EU Commission Task Force for Smart Grids

Expert Group 4

Smart Grid aspects related to Gas

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1. Scope and purpose of the document

The tasks and scope of work of the Expert Group 4 (EG4) of the EC Task Force for Smart Grids are based on the Mission, Vision and Work Programme presented at the 7th meeting of the Task Force Steering Committee on 17th December 2010.

According to these, the key deliverables of EG4 are a description of the services and functionalities of smart gas grids, based on the work on electricity grids carried out by the Task Force.

EG4 has concluded that smart gas grids cannot be developed in isolation but should be linked to future electricity smart grids and should facilitate smart energy utilisation, e.g. in cogeneration (CHP), heating and cooling. Benefits of cogeneration and micro-generation, together with initiatives related to standardisation and future regulations are specifically addressed in this report.

Smart gas grids can be developed independently of a complete roll-out of smart gas meters. However, when smart gas meters are used, they would provide opportunities to offer additional benefits and services to stakeholders including consumers.

The report addresses the following topics:

- Comparison between gas and electricity utilisation, and the differences in the generating and distribution systems (chapter 4)
- High level functionalities/services of smart gas grids which are enablers for smarter utilisation of energy and smarter use of the network (chapter 5)
- Products and opportunities of the smart grid concept (chapter 6)
- Recommendations for data security, data handling and data protection (chapter 7)[1]
- Roles and responsibilities of actors involved in smart gas grids (chapter 8)[2]
- Examples of innovative projects related to smart gas grids (chapter 9)
- Standardisation (chapter 10)
- Concluding remarks and recommendations for next steps (chapter 11).

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[1] The recommendations on these matters included in the EG2 report are largely applicable for smart gas grids, with the minor caveat noted in chapter 7.

[2] The conclusions of the EG3 report on roles and responsibilities relate to electricity smart grids and are **not** applicable to smart gas grids.

2. Introduction

Smart grids have an essential role in the process of transforming the functionality of the present energy supply system so that they are able to provide a user-oriented service, supporting the achievement of the 20/20/20 targets:

- a reduction by 2020 in EU greenhouse gas emission of at least 20% below 1990 levels
- 20% of EU energy consumption to come from renewable resources
- a 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency

whilst guaranteeing high security, quality and economic efficiency of the gas supply in an open market environment.

Smart gas grids will support the ability of gas to play a major ongoing role in the energy mix while meeting the carbon targets and the renewable energy targets, and will enable the active participation of the end-users in the energy market.

In particular, uncertainties around the future development of efficient and large scale electricity storage technologies means that gas is likely to remain a key provider of both heating and electricity balancing services.

“Dual fuel” (electricity and gas) appliances, an increased use of Natural Gas Vehicles (NGV) for transport, and biomethane injection into the gas grid, together with extensive use of cogeneration (CHP) all offer solutions to manage greenhouse gas emissions, to enhance the efficiency of the networks and to empower consumers to optimize their energy use.

Harmonization and interoperability of equipment, services and communication systems on a European level are essential for the free circulation of goods, the transparency and the competitiveness of markets. However harmonisation must not stifle innovation and technological development.

Secure and robust energy networks are essential for the continued improvement in the operation of the European energy markets. This will only be possible if the associated information and communication networks are secure and robust. It is also essential to maintain data and system security and to respect the fundamental rights and freedoms of consumers.

3. Smart gas grid concept and definitions

The smart gas grid concept is based on maximising the efficiency of overall energy usage and taking full advantage of all the opportunities that the gas grid can offer. It is proposed that this may be achieved by means of the additional functionalities described in chapters 5 and 6.

The implementation of this concept will be made possible by the participation of all smart gas grid stakeholders, according to their specific roles and responsibilities which are described in greater detail in chapter 8. Accordingly, smart gas grid participants are categorised in this report as follows:

- Network operators: transmission system operators (TSO), distribution system operators (DSO)
- Grid users: consumers, end-users and producers of non-conventional gases[3]
- Suppliers: including shippers and service providers.

In most EU Member States, DSOs combine several roles, including network operators, meter operators (including data collection) and application and services providers (data clearing).

Network operators play a key role in the deployment of smart grids. Their task is to implement the network infrastructure which allows the flow of both energy and information between consumers, producers, suppliers and all the other actors in the new smart grid framework. It is anticipated that this will allow new market opportunities, as outlined in chapters 5 and 6 below.

4. Comparison between gas and electricity grids and energy utilisation

Gas networks store large amounts of energy and therefore react relatively slowly over time to changes in demand. However, electricity networks require real-time responses to changes in demand as electricity cannot easily be stored. Therefore there are large benefits for the electricity industry to utilise tariffs to manage peak instantaneous demands, whereas for gas there is less need for real-time information or for control of consumer appliances. However, gas networks and/or heating or cooling systems could be used as a ‘buffer’ to reduce the peaks on the electricity network.

Residential gas appliances are mainly used to provide heating and hot water, which provide for basic needs (hot food and minimum comfort temperature). There is limited scope to reduce energy consumption in these areas; any reductions will be dependent on improvements in appliance efficiency and / or on increases in the level of insulation in the home. There are a number of factors over which the consumer has no short term influence (e.g. external temperature and humidity). By contrast, the multiplicity of electrical appliances provides opportunities for consumers to optimise their electricity consumption and manage their peak demand.

The smart gas appliances described in this report provide opportunities for more efficient utilisation of energy in residential, commercial and industrial applications (gas, electricity, heating and cooling).

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[3] Could be biomethane, SNG, H_2…

5. High level functionalities and services

This chapter lists the four high level functionalities/services which could be delivered by smart gas grids.

5.1. Flexible grids

As noted above, a key existing feature of the gas grid is its ability to store energy. This storage provides flexibility in use of gas between day and night, and between summer and winter and flexibility in relation to production of other energy (e.g. electricity, heating and cooling). In addition to the provision of discrete storage of energy in dedicated facilities, the gas network itself may be used to store energy (by cycling of pressure in the network) when gas is not directly consumed.

In the future, flexible grids will enable the integration of electricity, gas, heating and cooling with the result that the overall efficiency of the grid(s) is optimized. The result will be a sustainable, economic and reliable future energy system.

Peaks in electricity consumption could be reduced / removed by the use of dual fuel applications and the use of suitably configured combined heat and power / cogeneration.

Flexible grids could include the following functions:

- Interaction between electricity, gas, heat and cooling
- Planning future investments
- Smart /combined energy utilisation (e.g. cogeneration and micro-CHP)
- Monitoring of system operations in real time and optimisation of pressures/flows
- Data exchange between different market players
- Bidirectional energy networks.

5.2. Acceptance of non-conventional gases

This functionality is necessary to allow the injection of different non-conventional gases such as biomethane, bio-SNG, coal-bed methane and hydrogen into the network. The gas quality has to be monitored to ensure safe use in the gas appliances, and to achieve accurate billing. In some circumstances an acceptable gas quality may be achieved by blending with network gas.

Acceptance of non-conventional gases requires the following features:

- Gas quality remote monitoring
- Active flow and pressure remote control
- Improved network analysis and capacity planning
- Bidirectional gas networks.

5.3. Smart gas utilisation

Smart gas utilisation offers solutions to manage greenhouse gas emissions, to improve the efficiency of the networks and to empower end-users to optimize their energy use and to allow them to participate actively in the energy market.

Increasing the efficiency of gas usage is a fundamental objective of the European energy strategy and smart gas grids will support this objective. For example, the use of CHP should be encouraged as it provides heat and embedded power and thus optimises utilisation efficiency.

Smart gas utilisations could include:

- Gas fired heat pumps for residential and commercial use
- Cogeneration, micro-CHP and fuel cells
- Gas fired cooling systems
- Dual fuel appliances
- Natural Gas Vehicles.

5.4. Grid operation and safety - management of continuity of supply

Gas systems are located in an increasingly complex environment with increased safety consequences when its integrity is compromised. Smart (self) monitoring of the system could be a cost effective solution in relation to the optimisation between replacement or maintenance.

This functionally could optimise the operation of all distribution assets and improve the efficiency of the energy networks through enhanced automation, monitoring, protection and real time operation.

Safety related issues and management of the networks could be improved by the smart gas grid concept. The use of smart tools in the field of pressure regulation, traceability, internal pipe inspection, odorisation, and cathodic protection could also improve the integrity of the network.

The introduction of new techniques of more ‘active’ control of the distribution system would lead to a more efficient network.

6. Opportunities and products

This chapter describes the opportunities and products that smart gas grids could deliver.

The benefits and the technical feasibility of each product or opportunity are highlighted, together with an indication of the required effort and any issues resulting from the change.

6.1. Interaction between gas, electricity, heat and cooling

Outcome: Enables the end-users to participate actively in the energy market and to choose the most efficient source of energy for their needs.

Providers: DSOs, suppliers, manufacturers of appliances.

Primary beneficiaries: End-users, society, suppliers, network operators.

Technical feasibility and needs: The required technologies are feasible but not yet common on the European market.

Evaluation: There are already projects going on in some local networks, but a cost/benefit evaluation is necessary.

Energy distribution systems currently face important challenges such as an increase in (peak) electricity consumption, an increase in the share of distributed generation, increased investment risk, changing market models and configurations, and security of supply issues. Those challenges appear to be accelerating, and also becoming more complicated as new issues such as privacy, financial stability, etc. appear.

Therefore, a successful energy strategy will need to pursue an integrated approach encompassing electricity, gas, heating and cooling. An integrated approach will permit optimisation of the societal benefits from possible synergies (e.g. micro-CHP, the use of waste heat, smart meters, integrated heating and cooling systems).

Consumers need light, warmth and comfort and will wish to obtain these in the most efficient, safe and cost-effective way.

As the expectation is that electricity supply will be increasingly decarbonised in the future, it has been argued by some that domestic heating should switch from fossil natural gas to renewable electricity. However, this could lead to huge investment requirements in electricity network reinforcement. For example, at present in the UK four times as much energy is delivered to homes in the form of gas as is delivered in the form of electricity. Recent analysis by the UK Energy Networks Association (using Redpoint Consultants) has demonstrated that the difference in total UK network investment between a scenario where gas continues to be used for heating and one where heating is completely provided by electricity could be as much as €800bn net present cost between now and 2050, or over €20k per household.

The primary interest of consumers is to ensure their energy needs continue to be met irrespective of the type of energy used. It will be in the interests of energy suppliers to offer them attractive supply contracts which meet their demands and also reward them for producing electricity at critical times (e.g. at times of generation/network stress when electricity prices are high).

For the supplier, this flexibility has a number of advantages. It allows consumers to play an active role in the energy market by encouraging a stronger and more direct involvement in their energy usage and management. It opens the door to the opportunities provided by more flexible contracts, and enables the supplier to obtain a better portfolio management with fewer risks.

The integration of electricity, gas, heating and cooling will improve the overall efficiency of the grid(s), in order to achieve a sustainable, economic and more reliable future energy system. For example: the use of (non-conventional) gases for cooling applications could help to reduce peaks in gas consumption between summer and winter period, and also to smooth summer peaks in the electricity consumption. This would improve the overall distribution efficiency of both forms of energy.

For grid operators, local electricity consumption peaks could be reduced by the use of dual fuel appliances, or even more by using combined heat and power or cogeneration at local or even residential level. The use of existing grids (electricity, gas, district heating/cooling) should be optimized, but new investments in communication, supervision, etc should also be made. Using local storage of energy – to anticipate peak demands by other energy carriers – the gas network could be used for short term storage of energy. In order to allow the gas network to respond to these new demands, more advanced monitoring and management of flows and pressures and electricity demand side management will be necessary. There will be a need for investment in connection of the different infrastructures, monitoring systems and gas quality survey equipment, and new skills and technologies will also be required. It is not yet known if demand forecasting and the operation of the networks will be more difficult in the case of integrated generation, distribution and utilisation. The method and the extent of communication required for this, and the use of data between the different stakeholders should all be examined.

Economic benefits due to an interactive management of electrical and gas systems can be:

- reduction of investment in reinforcements of electricity or in gas grids
- reduction of energy storage needs
- avoidance of investment in power plants for producing electricity only at peak times.

In addition to the benefits to consumers, suppliers and grid operators, smart energy utilisation also provides benefits for society and supports achievement of European objectives. The communication of the European Commission on infrastructure dated 17th November 2010 calls for an investment of 1,000 billion Euros in energy infrastructure. However, there are considerable technological, financial and market-related uncertainties regarding the future mix of energy supplies. There is hence an increasing danger of system lock-in and, consequently, there is a need to optimize the energy infrastructure in order to minimise those risks.

For interaction between gas, electricity, heating and cooling to be possible, interoperability is a key issue. Standardisation and harmonisation are necessary but, they should not restrict innovation and competition.

6.2. Injection of non-conventional gases into natural gas grid

Outcome: Reduces the carbon intensity of the gas grid.

Providers: Non-conventional gas producers, DSOs, suppliers.

Primary beneficiaries: Non-conventional gas producers, society.

Technical feasibility and needs: The technology for manufacturing biomethane is available. European legislation/standards concerning the required quality of injected biomethane is not currently available neither are the roles and responsibilities of the involved parties currently defined. Other gases could be injected in the gas networks but there is no experience available at the moment. The explanation developed below is only about biomethane.

Evaluation: Manufacturing biomethane for injection in the gas network requires incentives that take account of its green house gas emission benefits to make it cost-effective.

The European Directive 2009/73/EC, concerning common rules for the internal market of natural gas states that gases from renewable sources should be permitted to access into the gas networks as long as they meet the technical and safety standards.

In this context, Member States must ensure non-discriminatory access to the gas network for biomethane obtained from anaerobic digestion or gasification of biomass. The composition of the raw biogas varies depending on the characteristics of the substrates for the production of gas, the technology and the environmental policies. Because biogas is produced from unconventional sources (solid waste, agro-industrial waste, sewage sludge, etc) and contains a variety of impurities, it has characteristics that make it unsuitable for direct injection into the gas grid without purification treatment.[4]

To inject biomethane into the natural gas network, strict purification, quality requirements, safety requirements and standards for network access have to be taken into account. These rules and standards should ensure safe injection in the natural gas grid.

In the future gas from renewable sources could make up a significant proportion of energy supplies in Europe, helping to increase the contribution from renewable energies and improving energy security by reducing dependence on foreign energy. Biomethane is CO2 neutral, and so its use in substitution for fossil gas will assist European nations in achieving their greenhouse gas reduction targets.

For a number of years there has been wide experience of the use of biogas for power generation and heat production. However, injection into natural gas networks is a more efficient application (the efficiency of electricity production is relatively low (35-40%) in the absence of a local use for the waste heat) and / or more flexible as the potential use of the biogas for combustion is not limited to the site where the biogas plant is located.

Commercial aspects of the technologies for biomethane production and processing require further development. However there is experience at industrial scale depending on its application. In the case of injection into the natural gas grid, there is already experience in several countries (e.g. Austria, France, Germany, Netherlands, Sweden, Switzerland, Norway and United Kingdom)

Specifications for purification and treatment for the injection into the transmission or distribution grids of natural gas are required and the conditions for allowing injection should be determined at European level.

Prior to injection, appropriate contracts between biomethane producers, TSO, DSO and supplier must be established to facilitate the entry into the market of the gas produced.

The system must be able to provide the necessary information to the DSO or TSO. In this way they can assess whether the values of the constituents are within limits.

For the safe use of the gas by the end-users and for correct billing, the quality has to be monitored and in case of off-spec gas, necessary timely actions have to be taken to stop such gas entering the network.

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[4] However, a project in the Netherlands is examining the possibility of injecting raw biogas into a local network, to determine whether this is feasible in relation to low CV networks – see section 9.4.

6.3. Gas quality monitoring

Outcome: Verification of the gas quality for safe utilisation and correct billing when more different non-conventional gases are injected in the network.

Providers: Network operators and producers of biomethane.

Primary beneficiaries: End-users.

Technical feasibility and needs: Needs complex and accurate measuring systems and data communication.

Evaluation:

Today gas quality is monitored upstream or at entry points into the gas distribution network. When gases from different sources are injected into the distribution network at new entry points, additional monitoring of the gas quality should be undertaken in order to ensure the safe use of the gas appliances and accurate billing.

This will require analyzers of gas quality to be placed at the injection points in the network in order to ensure the quality of gas injected is acceptable. If the gas becomes off-spec, active control of gas flow (shut down), buffering, propane injection, or blending with other gases will be required.

As a general principle, regardless of the developments that can be implemented in a smart gas grid, gas injected into the gas network must meet predetermined quality specifications.

At present, these specifications are being defined at Member State level but there is a requirement for harmonized European specifications.

The producer that manages the injection of gas into the network should be required to deliver, at the delivery point, the contracted amount to the energy suppliers in relation to energy content.

For safety reasons, it is necessary to implement control systems for odorisation in addition to the requirement to monitor the quality of the gas. The objective is to provide gas with a distinctive smell that can be easily detected by any non-specialised person without any detection device.

These operations can be managed by the implementation of a series of measures to provide additional intelligence to the grid. These developments are likely to be included in smart gas grid projects.

6.4. Storage

Outcome: A major issue in respect of electricity utilisation is that electricity storage is difficult and costly. By contrast gas can be readily stored, on a seasonal basis in depleted gas reservoirs, in salt cavities and using Liquefied Natural Gas (LNG); also on a diurnal basis in the grid itself and in low pressure gas holders. With the exception of the low pressure networks, other pressure tiers could, offer short term storage capacity using line pack. The availability of line pack will depend on the length and diameter of the pipe and the pressure range available.

Providers: TSOs/DSOs, suppliers.

Primary beneficiaries: Grid-users, suppliers.

Technical feasibility and needs: When using the natural gas grid for storage, there are several technical considerations. The mixed gas quality has to be monitored and the flows and pressures also have to be controlled on line. This requires a complex and secure communication system and automated equipment.

Evaluation: Diurnal storage may be provided by the high-pressure transmission system relatively cheaply if the requirements are identified at the design stage. Compressing gas to a higher pressure level demands large investment and high running costs.

Depleted reservoirs / salt cavities can provide very large volumes of storage, but they require significant capital investment.

6.4.1. Depleted reservoirs / salt cavities

Seasonal storage in depleted gas reservoirs and underground salt cavities exists to enable gas suppliers to manage gas supply and demand in a economical manner. In a competitive gas market, injection into and production from seasonal storage is managed by gas suppliers according to economic signals relating to the cost or flexibility of gas production and system balancing costs provided by the TSO.

6.4.2. Liquefied Natural Gas (LNG)

LNG can form part of seasonal storage capability, and can be operated in the same way as depleted reservoirs / salt cavities. In addition, if located at the extremities of the transmission system, it can also be used by the TSO to act as transmission support at times of peak demand, to avoid transmission reinforcement.

6.4.3. Line pack

Line pack is the ability of a gas grid to buffer gas based on cycling the pressure of the pipeline between its allowable limits (subject to demand constraints). Although line pack exists in all gas pipelines from low to high pressure, in practice the lower pressure tiers are generally not utilised for this purpose as the volumes that can be stored by cycling the limited pressure range will not be material enough. Line pack is generally provided in the national or regional transmission networks, where available quantities of gas are much higher, due both to the higher operational pressures and the greater range of gas pressure that is available.

The usable line pack (= storage capacity) depends on the pressure level, the length and diameter of the pipes and the possibility to adjust the pressure levels during daily operations. A smart gas grid could offer this functionality when equipped with the necessary pressure, flow and gas quality monitoring and with smart pressure regulators guaranteeing the needed pressure at the consumers’ level.

6.4.4. Above ground storage

Above ground storage in low pressure gas holders was common practice at the time manufactured gas was used. The production of gas could not follow the demand profile of consumers, so the gas was stored in gas holders on a diurnal basis and released into the network when required. The use of gas holders is declining in most countries due to their relatively high maintenance costs, and in view of the value of the land which can potentially be released if gas holders can be replaced by line pack storage.

6.4.5. Interconnection between low and high pressure

Biomethane production plants can potentially be connected to any pressure tier of the gas network. The preferred connection point will normally be the closest pipeline to the production plant.

However, it is important that the production plant is connected at economically the most efficient point, as it is possible that the nearest pipeline to the production plant may not have sufficient capacity to absorb 100% of the biomethane at times of low system demand (in particular on summer nights). In such circumstances the gas could be compressed and delivered into the higher pressure tier at the local pressure reduction station, or a longer connecting pipeline to the higher pressure tier could be built, depending on the relative capital and operating costs of these options. If it is necessary to compress the gas into a tier of the transmission system which transports unodorised gas it may also be necessary to deodorize the gas. In these cases the cost of the deodorization plant has to be taken into account in the global cost/benefit analysis.

6.5. Monitoring of flows and pressure and active flow control

Outcome: Allows the possibility to inject non-conventional gases and use the network as short term storage.

Providers: TSO/DSOs.

Primary beneficiaries: Grid-users.

Technical feasibility and needs: Needs a reliable communication network for monitoring the flows and pressures on the network and to adjust the set-points of the pressure regulators. These technologies are already available on the market.

Evaluation: Cost/benefits analyses need to be conducted.

A smart gas grid should supply centralised and detailed information about significant points which are representative of the network, or of a part of it, in case of extended networks. This allows correct balancing of the network both from physical and commercial point of view.

Concerning smart gas grids, transmission system management should guarantee optimal and flexible configuration of the gas flows.

The main benefits are related to:

- Energy savings (reduction of fuel gas for compressor station utilization)
- Reduction of pressure losses
- Reduction of gas storage utilisation (in/out)
- Network efficiency
- Security and emergency management:
    - quick detection of anomalies or breakdowns
    - management of a critical path to guarantee constant flows
    - data management about the possibility to switch with other energy sources.

In the long term, monitoring of pressure and flow allows more effective investment planning (enhancements, reinforcement and elimination of redundancy).

The use of smart pressure regulators, would allow indirect flow measurement, remote outlet pressure control, flow limitation and remote monitoring. The pressure in the network could be continuously adapted as a function of the demand, taking into account both consumption and injection. In case of incidents on the network, the pressure and flow could be reduced remotely.

6.6. Cogeneration (CHP, mini and micro CHP)

Outcome: Reliable, energy efficient and cost efficient provision of heat and electricity.

Foster greater consumption awareness taking advantage of smart electricity metering systems and improved customer information.

Allows consumers to modify their behaviour according to price, load signals and related information

In some configurations, offers solutions to allow grid users and suppliers to participate in an ancillary services market to enhance network operation.

Providers: Consumers, suppliers, network operators and manufacturers.

Primary beneficiaries: End-users, industry, producers of non conventional gases.

Technical feasibility and needs: Many large CHP units exist already across Europe. No additional technical requirements on the gas networks are needed.

Evaluation: Customers benefit from wider use of CHP in the network through higher overall efficiency within the energy supply system. CHPs reduce the investment in the electricity transmission network by providing electricity locally rather than transporting it over large distances. A cost/benefit evaluation can be based on the directive 2004/08/EC.

6.6.1. Large Industrial and commercial cogeneration (10MW and upwards)

Cogeneration (CHP) is already well established in Europe. It is a highly efficient method of providing heat and electricity simultaneously. CHP provides electricity fuelled from gas at a lower overall CO2 level than electricity generated in a condensing power station on gas. This higher efficiency approach to primary energy use requires an integrated supply of heat and electricity which is achieved normally by sizing of the plant to meet a reasonable proportion of the heat demand rather than the peak heat demand of a process in a particular application. CHPs of several 100 MWe exist in particular in the refining, chemical and paper sectors and their characteristics are driven by the characteristics of the industrial process they serve.

Many CHPs can work in either CHP mode or if commercial circumstances dictate can shut down and use a standby boiler only to provide the heat. This shift in mode causes the local consumption of gas to drop but the overall system energy consumption to increase, as the efficiency drops and the site imports electricity from the main electricity grid. Smart grids should seek to maintain and encourage the operation of plants in CHP mode and thus improve the overall efficiency of primary energy use in the total energy supply system.

•Active participation of consumers in the energy supply market: Transparency of electricity tariff and availability of member state comparative pricing will encourage participation of customers in the energy supply market.

•Interaction between electricity, gas, heating and cooling: Large CHP offers guaranteed forward supply of electricity on a predictable schedule determined by the host industry process.

•Energy efficiency: CHP Directive guarantees a minimum primary energy saving using CHP compared to separate production of heat and electricity using natural gas. Electricity TSOs benefit from reduced grid losses in transmission to the large industrial.

•Reduction of CO_2: CO_2 reductions resulting from energy efficiency as above.

•Better utilisation of the grid: The smart electricity grid should allow the integration of large CHP; this will improve the flexibility of operating of the electricity grid.

•Interoperability: New equipment development is increasingly adding flexibility to the operation of large CHPs and this is foreseen to continue. Such flexibility could greatly improve the role of larger CHPs in providing interoperability between the gas and electricity networks.

6.6.2. Mini- or micro CHP (1MW -1kW)

The CHP Directive 2004/08/EC defines micro CHP as below 50kW and mini CHP as below 1MW. CHPs with these capacities already exist in considerable numbers in Europe with a large expansion expected in the 1-2 kW capacity range. The inclusion of storage with some of these units and the flexibility of plants in the 100kWs applications such as in agriculture, schools and public buildings, has led to examples of aggregation of electrical supply from CHP plants offering innovative grid services for peak shaving and grid balancing.

•Benefits for the stakeholders (customers, supplier/shipper; DSO/TSO): Customers should have additional transparency of gas tariff and ability to compare to member state norms. For electricity, DSO/TSO the creation of a local balancing market so that new players may offer balancing services at DSO level is required. No additional investment needed in gas network. For electricity TSO/DSO there are avoided investments in a) Excessive cross border flows b) excessive reinforcement of the electricity grid to prepare for down time of intermittent sources.

•Active participation of consumers in the energy supply market: The mini and micro CHP capacity ranges empower citizens to take part in the energy market. These units offer consumers direct participation. Awareness of energy consumption (total and pattern) influence consumption - both for gas and electricity. On current evidence independence/ choice of supply and participation in CO2 reduction are seen as valuable characteristics by specific customer groups.

• Interaction between electricity, gas, heating and cooling: Strong interaction with grid support of intermittent renewables on the electricity grid by providing grid balancing services using near term storage of heat as necessary.

•Energy efficiency: The CHP Directive 2004/08/EC guarantees a minimum primary energy saving in CHP compared to separate production of heat and electricity on natural gas. Micro CHP provides an immediate improvement in Primary energy performance compared to a condensing or other boiler and is particularly effective where biomethane supply is available. It has a specific role to play in improving the energy performance of existing building stock. It removes capacity demand from separate production of electricity. On site production and use reduces electricity grid losses in distribution where they are particularly high.

•Reduction of CO2: in direct proportion to the efficiency gains according to CHP Directive 2004/08/EC

•Better utilisation of the grid: Micro and Mini CHP are highly efficient solutions for shifting load between the electricity and the gas network, by incorporating local storage via heat storage.

•Interoperability: Mini and micro CHP combined with smart electricity meters (consumption and generation) and supplier services, link the gas and electricity networks effectively.

6.7. NGV (Natural Gas Vehicles)

Outcome: Enables consumers to choose lower-carbon fuel for motor vehicles of all types.

Providers: Vehicle manufacturers, manufacturers of CNG compressors, suppliers.

Primary beneficiaries: End-users, society.

Technical feasibility and needs: This technology is already on the market. No adaptation of the grid is needed.

Evaluation: This has no particular influence on the gas network.

Gas as an alternative fuel to oil-derived fuels (petrol or diesel and LPG) should be more heavily promoted at the European level. The technologies for gas-driven cars are far more advanced than for electric cars and have considerable advantages in relation to efficiency. In order to expand the market for CNG (Compressed Natural Gas) and LNG (Liquid Natural Gas) vehicles (mainly trucks), there is no need to create a new gas distribution infrastructure as suitable gas filling stations can normally easily be connected by the DSO using the existing natural gas grids. The public transport area in particular has a high potential when it comes to implementing NGVs in local communities.

An important aspect of the case for the use of gas in vehicles is biomethane. Biomethane should be promoted in the context of smart gas grids, especially since its environmental performance is equal or superior to those for the majority of the liquid renewable fuels, and fares considerably better than conventional fuels. Biomethane produces no sulphur emissions, no particulates and competitive levels of nitrogen oxides. Another significant advantage of the biomethane is that it can be injected into the gas network and blended with natural gas to be used in vehicles.

Natural gas/biomethane has the potential to become the *recommended urban fuel.* Its advantages in noise and minimal exhaust emissions make it ideal for use in urban fleets: buses, refuse collection trucks, distribution vehicles and taxis. The refuelling of large numbers of urban vehicles would normally be carried out using high capacity, high pressure tanks that are able to fill the vehicle tanks of e.g. an urban bus in a very short time; as little as 3 minutes. These high capacity tanks may be filled by compressing gas from the grid during the night to take advantage of the marginal cost of the electricity used in the compressors.

6.8. Dual fuel appliances

Outcome: Enables the end-users to participate actively in the energy market and to choose the most efficient energy.

Providers: Suppliers, manufacturers of appliances.

Primary beneficiaries: End-users, society.

Technical feasibility and needs: The needed technology is possible but not yet common in the European market.

Evaluation: These have no particular influence on the gas network. Although the technology for dual-fuel is known, they are not yet common use in Europe.

In the event that domestic and commercial heating begins to be provided more and more by low / zero carbon electricity supplies, various strategies for mitigating the peak electricity requirements have been proposed, such as

- widespread use of storage (either of electricity itself, subject to improvements in battery technology, or of hot water)
- demand side management of electricity peak via electricity smart grid, e.g. remote appliance switching
- use of plug-in electric vehicles as a source of distributed power (a special case of the above)
- local renewable distributed generation (solar, wind)

However, due to the seasonal peak in space heating demand, and the potential non-availability of local renewable sources of electricity at times of peak heat demand, additional solutions are required. Injecting biomethane into the gas grid is one solution which can enable European countries to continue to use gas for home heating / industrial process heating whilst achieving future greenhouse gas targets.

In addition, in the future, given a cost effective dual fuel gas / electric appliance, it should be possible for smart grids to provide market information (in particular peak capacity price signals) to a home heating controller to enable the cheaper fuel to be utilised for home heating.

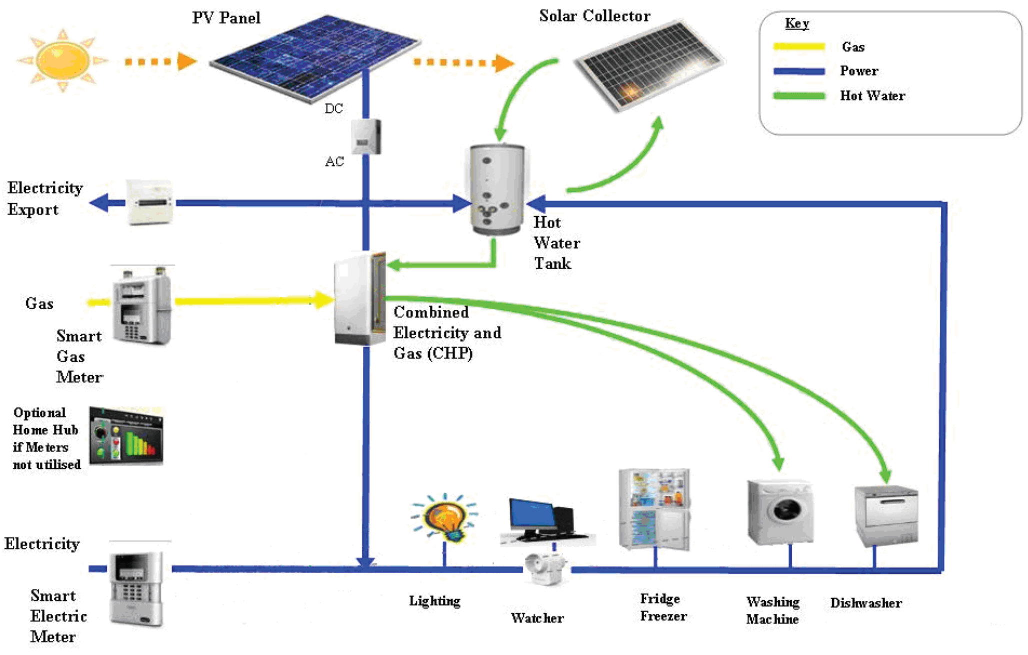
Dual fuel / dual output appliances can take a number of forms:

- Gas condensing boiler plus ground/air source electric heat pump: essentially two appliances; the heat pump would provide the base load (typically 3 – 4 kW) and the boiler would provide the peak. Likely to be an expensive capital cost solution.
- Gas condensing boiler plus electric storage heaters: again the electric storage heaters could provide the base load with the boiler providing the peak heat load. Less expensive than the heat pump option above, but higher running costs.
- Utilisation of combined Heat and Power: At micro (domestic) or larger (neighbourhood) scales, to take advantage of differential tariffs. See section 6.6 above.

The gas supply to the appliances could be certified to be ‘green gas’ by means of a suitable certification scheme matching gas offtakes with biomethane entry from anaerobic digestion / biomethane plants.

Finally, the appliances outlined above could also operate in combination with additional renewable devices such as solar thermal and solar photovoltaic. A conceptual diagram of a smart grid – in-house system shows a possible system operation. Control of the heat and electricity outputs could be via a home controller set by the consumer, or, if sufficiently flexible, and if the consumer agrees, could be managed by the energy supplier to optimise his market position in relation to wholesale energy markets and network capacity payments.

Smart grid – example of an in-house system



6.9. Enhancing efficiency in day-to-day grid operation

Outcome: Better surveillance of a more complex network.

Providers: TSO/DSOs.

Primary beneficiaries: Grid-users.

Technical feasibility and needs: Available.

Evaluation: Cost/benefit analyses need to be undertaken.

Automated component quality and integrity surveillance enables the prediction of failures avoiding gas losses and interruptions of service.

New sensors could be developed which can measure stresses on pipeline and the strength of materials in situ. Combined with modern communication, methods and/or state of the art mobile and autonomous robotic sensor platforms, information could be gathered about the status of the grid. This could be used to optimise ‘just in time’ maintenance and replacement and to minimize cost and disruption to network services and other networks (traffic).

6.10. Better planning and design of future network investment

Outcome: Better planning of more complex networks where gas is injected from different sources.

Providers: TSO/DSOs

Primary beneficiaries: Grid-users.

Technical feasibility and needs: Available

Evaluation: Cost/benefit analyses need to be undertaken.

Improved asset management, replacement and extension strategies should be based on monitored information about the quality of network components and by information on actual flows and pressure patterns.

7. Data safety, data handling and data protection

For gas smart grids, data exchange can be treated the same as for electricity (EG2 report[5]) but it should be noted that for apparatus in gas networks (e.g. meters), the required electrical power is normally provided by batteries and not by mains power. Care should be taken to comply with all safety issues relating to the presence of gas.

8. Roles and responsibilities of actors involved in the smart gas grid deployment

The EG3 report[6] is focussed on smart electricity grids and its conclusions are not fully applicable for smart gas grids.

Roles and responsibilities can differ from one country to another according to the organisation of their energy markets.

Actors involved in the smart gas grids deployment are:

- Actors directly driven by regulation:
    - Network Operators: Transmission System Operators and Distribution System Operators
    - Metering Operators (which are in most cases included in TSOs or DSOs)
- Consumers
- Actors driven by market rules (non regulated):
    - Energy suppliers, shippers, gas producers
    - Providers of equipments and products
    - Service providers
- Regulators and other bodies defining rules (e.g. municipalities)

A brief overview of the roles and the responsibilities of the different actors in the deployment of smart gas grids, based on the opportunities and products described in chapter 6, is provided below:

8.1. Network operators

DSO or TSO is responsible for the construction and the operation of the grid. For smart gas grids, they have responsibility for the measurements necessary for operation of the grids, such as control of the gas quality, and remote actions for ensuring safety... The network operator has to adapt the operability of the grids and define the functional requirements for measurements made on his network in order to satisfy the needs of suppliers and of grid users, defined through functional specifications defined under the umbrella of the regulator.

Network operators can also promote innovation, such as the piloting of energy uses e.g. new business models using micro CHP units remotely controlled to meet the near term peak demand and to balance renewable intermittency.

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[5] http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group2.pdf

[6] http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group3.pdf

8.2. Meter Operators

Metering operators are responsible for installing and operating measurement devices at entry to and exit from gas networks. They also have to communicate metering data to the different stakeholders (generally suppliers, shippers and adjacent networks, for delivery meters located at the interface), according to functional specifications, defined under the umbrella of the regulator

Meter operators are required to comply with technical specifications consistent with national/regional network codes which will reflect the market needs and inter alia the functional requirements of network operators. In this particular case, metering operators will have to take into account the frequency and the quality of service necessary for the good operation of the gas grid system.

8.3. Consumers

Consumers are responsible for choosing the services. They have a key role in the economy of smart gas grids because their behaviour, such as undertaking arbitrage between different forms of energy or piloting of energy uses, will drive the profitability of smart gas grids. Elsewhere, they have a role concerning the authorisation for different stakeholders to have access to the data concerning their consumptions.

8.4. Suppliers

Energy suppliers or shippers have a key role in the application of smart gas grids in relation to energy management. They are involved in the definition of the functional requirements. By offering new services and flexible energy contracts (electricity, gas, heat and cooling), the consumers should be encouraged to a more efficient energy usage and the portfolio management risk of the suppliers should be decreased.

8.5. Manufacturers of equipments and products

Some equipment required in smart gas grids is already available, while other technologies will be developed. To enable the benefits of smart gas grids to be fully realised, the market should benefit from further innovation and cost reduction through a wider usage of these products. An open standard based approach on the European level will be the key for the market development.

8.6. Service providers

Service providers provide for the needs of the different stakeholders. Their responsibility is defined by contracts. An important interest for them will be the interoperability of the communication systems used in smart gas and electricity grids and the optimisation of the communication infrastructure used in the different applications of smart gas and electricity grids.

8.7. Regulators

Regulators have responsibility for fixing the tariffs of the basic and optional services provided by the system and meter operators. They also approve or oversee contractual rules between network and meter operators and the other stakeholders, including in some cases technical specifications. They can also have a major role in imposing interoperability of communication systems in order to facilitate competition between non-regulated actors (grid users, providers of equipment, products and services).

9. List of innovative projects in relation to smart gas grids

9.1. German project concerning the synergy between gas and power grids

9.1.1. Background

Renewable energy sources will play an increasingly important role in the energy mix of the future. However, electricity from the energy sources with the highest potential, wind and solar, cannot be stored, is subject to severe fluctuation and cannot be exploited in line with demand. The amount of power fed into the grid depends on weather conditions and the time of the day.

If power generation from renewable sources is to be expanded as planned, the development of storage technologies and capacities will be crucially important. Cost-effective processes with minimal energy losses are needed to store surplus electricity from renewable sources. Large hourly, daily and to some extent even seasonal storage capacities will be required, as well as efficient conversion technologies.

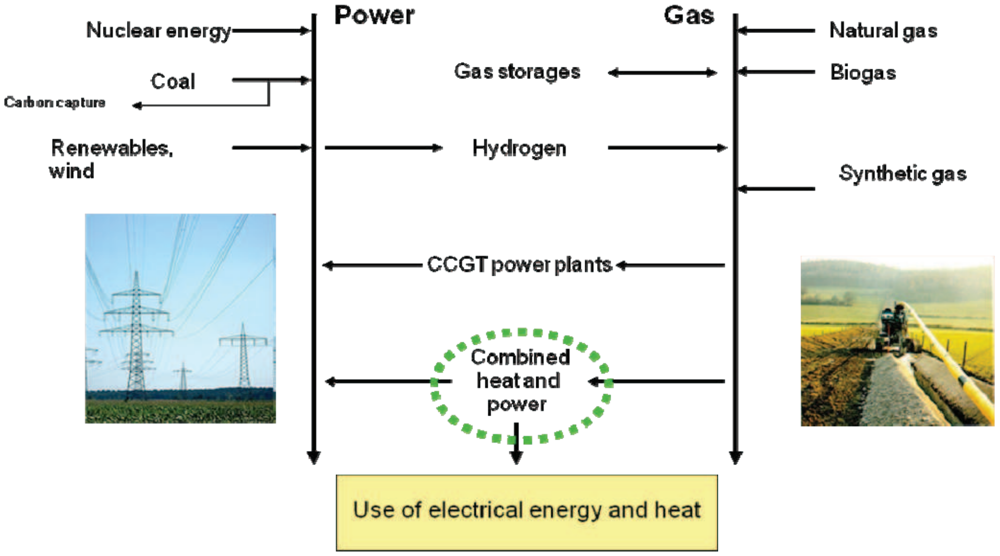
In the electricity industry, a number of different approaches are currently being pursued. Key elements in these efforts are the costly expansion of network infrastructure (the German Energy Agency estimates that some 3,600 kilometres of additional power lines will be needed) and research and development in the area of innovative power storage technologies. The energy system of the future will feature two key aspects – an increasingly volatile power network and a gas network that is flexible thanks to its storage capacity. One of the challenges faced by the gas industry is to combine these two systems in an intelligent way.

9.1.2. Power-to-Gas

A highly promising possibility of storing power from renewable sources more effectively at competitive cost is the conversion of wind or solar power into hydrogen. The process has an efficiency of about 80% and the only by-product is oxygen. The hydrogen produced could be fed into gas networks and used for all the applications where natural gas is used today, e.g. for heating homes or power generation. In Germany, it is already permissible to add up to 5% hydrogen to natural gas. This would mean that up to 5 bcm of hydrogen from renewable sources could be injected into the German gas network each year. Current estimates indicate that the German gas network has the potential for absorbing excess energy from renewable power generation up to 2050. As manufactured gases, which are already used successfully in many parts of the world, contain up to 50% hydrogen, the injection of hydrogen would not take the gas industry into uncharted waters. An additional benefit of this approach would be that low-efficiency part-load operation of condensing power stations could be reduced. With the supply of power from renewable sources, these power stations could continue to operate on full load at optimum efficiency, generating the electricity needed for electrolysis and hydrogen production. However, calculations for this application have not yet been finalised. As a further step, synthetic natural gas could be produced from hydrogen. This option has the advantage of allowing mixture with natural gas in practically any proportions but would have the drawbacks of some loss of efficiency. The attraction of power-to-gas technology is that it allows the use of the existing gas network infrastructure, making gas infrastructure the enabler of renewable energy sources and transforming the gas network into a virtual electricity storage facility.

9.1.3. Gas-to-Power

Power could then be generated from gas using high-efficiency energy conversion technology, ideally in cogeneration plants or highly efficient gas-fired power stations. These technologies also offer the benefit of rapid adaptation to demand changes. In combination with well-thought-out waste heat utilisation systems (Combined Heat and Power), overall efficiencies of the order of 90% can be reached. The use of this technique is also conceivable at the distribution level. The key advantage of decentralised energy production is the effective use of the heat for households. Fuel cells can also achieve very high electrical efficiencies; promising systems with efficiency levels of the order of 60% are already being tested, even for low-output plants.



9.2. IJknet, the Netherlands, safeguarding the grid via sensor technology

9.2.1. Introduction

The Dutch ground contains communication, water and energy infrastructure – these are essential for the Dutch economy and society. The gas infrastructure was mostly constructed in the 1960s and 1970s, therefore most of the gas infrastructure is 40 to 50 years old.

An important task of the DSO is to guarantee the safety of the gas infrastructure. By a better estimation of the quality of the gas infrastructure it is possible to better align the priorities for replacement with the risks, which leads to improved system safety and a better decision making process for making the right investment at the appropriate time.

In addition to the replacement of their own gas infrastructure; DSO's need to take account of the maintenance and replacements activities of other infrastructure companies (roads, sewage systems, telecommunications, etc) as all these other excavations have an effect at the gas infrastructure.

9.2.2. Goals

There is a strong desire to improve the current processes to prevent leakages and breaks; the direction of the improvement is to enhance the warning system to make it more effective, efficient and transparent. It needs to be made more effective because there are still unexpected leakages and breaks, more efficient because replacement is costly and there is limited capacity (money, people) to replace the infrastructure, and more transparent because it is currently difficult to show the supervisory authorities that an alternative approach is not responsible.

Safeguarding vulnerable infrastructure may be possible with the aid of sensor technology, to continuously monitor (parts of) the infrastructure. Monitoring technology is already widely used in the industry. In the Netherlands, sensor technology is already developed for monitoring dykes, embankments and viaducts.

9.2.3. Results

In 2010 a start was made by conducting a study in an appropriate test facility (inside/outside). To achieve more understanding of the fundamental issues, in 2011 there will be further tests for the “Proof of Principle”.Seven areas have been identified for further study:

1. Integration of the models in a monitoring system
2. Sensor model for excavations
3. Ground model for the behaviour of excavations
4. Constructive model for infrastructure at excavations
5. Fracture mechanics model: relation between tension and failure
6. Decision model and reliability model, how to deal with uncertainties
7. ICT integration, how to get reliable, robust and adequate data and how to transform it to a proper signal.

9.3. Micro CHP project, Apeldoorn the Netherlands, 172 micro CHP’s

9.3.1. Introduction

The energy transition to a more sustainable energy future is in progress. Crucial to this is a reliable, affordable and sustainable supply of energy and for this the development of stable local energy systems is essential. It is expected that a large variety of different types of intermittent generators (micro CHPs, solar, etc) will connect to the grid; leading to increased uncertainty with respect to the planning and operation of the grid.

Up until now only small scale tests with micro CHPs have been undertaken. A large scale field test has not been carried out. In Apeldoorn, the Netherlands, a large field test with 172 micro CHPs is now under way. A micro CHP is a new energy system that combines the function of a boiler with the production of electricity. Decentralised generation has the potential ability to be used for “peak shaving” or for local balancing, without affecting the comfort or freedom of the consumer.

9.3.2. Goals

The project has three goals:

1) The (technical) realisation of a dense, intensively used system with electricity generation, and monitoring the effects on the grids (electricity and gas)
2) To analyse the energy savings within the different households and the effect of those savings on overall energy consumption.
3) Preparation of an “energy transition district” where different forms of energy generation can be tested and power-matching can be applied.

It is expected that the patterns of electricity and gas consumption through the seasons will differ from the traditional pattern. The following monitoring goals have been identified:

- What are the problems associated with energy flows at local (low voltage) level if a high number of micro CHPs are present?
- What is the consumer behaviour regarding the different heat/gas and electricity patterns?
- Do these different energy patterns require the grid development criteria to be changed? .

9.3.3. Results

The project was started in 2007 and the installations were completed in 2010. Although the project is still running there are some initial conclusions; there has been no noticeable (negative) effect on the gas grid, rather there has been a significant improvement in the low voltage quality (stability has improved and there are fewer flickers).

The next phase of the project is the testing of load management and energy steering mechanisms (power matching).

9.4. Bionet: raw biogas injection in to the low CV-gas grid; a Dutch project in cooperation with a boiler manufacturer

9.4.1. ***Introduction***

A problem that occurs with the feed-in of gases with a different origin (such as biogas) is that the bandwidth for gas quality (Wobbe-index) that is currently permissible is extremely narrow. These stringent requirements for gas quality means that upgrading of biogas is required to meet these requirements, which is very costly, it is estimated that an additional investment of 0.22 – 0.37 €/Nm^3 is required.

In the near future it is expected that the origins of the natural gas will become more diverse than is currently the case as the traditional reservoirs close to the users are almost depleted. The proportion of gases with alternative origins, e.g. shale gas, biogas, bio-synthetic gas, hydrogen and LNG, will increase. This may give rise to problems with systems and appliances using gas and make the procedures regarding switching, nomination, and settlement and to determine the exact calorific value for billing more difficult.

9.4.2. ***Goals***

The project has several goals and was developed in cooperation with a boiler manufacturer.

○ The separate techniques are already available; it is the combination of them that is new. One goal is to demonstrate that a working biogas injection chain can be developed.

○ Another goal is to reduce the cost of the gas production chain making biogas injection a more economic attractive option.

○ The final goal is to investigate the technical, legal and operational difficulties with a raw biogas injection system, and to monitor customer expectation and behaviour.

9.4.3. ***Results***

The project starts in 2011 and has a size of around 200 houses. The project includes a biogas/natural gas mixing station, boilers that can accommodate variable gas quality and a different set of procedures regarding the determination of the calorific value. After three years the project results will be analysed and – if successful – will be continued.

9.5. GreenLys project (France)

9.5.1. ***Introduction***

GreenLys is a large demonstration project located in Grenoble and Lyon. It includes specifications, recommendations and field tests of smart grid technologies in these two locations. Mainly focused on electricity smart grids, the project also evaluates the contribution of gas systems like micro / mini CHPs and hybrid heat pumps.

The GreenLys consortium involves several actors: DSOs, energy providers, equipment providers, ITC companies, and academic institutions and is also supported by the municipalities.

9.5.2. ***Goals***

The main goals of the project are to:

- Gather field experience of the electrical smart grid concept.
- Identify and quantify the costs, the benefits (economy, society and environment) and the social interest associated with the development of a communication system on the electricity network.
- Provide a knowledge database.
- Obtain a global economic vision of the added value of smart grids including network services and customers' services.

- Develop and validate a technology enabling controlled integration of decentralised energy sources (electricity production from gas) and study the effects of the use of smart metering.
- Indentify the support that gas technologies could provide to the smart grid, especially by decreasing the peak electrical load.
- Development of clients' participation in Demand Side Management.

Experimental sites in Grenoble and Lyon aim to examine the operation of several complementary sources of energy including gas. About 100 gas CHPs and 10 hybrid heat pumps have been included in the project. The sites are also equipped with an energy management system which controls the power consumption and production, and aggregates and analyses the data obtained through automatic meter reading system for electricity, gas and water (in the case of Grenoble).

9.5.3. ***Status of the project***

The roll-out has started in early 2011. Gas technologies should be introduced in 2012. Results are expected during the period 2015 - 2020.

9.6. NaturalHy project (GERG)

To transport large volumes of hydrogen over long distances in Europe, the only pragmatic solution would appear to be to deliver mixtures of natural gas and hydrogen via the existing natural gas pipeline network.

NATURALHY was a large EC-funded GERG project with 39 European partners combining their efforts to assess the effects of the presence of hydrogen on the existing gas network, investigating key issues such as: the durability of pipeline material, integrity management, safety aspects, utilisation and life-cycle and socio-economic assessment.

The main deliverable of the project is a Decision Support Tool which will enable pipeline operators to decide to what level they can safely inject hydrogen into their existing gas grids.

The project has proved that:

- depending on the steel from which high pressure pipelines are constructed, these pipelines could be used for gas mixtures that contain up to 50 % of hydrogen;
- safety related to the transmission, distribution and use of natural gas is not significantly compromised compared to the current situation with natural gas if up to 30 % of hydrogen is added to natural gas. Gas turbines with pre-mixed burners may, for example, be an exception.
- the maximum percentage of hydrogen that can be allowed depends on appliance type and condition as well as on local natural gas distribution conditions. For domestic appliances, a method has been derived to address these questions on the level of a distribution region (country).

There is no doubt that the NATURALHY project has been an important step in providing hitherto unavailable information which could make a significant contribution to the 'greening' and de-carbonisation of natural gas with hydrogen.

However, it is very important to note that there are no simple answers. Each potential addition of hydrogen to a particular part of the European gas network must be considered individually by grid operators for their own systems, in conjunction with the project's "Decision Support Tool".

Let's not forget that there are, of course, remaining issues to be addressed. For example, the interaction of hydrogen with major pipeline components, such as compressors, valves and turbines. Storage is also an important issue that needs further consideration, whether it be underground or when mixed with CNG for transportation.

10. Standardisation

Some existing mandates and on-going standardisation work are related to the gas smart grid concept, but some additional work should be considered.

Mandate M/475 for the standardisation of biomethane for use in transport and injection in natural gas grids. The standardisation work on the quality specification for biomethane will be done by CEN TC 408.

Recommendation:

In addition to this mandate, EG4 recommends the consideration of a mandate to CEN for standardisation work concerning technical and safety requirements for pressure regulating and metering stations injecting biomethane and/or other non-conventional gases in the gas networks.

Mandate M/400 to CEN for standardisation in the field of gas quality is being carried out by CEN/BT WG 197 (Phase I: testing) and CEN/TC 234 (Phase II: standardisation).

Recommendation:

Additional investigation and standardisation work should define the additional requirements of gas quality for future technologies such as small turbines, storage or fuel cells.
The latter are already described in standards published by IEC/TC105. In addition ISO/TC197 is working on standards concerning systems/devices relating to hydrogen. However, fuel cells are very sensitive to constituents in the gas composition, e.g. N_2, heavy carbon, organic Si, sulphur compounds, H_2 and CH_4 ratio, and the density of C_2H_6 and C_3H_8. The huge range of gas compositions permitted for distributed gas in Europe could be an obstruction to the residential use of fuel cells.

Mandate M/441 to CEN, CENELEC and ETSI in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability (smart meters). The coordination is overseen by the Smart Meter Co-ordination Group. Standardisation in the gas field is conducted by CEN TC 294 for the communication, by CEN TC 237 concerning gas meters and by CEN TC 234 for the installation requirements.

Mandate M/490 to CEN, CENELEC and ETSI concerning the standardisation of smart electricity grids.

Recommendation:

EG4 recommends additional research on low cost and low maintenance gas quality measuring instruments and standardisation work on European level.

Recommendation:

EG4 also recommends additional research on smart pressure regulators/flow controllers and standardisation work on European level.

11. Conclusions and further recommendations

In view of the breadth of the tasks and the scope of work of EG4, and taking into account the limited time-frame, this report should not be seen as definitive in relation to all questions concerning smart gas grid deployment. However, this report provides an initial view concerning the important role that gas and smart gas grids can play in achieving European targets in relation to energy.

By promoting the new functionalities, opportunities and products described in chapters 5 and 6, realisation of the concept of smart gas grids will enable the integration of electricity, gas, heating and cooling and the optimisation of both overall energy efficiency and overall grid(s) efficiency.

Further development will be required to ensure that the options are fully exploited. This will require the cooperation of all stakeholders and the development of suitable market mechanisms.

The use and the concept of smart gas grids are very different from smart electricity grids, in particular due to the greater possibility, compared to electricity grids, of readily storing energy Smart electricity grids aim to optimise the electricity market and economy. By contrast, smart gas grids aim to create a fruitful and flexible interaction between gas grids and other networks including electricity grids, and other distributed sources of gas.

For smart grids to be successful in achieving the ambitions set out in this report, EG4 recommends (in addition to the standardisation recommendations given in chapter 10) the following regulations/actions on European level:

- Define the responsibilities for gas quality and composition at a European level. At present this is different and/or not clearly defined in the different European member states.
- Promote smart gas utilisation and gas appliances which accept a wider range of gas compositions. This would increasingly allow a wider range of gas composition in the network.
- Align the 3rd energy package directives in order to allow for more interaction between energy carriers.
- Promote NGVs, especially in relation to public transport and commercial / goods vehicles
- Promote cooling with gas, based on absorption.
- Stimulate projects on smart gas grids at European level (such EU FP7 or future EU FP8).
- Stimulate development of bio-synthetic natural gas pilot plants.
- Promote biomethane injection generally, including by the provision of subsidies and the setting of European targets, as a route to decarbonising gas supplies. This would facilitate the continued efficient use of the existing extensive gas network whilst achieving greenhouse gas reduction targets. Reduction of the costs of grid injection will also be an important component of this activity, to avoid project developers choosing to use biogas for low-efficiency electricity generation rather than gas grid injection.
- Develop a regulatory framework to provide incentives for smart grids deployment.