Gas Management Systems for Changing Gas Markets

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ABSTRACT

The liberalisation of gas markets with increasing competition and consequences such as unbundling has major implications for the organisation and operation of producers as well as distributors. The challenges from outside are enormous and changes have to be implemented as soon as possible to cope with the continuously changing and more competitive environment. The consequences will have impacts on any part of the supply chain: from production and/or import, via transmission, underground storage, distribution to the end consumer, billing and accounting. Therefore much more separate business activity within the up-, mid- and downstream areas would be necessary to ultimately handle the same total gas volume. The importance of short-term contracts, spot markets and trading will grow. To allow quick responses to changing markets, up-to date and consistent information (demand requests, status of contracts, status of the total system, process data, etc.) has to be provided. All this results in different Information Technology (IT) systems from those which are currently used, and changes in daily work. BEB produces hydrocarbons in Germany and operates as well transmission systems (also third party pipelines) and underground storages, imports roughly 50% of its total supply, and supplies roughly 20% of the German gas demand. In this paper examples are given how and where BEB will use new technologies for gas management.

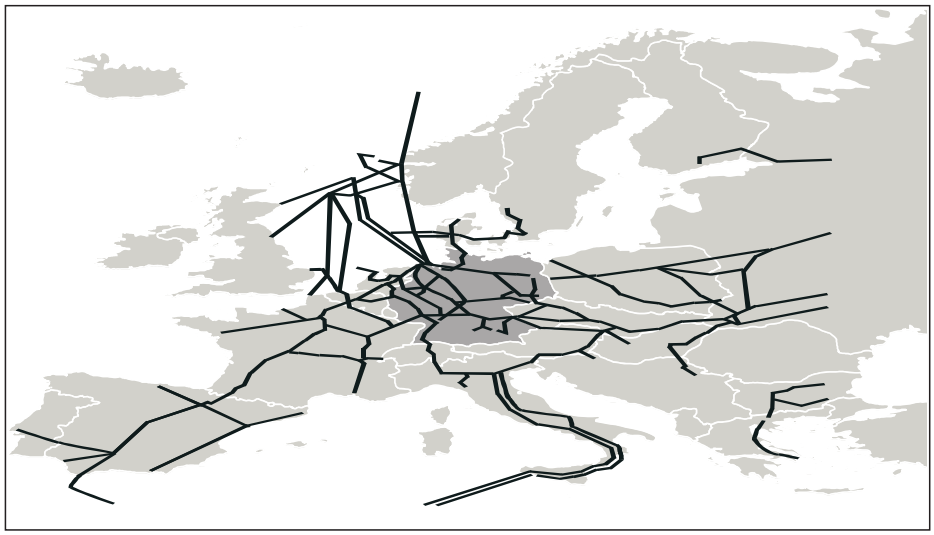

Fig. 1 European high pressure gas transmission network

1 GENERAL ASPECTS OF CHANGING GAS MARKETS

In little more than 30 years natural gas has shown a rapid success story in Europe. From the beginnings of small domestic finds a major import and export industry has developed which will continue to grow. With the high capacity transport pipeline system which has essentially been constructed within this period, most of the Western countries are interconnected either directly or indirectly (Fig.1). One of the key functions of this international pipeline network is the import and distribution of the gas of Russia, Algeria, the Netherlands and Norway.

In the meantime an infrastructure has been developed along these systems with a large number of gas utilities at various distributor levels as far as the end consumer, often covering the entire natural gas supply area. Considerable investments have been made in pipeline networks, storage infrastructure, measuring technology, and, last but not least, for control systems. Within these few years intensive efforts have been made in particular as far as gas redistributors are concerned to initiate and put into practice the necessary technical, operational and organisational changes in good time.

However, it is less the change in gas sales trends than rather increasingly political influences and their consequences in the individual countries which will be the dominating factor in determining the future environment and the resultant requirements for the marketing of this energy source. In addition to effects of the liberalisation the increasing pressure on prices will lead to major change processes within the individual companies.

The present consequences involving cost and investment reductions, increased asset utilisation, personnel cutbacks and outsourcing seem at first glance to be inconsistent with the primary aims of the customers. Supply security, product quality, flexibility and customer services are still in demand and might even possibly have to be intensified in the course of competition.

If it is desired to eliminate this contradiction, at least in certain sectors, then the players in this game must improve their performance in many areas. Engineering, information technology, business structures and processes and many other aspects must be queried. As far as those aspects which are today generally understood as gas management are concerned, requirements of a completely new dimension are not only to be expected but are already on the agenda. Whoever wants to survive in future must introduce change processes at an early stage.

The subsequent detailed treatment of the subject is intended to shed light first on the way in which BEB in its role as a gas redistributor and a gas producer has initiated this process, secondly on its current position in the design of a new gas management system and thirdly on outlining where BEB's future aims and visions lie.

These individual topics are divided into three aspects of the concept Gas Management System (Fig. 2). Under the heading »BEB's gas Business today and tomorrow« the gas business of BEB today and the challenges of tomorrow are described.

The heading »System technology and development« shows the essential items in the current change processes of system architecture from new process computers to gas network simulation with forecasts to the standardisation of inter-company communication.

In the final part, »Management requirements«, explicit treatment is made of the spheres of organisation, communication and information which must withstand ex-

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treme demands in the future fast-moving gas business and on the basis of which the policy-making decisions of the company are to be made.

2 BEB's GAS BUSINESS TODAY AND TOMORROW

2.1 Supply Situation

Influenced by the Europe-wide trend towards internationalisation of the gas markets corresponding changes have been made in the gas supply of Germany and to a somewhat different degree within BEB. Due to the central location within the European integrated natural gas pipeline system the supply portfolio contains essentially supply from domestic production as well as imports from Russia, Norway, the Netherlands and Denmark.
The advantages of such a diversification from the point of view of supply security and purchasing optimisation are evident. In order to ensure a flexible use of the reserves transport pipeline systems will, however, also be required as well as efficient daily scheduling and dispatching.

2.2 Technical Infrastructure

A meshed transport system located in the North of Germany has a multiplicity of connection points both to the import stations as well as to large and small gas production sites. The supply spectrum is supplemented by four underground storages, two pore storages for seasonal structural demand and two cavern storages for peak shaving purposes.
The transport network comprises an approx. 3500 km long pipeline system with 7 compressor stations. Here it must be borne in mind that joint ventures have been established in several sectors, which involve not inconsiderable additional demands in the sphere of gas management. On the production side more than 1400 km of pipeline, about 170 gas dehydration units with about 200 wells are to be included.
In 1998 a volume of around 26 x 109 m³ was handled on the transport system operated by BEB – this corresponds to about 27% of the total sales of Germany – which was supplied at no less than 25 stations. With an own demand of some 18 x 109 m³ the high percentage of third party pipeline transports is clear even today, arising from negotiated transport contracts and the above-mentioned joint ventures with consortium partners in the production sector, with presuppliers and with other gas redistributors.

2.3 Operating Infrastructure

The large number of supply sources already mentioned makes up a broad spectrum of gas characteristics such as density, calorific value and Wobbe index. When using these supplies increasing demands will be made on scheduling and dispatching.

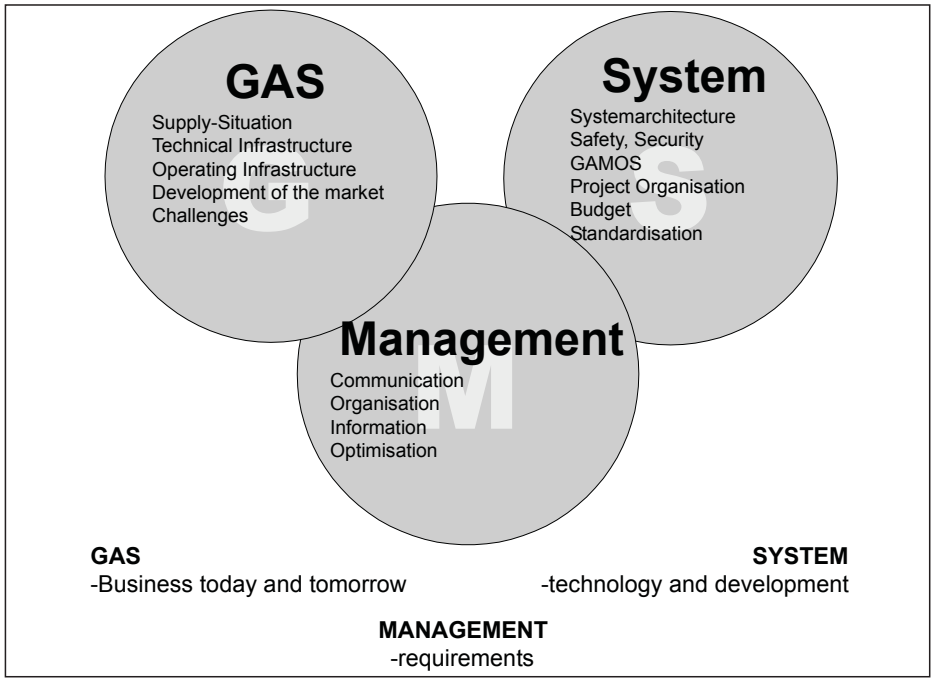

Fig. 2 The three aspects of a Gas Management System

On the one hand the sensitivity of the customers to calorific value fluctuations and ranges of specific methane numbers, in particular due to the use of new technologies such as cogeneration plants, has increased. Also, requirements of the supervisory authorities and further requirements of our customers increasingly affect presuppliers. On the other hand, from the point of view of availability and price and cost optimisation an ever greater flexibility in the use of supplies, storages and also transport facilities is absolutely necessary.

2.4 Development of the market

The BEB market structure covers a broad spectrum. Via more than 200 metering stations BEB's customers ranging from a single dairy producer to the largest gas redistributor in Germany or customers abroad are supplied. The offtake pattern of these customers differs greatly. Individual municipalities have a marked temperature-dependent offtake pattern. On the other hand, gas redistributors optimise by using their own storage infrastructure or other supply sources, which tends to result in a more constantly high load over the entire winter period. At the moment also due to the changing environment the following developments or trends relevant for gas management can be noted:

– The European trend in the gas business is forging ahead. Even today BEB purchases gas, as already mentioned, from Russia, Denmark, the Netherlands and Norway. At the same time it is operating contracts with Belgium, the Netherlands, England, Denmark, Sweden and the Czech Republic .
– These items demand both of the GMS and of the on-site engineering an increased flexibility in measurement and control technology, as with the compressor stations where Min-Flow problems can occur under certain circumstances.
– The greatest changes are to be expected or are already being realised on the contractual side. Even if mergers between some public utilities and regional consumers should take place, three trends are evident:
  – Rise in the number of contracts to be handled in future.
  – The lead time for implementation will be shorter.
  – The duration, in particular of spot agreements, will be shorter.

This development is of decisive importance for the necessity of change processes in the companies involved. In particular the greatest demands are made on the transfer of business information and internally and externally communicated process data with consistent data processing.

2.5 Challenges

The greatest challenge is the change process itself. Due to the existing additional stress in doing it is extremely difficult to adopt the correct attitude and to make available the personnel resources for the development of the technical, operational and organisational change processes so urgently needed. – The situation reminds a little of the good man who wishes to saw through a beam with a blunt saw and, when asked whether he intends to sharpen the sawblade, answers only with the remark that he has no time for this as he must get finished quickly.
The gas utilities are currently under great stress. On frequent occasions improvisation is necessary in implementing the initial steps towards more flexible business practices, as suitable tools are not available.
It is necessary to create the correct prereq-

uisites for these change processes incorporating all current aspects, namely:
– The availability of the correct, effective organisational infrastructure for the change processes.
– Incorporation of separate organisational changes within the company (in the case of BEB this means the current re-orientation towards business units).
– Implementation of cost and investment planning at an early stage despite frequent non-availability of the necessary details.
– Development of new technologies and standards.
– New construction projects must often be integrated into running operations with very great operational effort and with teething problems.
– Incorporation of new spheres of activity into personnel planning, accompanied by early training activities.
– Specialised topics such as year 2000 compatibility.

3 SYSTEM

The broad scope of BEB's gas business ranging from the individual production well to the end user, combined with current and future challenges, has prompted the company to plan and implement a new Gas Management System (GMS). In the description of the overall concept which follows it will become clear that BEB believes the most effective method of implementation involves undertaking individual projects and installing system components in a step-by-step approach. This method is particularly justifiable because rapid changes in requirements mean that the needs cannot be described in sufficient detail in all areas.
The core requirement is that it should always be possible to adapt GMS to market requirements. The technology must not get in the way of market opportunities, organisational options and other requirements. It is not a matter of setting up a major proprietorial system but rather a portfolio of docked individual modules around a central core.

3.1 System architecture

GMS in its present form is a system made up of applications, some of which are completely independent of one another. Most of these systems are mainframe applications which were typical of the 1980s; in some cases they are only interlinked via file transfers. The significantly more efficient client/server architecture which is available nowadays is used wherever possible in order to minimise these costly interfaces. All applications and end user stations are networked accordingly. The differing requirements (e. g. real time for process control) have resulted in simplified form in a process control-related network and an office work-related network for all other upstream and downstream systems (planning, data archiving, accounting, etc.). Planning is in progress towards setting up an INTRANET for external communication in the gas industry (see below). The portfolio is being gradually completed around the central core, the »GMS Arsenal« (Fig. 3):
– Dual Dispatching Centre: Due to higher risk with respect to system support by the manufacturer of the SCADA system currently in use the job of setting up BEB's new process control system has been given top priority. The system is subject to exacting availability requirements, which means it will be set up at two locations, i.e. two identical control centres will be established. During normal operation, one is then used as the upstream control centre for production whilst the other serves as the downstream control centre for transport and storage. Should either of the two centres malfunction for any reason, the other centre is available as a 100% backup facility including all the tasks of the centre which has failed.
– Other local systems: All other functions required for daily dispatching are also duplicated and set up at both control centre locations. These functions include planning/dispatching tools, the communications server (see below), the online gas network simulation, the leak detection system (see below), the alarm system (handling of incidents, in particular in sour gas production), a data server for all data needed in the control centre, a configuration system, etc.
– GMS Arsenal: the arsenal will gradually be built up into a data warehouse. It serves as a central component, not only for long-term data archiving but also as the integrating factor in the entire GMS portfolio. Its function can be described as that of a broker for all systems in questions relating to data, information, configuration data, etc. This also includes the integration of non-digital documents such as current documentation/plans of facilities and wells. The chosen separation permits data searches or similar tasks to be undertaken without disrupting or blocking the work of the control centre. As a result, information should only have to be recorded once if possible, then maintained in a consistent format and made available to all users in a way which is efficient for them. It is intended to provide a uniform data basis for all tasks. It should be possible for users to access data from other BEB systems via the GMS interface in the same way as data from the GMS. New navigation principles on data, e.g. combining different topologies, have to be developped.
– Other modules: All other components should be integrated into the portfolio in a way which is oriented towards the work processes/similar tasks. These components include planning, information, scheduling and optimisation systems for the transport/storage sector as well as for production, in each case for working both with the respective asset and on the respective asset. The same applies for procedures following the delivery of the product (gas) or provision of the service (transport). To this end, it is necessary to integrate new modules

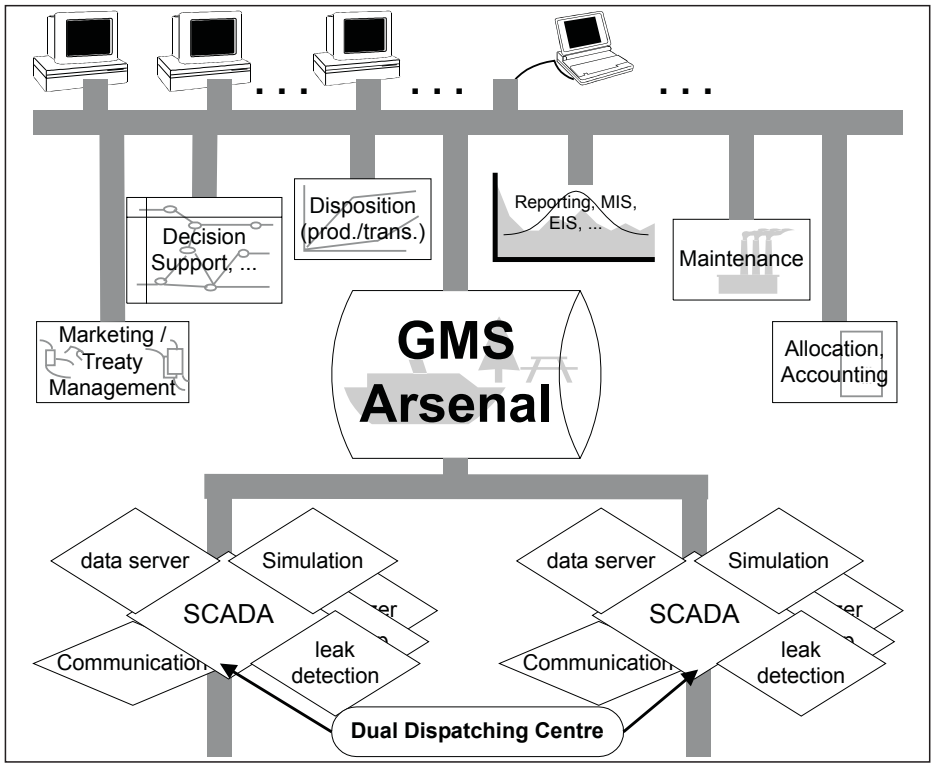

Fig. 3 Design of BEB´s Gas Management System

which meet the needs of the new market: technical volume determination including simulated values (reconstruction), contract allocation through to accounting.
– Configuration system: a significant drawback of all previous individual systems has been that each system must be separately configured and updated. A huge boost in efficiency can be achieved by introducing a configuration and system management tool.
– Operating and user level: It must be possible to use the GMS functions inside and outside the control centres by means of the PC infrastructure at BEB.

Only by implementing the high level of integration in the overall concept will it be possible to react to new requirements in the gas business in a quick and flexible manner.

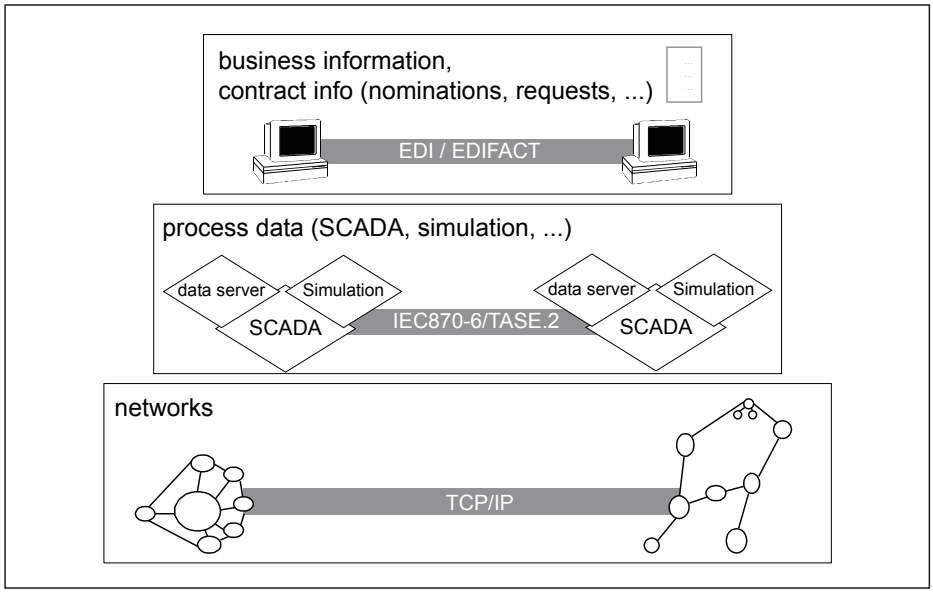

Fig. 4 Communication standards

3.2 Safety, Security

The safety and security precautions are intended to take account of all significant incidents such as accidents, malfunctions, failures and damage. Great importance is accorded to having the highest possible safety standard, particularly in connection with BEB's sour gas production. In this application, it is necessary to detect even the smallest leaks straight away and to localise them sufficiently accurately. To this end, a leak detection system has been set up which localises even the smallest leaks to within 100 m in one minute. This system is incorporated into the dispatcher control desk, i. e. it is integrated into the SCADA user interface.

An alarm support system is also integrated into GMS to enable efficient handling of the malfunction in the case of damage. This system largely automates communications activities, immediately provides cartographical material (GIS) and offers support in locating and notifying the operations personnel.

BEB currently has a decentralised back-up system for subnetworks of the transport and production system, referred to as »sub-centres«, in order to ensure that supplies can be maintained even if the control centre should fail. The principal modification in the redesign of the future GMS is that a second, identically equipped control centre will be set up as a back-up facility instead of this subcentre concept (see above, Dual Dispatching Centre).

The requirements on safety, security and availability of the GMS systems and data themselves must also be taken into consideration. The networking of the process control-related and the office work-related worlds within BEB as well as the future connection to partner networks (business information and process data exchange) harbour a significant level of potential risk, both as far as the safe operation of the networks themselves is concerned and with regard to running applications and the associated data. This means it is necessary to install a very well designed firewall system in addition to having redundant system potential including alternative communications pathways, backup mechanisms and authorisation checks. Automatic plausibility checks (e.g. concerning different data sources), logbooks etc. can make an efficient contribution to data security, failure checks, investigations into attempted attacks and other factors.

3.3 GAMOS

The online simulation system installed at BEB is known as GAMOS (manufactured by debis Systemhaus). GAMOS also includes the SCADA system which is currently being expanded to meet BEB's needs as part of the aforementioned Dual Dispatching Centre project. On completion, it will take over the process control function. Furthermore, GAMOS already includes various components (forecasting, contract module, etc.) which can fulfil some of the requirements listed above. debis also developed the communications server (see below) and integrated it into the GAMOS functions. As a result, GAMOS will become the major component in the process control-related network, i. e. the real-time element of the GMS at BEB.

3.4 Project Organisation

GMS is not being carried out as a major project by BEB, but rather in a coordinated sequence of individual GMS projects – reflecting its modular structure. To provide a better guarantee for the concept as a whole and its integrity, a task force has been set up which realises all GMS projects. The team comprises people from the user and system supervisor environment, from the IT department, from engineering and for project management support, administration and controlling. The team may be supplemented by further experts if required for the implementation of specific components. The main implementation phase will take at least three years.

3.5 Budget

Each GMS project is treated as an individual project in the normal budget planning practised at BEB. The necessity and economic aspects are also demonstrated separately for each individual project. The expenditure on the aforementioned safety and security precautions alone represents a relatively high proportion of the total expenditure for the new Gas Management System.

3.6 Standardisation

Strict observance of standards can constitute a decisive factor in the lifetime costs for a system. The following section refers to standards which can be sensibly applied to important subsystems or tasks of the GMS.

Communication with the process should be based on the modern IEC 870-6 TASE.2 standard in future. Based on this, communication with partners will use Internet technology and EDI within an intranet (Fig. 4).

Amongst other aspects, this will phase out the use of outdated telexes for exchanging business information. The communications server project has already been undertaken with this in mind. Business information is evaluated and automatically stored in GAMOS as contract data.

The appropriate standards still have to be finally adopted at committee level, whilst prototypes for the Intranet aspect of the dispatching centres and even for the gas industry are being planned.

Windows applications should be OLE-capable. The GUI guidelines for Windows, Windows NT or OSF/MOTIF (UNIX clients) should be observed for user interfaces. Software manufacturers should disclose their APIs and provide details of their version policy in good time.

As far as the observance of guidelines and standards is concerned, it is appropriate to mention ergonomics and visualisation as final items which have to be taken into account, particularly in the design of the new control desks for the dispatching workstations (e. g. VDI/VDE-guideline 3699).

4 MANAGEMENT

»Bravery is often a lack of insight, while cowardice is not seldom based on good information.« – However, this statement by Peter Ustinov cannot be directly transferred to the objective of BEB's efforts in the area of information and communication. BEB also continues to expect brave decisions by its Management. Nevertheless, in view of the complexity of the systems and the flood of information it is necessary to build up an infrastructure and a culture which minimise the remaining risk of individual business decisions. Bearing in mind the activity profile for the gas industry described above and the development of the technical infrastructure as the means to an end, this is now the point at which the desired management objectives and their implementation should be described in more detail.

4.1 Communication

The time requirements facing future gas business have already been described. The first prerequisite for their realisation involves setting up a fast and binding communications system – internally and externally. Whereas in the past the recipient used to obtain the paper copy of a contract or an amendment to a contract within one to three days, three days are now seen as the specific time span for a spot deal; this period includes everything from the customer's request and delivery through to invoicing. This can only be achieved if a suitable communications structure has been set up both internally and externally. Feedback and confirmation facilities built into these communications processes can make a significant contribution to general acceleration. There is an urgent need to speed up agreement on standards for setting up an appropriate communications network, particularly for the rapid establishment of external communication, whether it be process control data (TASE.2) or for business information of a more contractually binding character (EDIFACT). However, also the obvious means of communication must be employed in a strategically optimum and efficient manner. It is by no means obvious that for the individual interfaces within the business processes the appropriate means of communication to be used, such as telephone, mail, fax and E-mail, and the timing of information transfer are clearly regulated. All the more discipline within the processes is necessary for their controlled flexibilisation.

4.2 Organisation

Simply introducing the aforementioned communications technology will not be enough. The technical infrastructure must not stand in the way of the efficient handling of business; instead, it must provide effective support in this regard. This also applies with equal rigour to the organisation of the business. In this respect, the gas industry is going to find itself obliged to reorganise to meet the needs of customers and business processes – simply on grounds of efficiency and cost alone. Other industries have already gone through this. The establishment of the GMS must not be allowed to obstruct this continuous pressure for organisational changes; instead, GMS must be able to cope with all conceivable new constellations within a relatively short space of time. The significant requirements on the overall portfolio as described above were derived from this situation. In organising processes, attention must be paid to having the right tools and using them correctly, to having the right information and using it correctly, and – to a decisive degree – making sure that the management is correct so that good, fast and efficient decision-making is made possible. These speed requirements do not apply to the continuing long-term contracts and investment decisions in the pipeline, UGS and gasfield sectors. In these cases, GMS is actually merely a supplier of historical data.

4.3 Information

Up-to-date information with as few contradictions as possible represents the third element in providing support for efficient decision-making. This applies on the one hand to highly filtered management information and on the other hand to data needed for process control. It also applies equally, to give a third example, to precise facts in issues relating to accounting. Everyone involved in the chain must be provided with all required information quickly and efficiently. In future, better support must be provided for dealing with contradictory information whilst plausibility checks, alternative actions, scenarios, etc. must be prepared in a largely automatic fashion so as to enable decisions to be made rapidly. The techniques and tools will continue to improve; the possibilities of generating information and making it available to a wide public will be unlimited. This will however be the real problem of the future, and the need for a clearly structured and selective information management is already apparent today.

This is the important core of information policy:

– Information must be restricted to the most important statements.
– Information must be structured in a clear, orderly fashion.

When one considers what additional information can be received today by E-mail than would have been possible in the past in the form of paper copies, then it is certainly permissible to ask whether this is only a blessing. If information is not handled efficiently, this can have an extremely counter-productive effect upon the so important time factor in operating and management.

4.4 Optimisation

Information and communication will in future have a higher priority in the gas business than was the case in the past. Nevertheless, these have hitherto been a means to an end and should also remain so. They will make a major contribution to meeting the requirements and challenges of the new world and exhausting optimisation potentials. These latent business improvement possibilities must be further identified and taken into consideration in the course of the GMS project. In view of the

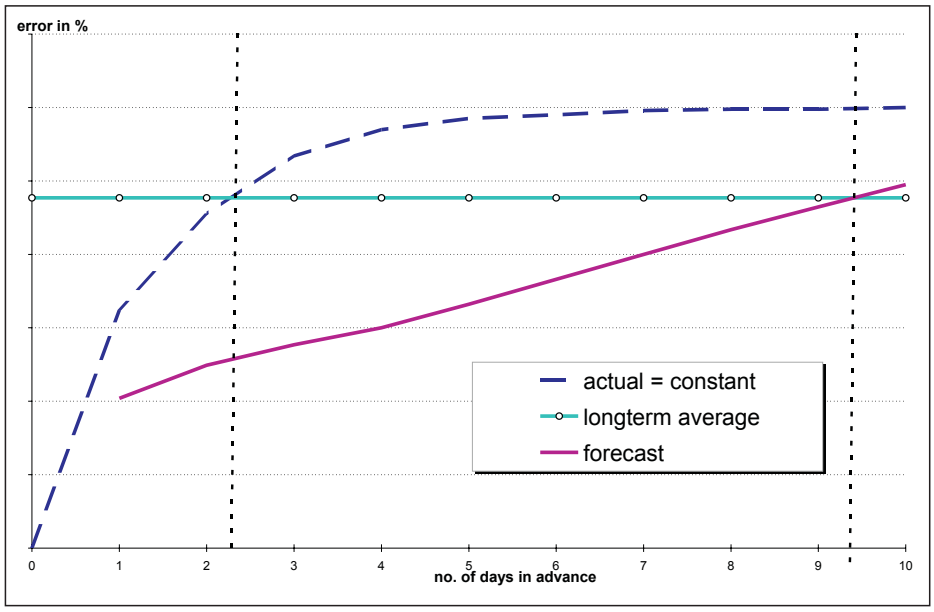

Fig. 5 Quality of meteorological forecasts

new time requirements and in the new political and economic environment consequences are bound to make themselves felt in Asset Optimisation.
What can we expect in detail?
– We shall analyse our transport and production system and the existing potentials in much shorter time units.
– We shall be much more strongly integrated into the economic optimisation process on the basis of system support.
– On the basis of gas network simulation we shall be busier than before with forecasts and predictive simulation with scenario planning.
– As soon as we have received the approval of our simulation procedure for the reconstruction of gas quality parameters for accounting purposes, it will be possible to critically query the scope of, in particular, the measuring technology infrastructure.
– We shall be able to further utilise our assets if we gain additional certainty by means of the simulation of, in particular, dynamic operating conditions.

These developments can no longer be stopped, and BEB is prepared for them. A basis for these optimisation potentials which cannot be completely neglected is a reliable sales forecast. The quality of such a forward-looking consideration depends either on good advance information from the customers or on an own market assessment on the basis of weather forecasts. Also in this case the major concern is information, which is obtained, transformed for the specific purpose and used in an appropriate manner. The optimisation horizon can be divided as follows:
– Within Dispatching the system-accompanying simulation enables two days to be planned in detail in advance and harmonised with all site constraints. Based on the current temperature and market situation, developments are forecast and the degrees of freedom are used for optimisation purposes, taking the dynamic conditions into account.
– The period of 3 to 7 days of the subsequent week is pre-structured from the scheduling point of view in particular on the basis of the weather forecasts. Scheduling of storage use will become more and more important, as storage operation is necessary, at least at BEB, for almost the whole of the year.
– The planning and optimisation process on a monthly basis uses temperature predictions at the most in individual scenarios, as the best results can be obtained with long-term average values.

These approaches have proven themselves so far and are also supported by meteorological services in that a specific forecast for a period of more than 10 days is not suitable and should not be used as a planning basis (Fig. 5).
New optimisation concepts have also to be taken into account, in particular optimisation tools which can handle steps of information by using the mathematical concept of pretopologies.

5 CONCLUSION

If we wish to continue to speed up the optimisation of our business processes, we shall be very dependent upon a further improved gas management. So that we can achieve this, the vital components of information and communication must in particular be placed upon a standardised, technically timely and binding foundation. Confucius was unaware of the Gas Management System 2500 years ago, but hardly any other statement is more fitting for GMS than his piece of wisdom:
»The way is the aim.«