Focus Area Networks

Vision Gas

The Gas Vision

The European natural gas network is and must continue to be a safe, integrated system, capable of coping with the vast quantities of gas that it transports and delivers in response to the demand from end-users.

Within the timescale addressed in this 'Vision', the natural gas infrastructure must evolve toward a more flexible, more intelligent system that will;

- become cheaper to build and to run;
- be more durable, without compromising safety and security;
- deliver a longer lifetime;
- be capable of accepting a wider range of gases;
- be able to be detected and located more easily;
- be easier to inspect, maintain, repair, or replace;
- provide the services demanded by the variety of end-users;
- be able to be constructed, maintained, repaired or replaced with minimal disruption to traffic and to quality of life of those in the vicinity, and at minimal cost.
- become an acceptable neighbour from the point of view of environmental and security issues

Three areas for research and innovation

1. Asset management
2. Safety, security of supply & security
3. Environmental impact

1. Asset management

Natural gas currently provides 23% of the European Union's primary energy consumption and it is anticipated that this will grow to around 28% by 2020[1]. As a consequence, owners and operators will experience considerable increases in the use of their networks in the coming years. They will only be able to respond to this challenge by building new infrastructure or by upgrading the existing infrastructure so that it can be used more effectively.

However, the construction of large numbers of new, high pressure, gas transmission pipelines is not feasible, so efforts will be concentrated on maintaining and upgrading existing assets by, for example, increasing the operating pressure. Much of the existing high pressure network will have to be used for the coming decades, which means that degradation mechanisms will have to be very well understood. Proof of pipeline integrity will be paramount and will demand new techniques for both inspection (especially for non-piggable lines) and rehabilitation.

In addition, many households still need to be connected to the gas network and, as a consequence, the low pressure gas distribution system will be progressively extended by means of new pipelines. Hence, there will be a continuing requirement for new technologies to enable the installation of new house connections and also for the repair and renovation of parts of the more than 1.2 million km of existing distribution pipes in Europe (EU15).

The challenge to the gas industry is to ensure that existing infrastructure can be inspected, maintained, repaired or renewed at minimal cost and with the minimum of disruption to traffic, quality of life and the environment, set against a background where safety is paramount.

These are all areas for which technological innovation, whether it be derived from new materials; new techniques; or information technology, is essential if advances are to be made and they all, therefore, very much depend on research and development activities.

ASSET MANAGEMENT -VISION		
2010	**2020**	**2030**
Design, development and application of new materials, monitoring systems, construction maintenance, renovation and replacement techniques capable of meeting increasing demand; extending lifetime; and reducing disruption to traffic and to citizens. Design, development and application of management and operational tools for maintenance and renovation of gas networks to reduce costs, without compromising safety, security or the environment.	Optimisation of the application of new materials, monitoring systems, construction maintenance, renovation and replacement techniques capable of meeting increasing demand; extending life-time; and reducing disruption to traffic and to citizens. Optimisation and upgrading of management and operational tools for maintenance and renovation of gas networks to reduce costs, without compromising safety, security or the environment.	A safe, integrated pipeline system with increased longevity, capable of rapid maintenance/repair, with minimal disruption incorporating new materials, new technologies and capable of carrying a wide range of gases.

[1] IEA

Strategic Research Agenda

- **Models**

Development of models to assess and predict the performance of pipeline structures subject to:

- variations in pipeline-soil interactions;
- pipeline ageing;
- increased loads, and;
- gas type and/or quality;

with the aim of extending life-time, with no reduction in safety;

- **Monitoring**

Development and use of the latest intelligent pigging to determine the integrity of pipelines.

Development of new sensors and techniques based on new materials and new technologies, such as: nanotechnology, for, for example, improved detection/condition-monitoring of existing lines.

Developments in sensor technology and techniques that will improve the capabilities and reduce the cost of remote sensing and telemetry.

Definition and implementation of a technological approach that will allow the maintainability and replacement of instrumentation at low cost.

The development of new, improved techniques for inspecting, assessing and rehabilitating existing pipelines.

- **Materials**

New generation of materials suitable for future pipeline systems.

New materials that will enable reduced cost maintenance and repair, with enhanced performance whilst extending durability, with minimal impact as far as their practical application is concerned.

Development and use of the latest pipe coating materials and their application techniques.

Smart & high performance pipeline materials (e.g. multifunctional & adaptive materials, incorporating nano-structures.

- **Management**

Development, feasibility and application of new methodologies for operation and maintenance of high pressure transmission pipelines;.

Development, feasibility and application of new methodologies for operation and maintenance of gas distribution networks.

Development, feasibility and application of models and tools for network integrity management for transmission and distribution networks.

Ensuring that the latest technologies and techniques are transferred to engineers and contractors so that they are well qualified to advise on the installation of new gas pipeline and distribution networks in rural, urban and congested areas.

Construction techniques

The development of:

- more efficient techniques related to transmission pipelines, for installation; for rehabilitation of existing lines; for improved monitoring; for risk assessment;
- new techniques and technologies for construction, repair, maintenance, replacement, reinforcement, with the lowest impact on traffic and the environment;
- 'no-dig' techniques for construction and in-service inspection of gas distribution networks;
- new approaches to trenchless technology, to ensure minimal disruption and to minimise the use of natural materials;
- techniques for maintenance, repair or replacement which assure safety conditions and no interruption of service;
- robotic techniques for inspection and repair of distribution pipelines.
- accurate methods for locating existing assets.
- new techniques to minimise the size and cost of excavations and backfilling.
- new techniques that will enable integration of new utility networks (gas, water, sewer, electricity, etc.) in a single built infrastructure or duct.
- small-dimensioned trenching, with new, mechanised, laying techniques;
- low cost techniques for pipeline construction and maintenance including lifetime optimisation and material recycling.

2. Safety, security and security of supply

These three, closely intertwined issues, which have long been priorities for owners and operators, and are now exercising the offices of the EU. It's clear that continued R&D will be vital if the gas industry's exemplary safety record is to be maintained and that it will become increasingly important as the European gas industry broadens its supply base to ensure that the flow of natural gas into Europe continues.

2.1 Safety

Safety is of prime concern in the gas industry and, in general, it's true to say that the European gas industry has an exceptional safety record. With the exception of the recent tragic incident in Belgium, in the last decade[2] the overall frequency of incidents causing an unintentional gas release has gradually reduced demonstrating the success of an increasing integration of safety in the total pipeline process; i.e. proper design and construction (including pipe manufacture), adequate maintenance, and safe operation. But, however well built and maintained gas pipelines Third Party Interference (TPI) is still the greatest cause of incidents on gas pipelines. As a result of information technology, it's increasingly possible these days to get information more quickly regarding the effectiveness of measures to increase the safety performance of (high pressure) gas transmission systems and this technology development must be continued to reduce even further the incidence of TPI in the gas industry.

Most of the existing high pressure network in Europe will continue to be used for the coming decades, which means that degradation mechanisms will have to be very well understood. Proof of integrity of pipelines will also be essential and will demand new inspection techniques (especially for non-piggable lines) and rehabilitation techniques.

[2] EGIG - European Gas Pipeline Incident Data Group

2.2 Security of supply

Of course, security of supply is paramount because, as society becomes more dependent on gas, there will be a corresponding increase in the expectation that disruptions must be avoided and that repairs, rehabilitation and maintenance of pipelines will have to be done without compromising the supply.

With regard to security of supply, the European Union is fortunate to be so well placed, given the wide geographical dispersion of natural gas. However, it needs to be understood that in future years Western Europe will become increasingly dependent on gas coming from Russia & the NIS and it is anticipated that the problems, whether political, geological or pipeline quality related in these countries are different from, and often more severe than, those in the EU. As a consequence, security of supply becomes an extremely important issues and it will be vital for those involved to address the relevant issues together, to ensure a secure, continuing delivery of natural gas into Western Europe.

2.3 Security

In recent times, security has acquired a considerably higher profile as a result of world events and societal changes. Europe needs to invest in this area in order to address, effectively and innovatively, existing and future security challenges (including natural and external risks].

Development and use of innovative technologies are the key to safe and efficient pipeline construction and operation. It's important to note that the existing European natural gas network, whether pipeline or LNG based, has benefited significantly over the years, and will continue to benefit, from a rigorous approach to system design and management, based ultimately on sound R&D.

The following issues, which apply to the three above categories, are also relevant elsewhere in this document, are likely to be more severe in countries outside the EU and, as a consequence, new technological developments will be essential to:

- prevent/detect Third Party Interference, whether accidental or malicious;
- detect natural gas emissions;
- monitor for landslides and subsidence;
- control corrosion and material defects.

SAFETY, SECURITY OF SUPPLY AND SECURITY-Vision		
2010	**2020**	**2030**
1. To identify, implement and integrate solutions (development of tools, materials, techniques, models, ICT) that increase safety and security and reduce the risks for users and citizens from external and natural hazards ▪ *definition of the needs of the operators in terms of management and operational impact;* ▪ *verification of the technical and economic feasibility of the technological solutions available or under development;* ▪ *definition of a plan or roadmap to apply new technologies;* ▪ *evaluation of impact on users, to reduce costs* ▪ *protecting against natural hazards* ▪ *protecting against Third Party Interference (TPI)* ▪ *protecting against terrorism (detection; protection-neutralisation).*	1. Optimise the use of solutions [tools, materials, techniques, models, ICT, etc) that increase safety and security and reduce the risks for users and citizens from external and natural hazards 2. Optimisation of safety, security and protection of networked systems. utility ***3.*** Continual anticipation and re-assessment of vulnerabilities-interdependencies,	An integrated pipeline protection system incorporating e.g. remote monitoring, inspection, telemetry and communication to achieve optimum levels of: ▪ security; ▪ safety of networked systems, and; ▪ to ensure security of supply into the EU.

o **Strategic Research Agenda**

Development of models and tools for risk and safety management, integrating issues such as safety culture, roles and responsibilities, training and competency, quality and performance management, etc. which ultimately have a major impact on the safety of operations.

Development of models, materials, monitoring systems, components, design and construction techniques able to:

- have a better understanding of material and network degradation mechanisms;
- predict, measure and prove pipeline integrity;
- develop new inspection techniques (especially for non-piggable lines);
- detect and reduce the vulnerability of pipeline networks to natural hazards (e.g. landslides) to guarantee the safety of the network.

Development of the techniques and technology to enable the physical adaptation of pipeline infrastructure by using, for example, smart materials/devices or interactive infrastructures with (evolving) self-knowledge

Develop new design models and techniques for gas networks which are less vulnerable to incidents, failures etc.

Design to reduce risks, with developments of tools for:

- risk modelling
- risk perception

Development of integrated sensor technologies and communication and information technologies for real-time control of network operations ("smart utility concept")

3. Environmental impact

Creating a global vision for the pipeline infrastructure of the future is aimed at selecting, in particular, environmentally friendly concepts which offer a compromise between reduced construction/maintenance costs and safety and environmental criteria. Within this, the sustainable use of resources, including the recycling of materials, are important.

Urban and suburban air quality is improving, but resident populations are still exposed to undesirable levels of vehicle-derived pollution. Vehicle technology has been effective in reducing transport emissions but a large number of people, particularly in urban and suburban areas, are still exposed to high pollution levels, and this will continue to be the case in future. There would be undoubted benefits to the environment, to quality of life, resource management and fuel efficiency from minimising the amount of street-works, related to buried infrastructure, taking place in cities and in rural environments. Consequently, more R&D funding targeted at developing the technologies to minimise street works disruption would have a considerable positive influence on air quality, traffic noise reduction and citizens' state of mind (consider road rage). It's must also be noted that this point applies to every utility: gas, water & sewerage, electricity and telecoms and, indeed, to all city administrations.

Areas where a clean, quiet atmosphere can be experienced are being progressively reduced by the increased density of urban areas and growing mobility and, whatever rules and regulations exist in Member States, the number of European citizens that are irritated by environmental noise or have their air polluted by traffic congestion shows an ever growing tendency. In this context, it must be noted that, in the U.K. alone, road traffic is predicted to grow by 50% between 1996 and 2030[3].

If we consider the long-term environmental picture and the vision for a 'Hydrogen Future' for Europe, it will be important to ensure that there will be suitable networks for the transport of gaseous hydrogen. The Gas Industry is the best qualified to determine the problems and solutions associated with this initiative and, given support for appropriate R&D, can therefore make a significant contribution to the EU's environmental aspirations.

Existing pipelines will have to be modified and/or new pipelines will have to be built, with minimal disturbance to the living environment and this will require extensive investigation, extensive safety modelling and testing and development of new construction techniques.

[3] U.K. Transport Research Laboratory

ENVIRONMENT VISION		
2010	**2020**	**2030**
Development of new techniques and equipments for more efficient street works Improved materials and technical solutions to reduce impact and negative effects (noise, pollution, etc.) on users and communities due to transport congestion from street works.	Optimisation of new materials and technical solutions to reduce impact and negative effects (noise, pollution, etc.) on users and communities due to transport congestion from street works. Optimisation of new generation of equipment for rapid, accurate location, installation/maintenance of pipelines with minimum disruption to citizens and traffic.	Radically innovative approaches to gas network installation, maintenance and repair which minimise environmental impacts on communities. Very high percentage of 'no-dig' interventions. Innovative techniques and technologies to ensure maximised recycling (>50%) and re-use of materials to ensure significant reductions in the consumption of natural resources.

Strategic research agenda

Design for environment (including cost/effectiveness performance analysis) to integrate innovative systems solutions

New, low impact techniques for construction, maintenance, repair or renewal, including new maintenance and back-fill re-cycling techniques and the integration of composite materials to minimise environmental pollution.

Development of techniques and technologies to enable small-dimensioned trenching and new, mechanised, network installation techniques – for security, for reduction of disruption, pollution, working time and cost.

Development or improvement of technologies, such as Ground Penetrating Radar (GPR) and trenchless (no-dig) technologies, for reducing the size and duration of street works, minimising the volume of transported soils and increasing the quality of life by minimising problems associated with urban traffic problems;

New techniques/materials for installation, operation, repair and maintenance which reduce the environmental impact (e.g. repairing without loss of gas).

Development of new excavation techniques that allow recycling and re-use of materials, with the aim of substantially reducing the consumption of natural resources.

Development of new construction techniques to reduce noise emission in specific installations, such as compressor stations and MRS.

Design and application of new technologies to reduce gas venting to the atmosphere.

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