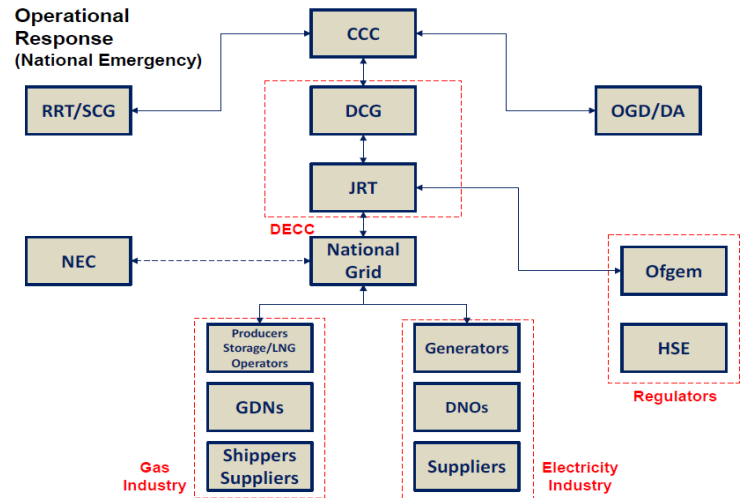
²⁵ Belgium JRC-IET Questionnaire to Competent Authorities, July 2011

of the EU, Canada accords substantial powers to the Federal Government in the event of an emergency (through the Energy Supplies Emergency Act, under which the Energy Supplies Allocation Board can be established).²⁶

In setting out the roles and responsibilities of stakeholders in an emergency, it is above all necessary to clarify lines of communication; frequently national emergency plans contain provisions to exchange contact details and for individual parties to be nominated to represent key actors in the gas emergency supply chain. This facilitates information sharing and encourages collaborative efforts among industry, government and end users in tackling gas supply interruptions. These bodies, in turn, are typically under various obligations to report and/or manage the incident. In this context it is usually the main transmission system operator that has the greatest operational role to play during a crisis. The TSO is responsible for informing government actors and crisis management bodies (often in real-time) of developments during an interruption, and must coordinate most downstream activities in the supply chain (e.g. supply- and demand-side responses entailing storage withdrawal, fuel-switching, reverse flows, etc). Moreover, TSOs are responsible for informing market players and network users (often in advance) of available capacities and interruption schedules, including their duration. These actors, in turn, are obliged to heed instructions from the TSO as it attempts to balance the network in exceptional circumstances.

In this context, gas market players (suppliers, shippers, traders, etc) operate under increasingly restrictive rules during each successive crisis level; it is common that certain user rights to access the pipeline network or booked storage capacity are curtailed or suspended in order to effectively allocate network capacity. Outside of normal operating conditions, market players must orient themselves around such new rules, some of which require cooperation in place of competitive activities. In

Figure 8.- UK's 'Horizontal' Emergency Planning Framework



Organisation	Role & Responsibilities
DCG	The DECC Coordinating Group provides the strategic Lead Government Department interface between DECC and the CCC.
JRT	The Joint Response Team acts as the interface between the gas and electricity industries and government.
JRT Incident Controller	The Joint Response Team is led by a DECC Senior Official as the Incident Controller.
NEC	The Network Emergency Coordinator is responsible under safety legislation for the coordination of a network gas supply emergency.
National Grid	National Grid as the operator of the gas and electricity transmission manages the response to a national gas or electricity emergency.
CCC (COBR)	The Civil Contingencies Committee operates in COBR and manages the central government response to an energy emergency.
DNOs	The electricity Distribution Network Operators own and operate the local electricity networks and manage local electricity supply emergencies.
GDNs	The Gas Distribution Networks own and operate the local gas distribution network and manage local gas supply emergencies.
Shippers & Suppliers	Shippers and suppliers are responsible for communication with the consumers in an emergency.
Producers	Gas producers and storage facility operators are responsible for maximising gas supplies in an emergency, if directed.
Interconnectors LNG Operators	Interconnectors and LNG facility operators are responsible for maximising gas supplies in an emergency, if directed.
Generators	Electricity generators are responsible for maximising electricity supply in an emergency, if directed.
OFGEM	The Office of Gas and Electricity Markets regulates the gas and electricity markets and is a member of the JRT in an emergency.
HSE	The Health and Safety Executive are responsible for safety legislation and may grant exemptions to safety regulations in an emergency if appropriate.
Regional/Local Resilience	The Regional and Local Resilience 'Gold Command' Teams are responsible for managing the civil consequences of an emergency.

Source: UK, DECC, National Emergency Plan for Gas and Electricity, Version 13, 04-2010

²⁶ International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Canada, 2010

this context it is useful to make provisions to enable and/or encourage cooperation between market players in exceptional circumstances. In the second crisis management phase in Germany, for example, a 'clearing mechanism' between several energy companies and the Ministry of Economy can be initiated. This mechanism is based on a voluntary agreement between the German government and the gas industry which allows coordinated action and mutual assistance between companies, such as redirecting gas flows, freeing transport capacities and making gas swaps.²⁷

The suspension of commercial capacity allocation by operators is often legally mandated by public service obligations (PSOs) that set out security of supply standards. According to Article 13 of the Regulation, EU member states are obliged to make these standards public (in addition to formulating them as set out in Article 3 of Regulation 2009/73/EC). In some cases these obligations are extensive. In France, for example, Decree No. 2004-251 of 19 March 2004 requires operators to ensure continuity of supply for households in case of a) six months of an interruption to the main source of gas supply, b) a 1-in-50 winter or c) extremely low temperature for a period of up to three days statistically occurring once every fifty years.²⁸ Similar provisions exist in Denmark, where Energinet.dk must ensure gas to protected customers (designated as 'primary energy supply') when the largest gas supply source is interrupted either for 3 consecutive days of -13°C or 60 days of normal winter conditions.²⁹ Other standards are less demanding; Annex 1 below indicates some of the differences between member states' security of supply

standards. More generally, Regulation 994/2010 provides both the infrastructure and supply standards as minimum benchmarks for complying with security of supply norms. These obligations are usually met through gas stocks (see below).

It is important that member states' public service obligations are closely scrutinised in order to determine their practical implications during a gas supply emergency. For example, Estonia's obligation that heat suppliers consuming more than 500 GWh annually hold a 3 day reserve does not apply to the several hundred smaller heat producers in that country. The exemption of these producers from back-up supply obligations may have important implications for heating services in several municipalities during a crisis.³⁰ In addition to such practical scrutiny, competent authorities are obliged to indicate how the supply standards or any related obligations imposed on natural gas undertakings may be temporarily reduced in case of a wider Union or regional emergency.³¹

Outside of the European Union, the example of New Zealand provides an interesting contrast to the prevailing public-private relationships and associated PSOs described above. The country has created a 'co-regulatory' structure of governance whereby the gas industry plays an active part in designing and enforcing energy legislation.³² Thus, rather than having public bodies impose security of supply obligations on gas undertakings, the New Zealand government has propagated a self-regulating, industry-led response mechanism to potential gas emergencies. Accordingly, a publicly-traded multi-network infrastructure company

²⁷ Germany, Gas Emergency measures, presentation by Klaus Jenny to Gas Coordination Group, 20-03-2009

²⁸ France, *Arrêté du 27 octobre 2006 relatif aux mesures nationales d'urgence visant à garantir la sécurité de l'approvisionnement en gaz naturel en cas de crise*, JORF n°259, 8-11-2006 [page 16762, texte n° 7, Article 2] at <http://textes.droit.org/JORF/2006/11/08/0259/0007>

²⁹ Denmark, Energinet.dk, Rules for Gas Transport, Version 10.1, 05-2011 [Article 19(1)] at

http://www.energinet.dk/SiteCollectionDocuments/Engelske%20dokumenter/Gas/Rules%20for%20Gas%20Transport%2010_1.pdf

³⁰ Sachi Findlater and Pierre Noel, *A qualitative assessment of Baltic State gas security of supply*, Energy Policy Research Group, University of Cambridge UK, [p. 10] at <http://www.eprg.group.cam.ac.uk/wp-content/uploads/2010/03/FindlaterNoelCombined2EPRG1008.pdf>

³¹ EC/994/2010, Article 8.2

³² <http://gasindustry.co.nz/>; see also New Zealand, Gas Governance (Critical Contingency Management) Regulations 2008, SR 2008/426, 4.11.2008, at <http://www.legislation.govt.nz/regulation/public/2008/0426/last/DLM1683495.html>

Best practices:

- The use of triggers, early-warning mechanisms, GBA, and storage monitors are advisable because they provide clarity on what crisis levels are active.
- Roles and responsibilities must be clearly defined, preferably in a publicly-available emergency planning document that sets out these roles and responsibilities for each crisis level. Moreover, it is advisable to provide contact details and nominate representatives for each body involved in a crisis.
- The determination of crisis levels can be qualitatively assessed but preferably backed by quantitative monitoring and data analysis accumulated by the TSO. In this way, the determination of crisis levels can be the result of both quantitative and qualitative analysis, which can lend a flexibility and possible adjustments to the specificities of a given crisis scenario.

known as Vector Limited is responsible for emergency management, fulfilling the role of Critical Contingency Operator (CCO). The measures contained in New Zealand's Gas Outage and Contingency Management Arrangements are the product of extensive consultations among industry stakeholders, including a thorough review of the thresholds, guidelines, and assumptions contained therein.³³

In addition to the standards noted above, a key part of defining the terms of reference in an emergency plan is to clarify what is meant by protected customers. In most cases protected customers are implicitly defined in a TSO's disconnection order. However, some member states have extended the coverage of security of gas supply standards to all small customers consuming less than 100.000 (Portugal), 170.000 (Netherlands), or 400.000 (Czech Republic) cubic metres per year.³⁴

A final observation needs to be made concerning roles and responsibilities during a supply crisis. In most cases, the obligations on operators, suppliers and consumers apply to national gas sectors only; the literature review has not revealed a case where reference is made to

cooperation with any actors operating outside this perimeter.³⁵

4.3 DESIGNING EMERGENCY MEASURES

The most comprehensive emergency plans clearly set out which emergency measures are used under what conditions. Backed by obligations for continuous monitoring and information sharing amongst a wide range of market and non-market actors, an emergency plan optimizes the measures deployed to countenance a gas supply shortfall according to clear guidelines, thresholds and assumptions. The measures reviewed below provide some examples of best practices, highlighting in particular the different ways in which member states go about dealing with a gas supply deficit. It is important to state at the outset that the measures taken often reflect the particular characteristics of the natural gas supply system in each respective country. In this context there are no 'one-size-fits-all' approaches. Nonetheless it is possible to extrapolate from an analysis of these various measures the over-riding importance of maintaining an adequate level of system *flexibility* in case of a disruption. This flexibility is contingent not only on supply diversity and spare capacity but also on the management of demand-side response and the

³³ New Zealand, Gas Critical Contingency Management Arrangements, at http://gasindustry.co.nz/sites/default/files/consultations/andrew.walker@gasindustry.co.nz/Statement_of_Proposal.pdf; note that there are several consultation papers, responses, updates and associated documents available on the same website.

³⁴ EC SEC (2009) 978

³⁵ EC SEC (2009) 978, p. 12

regulatory framework in which both forms of emergency measures are housed. Table 2 summarises the emergency measures available in selected member states as per the results of the JRC questionnaire (in addition to information given by IEA reviews).

4.3.1 SUPPLY SIDE FLEXIBILITY

Gas Storage and Stocks

Natural gas storage has several uses beyond ensuring security of supply, but for the purposes of emergency planning there are two relevant types: dedicated strategic storage facilities operated by government, and commercial storage facilities that contain various market players' minimum stock obligations (of course, regular operational and commercial storage also serves as a valuable source of spare capacity during a crisis). In managing national storage options, the IEA recommends that countries adopt clear provisions and regulations that distinguish in a transparent manner the relevant volumes reserved for stock obligations from the capacities available for commercial and operational purposes.³⁶ The circumstances, conditions and objectives for their handling, building-up and release should also be clearly set out in an emergency plan.

There are several different arrangements in member states concerning the use of storage capacity for purposes of security of supply. Often storage capacity may be allocated automatically based on the public service obligations mentioned above, where operators, shippers and suppliers must conform to defined levels of gas in storage to meet the demands of their customer portfolio under various weather severity levels. In such cases the obligations for maintaining minimum stockpiles of gas can be variably conferred on TSOs (Denmark, Czech Republic, Bulgaria, and Belgium), shippers (Italy

and Poland, for non-EU imports) and suppliers (France, Spain and Hungary).³⁷

The quantities of gas stocks to be held and the management and timing of their release are also different amongst member states. By Royal Decree 1766/2007, Spain obliges natural gas and LPG operators to maintain minimum stocks, equivalent to 20 days of consumption, which are placed in underground storage regulated by the government and accessible by it in case of emergency. Volumes required to be held by suppliers and operators are calculated on the basis of firm, or non-interruptible, sales. This obligation is monitored by the Spanish stockholding agency (CORES), which is responsible for managing and controlling (but not supplying) the country's strategic oil and gas stocks. A similar system whereby stocks are monitored by an independent agency is in place in Hungary, which has a dedicated strategic storage capacity of 1.2 bcm. The Hungarian Hydrocarbon Stockpiling Association (HUSA) is responsible not only for monitoring but also maintaining natural gas reserves at 300 Mm³ as prescribed by a 2006 legal act.³⁸

Compulsory stockholding arrangements are best managed by setting out the conditions under which they are released. For example, Portugal has a robust stockholding obligation whereby gas importers are mandated to hold gas reserves equivalent to 15 days' consumption of non-interruptible gas-fired power plants (i.e. electricity producers) and 20 days' consumption of non-interruptible customers (particularly households) in the remaining market.³⁹ However, Portugal does not have automatic triggers under which the use of these stocks can be authorized. This is a contrast to countries such as Spain or Poland. In the former, Enagas and the Ministry of Trade, Industry and Tourism can authorize

³⁶ International Energy Agency, *Regulatory Reform: European Gas*, OECD, 2000, [p. 100], at <http://www.oecdbookshop.org/oecd/display.asp?lang=en&sf1=identifiers&st1=5lmqcr2kf9wk>

³⁷ Poyry 2010, [p. 14]

³⁸ Hungary, Stockpiling Association (HUSA), Annual Report, 2008, at <http://www.husa.hu/userfiles/dokumentumok/Annual-report-2008.pdf>

³⁹ Portugal, Decree Law 140/2006, 26-07-2006, at <http://dre.pt/sug/digesto/index.html>

the use of compulsory stocks under declared emergency levels. Similarly, Poland's system of compulsory gas stocks can only be mobilized in "Phase II" of a gas emergency, after approval from the Minister of Economy. Instructions are then given by the TSO to the storage system operator that specifies the required hourly quantities that need to be delivered to the transmission system.⁴⁰

There are alternatives to minimum stockholding obligations for designated customers; some countries set national-level standards applicable to the whole country. Like Hungary's obligation to keep 45 days of strategic storage in reserve, Greece has set aside a quarter of the existing storage space at Revithoussa LNG terminal for the purpose of maintaining the security of natural gas supply on a short-term basis. LNG storage also accounts for a large share of national storage capacity in Spain (33%) and Belgium (25%).

One example of good practice in handling storage for the purpose of emergency preparedness is the UK's publication of storage monitor curves. These describe the minimum volumes of gas that need to be stored during a particularly severe winter, for both protected (the safety monitor) and firm customers (the firm monitor). National Grid for Gas provides⁴¹ this information in three categories – short range storage (less than 5 days at max deliverability), medium range (5-70 days) and long range (over 70 days). One of the initial 'triggers' in the UK's emergency plan is a breach of the gas storage safety monitor⁴²

⁴⁰ Poland, Gaz-System, Transmission Network Code, Part II, Balancing and System Congestion Management, Article 6.2.3 at http://en.gaz-system.pl/fileadmin/pliki/iriesp/en/Transmission_Network_Code_part_2.pdf

⁴¹ International Energy Agency, Gas Emergency Policy; where do IEA countries stand?, Information Paper, 05-2011, [p. 6-7] at http://www.iea.org/papers/2011/gas_emergency_policy.pdf; EC SEC (2009) 978, [p. 26]

⁴² <http://www.nationalgrid.com/uk/Gas/Data/storage/>, see also Poyry, 2010 p. 13

Table 2.- Gas Emergency Measures in Selected EU Member States

		AT	BE	DK	EE	FI	IE	EL	ES	FR	IT	HU	NL	PL	PT	SK	UK
Market Measures - Supply	production flexibility	X		X			X						X				
	import flexibility		X		X				X	X	X		X	X	X		
	storage	X	X	X			X		X	X	X	X	X	X	X		
	diversification	X	X						X	X	X				X	X	
	reverse flows / bi-directional capacity	X	X						X						X	X	X
	TSO coordinated dispatching		X		X		X		X						X		
	short/long-term contracts/arrangements	X			X				X	X	X				X		
	regional cooperation measures		X						X	X					X	X	
	other																
Market measures - Demand	interruptible contracts	X		X			X	X	X	X	X			X			X**
	fuel switching + backup fuels	X			X		X		X	X	X	X				X	
	voluntary firm load shedding						X				X						
	increased efficiency/RES								X	X						X	
	stocks / drawdown						X		X	X	X				X		
	pricing mechanism								X							X	
	other																
Non-market measures - Supply	strategic storage								X		X	X		X	X		
	enforced use of stocks	X					X										
	enforced use of electricity substitution	X					X				X						
	enforced gas production	X					X										
	enforced storage	X	X	X			X			X	X	X		X			X
	alternative fuel obligation				X	X	X	X							X	X	
Non-market measures - Demand	enforced fuel switching	X			X		X				X						X
	enforced interruptible contracts	X									X						
	enforced firm load shedding	X					X			X	X						
	price regulation																
	other																X*

NB: *: restricting gas off-takes

** : shortly to change due to new legislation

Source: Compilation of answers to questionnaire in Annex 3 and footnote 45.

Figure 9.- Gas Storage in Europe



Source: European Federation of Energy Traders (EFET), Gas Storage in Europe; adding security through flexibility, at www.efet.org/GetFile.aspx?File=3069

The relative contribution of storage in dealing with an emergency may be indicated by plotting the ratio of storage capacity to peak demand against the percentage of total gas demand serviced by imports (see figure 9). Of course, this only provides an indication of how much stored gas is available to honour contracted demand during an emergency. In practice, it is necessary to buttress this analysis by analysing daily storage withdrawal rates as well as the available capacities of transmission lines to carry this gas to the required exit point. An illustrative example is the pipeline connection providing Lithuania with stored gas in Latvia; it has a technical capacity of approximately 5MCM/day but, due to limitations on the Latvian transmission network structure and the amount of storage withdrawal capacity available to Lithuania in winter, can only ship 1MCM/day.⁴³ By contrast, E-Control in Austria managed the January 2009 Russia-Ukraine gas crisis by drawing on unused Haidach storage capacity that was located within the territory of Austria and could be transited through the German gas grid. Equally, the increase in imports from Germany three days later was possible because of E-Control's reserved feed-in capacity on the Oberkappel

interconnection point.⁴⁴ The lesson here is that the degree of redundancy built into gas storage, production and transport facilities along the *whole of the supply chain* is an important factor determining the degree of flexibility during a crisis. This is all the more pertinent for Czech Republic, Estonia, Luxembourg, Slovak Republic, Slovenia, Sweden and Switzerland, all of which are connected to storage sites located in neighbouring countries.⁴⁵

Besides drawing on strategic storage and stocks, there are residual balancing tools available to TSOs that may double as emergency measures. These include the use of linepack, operational storage or LNG peak shaving facilities. The latter, usually situated in strategic locations close to areas of densest demand, provide a high level of deliverability that can supplement transmission network capacity. An example is Dudzele in Belgium, which has a relatively small working capacity of 59 mcm but can ensure a high degree of deliverability in the short term. Equivalent regional tools may include those market-

⁴⁴ Austria, E-Control, Annual Report, 2009, [p. 41] at <http://e-control.at/de/publications/annual-reports>

⁴⁵ IEA, Gas Emergency Policy; where do IEA countries stand?, 2011, p. 9

⁴³ Findlater and Noel, 2010, p. 14

Best practices:

- Emergency measures are most effective when they are derived from a rigorous appraisal of the system's capacity to cope with abnormal operating conditions. In the majority of cases there is a trade-off between security and cost. Accordingly, the focus should be on system optimization rather than on mandating high standards of security (e.g. through costly back-up fuels, LNG, storage or stock obligations). There is always the risk that such standards are prohibitively costly to maintain while imposing logistical burdens on consumers, operators, suppliers or shippers.
- Compulsory stocks and strategic storage need to be carefully assessed, as there is a danger that they can discourage investments in more market-based security measures (e.g. commercial storage) due to public goods and free-rider problems.
- Short term supply-side flexibility is best ensured when enough capacity is built into the whole supply chain.
- It is advisable to monitor and test supply-side measures (more of which below).
- Governments and regulators are responsible for ensuring public service obligations, but the means/instruments to achieve minimum standards should, as much as possible, be left to market players.
- Emergency plans should be aware of the impact of a gas supply disruption on district heating and gas-fired electricity generation.
- A diversity of measures is favourable to relying on one primary tool (e.g. strategic storage) to handle disruptions.

based harmonization measures promulgated by ACER and ENTSO-G, namely the use of operational balancing agreements, cross-border congestion management and interconnection agreements.

Spare capacity on interconnection points

A diversity of entry points can be considered a source of resilience because they increase the total spread under which natural gas supply enters the system. However, diversification's effect on system resilience can vary depending on whether the cross-border entry/exit points are operating to their maximum capacity, as well as the extent to which their flows can be redirected. Indeed, spare capacity on interconnection points is a necessary accompaniment to an analysis of the degree of entry point diversification. Moreover, spare capacity is only beneficial during an emergency if associated supply contracts permit their use. An instructive example is the case of Poland during the 2009 gas crisis, which had spare capacity on the Wysokoje entry point that could

not be utilized due to contractual constraints with Central Asian gas suppliers.⁴⁶

LNG

Liquefied natural gas (LNG) is often considered one of the primary solutions for attaining a diversified gas supply balance. LNG terminals provide a valuable source of flexibility to meet peak/seasonal demand periods in addition to contributing to security of supply. For example, with the largest LNG market in Europe, Spain's regasification capacity (173 mcm/d) on its own is able to cover the country's estimated peak demand (168 mcm/d).

In most cases, LNG's contribution to emergency response is as an initial capacity-increasing measure in the early stages of a supply interruption, and is hence synonymous

⁴⁶ Poland, National Energy Regulatory Report to the European Commission, 07-2009, [p. 59] at http://www.energy-regulators.eu/portal/page/portal/ver-1/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202009/NR_En/E09_NR_Poland-EN.pdf

with options to maximize imports or increase production. In order for LNG to serve as an effective supply-side buffer during an emergency situation, it is necessary to ensure a high degree of short-term deliverability. This requires, inter alia, sufficient spare import capacity and a diversified supplier portfolio with built-in flexibility enabled by spot/short-term purchases and sufficient arbitrage possibilities (e.g. stakeholder agreement to redirect LNG cargoes). Once these prerequisites are in place, the daily send-out capacity (possibly expressed as % of peak demand) is an important indicator of LNG's effectiveness as an emergency measure.

Production flexibility

Production flexibility is primarily available to gas exporters, e.g. those with enough production to serve a swing function. In other words, the amount of spare production capacity available to major producers can be a useful tool in coping with a gas deficit from other supply sources (e.g. imports or storage). Indigenous gas production swing as an emergency measure is used in the Netherlands, Denmark and UK (and to a more limited degree in Czech Republic, Hungary, Poland, Slovakia, and Romania).⁴⁷

4.3.2 DEMAND-SIDE FLEXIBILITY

The demand-side profile is an important determinant of the degree to which the gas system is able to adequately respond to an emergency situation. It is not within the remit of this report to provide a detailed survey of the various ways in which gas is utilized, but suffice to say there are some types of facilities, e.g. combined cycle gas turbines (CCGT) and some cogeneration plants (CHP) which are more amenable to the use of back-up fuels than facilities where gas is directly used in process applications (such as furnaces, metal smelting, heat

treatment, etc).⁴⁸ Hence, an emergency plan must reflect as well as adapt to such differences in end uses for natural gas. In Estonia, for example, gas supplies are important for district heating (DH) purposes. Therefore, the disconnection order is predominately related to the contingency measures available to the DH sector; for example, lowering water temperature supplied for space heating is one of the primary demand-side measures used in Estonia, in addition to the obligation that heat supply undertakings maintain a reserve fuel.⁴⁹ In other countries where gas may be predominately used to produce industrial chemicals such as fertilizer, there is the option of temporarily suspending local production and opting for imports (the costs of doing so being determined by the prevailing market conditions).

Firm load shedding and disconnection order

Many emergency plans commingle supply and demand side measures, imposing a combination of demand restraint and supply-side options. In the case of the former, there are several measures available, principal among which are fuel-switching capabilities, interruptible contracts and associated TSO disconnection orders, as well as firm load shedding in the electricity sector (whereby grid operators remove or lower pre-selected loads from a power system, either automatically by SCADA relays or manually carried out by personnel).

Some countries have opted for alternative fuel obligations to bolster demand-side response. This is the case in Greece, Ireland, Portugal, the UK and Finland. The latter requires all non-industrial players to hold three months of alternative fuels and as a corollary can lay claim to the largest proportion of interruptible capacity in the EU.⁵⁰ Of course, in some cases fuel switching may not be considered a priority tool to face disruptions if the supply system is designed to be highly flexible (e.g.

⁴⁷ FP7, Security of energy considering its uncertainty, risk and economic implications (SECURE), Deliverable 5.2.1, [p. 60-62] at <http://www.secure-ec.eu/>

⁴⁸ Poyry Consulting, GB Gas Security of Supply and Options for Improvement, Report for DECC, 03-2010, [p. 38] at <http://www.poyry.co.uk/linked/services/pdf/8.pdf>

⁴⁹ Republic of Estonia, National Energy Regulatory Report to the European Commission, 2009, [p. 103]

⁵⁰ IEA 2011, Gas Emergency Policies, p 7; SECURE Deliverable 5.2.1, [p. 34]

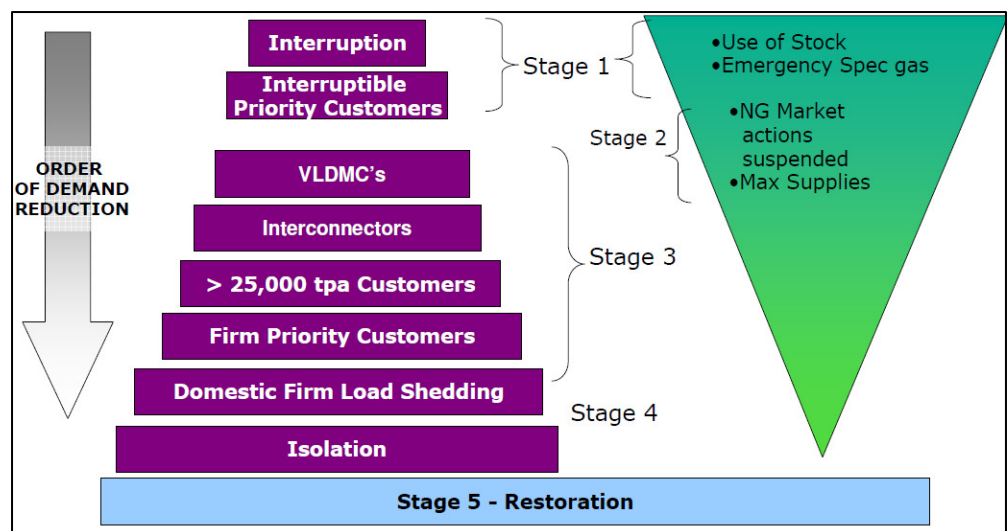
through substantial LNG supplies or a high degree of diversification). In other cases the quantity of fuel stocks are not linked to a predetermined number of days. This is the case in Italy, where switching can only occur following a specific governmental request (given the high costs involved).⁵¹

Once it is clear that available supply is no longer capable of meeting contracted demand, the first line of defence is usually to cease delivery to industrial customers with interruptible contracts (in most cases these apply to facilities with dual-fuel installations). Interruptible contracts may be mandatory, as is the case with Greek electricity producers with units that have fuel-switching capabilities.⁵² In other cases they are voluntary, as in Romania where customers consuming less than 30,000 m³/h can opt for a 24-hour interruption provision.⁵³ In more mature gas markets with advanced market pricing regimes, large gas consumers can enter into commercially advantageous contracts where supplies can be interrupted under certain conditions (e.g. via a price cap). These customers can also receive a discount on their energy prices in return for accepting less secure supplies.⁵⁴

In most cases the order of disconnection begins with interruptible contracts, but thereafter there is variation among member states in the way the procedure is

carried out. In the UK, for example, there are five types of supply points that follow a strict order of disconnection (interruptible; supply points; large firm supply points; firm supply points; priority supply points). Where an emergency calls for reduction at firm supply points, consumers at 'large' firm supply points are required to reduce demand before other categories of consumer.⁵⁵ The disconnection order or 'shut-off plan' for Belgium is more network-oriented (a likely by-product of the bottom-up TSO-led emergency planning framework mentioned above). Interruptible capacity commences first with all exit interconnection points, followed by quality conversion points and then domestic exit points. Nominated exit quantities at interconnection

Figure 10.- UK Supply and Demand-Side Actions during an Emergency



Source: United Kingdom, National Grid, Presentation for JRC visit to Warwick Control Room, 11-04-2011

⁵¹ International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Italy country update, 2010 at http://www.iea.org/papers/security/italy_2010.pdf, [p. 16]

⁵² Greece, Law 3428/2005, Liberalization of Natural Gas Market, [Article 14] at <http://www.desfa.gr>

⁵³ EC SEC (2009) 978, [p. 30]

⁵⁴ UK, DECC, Gas Security of Supply: Policy Statement, April 2010, [p. 21] at http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20markets/gas_markets/1_20100512151109_e_@@_gassecuritysupply.pdf

⁵⁵ UK, National Grid for Gas, Uniform Network Code, TPD Section Q - Emergencies, Version 3.30, 26-04-2010, [p. 15] at <http://www.gasgovernance.co.uk/code>; Firm supply points are considered large when their annual quantity is greater than 732,000 kWh.

points are limited before firm capacity at quality conversion points is constrained. The final step before curtailing end users involves the enforced use of commercial storage.⁵⁶ The Czech Republic's Ministry of Industry and Trade public notice no. 334/2009 categorises customers into seven groups by the nature and volume of demand (e.g. gas used for heating or public services) and sets out five regulating degrees for curtailing gas supply and five regulating degrees for interrupting gas supply.⁵⁷ The last consumer group consists of small business and households and would be supplied in all but the most severe of disruptions.

There are also differences between member states in terms of the ratio of interruptible contracts to total demand. Poland's state-owned gas monopoly, PGNiG, has six major gas consumers with interruptible contracts, which can be notified 8 hours in advance of a suspension to their supplies. Together, these consumers constitute around 10% of industrial gas demand, thus serving as an equivalent buffer against short-term supply shocks. Denmark has an even greater proportion of interruptible capacity; Energinet.dk has arrangements with around 40 major gas consumers which can have their supplies partially or in some cases fully suspended. According to the IEA, these arrangements amount to around 20% of total Danish winter gas consumption.⁵⁸ In other cases regulatory reforms may reduce the proportion of interruptible contracts. The UK in 2010 had around 1,000 end users with interruptible contracts but, due to the adoption of a more restrictive auction-based system for distribution network operators, has significantly reduced this number.⁵⁹

⁵⁶ Belgium, JRC-IET Questionnaire to Competent Authorities, July 2011

⁵⁷ Czech Republic, National Energy Regulatory Report to the European Commission, 07-2010, [p. 52]

⁵⁸ International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Denmark country update, 2011 at

http://www.iea.org/papers/security/denmark_2011.pdf

⁵⁹ UK, Ofgem, Interruptible to Firm – Supply Point Transition, Final Modification Report, 0374, 18-08-2011 at

Interruptible contracts are closely related to load shedding strategies in the electricity sector. Indeed, natural gas is increasingly used as a primary fuel for electricity generation. In this context it is important to recognize that lack of gas supply may contribute to a lack of generating capacity in the electricity grid. Measures in place to handle such shortfalls, such as load shedding for firm and interruptible customers, voltage reduction, energy purchasing, and eventual rolling blackouts should ideally be integrated into a gas emergency plan. The UK has done so by creating a Gas & Electricity Industry Emergency Committee (GEIEC) which is made up of a number of industry and regulatory bodies from both sectors. Similarly, Ireland has integrated interruptible contracts and load shedding in its gas emergency plan. Accordingly, the country's strategy rests on three customer categories – large daily metered (LDM, annually consuming over 57GWh), daily metered (DM, 5.55 – 57GWh) and non-daily metered (NDM, < 5.55GWh). In order to ensure more flexibility in matching the load shedding to the amount of gas required to rebalance the network, the LDM category is further subdivided into three consumption categories (> 1.500GWh; 260 – 1.500GWh; or 57 – 260GWh). After all three of these loads have been reduced to zero, the NGEM progresses to any daily metered offtake, followed by two categories of non-daily metered end users (non-household / household).⁶⁰

Disconnection orders are determined according to various criteria set out in relevant legal acts and emergency plans. The order of curtailment and suspension is primarily driven by the requirement to shed load at the fastest possible rate and, in practical terms, this means that the largest loads are shed first. Of course, to supplement this largest-to-smallest approach, criteria are in place to set an order that minimizes the socio-economic impact of a disruption. For example, E-Control's Energy Emergency Order takes into account the degree of urgency, substitution possibilities,

http://www.gasgovernance.co.uk/sites/default/files/Final%20Modification%20Report%200374%20v2_1.pdf

⁶⁰ Ireland, Gaslink Emergency Plan, 2009, [p. 16]

macroeconomic impacts and effects on the district heating supply.⁶¹ In the case of load shedding strategy, the Spanish TSO Enagas, in consultation with the electricity sector, allocates interruptible contracts according to the peak demand coverage ratio.⁶²

Whatever criteria are adopted, it is considered good practice to involve stakeholders. For example, French industrial authorities, in cooperation with gas system operators, circulated a questionnaire in 2009 for all industrial customers connected to the natural gas transmission system.⁶³ Based on the results of the survey, 4 load-shedding criteria were defined to establish the order of priority for a reduction/suspension of natural gas to these customers. The criteria was based on a series of questions, including whether the industrial user performed a public interest role, whether suspending gas would cause public health or environmental risks, and finally whether a loss of supply would cause an immediate risk of damage to the customer's production facility. In addition to involving stakeholders, transparency is also an important part of a disconnection strategy. For example, Hungary's TSO, FGSZ, has published a detailed order of restriction for large end users, including quantities of gas consumed and the amount restricted for each crisis phase. This provides a transparent and useful reference document for Hungary's demand-side response capabilities.⁶⁴

The order in which demand and supply-side measures are implemented has a crucial bearing on the overall

efficiency of the emergency plan. In most cases spare supplies (in the form of stocks or storage withdrawal) are released simultaneously with demand-side measures such as curtailing interruptible capacities. This is prescribed by the UK's order of emergency actions. However, there are exceptions; Spain's stocks are released only after firm load shedding has commenced.⁶⁵

One of the last resorts available during an emergency is government-mandated rationing. Rationing may be instituted if the supply disruption event is deemed to constitute a significant and widespread danger to life or property resulting from the reduced availability of natural gas. This option requires careful preparation by governments in consultation with users and industry to identify costs, capacities and legal/technical issues associated with imposed rationing protocols.⁶⁶

⁶¹ Austria, E-Control, *Emergency measures and Austrian emergency plan*, presentation to Gas Coordination Group, 03-20-2009, [p. 12]

⁶² International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Spain country update, 2011 at http://www.iea.org/papers/security/spain_2011.pdf p. 20; this indicator is similar to the reserve margin, which calculates the difference between net system capability and system maximum load requirements

⁶³ France, GRT Gaz, Questionnaire d'identification des risques et enjeux liés au délestage, 12-05-2009, at http://www.grtgaz.com/fileadmin/user_upload/Raccordement/Documents/FR/delestage-questionnaire.pdf

⁶⁴ Hungary, FGSZ, Approved classifications for restriction of gas, 2008-2011, at <http://fgsz.hu/dokumentum/korlatozasi-besorolas-gazevek-szerint>

⁶⁵ Spain, Ministerial Order, ITC/3126/2005

⁶⁶ International Energy Agency, Gas Market Review; Security in a globalizing market to 2015, 2007 [p. 79], at <http://www.iea.org/textbase/nppdf/free/2007/Gasmarket2007.pdf>

Best practices:

- Whatever measures are in place to deal with natural gas supply shortages, emergency plans are most effective when they are based on the results of a comprehensive risk assessment. Indeed, such plans should be cognizant of the results of various disruption scenario analyses carried out to identify bottlenecks and potential cascading effects of supply shortages.
- Emergency plans must clearly set out roles/responsibilities, define crisis levels, and match these with corresponding emergency measures. They also need to account for as much uncertainty and contingencies as possible (given within the bounds of the risk assessment results). Moreover, only by referring to the consequence analysis of the risk assessment and associated preventive action plan¹ is it possible to determine the degree of resilience afforded by various measures to maintain security of supply (whether they are demand- or supply-side measures). Thus, an integration of the risk assessment, preventive action and emergency plans can yield a powerful response to both short-term supply shocks and longer-term stresses on the energy system.
- Emergency plans are most effective when they have a clear demand side response. Not all MS clarify the order of disconnection, and some do not set out a gas curtailment or interruption plan that leads all the way to system isolation (in most cases, the categories stop at households/protected customers). Member states are encouraged to formulate an emergency plan that takes into account the procedures down to the last level.
- Governments, in cooperation with industry and consumers, should clarify the respective contribution of market and non-market measures. In case of the latter, the circumstances surrounding their activation and implementation should be clearly set out in an emergency plan.
- Measures not explicitly mentioned in an emergency plan need not be beyond reach. A certain level of adaptive thinking is encouraged, as long as the effects of various non-specified measures are clearly understood. For example, during the January 2009 gas crisis Bulgaria reactivated decommissioned coal-fired plants.¹ Similarly, during the 2006 Russia-Ukraine gas crisis, Italy temporarily relaxed environmental standards to allow the burning of fuel oil.
- A laudable characteristic worth highlighting is solidarity in the absence of institutional bonds or contractual commitments. This was the case when Hungary decided to deliver 2 million cubic metres of gas from its strategic storage reserve to Serbia, which was one of the most severely affected countries during the 2009 gas crisis.

4.4 MONITORING, REPORTING AND PERIODIC REVIEW

One of the most important aspects of a sound emergency procedure is the ability to monitor the supply situation from the top down in order to make appropriate decisions about allocations. Regulation 994/2010 states that, during an emergency, natural gas undertakings must inform competent authorities of daily flows for entry/exit points as well as for production, storage and LNG, in addition to three-day gas demand/supply forecasts that include the projected capability to supply protected customers (Article 13). There are several examples whereby national TSOs

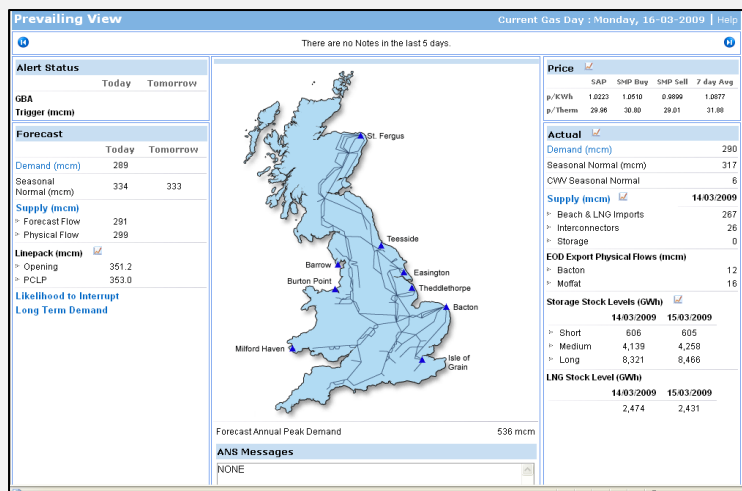
undertake continuous systematic monitoring of supply data, analysed to a high level of granularity. Austria's E-Control closely monitors hourly/weekly injections and withdrawals from the grid during emergencies, in addition to scrutinising annual technical data for large customers, system operators and producers. On the basis of this information, Austria can make four week forecasts of additional (contractual) supply capacities.⁶⁷

Response times are also an important consideration in effectively monitoring emergency operations, particularly when crises are sudden, high impact events. One crucial

⁶⁷ Austria, E-Control, *Emergency measures and Austrian emergency plan*, presentation to Gas Coordination Group, 03-20-2009

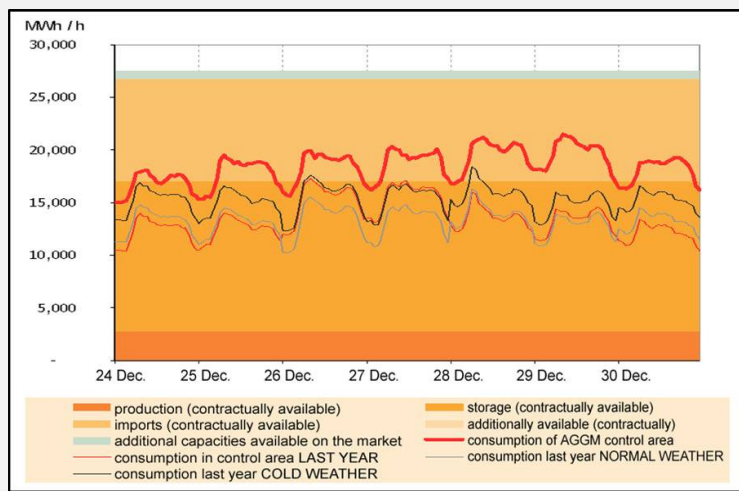
Figures 11 and 12.- Examples of Monitoring

UK – National Grid



United Kingdom, National Grid - Industry response & safety management, presentation by Jenny Phillips to Gas Coordination Group, 20-03-2009

Austria – E-Control



Austria, E-Control, *Emergency measures and Austrian emergency plan*, presentation to Gas Coordination Group, 20.03.2009

factor in this context is the time it takes for gas or back-up fuels to come on-stream. For example, the physical characteristics of natural gas storage sites have a bearing on their ability to act as a buffer during short-term supply shocks. Of the three main types of underground storage sites – depleted fields, aquifers and salt cavities, the first two are larger but have quite slow withdrawal rates relative to salt cavities, which are smaller and hence require less cushion gas and benefit from faster withdrawal. The same applies to LNG peak shaving facilities, which are not usually endowed with high capacity but can be mobilized relatively quickly.

In accordance with stipulations from Regulation 994/2010 that emergency plans set out the technical constraints affecting the operation of the network (including the technical and safety reasons which may lead to reduction of flows in emergency situations), it is useful to report the capabilities of the system in a clear and transparent manner (Article 4.4). After all, security of supply standards can only be fulfilled when the requisite volumes of gas are capable of traversing the supply system. In this context, the minimum pressures at critical gas transmission system delivery points must be determined in order to ensure that flows of gas into

distribution networks and interconnecting pipelines are adequate to meet demand and maintain minimum pressures in distribution networks.⁶⁸ This constitutes another important dimension of monitoring emergency situations.

In addition to real-time monitoring during a crisis, it is also considered good practice to conduct regular reviews during normal operational periods. In particular it is advisable to set up periodic checks of supply levels – such as those carried out by the Hungarian Hydrocarbon Stockpiling Association, Spain’s CORES or by a handful of national energy regulators. This is a preventive measure to avoid cases where emergency preparedness is compromised because large customers fail to fulfil their public service obligations, for example to store back-up fuels.⁶⁹ There are also instances where operators must

⁶⁸ Australia, AEMO Gas Load Curtailment and Gas Rationing and Recovery Guidelines, V. 8, 13.05.2010 at http://www.aemo.com.au/emergency_public/0990-0005.pdf

⁶⁹ As the case of Bulgaria demonstrated during the 2009 gas crisis, see Aleksander Kovacevic, *The impact of the Russia-Ukraine Gas Crisis in South Eastern Europe*, Oxford Institute for

identify potential bottlenecks that may impede countermeasures in the case of a supply disruption and report these to government bodies. For example, the German *Energiewirtschaftsgesetz* obliges operators of gas interconnections to annually identify bottlenecks and system weaknesses and to report them to regulatory authorities.⁷⁰ In Czech Republic, under the Energy Act, all gas businesses, with the exception of gas traders, are also obliged to put in place emergency plans for the facilities and installations operated by them, follow these plans, and furnish them to the Ministry of Industry and

Best practices:

- It is advisable that operational actors monitor the situation during a supply crisis using a handful of indicators (often these are the best tools for reacting to crises in real-time) such as storage monitor curves, peak capacity margin, etc.
- Regular reviews of emergency measures should be undertaken, not least due to the perennial changes – both physical and regulatory – underway in European natural gas sectors and markets.
- TSOs and other operational actors that serve as essential information disseminators should have in place an easy-access IT system that allows numerous stakeholders to respond and adjust their behaviour to the unfolding crisis.
- As gas markets in Europe become more integrated, it is advisable to build and consolidate regional platforms capable of monitoring the supply situation and available capacities in multiple countries. Tools that could be strengthened in this regard include Gas Storage Europe's (GSE) Aggregated Gas Storage Inventory and ENTSO-G's Transparency Platform.

Energy Studies, Working Paper, 01.03.2009 [p. 12] at <http://www.oxfordenergy.org/2009/03/the-impact-of-the-russia-ukraine-gas-crisis-in-south-eastern-europe/>

⁷⁰ Germany, *Energiewirtschaftsgesetz*, § 16(5), 13.07.2005 at <http://www.bmwi.de/BMWi/Navigation/Service/gesetze,did=22154.html>

Trade for review every year.⁷¹ In addition to this annual review, an early warning system is in place whereby both operators and traders are required to report any indications of potential disruptions to their respective supplies.⁷²

4.5 THE IMPORTANCE OF REGIONAL COOPERATION

In most cases, emergency plans treat external supply disruptions as exogenous and focus primarily on domestic response capabilities. While the latter form the key to an effective emergency plan, engaging with partners beyond borders to better manage cross-border interdependencies and associated risks is thus far a largely untapped source of resilience during a supply emergency. Indeed, as an EC assessment of the January 2009 Russia-Ukraine gas crisis concludes,

“Emergency planning was greatly hampered by a lack of consistency, coherence and comparability between the various definitions and measures which exist in the different Member States. Where measures were in place, their effectiveness was curbed by the narrow and localised approach to tackling supply difficulties, a lack of options to diversify supplies, and by a lack of access to up-to-date and complete information on supply, storage and demand. The EU needs to have common criteria on which Member States can base their emergency planning, and these need to be developed not just at the national level, but also at a regional and EU level with a view to the EU internal market dimension. Reactions based on national markets risk hampering the ability of gas traders to keep gas flowing efficiently in the internal market and thus exacerbate the situation for the EU as a whole.”⁷³

⁷¹ Czech Republic, National Energy Regulatory Report to the European Commission, 07-2010, [p. 52] at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202010/NR_En/E10_NR_CzechRep-EN.pdf

⁷² International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Czech Republic, 2010 [p. 17] at http://www.iea.org/papers/security/czech_2010.pdf

⁷³ European Commission, SEC (2009) 977 Assessment Report of Directive 2004/67/EC on Security of Gas Supply; The January 2009 Gas Disruption to the EU – an Assessment, 16.7.2009, [p. 51] at

Only a few national emergency plans cite an increase in import as an effective solution for coping with a gas supply deficit. Moreover, there is far less emphasis on building resilient networks capable of balancing *regional*, rather than national, gas markets. As a corollary, bi-directional capacity on cross-border entry/exit points are rarely mentioned in conjunction with other emergency response measures such as strategic stocks or interruptible contracts, even though they have been used during crises – e.g. flow lines from Belgium-UK, Bulgaria-Greece and Slovakia-Czech Republic were among those reversed in January 2009.

Thus, coordination amongst TSOs at a regional level could be strengthened and better developed in national emergency plans. The scope for cooperation can manifest itself in commercial terms through swap and short term contracts, OBAs, standby agreements in cases of emergency, and so on. Cooperation between market players can also be encouraged at the political level, a good example of which is Irish-UK cooperation. Given the former's high degree of dependence on UK gas imports, both countries have initiated a Joint Gas Emergency Planning working group and have conducted joint emergency exercises.⁷⁴ On the level of information sharing, Bord Gais Networks has clarified with the Network Emergency Coordinator (NEC) in Great Britain the arrangements that will apply in the event of a gas supply emergency in the latter. Aside from bilateral arrangements, steps are being taken to strengthen regional forums; one example of which is the Declaration by the Visegrad Group's energy ministers, which mentions the need to coordinate emergency planning in accordance with Regulation 994/2010.⁷⁵ Such cooperation could help streamline the conditions under

http://ec.europa.eu/energy/strategies/2009/doc/sec_2009_09_77.pdf

⁷⁴ Gaslink, Network Development Statement, 07.2011, [p. 49] at

http://www.gaslink.ie/files/Copy%20of%20library/20110726011801_Gaslink_NDS.pdf

⁷⁵ See <http://www.visegradgroup.eu/2011/declaration-of-v4-energy>

which cross-border interconnections are utilised (or possibly reversed), which would significantly improve flexibility during a supply crisis; this is apparent from the experience of the January 2009 gas crisis, where many reverse flows took more than 10 days to arrive.⁷⁶

Despite these examples of cross-border cooperation, there are also instances where existing rules contained within national emergency plans potentially conflict with provisions in Regulation 994/2010 to maintain transnational access to infrastructure.⁷⁷ For example, Slovak law obliges storage system operators to stop deliveries to companies supplying foreign customers during emergency situations.⁷⁸ Similarly, the shut off plan in Belgium first suspends gas flows to interruptible exit interconnectors before doing so on domestic entry points (regardless of the quantities contracted by either point).⁷⁹ Moreover, several disconnection protocols mandate a suspension of supplies secured via third party access regimes before equivalent domestic supplies are curtailed. This is the case in the UK and Spain.⁸⁰ Of course, there may be justifiable reasons to withhold gas to a given exit point; in case of an emergency situation in Poland, the TSO has the discretionary right to 'not accept gaseous fuel for transmission or not deliver gaseous fuel to an exit point if this could result in a threat to security of the transmission system operations, human health or lives or the environment, or could cause damage to property.'⁸¹

⁷⁶ European Regulator Group for Electricity and Gas (EREG), GRI South South-East Region; achievements and bottlenecks, presentation by Michael Schmoltzer at 4th Gas Forum, Ljubljana Slovenia, 10-09-2009 at <http://www.energy-community.org/pls/portal/docs/406206.PDF>

⁷⁷ EC/994/2010, Article 10(7); 11(5)

⁷⁸ ERGEG, GRI-SSE achievements and bottlenecks, 10.9.2009

⁷⁹ Belgium, JRC-IET Questionnaire to Competent Authorities, July 2011

⁸⁰ United Kingdom, National Grid, Presentation for JRC visit to Warwick Control Room, 11-04-2011 [see UK supply/demand-side measures table above]; Spain, JRC-IET Questionnaire to Competent Authorities, July 2011

⁸¹ Poland, Gaz System, System Balancing Procedures, 2011, point 6.15

4.6 EMERGENCY PLANS IN LIBERALISING MARKETS⁸²

As a corollary to recognising the necessity for enhanced regional cooperation, gas emergency plans should also adjust to the demands of a liberalizing gas market. Indeed, in several of the more mature gas markets, security of supply is a responsibility increasingly shared between a large number of market players – suppliers, operators and consumers alike. The latter may opt for back-up solutions to cope with interruptions or make contractual provisions for ensuring a given level of security from the supplier. In the transportation sector in particular, security of supply may be delivered via incentives for market participants to balance their inputs to and off-takes from the gas pipeline system.⁸³ In this context, capacity allocation and third party access have considerable importance for emergency response. Where most of the capacity on gas transmission pipelines is booked on a long-term basis by incumbents (whether it is used or not), the system flexibility during a crisis will be limited. By contrast, TSOs providing short-term ‘on-demand’ services under the ‘use it or lose it’ principle may be better equipped to source requisite capacities in case of shortfalls on the secondary market.

In a centrally cleared within-day trading market, the responsibility for balancing the system then becomes shared between TSOs and shippers, which interact to ensure physical and commercial balancing obligations are met. Imbalances, which occur when network users’ injections into the balancing zone differ from their off-takes, can potentially be addressed through cross-border

balancing zones – either between TSOs or led by shippers.⁸⁴ This can enable TSOs to act as intermediaries to facilitate access to flexible gas in neighbouring markets, an arrangement that can be built into an emergency plan. For example, Belgium’s Fluxys has an operational balancing agreement (OBA) with adjacent TSOs, enabling collaboration in order to meet residual balancing needs as well as the possibility of coordinated dispatching.⁸⁵

Thus, in many ways the development of regional emergency plans hinge on functional and integrated gas markets. As the third energy package progresses there are increasingly visible signs of market players engaging in regional cooperation, e.g. the creation of hub-to-hub trading, regional balancing zones, and so on. These actions create the corresponding need to develop tools to collectively manage not only system balancing needs but also short-term supply shocks, as well as to better monitor cross-border entry/exit flows. For instance, operational balancing agreements between TSOs can ensure collective balancing through coordinated dispatching (in addition to the recent OBA between Slovakia and Czech Republic⁸⁶, observe the example of Belgium above); this can also serve as a powerful tool to coordinate reverse flows.

Cross-border collaboration can manifest itself in two ways – either directly between stakeholders (at the policy level through the integration of governmental crisis management teams or via commercial agreements between system operators) or through the use of institutions at a European level, for example via ACER’s Gas Regional Initiatives, the Gas Coordination Group or ENTSO-G. Indeed, national monitoring results could be fed into an EU-wide early warning/crisis management system managed by one of these bodies.

⁸² More information can be found in International Energy Agency, Security of Gas Supply in Open Markets, 2004 at <http://www.iea.org/w/bookshop/b.aspx?new=10>

⁸³ UK, Ofgem, Gas Security of Supply Significant Code Review, Initial Consultation, 11-01-2011, [p. 1] at <http://www.ofgem.gov.uk/Markets/WhlMkts/CompandEff/GasSCR/Documents1/Initial%20Consultation%20-%20Gas%20Security%20of%20Supply%20Significant%20Code%20Review.pdf>

⁸⁴ See ACER, Framework Guidelines on Gas Balancing in Transmission Systems, 18 October 2011, [p. 16-7] at http://www.acer.europa.eu/portal/page/portal/ACER_HOME/Communication/News/FG%20Gas%20Balancing_final_public.pdf

⁸⁵ Belgium, JRC-IET Questionnaire to Competent Authorities, July 2011

⁸⁶ Slovakia, EUStream, Press Release, 21.12.2010 at http://www.eustream.sk/en_media/en_news

4.6.1 PRICES AND COMPENSATION

In addition to adapting to changing market conditions, there is also an obligation to clarify the mechanisms for compensation to natural gas undertakings that make gas available during a supply disruption.⁸⁷ This provision is predominately related to the regime in place by which gas is priced during an emergency. The various methods used can be categorized according to whether

- Prices are “administered” (i.e. they are centrally determined) ex ante (in advance) with the prices either being a single price, or a price cap
- Prices are determined on an indemnity basis ex post, or
- Prices are determined through some market mechanism.⁸⁸

In the first category, the simplest option would be a single posted price that applies regardless of the loads curtailed. A more complex variation would be to install multi-tier posted prices linked to the order of curtailment and suspension, with the posted price depending on an assessment of the value of gas associated with the marginal category of load curtailed during each balancing period.⁸⁹ In either case, price caps would provide a means for participants to manage risk under extreme situations and limit windfall gains and losses. In the case of prices being determined ex post, or after the crisis, the price/compensation amounts would be based on the insurance principle of indemnification, and likely determined either by the system operator, an appointed expert or by an arbitrator.

⁸⁷ 994/2010 (36) and Article 10(l)

⁸⁸ Farrier Swier Consulting, *Emergency Management and Gas Outages; Economic Issues*, Report prepared for the Gas Industry Company Ltd (NZ), 07.03.2006 [p. 31] at http://gasindustry.co.nz/sites/default/files/consultations/180/report_prepared_for_gic_by_farrier_swier_consulting_in_association_with_johnson_winter_and_slattery_-_emergency_management_and_gas_outages_-_economic_issues.pdf

⁸⁹ Ibid, p. 33

Options also exist for market pricing mechanisms to be used during an emergency situation. Demand side bidding, for example, involves shippers establishing a price at which each gas user is prepared to have a defined volume of their nominated gas load curtailed. The emergency balancing price would be determined based on the marginal load curtailed and would be recovered from shippers in negative imbalance.⁹⁰ Another option, assuming a liberalised gas market with third party access and trading, would be to implement wholesale market arrangements whereby gas supply injections and withdrawals by controllable loads are managed in response to market clearing prices.⁹¹ Indeed, a centralised trading arrangement carrying up-to-date information on bids and offers responding to market clearing processes and price signals should be able to balance the network in the short term.

However, it should be noted that the fundamental method behind market-based strategies to resolve supply deficits is essentially by incentivising large consumers to make their reserve fuels and interruptible loads available on the (spot) market; if large consumers are willing to pay the price, they can avoid having their demand curtailed.⁹² If the purpose of emergency arrangements is to conserve gas for protected customers, this can be considered counterproductive. But, if emergency arrangements are meant to allocate available gas most efficiently (regardless of who actually ends up consuming the gas), then market arrangements are useful. This is a socio-economic dilemma whereby the incentive to supply gas to the highest bidder must be balanced against the need to serve protected customers (which can essentially be considered ‘free-riders’ as they have no incentive or obligation to conserve gas).

In the UK, frozen cash-out during an emergency and lack of compensation for firm customers are considered important gaps in emergency arrangements. The former may lead to instances where the cash-out price is below

⁹⁰ Ibid, p. 35

⁹¹ Ibid, p. 62

⁹² Ibid, p. 79

the price that customers without interruptible contracts would be willing to pay, which may lead to a disconnection despite the end user attributing a higher value to security of supply. Options to address these issues are compensation at the value of lost load (VoLL) for disconnected firm customers and more dynamic price signals in the event of an emergency, in order to better reflect the value that different customers assign to security of supply whilst ensuring that the GB market is able to attract gas imports during an emergency.⁹³

On the other side of compensation issues are penalty charges during emergencies. The Austrian TSO E-Control can impose penalties on end users consuming natural gas above the restriction measures; these charges are then used to implement future security of supply measures.⁹⁴ Similarly, during an emergency the Italian operator can impose fines for non-compliance with the full use of booked import capacity.⁹⁵ More generally, companies with firm capacities usually pay more for gas deliveries than interruptible customers; the proceeds from these charges are usually fed into improving system balancing or, in the case of Greece, security of supply levies are used by the TSO to fulfill its obligation to compensate interrupted supplies to customers with more flexible arrangements.

The pricing options and associated issues reviewed here assume a liberalised gas market which is not necessarily the case in several member states. In fact, as a Commission impact assessment of the January 2009 gas crisis observes, “direct and indirect subsidies or price distortions, either at the public level or through commercial policies, were identified as reducing the capacity for markets to deal with supply emergencies by

⁹³ UK, OFGEM, Gas Security of Supply SCR Initial Consultation, 11.01.2011

⁹⁴ Germany, *Energielenkungsgesetz*, 1982 / 2006, § 20f. “Für das entgegen Beschränkungsmaßnahmen für den Erdgasverbrauch mehrverbraachte Erdgas sind Mehrverbrauchsgebühren zum Erdgaspreis einzuheben”

⁹⁵ International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Italy, 2010 [p. 17] at http://www.iea.org/papers/security/italy_2010.pdf

removing incentives for investment in new infrastructure and for greater efficiency in energy use.”⁹⁶

4.1.7 CARRYING OUT EXERCISES

The IEA has noted the importance of organizing regular emergency exercises. In the UK, the Energy Emergencies Executive is responsible for establishing an exercise programme to be carried out by the Network Emergency Coordinator in order to test the effectiveness of the NEP and the Joint Response Team.⁹⁷ To this end, the NEC undertook a full-scale simulation of a Network Gas Supply Emergency (NGSE). The exercise occurred over two days during normal working hours and involved competent authorities carrying out duties related to the five stages of an NGSE (potential; declaration; firm load shedding; allocation & isolation; restoration). Following the exercise, a report was produced for the Health and Safety Executive (HSE) detailing the effectiveness of the emergency arrangements and highlighting key findings.⁹⁸ A similar initiative was undertaken by DECC to test the capability and robustness of the department’s response to a major gas disruption and its associated consequences for other government departments, industry and other stakeholders. This exercise, known as AVOGADRO, was performed in June 2010 in cooperation with Ireland.⁹⁹ In the wake of the January 2009 Russia-

⁹⁶ European Commission, SEC (2009) 977 Assessment Report of Directive 2004/67/EC on Security of Gas Supply; The January 2009 Gas Disruption to the EU – an Assessment, 16.7.2009, [p. 51] at http://ec.europa.eu/energy/strategies/2009/doc/sec_2009_09_77.pdf

⁹⁷ UK, DECC, National Emergency Plan for Gas and Electricity, Version 13, 04-2010, [p. 9] at http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/resilience/gas_electric/1_20100430123757_e_@@_nationalemergencyplangaselec.pdf

⁹⁸ UK, National Grid, NEC Network Emergency Exercise Prelude, presentation by Paul Youngman at www.nationalgrid.com/NR/rdonlyres/DE5958D2-4D16-4BB7-8A24-3BC0F64BFC35/28814/ExercisePrelude.pdf and <http://www.hse.gov.uk/gas/supply/prelude-report.pdf>

⁹⁹ DECC, Implementation of Security of Gas Supply Regulation; Regional Cooperation, presentation to JRC by Gill Campbell, 11.04.2011

Ukraine gas crisis, several other countries conducted emergency preparedness exercises. Austria's E-Control did so on 1 December 2009, simulating reductions in gas use by large consumers (two industrial companies and three power station operators) in a crisis scenario.¹⁰⁰ Referring again to the case of New Zealand, the need to perform exercises has been integrated into the country's crisis management legislation.¹⁰¹ The first step in the relevant clause is to determine whether emergency contact details are current, an important practical consideration.

A report by Euracom on contingency planning notes the importance of carrying out desktop simulations in addition to real exercises. The project recommends preparing contingency exercises by designing what is known as a call tree (a list of contact details for personnel needed to execute and operate an emergency plan), a walkthrough (a peer review where each stage of an emergency plan is evaluated) and a 'table top exercise' wherein a contingency scenario is introduced to a crisis management team in order to test their response capabilities.¹⁰²

¹⁰⁰ Austria, E-Control, Annual Report 2009, [p. 43]

¹⁰¹ New Zealand, Gas Governance (Critical Contingency Management) Regulations 2008, SR 2008/426, 4.11.2008, [Paragraph 34] at <http://www.legislation.govt.nz/regulation/public/2008/0426/latest/DLM1683495.html>

¹⁰² European Risk Assessment and Contingency Planning Methodologies for interconnected Networks (EURACOM), Deliverable 2.3, 7th Framework Programme, European Commission, 2010, [p. 93] at <http://www.eos-eu.com>

5. CONCLUSIONS

This report has been divided in three main parts, which correspond with sections 2, 3 and 4 respectively. The first part has been dedicated to put the Preventive Action Plan and the Emergency Plan in the context of a Risk Management process. In this context, both plans are included in the Risk Treatment phase, which comes after the end of the Risk Assessment phase. The Preventive Action Plan incorporates mainly protective and preventive measures designed to reduce both components of the risk concept (likelihood and consequences), while the Emergency Plan focuses on response and recovery actions.

The second part deals with the Preventive Action Plan. A procedure has been proposed to perform Preventive Action Plans in line with the Regulation and based on the results of the Risk Assessments. This procedure may be divided in three key steps: 1) the identification of key scenarios and establishment of priorities to reduce risk, 2) the risk reduction loop, and 3) the edition of either the national or the joint Preventive Action Plan.

The first step helps providing information about which risks should be addressed first in order to be more effective in the reduction of risk and the fulfilment of standards. The second step deals with the types of strategies that may be adopted to reduce the risk and fulfil the standards, the necessary assessment of how effective (in terms of reducing risk) and how cost-effective each strategy is, and when the risk reduction process may be stopped. The last step deals with the type of information that should be included in the Preventive Action Plans and the need or not of regional plans.

The third part is dedicated to the Emergency plan and is a result of an extensive literature review. The impact of a disruption to gas supplies varies considerably amongst EU member states. This is not only due to differences in supply/demand balances and associated infrastructural constraints but also the regulatory framework governing the management of emergency situations. The tools

available to market players also vary depending on the extent to which the national gas market is sufficiently competitive and liquid. Where the market is concentrated and dominated by single vertically-integrated players, the extent of government intervention to meet security of supply standards is usually more substantial.¹⁰³

Any potential measures designed to reduce the negative impact of a gas supply interruption should be justified on the basis of the risk assessment results and concomitant preventive action plan. It is this integrated approach to emergency and risk management that can ensure a resilient gas network that is housed in a reliable and secure energy system.

Having reviewed the state of play in several EU member states as well as the EC Regulation 994/2010 requirements for emergency plans, this report concludes that the key requirements for a gas emergency plan are:

- Clarity on the obligations of all players for each defined crisis level
- Clear communication in emergency situations, including all relevant reporting, monitoring and notification procedures;
- Measures which are proportionate to the crisis level, sensitive to the gas demand profile, aware of the regional context, inconsequential to normal market operation, transparent and non-discriminatory during implementation and verifiable during emergencies as well as under normal conditions.
- Clearly understood and impartial order of disconnection and the associated classification of gas users (e.g. interruptible/ non-interruptible/ protected)
- Clear regulatory, legal and operational provisions applicable during each defined crisis level, including compensation arrangements as well as penalties on players which fail to fulfil their operational or security of supply obligations.

¹⁰³ See IEA, Security of gas supply in open markets, 2004, [pp. 293-296]

- Coordinated planning with third countries (e.g. suppliers, transit/neighbouring countries, non-domestic players).

Although the regulation imposes no obligation regarding the development of full scale or desktop emergency exercises, these are good practices that may help testing the Emergency Plan global performance.

As a final remark, we would like to stress that, albeit the corresponding Competent Authority has the responsibility of developing both plans, the complexity of the issues under study and the relevance of gas security of supply for the EU makes necessary the contribution and deep involvement of all stakeholders.

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7. ANNEXES

Annex 1.- Security of Supply Standards and Public Services Obligations in EU MS

Austria	No specific obligations (e.g. days/volumes) found ¹⁰⁴
Belgium	The TSO, Fluxys, has a mandated public service obligation to be able to supply all uninterruptible customers in the case of severe temperatures that would occur based on the winter of 1962/3 or 5 consecutive days with temperature < -11°C. For this purpose Fluxys maintains reserved strategic storage, which are charged to users through transmission tariffs.
Bulgaria	No specific obligations (e.g. days/volumes) found ¹⁰⁵
Czech Republic	Producers and traders must ensure supply to customers with annual consumption lower than 400,000 cu m in case of a) partial (20%) disruption of the total daily volume for a period of 8 weeks in the winter season; b) five days of an average temperature of -14°C and c) a 1-in-20 winter. ¹⁰⁶
Denmark	TSO is obliged to procure storage capacity to meet demand of non-interruptible customers for 60-days at normal winter temperature, 3 days at -14°C (equivalent to 1 in 50 peak day). Shippers are required to keep a certain percentage of gas storage during winter months to meet demand of non-interruptible customers
Estonia	A heat supply undertaking with an annual estimated production volume over 500,000 MWh per network area is required to hold enough reserve fuel to generate heat supply for a duration of three days. ¹⁰⁷
Finland	All non-industrial players must hold three months of alternative fuels. ¹⁰⁸
France	Shippers supplying domestic & public interest customers are required to withstand a loss of main supply for a 6-month period under normal weather conditions, to ensure supplies for both a 1-in-50 winter and a 3-day 1-in-50 period of extreme winter conditions.
Germany	Suppliers have a legal requirement to take reasonable steps as prudent operators to ensure security of supply for their customers under normal and exceptional conditions, with severe penalties for failure. This obligation is discharged via contracts with TSOs and storage operators/providers.
Greece	New gas-fired power producers are obliged to hold at least five days of back-up reserves of dual fuel (i.e. either diesel at a storage facility on the power plant's premises, or LNG reserves at the Revithoussa LNG Terminal). ¹⁰⁹

¹⁰⁴ Austria, *Gaswirtschaftsgesetz*, 2011, [Section 5]

¹⁰⁵ Bulgaria, Energy Act, SG No. 74/2006, at <http://solicitorbulgaria.com/index.php/bulgarian-energy-act-part-1>

¹⁰⁶ Czech Republic, National Energy Regulatory Report to the European Commission, 07-2010, [p. 52] http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202010/NR_En/E10_NR_CzechRep-EN.pdf

¹⁰⁷ Republic of Estonia, National Energy Regulatory Report to the European Commission, 2009, p. 103, at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202009/NR_En/E09_NR_Estonia-EN.pdf see also Republic of Estonia, District Heating Act, Section 7.3, 11-02-2003, at <http://www.konkurentsiamet.ee/?id=11927>

¹⁰⁸ International Energy Agency, Gas Emergency Policy; where do IEA countries stand?, Information Paper, 05-2011, at http://www.iea.org/papers/2011/gas_emergency_policy.pdf

¹⁰⁹ International Energy Agency, Oil & Gas Supply Security; Emergency Response of IEA Countries, Greece country update, 2010 at http://www.iea.org/papers/security/greece_2010.pdf

Hungary	Natural gas must be strategically stored at a UGS facility that has a daily withdrawal capacity of 20 million m3 for at least 45 days. ¹¹⁰
Ireland	Power generators are separated into two categories - high and low merit. These must hold stocks equivalent to five days (high merit units) or three days (low merit units) continuous operation at 90% of the unit's normal fuel capacity. CHP units with a capacity greater than 10MW are required to hold stocks equivalent to one day of continuous running on the unit's rated capacity on its primary fuel. These stocks must be held on site or in close vicinity connected by a dedicated supply line and pump. ¹¹¹
Italy	Approx 40% of storage is reserved for Strategic Storage, whose release is controlled by the government. This should cover for 60 days a 50% disruption of peak capacity at the main national entry point. Additionally there is a legal obligation on each importer to maintain 10% of its import requirements in storage (minimum quantity specified by Ministry for Industry each year).
Latvia	No specific obligations (e.g. days/volumes) found ¹¹²
Lithuania	Gas reserves accumulated for household consumers must be sufficient to meet demand for a period of 30 days (a schedule is in place for an additional 10 days each year until the level of 60 days is reached.) Non-household consumers using gas for the purpose of production of energy to be sold or consumed for covering public demand shall hold reserves equalling the demand of 1 month. ¹¹³
Luxembourg	No specific obligations (e.g. days/volumes) found ¹¹⁴
Netherlands	Shippers must have contracts in place to meet demand of small customers down to -9°C. The TSO, GTS, is required to protect supplies to small customers during extremely cold winters. It procures storage gas to meet their increased demand when temperatures drop below -9°C (down to -17°C). Shippers pay for the above arrangements through a PSO tariff. ¹¹⁵
Poland	Companies engaging in international gas trade must maintain compulsory gas stocks equivalent to 30 days of the total average daily amount of gas brought in by suppliers of the Polish market. These mandatory stocks of natural gas are required to be stored in installations that enable delivery of the entire stocks to the gas transmission system within 40 days. ¹¹⁶
Portugal	Gas importers are mandated to hold gas reserves equivalent to 15 days' consumption of non-interruptible gas-fired power plants (i.e. electricity producers) and 20 days' consumption of non-interruptible customers (particularly households) in the remaining market.

¹¹⁰ Hungary, National Energy Regulatory Report to the European Commission, at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202010/NR_En/E10_NR_Hungary-EN.pdf, see also Hungary Act XXVI of 2006 on strategic storage of natural gas, at http://www.eh.gov.hu/gcpdocs/201006/law_on_strategic_storage_of_natural_gas.doc

¹¹¹ Ireland, Commission for Energy Regulation, Secondary Fuel Obligations on Licensed Generation Capacity in the Republic of Ireland, Decision Paper, CER 09/001, 12 -01-2009 at <http://www.cer.ie/en/electricity-security-of-supply-current-consultations.aspx?article=7d14283f-b667-4cdc-996b-61f6e56fd94e>

¹¹² Republic of Latvia, Security of Supply Natural Gas Risk Assessment, 2010; see also Findlater and Noel, 2010 [p. 8]

¹¹³ Republic of Lithuania, Ministerial Resolution No. 163, 26 February 2008; see also Lithuania, Natural Gas Risk Assessment, 2010, p. 37-8

¹¹⁴ Luxembourg, Organisation du marche du gaz naturel, N 153, 1-08-2007 at <http://www.legilux.public.lu/leg/a/archives/2007/0153/a153.pdf#page=6>

¹¹⁵ Netherlands, National Energy Regulatory Report to the European Commission, 2009, [p. 36] at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202009/NR_En/E09_NR_Netherlands-EN.pdf

¹¹⁶ Poland, Act on Stocks of Crude Oil, Petroleum Products and Natural Gas, 16-02-2007 [Article 24]; this act was recently amended to allow stocks to be held outside the territory of Poland, at <http://eng.arm.gov.pl/ftp/1/act.doc>

Romania	The minimum gas stock is determined by the Market Operator of the Gas National Dispatcher, for each supplier, so that it covers about 12.5% of the volume of gas to be supplied to captive customers. ¹¹⁷
Slovak Republic	TSOs are obligated to supply gas to final customers in case of a) a 10-week long suspension of 30% of total gas supply, b) gas consumption for five consecutive days of -12 degrees celsius during this scenario, c) a 1-in-20 winter, d) a complete suspension of supplies for 30 consecutive days ¹¹⁸
Slovenia	Gas suppliers are required to have reserve supplies equivalent to 20% of demand from 'special customers' for a period of 14 days during the average monthly temperature in the last 20 years. Additionally, suppliers must reserve 40% of supplies to special customers for a period of 5 days during the average January temperature in the last 20 years. ¹¹⁹
Spain	Shippers cannot source >50% of portfolio from any one country. The TSO must hold 20 days of total non-interruptible sales [10 of which are reserved for strategic purposes, the other 10 available for commercial use]
Sweden	No specific obligations (e.g. days/volumes) found
UK	Operators must ensure supply to domestic customers in a 1-in-20 peak demand day and a 1-in-50 winter period. ¹²⁰
	Sources: Poyry 2010, as footnoted, EC SEC 2009

¹¹⁷ Romania, National Energy Regulatory Report to the European Commission, 31-07-2009, [p. 106] at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202009/NR_En/E09_NR_Romania-EN.pdf

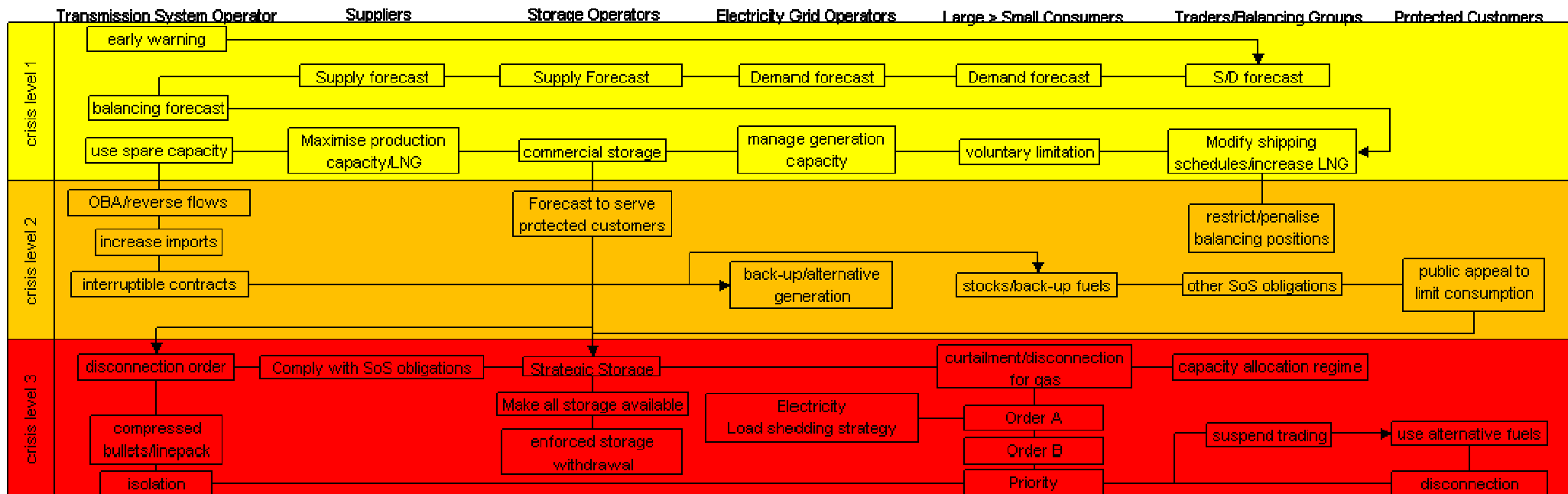
¹¹⁸ Slovakia, Amendment to Energy Act, 15 March 2009 [§ 14, paragraph 13], at http://www.urso.gov.sk/doc/legislativa/z_073-2009_sk.pdf

¹¹⁹ Slovenia, Regulation on the provision of security of natural gas supply, st 8/2007, 29-01-2007, [Article 3] at <http://www.uradni-list.si/1/objava.jsp?urlid=20078&stevilka=319>

¹²⁰ Poyry Consulting, *GB Gas Security Of Supply and Future Market Arrangements*, Report to the Gas Forum, 10-2010, [p. 9] at http://www.illexenergy.com/pages/Documents/Reports/Gas/528_GB_Gas_Security_&Market_Arrangements_v1_0.pdf

Annex 2.- Gas Emergency Operational Framework Template

Emergency measures should ideally follow an order linked to crisis levels and be categorized according to the various actors responsible for their implementation. One possible framework structuring this information is set out below. Not all the measures listed may be available to a given member state and the order provided is merely indicative of what may be considered common emergency planning procedures. For example, the initiation of interruptible contracts by network operators is normally followed by the use of stocks or back-up fuels held by large industrial customers and power generators. The depletion of these stocks, in turn, usually results in strategic storage withdrawal or, if unavailable, the implementation of disconnection plan. It must be stressed, however, that this framework is purely indicative and that actual allocations made using supply-side options such as storage may differ depending on the nature of the crisis and the available capacities to service various demand points.



Annex 3.- Questionnaire sent out to competent authorities



QUESTIONNAIRE TO COMPETENT AUTHORITIES OF MEMBER STATES

The survey below is intended to be filled out by ‘Competent Authorities’ who are responsible for ensuring the implementation of the measures set out in EC Regulation 994/2010 concerning measures to safeguard the security of gas supply. The information will be used to produce a JRC-IE report reviewing current practices in establishing and implementing Emergency and Preventive Action Plans (as set out in Articles 4, 5 and 10 of this Regulation), and to provide practical guidance in this regard.

This work is carried out by the Energy Security Unit of the JRC under the auspices of the European Commission DG-Energy and the Gas Coordination Group. In no circumstances will the information provided be circulated beyond these institutions.

Name and contact details of your organisation:

SECTION 1: Gas Emergency Plans

Please provide, with as much detail as possible, the steps your organisation takes in response to a gas supply disruption – including crisis levels, roles and responsibilities, and concrete measures taken. If an Emergency Plan or equivalent (e.g. Crisis Response Mechanism) is publicly available, please attach a copy to the response email.

Reference documents (e.g. relevant legal acts, regulations):

A) Crisis levels

1. Define the crisis levels / severity scales used in your current Emergency Plan (and, if possible, note their conformity to Article 10.3 of EC/994/2010)

2. Are any standards used to define these levels?

3. Are protected customers defined?

B) Roles and responsibilities

4. Define the roles and responsibilities of your organization in each crisis level:

5. Are there any tasks related to Regulation 994/2010 (e.g. Emergency Plans, Risk Assessments, Preventive Action Plans) that are/will be delegated to other bodies?

6. Is there a designated crisis manager/team?

7. Is there an operational handbook (or equivalent) to handle emergencies?

8. Detail any reporting obligations, cooperative arrangements or information sharing arrangements with other actors in the supply chain (e.g. other TSOs, electricity distributors and district heating systems, industrial customers, traders, suppliers, regulatory authority, etc)

9. Are the measures taken in an emergency subject to compensation? If so, under what conditions does this compensation occur?

C) Emergency measures

10. Briefly describe the measures/steps taken at alert and emergency levels (and then refer to the checklist below for elaboration, if applicable)

11. Are there any cooperative arrangements between your organization and any actor from a third country? If so, please elaborate.

Section II: Gas Preventive Action Plans

12. At present, does your organization perform a risk assessment related to gas infrastructure?

If yes, please provide information about the following:
Methods for identifying vulnerabilities in the gas system

Planned and/or existing mitigation measures to reduce the risk of a gas supply interruption (as well as an assessment of their potential effects)

Regional cooperative arrangements with actors in third countries (TSOs, regulators, state bodies, etc).

Checklist of Emergency Measures

(Tick each box if the following measures are used in the event of an emergency. Where possible, please provide additional details/elaboration, such as the type of data or indicators used and/or the crisis level to which the measure corresponds)

A. Supply side market measures

Production flexibility

Import flexibility (LNG)

Storage

Diversification (supply/routes)

Reverse flows / bi-directional capacity

TSO coordinated dispatching (national/neighbour countries?)

Short/long-term contracts/arrangements

Regional cooperation measures (interconnections)

Other (specify)

B. Demand side market measures

Interruptible contracts / disconnection order

Fuel switching (+backup fuels)

Voluntary firm load shedding

Increased efficiency / use of RES

Customer stocks / drawdown

Pricing mechanism

Other (specify)

Supply side non-market measures

Strategic storage

Enforced use of stocks (Council Directive 2009/119/EC imposes an obligatory stock of crude oil)

Enforced use of electricity generated from sources other than gas

Enforced increase of gas production levels

Enforced storage withdrawal

Other (specify)

D. Demand side non-market measures

Enforced fuel switching

Enforced interruptible contracts (where not fully utilized by the market)

Enforced firm load shedding

Price regulation

Other (specify)

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Abstract

The aims of this document are to provide guidance in the development of a Preventive Action Plan and a collection of best available practices to provide assistance in the design of Emergency Plans, in line with EU Regulation 994/2010 concerning measures to safeguard natural gas supply.

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