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# Technical Assistance for Improvement of Performance-Based Tariff Regulation of EMRA for Turkish Energy Markets through Introducing an Enhanced Monitoring System

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## Task 4: Preparation of Smart Grid Road Map and Required Methodological Tariff Approaches for Natural Gas Markets

Activity 4.1 - Smart Grid and Methodological Tariff  
Approaches Report for Natural Gas Sectors (Volume I)

Prepared: August 2020





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## Abbreviations

€/EUR	European Euros
£/POUND	British Pound Sterling (in 2019 1 Euro costs 0.88 POUND)
₺/TL	Turkish Liras (in 2019 1 Euro costs 6.3477 TL)
\$/USD	United States Dollars (in 2019 1 Euro costs 1.12 USD)
ACER	Agency for the Cooperation of Energy Regulators
ACM	The Netherlands Authority for Consumers and Markets
AGC	Automated Generation Control
AI	Artificial Intelligence
API	Application Programming Interface
APMS	Asset Performance Management System
ARERA	The Italian Regulatory Authority for Energy, Networks and Environment
ATR	Auto Thermal Reforming
BAU	Business as Usual
BioSNG	Bio-Synthetic Natural Gas
BOTAS	The Turkish Petroleum Pipeline Company
BOTAS	Turkish Gas Transmission Co.
BRP	Balancing Responsible Parties
CAPEX	Capital Expenditures
CBA	Cost-Benefit Analysis
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilization and Storage
CEDEC	The European Federation of Local Energy Companies
CEER	Council of European Energy Regulators
CEN	European Committee for Standardization
CEP	Clean Energy Package
CfD	Carbon Contracts for Difference
CHP	Combined Heat and Power
CIM	Common Information Model
CIP	Critical Infrastructure Protection
CISO	Chief Information Security Officer
CNG	Compressed Natural Gas
CRE	The French Energy Regulatory Commission
CRU	The Commission for Regulation of Utilities
CVD	Clean Vehicles Directive
DCS	Distributed Control System
DER	Distributed Energy Resources
DPIA	Data Protection Impact Assessment Template
DSO	Distribution System Operator
EAM	Enterprise Asset Management
EBB	Electronic Bulletin Board
EBRD	European Bank for Reconstruction and Development
EC	European Commission





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EMRA	Energy Market Regulatory Authority
ENISA	European Union Agency for Cybersecurity
ENTSOG	European Network of Transmission System Operators for Gas
EnWG	German Energy Industry Act
EREG	European Regulators' Group for Electricity and Gas
ERP	Enterprise Resource Planning
ESB	Enterprise Service Bus
EU	European Union
EUR	Euro
FCH JU	Fuel Cells and Hydrogen Joint Undertaking
GDN	Gas Distribution Networks
GDPR	General Data Protection Regulation
GIS	Geographic Information System
GNI	Gas Networks Ireland
GO	Guarantees of Origin
GRDF	Gas Network Distribution France
GTM	Gas Target Model
GWh	1 Billion-Watt Hours
HDFS	Hadoop Distributed File System
ICT	Information and Communication Technology
IED	Intelligent Electronic Device
IMS	Information Management System
INC	Interoperability Network Code
IoT	Internet of Thing
IPCEI	Important Projects of Common European Interest
IRM	Innovation Rollout Mechanism
IT	Information Technologies
KPI	Key Performance Indicator
LCNG	Liquid to Compressed Natural Gas
LNG	Liquified Natural Gas
LPG	Liquefied Petroleum Gas
MDMS	Meter Data Management System
ML	Machine Learning
MsbG	Metering Act
NERC CIP	North American Electric Reliability Corporation Critical Infrastructure Protection
NG	Natural Gas
NGG	National Grid Gas
NGN	Northern Gas Network
NGV	Natural Gas Vehicle
NIA	Network Innovation Allowance
NIC	Network Innovation Competition
NIP	National Innovation Programme
NIS	Network and Information Security
NRA	National Regulatory Authority



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NTS	National Transmission System
OES	Operators of Essential Services
Ofgem	Office of Gas and Electricity Markets
OIES	Oxford Institute for Energy Studies
OMS	Outage Management System
OPEX	Operational Expenses
OT	Operation Technology
OTA	Over the Air
P2G	Power-to-Gas
PE	Polyethylene Pipe
PES	Primary Energy Sources
PET	Privacy Enhancing Technologies
PLC	Programmable Logic Controller
PPP	Public Private Partnership
QoS	Quality of Service
R&D	Research and Development
RAB	Regulatory Asset Base
RED	Renewable Energy Directive
RES	Renewable Energy Source
RIIO	Revenue=Incentive + Innovation + Output
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SCBA	Societal Cost Benefit Analysis
SGN	Scotia Gas Networks
SMR	Steam Methane Reforming
SMS	Short Message Services
SNG	Synthetic Natural Gas
TD	Technical Domain
TIGF	Total Infrastructure Gaz France
TOTEX	Total Expenditure
TPA	Third Party Access
TSO	Transmission System Operator
TYNDP	Ten Year Network Development Plan
TYNP	Ten Year Network Development Plan
UK	United Kingdom
WACC	Weighted Average Cost of Capital
WFM	Workforce Management
WWU	Wales & West Utilities





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## 1 Introduction to Entire Report

As part of the TARIFF Project's Task 4, "Preparation of Smart Grid Road Map and Required Methodological Tariff Approaches for Electricity and Natural Gas Markets", one of the deliverables is to review and assess EU and Turkey practices regarding deployment of smart grids, and deliver a report on the regulatory recommendations and roadmap for electricity and natural gas distribution and transmission sectors.

The main objective of Task 4.1 report is the elaboration of a comparative desktop analysis, so to assist to the Beneficiary to identify amendment options for secondary legislation, as well as developing a smart grid roadmap in line with best practices.

Task 4.1 report has been organized in 2 separate volumes:

- Volume-I: Smart Grid and Methodological Tariff Approaches Report for Natural Gas Sectors
- Volume-II: Smart Grid and Methodological Tariff Approaches Report for Electricity Sectors

The scope of this report (Volume-I<sup>1</sup>) consists of the following elements:

- Gas Distribution Sector Report
- Gas Transmission Sector Report

Within the individual sections, practices, adopted by selected European Countries, were examined in depth to realize a gap analysis with the practises adopted by the beneficiary country and to elaborate the needed recommendations. Also, smart grid roadmap has been developed for the mentioned sectors.

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<sup>1</sup> Relevant chapters for Electricity Distribution and Transmission are presented in Volume-II.





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## 2 Gas Distribution Sector Report

### 2.1 Introduction of Gas Distribution Part

To meet the European goals for energy transition, the development of smart and integrated networks is of great importance. These smart networks need to be developed following a holistic energy system approach that includes gas, electricity, heat, transport and information technologies. Moreover, as network and gas utilization will play a major role in achieving the efficiency goals and will enable cost saving solutions for many problems encountered in the electricity networks.

This holistic energy system approach requires active networks with interactive functionalities to integrate multiple energy sources and services to foster the participation and engagement of consumers in using and producing energy more efficiently. In contrast with electricity grid that require real-time responses to sudden changes in demand, peak load reduction or load control, gas networks are inherently more flexible due to their ability to store large amounts of energy. However, as the uncertainties related to future development of efficient and large-scale electricity storage technologies remain, gas will increasingly become a key provider of both heating and electricity balancing services.

An overview of the interaction between the smart gas grid networks with the ICT and electricity networks is illustrated in Figure 1 below.

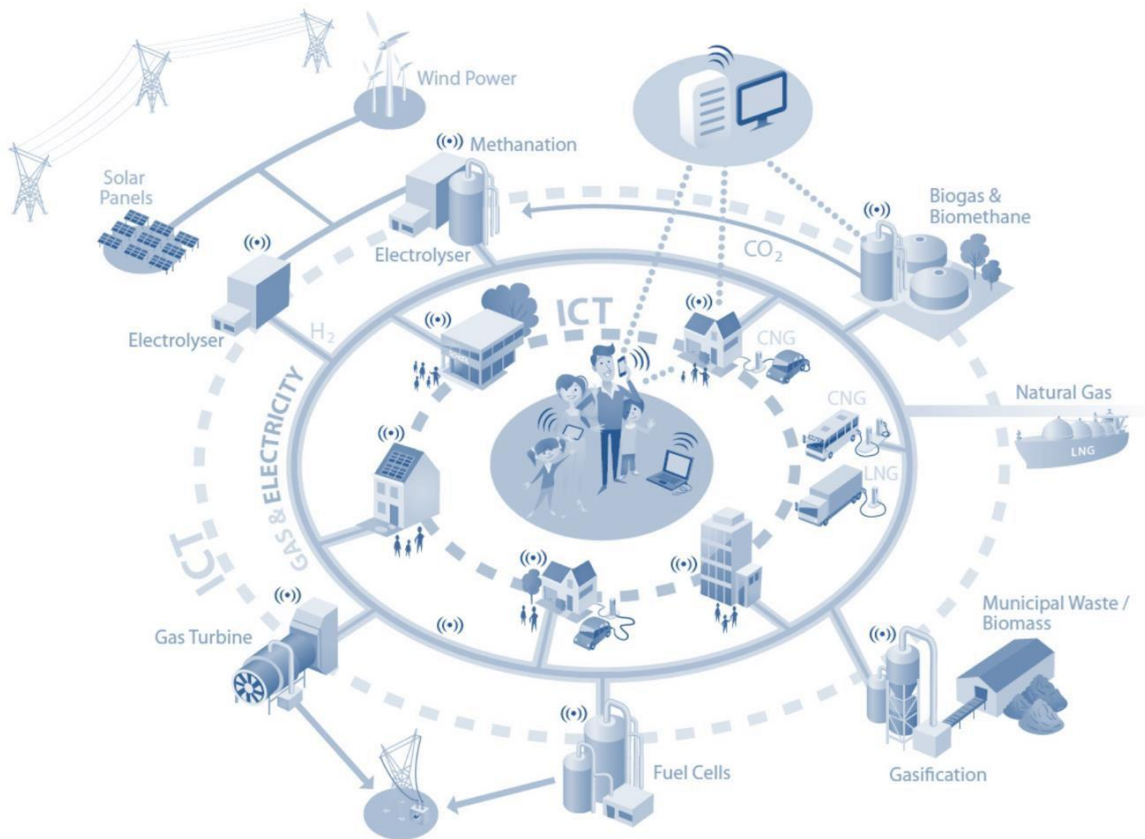


Figure 1: Smart Energy Networks (Source: Eurogas)



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The major benefits of smart gas grids are:

- Reducing greenhouse gas emissions,
- Increasing the share of renewable energy (biomethane, syngas, injection of H<sub>2</sub>, etc.),
- Optimising the intermittent production of renewable energy,
- Contributing to improve the security of supply,
- Improving energy efficiency by enabling the active participation of the end users,
- Creating the conditions for efficient use of energy networks, giving consumers the ability to choose the most economic energy source in real-time, and at the same time save energy,
- Avoiding costly investments in electricity grids by using gas networks and gas appliances, supporting economic development,
- Enabling consumers to become “prosumers” by using gas to lower the “peaks” in the electricity network and to reduce energy losses in the electricity transmission and distribution networks,
- Enabling synergies between gas and electricity networks through the encouragement of distributed generation; and
- Comparing with electricity, gas can be stored more cost-efficiently and the scope for local production is limited to the feed-in of alternative gases such as biogas.

## 2.2 European Legislative Framework Related to Smart Grids

An overview of the legislative framework related to smart grids for gas distribution is provided in below. Since smart grids for the gas distribution sector is highly related upon the deployment of smart meters for gas, a specific focus is given in this area.

Table 1: Directives and regulations related to smart grids for gas distribution

Directive/Regulation	Description
<b>Directive 2009/73/EC</b>	Directive 2009/73/EC sets that in order to promote energy efficiency, Member States or the National Regulatory Authority (NRA) shall strongly recommend that natural gas undertakings optimize the use of gas, for example by providing energy management services, developing innovative pricing formulas or introducing intelligent metering systems or smart grids where appropriate.





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Directive/Regulation	Description
<b>Directive 2012/27/EC</b>	This Directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20 % headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy and provides for the establishment of indicative national energy efficiency targets for 2020. The requirements laid down in this Directive are minimum requirements and shall not prevent any Member State from maintaining or introducing more stringent measures. Such measures shall be compatible with Union law. Where national legislation provides for more stringent measures, the Member State shall notify such legislation to the Commission.
<b>Recommendation 2012/148/EU</b>	Provides additional instructions on the deployment and the minimum common features of smart metering systems as well as on data protection and privacy of final customers. It requires Member States to ensure that network operators are incentivized to improve efficiency in infrastructure design and operation, and, within the framework of Directive 2009/72/EC, that tariffs allow suppliers to improve consumer participation in system efficiency, including demand response, depending on national circumstances.
<b>Recommendation 2014/724/EU</b>	Commission Recommendation 2014/724/EU on Data Protection Impact Assessment Template (DPIA) for smart grids and smart metering systems provides guidance to Member States on measures to be taken for the positive and wide-ranging dissemination, recognition and use of the Data Protection Impact Assessment Template for Smart Grid and Smart is also applicable to natural gas metering systems.
<b>Directive 2019/944/EU</b>	The Directive EU 2019/944 updates the common rules for the generation, transmission, distribution, energy storage and supply of electricity. Specific provisions related to smart metering systems are included from Article 19 to Article 21, and Annex II.

### 2.2.1 Directive 2012/27/EC

Provisions of Directive 2012/27/EC on energy efficiency are also applicable to natural gas meters. Article 9 of Directive 2012/27/EC reads:

*“Where, and to the extent that, Member States implement intelligent metering systems and roll out smart meters for natural gas [...]:*

*(a) they shall ensure that the metering systems provide to final customers information on actual time of use and that the objectives of energy efficiency and benefits for final customers are fully taken into account when establishing the minimum functionalities of the meters and the obligations imposed on market participants;*

*(b) they shall ensure the security of the smart meters and data communication, and the privacy of final customers, in compliance with relevant Union data protection and privacy legislation; [...]*





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*(e) they shall require that appropriate advice and information be given to customers at the time of installation of smart meters, in particular about their full potential with regard to meter reading management and the monitoring of energy consumption.”*

### **2.2.2 Recommendation 2014/724/EU**

Commission Recommendation 2014/724/EU on Data Protection Impact Assessment Template (DPIA) for smart grids and smart metering systems provides guidance to Member States on measures to be taken for the positive and wide-ranging dissemination, recognition and use of the Data Protection Impact Assessment Template for Smart Grid and Smart is also applicable to natural gas metering systems. In summary, for natural gas systems we see an effort made by the European Commission for alignment of the relevant provisions for gas smart metering to those offered for electricity meters. Nevertheless, such efforts and relevant recommendations are to a grant extend much lighter than those for natural gas.

### **2.2.3 Directive 2009/73/EC**

Directive 2009/73/EC sets that in order to promote energy efficiency, Member States or the National Regulatory Authority (NRA) shall strongly recommend that natural gas undertakings optimize the use of gas, for example by providing energy management services, developing innovative pricing formulas or introducing intelligent metering systems or smart grids where appropriate (Article 4).

Further, Annex I of the Directive lists measures on consumer protection. In paragraph (2) of Annex I, Member States are called to ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the gas supply market. The Directive provides that the implementation of those metering systems may be subject to an economic assessment of long-term costs and benefits (CBA) to the market and the individual consumer. The form of intelligent metering which is economically reasonable and cost-effective must be considered together with a relevant feasible timeframe. Such assessment should take place by 3 September 2012.

The Directive specifies that subject to the CBA assessment above, Member States or the NRA, shall prepare a timetable for the implementation of intelligent metering systems, ensure the interoperability of those metering systems to be implemented and shall have due regard to the use of appropriate standards and best practices and the importance of the development of the internal market in natural gas. No obligation for a specific target exists as is the case with electricity. The respective Electricity Directive (2009/72/EC) sets a target of up to 10 years for the implementation of intelligent metering systems and for at least 80% of consumers to be equipped with intelligent metering systems by 2020 in case of a positive CBA assessment. No such explicit provisions are found in Directive 2009/73/EC for gas. Thus, provisions for natural gas smart metering are clearly, and by substance, lighter than the ones provided for electricity.

### **2.2.4 Recommendation 2012/148/EU**

The definition of smart metering has been provided by the Commission Recommendation 2012/148/EU on the preparation for the roll-out of smart metering systems:

*“‘smart metering system’ means an electronic system that measure energy consumption, adding more information than a conventional meter, and can transmit and receive data using a form of electronic communication. “.*

In accordance with Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC and Directive 2009/73/EC





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of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC, Member States are required to ensure the implementation of smart metering systems that assist the active participation of consumers in the electricity supply and gas supply markets and implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of smart metering is economically reasonable and cost-effective and which timeframe is feasible for their deployment.

### 2.2.5 Directive 2019/944/EU

The Directive EU 2019/944 updates the common rules for the generation, transmission, distribution, energy storage and supply of electricity. Specific provisions related to smart metering systems are included from Article 19 to Article 21, and Annex II.

Article 19 recalls the provision under which Member States shall recommend energy market undertakings to implement smart metering systems. Although the Article 19 mentions “electricity markets”, the stipulated provisions are also applicable for the gas market as well. Specifically, Article 19 states the following:

- Member States shall ensure the deployment of smart metering systems to foster the active participation of customers in the energy market, subject to a cost-benefit analysis (CBA) according to what is stipulated in Annex II of the Directive, as well as in Recommendation 2012/148/EU,
- Member States shall adopt and publish the minimum functional and technical requirements for the smart metering systems to be deployed in their territories, in accordance with Article 20 and Annex II of the Directive,
- Member States shall ensure the interoperability of the smart metering systems, as well as their ability to provide output for consumer energy management systems, by ensuring compliance of the said systems with the relevant available standards, including those enabling interoperability, to best practices and to the importance of the development of smart grids,
- Member States shall ensure that final customers contribute to the associated costs of the deployment in a transparent and non-discriminatory manner, while taking into account the long-term benefits to the whole value chain, and
- Member States at which the smart metering systems have been negatively assessed via the CBA, shall ensure that this assessment is revised at least every four years, or more frequently, in response to significant changes in the underlying assumptions and in response to technological and market developments.

Moreover, according to Article 20 in case of Member States where the deployment of the smart metering systems has been positively assessed via the CBA, smart metering systems should be in accordance with European standards, the Commission Recommendation 2012/148/EU, and with other specific requirements as per Article 9 of the Energy Efficiency Directive 2012/27/EU, such as:

- The information that metering systems provide to final customers on actual time of use,
- The security of the smart meters and data communication, and the privacy of final customers,
- The availability of these data for the customers; and
- The appropriate advice and information be given to customers at the time of installation of smart meters





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Article 21 states that customers are entitled to a smart meter, even where the deployment of smart metering systems has been negatively assessed. In such case, customers should bear the associated costs of deployment, under fair, reasonable and cost-effective conditions.

Article 23, which is related to data management of smart metering data. The processing of personal data within the framework of this Directive shall be carried out in accordance with Regulation (EU) 2016/679. Moreover, Article 23 stipulates that:

- Member states shall specify the rules on the access to data of the final customer by eligible parties in accordance with this article and the applicable union legal framework,
- Member states shall organise the management of data in order to ensure efficient and secure data access and exchange, as well as data protection and data security,
- The rules on access to data and data storage for the purpose of this directive shall comply with the relevant union law,
- Member states shall authorise and certify or, where applicable, supervise the parties responsible for the data management, in order to ensure that they comply with the requirements of this directive, and
- No additional costs shall be charged to final customers for access to their data or for a request to make their data available.

Article 24, which is related to the interoperability requirements and procedures for access to data from smart metering systems, lays down the following:

- Member States shall facilitate the full interoperability of energy services within the Union, and
- the Commission shall adopt, by means of implementing acts, interoperability requirements and non-discriminatory and transparent procedures for access to data, and

Finally, Annex II “Smart Metering systems” of the recast Electricity Directive states, with respect to the aforementioned CBA, that:

*“Subject to that assessment, Member States or, where a Member State has so provided, the designated competent authority, shall prepare a timetable with a target of up to ten years for the deployment of smart metering systems.*

*Where the deployment of smart metering systems is assessed positively, at least 80% of final customers shall be equipped with smart meters either within seven years of the date of the positive assessment or by 2024 for those Member States that have initiated the systematic deployment of smart metering systems before the date of entry into force of this Directive”.*

## 2.2.6 Legal and Regulatory Framework at Energy Community Level

The core Energy Community Acquis Communautaire includes the following legal acts with provisions for smart metering:

- Directive 2009/73/EC concerning common rules for the internal market on natural gas
- Directive 2010/31/EC on the energy performance of buildings
- Directive 2012/27/EC on energy efficiency





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Commission Recommendations 2012/148/EU on the preparations for the roll-out of the smart metering systems and 2014/724/EU on Data Protection Impact Assessment Template (DPIA) for smart grids and smart metering systems have not been transposed in the Energy Community, nevertheless they provide relevant guidance to also Energy Community Contracting Parties. The only difference between the Directive 2009/73/EC as Incorporated and adapted by Ministerial Council Decision 2011/02/MC- Energy Community for the Energy Community and the European original legal document is the deadline for the CBA assessment set in Annex I. In the Energy Community legal framework the respective deadline for the economic assessment of all the long-term costs and benefits to the market and the individual consumer (or the assessment on which form of intelligent metering is economically reasonable and cost-effective) and which timeframe is feasible for their distribution is the 1st January 2014 as opposed to 1st January 2012 for EU Member States.

### 2.3 Smart Grid Regulations in Gas Distribution: International Benchmark

The analysis of international experiences aims to extract relevant information necessary to know how smart grids for gas distribution are implemented in selected European countries. We have analysed the regulatory framework.

The following countries are considered in the analysis:

- United Kingdom,
- Italy,
- Ireland,
- France, and
- Finland.

#### 2.3.1 United Kingdom

The UK's RIIO framework stands for **Revenue = Incentives + Innovation + Outputs** and is considered as one of the most comprehensive performance-based regulatory frameworks. The RIIO has been developed in such a way so that it rewards utilities for achieving desired outcomes.

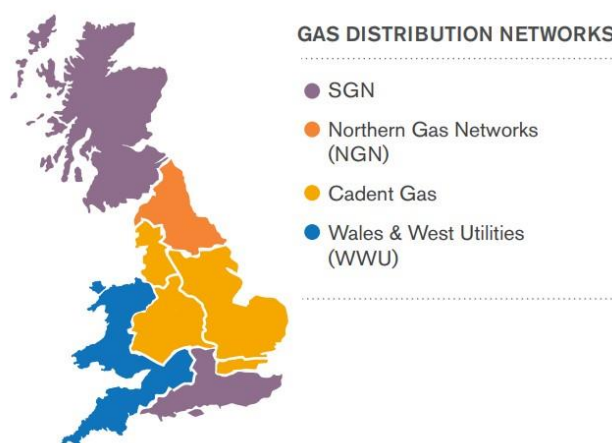


Figure 2: Gas Distribution Networks in UK



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### 2.3.1.1 Network Regulation: The RIIO Model

The primary objective of the RIIO model is to foster the development of the electricity and gas networks in an efficient manner towards sustainable energy markets. The first RIIO control for gas distribution was introduced in 2013. A schematic overview of the RIIO model is shown in Figure 3.

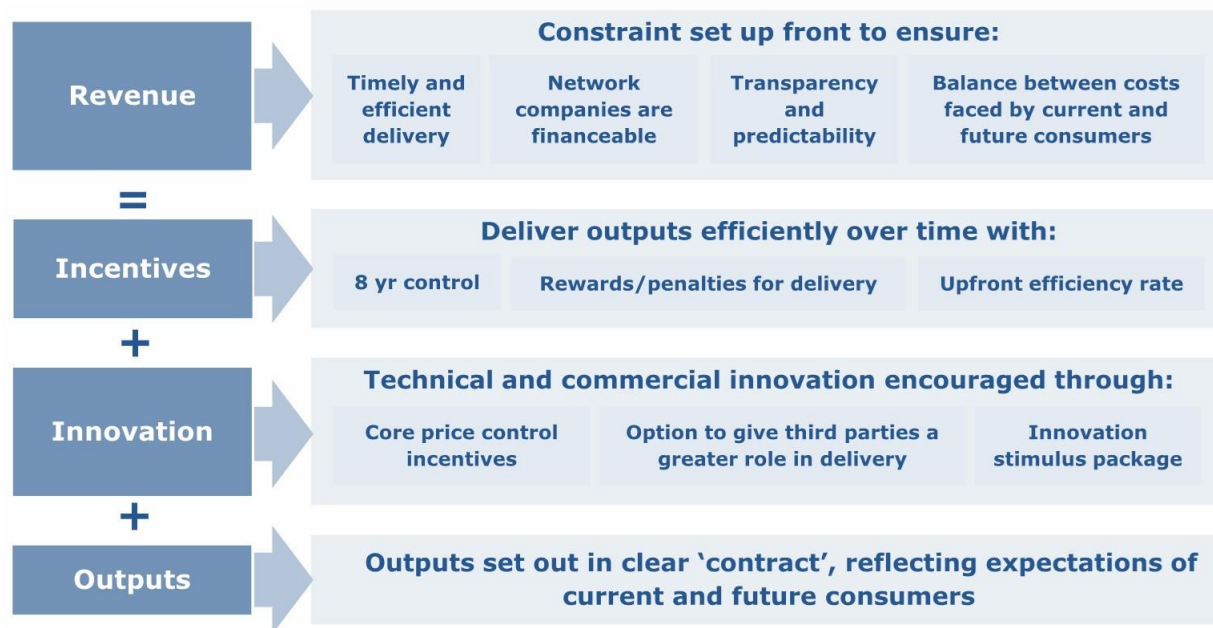


Figure 3: The RIIO Model

The RIIO model consists of four (4) main features, selected in such a way to encourage utilities to innovate and achieve favourable outputs:

- A multi-year rate plan,
- The total expenditure (TOTEX) approach,
- Performance incentives, and
- An innovation fund.

### 2.3.1.2 RIIO-GD1 Network Price Control

RIIO-GD1<sup>2</sup> is the first price control review for gas distribution to use the RIIO model of network regulation. The RIIO-GD1 price control specifies the goals that the eight (8) Gas Distribution Networks (GDNs) need to deliver to their customers. Moreover, it stipulates the associated revenues that the gas distribution network operators are allowed to collect for the eight-year period ranging from 1 April 2013 until 31 March 2021. The main purpose of the RIIO network regulation model is to incentivize gas DSOs to provide their customers with real benefits, while at the same time drives the gas distribution companies to address the challenges of delivering a low carbon, sustainable energy sector at value for money for existing and future customers.

As a continuation of RIIO, for which the current price controls for gas distribution (RIIO-GD1) end on March 31, 2021, RIIO-2 will be the next price controls for the network companies running the gas and electricity transmission

<sup>2</sup> <https://www.ofgem.gov.uk/gas/distribution-networks/network-innovation>



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and distribution networks. In order to foster even more the reduction of costs for consumers and gas DSOs, as well as to promote the energy transition via innovation and competition, the following decisions were taken by Ofgem for the RIIO-2 framework:

- to retain an innovation stimulus package, limited to innovation projects that might not otherwise be delivered under the core RIIO-2 framework. Ofgem will carry out further work on three broad areas of reform
  - Increased alignment to energy transition challenges,
  - Greater coordination with wider public funding and
  - Increased third party engagement (including potential direct access)
- to extend the role of competition (for the market) where it is appropriate and provides better value for consumers to identify projects suitable for competition in other sectors.

### ***Gas Network Innovation Competition***

The gas Network Innovation Competition (NIC), which is part of Ofgem's RIIO price controls, is an annual opportunity for gas network companies to compete for getting funding to develop and demonstrate new technologies, as well as operating and commercial agreements. The requested funding will be awarded to the best innovation projects that foster the understanding of gas network operators on what needs to be done to provide environmental benefits, as well as to reduce costs and maintain security of supply as UK moves towards a low carbon economy. The available funding under the gas NIC is up to £20 million per annum.

### ***Gas Network Innovation Allowance***

The Network Innovation Alliance (NIA), which is also part of the RIIO-GD1 price control of Ofgem, is a set allowance that is received by each RIIO network licensee as part of their price control allowance.

Funding under NIA is limited and can be used for:

- funding smaller technical, commercial, or operational projects directly related to the licensees' network that have the potential to deliver financial benefits to the licensee and its customers; and/or
- funding the preparation of submissions to the Network Innovation Competition (NIC) which meet the criteria set out in the NIC Governance Document.

NIA focuses on the funding of innovative pilot projects as part of its price control settlement. In this respect, the NIA provides funding to smaller R&D and demonstration projects covering all aspects of innovation, such as commercial, technological, and operational. On the other hand, NIC focuses on more complex innovative projects, a fact that also justifies its annual competitive process, and has the potential of supporting projects that deliver low carbon and/or environmental benefits to customers.

The amount of funding under NIA that is available to each Network Licensee can be calculated using the formulae in the NIA Licence Condition. Moreover, the allowance is set at the start of the price control based on the quality of the innovation strategy proposed. Under the RIIO-GD1 price control for gas distribution a 0.5 to 1% of yearly revenue is allocated. Moreover, a maximum of 90% of NIA expenditure can be covered by the set allowance. With regards to NIC, in 2017-2018, two gas distribution network projects were selected by Ofgem to receive a total of £15.2 million of NIC funding. Ofgem have committed to making £20 million available each year through the Gas NIC





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annually until March 2021<sup>3</sup>. Additionally, the RIIO-GD1 price control period 2013-2021, the percentage of innovation within allowed revenues for gas DSOs under the NIA was between 0.5% (SGN and WWU) and 0.6% (NGGD and NGN). For the NIC, the percentage of innovation within allowed revenues as 0.6%. Finally, depending on the chosen method, the total innovation funding available for UK’s gas distribution companies is around 1% of TOTEX, as per the RIIO-GD1 decision. The main difference is that half of this funding is subject to competition, where only the best innovation projects proposed receive funding. This ensures that through this competition the risk of projects not delivering benefits to the customers is reduced.

### 2.3.1.3 Innovation Roll-out Mechanism

Ofgem’s innovation stimulus, apart from the NIA and NIC measures, also includes an Innovation Roll-out Mechanism (IRM). The purpose of IRM is to fund the roll-out of proven innovations which will contribute to the development of a low-carbon energy sector in UK and provision of broader environmental benefits. The IRM provides funding also to transition proven innovative technologies to business as usual (BAU) if the roll-out of these technologies cannot be funded under the TOTEX allowance of the gas DSO. During RIIO-1, there are two application windows for gas distribution companies to apply for funding. However, Ofgem does not see any compelling evidence for a need of IRM in RIIO-2, mainly due to the fact that the price control period of five (5) years in RIIO-2 raises the need for a dedicated funding mechanism for the support of roll-out. Additionally, gas DSOs will to be supported via the TOTEX incentivization mechanism to roll-out of proven innovative technologies, by retaining a share of any efficiency savings that result.

### 2.3.2 Italy

Italy has more than 200 gas distribution and metering companies, with the smallest service less than 5.000 clients, while the largest distribution company serves more than 5.000.000 customers<sup>4</sup>. The distributed volume of gas is more than 20 billion m<sup>3</sup>, while the aggregated RAB is approximately 17 billion EURO.

The current distribution tariff system in Italy is illustrated in Figure 4 shown below.

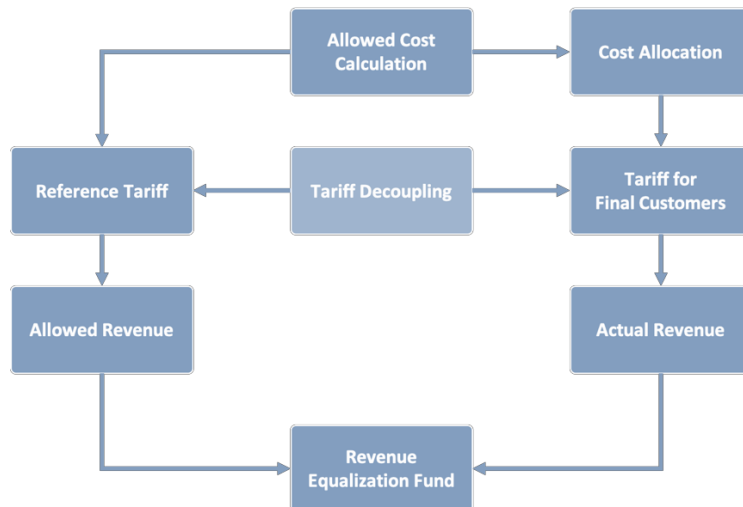


Figure 4: Current distribution tariff system in Italy (Source ARERA)

<sup>3</sup> “Gas Network Innovation Competition Governance Document – v3.0”, Ofgem, 2017

<sup>4</sup> “Distribution Tariff Setting Methodologies in Italy”, ARERA 2019



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The way the tariff regulation has been evolving in Italy is shown graphically in Figure 5, where it is shown that, starting from 2008, innovation plays an important role either through pilot projects that support innovation or output-based incentives for innovation activities related to smart grids. This approach of supporting innovation has also been integrated in the new regulatory strategic framework approved with the decision 242/2019/A (June 2019), in a more comprehensive regulation by objectives of services and expenditure (ROSS) approach.

		<b>Innovation</b>				
			Pilot Project Supporting Innovation	Output Based Incentives for Smart Grids	<b>ROSS</b>	
<b>Quality</b>	Quality of Service (Output Based)	Quality of Service (Output Based)	Quality of Service (Output Based)	Quality of Service (Output Based)		
<b>Cost of Service</b>	Price Cap (Capital Costs and Operating Costs)	Rate of Return (Capital Costs) + extra-WACC	Rate of Return (Capital Costs) + extra-WACC	Rate of Return (Capital Costs) + phase out extra-WACC		
		Price Cap (Operating Costs)	Price Cap (Operating Costs)	Price Cap (Operating Costs)		
					Innovation Support Output-based Incentives (Quality Resilience) Forward-looking Approach Efficiency Incentives	
	Pre-privatization	2000	2004	2008-2012	2016	202x

Figure 5: Evolution of tariff regulation in Italy (Source ARERA)

The building blocks of allowed cost calculation in Italy are shown in Figure 6 below.

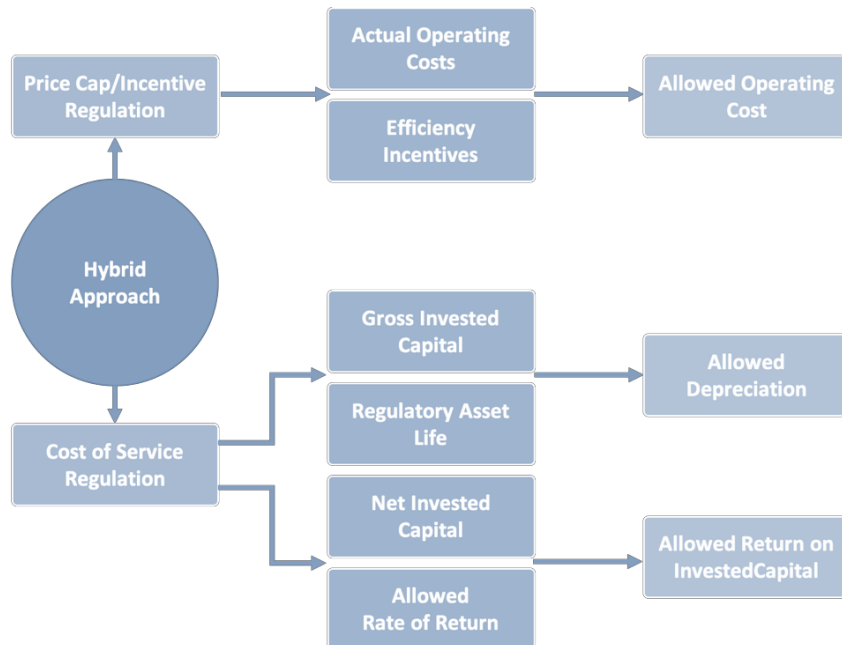


Figure 6: Building blocks of allowed cost calculation in Italy (Source ARERA)

The allowed operating costs are basically aligned to actual cost at the beginning of each regulatory period that lasts for 6 years (previously 4 years). Moreover, the actual costs are calculated on the basis of costs reported in the separated annual accounts according to the unbundling rules defined by the NRA. It should be mentioned that the



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actual costs considered to set the allowed operating costs are net of non-recurring costs, financial costs, advertising and marketing costs, sanctions, tax funds, litigation costs (if unsuccessful), and not compulsory insurance costs<sup>4</sup>.

The Italian NRA, the Autorità di Regolazione per Energia Reti e Ambiente (ARERA, previously AEEGSI), follows a six-year period for gas distribution, where revenues are being established ex-ante with a RAB-based approach and with deviations from forecast expenses being treated differently according to whether they are operational (incentive regulation) or capital (cost of service).

Starting from 2020, a TOTEX approach will be adopted for both electricity and gas to cope with the distortion that may be posed by the current regulatory approach. Under the TOTEX approach CAPEX and OPEX are treated in the same way by the regulatory authority. Finally, the implementation of smart grid and innovation projects are incentivized by a 2% increase in the WACC for twelve (12) years. The TOTEX approach is considered by ARERA more efficient compared to the present hybrid approach (price cap applied to operating costs and cost of service regulation applied to capital costs). In the new regulatory strategic framework approved with the Decision 242/2019/A (June 2019) the TOTEX approach has been integrated in a more comprehensive regulation by objectives of service and expenditure approach (ROSS). Moreover, DCO 335/2015 outlines the key features of TOTEX approach:

- focus on future expenditure;
- output orientation; and
- stronger incentive to improve total productivity.

It should be mentioned that the adoption of a TOTEX approach implies giving more relevance to forecast and business plans. Due to information asymmetry, it is therefore necessary to introduce “truth telling” incentives in order to obtain credible business plans from regulated companies. Also, cost assessment and total expenditure analysis play a key role in the implementation of TOTEX, while at the same time requires to strengthen enforcement, in order to control the actual level of outputs and of expenditure.

### 2.3.3 Ireland

The purpose of Gas Innovation Fund is to encourage creativity and foster innovation in the gas sector, by supporting solutions that meet the needs of the gas industry, thus making innovation part of the GNI and the gas industry. The establishment of the Innovation Fund was approved by the Commission of Regulation of Utilities (CRU) under PC3. The purpose of this fund is to support innovation in the gas industry. Under GNI’s fourth price control (PC4) a new gas innovation fund was allowed.

In the context of CRU’s decision PC4 an OPEX allowance was provided to support innovation funding for the PC4 period ranging from October 2017 to September 2022. In making its decision the CRU was “mindful that ongoing utilisation of the gas network is important so as to ensure that gas remains competitive as a fuel and that tariffs are contained for customers”. It should be mentioned that gas innovation funding has been provided for the Causeway Study, governance and programme management, Research and Strategic Projects.

The Causeway Study is a jointly funded project by EU and CRU that its main focus is to study the impact that the installation of 14 CNG stations in Ireland will have on the gas network. A grant of €6.5m was provided by the EU, while CRU has approved an additional €12.83m for the study to be completed. The allowance for the Causeway Study makes up the majority of the €17.5m that was approved by the regulator for innovation. It should be mentioned that CRU indicated that an additional €2.5m might be available at a later date in PC4 for innovation





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funding and that the decision about the additional €2.5m will be informed by the outcomes and outputs of the innovation fund throughout PC4. Finally, CRU has provided an allowance of €0.5m for the PC4 period to GNI to maintain the innovation framework developed during PC3, as well as for purposes of program management.

### 2.3.4 France

An incentive scheme for R&D costs has been introduced by the French Energy Regulatory Commission (Commission de regulation de l'énergie – CRE) in the current price control started in 2017. CRE uses a revenue cap with a four-year regulatory period. For each year, the revenues are set ex-ante, serving as an estimation of OPEX and a return on the RAB. It should be mentioned that OPEX and CAPEX are treated differently, thus forming a hybrid system in which OPEX are subject to incentive regulation while CAPEX is subject to rate of return regulation and can thus create incentive bias. CRE also introduced a further differentiation between network and non-network expenses. While network expenditures are treated as before, for non-network expenditures OPEX and CAPEX are subject to the same incentives.<sup>5</sup>

The need for gas DSOs to lead the necessary innovation actions and R&D projects in order to provide to their customers efficient and high-quality services was recognized as a need by CRE. CRE aim is to ensure that GRDF, the gas distribution company of France, has the necessary resources for carrying out the required R&D activities and that these resources are used in the most efficient manner.

In this respect, CRE defines as an R&D budget all the amounts that will be used for R&D, as well as for performing the necessary innovation activities. The present decision introduces a mechanism aimed at providing GRDF with the means to carry out the R&D projects required for the construction of the networks of the future by guaranteeing in particular that tariff matters do not hinder R&D projects. Moreover, GRDF has also set up a mechanism for monitoring gas-related projects, in order to provide gas market stakeholders with visibility into the innovation projects fostered and funded by GRDF.

R&D forecasted expenditure presented by GRDF for smart grid projects is included in the incentive-based regulation mechanism. However, these expenses exclude R&D activities focused on increasing the number of customers connected to the gas networks and, as such, they are not taken into account in the regulation mechanism, but rather they fall within a specific incentive-based regulation. It should be mentioned that the R&D costs related to smart grid projects that were considered in the ATRD5 tariff, represent an average €10.7 M per year over the 2016-2019 period.

Actual R&D OPEX incurred by GRDF are reviewed by CRE at the end of the tariff period. Any positive difference between the forecasted and actual trajectories will be returned to the customers. For the reviewing purposes, GRDF submits to CRE a review of the previous year. This review is submitted before the end of the first quarter of each calendar year. Any recorded annual differences between the forecasted and actual trajectories need to be justified by GRDF within the annual report that is submitted to CRE. Finally, CRE publishes a biannual report with the R&D actions performed by GRDF that provides visibility into the innovation projects led by GRDF and funded under the ATRD tariff.

<sup>5</sup> Regulation, Innovation, and Systems Integration: Evidence from the EU





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### 2.3.5 Finland

According to CEER<sup>6</sup>, the aim of incentivizing innovation is to foster the development and use of innovative technical and operational solutions by the network operators in their operations. This way the gas distribution network operator may incur research and development costs before the new technologies are in full use and utilisable. The Finnish NRA deducts reasonable R&D costs during the calculation of realised adjusted profit for network operators, in order to foster the active innovation and R&D efforts. However, acceptable R&D and innovation activities costs must be recorded as expenses in the unbundled profit and loss account since capitalised R&D costs are not accepted to be included in the calculation of the innovation incentive. Moreover, the acceptable R&D costs need to be directly related to new knowledge creation, as well as use of new technologies and the development of products or network operation methods for the gas distribution sector.

Finally, the impact of the innovation incentive is deducted when calculating realised adjusted profit. The impact of the innovation incentive is calculated so that a share corresponding to a maximum of 1% of the DSO's total turnover from network operations in the unbundled profit and loss accounts in the regulatory period are treated as reasonable research and development costs. The incentive is applied to all network operators.

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<sup>6</sup> CEER – Report on Regulatory Frameworks for European Energy Networks 2019





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### 2.3.6 Recap of EU Countries

Table 2 provides an overview of the cross-country comparison of smart grid incentives/funding mechanisms, as well as of smart grid areas for gas DSOs.

Table 2: Cross-country Comparison of Smart Grid Incentives/Funding Mechanisms and Areas for Gas DSOs

Smart Grid for Gas Distribution	United Kingdom	Ireland	Italy	France	Finland
<b>Smart Grid and Innovation Regulatory Incentives in use</b>	Two funding mechanisms in place for innovation projects: The Network Innovation Alliance (NIA) and the Network Innovation Competition (NIC).	For the price control period ranging from 2013-2017 an allowance of €0.8 million was available for gas distribution innovation OPEX funding.	Starting from 2020, a TOTEX approach will be adopted for both electricity and gas to cope with the distortion that may be posed by the current regulatory approach.	For each year, the revenues are set ex-ante, serving as an estimation of OPEX and a return on the RAB. OPEX and CAPEX are treated differently. OPEX are subject to incentive regulation, while CAPEX is subject to rate of return regulation and can thus create incentive bias.	Innovation incentive is calculated so that a share corresponding to a maximum of 1% of the DSO's total turnover from network operations.
<b>Financing Innovation Incentives</b>	Innovation incentives are included as part of the RIIO model.	Innovation funding is treated as a pass-through cost item and is not part of the efficiency requirement.	Under the TOTEX approach CAPEX and OPEX are treated in the same way by the regulatory authority. The implementation of smart grid and innovation projects are incentivized by a 12% increase in the WACC for twelve (12) years	CRE introduces further differentiation between network and non-network expenses. Non-network expenditures OPEX and CAPEX are subject to the same incentives.	Allowed innovation incentive is recovered from end-users through tariffs.





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Smart Grid for Gas Distribution	United Kingdom	Ireland	Italy	France	Finland
<b>Implementation, Monitoring, Reporting Obligations and Audit</b>	For projects funded under the NIC of Ofgem, the beneficiary has to report, during the project proposal application submission project-specific financial information. A Close Down Report is also submitted for each project that has received NIC funding.	The Gas Innovation Fund requires applicants to provide a detailed budget for any proposal submitted, along with information on budget justification and other co-funding sources.	Information not available.	GRDF submits to CRE a review of the previous year. This review is submitted before the end of the first quarter of each calendar year.	R&D costs should be recorder separately in the unbundled financial statements.
<b>CBA for Smart Meters</b>	Positive	Negative	Positive	Positive	Negative
<b>Considered Market Actors in CBA for Smart Meters</b>	Supplier Consumer State/Society	DSO Supplier Consumer State/Society	DSO Supplier NRA Consumer State/Society BRP Telecom Service Provider	DSO Consumer State/Society	Information not available





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Smart Grid for Gas Distribution	United Kingdom	Ireland	Italy	France	Finland
<b>Considered Costs in CBA for Smart Meters</b>	<p>CAPEX</p> <ul style="list-style-type: none"> <li>Investment in smart meter</li> <li>Investment in IT</li> <li>Investment in Telecom</li> <li>Investment in in-home display</li> <li>Sunk cost of conventional meters</li> </ul> <p>OPEX</p> <ul style="list-style-type: none"> <li>IT maintenance</li> <li>Network management and front end</li> <li>Telecom</li> <li>Change management</li> <li>Unplanned renewal and failures of smart meter</li> <li>Revenue reduction</li> <li>Meter reading</li> <li>Consumer engagement program</li> </ul>	<p>CAPEX</p> <ul style="list-style-type: none"> <li>Investment in smart meter</li> <li>Investment in IT</li> <li>Investment in Telecom</li> <li>Investment in in-home display</li> <li>Sunk cost of conventional meters</li> </ul> <p>OPEX</p> <ul style="list-style-type: none"> <li>IT maintenance</li> <li>Network management and front end</li> <li>Telecom</li> <li>Change management</li> <li>Unplanned renewal and failures of smart meter</li> <li>Revenue reduction</li> <li>Meter reading</li> <li>Call centre and customer service</li> </ul>	<p>CAPEX</p> <ul style="list-style-type: none"> <li>Investment in smart meter</li> <li>Investment in IT</li> <li>Investment in Telecom</li> <li>Investment in in-home display</li> <li>Sunk cost of conventional meters</li> </ul> <p>OPEX</p> <ul style="list-style-type: none"> <li>Network management and front end</li> <li>Meter reading</li> <li>Call centre and customer service</li> <li>Consumer engagement program</li> </ul>	<p>CAPEX</p> <ul style="list-style-type: none"> <li>Investment in smart meter</li> <li>Investment in IT</li> <li>Investment in Telecom</li> <li>Sunk cost of conventional meters</li> </ul> <p>OPEX</p> <ul style="list-style-type: none"> <li>IT maintenance</li> <li>Network management and front end</li> <li>Telecom</li> <li>Change management</li> <li>Unplanned renewal and failures of smart meter</li> <li>Revenue reduction</li> <li>Meter reading</li> <li>Call centre and customer service</li> <li>Consumer engagement program</li> </ul>	Information not available





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Smart Grid for Gas Distribution	United Kingdom	Ireland	Italy	France	Finland
<p><b>Considered Benefits in CBA for Smart Meters</b></p> <ul style="list-style-type: none"> <li>• Bill reduction due to energy efficiency</li> <li>• Increased competition in retail market</li> <li>• Meter reading &amp; operation savings</li> <li>• Air pollution (particulate matters, NO<sub>x</sub>, SO<sub>2</sub>)</li> </ul>	<ul style="list-style-type: none"> <li>• Bill reduction due to energy efficiency</li> <li>• Meter reading &amp; operation savings</li> <li>• Non-technical (administrative, including fraud) losses</li> </ul>	<ul style="list-style-type: none"> <li>• Bill reduction due to energy efficiency</li> <li>• Meter reading &amp; operation savings</li> <li>• Non-technical (administrative, including fraud) losses</li> </ul>	<ul style="list-style-type: none"> <li>• Bill reduction due to energy efficiency</li> <li>• Increased competition in retail market</li> <li>• Meter reading &amp; operation savings</li> <li>• Operation &amp; maintenance of assets</li> <li>• Technical losses reduction</li> <li>• Non-technical (administrative, including fraud) losses</li> <li>• Outage management (based on reduced customer indemnification)</li> <li>• CO<sub>2</sub></li> <li>• Air pollution (particulate matters, NO<sub>x</sub>, SO<sub>2</sub>)</li> </ul>	<ul style="list-style-type: none"> <li>• Bill reduction due to energy efficiency</li> <li>• Meter reading &amp; operation savings</li> <li>• Operation &amp; maintenance of assets</li> <li>• Technical losses reduction</li> </ul>	Information not available
<b>Number of CNG Stations</b>	7	0	1,010	37	23
<b>Number of LNG/LCNG Stations</b>	13	0	2	3	1
<b>Number of Gas-Driven Vehicles</b>	718	3	885,300	13,550	1,689





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## 2.4 As-Is Policy and Regulatory Framework in Turkey for Gas Distribution

### 2.4.1 Overview of Energy Sector Strategic Plan

Regulatory framework for the gas distribution sector is highly aligned and influenced by the national energy strategies and laws. The national regulatory authority, Energy Market Regulatory Authority (EMRA) acts as the oversees and regulates the market for electricity, natural gas, petroleum and LPG, ensure effective and fair competition, protect the interests of consumers, ensure safety, quality, competence, continuity, reliability in energy supply and encourages the sustainability of energy at all levels.

The regulatory framework in Turkish gas market includes the Laws, Regulations, Communiques, Board Decisions and other related Principles and Procedures as well as strategy documents published by the Ministry of Energy and Natural Resources. Regarding the future improvement of sector reforms, there has been a series of strategic efforts and documents that has been mainly driven by Ministry of Energy and Natural Resources (MENR).

The main document that summarizes the current perspective for the energy industry overall is the '2019-2023 Strategic Plan' that was published by the MENR in January 2019. This strategy document is an update and continuation of the previous strategic plan, that covered the time interval between 2015-2019. "2019-2023 Strategic Plan' particularly focuses on the goals below:

1. Security of Sustainable Energy Supply
2. Prioritization of Energy Efficiency
3. Enhancement of Institutional and Sectoral Capacity
4. Increase in Regional and Global Activity in Energy and Natural Resources
5. Technology Development and Localization in Energy and Natural Resources Domain
6. Increase of Predictability for Energy Markets
7. Increase of Production Capacity Through Sustainable Mining Practices

Under the strategic goals, a number of targets are emphasized in order to continue with the reforms and boost the positive transformation of national energy industry in all related sub-domains. These targets, which are clustered under the strategic goals are given in the table below.





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Strategic Goal	Target
<b>Security of Sustainable Energy Supply</b>	<ul style="list-style-type: none"> <li>Level of installed electrical capacity based on local and renewable resources will be increased from 59% to 65% in comparison to total installed capacity.</li> <li>Nuclear energy will be included in the national energy mix and efforts will be shown to increase its share in energy supply.</li> <li>Natural gas and electricity infrastructure will be strengthened.</li> <li>Exploration activities for petroleum and natural gas will be continued, prioritizing offshore activities.</li> <li>Technological transformation activities will be implemented in electricity sector.</li> </ul>
<b>Prioritization of Energy Efficiency</b>	<ul style="list-style-type: none"> <li>Efforts will be continued to increase energy efficiency.</li> <li>Market infrastructure will be formed for demand side participation in electricity and natural gas markets.</li> <li>Works will be undertaken to increase public awareness regarding energy efficiency.</li> <li>Energy system planning will be done for electric vehicles.</li> </ul>
<b>Enhancement of Institutional and Sectoral Capacity</b>	<ul style="list-style-type: none"> <li>Career management system will be developed to enhance technical capacity of employees.</li> <li>Cloud, digitalization and governance systems will be developed in an integrated manner.</li> <li>Strategic communication plans will be developed to increase public awareness with respect to mining, domestic coal and nuclear energy.</li> <li>Regulations and human resource will be developed for nuclear energy.</li> <li>Institutional and sectoral capacity will be enhanced for energy and mining industries.</li> </ul>
<b>Increase in Regional and Global Activity in Energy and Natural Resources</b>	<ul style="list-style-type: none"> <li>Efforts will be continued to position Turkey as an energy trading hub.</li> <li>In prioritized areas, strategies will be realized to improve cooperation and investment opportunities with countries of interest.</li> </ul>





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Strategic Goal	Target
<b>Technology Development and Localization in Energy and Natural Resources Domain</b>	<ul style="list-style-type: none"> <li>• Efforts will be continued to increase share of locally manufactured equipment in the domain of energy and natural resources</li> <li>• R&amp;D projects that have strategic importance for energy and natural resources domain will be increased.</li> <li>• Clustering projects will be realized.</li> <li>• National Systems will be implemented for national energy infrastructures.</li> <li>• Underwork for digital transformation will be delivered for the mining industry.</li> </ul>
<b>Increase of Predictability for Energy Markets</b>	<ul style="list-style-type: none"> <li>• Activity and scope of energy markets will be enhanced.</li> <li>• Bureaucratic processes will be reduced in energy and mining investments.</li> <li>• Supply planning will be made in alignment with medium and long-term demand projections.</li> <li>• Improvements and simplifications will be made in favour of electricity and natural gas consumers.</li> <li>• Transparency and financial predictability of markets will be enhanced.</li> </ul>
<b>Increase of Production Capacity Through Sustainable Mining Practices</b>	<ul style="list-style-type: none"> <li>• Mining potential of the country will be assessed and known reserves will be evaluated.</li> <li>• Industrial raw materials, mining products with strategic and critical importance will be channelized to national economy.</li> <li>• Projects focusing on local processing of mined material into end-products will be realized.</li> <li>• Development of new boron products and increase in boron sales volume will be realized.</li> <li>• Mining activities will be continued in an effective, efficient and secure manner with respect to international standards.</li> </ul>

Among the strategic goals and targets declared by this document, it can be stated that gas distribution activities are central to the national energy strategy due to an enabling role in sustainable energy supply, energy efficiency, technology development and increase of market predictability. It is also clear that development trends in Turkish gas distribution sector have direct impact on enhancement of institutional and sectoral capacity, although sectoral capacity of gas distribution sector has already been developing in a rapid manner.

#### 2.4.2 Smart Grid Expenditures Recognized in Natural Gas Distribution Sector

EMRA implements the Natural Gas Distribution Sector Tariffs Preparation Guide to be able to receive the data required in the tariff determination process for natural gas distribution companies in a common standard. Certain smart grid related expenditures are also included in OPEX and CAPEX parts of this guide.





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### 2.4.2.1 OPEX Items

In OPEX tables for gas distribution companies, the following cost items are recognized and incorporated that are related to smart grid expenditures.

- Technology Services:
  - Annual rental and/or maintenance and repair expenses accrued to the DSO for hardware and/or software services outsourced,
  - Annual maintenance and repair costs and annual license fees incurred for software (intangible fixed assets) acquired for distribution activity.
- Software Lease Expenses (with the descriptions below)
  - Software Description: A short description of the software
  - Installation Date: The date the software lease is signed will be entered.
  - Purpose of Use: For which purposes the acquired software is used (e.g. human resources, accounting, stock management, etc.) will be entered.
  - Software Provider/Vendor: Name of the company from which the software-as-a-service was purchased
  - Related Year Total Rental Value: The total rental price paid for the software in the relevant year.
- Communication Expenses
  - Radio: Wireless communication expenses accrued.
  - Telephone: Telephone expenses accrued in the relevant year (Expenses incurred for notifications made via SMS related to distribution activities are also declared in this sub-item).
  - Internet: Internet expenses accrued.
  - SCADA and Remote Reading Systems: Within the scope of communication expenses, SCADA and remote reading systems expenses accrued. (Expenses declared under the heading "SCADA Expenses" in CAPEX tables will not be included in OPEX).
- Research and Development: It consists of research and development expenses incurred within the scope of distribution activities.
  - Projects Accepted by EMRA R&D Commission: Accrued expenses for projects approved by the R&D Commission.
  - Projects Not Accepted by EMRA R&D Commission: Expenses incurred for projects not approved by the R&D Commission.

### 2.4.2.2 CAPEX Items

Most of the smart grid related investment budget is categorized under "Other Investments". In CAPEX tables for gas distribution companies, the following cost items are recognized and incorporated that are related to smart grid expenditures

- SCADA Investments



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- Boards, computers, servers etc. installed in the Dispatch Control Centre (SKM) created during the Remote Control and Monitoring System (SCADA) installation phase.
- Special software purchased within the scope of SCADA investment,
- Material and labour costs incurred for the physical elements provided for the communication between the relevant station and SKM after the city entrance, region and customer stations are put into operation, and the costs are covered by the distribution company,
- Remote monitoring, intervention and telemetry elements installed on the network within the scope of SCADA investment and covered by the distribution company, excluding the city entrance, region and customer stations, and the installation (labour) costs of these materials,
- SCADA investments for cathodic protection systems,
- SCADA Investments for hardware and software installed in SKM, to be made after installation, not in the nature of maintenance and repair
- Geographical Information Systems:
  - GIS Investments
  - Landscape and Digital Map Investments
  - Survey and Project Design Expenses
  - As-Built Project Investments
- LNG Investments: In accordance with the relevant legislation, investment expenditures for gasification units and other relevant investment items built and made ready for use by the distribution company for distribution regions where natural gas supply is deemed appropriate with LNG are reported under this investment item. Details regarding LNG investments are presented separately by the relevant distribution company.
- CNG Investments: In accordance with the relevant legislation, investment expenditures for filling and unloading facilities built and made ready for use by the distribution company for distribution regions where natural gas supply is deemed appropriate with CNG, the acquired transportation systems and investment expenditures for other related investment elements are reported under this investment item. Details of the CNG investments are presented separately by the relevant distribution company.

#### 2.4.3 Smart System Obligations in Communique for Gas Sector Distribution and Customer Services

In order to develop the smart grid applications in the natural gas market, it was ensured by EMRA that all distribution companies installed Dispatch Control Centres (SKM) in the first place. Data transfer is made to the Electronic Bulletin Table managed by BOTAŞ through these centres.

##### Dispatch Control Centre

The dispatch control centre includes hardware and software that will detect and record the measurements made remotely and analyze these records, detect unusual reduction or increase in consumption and the interventions that can be made on the meters and the places where field inspection is required. It is also designed to allow remote control of points that are considered critical according to the city grid plan.

The distribution company makes the natural gas programming according to the seasonal changes that occur depending on the data of the dispatch control centre and ensures the system balancing.





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## Communication Systems

The communication systems of the subscribers can be installed by the distribution company within the scope of the subscriber connection fee. Eligible consumers whose consumption amount is above the amount determined by EMRA, eligible consumers who use the right to choose suppliers and other eligible consumers to be determined by EMRA, upon request of the distribution company, establish the dispatch control centre and communication systems at their own expense within the framework of the rules determined by the distribution company. The operation of these systems installed is at the disposal of the distribution company, and all maintenance and repair costs are covered by the distribution company.

## Flow Control

The distribution company carries out pressure controls on pipelines, regional regulators and valves for a period of at most fifteen days, keeps reports and keeps these reports in order to ensure balanced and safe natural gas flow. The distribution company makes periodic checks in the networks with a dispatch control centre and the arrangements in the centre that allow the system to intervene in case of emergency.

### 2.4.4 R&D Legislations

In Turkey, R&D activities of gas distribution companies are regulated by the R&D Principles and Procedures published in the Official gazette dated 28 March 2014. R&D budgets within the scope of tariffs shall be only used to increase innovation, efficiency and service quality, decrease losses and costs related to losses, develop technology related to system operation, generate information and improve electricity and natural gas infrastructure.

All of the expenses to perform an R&D project including software/hardware, engineering/consultancy, training, documentation, transportation, personnel etc. are met by R&D budget. General expenses related to R&D activities (establishment of design or R&D centres by DSOs, collaborations with start-ups/entrepreneurs, etc.) and expenses of the projects that were rejected during the application phase are financed from R&D budget (at most 10% of the R&D budget).

R&D project applications are done each year in January and July and decisions regarding the applications are finalized within 3 months.

Within the scope of the application document; name, aim, scope of the project, scientific and technological characteristics, innovation level, risk assessment, targets, value added, efficiency and power of competition, total expected budget and duration as well as parties of the project have to be defined.

DSOs might apply for the projects on their own or for a common project.

Projects that are within the scope of operational activities are that have the characteristic of investment are not accepted as R&D projects.

R&D projects that are funded by EU, TUBITAK or similar institutions are also approved as R&D projects without additional evaluation. The budget that is not funded is met by DSO's own R&D budget.

Budget and duration of approved R&D projects do not change. However, in case it is approved by the commission, duration of the project might be extended at most 50% and budget might be revised once.





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Promoting development required technology and innovation for efficient and effective system operation, current legislation frames R&D activities based on the following criteria:

- Development of technology and know-how for system operations
- Increase in the prevalence of domestic technology
- Enhancement of service quality, system performance and security
- Reduction of costs through operational efficiency and improvement of system losses
- Reaching the international quality standards in natural gas distribution system

Supporting the abovementioned strategy, allocated R&D budget can be utilized for any costs and expenses such as consultancy, training, certification, transportation, equipment, even before and after project application and approval by the Commission. Besides, any reasonable costs regarding entrepreneurship activities, incubators, acceleration programs, idea generation competitions as well as activities under participation to promote and encourage entrepreneurship can be covered by R&D tariff model up to 10% of the approved R&D budget.

Furthermore, in the event that a patent is obtained as a result of the realization of an R&D project approved by the Commission within the framework of the Procedures and Principles, an extra amount that corresponds to 5% of the approved project budget per patent, excluding the R&D budget of the relevant distribution company (shall not exceed 500,000 (five hundred thousand) TL per project) is added to budget of the DSO. The added amount is not taken into account in the correction procedures of the related distribution company's R&D budget. This recent incentive added to the secondary legislation is a robust sign that shows EMRA's attitude fostering the innovation activities.

In addition to financial promotions, further convenience is provided through semi-annual application and prompt evaluation periods. Digital application folder is expected to satisfy at least project name, purpose, scope, term/schedule, originality, targets, industry & utility benefits, financial plan through standard forms which can be jointly prepared based on complementary competences of distribution companies as well as individual application.

Approved R&D project budget may be revised for once only and the period may be revised more than once, provided that it does not exceed 50% of the approved period. In case of achievement of any invention, (patent or petty patent) industrial design, artefact, integrated circuit design, technical information and software as a deliverable of the R&D projects, probable intellectual and industrial property rights are considered in possession of the project executor DSO.

Distribution companies are supposed to report and notify following cases regularly:

- Semi-annual development reports shall be submitted within 30 days
- Conclusion reports shall be submitted within 30 days as of the completion date
- Semi-annual Detailed progress reports regarding developments prior to the R&D activities, works completed or in progress, realized expenses, gained benefits and deliverables as well as necessary justification for termination of the R&D project or related activities

In order to announce the activity and achievements, a common website can be designed and setup with the attendance of all the distribution companies or other electronic platforms may be used following Commission's approval. Such expenses are covered by R&D tariff within the previously mentioned 10% of approved R&D budget.





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## 2.5 Gap Analysis and Regulatory Recommendations for Gas Distribution

### 2.5.1 Identified Barriers

Some of the barriers identified by ERGEG are: uncertainty, lack of clear roles and responsibilities, data management, security and privacy issues, political will, regulatory structures and alignment of incentives, market requirements, ineffective implementation of unbundling, insufficient supporting schemes for RES, lack of definition of smart grids functionalities, safety and more. ERGEG believes that some of these tentative barriers can be solved through the European Commission's task force for the implementation of smart grids in the internal energy market, as this task force plans also to deal with definition of roles and responsibilities and issues related to data handling, data protection and data safety. ERGEG agrees that possible barriers should be identified and considered. Their impact will differ across Europe; however, ERGEG still considers that there are no fundamental barriers to the deployment of smarter distribution and transmission systems where necessary and cost-efficient.

One other barrier, not mentioned in the Consultation Paper, referred to the availability of skilled workforce (especially with reference to the knowledge of innovative solutions). Indeed, one respondent mentioned as a possible performance indicator the percentage of time / human resources devoted to training activities. ERGEG agrees that sufficient trained, educated and available personnel are necessary now and, in the future, however, the means to achieve this need to be further elaborated and discussed by relevant parties, mainly at national level.

Engagement of grid operators with their network users was mentioned as an important item for the deployment of smart grids. In addition, the need for the engagement of suppliers (and more generally, players acting in competitive markets) with their customers was mentioned. ERGEG believes that this is an important issue for an effective user-centric deployment of smart grids. ERGEG believes that a possible regulatory approach to promote user and customer engagement is carefully to address the regulation of commercial quality (i.e. information, customer treatments, etc. provided by regulated parties to their users and customers).

- Whereas the four responding TSOs observed no risks (or do not explicitly reply), mainly due to unbundling provisions, all six DSOs which explicitly replied envisaged risks of cross-subsidies.
- Industry Associations did not seem concerned that cross-subsidising between TSOs and DSOs would be any problem; to the extent this is necessary due to the nature of their businesses. However, they have some more concern towards new services and non-regulated companies. One respondent emphasises that it should be prevented that users and especially vulnerable users are charged for expenses and developments they will hardly benefit from.

The research/consultant group see that cross-subsidies can happen, but the risk can be reduced by regulatory measures, inter alia a more efficient unbundling also of distribution system operators. One of the respondents in this group answers clearly that there are no risks of cross-subsidies, another one that intelligent regulatory rules can prevent any cross-subsidising between stakeholders.

As anticipated, ERGEG believes that TSOs and DSOs are the prime movers for the deployment of smart grids, also by allowing new marketplaces and opportunities for suppliers and energy service companies. With respect to the latter, it is evident that grid tariffs do not pay expenses by actors in competitive markets.

In addition to a careful implementation of unbundling provisions, a thorough evaluation of the distribution of costs and benefits related to smart grids across the whole supply chain and a clear identification of roles and responsibilities of the different stakeholders were mentioned as instruments to avoid future cross-subsidies. With





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respect to the latter, the ongoing activities within the task force on smart grids promoted by the European Commission focus on roles and responsibilities and can contribute regarding these matters.

Apart from the barriers outlined by ERGEG, a number of additional challenges are listed below that are related to smart grids for gas distribution:

- Lack of EU-wise technical standards for individual technologies, as well as for the interoperability of smart grid solutions for gas distribution,
- Smart grid deployments in gas distribution networks are limited in EU, as well as in other contrived worldwide, therefore there are no lessons learnt available that can serve as best practices for the deployment of smart grid solutions for gas distribution companies,
- Not active participation of gas distribution companies in the development of smart grid technologies,
- Strict data protection laws and the new General Data Protection Regulation (GDPR) can be, in some cases, a barrier for the exploitation of the full potential of the deployment of smart grid solution (e.g. In the case of smart meters for gas),
- Due to the limited potential of flexibility services in the gas grids, there is limited interest to deploy innovative smart grid solutions compared to electricity networks,
- Lack of clear regulatory framework and/or existing complex regulation constitutes a barrier for the fast deployment of smart grid solution for gas distribution,
- The existing regulatory framework does not provide the necessary incentives to gas DSOs to invest in innovative smart grid technologies that will generate benefits for the end-customer in the long run,
- Lack of a performance-based regulatory framework that will encourage gas distribution companies to increase the efficiency of their networks via the deployment of smart grids solution, and
- Lack of clear roles and responsibilities for the regulated entities to encourage the introduction of new services or markets.

### 2.5.2 Overarching Principles

Based on ERGEG position paper on smart grids<sup>7</sup> the following overarching principle for smart grids for gas distribution are proposed.

#### Overarching Principles for Smart Grids Gas Distribution

##### OP1: Output and input regulation

EMRA should focus on outputs in their regulation of gas distribution companies, by designing the regulatory framework taking into account both the economic and technical aspects, as well as the fact that developing a smart gas grid is not a goal in itself, but is a means to an end, i.e. a regulatory approach towards smart grids alone, is not envisaged. However, since the deployment of a smart gas grid is a heavy technical endeavour, input

<sup>7</sup> "Position Paper on Smart Grids – An ERGEG Conclusions Paper", ERGEG, 2010





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regulations cannot be neglected. Input regulations may be related to the preparation and approval of the gas network codes, as well as to standardization issues which fall under the input regulation.

**OP2: Effects and benefits expected by smart grids**

The application of smart grid technologies and services for the gas distribution companies, should have clear effects and benefits towards both the gas DSOs, as well as towards the consumers. Such benefits may include<sup>7</sup>:

- Increased sustainability,
- Adequate capacity of distribution grids for providing gas to consumers,
- Adequate grid connection and access for all kinds of grid users,
- Satisfactory levels of security and quality of supply,
- Enhanced efficiency and better service in gas supply and grid operation,
- Coordinated grid development through regional and local grid planning to optimize distribution grid infrastructure; and
- Enhanced consumer awareness and participation in the market by new players.

**OP3: Performance indicators and output measures for smart gas grids**

EMRA should have in place a clear and straightforward approach for the evaluation of smart gas grid projects, based on performance indicators and output measures. The evaluation framework should be based upon transparent Key Performance Indicators (KPIs), so that all targets are measured and evaluated in an observable, quantifiable, and verifiable manner. Moreover, these indicators should be supported by a complete regulatory framework and a long-term reasonable rate of return to avoid the sub-optimization for some of the indicators. Additionally, wherever the performance targets and the corresponding indicators are associated with economic effects, they should be decoupled from external effects outside the control of the gas DSOs. Finally, the evaluation process should be implemented in a form of reward/penalty compensation mechanism based on the best output measures.

**OP4: Encouraging innovation along research, development, demonstration chain**

EMRA should foster innovation and research and development (R&D) activities related to smart grids for gas distribution. KPIs for innovation and demonstration projects should differ from the performance indicators for large-scale and/or rollout projects. This differentiation is justified by the fact that the innovation and R&D activities include also additional elements, such as the dissemination of the results and the required training, as well as they should also take into account the replicability of the projects. Moreover, according to ERGEG<sup>7</sup>, KPIs for demonstration will also depend a lot on what is actually being trialled. It was remarked, and ERGEG fully agrees, that the performance-based approach could fit well the deployment phase, whereas different approaches for incentivizing the demonstration phase might be opportune.

Smart grid technologies for gas distribution networks, as well as potential demonstration and large-scale projects, should be evaluated according to a nation strategic roadmap for smart grids for energy networks to be developed by EMRA in collaboration with the energy network operators. This evaluation needs to take into considerations the following aspects:





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- Identification of what it is research, development, demonstration and deployment,
- Ex ante and ex post assessment of benefits,
- Ensure market participants as point of contact to the customers assuring that independent market operators are involved in measuring benefits,
- Replicability and openness of projects,
- Transparent validation procedures,
- Well-defined and transparent criteria for monitoring of demonstration projects,
- Evaluation of project indicators tailored to each demonstration allowing to measure projects' results; and
- Ensure proper coordination among research projects, including avoidance of overlapping and duplication.

It remains at EMRA's responsibility to assess the benefits and the costs of the possible large-scale or demonstration projects for smart gas grids, according to national priorities and in coherence with the applicable national regulation systems.

#### **OP5: Standardization, harmonization and interoperability**

Interoperability is a key requirement for smart gas grid projects. It should be mentioned that even though some technological domains are already covered by a sufficient number of standards, there are cases where interoperability standard are missing. Moreover, there technical domains where a large number of standards are available, thus making the selection of the appropriate standards by the gas DSOs a complicated process.

It is highly recommended that EMRA establishes a task force for the implementation of smart gas grids in the internal energy market. The purpose of this task force is to deal with inter alia services and functionalities for smart gas grids and smart gas meters, as well as a standardisation strategy for smart gas grids.





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### 2.5.3 Overview of Recommendations

Table 3 provides a summary of the regulatory recommendation for smart grids for gas distribution. A detailed analysis of the recommendations is given in the next subsection.

Table 3: Summary of Regulatory Recommendations

ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
<b>Regulatory Framework</b>				
R1	Stable Regulatory Framework	EMRA should make sure that a long-term stable regulatory framework and a reasonable rate of return for cost-efficient smart grid investments is in place.	Since the majority of the smart grids projects for gas distribution require a long period of time to be deployed to their full extent, a stable regulatory framework is required to attract investors and minimize the project-related risks.	EMRA
R2	Performance-Based Incentive Regulation	EMRA should consider performance-based incentives for smart grids projects.	Smart grid investments should be incentivized based on performance criteria and decoupling should be considered between gas DSO's profits and the volumes of gas they deliver.	EMRA, Gas DSOs
R3	Regulation of Outputs	EMRA should pursue regulation of outputs as a mechanism to ensure value for money paid by network users.	EMRA will be able to assess the metrics for the quantification of the most important output effects and benefits at national level.	EMRA
R4	Key Performance Indicators	EMRA should define specific key performance indicators for measuring performance in case a performance-based regulatory framework for smart grid projects is in place.	Clearly defined KPIs for smart grid projects should be used in case the regulatory model is based on performance.	EMRA
R5	Improve User Awareness	EMRA and the gas DSOs should promote mechanisms for improved consumer awareness of gas use and market opportunities.	Promotion should be performed via actions of suppliers and other market participants, as well as through an improved engagement of network operators with their network users.	EMRA, Gas DSOs





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R6	Incentivization of Smart Grid Solutions	EMRA should encourage the deployment of smart grid solutions in the gas distribution sector.	EMRA should incentivize gas DSOs to pursue innovative solutions where this can be considered beneficial from the viewpoint of the society.	EMRA, Gas DSOs
R7	Extended Regulatory Periods	EMRA may consider applying extended regulatory periods for smart grid projects.	EMRA may consider adjusting the regulatory period to ensure that smart grid project benefits are realized within the regulatory period.	EMRA, Gas DSOs
R8	Cost-Benefit Analysis	Gas DSOs should perform a cost-benefit analysis for possible demonstration smart grid projects.	The CBA allows gas distribution stakeholders to breakdown the associated costs and benefits and take the necessary decisions based on societal cost-benefit assessment.	EMRA, Gas DSOs
R9	Communication and Dissemination Activities	Gas DSOs should make sure that results and lessons learned from smart grid demonstration projects are disseminated.	In case of smart grid demonstration projects for gas distribution, financed or co-financed by additional grid tariffs or from public funds, gas DSOs should ensure the dissemination of the results and lessons learned to all interested parties, including other network operators, market participants, etc.	EMRA, Gas DSOs
R10	Participation in Standardization Organizations	Gas DSOs should participate in standardization organizations.	The purpose of the participation and cooperation is for gas DSO to adopt or to participate in the development of protocols and standards related to information management and data exchange to ensure the interoperability in current and future deployment of smart grid projects for gas distribution.	Gas DSOs
R11	New Market Opportunities	EMRA should clarify the difference between regulated grid activities and market opportunities.	EMRA should clarify the difference between regulated grid activities and market opportunities for new services under a competitive regime and to carefully monitor the possible presence of cross-subsidies between network activities by TSOs or DSOs and market-based activities.	EMRA





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R12	Incentives for Investments in Conventional Network Reinforcements	EMRA should allow for adequate incentives for investments in conventional reinforcements in gas distribution networks.	The conventional reinforcements should be justified by means of a societal cost benefit analysis (SCBA) that will take into account the robustness of the network investment for different scenarios. The gas DSO may be obliged through regulation to perform an integrated investment assessment via the SCBA.	EMRA, Gas DSOs
R13	Balanced Investments in Conventional Network Reinforcements and Smart Grids	Gas DSOs should consider balanced investments in conventional network reinforcements and smart grids.	Since innovative smart grid solutions for gas DSOs bear a higher risk compared to conventional network reinforcements, EMRA should make sure that these higher risks are properly accounted for in regulatory assessments for allowing smart grids solutions to be considered as a viable network planning option for gas distribution.	EMRA, Gas DSOs
R14	Smart Grid Guidance	EMRA should provide general guidelines for smart grid projects.	Promotion of specific technologies or solutions should not be the main concern of EMRA, rather than a decision made by the gas DSOs that should be responsible for the selection of the smart grid solutions to be deployed.	EMRA, Gas DSOs
R15	Demonstrable Benefits	EMRA should request gas DSOs to demonstrate measurable benefits for smart grid projects.	Based on a set of clearly predefined KPIs, gas DSO should be able to demonstrate to EMRA measurable benefits throughout the whole lifecycle of a smart grid project.	EMRA, Gas DSOs
R16	Monitor of Cybersecurity Related Expenditure	EMRA should require gas DSOs to monitor cybersecurity related expenditure.	EMRA need to be prepared to monitor and evaluate cybersecurity expenditure of certain regulated entities.	EMRA, Gas DSOs
R17	Flexibility Services	Gas DSOs should evaluate the procurement model for flexibility services using a cost-benefit analysis approach.	Due to the limited potential of flexibility services in the gas grids, a cost-benefit analysis (CBA) should be performed by the gas DSOs to evaluate whether the benefits of a procurement model outweigh the resulting administrative burdens.	EMRA, Gas DSOs





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R18	Gas DSOs in the Provision of Energy Efficiency Services	Gas DSOs should play an informative and facilitating role in the provision of energy efficiency services.	To prevent market distortion, it is recommended that gas DSOs focus on non-discriminatory information provision.	EMRA, Gas DSOs
<b>Smart Gas Meters</b>				
R19	Customer Control of Metering Data	Customers should have full control over their gas consumption data.	Customer should always choose the way in which their metering data should be used and by whom, with the exception of metering data required to fulfil regulated duties and within the national market model.	Gas DSO
R20	Information on Actual Consumption and Cost	Customers should be informed, at least on a monthly basis, on their actual gas consumption and related costs.	Since smart meters allow for the remote meter reading, such information should be provided to customers at least on a monthly basis. The information provided should be presented in an easy-to-understand way.	Gas DSOs
R21	Access to Information on Consumption Data on Customer Demand	Customers should be able to access on demand information related to their gas consumption data and related costs.	The data provider should offer to the customer different communication channels for providing the gas consumption data.	Gas DSOs
R22	Supplier Switching	Supplier switching should be facilitated for customers leveraging the smart metering infrastructure.	Due to interval metering, all metering data are considered to be accurate, thus facilitating the supplier switching processes, moving or change of contract.	Gas DSOs
R23	Bills Based on Actual Consumption	Bills issued to the customers should be reflect actual gas consumption.	As a result of remote reading, bills issued to the customers should be reflect actual gas consumption.	Gas DSOs
R24	Remote Activation and De-activation of Supply	Smart gas meter should allow the remote activation and re-activation of supply.	Based on the bidirectional communication offered by smart gas meters, the remote activation and de-activation of supply for a customer should be possible.	Gas DSOs





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R25	Alert in case of Exceptional Energy Consumption	Customers should be informed in case of exceptional gas consumption.	Upon customer request, up-to-date information on exceptional gas consumption should be communicated to the customer.	Gas DSOs
R26	Remote Configuration of Smart Gas Meters	Smart gas meters should support remote configuration.	The gas DSOs should make sure that the smart metering system will allow for the program software to be upgraded remotely.	Gas DSOs
R27	Whole System Approach Cost-Benefit Analysis	The cost-benefit analysis for smart gas meter should take into account the whole value chain of gas distribution.	The CBA should take into account, not only the customer benefits, but also the whole gas value chain including gas DSOs, suppliers, etc. Cybersecurity and data privacy related costs should also be part of the CBA.	Gas DSOs
R28	All Customers should Benefit from Smart Metering	All customers should be eligible to obtain a smart gas meter.	In the case of wide geographical spread of gas customers, or any other special circumstances, gas DSOs could exclude customers or group of customers from the smart meter rollout.	Gas DSOs
R29	No Discrimination when Rolling out Smart Meters	Gas DSOs should avoid discriminatory behaviour during the smart gas meters rollout.	Discrimination based on distinguishing between customers served by suppliers other than the vertically integrated supplier or distinguishing between customers served under regulated prices in relation to customers served on the free market should be avoided.	Gas DSOs
<b>Cybersecurity</b>				
R30	Improve the Regulatory and Policy Framework	EMRA should develop specific policy documents and regulations regarding cybersecurity and privacy for the smart gas distribution, grid in order to improve the current regulatory and policy framework.	The existing regulatory framework should be extended to also include policies and regulations related to cybersecurity and data privacy for smart grids in the gas distribution sector.	EMRA





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R31	Coordinate Smart Grid Cyber Security Initiatives	EMRA should foster the creation of a public-private partnership to coordinate smart grid cybersecurity initiatives for gas distribution.	The public-private partnership (PPP) should act as a central coordinating entity at the national level with a global vision of all European and international initiatives dealing with cybersecurity and data privacy issues.	EMRA
R32	Foster Awareness Raising and Training Initiatives	EMRA and gas DSOs should foster the creation of initiatives targeting awareness-raising of C-level in relation to the importance of the cybersecurity and data privacy in the smart grid for gas distribution.	Part of the awareness raising and training initiatives, EMRA and gas DSOs should also promote training initiatives focused on how to use security-by-design principles for the gas distribution sector.	EMRA, Gas DSOs
R33	Foster Dissemination and Knowledge Sharing Initiatives	EMRA and gas DSOs should foster the dissemination activities on smart grid cybersecurity issues between the stakeholders of the gas sectors and the R&D institutions.	Knowledge sharing initiatives, related to cybersecurity for smart grids for gas distribution, should include both gas DSOs and TSOs, as well as other gas stakeholders, with EMRA playing a key role as a unified point for information exchange among smart grid stakeholders.	EMRA, Gas DSOs
R34	Development of a Minimum Set of Reference Standards and Guidelines	Gas DSOs should develop a minimum set of reference standards and guidelines for cybersecurity for the smart grid, leveraging existing initiatives such as Common Criteria, ISA99, and ISO 27000.	Standardization for cybersecurity is of high importance for gas DSOs since it allows for unified and interoperable cybersecurity and data privacy framework for smart grids for gas distribution.	Gas DSOs
R35	Development of Cybersecurity Certification Schemes	EMRA and gas DSO should promote the development of security certification schemes for products and organizational security, leveraging existing initiatives such as Common Criteria, ISA99, and ISO 27000.	The purpose of the promotion of cybersecurity certification schemes for product and organizational security is to harmonize cybersecurity and resiliency requirements across the various gas network stakeholders.	EMRA, Gas DSOs





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R36	Creation of Test Beds and Security Assessments	Gas DSOs should create the required test beds to assess if products are secure according to basic cybersecurity principles, such as those defined by the requirements for vendors.	The purpose of this testing is to reveal and identify security flaws at the organizational level. It should be mentioned that these actions should be considered as an intermediate step to fill the gap while certification schemes are being developed.	EMRA, Gas DSOs
R37	Refine Strategies to Coordinate Large Scale Cyber Incidents	Gas DSOs should develop strategies to respond to large-scale cyber incidents that may be affecting multiple gas DSOs and TSOs.	The strategies should also cover aspects related to alarm escalation, political decisions (e.g. isolating a TSO) and pre-established incident handling procedures.	EMRA, Gas DSOs
R38	Foster Research in Smart Grid Cybersecurity	EMRA should foster and promote the R&D activities related to smart grid cybersecurity between the gas DSOs and the academia and research institutes in the context of national, European, and/or international research programs.	Research areas may include protection of monitoring functionalities, robust, secure and resilient architectures, trust and assurance and end-to-end, and security in dependable systems.	EMRA, Gas DSOs
R39	Operators of Essential Services	EMRA should request from gas DSOs to develop and apply cybersecurity standards and measures.	The development and application of cybersecurity standards and measures by all OESs will create a homogenous and secure ecosystem that will allow the development of a secure culture for further innovation and digitalization in the gas distribution sector.	EMRA, Gas DSOs
R40	Compliance with NIS Directive	EMRA should encourage the gas DSOs to adopt, as much as possible, the NIS Directive and provide the necessary support to transport horizontal regulation into best practices for the gas distribution sector.	The compliance with the NIS Directive, will allow gas DSOs to comply with the security requirements in place for the European Member States.	EMRA, Gas DSOs
R41	Guidance on Cybersecurity Governance	EMRA should provide clear guidance to gas DSOs on cybersecurity governance and define the role and responsibility of the Chief Information Security Officer within the organization.	The CISO should be provided with independence, resources, and a proper mandate from top executive management, in order to have an impact in the cybersecurity landscape for gas distribution.	EMRA, Gas DSOs





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ID	Recommendation	Explanation	Supportive Arguments	Key Stakeholders Involved
R42	Cybersecurity Strategy	Gas DSOs should develop a cybersecurity strategy that will include all the necessary security measures prior implementing cloud-based technologies and smart grid solutions that could potentially create security holes in their IT infrastructure.	Developing a cybersecurity strategy will allow the further development of a cybersecurity culture within the gas distribution sector.	EMRA, Gas DSOs





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## 2.5.4 Recommendations on Detailed Topics that are Related to Smart Grids

A set of recommendations related to smart grids for gas DSOs are presented in full detail below. The recommendations have been grouped in the following categories:

- Regulatory Framework,
- Smart Gas Meters,
- Smart Gas Grid, and
- Cybersecurity.

### 2.5.4.1 Regulatory Framework

The recommendations presented in this subsection are focused on regulatory-related aspects of smart grids.

#### Recommendation 1 Stable Regulatory Framework

EMRA should make sure that a long-term stable regulatory framework and a reasonable rate of return for cost-efficient smart grid investments is in place.

**Supportive Arguments:** Since the majority of the smart grids projects for gas distribution require a long period of time to be deployed to their full extent, a stable regulatory framework is required to attract investors and minimize the project-related risks<sup>7</sup>.

#### Recommendation 2 Performance-Based Incentive Regulation

EMRA should consider performance-based incentives for smart grids projects.

**Supportive Arguments:** Smart grid investments should be incentivized based on performance criteria and decoupling should be considered between gas DSO's profits and the volumes of gas they deliver.

#### Recommendation 3 Regulation of Outputs

EMRA should pursue regulation of outputs as a mechanism to ensure value for money paid by network users.

**Supportive Arguments:** Based on this approach, EMRA will be able to assess the metrics for the quantification of the most important output effects and benefits at national level.



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#### Recommendation 4 Key Performance Indicators

EMRA should define specific key performance indicators for measuring performance in case a performance-based regulatory framework for smart grid projects is in place.

**Supportive Arguments:** Clearly defined KPIs for smart grid projects should be used in case the regulatory model is based on performance<sup>8</sup>.

#### Recommendation 5 Improve User Awareness

EMRA and the gas DSOs should promote mechanisms for improved consumer awareness of gas use and market opportunities.

**Supportive Arguments:** Promotion should be performed via actions of suppliers and other market participants, as well as through an improved engagement of network operators with their network users.

#### Recommendation 6 Incentivization of Smart Grid Solutions

EMRA should encourage the deployment of smart grid solutions in the gas distribution sector.

**Supportive Arguments:** EMRA should incentivize gas DSOs to pursue innovative solutions where this can be considered beneficial from the viewpoint of the society.

#### Recommendation 7 Extended Regulatory Periods

EMRA may consider applying extended regulatory periods for smart grid projects.

**Supportive Arguments:** In case the smart grid project period differ from the regulatory period, EMRA may consider adjusting the regulatory period to ensure that smart grid project benefits are realized within the regulatory period. This can be achieved either via extended regulatory periods or regulatory “holidays” for innovative smart grids projects for gas distribution<sup>8</sup>.

#### Recommendation 8 Cost-Benefit Analysis

Gas DSOs should perform a cost-benefit analysis for possible demonstration smart grid projects.

<sup>8</sup> Recommendations for incentivizing innovation in the gas DSO sector – Position Paper”, EUROGAS, October 2016





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**Supportive Arguments:** Possible smart grid demonstration projects should be evaluated in the basis of a cost-benefit analysis (CBA) taking into account costs and benefits for each stakeholder and for the society as a whole. The CBA allows gas distribution stakeholders to breakdown the associated costs and benefits and take the necessary decisions based on societal cost-benefit assessment.

#### Recommendation 9 Communication and Dissemination Activities

Gas DSOs should make sure that results and lessons learned from smart grid demonstration projects are disseminated.

**Supportive Arguments:** In case of smart grid demonstration projects for gas distribution, financed or co-financed by additional grid tariffs or from public funds, gas DSOs should ensure the dissemination of the results and lessons learned to all interested parties, including other network operators, market participants, etc.

#### Recommendation 10 Participation in Standardization Organizations

Gas DSOs should participate in standardization organizations.

**Supportive Arguments:** Gas DSOs should be encouraged to participate in smart grid discussion and cooperation activities with various national, European, and international standardization organization, gas grid operators and manufacturers. The purpose of the participation and cooperation is for gas DSO to adopt or to participate in the development of protocols and standards related to information management and data exchange to ensure the interoperability in current and future deployment of smart grid projects for gas distribution.

#### Recommendation 11 New Market Opportunities

EMRA should clarify the difference between regulated grid activities and market opportunities.

**Supportive Arguments:** EMRA should clarify the difference between regulated grid activities and market opportunities for new services under a competitive regime and to carefully monitor the possible presence of cross-subsidies between network activities by TSOs or DSOs and market-based activities.

#### Recommendation 12 Incentives for Investments in Conventional Network Reinforcements

EMRA should allow for adequate incentives for investments in conventional reinforcements in gas distribution networks.





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**Supportive Arguments:** In case smart grids investments for gas distribution networks are not feasible from a technical and/or economic perspective, EMRA should allow for adequate incentives for investments in conventional reinforcements in gas distribution networks. The conventional reinforcements should be justified by means of a societal cost benefit analysis (SCBA) that will take into account the robustness of the network investment for different scenarios. The gas DSO may be obliged through regulation to perform an integrated investment assessment via the SCBA. It is advised that, for limiting administrative burdens, a SCBA might be limited to all investment proposals that meet a certain minimum monetary size.

### Recommendation 13    Balanced Investments in Conventional Network Reinforcements and Smart Grids

Gas DSOs should consider balanced investments in conventional network reinforcements and smart grids.

**Supportive Arguments:** Since innovative smart grid solutions for gas DSOs bear a higher risk compared to conventional network reinforcements, EMRA should make sure that these higher risks are properly accounted for in regulatory assessments for allowing smart grids solutions to be considered as a viable network planning option for gas distribution<sup>9</sup>.

### Recommendation 14    Smart Grid Guidance

EMRA should provide general guidelines for smart grid projects.

**Supportive Arguments:** EMRA’s role in smart grid projects for gas DSOs should be to provide the overall direction and a flexible regulatory framework for innovative smart grid projects. Promotion of specific technologies or solutions should not be the main concern of EMRA, rather than a decision made by the gas DSOs that should be responsible for the selection of the smart grid solutions to be deployed.

### Recommendation 15    Demonstrable Benefits

EMRA should request gas DSOs to demonstrate measurable benefits for smart grid projects.

**Supportive Arguments:** Based on a set of clearly predefined KPIs, gas DSO should be able to demonstrate to EMRA measurable benefits throughout the whole lifecycle of a smart grid project.

<sup>9</sup> “The role of DSOs in a Smart Grid environment”, DG ENER, 2014





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### Recommendation 16 Monitor of Cybersecurity Related Expenditure

EMRA should require gas DSOs to monitor cybersecurity related expenditure.

**Supportive Arguments:** EMRA should require gas DSOs to monitor the cybersecurity related expenditure and the effects of those cybersecurity-related investments to the risk landscape of the gas distribution system. Moreover, EMRA need to be prepared to monitor and evaluate cybersecurity expenditure of certain regulated entities.

### Recommendation 17 Flexibility Services

Gas DSOs should evaluate the procurement model for flexibility services using a cost-benefit analysis approach.

**Supportive Arguments:** Due to the limited potential of flexibility services in the gas grids, a cost-benefit analysis (CBA) should be performed by the gas DSOs to evaluate whether the benefits of a procurement model outweigh the resulting administrative burdens. In this analysis the following aspects should be taken into consideration:

- potential of flexibility services provided by the gas grid to the electricity grid and vice versa,
- in case gas DSOs promote the development of natural gas vehicles infrastructure, a clear exit-strategy for the DSOs should be formulated and executed when the market is able to take over the infrastructure provision, preventing market distortion,
- in case smart electricity meters are rolled out, efficiencies resulting from a combined roll-out with smart gas meters should be further explored, and
- shall smart electricity meter data is collected and provided to the market, explore efficiencies of collaboration between electricity and gas DSOs in data collection, transmission and handling.

### Recommendation 18 Gas DSOs in the Provision of Energy Efficiency Services

Gas DSOs should play an informative and facilitating role in the provision of energy efficiency services.

**Supportive Arguments:** Due to its regulated nature the gas DSO has a limited role to play in the provision of energy efficiency services. However, EMRA might decide that gas DSOs could play a role in promoting energy efficiency services. To prevent market distortion, it is recommended that gas DSOs focus on non-discriminatory information provision. Moreover, should DSOs be obliged to pursue energy efficiency, it is recommended that gas DSOs strive to hiring market parties for the actual implementation. Furthermore, it is recommended that gas DSOs incorporate developments in the energy efficiency services market in network planning and network operations.





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### 2.5.4.2 Smart Gas Meters

The recommendations on smart meters for gas distribution are below.

#### Recommendation 19 Customer Control of Metering Data

Customers should have full control over their gas consumption data.

**Supportive Arguments:** Customer should always choose the way in which their metering data should be used and by whom, with the exception of metering data required to fulfil regulated duties and within the national market model. Moreover, the party that requests the data should inform the customer about the information needed and the frequency of the data and seek customer's approval.

#### Recommendation 20 Information on Actual Consumption and Cost

Customers should be informed, at least on a monthly basis, on their actual gas consumption and related costs.

**Supportive Arguments:** Gas consumption and related costs should be communicated to customer free of charge, in order to allow the end customer to adjust their gas consumption. Since smart meters allow for the remote meter reading, such information should be provided to customers at least on a monthly basis. The information provided should be presented in an easy-to-understand way.

The provider of the said service should offer to the customer different communication channels for providing the gas consumption data. Such communication channels include, but they are not limited to, messages via the short message service (SMS), email, call centre, etc. Specific care should be taken with regards to the communication with vulnerable customer groups. In such cases paper-based communication (probably against a reasonable fee) may apply.

#### Recommendation 21 Access to Information on Consumption Data on Customer Demand

Customers should be able to access on demand information related to their gas consumption data and related costs.

**Supportive Arguments:** The data provider should offer to the customer different communication channels for providing the gas consumption data. Such communication channels include, but they are not limited to, messages via the short message service (SMS), email, call centre, etc. Specific care should be taken with regards to the communication with vulnerable customer groups. In such cases paper-based communication (probably against a reasonable fee) may apply.

Access to historical consumption data should also be provided, free of charge, at the frequency set nationally.



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## Recommendation 22 Supplier Switching

Supplier switching should be facilitated for customers leveraging the smart metering infrastructure.

**Supportive Arguments:** As a result of remote reading, customer consumption data are directly accessible to suppliers. Due to interval metering, all metering data are considered to be accurate, thus facilitating the supplier switching processes, moving or change of contract.

## Recommendation 23 Bills Based on Actual Consumption

Bills issued to the customers should be reflect actual gas consumption.

**Supportive Arguments:** As a result of remote reading, bills issued to the customers should be reflect actual gas consumption. However, this recommendation does not preclude the possibility of offerings involving different payment schemes such as fixed monthly payments with a yearly reconciliation bill.

## Recommendation 24 Remote Activation and De-activation of Supply

Smart gas meter should allow the remote activation and re-activation of supply.

**Supportive Arguments:** Based on the bidirectional communication offered by smart gas meters, the remote activation and de-activation of supply for a customer should be possible. The remote de-activation can be performed:

- upon customer request to the relevant service provider,
- for safety reasons, or
- in the case of debt.

For the de-activation of supply the regulatory framework should describe under which safety conditions this can be performed.

It should be mentioned that, for safety reasons, in most cases, it is necessary that gas activation is always performed manually by personnel on-site. Before the manual operation, primarily there has to be a remote enabling of activation by the party responsible, to prevent dangerous activation under unsafe conditions. In cases where this is initiated by someone other than the customer, the regulatory framework should describe in detail the procedures and timeframes to be applied. In any event, customer protection and public service rights and obligations should be respected to ensure this service is used correctly.



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### Recommendation 25 Alert in case of Exceptional Energy Consumption

Customers should be informed in case of exceptional gas consumption.

**Supportive Arguments:** Upon customer request, up-to-date information on exceptional gas consumption should be communicated to the customer. This information could be subject to a reasonable fee. Communication channels include, but they are not limited to, messages via the short message service (SMS), email, call centre, etc. Specific care should be taken with regards to the communication with vulnerable customer groups.

The consumption level that needs to be reached before triggering the notification should be configured by the customer.

### Recommendation 26 Remote Configuration of Smart Gas Meters

Smart gas meters should support remote configuration.

**Supportive Arguments:** The gas DSOs should make sure that the smart metering system will allow for the program software to be upgraded remotely. During upgrade operations, the metering system must hold the values stored and at the same time keep on reading and measuring the gas withdrawn.

Remote configuration and software upgrade allow for reduced costs and time for the performance of the upgrade.

### Recommendation 27 Whole System Approach Cost-Benefit Analysis

The cost-benefit analysis for smart gas meter should take into account the whole value chain of gas distribution.

**Supportive Arguments:** The CBA should take into account, not only the customer benefits, but also the whole gas value chain including gas DSOs, suppliers, etc. Cybersecurity and data privacy related costs should also be part of the CBA. For gas DSOs, the CBA should consider gas distribution related benefits that will eventually lead in a more efficient operation of the gas distribution networks.

### Recommendation 28 All Customers should Benefit from Smart Metering

All customers should be eligible to obtain a smart gas meter.

**Supportive Arguments:** The smart meter rollout should not exclude a priori any gas customer, so that all customers benefit from the services developed through smart metering systems, thus enabling them to become active in the energy market. In the case of wide geographical spread of gas customers, or any other special circumstances, gas DSOs could exclude customers or group of customers from the smart meter rollout.



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### Recommendation 29 No Discrimination when Rolling out Smart Meters

Gas DSOs should avoid discriminatory behaviour during the smart gas meters rollout.

**Supportive Arguments:** Discrimination based on distinguishing between customers served by suppliers other than the vertically integrated supplier or distinguishing between customers served under regulated prices in relation to customers served on the free market should be avoided.

To avoid unnecessary costs for customers, the timing of the actual metering installation in different regions may have to be considered.

#### 2.5.4.3 Cybersecurity

The introduction of smart grids functionalities in gas distribution will also require changes not only in the regulatory and policy framework, but also at the operational and IT levels. The recommendations related to cybersecurity for smart gas grids are provided in this subsection.

### Recommendation 30 Improvement of the Regulatory and Policy Framework

EMRA should develop specific policy documents and regulations regarding cybersecurity and privacy for the smart gas distribution, grid in order to improve the current regulatory and policy framework.

**Supportive Arguments:** The existing regulatory framework should be extended to also include policies and regulations related to cybersecurity and data privacy for smart grids in the gas distribution sector. These policies and regulations should:

- consider privacy and cybersecurity as two intrinsically interdependent topics,
- define cybersecurity measures to be considered in ongoing smart grid activities,
- require from gas DSOs to perform risk assessments,
- require manufacturers, integrators, services providers and grid operators to comply with specific cybersecurity certifications,
- implement penalties for entities not complying with the regulations in place,
- publicize the compliance results, and
- require from gas DSOs to report cybersecurity incidents to EMRA or the national authority that is responsible for cybersecurity aspects of critical infrastructure.

Moreover, EMRA should continue organize and support cybersecurity-related trainings and inspections to ensure compliance with the existing regulatory framework and to foster the gas distribution sector's awareness on cybersecurity issues.



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### Recommendation 31 Coordinate Smart Grid Cyber Security Initiatives

EMRA should foster the creation of a public-private partnership to coordinate smart grid cybersecurity initiatives for gas distribution.

**Supportive Arguments:** The public-private partnership (PPP) should act as a central coordinating entity at the national level with a global vision of all European and international initiatives dealing with cybersecurity and data privacy issues. The main objectives for the PPP should focus on:

- the avoidance of duplicated work,
- the enhancement of communication among task forces and work groups,
- the definition of a clear and unified strategy for ongoing and new initiatives,
- the identification of synergies among national and European initiatives,
- the dissemination of the work being done, and
- the establishment of a common dictionary of technical terms;

### Recommendation 32 Foster Awareness Raising and Training Initiatives

EMRA and gas DSOs should foster the creation of initiatives targeting awareness-raising of C-level in relation to the importance of the cybersecurity and data privacy in the smart grid for gas distribution.

**Supportive Arguments:** Part of the awareness raising and training initiatives, EMRA and gas DSOs should also promote training initiatives focused on how to use security-by-design principles for the gas distribution sector. These may include:

- guidelines and best practices for manufactures for building secure smart grid devices and applications,
- analysis of threats and risks affecting the resiliency and security of the gas distribution grid for grid operators, and
- issues related to fraud prevention and data privacy for services providers and end consumers.

### Recommendation 33 Foster Dissemination and Knowledge Sharing Initiatives

EMRA and gas DSOs should foster the dissemination activities on smart grid cybersecurity issues between the stakeholders of the gas sectors and the R&D institutions.

**Supportive Arguments:** EMRA and gas DSOs should promote the dissemination of results and lessons learned from ongoing and future initiatives. Knowledge sharing initiatives, related to cybersecurity for smart grids for gas distribution, should include both gas DSOs and TSOs, as well as other gas stakeholders, with EMRA playing a key role as a unified point for information exchange among smart grid stakeholders.





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### Recommendation 34 Development of a Minimum Set of Reference Standards and Guidelines

Gas DSOs should develop a minimum set of reference standards and guidelines for cybersecurity for the smart grid, leveraging existing initiatives such as Common Criteria, ISA99, and ISO 27000.

**Supportive Arguments:** Standardization for cybersecurity is of high importance for gas DSOs since it allows for unified and interoperable cybersecurity and data privacy framework for smart grids for gas distribution. The minimum set of reference standards and guidelines should include, among other topics:

- TD-1: a common reference architecture,
- TD-2: a reference risk assessment methodology,
- TD-3: technical requirements for smart grid systems; and
- TD-4: guidelines on security governance for legal entities involved in the future grid.

This body of standards and guidelines shall set a basis for conducting assessments and support the development of a national certification scheme for vendors and grid operators.

### Recommendation 35 Development of Cybersecurity Certification Schemes

EMRA and gas DSO should promote the development of security certification schemes for products and organizational security, leveraging existing initiatives such as Common Criteria, ISA99, and ISO 27000.

**Supportive Arguments:** The purpose of the promotion of cybersecurity certification schemes for product and organizational security is to harmonize cybersecurity and resiliency requirements across the various gas network stakeholders. This can be achieved by establishing the basis for a minimum set auditable controls for the various stakeholders. The responsibility for the issuance of the cybersecurity certificates should be accredited to the National Certification Authorities.

### Recommendation 36 Creation of Test Beds and Security Assessments

Gas DSOs should create the required test beds to assess if products are secure according to basic cybersecurity principles, such as those defined by the requirements for vendors.

**Supportive Arguments:** It is important for gas DSOs to create the required test beds for the evaluation of the various products and service according to basic cybersecurity principles. Whenever gas DSOs are not capable of performing such assessments, the cooperation of gas DSOs with independent third-party companies and organizations to carry out security assessments and penetration testing on gas DSOs should be incentivized. The purpose of this testing is to reveal and identify security flaws at the organizational level. It should be mentioned that these actions should be considered as an intermediate step to fill the gap while certification schemes are being developed. It is also recommended that the suggested test beds are developed as PPP that could, eventually, become accredited certification evaluators once the proposed certification schemes are ready.





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### Recommendation 37 Refine Strategies to Coordinate Large Scale Cyber Incidents

Gas DSOs should develop strategies to respond to large-scale cyber incidents that may be affecting multiple gas DSOs and TSOs.

**Supportive Arguments:** Gas DSOs should have in place measures and strategies for coordinated actions as a response to large-scale cyber incidents that may be affecting multiple gas DSOs and TSOs. These strategies should take into account the national Critical Infrastructure Protection (CIP) agencies, as well as other crisis management structures in place. They should also cover aspects related to alarm escalation, political decisions (e.g. isolating a TSO) and pre-established incident handling procedures.

### Recommendation 38 Foster Research in Smart Grid Cybersecurity

EMRA should foster and promote the R&D activities related to smart grid cybersecurity between the gas DSOs and the academia and research institutes in the context of national, European, and/or international research programs.

**Supportive Arguments:** EMRA should promote the R&D activities related to smart grid cybersecurity between the gas DSOs and the academia and research institutes. The research areas may include:

- protection of monitoring functionalities and automated decision-making systems of the smart grid,
- robust, secure and resilient architectures, such as self-healing and graceful degradation, as well as generation, distribution and storage of cryptographic material,
- trust and assurance and end-to-end security, including dependencies and threat analysis and use-case modelling, active monitoring for incident detection, security metrics, and security mechanisms against Denial-of-Service (DoS) attacks,
- security in dependable systems, such as legacy systems; encryption functionalities and application/network filtering,
- privacy and security by design, including common procedures and interfaces, protection against zero-day vulnerabilities, and optimization of cryptographic protocols,
- supply chain protection,
- secure smart grid in the cloud, and
- legal and economic aspects of cyber security in the smart grid for gas distribution.





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### Recommendation 39 Operators of Essential Services

EMRA should request from gas DSOs to develop and apply cybersecurity standards and measures.

**Supportive Arguments:** All gas DSOs should be characterized as Operators of Essential Services (OES). The development and application of cybersecurity standards and measures by all OESs will create a homogenous and secure ecosystem that will allow the development of a secure culture for further innovation and digitalization in the gas distribution sector.

### Recommendation 40 Compliance with NIS Directive

EMRA should encourage the gas DSOs to adopt, as much as possible, the NIS Directive<sup>10</sup> and provide the necessary support to transport horizontal regulation into best practices for the gas distribution sector.

**Supportive Arguments:** The compliance with the NIS Directive, will allow gas DSOs to comply with the security requirements in place for the European Member States.

### Recommendation 41 Guidance on Cybersecurity Governance

EMRA should provide clear guidance to gas DSOs on cybersecurity governance and define the role and responsibility of the Chief Information Security Officer within the organization.

**Supportive Arguments:** The Chief Information Security Officer (CISO) will serve as the reference contact point in all gas DSOs. The CISO should be provided with independence, resources, and a proper mandate from top executive management, in order to have an impact in the cybersecurity landscape for gas distribution. Providing CISOs with proper skills and resources, and with proper executive commitment, may help in achieving ambitious goals in a shorter time.

### Recommendation 42 Cybersecurity Strategy

Gas DSOs should develop a cybersecurity strategy that will include all the necessary security measures prior implementing cloud-based technologies and smart grid solutions that could potentially create security holes in their IT infrastructure.

**Supportive Arguments:** Developing a cybersecurity strategy will allow the further development of a cybersecurity culture within the gas distribution sector.

<sup>10</sup> <https://ec.europa.eu/digital-single-market/en/network-and-information-security-nis-directive>



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### 2.5.5 Digitalization and Smart Grid Master Plan

With regards to the plans for smart grid activities of the gas distribution companies, gas DSOs will prepare and submit to EMRA their “Digitalization and Smart Grid” master plans.

In the following, a guideline is provided with best practise recommendations related to the sections and subsections of the “Digitalization and Smart Grid Planning” master plan in terms of their scope and contents. The proposed structure for the “Digitalization and Smart Grid Planning” to be prepared by the gas DSOs is shown below, where [Gas DSO] should be replace with the name of the particular gas distribution company responsible for the preparation of the plan.





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## “Digitalization and Smart Grid Planning” Master Plan

### 1. Background

- 1.1. Introduction to [Gas DSO]
- 1.2. Overview of Digitalization and Smart Grid Strategy

### 2. Introduction

- 2.1. Digitalization and Smart Grid Planning Process
- 2.2. Stakeholder Involvement
- 2.3. Assessment of Effective Regulatory Framework for Smart Grids

### 3. Innovation for [Gas DSO]

- 3.1. Scope of Digitalization and Smart Grid
- 3.2. Stages of Digitalization and Smart Grid
- 3.3. Digitalization and Smart Grid Objectives
- 3.4. Funding Digitalization and Smart Grid Projects
- 3.5. Approach to Innovation
- 3.6. Selecting and Prioritizing Smart Grid Areas
- 3.7. Developing Plans for Digitalization and Smart Grid
- 3.8. Stakeholder Engagement
- 3.9. Collaboration Between DSO and TSO

### 4. Digitalization and Smart Grid Progress

- 4.1. Performance to Date
- 4.2. Planned Activities

### 5. Governance Arrangements

- 5.1. Partners and Supplier Arrangements
- 5.2. Managing Risk and Future Uncertainty
- 5.3. Tracking Benefits
- 5.4. Keeping the Strategy Up to Date

### 6. Delivering Benefits from Digitalization and Smart Grid





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## 2.6 Smart Grid Roadmap for DSOs

The following subsections provide an overview of the current situation related to smart grids for gas DSOs in Turkey, assess the needs for smart grids technologies and solutions to be integrated with the gas distribution networks, and provide a list of recommendations for smart solutions for gas distributions companies. Finally, a proposed roadmap for smart gas grids for the distribution sector is presented along with the respective implementation roles and responsibilities for the regulated entities in gas distribution.

### 2.6.1 As-is Status of Smart Grids in DSOs

Through the last two decades, gas pipelines have spread across the country with large amount of investments and Turkey experiences a rapid growth in penetration of natural gas. By the 2018, the natural gas distribution penetration is increased to 100% with gas supplied to all 81; in 2003, it was only supplied to 6 cities. Such rapid expansion of gas distribution is closely associated with the success of greenfield tendering of gas distribution licenses run by EMRA. Natural gas is supplied to 81 cities via 72 licensed natural gas distribution companies. In order to increase penetration and provide better services, these companies have executed a continuous investment program. The gas distribution grid is fully open to third party access providing non-discriminatory access to all system users.

For the sake of assessment of the as-is status of smart grids in Gas DSOs, the following questionnaire has been prepared and the responses have been completed based on public information published by EMRA or Gas DSOs. The following table summarized the as-is status of majority of Gas DSOs in the sector.

Table 4: As-is Status of Smart Grids in Gas DSOs

Advanced Network Management	As-is Status of Majority of Gas DSOs in Turkey
<b>TD-1: Control Centre &amp; Process Environment</b>	
1. Do Gas DSOs have a SCADA system?	Yes, for all Dispatch Control Centres, as well as local SCADA in the relevant stations.
2. Do Gas DSOs have the ability of performing remote fault identification and localization?	Yes, for DSOs with advanced SCADA functionalities
3. Do Gas DSOs operate their own weather forecast service?	No, generally received as a outsourced service if required
4. Do Gas DSOs operate their own demand forecast studies?	Yes.
5. Do Gas DSOs have any other gas specific applications in operation (integrated ones or stand-alone), such as Day Planning, Peak Determination, Schedule Balancing, Missing Data Estimation, Operator Training Simulator, etc.?	Yes, for some of the DSOs
6. Do Gas DSOs have in operation substation automation systems?	Yes.



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7. Does gas distribution network have (at least partially) telecontrol and self-healing capabilities?	Yes, telecontrol capabilities are used.
8. Do Gas DSOs have in place and leakage detection system?	Several R&D projects have been executed for this purpose.
<b>TD-2: Protection Systems</b>	
9. Do Gas DSOs have in place a Protection Information System?	Cathodic protection schemes are implemented, with ad-hoc recording of the relevant system parameters.
<b>Smart Gas Meters</b>	
<b>As-is Status of Majority of Gas DSOs in Turkey</b>	
10. Do Gas DSOs have smart gas meters already deployed to customers?	No, only a few R&D projects are being executed
11. Have Gas DSOs already carried out a pilot involving smart gas meters?	Several R&D projects for smart gas metering have been approved by EMRA. Also, some DSOs have initial thoughts for deployment of smart gas meters.
12. Are there any plans to start the rollout of smart meters?	Some DSOs have willingness for deployment of smart gas meters, but no robust rollout planning yet.
o If yes, what is the time horizon?	Not Applicable.
13. Is there discussion with electricity DSOs in order to jointly rollout smart meters to reduce installation costs?	No. However, it's mentioned in related electricity secondary legislation (Procedures and Principles for Automatic Meter Reading Systems)
<b>TD-3: Smart Gas Meters Functionalities</b>	
14. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they allow end-customers to have full or partial control over their data?	Not Applicable. However, several DSOs provide web platform for customers to access their invoice and other data.
15. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they provide information on actual consumption and cost, on a monthly basis, free of charge to the end-customers?	Not Applicable as of today. However, it can be implemented.
16. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they provide information on consumption data to the end-customers on demand?	Not Applicable as of today. However, it can be implemented.





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17. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they support easier supplier switching, move or change contract?	Not Applicable as of today.
18. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they support issue bills based on actual consumption?	Not Applicable as of today. However, it can be implemented.
19. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they support remote activation and deactivation of supply for gas smart meters?	Not Applicable as of today. However, it can be implemented.
20. In case Gas DSOs have deployed or planning to deploy smart gas meters, do they support triggering of alarms in case of exception energy consumption?	Not Applicable as of today. However, it can be implemented.
21. In case Gas DSO have deployed or planning to deploy smart gas meters, do their meters support over-the-air (OTA) firmware upgrades?	Not Applicable as of today. However, it can be implemented.
22. Do Gas DSOs consider carrying out a cost-benefit analysis (CBA) prior to a smart meter rollout for gas distribution?	Yes, there are initial ideas towards implementation of CBA for smart meters.
23. Do Gas DSOs consider rolling out smart gas meters only for a specific group of customers?	So far, no regulatory obligation is over there. It will depend on relevant legislation once it is defined. However, it might be expected to use consumption level of customers as main criteria to install smart gas meters to customers.
<b>TD-4: Smart Gas Meters Communications</b>	
24. What type of technology are Gas DSOs considering for smart gas meters communication?  Multiple Choice [4G/GPRS, NB-IoT, LTE-Cat3M, LoRa, Zigbee, RF (proprietary), other]	In R&D projects, different wireless solutions are considered.
<b>Digitalization and Communication</b>	<b>As-is Status of Majority of Gas DSOs in Turkey</b>
<b>TD-5: Asset &amp; Data Management, Analytics, Enterprise IT, Application Integration</b>	
25. Do Gas DSOs operate a workforce management (WFM) system?	Yes, many DSOs have implemented relevant Enterprise IT system.
26. Do Gas DSO use an Enterprise Resource Planning (ERP) system?	Yes, many DSOs have implemented relevant Enterprise IT system.
27. Do Gas DSOs use an Asset Performance Management System (APMS)?	No, only asset recording is available in GIS.





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28. Do Gas DSOs have a detailed description of their distribution network and assets using a Geographic Information Systems (GIS)?	Yes. And GIS improvement investments and studies are on-going in many DSOs
29. Do Gas DSOs have the IT infrastructure to store and analyse big data for the improving the operational process and asset performance?	Several DSOs have plans to implement big data platforms.
30. Do Gas DSOs apply Machine Learning (ML) and Artificial Intelligence (AI) algorithms for forecasting and preventive maintenance tasks?	No.
31. Is there a common platform for data exchange between IT and OT systems with BOTAŞ?	In order to develop the smart grid applications in the natural gas market, it was ensured that all distribution companies installed Dispatch Control Centres (SKM) in the first place. Data transfer is made to the Electronic Bulletin Table managed by BOTAŞ through these centres.
32. Is there provision for data exchange with external parties (e.g. via ICCP, web services, etc.)?	Yes, as required.
33. Does Gas DSOs have an Enterprise Service Bus (ESB) architecture for the integration of the IT and OT systems?	Mainly SAP applications are integrated via ESB architecture (SAP PI, etc.)
34. Have Gas DSOs planned to be developing/using extensions of the Common Information Model (CIM), defined for electricity, for gas?	No.
35. Do Gas DSOs have a data model specifically customized for the needs of the organization?	Yes, in GIS and Enterprise Applications, as well as SCADA system.
<b>TD-6: IT and Communication Infrastructure</b>	
36. Do Gas DSOs use cloud-based solutions/applications?	Depending on the holding company's IT strategy, that's an option if the data centre is located within Turkey.
37. Do Gas DSOs rely on new IT models (e.g. Platform-as-a-Service, Software-as-a-Service, etc.)?	Yes, for several IT needs.
38. For the communication with field and substation devices, what type of telecommunication infrastructure do Gas DSOs use?  Multiple Choice: [public, private, hybrid]	Mainly public. Tunnelling, encryption and other cyber security measures are implemented.
39. Do Gas DSOs consider new telecommunication technologies (e.g. 5G) for the communication with field and substation devices?	No. Only within R&D projects.
40. Do Gas DSOs have plans for deploying their own telecommunication network?	No.





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Cross-cutting Topics	As-is Status of Majority of Gas DSOs in Turkey
<b>TD-8: Artificial Intelligence and Machine Learning Applications</b>	
41. Do Gas DSOs use AI- and/or ML-based advanced analytics applications?	No.
42. Do Gas DSOs consider/use Internet of Things based applications within the organization?	Yes, through R&D projects.
<b>TD-9: Cyber and Physical Security Systems</b>	
43. Do Gas DSOs implement (or did they already deploy) cybersecurity measures in the organization?	Yes.
44. Is there a cybersecurity framework imposed by EMRA for gas DSOs?	Yes, both through ISO certification and through detailed rules and principles defined in special legislation for Cyber Security Industrial Control Systems.
45. Do Gas DSOs consider privacy and cybersecurity as two intrinsically interdependent topics within the organization?	Yes, GDPR and ICS processes are handled separately. The related effective regulations are also different.
46. Do Gas DSOs consider cybersecurity measures for current or future smart grids deployments (e.g. smart meters)?	Not yet.
47. Are Gas DSOs obliged by EMRA to perform a risk assessment?	Yes.
48. Do Gas DSOs request that manufacturers, integrators, services providers comply with specific cybersecurity certifications?	Ad-hoc practices in different DSOs. Some of them have detailed definition in their procurement documents/ technical specifications.
49. Are there any regulatory penalties for not complying with specific cybersecurity standards?	Yes.
50. Are there any dissemination and knowledge-sharing activities within DSOs' organization to raise awareness related to cybersecurity issues?	Yes.
51. Is there a minimum set of reference standards and guidelines related to cybersecurity that is applied within DSO organization?	Yes.
52. Do Gas DSOs have testbeds and/or labs for performing cybersecurity assessments for hardware and software?	Cybersecurity-related trainings and inspections are already organized by EMRA's Information Technologies Department to ensure compliance with the existing regulatory framework and





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	to foster the gas distribution sector's awareness on cybersecurity issues.
53. Apart from cybersecurity, do Gas DSOs also implement measures related to physical security?	Yes.

### 2.6.2 Recommended Smart Solutions for DSOs

In this section we provide the set of recommendations for smart grids in the gas distribution sector. To better organize the proposed recommendations, the following technical domains (TDs) are considered:

- TD-1: Control Centre & Process Environment
- TD-2: Protection Systems
- TD-3: Smart Gas Meters Functionalities
- TD-4: Smart Gas Meters Communications
- TD-5: Enterprise IT and Application Integration
- TD-6: IT and Communications Infrastructure
- TD-7: Smart Grid Services
- TD-8: Artificial Intelligence and Machine Learning
- TD-9: Cyber and Physical Security.

These TDs can be group into the following broader categories, as shown in the table below.

*Table 5: Technical Domains Categorization*

Category	Technical Domains
<b>Advanced Network Management</b>	TD-1, TD-2
<b>Smart Gas Meters</b>	TD-3, TD-4
<b>Digitalization and Communication</b>	TD-5, TD-6
<b>Smart Grid Services</b>	TD-7
<b>Cross-cutting Topics</b>	TD-8, TD-9

A graphical representation of the categories and the technical domains is provided in Figure 7.



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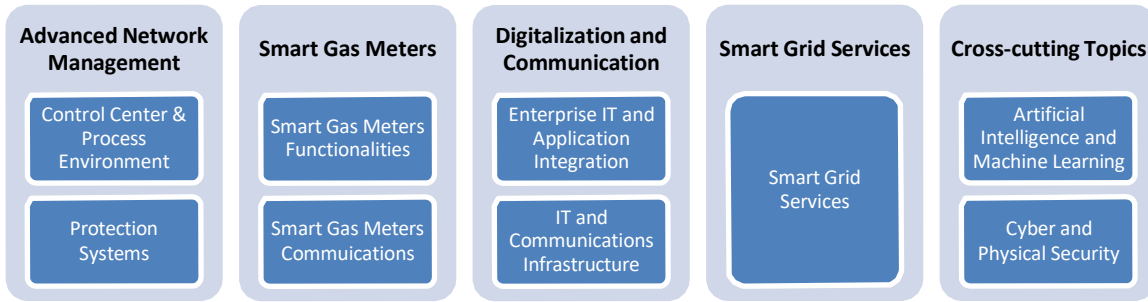


Figure 7: Smart Grid Categories and Technical Domains

Table 6 provides a summary of the smart grid recommendations for gas distribution. A detailed analysis of the recommendations is given in the next subsection.





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Table 6: Summary of Smart Grids Recommendations for Gas Distribution

ID	Recommendation	Technical Domain	Priority	Key Stakeholders Involved
<b>Advanced Network Management</b>				
R1	Gas Distribution SCADA	Control Centre & Process Environment	Short-term	Gas DSOs
R2	Remote Fault Identification and Localization		Medium-term	Gas DSOs
R3	Forecasting Services		Short-term	Gas DSOs
R4	Distribution Automation		Medium-term	Gas DSOs
R5	Protection Information System	Protection Systems	Medium-term	Gas DSOs
<b>Smart Gas Meters</b>				
R6	Smart Gas Meters	Smart Gas Meters Functionalities	Medium-term	EMRA, Gas DSOs
R7	Meter Data Management System		Medium-term	Gas DSOs
R8	Remote Activation and Deactivation		Medium-term	Gas DSOs
R9	Alarms on Energy Consumption		Medium-term	Gas DSOs
R10	Smart Meter Firmware Upgrades		Medium-term	Gas DSOs
R11	Smart Gas Meters Communications	Smart Gas Meters Communications	Medium-term	Gas DSOs
<b>Digitalization and Communication</b>				
R12	Workforce Management System		Medium-term	Gas DSOs





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ID	Recommendation	Technical Domain	Priority	Key Stakeholders Involved
R13	Enterprise Resource Planning	Enterprise IT and Application Integration	Medium-term	Gas DSOs
R14	Asset Performance Management System		Medium-term	Gas DSOs
R15	Geographic Information System		Short-term	Gas DSOs
R16	Big Data Analytics		Short-term	Gas DSOs
R17	Information Management System		Medium-term	Gas DSOs
R18	Common Information Model		Short-term	Gas DSOs
R19	Cloud Solutions		Medium-term	Gas DSOs
R20	Telecommunications Infrastructure		IT and Communications Infrastructure	Short-term
<b>Smart Grid Services</b>				
R21	Flexibility Services	Smart Grid Services	Long-term	EMRA, Gas DSOs
R22	Energy Efficiency Services		Medium-term	EMRA, Gas DSOs
R23	Power-to-Gas		Medium-term	EMRA, Gas DSOs
R24	LNG/CNG Transportation		Medium-term	EMRA, Gas DSOs
R25	Combined Heat and Power		Medium-term	EMRA, Gas DSOs
<b>Cross-cutting Topics</b>				
R26	Artificial Intelligence and Machine Learning		Long-term	Gas DSOs





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ID	Recommendation	Technical Domain	Priority	Key Stakeholders Involved
R27	Internet of Things	Artificial Intelligence and Machine Learning	Short-term	Gas DSOs
R28	Cybersecurity Testbeds and Security Assessments	Cyber and Physical Security	Short-term	EMRA, Gas DSOs
R29	Cybersecurity for Big Data		Short-term	EMRA, Gas DSOs
R30	Physical Security		Short-term	EMRA, Gas DSOs





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### 2.6.2.1 Advanced Network Management

Recommendation 1	Gas Distribution SCADA
<p>Gas DSO are strongly recommended to integrate into their Supervisory Control and Data Acquisition (SCADA) system all substation and field devices in order to increase the situational awareness over their gas distribution network. Gas DSOs should also consider during the procurement of SCADA systems, as well as other Operation Technology (OT) systems, that these systems provide all the required interfaces for the integration and exchange of information with existing and future IT and OT systems. Moreover, field devices should also provide the necessary hardware interfaces and support the required telecommunication protocols for their integration with SCADA systems.</p>	
<p><b>Prioritization:</b> Short-term</p>	<p><b>Technical Domain:</b> Control Centre &amp; Process Environment</p>

Recommendation 2	Remote Fault Identification and Localization
<p>The ability to perform remote detection and localization of faults in the gas distribution network will allow gas DSOs to increase the quality of supply to their customers, to operate their network in a more efficient way, as well increase the safety associated with the distribution networks. Gas pipeline leakage detection aims to identify the nearest sensor to the fault that indicates the faulty pipe segment in the distribution network.</p>	
<p><b>Prioritization:</b> Medium-term</p>	<p><b>Technical Domain:</b> Control Centre &amp; Process Environment</p>

Recommendation 3	Forecasting Services
<p>Gas demand forecasting is an important service for gas DSO, since it allows gas distribution companies in the calculation of safety monitors, which are used to ensure sufficient gas is held in storage to underpin the safe operation. Moreover, demand forecasts are a key element of security of supply analyses. Advanced approaches to demand forecast that include neural networks and deep learning technique, decrease the forecasting error, thus providing more accurate predictions for gas demand to the gas DSOs.</p>	
<p><b>Prioritization:</b> Short-term</p>	<p><b>Technical Domain:</b> Control Centre &amp; Process Environment</p>

Recommendation 4	Distribution Automation
<p>Distribution automation and substation automation solutions offer gas DSO the ability to remotely monitor and control the or gas distribution assets. Control functionality includes intelligent control over gas distribution network functions and is considered one of the keys enabling technologies for the realization of the smart grid for gas distribution.</p>	





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#### Recommendation 4 Distribution Automation

**Prioritization:** Medium-term

**Technical Domain:** Control Centre & Process Environment

#### Recommendation 5 Protection Information System

It is highly recommended that gas DSOs deploy in their distribution networks the required smart grid infrastructure for the remote monitoring and control of aspects related to pressure regulation, traceability, internal pipe inspection, odorization, and cathodic protection towards improving the integrity of the network. It should be mentioned that a protection information system is expected to optimize the operation of all distribution assets and improve the efficiency of the energy networks through enhanced automation, monitoring, protection and real time operation<sup>11</sup>.

**Prioritization:** Medium-term

**Technical Domain:** Protection Systems

### 2.6.2.2 Smart Gas Meters

#### Recommendation 6 Smart Gas Meters

Smart gas meters are a key component of the realization of a smart grid for the gas distribution. A smart meter is characterized by the ability to provide bidirectional communication between the meter and the Meter Data Management System (MDMS). Apart from the ability for the remote monitoring of the gas consumption, the information collected from smart gas meter can be used to offer insights on the distribution network of gas DSOs. A study<sup>12</sup> from December 2019 on the deployment of smart meters in the EU found that on average, smart meters provide savings of €230 for gas and €270 for electricity per metering point (distributed amongst consumers, suppliers, distribution system operators, etc.) as well as an average energy saving of at least 2% and as high as 10% based on data coming from pilot projects. Gas DSOs should also consider synergies with electricity DSOs during the pilot and rollout phases of the smart gas meters deployment in order to significantly reduced installation costs.

**Prioritization:** Medium-term

**Technical Domain:** Smart Gas Meters Functionalities

#### Recommendation 7 Meter Data Management System

The Meter Data Management System (MDMS) ingests, stores, cleans, and analyses data retrieved from smart metering systems. Data from the MDMS can be used for billing purposes, as well as to provide insights regarding gas demand and consumption, as well their forecasted values. By applying data analytics and data mining methods, smart gas metering data can be used to leakage detection and localization.

<sup>11</sup> "Smart Energy Grid aspects related to Gas", Marcogaz, 2015

<sup>12</sup> "Benchmarking smart metering deployment in the EU-28", European Commission, April 2002





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<b>Prioritization:</b> Medium-term	<b>Technical Domain:</b> Smart Gas Meters Functionalities
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Recommendation 8	Remote Activation and Deactivation
<p>The bidirectional communication capabilities offer by smart gas meters, allow also for the remote activation and deactivation of the gas supply to the end-customers. This functionality can be used to disconnect gas customers due to debt, but also to deactivate the supply for safety reasons, for example in case a gas leakage has been detected.</p>	
<b>Prioritization:</b> Medium-term	<b>Technical Domain:</b> Smart Gas Meters Functionalities

Recommendation 9	Alarms on Energy Consumption
<p>The analysis of the smart gas meter readings collected in the MDMS can reveal possible abnormal gas consumption profiles that might be attributed to gas leakage or unintended large consumption of gas by end-customers. In such a scenario, an alarm should be triggered in the MDMS or the SCADA systems to alert the gas DSO for the related incidents.</p>	
<b>Prioritization:</b> Medium-term	<b>Technical Domain:</b> Smart Gas Meters Functionalities

Recommendation 10	Smart Meter Firmware Upgrades
<p>Smart gas meters should be support Over The Air (OTA) firmware updates to allow gas DSO to perform the necessary firmware updates, either in the case of upgrading the functionality of installed meters or when a malfunction of the meter has been identified. Moreover, remote configuration of smart gas meters should be possible, to allow gas DSOs to change the configuration of already installed meters, without the need of a field visit by the gas DSO's personnel, thus reducing the time needed, as well minimizing the associated costs.</p>	
<b>Prioritization:</b> Medium-term	<b>Technical Domain:</b> Smart Gas Meters Functionalities

Recommendation 11	Smart Gas Meters Communications
<p>Gas DSOs should properly evaluate the possible technologies available for the communication of the smart gas meters with the MDMS. It is recommended that all available telecommunication technologies for smart gas meters should be assessed during the pilot phase before the smart meters' rollout. The mixture of the tested technologies should be based on state-of-the-art technology evaluations, always taking into account the specific requirements imposed by the gas DSOs. If deemed appropriate, more than one telecommunication technologies</p>	





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can be used during the rollout of the smart meters. Gas DSOs should also consider synergies with electricity DSOs during the pilot and rollout phases of the smart gas meters deployment.

**Prioritization:** Medium-term

**Technical Domain:** Smart Gas Meters Communications

### 2.6.2.3 Digitalization and Communication

#### Recommendation 12 Workforce Management System

Workforce management (WFM) solutions consists of the desktop and mobile applications that allow gas DSOs to manage efficiently staff scheduling, thus enabling the optimization of field resource distribution and streamlines field operations. WFM solutions generally include the following modules:

- labour scheduling: manages manage employees' skills and compliance requirements more effectively,
- time and work data collection: captures and reports detailed information about labour use,
- leave management: processes paid time-off requests with visibility into the staffing and liability implications,
- task and activity management: delivers a detailed view of labour management requirements to help with the sophisticated decision making required for activity-based management; and
- time and attendance: receive input from the other modules and apply rules against the reported times, based on the company's requirements.

**Prioritization:** Medium-term

**Technical Domain:** Enterprise IT and Application Integration

#### Recommendation 13 Enterprise Resource Planning

Enterprise Resource Planning (ERP) systems refer to the collection of integrated applications that an organization can uses to collect, store, manage, and interpret data from many business activities. Based on the fact that the smart gas grid will enable interaction with the various cross-sector business actors, it is recommended that gas DSOs operate an ERP system to cope with the processing of multidisciplinary data. Gas DSOs should also ensure that the ERP system provides all the required interfaces for the integration and exchange of information with existing and future IT and OT systems of the gas DSO.

**Prioritization:** Medium-term

**Technical Domain:** Enterprise IT and Application Integration

#### Recommendation 14 Asset Performance Management System

It is recommended that gas DSOs implement and operate an Asset Performance Management System (APMS) to manage in an efficient and systematic manner the gas distribution assets and forecast their expected times to



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failure, thus promoting the efficient operation of the gas distribution network. An APMS has to keep updated information on the equipment deployed by taking into account:

- commissioning and decommissioning of the devices,
- historical information of the device operations, and
- aging of the devices due to time and weather conditions.

Gas DSOs should also consider during the procurement of an APMS that the system provides all the required interfaces for the integration and exchange of information with existing and future IT and OT systems.

**Prioritization:** Medium-term

**Technical Domain:** Enterprise IT and Application Integration

### Recommendation 15 Geographic Information System

It is highly recommended that gas DSOs should always operate an updated Geographic Information System (GIS), containing all latest information regarding the assets and their geographical location. It is deemed important that an integration with the existing and future IT and OT systems of the gas DSO should be in place, especial with SCADA and the APMS. Moreover, it is also recommended that the exchange of topological data between the GIS and the SCADA system should be supported, so that changes in one of the systems to be reflected on the second system. DSOs should also consider during the procurement of a GIS that the system provides all the required interfaces for the integration and exchange of information with existing and future IT and OT systems.

**Prioritization:** Short-term

**Technical Domain:** Enterprise IT and Application Integration

### Recommendation 16 Big Data Analytics

With the deployment of smart grid solutions for the gas distribution grid, gas DSO will have at their disposal a large volume of data. Big data are characterized by the 5Vs: volume, velocity, variety, veracity and value. Although Information and Communication Technologies (ICT) have been already incorporated within the gas DSOs, recent advances in technologies, telecommunications and data analytics are progressively changing the data landscape, by introducing the notion of big data. Via the digitalization of the gas distribution sector, data is becoming more granular and new tools are being developed to better tailor communication, increase transparency and, most importantly, develop more personalized offers and services<sup>13</sup>. It should be mentioned that although digitalization holds a lot of promise, it also comes with new challenges for the consumers and the regulated entities, such as the exchange and handling of big data in a safe and regulatory-compliant way<sup>14</sup>. ENISA<sup>15</sup> recommends several measures for treating big data, such as:

- privacy by design,

<sup>13</sup> "CEER Cybersecurity Report on Europe's Electricity and Gas Sectors", CEER, 2018

<sup>14</sup> "The power sector goes digital: Next generation data management for energy consumers", EURELECTRIC, 2016.

<sup>15</sup> "Privacy by design in Big Data. An overview of privacy enhancing technologies in the era of Big Data analytics", ENISA, 2015.





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- decentralized versus centralized data analytics,
- transparency and control,
- user awareness and promotion of Privacy Enhancing Technologies, and
- a coherent approach towards privacy and big data.

More information on cybersecurity and big data can be found in Recommendation 29.

**Prioritization:** Short-term

**Technical Domain:** Enterprise IT and Application Integration

### Recommendation 17 Information Management System

Within the gas DSO environment, an Information Management System (IMS) refers to collection of applications and tools that allow the integration of the Information Technology (IT) and Operation Technology (OT) systems of the gas DSO. In the modern utility environment, an Enterprise Service Bus (ESB) architecture is used to enable the integration of the various systems, tools, and services. Compared to the traditional point-to-point architecture for system integrations, where the addition of a new system would require the development of the necessary interfaces with each one of the existing systems, the ESB permits, via the use of a data information bus based on a common data model, the seamless integration of any new IT or OT system via the development of the required interfaces for the said system with the ESB.

**Prioritization:** Medium-term

**Technical Domain:** Enterprise IT and Application Integration

### Recommendation 18 Common Information Model

The Common Information Model (CIM) is a suite of open international standards addressing energy management, asset management, and market systems. Even though CIM is focused on electricity, it can be extended to gas, thus giving the ability to gas DSO to develop their own customized data model that would be compatible with the CIM. It is recommended that EMRA fosters the use of the CIM not only within the gas DSOs, but also throughout the system operators for both gas and electricity as the common data model that will allow the seamless data exchange and coordination of all involved energy actors.

**Prioritization:** Short-term

**Technical Domain:** Enterprise IT and Application Integration

### Recommendation 19 Cloud Solutions

Smart grids highly depend on the coordination between the various energy actors, as well as on the coupling with other sectors. This interaction with the various cross-sector business actors can be supported by creating





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### Recommendation 19 Cloud Solutions

open cloud solutions that support open Application Programming Interfaces (APIs)<sup>16</sup>. To this extent, it is recommended that gas DSO should explore the proper combination of cloud solutions, as well as open source and proprietary solutions to support the synergies between the gas actors, as well as the interaction with the actors of the electricity sector. Such cloud solution may also include new IT models, such as Platform-as-a-Service and/or Software-as-a-Service solutions. It should be mentioned that specific care for cybersecurity issues related to cloud and open source solutions should be taken.

**Prioritization:** Medium-term

**Technical Domain:** IT and Communication Infrastructure

### Recommendation 20 Telecommunications Infrastructure

Gas DSOs should perform the required technical studies and CBA to define the technologies to be used for the communication with substations and field devices. The technical studies should take into account not only technical requirements for telecommunication, such as Quality of Service (QoS), data rates, and latency, but also assess the reliability of the various telecommunication solutions based on the criticality of the services and processes to be deployed using the specific telecommunication technology. Moreover, EMRA should encourage gas DSOs to carry out studies for evaluating the feasibility of deploying and operating their own private telecommunication networks or use existing telecommunication infrastructure from other system operators, such as electricity DSOs and TSOs. The possibility of gas DSOs deploying and operating a telecommunications network together with electricity DSOs and TSOs should also be promoted by EMRA.

**Prioritization:** Short-term

**Technical Domain:** IT and Communication Infrastructure

#### 2.6.2.4 Smart Grid Services

### Recommendation 21 Flexibility Services

Gas technologies are capable of providing flexibility solutions to the electricity grids either through power-to-gas solutions, by storing the excess of electricity supply, or via Combined Heat and Power (CHP) solutions, by lowering electricity demands. To meet the energy and climate goals of European Union and foster the energy transition, it is important that the regulations and policies adapt to the new and future roles, related to flexibility, of the gas DSOs. This can be achieved by:

- fostering R&D of gas technologies that provide flexibility to the energy system, such as technologies related to biomethane, hydrogen, micro-CHP, reverse flows and others,
- encouraging renewable and smart gas producers to become flexibility providers via power-to-grid and micro- and mini-CHP solutions and
- considering the active role of gas DSOs in managing flexibility on their grids.

<sup>16</sup> "Digitalization of the Energy System and Customer Participation: Description and recommendations of Technologies, Use Cases and Cybersecurity", ETIP-SNET Position Paper Summary, European Technology & Innovation Platform – Smart Networks for Energy Transition, 2018





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### Recommendation 21 Flexibility Services

**Prioritization:** Long-term

**Technical Domain:** Smart Grid Services

### Recommendation 22 Energy Efficiency Services

According to CEER<sup>17</sup>, it is highly recommended that gas DSO should be incentivized by EMRA to promote energy efficiency awareness for their customers as a way to optimize network investment or reduce energy losses (which are capital concerns of network operators). Gas DSOs should actively engage customers in energy efficiency services, since general information sharing about energy use cannot be considered as a direct service offered by the gas DSOs, in the sense that it cannot be charged to an individual consumer that contracts the service. Finally, energy audits and other energy efficiency service offered directly to the customers should not be within the scope of services offered by the gas DSOs.

**Prioritization:** Medium-term

**Technical Domain:** Smart Grid Services

### Recommendation 23 Power-to-Gas

Gas DSOs are encouraged to explore power-to-gas solutions as the one of the most important aspects of gas technologies that can provide flexibility to the electricity system. Especially power-to-gas system offer innovative and efficient solutions for transforming surplus supplies of electricity from renewable sources into synthesized gas that can then be injected into the gas network. Power-to-gas technologies provide a number of benefits, some of which are listed below.

- The transformation of electric power into hydrogen or SNG allows to use the energy at any time and locations by using the gas networks.
- The transformed electric power into hydrogen or SNG can be stored in the gas grid and made available when and where needed.
- The produced methane and hydrogen from power-to-gas can be used in a variety of industrial application applications leveraging the existing gas infrastructure.
- Peaks in renewable energy production can be efficiently managed by transforming renewable energy into SNG and hydrogen, thus reducing RES curtailment.
- Troughs in power production can also be balanced by generating electric power from power-to-gas plants.

**Prioritization:** Medium-term

**Technical Domain:** Smart Grid Services

<sup>17</sup> "C18-DS-46-08 – New Services and DSO Involvement", CEER, March 2019





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### Recommendation 24 LNG/CNG Transportation

Gas becomes increasingly important in the transportation sector, in both Liquefied Natural Gas (LNG) and Compressed Natural gas (CNG) forms. The use of gas for maritime transportation is not negligible in Europe while the gas fuelled private vehicles are getting more and more competitive especially due to environmental standards of the EU. The CO<sub>2</sub> emissions from natural gas vehicles (NGVs) can be further reduced by using biomethane as a fuel. Biomethane has a significant market share in Finland, Germany, the Netherlands and Sweden. It is recommended that gas DSOs should perform a feasibility study and a CBA for the deployment of NGV filling station infrastructure.

**Prioritization:** Medium-term

**Technical Domain:** Smart Grid Services

### Recommendation 25 Combined Heat and Power

Combined Heat and Power (CHP) systems produce simultaneously electricity and useful heat and can achieve energy efficiency levels of around 90%. According to the European Cogeneration Directive (2004/8/EC) a small-scale CHP unit is defined as the unit with an electrical capacity: micro-CHP is below 50kW and mini-CHP is below 1MW. The micro-CHP systems are currently powered by natural gas, biogas, biomethane, biofuels or liquefied petroleum gas (LPG).

Mini- and micro-CHP systems provide a number of benefits, since they allow a greater interaction between the electricity and gas systems. Moreover, they bring efficiency and flexibility to the energy system. Some of the benefits of mini- and micro-CHP systems are provided below<sup>18</sup>.

- Provide the ability for load shifting between the electricity and the gas network using heat storage, thus maximizing the efficient utilization of electricity and gas grids.
- Provide fuel savings by avoiding exhaust heat losses in many large power generation stations, thus leading to significant reductions of CO emissions (some 3 to 6 tons of CO emissions annually), as well as reductions in NO<sub>x</sub> and CO<sub>2</sub>.
- Micro-CHP reduce transmission and distribution losses of electricity from power stations to end-users.
- Allow electricity DSOs/TSOs to avoid investments in cross border-flows, as well as investments related to the reinforcement of the electricity grid of infrastructure.
- Low need for additional investment in the gas network since gas grid infrastructure is as already in place.
- Micro-CHP systems and the electricity smart meters, for both consumption and generation of electricity, and supplier services, provide the necessary link between the gas and electricity networks, thus providing high interoperability.

<sup>18</sup> "Flexibility in the Energy Transition: A Toolbox for Gas DSOs", CEDEC-Eurogas-GEODE





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### Recommendation 25 Combined Heat and Power

**Prioritization:** Medium-term

**Technical Domain:** Smart Grid Services

#### 2.6.2.5 Cross-cutting Topics

### Recommendation 26 Machine Learning and Artificial Intelligence

According to CEER conclusion paper on dynamic regulation to enable digitalisation of the energy system<sup>19</sup>, analytics, such as Machine Learning (ML) and Artificial Intelligence (AI), are among the key drivers of digitalization along with data and connectivity. It is recommended that gas DSOs to employ ML/AI algorithms for performing data mining from the available IT- and OT-related data. These algorithms will allow gas DSOs to develop applications for increasing the operational efficiency and safety of gas distribution networks. Such applications may include predictive and preventive maintenance of pipelines and related equipment, more accurate forecasting tools, leakage detection, and others.

**Prioritization:** Long-term

**Technical Domain:** Artificial Intelligence and Machine Learning

### Recommendation 27 Internet of Things

The European Parliament refers to the Internet of Things (IoT) as a “*distributed network connecting physical objects that are capable of sensing or acting on their environment and able to communicate with each other, other machines or computers*”<sup>20</sup>. According to CEER<sup>21</sup>, IoT is an integrated part of smart homes, since it provides customers with the ability to manage appliances, devices and sensors, which can communicate with each other and be controlled remotely, as well as to give to customers access to gas consumption data. It is recommended that gas DSOs should prepare their IT infrastructure and systems in such a way that they can cope with the large volume of incoming data from the various IoT devices. The IT systems should be able to perform processing, sorting, cleaning, analysis and visualization of IoT data and to integrate the data with the IT and OT systems of the gas DSO. The analysis of the big data generated by the IoT devices will enable gas DSOS to realize automation, control, management, problem detection and prediction applications in the smart gas grid. It should be mentioned that all customer related IoT device data should be in compliance with data protection laws and the new General Data Protection Regulation (GDPR), which came into force in May 2018.

**Prioritization:** Short-term

**Technical Domain:** Artificial Intelligence and Machine Learning

### Recommendation 28 Cybersecurity Testbeds and Security Assessments

<sup>19</sup> “CEER Consultation on Dynamic Regulation to Enable Digitalisation of the Energy System Conclusions Paper”, CEER, 2019

<sup>20</sup> [http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557012/EPRS\\_BRI\(2015\)557012\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557012/EPRS_BRI(2015)557012_EN.pdf)

<sup>21</sup> “CEER Report on Smart Technology Development”, CEER, 2018





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It is highly recommended that EMRA promotes the creation of cybersecurity testbeds that will allow, via agile testing methodologies, the assessment of the security of smart grid solutions and products according to a pre-defined set of security principles. EMRA should also incentivize the participation of third-party companies and organizations in these cybersecurity testbeds that will carry out the required penetration tests to the IT and OT systems of the gas DSOs, as well as other smart grids actors. Cybersecurity testbeds, could also serve as independent evaluators, accredited by National Certification Authorities, for future certifications schemes, as well as they could take the responsibility of knowledge sharing, dissemination, and training.

**Prioritization:** Short-term

**Technical Domain:** Cyber and Physical Security

### Recommendation 29 Cybersecurity for Big Data

According to ENISA<sup>15</sup>, it is highly recommended that the following measure should be taken for treating big data:

- Privacy by Design Applied (Anonymization in Big Data): Data Protection Authorities, data controllers and the big data analytics industry need to actively interact in order to define how privacy by design can be practically implemented (and demonstrated) in the area of Big Data analytics, including relevant support processes and tools.
- Decentralized versus centralized data analytics: The research community and the big data analytics industry need to continue their efforts in combination towards decentralized privacy-preserving analytics models. Policy makers need to encourage and promote such efforts, both at research and at implementation levels.
- Transparency and control: The big data analytics industry and the data controllers need to work on new transparency and control measures, putting the individuals in charge of the processing of their data. Data Protection Authorities need to support these efforts, encouraging the implementation of practical use cases and effective examples of transparency and control mechanisms that are compatible with legal obligations.
- User awareness and promotion of Privacy Enhancing Technologies (PETs): The research community needs to adequately address aspects related to the reliability and usability of online PETs. The role of the Data Protection Authorities is central in user awareness and promotion of privacy preserving processes and tools in online and mobile applications.
- A coherent approach towards privacy and big data: Policy makers need to approach privacy and data protection principles (and technologies) as a core aspect of big data projects and relevant decision-making processes.

**Prioritization:** Short-term

**Technical Domain:** Cyber and Physical Security





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**Recommendation 30**

**Physical Security**

It is highly recommended that gas DSO should take all the necessary precautions to enforce the required physical security measures in parallel with the cyber ones. Physical security for gas DSO becomes of paramount importance given the increasing number of connected Intelligent Electronic Devices (IEDs) that provide information and control to the IT and OT systems of the gas DSOs. Since field devices, including devices located in substation, are highly susceptible to attacks, the physical perimeter of these devices should be secured. In case of installed smart gas meters, it is recommended that the meters have a tamper detection mechanism that will trigger an alarm in the MDMS upon access attempts from unauthorized personnel.

**Prioritization:** Short-term

**Technical Domain:** Cyber and Physical Security





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### 2.6.3 Prioritization and Roadmap

Based on the analysis carried out in the previous sections with regards to the categories and the technology domains the following priority matrix is proposed, as illustrated in Figure 8.

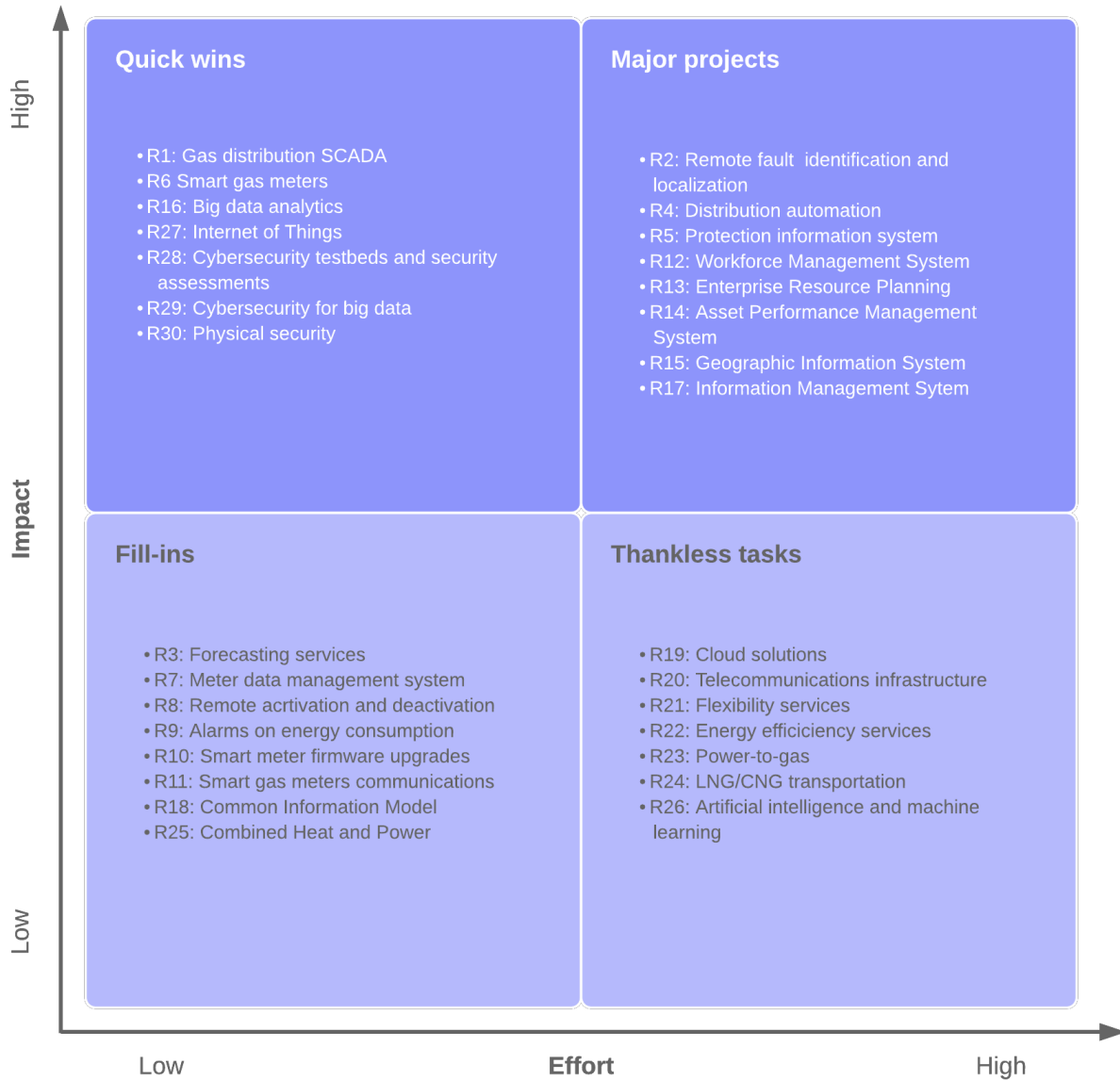


Figure 8: Priority Matrix for Smart Grids for Gas Distribution

A more detailed roadmap for 2025-2030 is shown in Figure 9 below.





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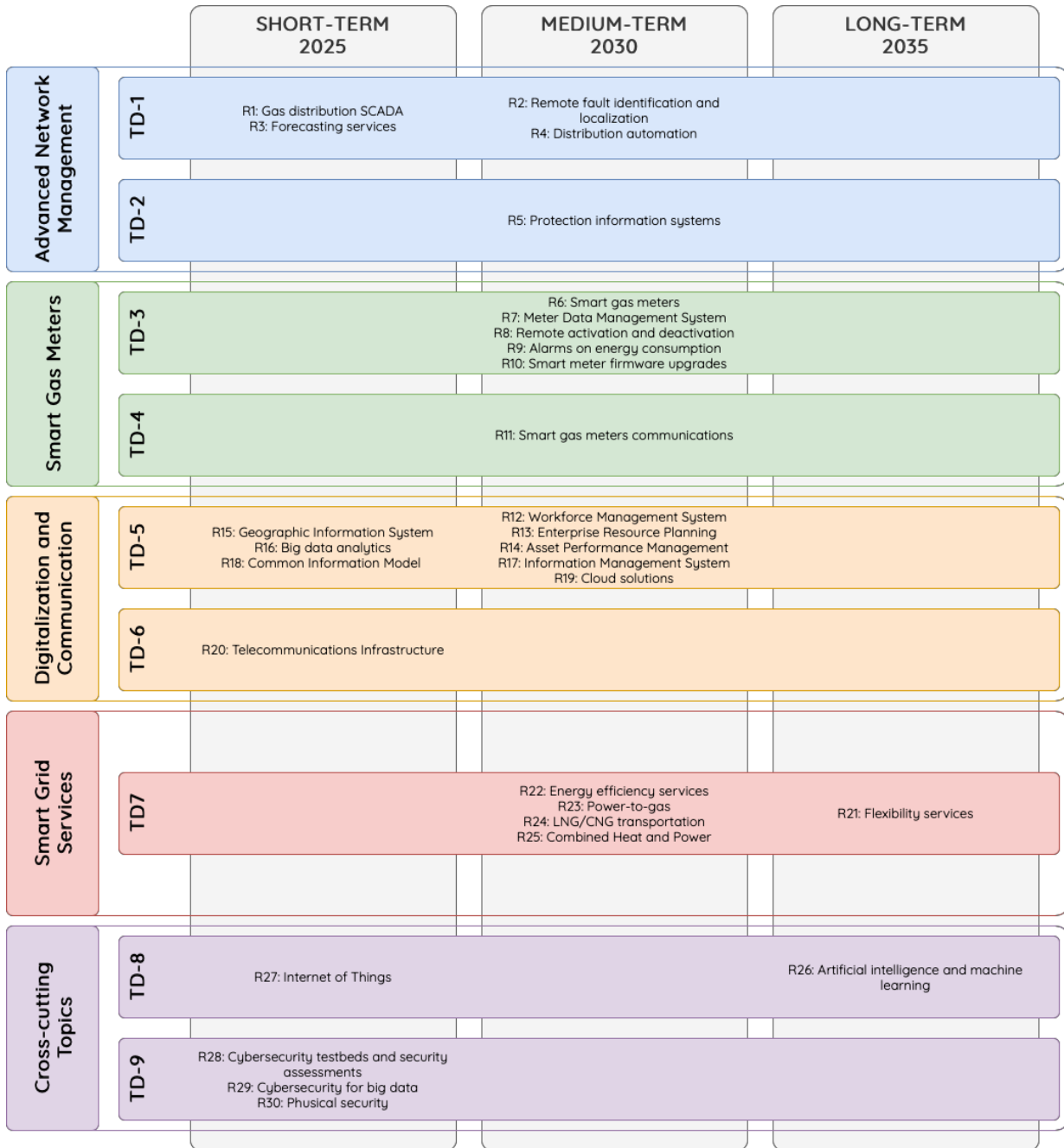


Figure 9: Smart Grid Roadmap for Gas Distribution





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#### 2.6.4 Recommendations on Implementation Roles and Responsibilities

The concept of smart gas grids is different from that of smart electricity grids. This is mainly attributed to the fact that gas grids have the ability of storing energy through the line-pack<sup>9</sup>. Another notable difference is related to disperse generation. In contrast with the large number of small-scale Distributed Energy Resources (DER) in electricity networks, mainly from solar and wind, decentralized green gas/bio-methane injections in the gas distribution grid are not expected to have a significant impact in the short to medium terms in the gas network.

EMRA and gas DSOs should promote the decentralized gas production. To foster the injection of non-conventional gases, such as Bio-Synthetic Natural Gas (BioSNG) or hydrogen, gas DSOs should be responsible for deploying the required smart grid infrastructure for remote monitoring to guarantee gas quality for the customers.

Gas DSOs also have the responsibility to operate the smart grid in such a way that it contributes to a further optimization of the local and regional energy systems, thus forming an intrinsic part of the so called “smart energy grid”. This is further justified by the fact that gas distribution networks can serve as the interlinkage between electricity and heat systems, thus contributing to the optimal management of a local or a regional energy system.

As already mentioned, smart gas meters are a key component of the smart gas grid. EMRA should have the responsibility to coordinate the parallel installation of smart meters for both electricity and gas, due to the savings obtained from reduced installation costs. Moreover, since smart meters also include a communication module for implementing the communication between the meter and the MDMS, having a shared single communication module for both the electricity and gas smart meters, is expected to reduce significantly the costs of the meters, as well their subsequent operation and maintenance. Additionally, the joint management of electricity and gas smart meters will allow the electricity and gas DSOs to efficiently utilize the respective smart metering data and allow synergies between electricity and gas DSOs.

EMRA should request from gas DSOs to carry out a CBA for the deployment of smart gas meters. In Europe, for many of the Member States the initial CBA was carried out on the back of pilot projects, in order to integrate the experiences from those projects, whereas the revised CBAs focus more on the actual scale and timing of the rollout. Based on a benchmarking smart metering deployment report<sup>12</sup> in the EU-28, the Member States can be grouped as followed regarding CBA for gas smart meters deployment:

- A first group of nine Member States did not conduct any gas smart metering CBA. These Member States are Bulgaria, Croatia, Estonia, Greece, Hungary, Poland, Portugal. Cyprus and Malta do not host any natural gas network and therefore did not perform a gas CBA.
- Thirteen Member States conducted one CBA: Austria, Czech Republic, Denmark, Finland, Germany, Italy, Lithuania, the Netherlands, Romania Slovakia, Slovenia, Spain and Sweden.
- Six Member States conducted two gas CBAs, namely Belgium, France, Ireland, Latvia, Luxembourg and the United Kingdom.

An overview of the revised CBA results, as of July 2018, considering a large-scale rollout of gas smart meters is shown in Figure 10.



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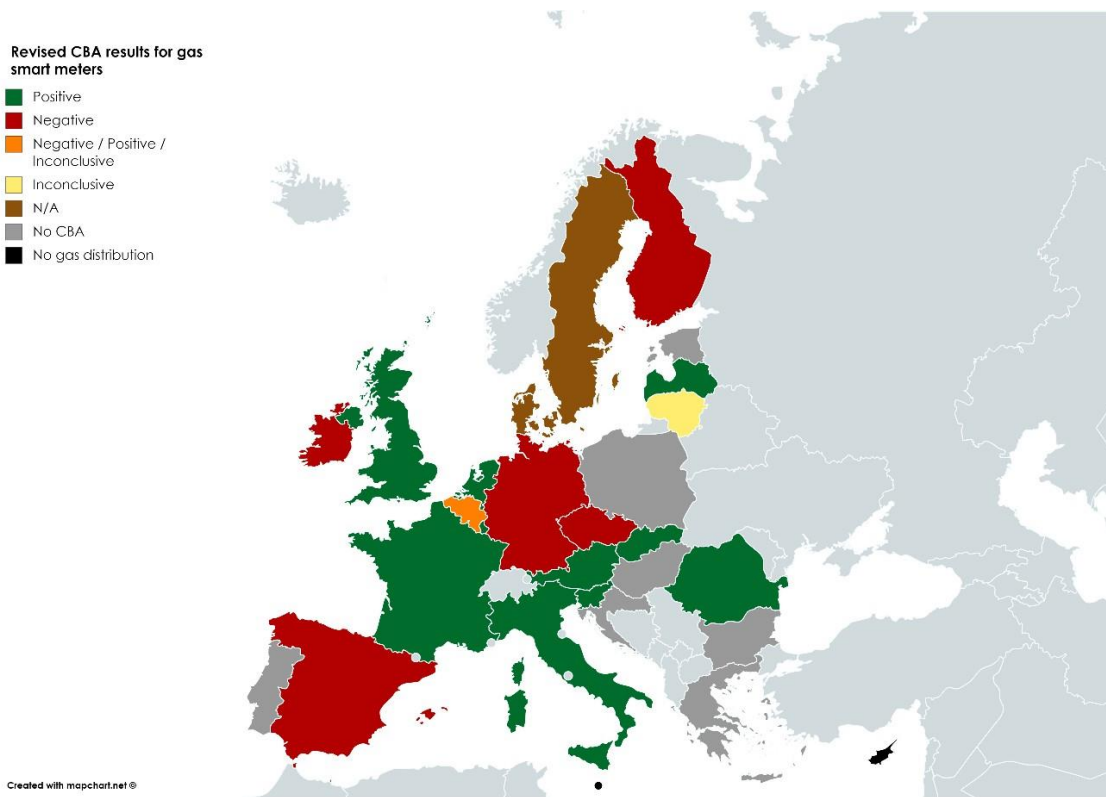


Figure 10: Revised CBA Results, as of July 2018, Considering a Large-Scale Rollout of Gas Smart Meters<sup>12)</sup>

According to the same report, four (4) primary market drivers were identified for the deployment of smart meters:

- Digitalization of the distribution grid and optimization of the network operations,
- Digitalization of retail market to foster innovation and new services by private actors,
- Supporting actions for tackling fuel poverty,
- Supporting energy efficiency.

The regulated entities and public institutions that could potentially be the key stakeholders in smart grid projects in the gas distribution sector are described below, along with their current and future roles and responsibilities.

### National Regulatory Authority

National Regulatory Authorities (NRAs) are responsible, among other things, about regulating network tariffs and their methodologies, as well as supervising the performance of DSOs. With regards to smart grid projects for gas distribution, NRAs are also responsible for setting the framework for incentivizing the smart grid-related activities. According to CEER<sup>22</sup>, NRAs should not decide on the technologies and/or solutions to be used in order to carry out the DSO’s distribution task, but their role is rather to set the framework so that the DSO to decide on suitable solutions according to the incentives set by each NRA. Specifically, in the case of smart gas meters, NRAs should be responsible of overseeing the conducting of the CBA and evaluate the outcome, both related to

<sup>22</sup> “C17-DS-37-05 – Incentives Schemes for Regulating Distribution System Operators, including for innovation”, CEER, 2018





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### National Regulatory Authority

associated costs, as well as to expected benefits. Moreover, issues related to data handling and exchange, and ownership and management of metering equipment, should be treated by the NRAs regarding allocation of roles and responsibilities in the private and the regulated domain. Finally, since the potential of flexibility services in the gas grid are limited, the NRAs should request from gas DSOs to perform a Societal Cost-Benefit Analysis (SCBA), to evaluate the necessity of the deployment of such services via analysing whether the benefits of a procurement model outweigh the resulting administrative burdens.

### Gas Distribution System Operator

Gas Distribution System Operators (DSOs) play a fundamental role in the operation of gas networks since they are responsible for the operation, maintenance, and development of the portion of the gas network that links the transmission system and the end customer. Moreover, gas DSOs play an important role as market facilitators for gas suppliers by making sure that the gas is transported in a safe and efficient manner. CEER<sup>22</sup> acknowledges also the importance of gas DSOs to decide on the suitable innovation solutions to be applied in their networks, according to the individual needs of the gas DSOs. With regards to smart grids for gas distribution, in case gas DSOs decide to participate active in the development of NGV infrastructure, it is recommended that a clear exit strategy for the gas DSOs should be formulated and executed when the market is able to take over the infrastructure provision, preventing market distortion. Finally, gas DSOs should explore efficiencies of collaboration between electricity and gas DSOs in data collection, transmission and handling, in case smart metering data is collected and provided to the market.

### Gas Transmission System Operator

Gas Transmission System Operators (TSOs) are responsible for the operation and maintenance of the gas transmission network, as well as its development. Moreover, one of the main roles of gas TSOs is to guarantee the security of supply to the increasing energy demands. Since the roles of gas TSOs and DSOs are by nature closely coupled, close collaboration and development of joint strategic plans for smart gas grid investments should be carried out in specific areas selected based on the prioritization of the smart grid activities between the gas system operators. Finally, dissemination of the results of the joint smart grid efforts with the relevant stakeholders of the energy system should be fostered.

### Electricity System Operators

The electricity TSOs and DSOs play an important role in modern energy systems. Gas technologies are capable of providing flexibility solutions to the electricity networks either through power-to-gas solutions, by storing the excess of electricity supply, or via CHP solutions, by lowering electricity demands. Electricity and gas DSOs should also explore the potential of flexibility services provided by the gas grid to the electricity grid and vice versa.





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### Electricity System Operators

Finally, if smart electricity meters are rolled out, efficiencies resulting from a combined roll-out with smart gas meters should be further explored, e.g. by conducting a SCBA.

Additionally, a number of non-regulated stakeholders, that are closely coupled, play an important role in the development of smart grids for the gas distribution sector.

### Consumers

Consumers are a key stakeholder in the energy chain, since according to CEER<sup>22</sup> the regulation focuses to innovation should be related to the whole system, but with a view on benefits for the welfare of consumers in general. Moreover, it is the consumers that they also fund smart grid projects through network tariffs. Finally, for gas DSOs, consumers paly also an additional role, that of the energy producer, via micro- and mini-CHP systems.

### Academia and Research Institutions

Academia, such as universities and R&D centres play an important role in smart grid activities in the European setting. Moreover, gas DSOs often collaborate with the academia and research institutions for their smart grid-related activities. CEER<sup>22</sup> proposes that incentives for innovation may also be anchored outside the regulatory system and therewith beyond the scope of the NRA. This may include public innovation funds for smart grid projects, national funding programs or European Framework Programs for Research and Innovation.

### International Entities

Several international entities provide financing for smart grid projects. Apart from funding available from the European Commission for innovation and smart grid activities, via several funding mechanisms, such as the Horizon 2020 and the Horizon Europe framework program, the LIFE program, the Connecting Europe Facility, as well as other funding schemes, funding is also available from financial institutions and entities, such as the European Bank for Reconstruction and Development (EBRD), the EuropeAid, and others.





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## 3 Gas Transmission Sector Report

### 3.1 Introduction to Gas Transmission Part

The advent and development of the smart grid concept is particularly relevant for operating the electric power grids and microgrids, but it also affects the gas network operators. The energy and climate targets adopted by the EU for 2020 and 2030 imply a massive deployment of renewable energy sources (RES) and a deep change in the generation mix, currently dominated by a few large and dependable nuclear or fossil-fired power plants. Because of the unpredictable characteristics of the RES, it has become important to constantly monitor their states in order to determine the amount of energy that is generated at all times. This will help in planning power usage and save energy when the sources are not enough for power generation.

Network operators are called to adapt their activities to integrate new classes of assets and processes, both on the supply side (intermittent generation from wind and sun) and on the demand side (smart meters, demand response, electro-chemical storage and electric vehicles), while making sure, at the same time, that the transition to a more decentralized system does not affect the high level of reliability and security of supply necessary for the healthy functioning of modern digital societies.

Due to the present wave of technological innovation and digitalization, as suggested by Vincent Rious and Nicolò Rossetto<sup>23</sup>, the actual work of the network operators is moving beyond the pure technical network monopoly area, as it traditionally understood in the energy sector, and is taking a first step closer to the communication sector.

In this framework, digitalization is the key enabler for the rise of a resilient and secure grid of the future.

As summarized recently by the Council of European Energy Regulators (CEER), digitalization has three implications for the energy system:

- The real time collection, processing, analysis and exchange of data increases productivity by allowing, for example, better informed decisions, operating efficiencies and reduced costs,
- The data can lead to new service offerings which impact the way that energy is consumed (such as smart buildings and heating/cooling services, the electrification of transport systems and dynamic energy retail pricing),
- Digitalization is necessary for the creation of new platforms and marketplaces, where active prosumers can participate in balancing the supply and demand for electricity.

These implications in turn provide value for consumers through increased cost savings, convenience, choice, consumer participation, quality and security of supply.<sup>24</sup>

<sup>23</sup> V.Rious and N. Rossetto, "Continental Incentive Regulation", in Meeus and Glachant (eds) Electricity Network Regulation in the EU, 2018

<sup>24</sup> CEER, *Conclusions Paper on Dynamic Regulation to Enable Digitalisation of the Energy System*, October 2019





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To this end, the recently updated European Union regulatory instruments stress more than ever the need for a large-scale roll-out of smart energy meters, recognizing as well the additional costs and benefits brought by this transformation.

Lastly, smart grids in the electricity and gas sector is also a prerequisite for smart sector integration of gas and electricity infrastructures, and for sector coupling, which allows the use of excess electricity from renewable sources to produce green hydrogen and synthetic methane via electrolysis and methanation, respectively.

### 3.2 European Legislative Framework Related to Smart Grids

During the last decades, numerous legislative measures, summarized in Figure 1, have foreseen and regulated the development of smart metering systems. Originally, the deployment of smart metering system was expected to help end-users understanding their actual energy consumption, creating as, a consequence, stronger incentives on the demand-side for energy efficiency. With the liberalization process of energy markets, the European Commission has also considered the smart metering system as “an effective tool to increase transparency and competition on retail markets for electricity, support self-generation and, in general, the integration of distributed energy resources, demand side flexibility and storage”.<sup>25</sup>

More recently, the booming of the digital economy and the proliferation of data led the European institutions to take measures for the protection of the personal data of European citizens. In case of non-personal data, non-discriminatory and transparent access by eligible parties is ensured through specific provision and rules, e.g. in the new Electricity Directive.

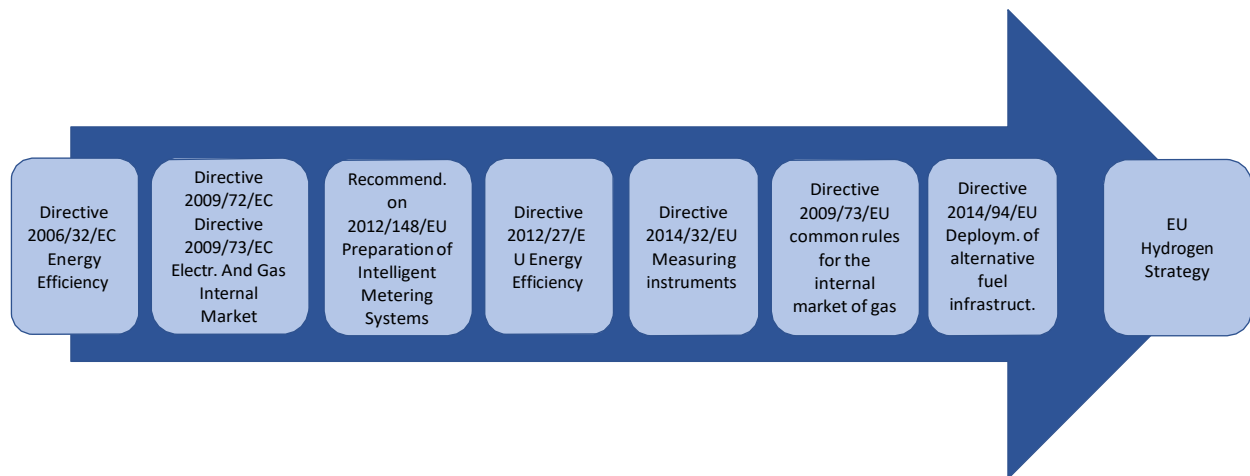


Figure 11: Evolution of European Legislation on Smart Grids





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<sup>25</sup> Tractebel, European Smart Metering Benchmark, European Commission DG Energy, June 2019





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### 3.2.1 Directives 2009/72/EC and Directive 2009/73/EC (Third Energy Package)

Directive 2009/73/EC, concerning common rules for the internal market and part of the so-called Third Energy Package, provides in Article 3.8 that

“In order to promote energy efficiency, Member States or, where a Member State has so provided, the regulatory authority shall strongly recommend that natural gas undertakings optimise the use of gas, for example by providing energy management services, developing innovative pricing formulas or introducing intelligent metering systems or smart grids where appropriate. “

In Annex A of the Directive instructions on the long economic assessment of long-term costs and benefits are provided:

“Member States shall ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the gas supply market. The implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution.

Such assessment shall take place by 3 September 2012.

Subject to that assessment, Member States or any competent authority they designate, shall prepare a timetable for the implementation of intelligent metering systems.

The Member States or any competent authority they designate, shall ensure the interoperability of those metering systems to be implemented within their territories and shall have due regard to the use of appropriate standards and best practice and the importance of the development of the internal market in natural gas. “

The definition of smart metering has been provided by the Commission Recommendation 2012/148/EU on the preparation for the roll-out of smart metering systems:

“‘smart metering system’ means an electronic system that can measure energy consumption, adding more information than a conventional meter, and can transmit and receive data using a form of electronic communication. “

Besides, the Recommendation

- Provides guidance to Member States on the design of smart metering systems to ensure the protection of personal data, also recommending a data protection impact assessment,
- Provides guidelines on the methodology for the economic assessment of the roll-out of smart metering,
- Lists a set of common minimum functional requirement for smart metering systems (for electricity).

In particular, Article 31 of the Recommendation defines the elements of the economic assessment:

- Tailoring to local conditions,
- Cost-benefit analysis (cba),



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- Sensitivity analysis,
- Performance assessment, externalities and social impact.

In the case of electricity, the Annex provide also a non-exhaustive lists of costs to be considered for the rollout of smart metering systems (OPEX, CAPEX, reliability and environmental costs, other costs), as well as a non-exhaustive list of formulae for the quantification of benefits.

### 3.2.2 Directives 2009/28/CE – on the promotion of the use of energy from renewable sources

Directive 2009/28/CE established a common framework for the promotion of energy from renewable sources, with specific dispositions for biofuels.

In particular,

- Member States shall assess the need to extend existing gas network infrastructure to facilitate the integration of gas from renewable energy sources (Art.10); and
- Where relevant, Member States shall require transmission system operators and distribution system operators in their territory to publish technical rules .... in particular regarding network connection rules that include gas quality, gas odorization and gas pressure requirements. Member States shall also require transmission and distribution system operators to publish the connection tariffs to connect renewable gas sources based on transparent and non- discriminatory criteria. (Art.11).

### 3.2.3 Directives 2009/73/EC and 2014/94/EU – on non-discriminatory access to biogas networks and the need to develop an adequate infrastructure for alternative fuels

Directive 2009/73/EC established common rules for the transmission, distribution, supply and storage of natural gas, laying down the rules relating to the organization and functioning of the natural gas sector, access to the market, the criteria and procedures applicable to the granting of authorizations for transmission, distribution, supply and storage of natural gas and the operation of systems. The rules established by this Directive for natural gas, including LNG, shall also apply in a non-discriminatory way to biogas and gas from biomass or other types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system.

Based on the consultation of stakeholders and national experts, Directive 2014/94/EU has identified

- electricity,
- hydrogen,
- biofuels,
- natural gas, and
- liquefied petroleum gas (LPG),

As currently the principal alternative fuels with a potential for long-term oil substitution, also in light of their possible simultaneous and combined use by means of, for instance, dual-fuel technology systems.

The Directive required the Member States to adopt development plans for such alternative fuels and promote the development of infrastructures in order to assure an adequate network of recharge and supply points for the public.





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### 3.2.4 European Commission Hydrogen Strategy

In July 2020, the European Commission has unveiled its hydrogen strategy as for a climate neutral Europe. The Commission recognizes that Europe is highly competitive in clean hydrogen technologies manufacturing and is well positioned to benefit from a global development of clean hydrogen as an energy carrier. Cumulative investments in renewable hydrogen in Europe could be up to EUR 180-470 billion by 2050, and in the range of €3-18 billion for low-carbon fossil-based hydrogen.

Combined with EU’s leadership in renewables technologies, the emergence of a hydrogen value chain serving a multitude of industrial sectors and other end uses could employ up to 1 million people, directly or indirectly. Analysts estimate that clean hydrogen could meet 24% of energy world demand by 2050, with annual sales in the range of €630 billion.

However, today renewable and low-carbon hydrogen are not yet cost competitive compared to fossil-based hydrogen. To harness all the opportunities associated with hydrogen, the European Union needs a strategic approach. EU industry is rising to the challenge and has developed an ambitious plan to reach 2x40 GW of electrolyzers by 2030. Almost all Member States have included plans for clean hydrogen in their National Energy and Climate Plans, 26 have signed up to the “Hydrogen Initiative”, and 14 Member States have included hydrogen in the context of their alternative fuels infrastructure national policy frameworks . Some have already adopted national strategies or are in the process of adopting one.

However, deploying hydrogen in Europe faces important challenges that neither the private sector nor Member States can address alone. Driving hydrogen development past the tipping point needs critical mass in investment, an enabling regulatory framework, new lead markets, sustained research and innovation into breakthrough technologies and for bringing new solutions to the market, a large-scale infrastructure network that only the EU and the single market can offer, and cooperation with our third country partners.

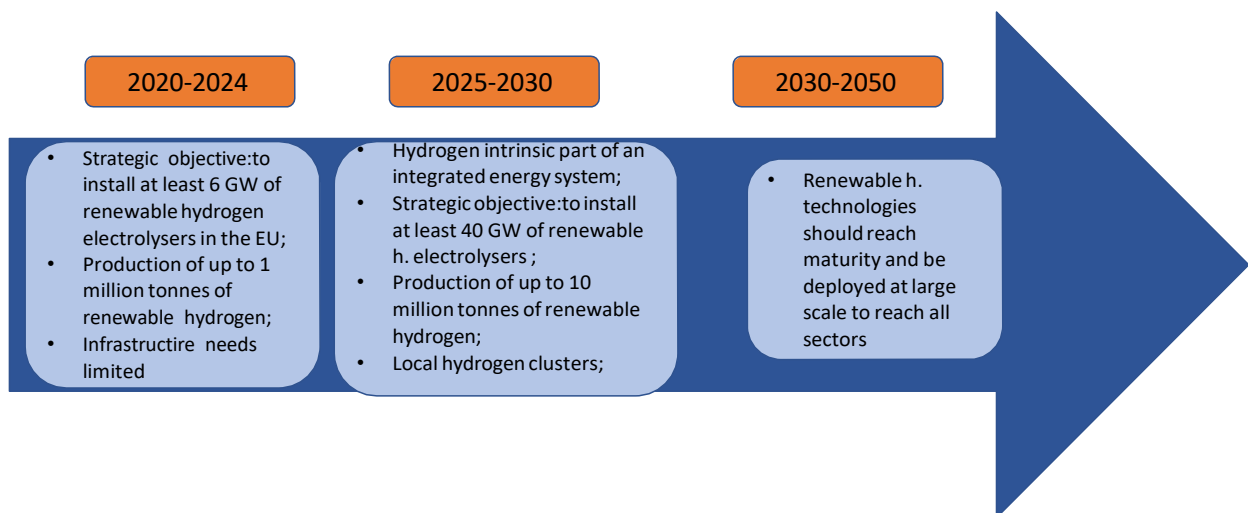


Figure 12: Hydrogen Roadmap for Europe





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The priority for the EU is to develop renewable hydrogen, produced using mainly wind and solar energy. Renewable hydrogen is the most compatible option with the EU's climate neutrality and zero pollution goal in the long term and the most coherent with an integrated energy system. The choice for renewable hydrogen builds on European industrial strength in electrolyser production, will create new jobs and economic growth within the EU and support a cost-effective integrated energy system. On the way to 2050, renewable hydrogen should progressively be deployed at large scale alongside the roll-out of new renewable power generation, as technology matures and the costs of its production technologies decrease. This process must be initiated now.

In the short and medium term, however, other forms of low-carbon hydrogen are needed, primarily to rapidly reduce emissions from existing hydrogen production and support the parallel and future uptake of renewable hydrogen.

The hydrogen ecosystem in Europe is likely to develop through a gradual trajectory, at different speeds across sectors and possibly across regions and requiring different policy solutions.

In the first phase, from 2020 up to 2024, the strategic objective is to install at least 6 GW of renewable hydrogen electrolysers in the EU and the production of up to 1 million tonnes of renewable hydrogen, to decarbonise existing hydrogen production, e.g. in the chemical sector and facilitating take up of hydrogen consumption in new end-use applications such as other industrial processes and possibly in heavy-duty transport.

In this phase, manufacturing of electrolysers, including large ones (up to 100 MW), needs to be scaled up. These electrolysers could be installed next to existing demand centres in larger refineries, steel plants, and chemical complexes. They would ideally be powered directly from local renewable electricity sources. In addition, hydrogen refuelling stations will be needed for the uptake of hydrogen fuel-cell buses and at a later stage trucks. Electrolysers will thus also be needed to locally supply an increasing number of hydrogen refuelling stations. Different forms of low-carbon electricity-based hydrogen, especially those produced with near zero greenhouse gas emissions, will contribute to scale up production and the market for hydrogen. Some of the existing hydrogen production plants should be decarbonised by retrofitting them with carbon capture and storage technologies.

Infrastructure needs for transporting hydrogen will remain limited as demand will be met initially by production close or on site and in certain areas blending with natural gas might occur but planning of medium range and backbone transmission infrastructure should begin. Infrastructure for carbon capture and use of CO<sub>2</sub> will be required to facilitate certain forms of low-carbon hydrogen.

In the second phase, from 2025 to 2030, hydrogen needs to become an intrinsic part of an integrated energy system, with a strategic objective to install at least 40GW of renewable hydrogen electrolysers by 2030 and the production of up to 10 million tonnes of renewable hydrogen in the EU.

In this phase, renewable hydrogen is expected to gradually become cost-competitive with other forms of hydrogen production, but dedicated demand side policies will be needed for industrial demand to gradually include new applications, including steel-making, trucks, rail and some maritime transport applications, and other transport modes. Renewable hydrogen will start playing a role in balancing a renewables-based electricity system by transforming electricity into hydrogen when renewable electricity is abundant and cheap and by providing flexibility. Hydrogen will also be used for daily or seasonal storage, as a backup and provide buffering functions, enhancing security of supply in the medium term.



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Additionally, the further retrofitting of existing fossil-based hydrogen production with carbon capture should continue to reduce greenhouse gas and other air pollutant emissions in view of the increased 2030 climate ambition.

Local hydrogen clusters, such as remote areas or islands, or regional ecosystems – so-called “Hydrogen Valleys” – will develop, relying on local production of hydrogen based on decentralised renewable energy production and local demand, transported over short distances. In such cases, a dedicated hydrogen infrastructure can use hydrogen not only for industrial and transport applications, and electricity balancing, but also for the provision of heat for residential and commercial buildings.

In this phase, the need for an EU-wide logistical infrastructure will emerge, and steps will be taken to transport hydrogen from areas with large renewable potential to demand centres located possibly in other Member States. The backbone of a pan-European grid will need to be planned and a network of hydrogen refuelling stations to be established. The existing gas grid could be partially repurposed for the transport of renewable hydrogen over longer distances and the development of larger-scale hydrogen storage facilities would become necessary. International trade can also develop, in particular with the EU’s neighbouring countries in Eastern Europe and in the Southern and Eastern Mediterranean countries.

In a third phase, from 2030 onwards and towards 2050, renewable hydrogen technologies should reach maturity and be deployed at large scale to reach all hard-to- decarbonise sectors where other alternatives might not be feasible or have higher costs.

In this phase, renewable electricity production needs to massively increase as about a quarter of renewable electricity might be used for renewable hydrogen production by 2050.

In particular, hydrogen and hydrogen-derived synthetic fuels, based on carbon neutral CO<sub>2</sub>, could penetrate more largely across a wider range of sectors of the economy, from aviation and shipping to hard-to-decarbonise industrial and commercial buildings. Sustainable biogas may also have a role in replacing natural gas in hydrogen production facilities with carbon capture and storage to create negative emissions, at the condition that biomethane leakage is avoided and only in line with the biodiversity objectives and the principles stated in the EU2030 Biodiversity Strategy .

### ***The Investment Agenda***

To support these investments and the emergence of a whole hydrogen eco-system, the Commission kick-starts today the European Clean Hydrogen Alliance – announced in the Commission’s New Industrial Strategy. The Alliance will play a crucial role in facilitating and implementing the actions of this Strategy and supporting investments to scale up production and demand for renewable and low-carbon hydrogen. It is strongly anchored in the hydrogen industrial value chain from production via transmission to mobility, industry, energy, and heating applications, and supports the related skills and labour market adjustments where needed. It will bring together the industry, national, regional and local public authorities and the civil society. Through interlinked, sector-based CEO round tables and a policy-makers’ platform, the Alliance will provide a broad forum to coordinate investment by all stakeholders and engage civil society.

The key deliverable of the Alliance will be to identify and build up a clear pipeline of viable investment projects. This will facilitate coordinated investments and policies along the hydrogen value chain, and cooperation across private





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and public stakeholders across the EU, providing public support where appropriate and crowding in private investment. It will also give visibility to these projects and allow them to find appropriate support where necessary. At this point, already 1.5-2.3 GW of new renewable hydrogen production projects are under construction or announced, and an additional 22 GW of electrolyser projects are envisaged and would require further elaboration and confirmation.

The Commission will also follow up on the recommendations identified in a report by the Strategic Forum for Important Projects of Common European Interest (IPCEI) to promote well-coordinated or joint investments and actions across several Member States aimed at supporting a hydrogen supply chain. The cooperation initiated within the hydrogen ecosystem in the Strategic Forum will contribute to a swift uptake of activity in the Clean Hydrogen Alliance. In turn, the Alliance will simultaneously facilitate cooperation in a range of large investment projects, including IPCEI projects, along the hydrogen value chain. The specific IPCEI instrument enables State aid to address market failures for large cross-border integrated projects for hydrogen and fuels derived from hydrogen that significantly contribute to achieve climate goals.

Additionally, as part of the new recovery instrument Next Generation EU, the InvestEU programme will see its capacities more than doubled. It will continue to support the deployment of hydrogen, in particular by incentivising private investment, with a strong leverage effect, through its original four policy windows and the new Strategic Investment Window.

The investments in electrolysers are estimated in a range between 24 and 42 billion Euro, from now to 2030. In addition, over the same period 220-340 billion Euro would be required to scale up and directly connect 80-120 GW of solar and wind energy production capacity to the electrolysers to provide the necessary electricity.

Other required investments:

- 11 billion to retrofit half of the existing plants with carbon capture and storage
- 65 billion for hydrogen transport, distribution and storage fuelling stations

Finally, adapting end-use sectors to hydrogen consumption and hydrogen-based fuels will also require significant investments. For instance, it takes some €160-200 million to convert a typical EU steel installation coming to end-of-life to hydrogen. In the road transport sector, rolling out an additional 400 small-scale hydrogen refuelling stations (compared to 100 today) could require investments of €850-1000 million.

### 3.3 Implementation of Gas Smart Grid in Europe

To face energy's main challenges

- The decreasing availability of fossil and nuclear primary energy sources (PES) and, accordingly, their rapidly increasing prices,
- the 70% dependency of Central Europe on imported PES,
- The increasing impact of greenhouse emissions on the environment

the European Union has set ambitious objectives for the year 2020 to:

- Lower energy consumption by 20% by enhanced efficiency of energy use,





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- Reduce co2 emissions by 20% and,
- Ensure that 20% of the primary energy is generated by renewable energy resources (res).

Since in the European Union, about 40% of PES that is used is currently applied for the generation of electricity and electric energy offers the best opportunity to be produced by renewable energy sources like wind power, solar energy, bio fuel and hydro power, the focus of the European Union has concentrated on electric energy, which has to carry the main part of the renewable energy production by having an annual share of >30% in 2020. Accordingly, all of the member states of the European Union have set their individual targets in support of the common strategy for 2020.

In the footsteps of the “classical” definition of electricity smart grid,<sup>26</sup> we can propose as definition of the gas smart grid the following:

“A Smart Grid is a gas network that can intelligently integrate the actions of all users connected to it—producers, storages, Shippers, TSOs, DSOs, and consumers—in order to efficiently deliver sustainable, economic and secure gas supplies

A Smart Grid employs innovative products and services together with intelligent monitoring, control, communication and self-healing technologies to:

- Enable the network to integrate users with new requirements,
- Better facilitate the connection and operation of the producers and storages,
- Enhance the efficiency in network operations,
- Allow gas consumers to play a part in optimizing the operation of the system,
- Provide consumers with more information and choice in the way they secure their gas supplies,
- Improve the market functioning and consumer services,
- Significantly reduce the environmental impact of the total gas supply system,
- Deliver enhanced levels of reliability, quality and security of supply. <sup>27</sup>

Consequently, a Smart Grid supports the introduction of new applications with far-reaching impacts: delivering gas more securely, cost efficiently and reliably through advanced control automation and monitoring functions providing self-healing capabilities after faults and enabling consumers to be better informed about their gas demand and to actively participate in the gas market .

This vision will lead to new products, processes and services, improving industrial efficiency and the use of cleaner energy resources while providing a competitive edge for Europe in the global marketplace. At the same time, it ensures the security of the infrastructure thereby helping to improve the daily lives of ordinary citizens. All this

<sup>26</sup> Smart Grids Strategic Deployment Document for Europe’s electricity networks of the future (SDD), 2008

<sup>27</sup> Buchholz, Bernd M., Styczynski, Zbigniew A.. Smart Grids, 2019





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makes Smart Grids – both in electricity and gas - a milestone in support of the European strategy for achieving the largest knowledge-based economy in the world.

Ultimately, the Smart Grids will combine existing technologies—improved and updated—with innovative solutions.

It is interesting to highlight that only recently the European Regulators and gas TSOs, through their associations (CEER, ACER, ENTSOG) have started discussing the impact of decarbonizing the energy sector on gas smart grid. The main elements of discussion and preliminary conclusion are included in the next section. As it can see, the discussion focuses mainly on the new gas model and the new regulatory framework required to support this transformation.

No functional or technical specifications are suggested neither at this level nor at the national regulatory level. In a sense, the TSOs, which are more and more interconnected at the European level, are requested in this new scenario to propose the best technical solutions or technologies to implement the new gas model, characterized by new fuels besides methane and by a stricter integration with the electricity sector.

This aspect differentiates the intervention of the European and national regulators on gas transportation smart grids from the gas distribution side, where strict requirements are expressed by the Regulators in terms of functional/technical specifications (e.g. the smart grid characteristics) or of timing of the roll-out of the same gas meters.

### 3.4 Future Market Design and Regulatory Framework

#### 3.4.1 CEER’s “Study on the future role of gas from a Regulatory perspective” (2018)

The Council of European Energy Regulators (CEER) has address the regulatory implications of paradigmatic changes under way in the energy sector in its “Study on the future role of gas from a Regulatory perspective”.

The development of future gas demand affects the traditional natural gas infrastructure. Since a reduction in the consumption of gas in the long period (beyond 2035) is expected, there is risk to have gas pipelines financed by the system but employed for a period not long enough to recover the investment (the so-called “stranded assets”).

To address under-utilisation and stranding of network assets, Regulators could apply different approaches such as depreciation policy (accelerated depreciation), asset valuation, adjustment of cost of capital and explicit compensation outside of network tariffs.

Consideration of some flexibility in depreciation policy would e.g. permit recovery of charges over the short to medium term when user demand is more certain and relieve the allowed revenue/tariffs on the longer term when user demand is less certain. Adjustment of depreciation allowance should be set in a way not leading to unbalanced tariff increases in the short to medium term that may discourage network users to book capacity.

From a regulatory point of view, CEER recommends to improve the coordination between the electricity and gas sectors and to actively support and foster renewable gases and new technologies with specific programmes, such as financing innovative pilot projects. The utilization of existing gas pipeline to carry renewable gases can attenuate the stranded asset risk, helping the system in the decarbonizing process and in integrating electricity and gas sectors.





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### 3.4.1.1 Gas Infrastructures

Operators of natural gas networks may also seek involvement in contestable activities as the ownership, development, management and/or operation of LNG/CNG refuelling infrastructure, power-to-gas (P2G) infrastructure and other new technologies. Where a combined provision of regulated and contestable services is possible, the regulatory framework, according to CEER, should ensure that customers and market participants benefit to the largest extent possible from the range of services, preventing unintended interactions between the regulated and contestable sectors in terms of cost and revenue allocation, and information advantages. Without regulatory control, also including the analysis of contractual relations, companies may be able to benefit from this by allocating costs to regulated activities, or by using information held by the regulated business.

As far as infrastructure for renewable gas are concerned, Regulators should accompany and steer the transition towards higher hydrogen quantities blended in the gas networks. There will be the need to adjust the technical specifications for the blended natural gas and regularly amend the relevant regulation. On the transmission level, there may be a need to revisit the Interoperability Network Code (INC) and the CEN provisions on gas quality. Moreover, regulators should steer the technology roll-out in terms of time and targeted penetration zones where the hydrogen quantities will gradually grow. They will need to develop the design of the commercial and access arrangements of such a system.

With respect to biomethane, regulators should set clear connection rules including connection charges, technical connection requirements, responsibilities for setting and maintaining the relevant product quality norms and metering and compression. Regulators may consider providing explicit incentives in national regulation to the parties injecting biomethane into the natural gas networks via the reduction of network tariffs/connection charges.

### 3.4.1.2 Regulatory Innovation Incentives

CEER supports the idea of innovation and decarbonization incentives as part of the regulatory framework as this facilitates development and drives improvement in processes and technology application in the gas sector. National regulators should set clear objectives and qualification criteria for what projects would be subject to innovation incentives. For example, innovation incentives can be provided for a new or unproven technology or operational practice directly related to the gas network. The innovation project should relate to the development, and research in a field, or technology that could help achieve certain targets such as decarbonization by the possibility of using biogas, CNG/LNG or hydrogen. Innovation and decarbonization incentives can be incorporated into the regulatory framework by using a special allowance. The allowance would be based on a proportion of the allowed revenues. In addition, regulators can apply special arrangements to specific investments in decarbonization/innovation initiatives such as accelerated depreciation allowances or/and WACC premium.

### 3.4.2 ACER-CEER's "The Bridge beyond 2025" (2019)

Trying to mirroring the "Clean Energy for all Europeans" Package (CEP) for electricity, ACER have presented a list of recommendations to update legislation and policies to facilitate decarbonization, improve market functioning and maximize the opportunities arising from sector coupling. Their key recommendations include:

- Decarbonized gases should be able to be integrated into existing gas markets, with full valuation of their environmental benefits, and captured in market monitoring through sustainability indicators published alongside European Gas Target Model (GTM) metrics. Clear definitions and categorization of decarbonized gases, including carbon capture and use or storage, should be established in European legislation, and





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consistent principles should be applied across the EU to facilitate the blending of decarbonized gases. Legislation should be sufficiently flexible to allow the emergence of new gases/technologies.

- To improve market functioning and address emerging issues, a new system of dynamic and targeted regulation should be established in EU law, based on the Agency's market monitoring and NRA analysis and action. In order to maintain flexibility to adjust metrics and thresholds over time and to decide on appropriate interventions at national or regional level, the detailed indicators and thresholds should not be fixed in legislation but rather established transparently by the Agency in collaboration with the NRAs.
- A technology-neutral, level playing field should be established between different conversion and storage facilities across the energy sector, so that they face equivalent categories of costs in network tariffs and levies, and equivalent recognition of environmental and security of supply benefits.
- New assets and activities should be facilitated through regulation, including a sandbox model at EU level for pilot, small scale projects and appropriate differentiation between competitive and monopoly activities. Any subsidies are a matter for governments rather than regulators and should not take the form of discounts on or exemption from network tariffs in any case. TSOs and Distribution System Operators (DSOs) should only be allowed to undertake potentially competitive activities under strict rules and as a last resort. While it is too early to be definitive, large-scale hydrogen networks could be expected to provide regulated third party accessing.
- For infrastructure planning, an effective regulatory framework at EU level, similar to that existing in some Member States, is needed to ensure a level playing field for new solutions. The existing network operators face challenges from decentralized solutions and can no longer be regarded as completely neutral. Improvements in network code governance introduced in the CEP for the electricity sector are needed in the gas sector as well.
- New investment in natural gas assets should be checked to ensure consistency with decarbonization targets. Re-use of existing assets should be explored prior to any decommissioning, with due consultation of neighbouring authorities and stakeholders where their markets may be affected.
- For tariffs, both regulators and stakeholders find that, at present, tariff design does not appear to be causing major issues at a pan-EU level and therefore the implementation of the Tariffs Network Code shall remain a priority. However, there are concerns in some regions and legislative changes can unlock better regulatory tools to address any instance where cross-border tariffs become a barrier to trade and where there is a risk of foreclosure of cross-border capacity.

### 3.4.3 ENTSOG 2050 Roadmap for gas grids

The development of smart grid in gas is the framework which envelops the European gas Transmission System Operators (TSOs)'s roadmap to make gas grid ready for decarbonization.

The emergence of new gases – in particular biomethane and hydrogen- requires from the TSOs the ability to solve the technical problems connected – by blending, conversion, flow management, etc. The grid companies will have to invest in and operate such facilities, in particular for digitalization (related to smart metering, gas quality detection, certification and data sharing) and for data provision by and between the gas grid companies and consumer appliances.

A significant level of digitalization and data provision should also be required to define the certificates expressing the climate value and the energy content of the gas -irrespective of its composition and of the content of





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biomethane, hydrogen and natural gas, in order to maintain and develop the gas-to-gas competition which has been widely achieved in the European gas market.

Digital and automated handling through the gas value chain will also be required, in order to track and transfer the climate value of a given source of gas, providing a trustworthy EU-wide Guarantees of Origin (GOs). Such system will ensure that biomethane, hydrogen and other renewable, low-carbon gasses can be tracked from production and import to consumption, across borders and across types of energy, i.e. Power to Gas (P2G).

To maintain and develop a single European gas market, notwithstanding the above mentioned disruptive changes (if not correctly managed), ENTSOG proposes the following recommendations:

- Aim for existing gas legislation to include hydrogen and strengthen the role of biomethane,
- Technical layer: Include in TSOs' services and establish the principles for reasonable remuneration of services provided by the gas grid companies: blending, conversion, flow management, digitalization and data provision, providing the flexibility for energy system,
- Energy value: Continue to trade biomethane, hydrogen and natural gas based on energy content
- Climate value: Document and track climate value of a given source of gas, a trustworthy EU-wide GOs/certificate system should be established.

On its part, ENTOG aims to

- Launch dialogue with new gases stakeholders and EU Institutions on establishing a common legal framework for all gases,
- Facilitate value chain cooperation of relevant stakeholders on all three layers (technical, energy and climate) and develop new market design elements (TSOs' services and integrated market for diverse gas qualities and GOs/certificates),
- Prepare position on missing legal framework for sector coupling and innovation (P2G).

A schematic representation on how the new gases could be transported via different pathways is presented in the figure below:

- Hydrogen can be produced by different technologies (electrolysis, Steam Methane Reforming (SMR), pyrolysis) and can be transported in dedicated pipelines as well as blended with methane,
- Biomethane can be produced from various feed-stock without major adjustment to the existing networks,
- CO<sub>2</sub> transportation will depend on the choice of the pathway.

Refurbishing part of existing infrastructure to 100% hydrogen readiness or construction of new large-scale hydrogen pipelines may require support scheme (such as Project of Common Interest) for projects to ensure transfer across borders and sectors.



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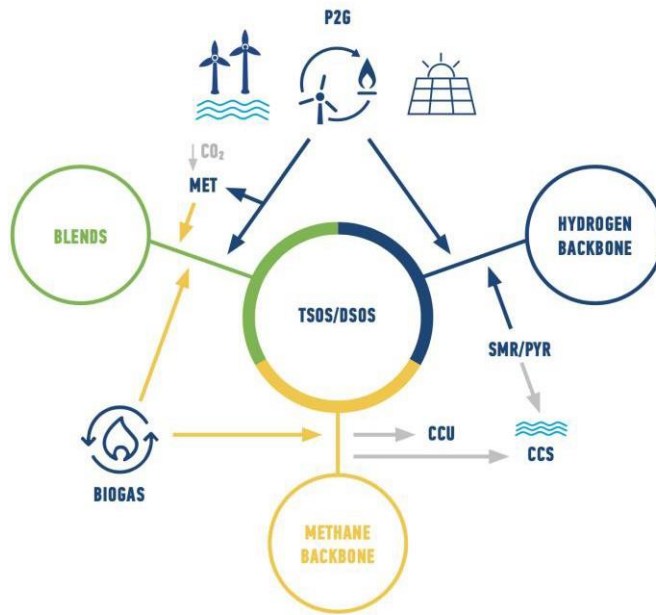


Figure 13: Principles for New Gases Transportation (ENTSOG Roadmap)

To manage this paradigmatic changes, European TSOs have chosen to work for coordination of planning, reflecting sector needs related to methane and hydrogen demand, preventing market fragmentation as hydrogen and biomethane usage develops. As representative of European TSOs, ENTSOG advocates as well a regulatory framework where the investments in digitalization, decarbonization and sector coupling are fully recovered.

### 3.4.3.1 Sector coupling

ENTSOG strongly believes that the future EU energy system should be built on a Hybrid Energy System, an interlinkage between the gas and electricity systems based on synergies between the two. The Hybrid Energy System will allow the EU economy to meet decarbonization targets, obtain flexibility, storage options, cross-border transportation capacities and security of supply in the most efficient way, realizing synergies between the existing infrastructures and building on new technologies.

Among the benefits provided by a Hybrid Energy System, sector coupling will alleviate the challenges the electricity system is facing regarding the production of large quantities of renewable energy and the need for long-term energy storage, handling peak production and consumption as well as facilitating long distance transportation.





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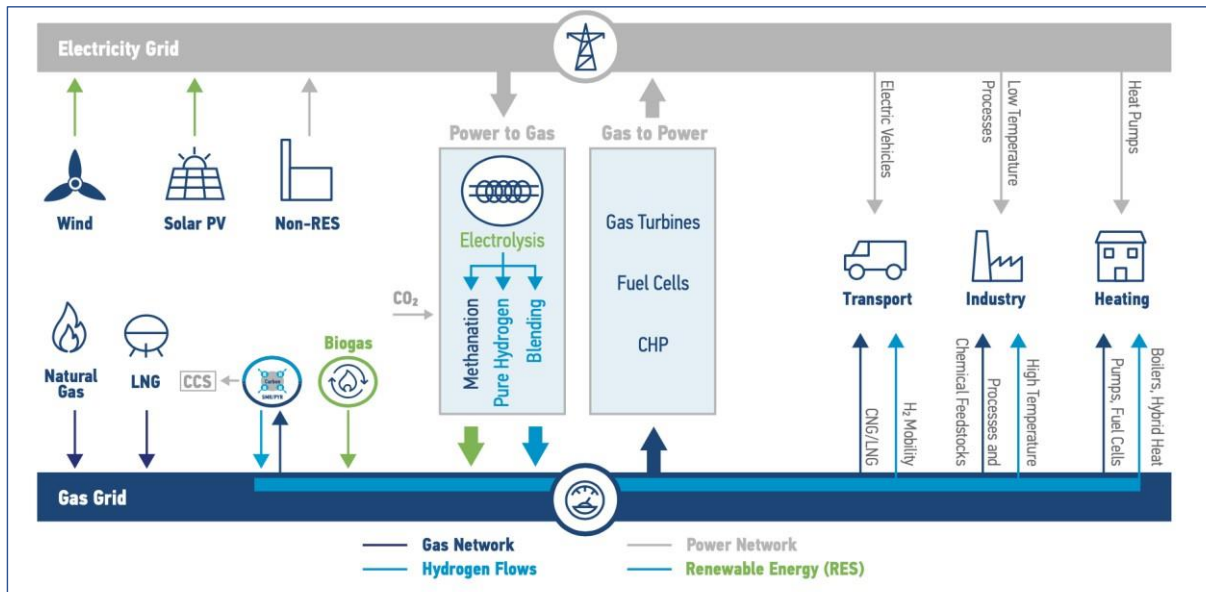


Figure 14: Interrelations between Electricity and Gas Grids (ENTSOG Roadmap)

The Power to Gas (P2G) concept alleviates local/regional infrastructure congestions in electricity infrastructure and can contribute to avoiding curtailment of non-dispatchable renewable electricity, reducing as well the occurrence of negative/very low electricity wholesale prices.

Since the present market conditions do not seem to sufficiently support an up-scaling of commercial activities needed for optimizing gas and electricity functioning, ENTSOG proposes that TSO ownership of P2G facilities should be considered, as a way of socializing costs as well as ensuring third-party access to such infrastructure. In this proposal, P2G should be considered as conversion facilities – converting from the electricity system to the gas system.

In this perspective, ENTSOG recommends to

- Establish the regulatory framework for the Hybrid Energy System,
- Align regulatory framework for electricity and gas where relevant,
- Coordinate planning of electricity and gas investment in infrastructure at national and EU level,
- Consider P2G definition as a conversion facility in gas legislation,
- Clarify the roles and responsibilities of the electricity and gas players,
- Clarify attribution of costs and benefits between gas and electricity consumers,
- Address distortion by taxes/levies on P2G in the context of sector coupling, since neither electricity consumed, nor hydrogen produced by P2G should be subject to end-user taxes and levies before the produced energy is being finally consumed.



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### 3.4.3.2 Regulatory sandbox

To provide the regulatory framework to develop the new necessary technologies to support the transformation of gas smart grids, ENTSOG suggests a wide-spread use of regulatory sandboxes, at EU level and also at national level under the supervision of NRAs. They will allow R&D activities to be handled under more flexible terms regarding some general rules such as state aid, funding access criteria, ownership unbundling, costs socialization via regulated assets and based on a specific regulatory oversight and cross-sectoral consultation.

Especially when the markets are not ready, regulatory sandboxes can provide support for early business models and immature technologies to scale up:

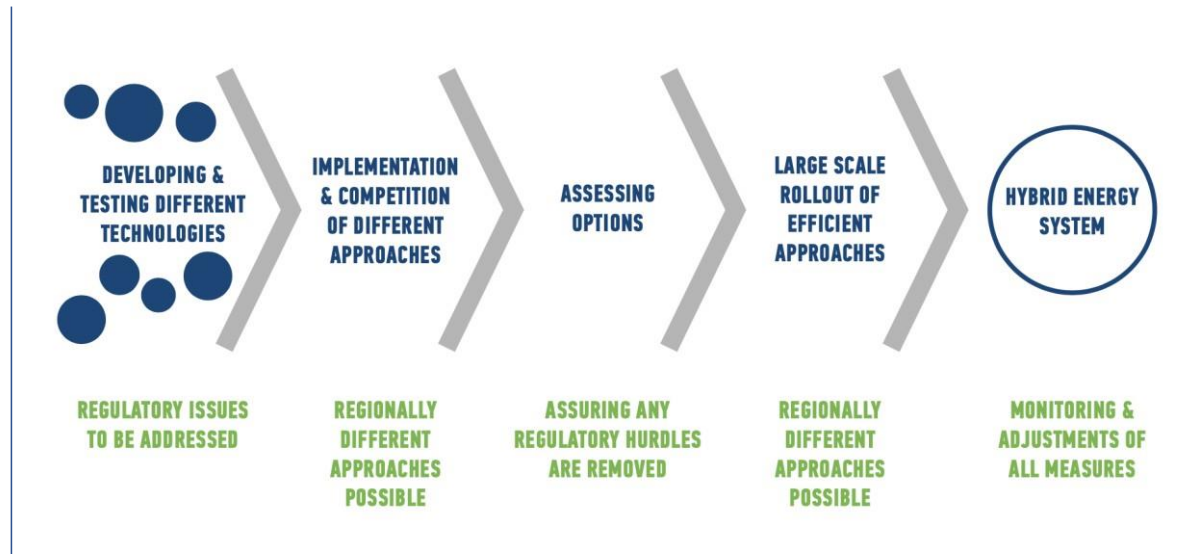


Figure 15: Regulatory Sandbox to Support the Development of New Technologies

Regulatory Sandbox guidelines should be established at EU level to offer some regulatory flexibility for TSO’s pilot project and clarity for NRAs for cost allocation in technology incubation/roll out phase.

### 3.4.3.3 European gas quality handling

Precise and quick exchange of gas quality data among operators and among member states will be crucial for operating the gas systems, providing information to end-user appliances as well as for ensuring fair and transparent billing processes. In the framework provided by the Interoperability Network Code and Data Exchange Rules, TSOs are actively cooperating on cross-border issues related to gas quality (with a specific focus on biomethane and hydrogen).

### 3.4.3.4 Future gas grid configuration

Depending on the evolution of hydrogen, biomethane and natural gas supply potential and user demand, smart grid functioning will change, depending also on Member States’ choice of technologies (e.g. P2G, biomethane, CCUS) best serving their national needs and circumstances.

Smart grid configurations are likely to evolve over time and co-exist, interoperate and complement each other in a given territory, where local conditions dictate.





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According to ENTSOG, TSOs will be integrators of the different blocks – besides gas transportation, another key role of TSOs and Distribution System Operators (DSO) will be the technical services enabling quality management, energy conversion and interoperability of different gases. These technology choices will be made by the Member States and the market depending on:

- Local renewable gas (biomethane and P2G) production potential,
- Local demand requirements and consumer technology interests,
- Access and distance to off-shore and on-shore CO2 storage facilities,
- Availability of CCUS technologies and applications,
- Feasibility of producing hydrogen from natural gas: SMR, Auto-Thermal Reforming (ATR), pyrolysis, etc., which could be realized either at the beginning of the value chain or closer to the end-use,
- Access to renewable and low-carbon gas import routes,
- Development status of electricity infrastructure,
- Storage potential and technical feasibility for hydrogen, methane and hydrogen-methane blends,
- Country-specific subsidy systems,
- Status of sector coupling,
- Individual member state energy mix, decarbonization targets and pathways.

As these developments will impact the gas quality management, European TSOs are preparing for managing the diversity of gas compositions. New TSO/DSO services will help to preserve and facilitate cross border trade for the benefit of all consumers and to ensure that achievements of the internal energy market are not hampered.

Digitalization and data sharing are required as enablers for enhanced network management (e.g. network modelling and planning, billing, gas quality services) and end-use adaptations to varying gas qualities. Additional investments in gas treatment or end-user equipment might be necessary when software-based solutions are not sufficient.

#### ***3.4.3.5 Market design consequences of the adopted pathway for decarbonizing the gas sector***

The three decarbonization pathways under discussion in the EU

- Methane pathway, including biomethane and post-combustion CCUS
- Blending of methane and hydrogen pathway
- Hydrogen pathway

will have different impacts on the gas market design and on the role of TSOs and smart grids, which ENTSOG summarizes as follows:



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Table 7: Gas Decarbonization Pathways

Pathway	Market			Role of TSOs	Impact on Regulation
	Main Characteristics	New features	What is Missing		
<b>Methane</b>	<ul style="list-style-type: none"> <li>Methane will continue to play an important role,</li> <li>Gradually the share of biomethane will grow,</li> <li>Only early local production of hydrogen,</li> <li>As a consequence, the commodity remains relatively homogeneous, methane and biomethane molecules with its traditional energy content are still traded.</li> </ul>	<ul style="list-style-type: none"> <li>Scaling up of the biomethane production with post combustion CCUS (carbon capture, utilization and storage), as methane remains the energy carrier in gas networks,</li> <li>Large scale CCUS development. The management and the strict EU-wide carbon accounting and management systems have to be established, to prove the CO<sub>2</sub> abatement;</li> </ul>	<ul style="list-style-type: none"> <li>European GOs/certificates,</li> <li>Principles for CO<sub>2</sub> transportation.</li> </ul>	<ul style="list-style-type: none"> <li>The TSOs role could be to invest in connection of biomethane production plans, to invest on reverse flows from distribution to transmission or grids or to invest in biogas upgrade to biomethane,</li> <li>TSOs can promote biomethane with a capacity tariff discount and could be investors in connections of biomethane plants,</li> <li>TSOs should be allowed to invest, own and/or operate CCUS facilities and CO<sub>2</sub> networks as regulated business,</li> <li>TSOs can use existing (not fully used) gas pipelines as CO<sub>2</sub> infrastructure;</li> </ul>	<ul style="list-style-type: none"> <li>The new roles of TSOs as investor or promoter of biomethane plants/connections should be allowed by NRAs with adequate coverage in tariffs,</li> <li>Regulation for promoting the deployment of CCUS systems can be applied in three ways: Natural monopoly position, TPA or Regulated Tariffs.</li> </ul>





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Pathway	Market			Role of TSOs	Impact on Regulation
	Main Characteristics	New features	What is Missing		
<b>Blending of Methane and Hydrogen</b>	<ul style="list-style-type: none"> <li>ENTSOG assumes that the commodity is no longer homogeneous anymore, but market participants can continue to trade energy value (kWh), and not methane or hydrogen separately.</li> </ul>	<ul style="list-style-type: none"> <li>With diverse gas quality, the importance of the TSOs gas quality services will increase,</li> <li>Conversion services like methanation (conversion H<sub>2</sub> in CH<sub>4</sub>) or methane reformer (CH<sub>4</sub> in H<sub>2</sub>), bending or separation, supported by large-scale roll-out of smart meters and chromatographs will help to increase the flexibility of supplies and increase acceptability for end use,</li> <li>ENTSOG also assumes greater integration of gas infrastructure with the electricity sector via P2G facilities, as well as important variability of supply of renewable hydrogen coming from electrolysis.</li> </ul>	<ul style="list-style-type: none"> <li>European gas quality services,</li> <li>Principles for sector coupling;</li> </ul>	<ul style="list-style-type: none"> <li>The injection of hydrogen and the interaction with the electricity system via renewable electricity will make the gas TSOs role more complex,</li> <li>This will require a more flexible and robust gas system to allow TSOs to respond to these challenges,</li> <li>TSOs will have to address the intermittence and decentralization of operations due to renewable electricity production/renewable hydrogen,</li> <li>Besides dispatching the fuel, the TSOs will also manage the consumer gas quality conversion services necessary for cross-border flows to maintain security of supply and market integration.</li> </ul>	<ul style="list-style-type: none"> <li>A regulatory framework for P2G should be established to ensure necessary cooperation mechanisms for electricity and gas operators,</li> <li>Establish the framework of regulatory sandbox to allow TSOs to co-shape the hydrogen injection strategy and invest in conversion facilities.</li> </ul>





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Pathway	Market			Role of TSOs	Impact on Regulation
	Main Characteristics	New features	What is Missing		
<b>Hydrogen</b>	<ul style="list-style-type: none"> <li>To move from blends to pure hydrogen delivery, TSOs will need to assess the readiness of the existing transmission pipelines to accommodate 100% hydrogen,</li> </ul>	<ul style="list-style-type: none"> <li>The production from renewable electricity using electrolysis, or the import will make hydrogen available in large, cross border dispatchable volumes,</li> <li>In this scenario, the commodity becomes homogeneous again and it is traded on energy content level on its climate value via pan-European Certificate system based on GOs from renewable, decarbonized or low-carbon processes.</li> </ul>	<ul style="list-style-type: none"> <li>A dedicated hydrogen network to transport and store hydrogen molecules,</li> <li>Market design ensuring non-discriminatory Third-Party Access to hydrogen infrastructure.</li> </ul>	<ul style="list-style-type: none"> <li>The TSOs will manage hydrogen pipelines, providing infrastructure optimization and cost savings as a result of coordinated planning reflecting the development needs of the sector (e.g. blending and/or dedicated pipelines; full/partial conversion to hydrogen of existing pipelines, etc.),</li> <li>The TSOs may own and operate P2G as conversion facilities without ownership of the commodity on a TPA basis,</li> <li>The TSOs shall ensure non-discriminatory TPA regime for market players to the hydrogen network.</li> <li>The TSOs should allow potential integration of hydrogen and (bio/synthetic) methane markets to deliver one price signal for gaseous energy, in a manner similar to the integration of H gas and L gas in some EU markets (Germany and France, for instance). This integration will prevent market fragmentation as hydrogen usage develops alongside (bio)methane usage.</li> </ul>	<ul style="list-style-type: none"> <li>Definition of the regulation for TPA non-discriminatory access to hydrogen networks.</li> </ul>





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The above three gas decarbonization pathways identified by ENTSOG, or a combination thereof, will develop depending on the decision made by the EU, the Member States and markets. The gas grids will have to be ready for, and able to adapt to the EU decarbonization process. Any premature lock-in will have negative effects and may result in much higher costs than necessary to achieve decarbonization goals.

The current EU decarbonization targets will have massive consequences on the existing gas market and its functioning. Decarbonization of the gas sector will require substantial adjustment of the gas market design to ensure the deployment of all promising technologies in the EU in a coordinated manner.

Without adjustment to the gas market design, a fragmentation of markets could possibly occur, with detrimental consequences for competition and security of supply.

As suggested by Jonathan Stern<sup>28</sup>, the founder of the Gas Programme at the Oxford Institute for Energy Studies (OIES), a cooperative value chain supporting investments in natural gas grids adaptations for biomethane and hydrogen-based technologies needs to be established. Only cooperation of the full value chain may scale up the industrial usage of the new gases. Even if Europe's market liberalisation has fragmented the industry and divided the value chain in a way that leaves many of the players with very different incentives, the companies involved in all parts of the chain need to cooperate more and develop concrete pilot projects to demonstrate that they are developing a decarbonisation strategy. On the other hand, policy-makers may need to accept that more and very different regulation, compared with what has been introduced over the past three decades, will be needed.

#### 3.4.4 ACER – NRA Survey on Hydrogen, Biomethane and Related Network Adaptations – July 2020

For the European Union (EU) to be climate neutral by 2050, gas networks will have to be gradually adapted to carry green gases such as biomethane and hydrogen.

A survey to the EU Agency for the Cooperation of Energy Regulators (ACER) has summarized the current situation provided by 23 national regulatory authorities (NRAs), which have looked into the current possibilities for admixing hydrogen and injecting biomethane or transporting pure hydrogen via existing gas networks, as well as network adaptations to allow this in the future. The survey follows by few weeks the unveiling of the EU Hydrogen Strategy by the European Commission.

The results show that 65% of the responding NRAs reported that the transmission system operators (TSOs) do not accept the injection or allow hydrogen volumes into the gas transmission network yet.

The survey also included questions on national strategies on hydrogen, technical and regulatory aspects, specific projects and investments needed.

##### Main findings:

- The readiness of gas transmission networks to accept hydrogen or biomethane is very diverse across the EU.
- In most cases, developments are at an early stage, driven mainly by pilot projects.

<sup>28</sup> Jonathan Stern, OIES, Narrative for Natural Gas in Decarbonizing European Energy Markets, Oxford 2019.



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- Most national regulators would support an EU-wide approach for setting hydrogen admixing limits, in pursuit of cross-border gas trading and market integration.
- Pure hydrogen networks could be built in parallel with the blending of hydrogen in the existing networks, depending on the specific market and network situation.
- Gas quality standards may need to be revised at EU level to ensure interoperability between Member States.
- Regardless of the actual choice of a hydrogen concentration limit, some network adaptations and selected investments will be needed. These investments will deserve greater attention in gas network development plans.
- It seems that blending of hydrogen would not initially require major changes in the current market design and legislation.

In particular, the survey finds that “regardless of the actual choice for a H2 concentration limit, essential network adaptations are required in order to allow H2 injections. Metering equipment requires upgrades or chromatograph replacement in order to be able to measure H2 concentrations. Gas turbines, compressor stations, CNG tanks and some types of storage can only accept low H2 concentration (< 5%) and may also need retrofiting”.

Moreover, end-user equipment may not accept higher or variable quantities of H2, which necessitates further detailed studies.

Network readiness to start H2 injection deserves appropriate attention in network development planning. TSOs may get additional responsibilities in order to enable H2 blending, in particular in terms of dispatching and gas quality (blending quality) control in the system.

Not surprisingly, the results of the survey show that developments regarding the readiness of the gas transmission network to accept H2 and to allow the injection of biomethane are at an early, to a large extent experimental or pilot, stage. This may be due to the absence of a clear policy direction that would steer the necessary regulatory framework for these alternative gases at national and EU level, and to the limited attention these network adaptations have received so far in gas network development plans. Technology developments, legal and regulatory, and network development efforts should go hand in hand in order to achieve an efficient and timely decarbonisation of the gas sector.

### 3.4.5 11 European TSOs - Hydrogen Backbone Plan – July 2020

In July 2020, a group of eleven European gas infrastructure companies from nine EU member states has presented a plan for a dedicated hydrogen transport infrastructure. New research shows that existing gas infrastructure can be modified to transport hydrogen at an affordable cost.

The plan has been developed by Enagás, Energinet, Fluxys Belgium, Gasunie, GRTgaz, NET4GAS, OGE, ONTRAS, Teréga, Snam and Swedegas. The companies foresee a network gradually emerging from the mid-2020s onwards to an initial 6,800 km pipeline network by 2030, connecting ‘hydrogen valleys’. By 2040, a hydrogen network of 23,000 km is foreseen, 75% of which will consist of converted natural gas pipelines, connected by new pipeline stretches (25%).





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Ultimately, two parallel gas transport networks will emerge: a dedicated hydrogen and a dedicated (bio)methane network. The network can be used for large-scale hydrogen transport over longer distances in an energy-efficient way, also taking into consideration hydrogen imports.

Creating this network has an estimated cost of €27 to €64 billion, which is relatively limited in the overall context of the European energy transition. The levelized cost is estimated to be between €0.09-0.17 per kg of hydrogen per 1000 km, allowing hydrogen to be transported cost-efficiently over long distances across Europe. The relatively wide range in the estimate is mainly due to uncertainties in (location dependent) compressor costs.

### 3.5 Smart Grid Regulations in Gas Transmission: International Benchmark

#### 3.5.1 Italy

As elsewhere in Europe, there is a quite different approach by the National Regulatory Authorities regarding gas smart meter implementation and smart grid in general, at the distribution and transportation level.

For the gas distribution sector, NRA have requested by the operators (DSOs in all but one case, suppliers in UK) detailed implementation plans, supported by cost-benefit analysis (CBA) and they have detailed the functional and technical specifications of the smart meters.

For the gas transportation sector, where gas smart grid is already in place, the focus is currently on how to support and incentivize gas transportation smart grid in the decarbonizing process and targets, set by the EU for 2050.

##### 3.5.1.1 Smart Grid Remuneration

From the regulatory point of view, the gas smart grid is considered and remunerated under two point of view:

- a) As investment (SCADA or other control systems, such as, for instance, demand forecasting, or telecommunication system), to be included in the regulatory asset base (RAB), once all the requested information and supporting documentation has been approved,
- b) As measurement activity, with a separate remuneration.

In line with the other regulated infrastructure services in the electricity and gas sector, ARERA has confirmed for the new regulatory period 5PRT (2020-2023) the general principles for the determination of the allowed capital cost and operating cost incurred by TSOs, i.e. determining the target revenues as the sum of:

- a) an appropriate return on the regulatory net invested capital, including any additional remuneration allowed as incentive for new investments, starting from the second regulatory period,
- b) economic and technical depreciation,
- c) allowed operating expenditure,
- d) costs incurred by TSOs for the operational balancing service of the system.

Despite substantial continuity with the general principles currently in force, ARERA confirmed its proposal to introduce, starting from the 5PRT, some elements that may facilitate the possible transition to the cost determination methodology based on total expenditure (TOTEX). In this regard, ARERA confirms its intention to:

- a) ensure an increasing coordination between tariff regulation and the assessments of the national Ten-Year Transmission Network Development Plans set up by TSOs as required by the Legislative Decree 93/11,



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- b) initiate a specific monitoring of the investments made and of the objectives achieved, also to check if they are consistent with the provisions of the Plans, requiring operators, starting from 2020, to provide reports that compare the outputs actually achieved with those declared in the Plans and used for cost-benefit analysis (hereinafter: CBA). These reports must be made available as annexes to the Plans of each, and must refer to the investments envisaged in the previous Plans and in operation for at least one year from the filing date of the report itself,
- c) require operators to also provide, in the reports described in point b) above, information on any discrepancies between the costs estimated in the Plans and used for the CBA and the costs actually incurred.

In addition, ARERA deems that for the 5PRT, incentives might be designed on an experimental basis aimed at increasing the efficiency of the investment expenditures, related in particular to the additional remuneration granted.

Concerning the investments that will become operational in the 2022-2023 period, ARERA intends to confirm its proposal towards overcoming input-based incentive mechanisms.

ARERA also confirms the possibility of implementing specific incentive mechanisms for projects or applications that are particularly innovative for natural gas transmission, particularly for:

- Initiatives aimed at encouraging the attainment of environmental objectives, such as the reduction of CH<sub>4</sub> emissions into the atmosphere, through specific mechanisms that encourage companies to take effective measures to control gas losses in the networks,
- Pilot projects to test innovative solutions to support energy transition, such as the use of transmission infrastructure that concerns biomethane and other green gases and P2G projects or hydrogen transmission, etc.).

In this regard, the regulatory approach of ARERA is summarized by Section II of the Consultation Document 420/2018/R/GAS, concerning new uses of the transmission networks in relation to innovative technological solutions capable of providing systemic and environmental benefits to the entire energy sector.

ARERA shares CEER's recommendations, contained in the 2018 study mentioned earlier, to improve the coordination between the electricity and gas sectors and to actively support and foster renewable gases and new technologies with specific programmes, such as financing innovative pilot projects. The utilization of existing gas pipeline to carry renewable gases can attenuate the stranded asset risk, helping the system in the decarbonizing process and in integrating electricity and gas sectors.

As far as the metering activity is concerned, ARERA assigns to the TSOs the following tasks:

- a) Read, collect and validate the metering data of the flows to and from the network (meter reading activity), regardless of the ownership of the metering station; the owners of the metering station, responsible for installation and maintenance of the meters (metering activity), must therefore make these data available to the main TSO;
- b) Ensure the reliability of the metering data collected; for this purpose, the main TSO must have the power to determine minimum metering station performance requirements.



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In the tariff structure adopted by ARERA for the transmission metering service, classified as a non-transmission service, tariffs must reflect the costs, be non-discriminatory, objective and transparent, and be applied to the beneficiaries of a given non-transmission service in order to reduce the degree of cross subsidisation between network users.

Based on the above principles, the tariff structure contains the following elements:

- a) a  $CM^T$  component, to cover the meter reading activity (which according to ARERA necessarily remains the responsibility of the main TSO) and the metering under the direct responsibility of the TSO; this component, stated in euro/year/Scm/d, applies to all delivery points and is calculated as the ratio between:
  - i. the capital expenditure and the operating expenditure relating to the metering activity, net of the capital expenditure relating to the metering stations at the end users,
  - ii. the forecasted contracted capacities at delivery points.
- b) a  $CM^{CF}$  component to cover the metering activity at the delivery points of the end users, stated in euro/year/Scm/d, applied only at delivery points where ownership of the metering station has been transferred to the TSO; the component is calculated as the ratio between:
  - i. the capital expenditure relating to the metering stations at the end users,
  - ii. the forecasted contracted capacities at delivery points of the end users that have transferred the metering station to the TSO.

The  $CM^{CF}$  component will be determined upon completion of a specific investigation into the costs relating to the metering stations transferred to the TSOs and the capacities associated with the relevant delivery points.

### 3.5.1.2 Pilot project in Italy – Hydrogen injected in the gas pipelines

As first experiment in Europe, Snam, the Italian TSO, has started in 2019 injecting gas and 5% hydrogen in its gas transportation pipelines in a pilot project to directly supply H2NG (mix of hydrogen and gas) to two industrial customers in the province of Salerno.

Applying the same 5% percentage of hydrogen to gas annually carried by Snam through its national pipelines would be equal to 3,5 billion cubic meters with a potential reduction of CO2 emission of 2,5 million ton (equivalent to CO2 produced by vehicles in Rome).

This pilot will help Snam verify the feasibility of mass hydrogen transportation alongside gas through its pipelines.

### 3.5.2 Germany

The German gas transportation system is quite unique in its structure: with 17 TSOs (compared with one in UK and the Netherlands and two in France), it has the most complex infrastructure, positioned in the middle of Europe, at the crossroads of North-South and East-West gas flows.

The complexity of the gas transportation management increases if we consider also

- The separation of the gas market in two commercial market areas (to be unified in 2022) for booking, trading and balancing purposes,



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- The transition from l-gas and h-gas<sup>29</sup> pipelines to h-gas only grids, which is Germany's biggest national infrastructure project and which will take, due to the high level of investment required, around 10 years,
- The decarbonization process.

As a consequence of this complexity, one of the most important characteristics of the German gas transportation market is represented by the high level of cooperation among TSOs, notwithstanding the large number of TSO in the Country. Mandatory cooperation by the TSOs is also enshrined in the German Energy Act (EnWG).

Another aspect is the high level of digitalization, state-of-the-art SCADA systems and widespread smart metering, to manage the flows of data among TSOs and between all the points of each TSO's pipeline. This is also required by the planning of transportation focused on shorter timeframe (day-ahead or intra-day).

The TSOs, according to the "gas market model", and in particular to the Metering Act (MsbG) of 2016, is responsible for processing and transmission of metering data (while for the electricity sector the responsibility has been transferred to the market role of meter operator). The Metering Act also required that smart metering technology should be implemented when installing transportation gas meters.<sup>30</sup>

### 3.5.2.1 Regulatory framework – TSO remuneration

An incentive- based regulatory regime was introduced in 2009 to replace cost-plus regulation. Under this regime, the revenue that network operators are allowed to earn within the regulatory period is determined using a mathematical formula and fixed for the period. It therefore makes sense (incentive) for network operators to lower their costs within the regulatory period (work efficiently) so as to increase their profits within the limits of the framework (revenue (fixed) minus costs (controllable) equals profit).

The Bundesnetzagentur carries out its efficiency benchmarking on the basis of the cost examination (TOTEX) and structural data validation before the start of each new regulatory period for gas and electricity network operators separately. The efficiency benchmarking involves assessing the operators' individual costs against the services they provide and determining each operator's cost efficiency compared to the other operators.

In addition to the (input) cost parameters, structural (or output) parameters are taken into account to replicate the services provided in each case as well as the regional characteristics. Possible structural parameters could include the number of connection points, peak load, the amount of energy delivered or injected, and transformer and compressor station data. The costs and structural data collected always relate to the base year, which is always the third year of a regulatory period.

### 3.5.2.2 The National Hydrogen Strategy

In June 2020, following months of discussions among ministries and relevant stakeholders, Germany's government has agreed on a national hydrogen strategy with focus on hydrogen made with renewable energies to boost its the energy transition.

An important point contained in the document is that "only hydrogen produced on the basis of renewable energies ('green' hydrogen) is sustainable in the long term." Hydrogen made with natural gas using carbon capture and storage (CCS) which is quite controversial in Germany is only to be used "on a transitional basis."

<sup>29</sup> High gas is gas with higher calorific value; correspondingly Low Gas is gas with low calorific value

<sup>30</sup> Bundesnetzagentur, Annual Report 2018





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In a first ramp-up phase until 2023, the Federal Government will take the following measures (the measuring affecting the gas grid are highlighted):

Sector / Area	Measure	
<b>General Principles</b>	1	A better framework for the efficient use of electricity from renewables (e.g. by means of sector coupling) and a fair design of the energy price components, to create greater scope for the production of green hydrogen.
	2	Possibilities for new business and cooperation models for operators of electrolyzers and for grid and gas network operators will be explored.
	3	The German government is supporting the switchover to hydrogen in the industrial sector by providing funding for investment in electrolyzers. To help decarbonize the steel and chemical industries additional financial funds can be added to the ones earmarked for the National Decarbonisation Programme.
	4	Potential adjustments to ensure that investment in offshore wind energy pay off include the designation of additional areas that can be used for offshore production of hydrogen, the infrastructure necessary for this, and the potential for additional auction rounds for the production of renewables.
<b>Transport</b>	5	The use of green hydrogen for the production of fuel and as an alternative to conventional types of fuel is to be embedded as part of a swift and ambitious transposition of the EU Renewable Energy Directive (RED II) into German law.
	6	The funding measures under the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) will continue.
	7	Development of and funding for installations for the production of electricity-based fuels, in particular electricity-based kerosene and advanced biofuels.
	8	Funding for the construction of a need-based refuelling infrastructure for vehicles, including heavy-duty road haulage vehicles, vehicle public transport and in local passenger rail services.
	9	Advocacy for an ambitious development of the European infrastructure facilitating cross-border transport powered by fuel-cells.
	10	Support for the establishment of a competitive supply industry for fuel-cell systems.
	11	Target-driven transposition of the Clean Vehicles Directive (CVD) to support zero-emissions vehicles in local transport.
	12	Advocacy for a carbon-based differentiation of the truck toll with reduced rates for climate-friendly drivelines under the Eurovignette Directive.





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Sector / Area	Measure	
Industrial sector	13	Advocacy for an international harmonisation of standards for mobility applications for hydrogen and fuel-cell-based systems
	14	The international competitive environment makes it impossible to fully pass on the cost of investment in zero-carbon technologies to the customer. This is why the Federal Government has launched several programmes under which it rewards the switchover from conventional fossil-fuel based technologies that come with inherent emissions to industrial processes that are low in greenhouse gas emissions or even climate neutral. The switchover to hydrogen as a base substance and fuel is key to this, particularly in the steel and chemical industries. The tools available for this are the fund for 'Decarbonising the industrial sector' and the programmes for 'hydrogen use in industrial production' (2020-2024) and 'avoiding and using CO2 in industries relying on base substances'.
	15	As part of the efforts to promote climate-friendly industrial procedures, the German Government are not only providing investment grants, but also supporting the use of electrolysers. For this purpose, the Government will launch a new pilot programme entitled 'Carbon Contracts for Difference (CfD)', which mostly targets the steel and chemical industries with their process-related emissions.
	16	Increasing the demand for industrial products manufactured using low-emission processes and hydrogen. The Federal Government wants to encourage work at national and European level to explore solutions as to how the markets for climate-neutral and recycled products can be boosted in energy-intensive industries. A demand quota for climate-friendly base substances, e.g. green steel, is being considered.
	17	Develop hydrogen-based long-term decarbonisation strategies together with stakeholders – particularly from the energy-intensive industries – within sector-specific dialogue formats (beginning in 2020 for the chemical, steel, logistics, and aviation sectors, with others to follow step-by-step).
Heat	18	As far as the building sector (residential and non-residential property) is concerned, there is the Energy Efficiency Incentive Programme for highly efficient fuel-cell heating systems in place since 2016. The Federal Government will continue to provide this funding and, if necessary, top it up.
	19	With a view to strengthening the long-term shift of the heating sector towards the use of renewables, the Federal Government is looking at ways of providing funding for 'hydrogen readiness' installations under the Combined Heat and Power Act.





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Sector / Area	Measure	
Infrastructure / Supply	20	The need for long-term action within this transformation process is being assessed together with the relevant stakeholders and a report compiled, complete with recommendations for action. This means that the possibilities for using existing structures (dedicated hydrogen infrastructure as well as parts of the natural gas infrastructure than can be adjusted and backfitted to make it H2-ready), starting with the supplier to the end consumer, need to be discussed and initiated in time. The same applies for possibilities to re-dedicate and re-use pipelines etc. for future hydrogen supply. The necessary regulatory basis for the construction and expansion of a hydrogen infrastructure will be prepared swiftly. For this purpose, a market exploration procedure is to take place shortly.
	21	Efforts to better link up the electricity, heat, and gas infrastructure will continue. The aim is to shape the planning, financing, and the regulatory framework in a way that makes it possible to coordinate these different parts of the infrastructure and develop them as required in line with the needs of the energy transition and in a cost-efficient way. In this context, it is necessary to consider the potential of the existing hydrogen infrastructure whilst also ensuring its compatibility in the EU context (work in progress; outcomes of a long-term study commissioned by the Federation will be available in 2nd semester 2020).
	22	As a new infrastructure is being created, special attention must be given to a needs based expansion of the network of hydrogen refuelling stations in road transport, at suitable locations within the rail- way network (e.g. Municipal Transport Financing Act), and for the waterways (cf. fields of application). Target groups here include individual users and operators of a large fleet of hydrogen-powered or fuel-cell-powered vehicles.
Research, Education, innovation	23	A joint hydrogen roadmap that is to serve as guidance: Germany wants to position itself as a lead provider of green hydrogen technology on the global market. For this purpose, a roadmap for the German hydrogen industry will be developed together with the science and business communities and civil society. This roadmap is designed to have international ripple effects.
	24	In the short term, demonstration projects on green hydrogen will be set up with the help of research being conducted into international supply chains. The aim here is to address some fundamental questions and aspects: ideal and typical supply and technology relations are to be developed; robust and modular solutions to be tested globally. Production sites located in our partner countries under our development cooperation are to be included in this (begins 1st semester 2020).
	25	A new cross-ministry research campaign entitled 'hydrogen technologies 2030' will see a strategic bundling together of research activities into hydro- gen-related key-enabling technology. (Implementation begins in Q2 2020). Key elements of the research campaign include, for instance, 'regulatory sandboxes for the energy transition' so as bring up PtX technologies that are close to market to an industrial scale and accelerate the process of innovation transfer;





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Sector / Area	Measure	
	26	A pro-innovative framework is to pave the way for the use of hydrogen technologies in real life. Assessments are being done to test if and what measures such as research and experimentation clauses could help test the market entry of hydrogen technologies and facilitate their transfer into practice. Within the short term, a pioneering project for scientific policy advice is to be set up. The project is to lay the basis for practical work to further develop the national and European legal framework to allow for a large-scale roll-out of applications for the production, storage, transport, and use of hydrogen and for related business models that are economically viable. This includes the development of a quality-assurance infrastructure that meets all the security requirements, complete with an assessment of the systems' and installations' efficiency, and of a billing system that is in compliance with calibration law and is based on reliable metering procedures. Any obstacles existing under the national or European legal framework must be identified and proposals for its development made (begins Q2 2020).
	27	The targets set out in the European Flightpath 2050 document are supported by Germany's Aviation Research Programme. This programme will continue with new funding for hybrid electric aviation.
	28	Continuation of the funding instruments for 'Maritime.Green' (green shipping) as set out in the Maritime Research Programme. At EU level, a partnership initiative for 'Zero-Emissions Water- borne Transport' is under preparation for the new HORIZON Europe programme. The target here is to develop a zero-emissions vessel with closed cycle of substances.
	29	Foster education and vocational training nationally and internationally: German Government is supporting and further developing vocational and scientific training and continuing education in the field of hydrogen technologies so as to pave the way for individual workers and companies to be able to handle hydrogen technologies efficiently and safely. This work is focused on imparting knowledge and skills to the staff that are to produce, operate, and do maintenance work in fields where hydrogen has so far played no more than a minor role.





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Sector / Area	Measure	
<b>Need for action at European level</b>	30	To ensure that a market can develop which contributes to the energy transition and to decarbonisation, as well as boosting export opportunities for German and European companies, there is a need for reliable sustainability standards and for a sophisticated quality infrastructure, proof of origin for electricity from renewable energy and for green hydrogen and its downstream products. At European level, the German Government wants to set sustainability and quality standards in the field of hydrogen and PtX products, and thus to actively foster the establishment of the international hydrogen market. This includes support for the development of European regulations, codes and standards in the various fields of application which will form the groundwork for the international market and ensure that the market ramp-up in Germany takes place in line with the needs of the energy transition. In parallel to this, Germany will also intensify the dialogue on common standards with other countries in order to pave the way towards a universalisation in international organisations.
	31	At EU level, the German Government wishes to intensify investment in research, development and demonstration of green hydrogen. One option is the creation of a new Important Project of Common European Interest (IPCEI) for the field of hydrogen technologies and systems as a joint project with other Member States. The focus here should be on the entire value and use chain for hydrogen (generation, transport, distribution, use). To this end, the Federal Government is proactively approaching the European Commission and EU Member States in order to attract support for such a project and to initiate its realisation (ongoing process).
	32	Against the background of the European Green Deal, the Federal Government is not least working towards an accelerated implementation of the EU hydrogen initiatives. Further to this, on the basis of this strategy it is supporting the drafting of a Green Paper by the Commission mapping out the prospective content of an EU Hydrogen Strategy. A joint market ramp-up of hydrogen technologies will tap economies of scale and create the basis for a successful internal hydrogen market.
	33	The establishment of a European hydrogen company to promote and develop joint international production capacities and infrastructure is being explored and will be progressed if there is sufficient European backing.

It will be for the competent ministries to ensure that the measures are implemented and financed on the basis of the existing budget estimates and financial plans. However, there is also a cross-cutting dimension to the National Hydrogen Strategy and there will be a strong focus on a systemic approach. This means that supply and demand will always be considered together.

The measures set out in the Action Plan are those for phase one of the National Hydrogen Strategy, i.e. the phase up to 2023, by which time the ramp-up is to begin and the basis for a well-functioning domestic market to be laid. Parallel to this, essential issues such as research and development and international aspects are to be tackled as





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well. The next phase, which is due to begin in 2024, is about stabilising the newly emerging domestic market, moulding the European and international dimension of hydrogen, and using it for German industry.



Figure 16: Phases of the National Hydrogen Strategy

A structured and dedicated governance for the National Hydrogen Strategy has also been defined, with a State Secretaries’ Committee on Hydrogen, composed of the relevant ministries, defining the strategic management (targets, objectives, action plan, etc..). 26 high level experts from business, science and civil society will form the National Hydrogen Council to advise and support the State Secretaries’ Committee on Hydrogen.

On its part, the Coordination Office will assist the ministries in implementing the Hydrogen Strategy and will monitor its implementation. It will also provide to the ministries a project management structure.





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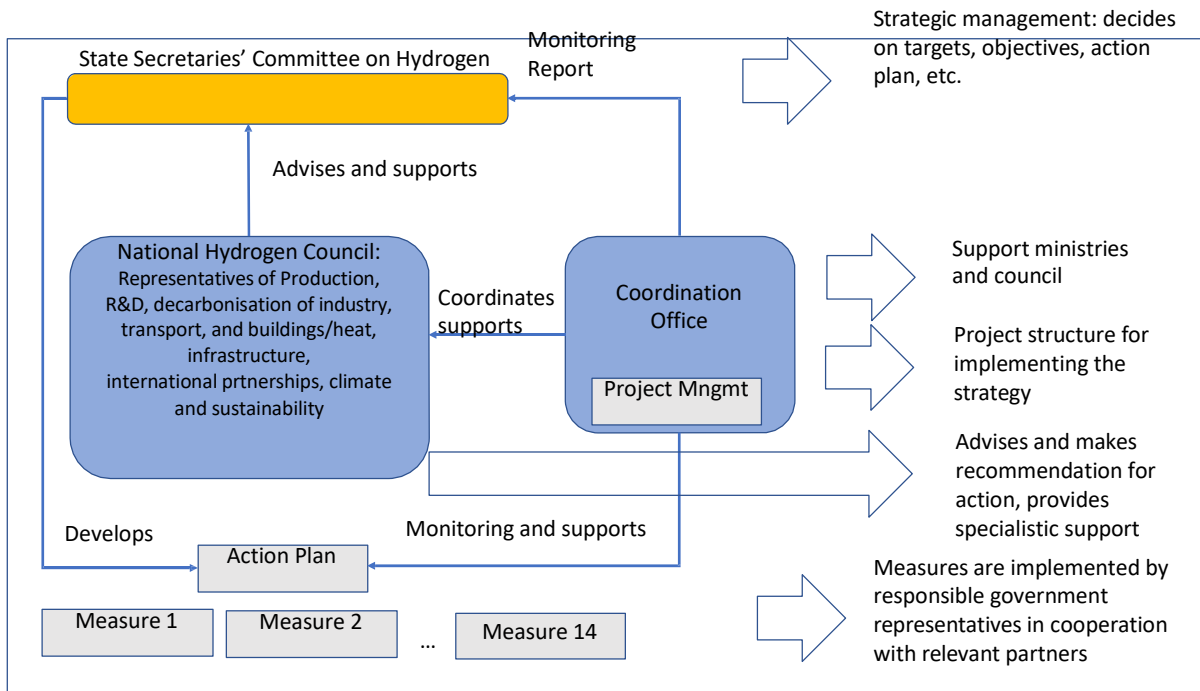


Figure 17: Governance Structure of the National Hydrogen Strategy

According to the economy and energy minister Peter Altmaier, the strategy is a "quantum leap" that will lift the energy transition and climate protection to a "new qualitative level". During a press conference marking the launch of the strategy, he called the initiative the "most important innovation since our decision to support the roll-out of renewables."

### 3.5.2.3 Innovative pilot projects

TSOs are starting to assess the impact of feeding hydrogen into gas transportation network.

For instance, Thyssengas, in a consortium with Gasunie Deutschland GmbH & Co. KG and TenneT TSO GmbH, is planning to implement the "Element One" project in Lower Saxony for sector coupling on an industrial scale. Regenerative electricity from offshore wind farms is to be converted into green gas. In several stages, a powerful electrolyser is planned for the production of hydrogen with a capacity of up to 100 MWe1:

- In phases 1 and 2, hydrogen produced from green electricity will flow into the existing gas pipelines as a supplement to natural gas. This will already make existing natural gas provision for heating systems and industry more climate friendly. At the same time, industries and transportation companies can extract the hydrogen they need for their processes and mobility from the hydrogen connections that will be set up. For example, from hydrogen refuelling stations with tankers. This helps companies work in a more environmentally friendly way – no matter where they are located.
- In phase 3 of the project, CO<sub>2</sub> from biogas facilities will be chemically combined with the hydrogen produced using green electricity. The resulting synthetic methane can replace fossil natural gas or be mixed with it without limit. When it is burned, only CO<sub>2</sub> that has previously been extracted from the environment is released – the carbon footprint is completely offset. Large-scale power-to-gas facilities: an engineering challenge of the energy transition.





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- In phase 4, Thyssen will integrate the nearby cavern storage facilities into the system, which will be able to store huge quantities of energy. In this way, volatile, wind-dependent energy can be turned into a constant flow of power.
- In the final phase 5, since L-gas supply is due to be terminated in the foreseeable future and there will be no more deliveries from the Netherlands, L-gas pipelines will become free. Thyssen will use the resulting pipeline capacities to transport the hydrogen created directly to industrial customers in North Rhine-Westphalia. This will improve the climate footprint in one of the most important industrial areas in Europe.

### 3.5.3 Netherlands

#### 3.5.3.1 Regulatory Framework and incentive for innovation

Since 2002, an incentive-based regulatory regime, defined by ACM after consultation with stakeholders, regulate the remuneration of electricity and gas TSOs. Under this regime, the revenues that network operators are allowed to earn within a certain period (regulatory period) is determined using a mathematical formula and fixed for the period. This incentivizes network operators to lower their costs in order to maintain or increase profits. TOTEX approach is used to determine the revenue cap set for the TSO.

#### 3.5.3.2 Innovation Projects

The development of hydrogen regions (“valleys”) can foster economic growth in the European regions while answering to the local energy needs and reducing pollution. It covers the entire hydrogen value chain: production, storage, distribution and final use. As such, “Hydrogen Valleys” offer a pathway for scaling up and making this technology a viable solution.

At European level, the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) had selected earlier this year the Northern Netherlands region to start negotiations for an EU grant agreement valued at 20 million euros. The grant is meant to develop a fully-fledged green hydrogen value chain in the Northern Netherlands, which will thus become the first fully-fledged "hydrogen region" in Europe. The HEAVENN project (H2 Energy Applications in Valley Environments for Northern Netherlands) is unique because it comprises an entire hydrogen value chain within one geographical region.

### 3.5.4 UK

According to the Office of Gas and Electricity Markets (Ofgem), the drive for decarbonization of the energy system in UK was expected to lead to substantial increases in the investment requirements on energy networks – its initial estimate was around £32bn by 2020 (around 75% of the existing regulatory asset bases of the network businesses). Besides, the decarbonization itself was likely to create an environment with higher risks of increasing costs as it was leading to a shift in the underlying generation mix to meet renewables targets and a change in the level and type of new connections.

As it knows, to manage this paradigmatic change, Ofgem has introduced a new regulatory framework, called RII031 in 2010. RII0 is an output-led system with outputs a core 'building block'. Network companies are expected to achieve agreed primary outputs and secondary deliverables (i.e. interim actions that are expected to lead to benefits in future regulatory periods) and to justify their business plans and submitted revenue requirements in relation to these outputs. The output categories are linked to licence obligations, existing standards of performance

<sup>31</sup> Revenues = Incentives+ Innovation+Outputs (RIIO)





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and policy objectives that networks can facilitate. The six key output categories considered under RIIO are safety, environmental impact, customer satisfaction, social obligations, connections, reliability and availability.

Within the regulatory framework of RIIO, Ofgem has introduced specific incentives to support innovations, i.e.:

- a) NIA (Network Innovation Allowance) which allows operators to recover 90% of the investment in innovative projects,
- b) NIC (Network Innovation competition), to support decarbonizing and sustainability projects, where national projects compete annually for a given amount of funds (20 Million £ in 2020).

The Initial Screening Process for the 2020 NIC has just concluded and two projects have been admitted to the next phase (Full Submission stage):

- H100 Fife (SGN): The project aims to construct a new end-to-end distribution network to test hydrogen from production to use in real consumer homes, with the opportunity for customers to opt-in to live trials.
- HyNTS (National Grid Gas): The project aims to test transmission network assets with flows of hydrogen blends between 20-100% at transmission pressures for the first time. The project intends to work in conjunction with Northern Gas Networks' ongoing H21 project at Spadeadam.

### 3.5.5 France

#### 3.5.5.1 "Plan National Intégré Energie-Climat" (2019)

In the Energy – Climate National Plan, the French Government has set its goals to fulfil the European decarbonizing targets. Key elements of this strategy are:

- Support to the decentralization of energy production, which requires smart grids more flexible,
- Development of the interrelationships among electricity, gas and heat sectors ("Power to gas" and "Power to Heat"),
- Doubling the installed capacity of renewable electricity between 2017 and 2028 with 36% of renewable in electricity production in 2028,
- Increase in the biogas injected in the gas transportation pipelines to 14-22 TWh in 2028 (vs 0,4 TWh in 2017),
- Biogas should reach 6 to 8% of the gas consumption in 2028.

The development of smart grids, especially with the deployment at distribution level of new equipments (smart meters, communication software, etc...), increase of digitalization and the development of IT platforms and software able to manage large amount of data will support this energy strategy and increase the energy efficiency.

#### 3.5.5.2 Regulatory Framework and Incentive for Smart Grids

As elsewhere in Europe, smart meters, and supervisory/remote control and communication software are included in the allowed revenues of the two TSOs (GRTgaz and TIGF).

The tariff for the use of the GRTgaz and TIGF natural gas transmission networks, (known as the ATRT6) entered into force on 1 April 2017 for a period of approximately four years. It was adopted after extensive stakeholder consultation and as a result of published studies. The ATRT6 tariff aims at giving gas TSOs the capacity to meet the





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challenges of the energy transition and to take into account the changes in the gas market in the coming years. TSO performance incentives are reinforced: a "non-network" incentive on capital expenditure is introduced, and there is a reinforcement of incentives on the costs of the main network development projects and on the quality of service provided for the users.

Besides, the tariff of the previous regulatory period (ATRT5) provided for a 3% bonus over 10 years, which was granted to a limited number of projects. Against the current background of decreasing demand and overcapacity on the European market, the ATRT6 provides for a new incentive regulation mechanism that introduces a bonus whose allocation and amount will depend on the results of a cost/profit analysis carried out by CRE (French Energy Regulatory Commission).

Its level is set to include GRTgaz 2020 projects and TIGF Research and Innovation. The developments related to the ATRT6 tariff are part of a framework for controlling the tariff level of gas transport in a context of demand decrease.

The French NRA, CRE (Commission de Régulation de l'Énergie), sets funds at the beginning of the regulatory period for R&D expenses. Since 2017 a share of these funds is specifically earmarked to projects which investigate new utilization of the gas pipelines.

### 3.5.6 European Best Cases - Summary

Across Europe, there is similarity in the regulation of gas transportation smart grid. Compared to distribution, National Regulatory Agencies are less prescriptive in requiring technical solutions or "smart" investments (compared with the smart meter roll-out plans and functionalities defined for DSOs). All TSOs rely on SCADA and remote management to control and operate their networks, and there is peer pressure among TSOs to stay aligned with the technical developments.

The challenges and the paradigmatic changes caused by the decarbonizing process have induced the NRAs, at European and national level, to reassess the regulatory approach to gas transportation to better support this transformation. The discussion is in its early phases and reflects the fact that there is still no identified or agreed technical solution to be implemented. As mentioned in the "New gas market design and Regulatory approach", regulatory obstacles have been identified (but not solved, so far). To maintain the unity of the European gas internal market, the solutions and the new approaches have to be common and synchronized, in order not to hinder the cross-countries flows and trades of gas.

For the moment, all NRAs seems to favour incentive schemes to support pilot projects, to assess new technologies or new gas to inject into the pipelines.





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Table 8: Regulatory Framework and Incentives for Smart Grids

	Italy	Germany	UK	Netherlands	France
<b>Role of NRAs and TSOs in the definition of pan European TSO actions</b>	<ul style="list-style-type: none"> <li>National NRAs and TSOs through their European associations (CEER and ENTSOG respectively, with a strong dialog with ACER) participate to the discussion at the European level               <ul style="list-style-type: none"> <li>To frame the new European strategy for gas transportation in order to be aligned with the European Green Deal,</li> <li>To coordinate policies in support of technical innovations in order to maintain the unity and exchanges in the European gas market, which might be fragmented by unilateral regulatory approach or technical solution;</li> </ul> </li> </ul>				
<b>Smart Grid current status</b>	<ul style="list-style-type: none"> <li>All TSOs have SCADA system and smart meters which control/read in remote and often in real times the main parameters of the gas transportation grid,</li> <li>At cross-border level, there is an increasing exchange of information and data between national dispatching centres,</li> <li>Also, with the national electricity smart grids and the DSOs, an increase in the exchange of data is expected in the near future,</li> <li>There are no direct functional or technical requirements of the gas smart grid, defined by the NRA, but TSOs are incentivized to use innovative technological solutions to meet European and national energy strategic objectives;</li> </ul>				
<b>Planning of smart grid and technology deployment</b>	<ul style="list-style-type: none"> <li>In all European countries, the investment plan of each TSOs has to be integrated and aligned with the Ten-Year Network development plan (TYNP), developed by ENTSOG, and with its development scenarios,</li> <li>This is particularly relevant in this phase of paradigmatic changes, in order to avoid under-utilization of assets or sunk costs.</li> <li>Even for the investments which are not included in the TYNDP, the procedure for approval (cost-benefit analysis, public discussion involving all the relevant stakeholders) is the same, provided that the investment is over a predefined threshold.</li> <li>The national TSO are required to publishes their Ten-Year Development Plan (e.g. see Snam’s “Ten Year Network Development Plan 2014-2023 “(in English).</li> </ul>				





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	Italy	Germany	UK	Netherlands	France
<b>Regulatory and Remuneration Framework</b>	<ul style="list-style-type: none"> <li>• Cost determination methodology based on total expenditure (<i>TOTEX</i>)</li> <li>• Smart meters and supervisory/remote control and communication software are included in the allowed revenues,</li> <li>• Separate remuneration for the measurement activity</li> </ul>	<ul style="list-style-type: none"> <li>• Incentive- based regulatory regime,</li> <li>• Smart meters and supervisory/remote control and communication software are included in the allowed revenues,</li> </ul>	<ul style="list-style-type: none"> <li>• Cost determination methodology based on total expenditure (<i>TOTEX</i>)</li> <li>• Smart meters and supervisory/remote control and communication software are included in the allowed revenues,</li> </ul>	<ul style="list-style-type: none"> <li>• An incentive-based regulatory regime,</li> <li>• Smart meters and supervisory/remote control and communication software are included in the allowed revenues,</li> </ul>	<ul style="list-style-type: none"> <li>• Smart meters and supervisory/remote control and communication software are included in the allowed revenues,</li> </ul>
<b>Incentive for new utilization of the grid</b>	<ul style="list-style-type: none"> <li>• Regulation incentives under discussion,</li> <li>• Innovative pilot projects by TSO</li> </ul>	<ul style="list-style-type: none"> <li>• Regulation incentives under discussion in the new hydrogen strategy,</li> <li>• Innovative pilot projects by TSO</li> </ul>	<ul style="list-style-type: none"> <li>• Incentives scheme in place (NIC),</li> <li>• Innovative pilot projects by TSO</li> </ul>	<ul style="list-style-type: none"> <li>• Incentives scheme in place,</li> <li>• Innovative pilot projects by TSO</li> </ul>	<ul style="list-style-type: none"> <li>• Incentives scheme in place,</li> <li>• Innovative pilot projects by TSO</li> </ul>





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	Italy	Germany	UK	Netherlands	France
<p><b>Relations between TSO and DSOs</b></p>	<ul style="list-style-type: none"> <li>The roll-out of smart meters, almost completed in some countries (e.g. Italy) or under way, at the DSO level will increase the quantity and quality of data provided by the DSOs to the TSOs, which will increase the efficiency and transparency of the gas transportation system;</li> <li>As mentioned by CEER in its recent paper on Whole System Approaches (2020), “with respect to the gas network, the shift from natural gas to renewable or low carbon gases will need a more structured coordination between DSOs and TSOs. In particular, the expected increase of decentralised gas production (particularly of biomethane, but also of gas produced from power-to-gas facilities) requires the sharing of data between DSOs and TSOs. Regarding local congestions, a reverse-flow approach from distribution to transmission level may be needed. Moreover, in countries that will choose to replace natural gas with hydrogen in their gas networks, there will be a need for adaptation and/or replacement of gas infrastructure, which requires coordinated actions between DSOs and TSOs. “</li> </ul>				





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### 3.6 Legislative and Regulatory Recommendations

Based on the current status of smart grid in Europe and the Turkish regulatory framework, our legislative and regulatory recommendations are contained in the table below.

Table 9: Legislative and Regulatory Recommendations

	Rationale	Recommendation
1	As shown recently in the EU Hydrogen Strategy, relevant investments will be required to modernize the TSOs and the other energy players. On the other hand, the risk of under-utilization of assets requires a careful and deep analysis of the investment proposed by the TSOs in the authorization process.	<ul style="list-style-type: none"> <li>Review the TSO investment approval process by EMRA, to be sure that the information provided by BOTAS cover all the relevant elements,</li> <li>The introduction of a cost-benefit analysis (CBA) could help the Regulator assess all the relevant aspects of the investment (from the demand forecast requesting the investment, to its cost up to its social and environmental impacts),</li> <li>The involvement of all the key stakeholders into the investment approval process has proved very useful in the European experience,</li> <li>BOTAS should publish in its website the Investment Development Plan</li> </ul>
2	The European NRAs are discussing the future gas model and regulatory changes to support decarbonization and the new roles of gas TSO;	<p>EMRA and BOTAS should</p> <ul style="list-style-type: none"> <li>discuss/formulate proposals to present to the Government to support the decarbonization target,</li> <li>identify any regulatory obstacle which might hinder the decarbonization process;</li> </ul>
3	European NRAs are introducing incentive schemes or funds to support gas TSOs to carry out pilot project (e.g. injection of hydrogen and biofuels into the gas pipelines)	<p>EMRA should</p> <ul style="list-style-type: none"> <li>Define a procedure to approve innovative pilot projects,</li> <li>consider incentives to fund initiatives proposed by BOTAS regarding usage of renewable gas o sector coupling</li> </ul>
4	In order to get a better understanding of the changes that are taking place in the European Gas Model	EMRA and BOTAS should increase the information exchanges with equivalent European institutions and players



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### 3.7 Gas Transportation, Security of Supply and Creation of a Gas Hub in Turkey

In Europe and elsewhere, gas transportation is strictly linked to the issue of security of supply, i.e. the ability of the gas suppliers and transporters to provide enough gas to industrial and residential consumers from as many sources as possible.

In Turkey, as shown by a recent study of the Oxford Institute for Energy Studies, huge seasonal gas demand fluctuations remain, and gas demand during the peak winter season can rise to a level higher than Botas' peak delivery capacity, especially if the gas imports are reduced by external factors.

In October 2017, Botas current gas transportation system capacity was around 200 mcm/d (excluding storage capacities), whereas peak demand can surge to 260 mcm/d.

Therefore, Botas is "forced to prioritize residential use by instructing both state-controlled utilities and independent gas-fueled power producers (IPP) to reduce gas consumption temporarily by as much as 50% of contractual level".<sup>32</sup>

Storage capacity is limited: in 2017 Botas-owned Tuz Golu and Marmara Degirmankoy had storage capacity of only 31 mcm/d and 3 bcm/y.

Extension of pipelines capacity can be provided by existing and new projects (TANAP and Turkstream) as well as by extension of LNG receiving terminals, FSRU and storage capacity.

For instance, considering the constraints on the transportation of large volumes of gas from the eastern part of Turkey to the most gas consuming region in the west, it is more convenient to import gas in the form of LNG terminal in the north west area of Turkey.

New storage capacities could not only help Botas and other market players to deal with seasonal balancing but also allow export gas surpluses in the future. This will also provide the flexibility to support the transformation of the Turkish gas market into a gas trading centre, allowing the Energy Market Operations Company (EPIAŞ) to extend trading, besides electricity, to gas on a day- and month-ahead basis.

Besides, more LNG receiving facilities including FSRUs will allow more private companies to import gas from various sources and bring extra gas volumes to Turkey. According to the Natural Gas Market Law (NGML 4646), the cornerstone of Turkish gas market regulation, private companies are not allowed to conclude contracts with and import gas from countries that have an active supply agreement with BOTAS, but they are allowed to import LNG from those same countries. This could foster competition in the domestic market and make import prices as well as the domestic balancing price more competitive, if the price signals are correct.

The development of a trading hub, where, for instance gas-fueled power plants with annual contracts with fixed volumes can

- trade and exchange gas exceeding their necessity, or
- buy additional gas from any seller authorized to operate at this hub, for instance from a spot LNG importer if the LNG prices are low,

<sup>32</sup> Oxford Institute for Energy Studies, "Gas Supply Changes in Turkey", January 2018



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will increase dramatically the flexibility of the system and help determine correct price signals in the market.

In this framework, the following recommendation might be proposed

	Rationale	Recommendation
1	Storage systems can play a more relevant role to support BOTAS manage the winter demand peaks and can provide flexibility to the system;	<ul style="list-style-type: none"> <li>Review the investment authorization process in order to consider all the costs and benefits of the proposed investment (see section 3.10)</li> <li>Support the development of storage with adequate remuneration of the investment and/or incentive</li> </ul>
2	LNG receiving facilities including FSRUs can enlarge the sources of gas supply and provide more flexible supply contractual terms, allowing also private companies to import from Countries where BOTAS has supply contract.	<ul style="list-style-type: none"> <li>Support the development of LNG receiving facilities including FSRUs with adequate remuneration of the investment and/or incentive;</li> <li>Utilization of the BOO (Build, Operate and Transfer) mechanism to incentive the development of LNG infrastructure;</li> </ul>
3	To increase the flexibility of the market and contribute to the formation of correct price signals	<ul style="list-style-type: none"> <li>Develop a gas hub to trade excessive quantities among authorized operators</li> </ul>

### 3.8 As-is Smart Grid Implementation in BOTAS

In Turkey as in all the European countries, SCADA system is the key tool to manage the transportation pipelines and collect all the relevant information in real time. Its design and functionalities have recently (August 2017) been reviewed<sup>33</sup>. Also, BOTAS-select vendor, Siemens, has been conducting the “SCADA Renewal and Backup Project”.

Besides the common challenges that gas transmission IT systems face nowadays (Security of Supply, Cyberattacks and Asset Utilization / Management), the liberalization of the gas market and redefinition of tariff structures will put stronger emphasis on allowed investment – revenue calculations, and hence cost item follows, according to the 2017 analysis.

<sup>33</sup> EU\_IPA Project, BOTAS SCADA System Assessment and Design



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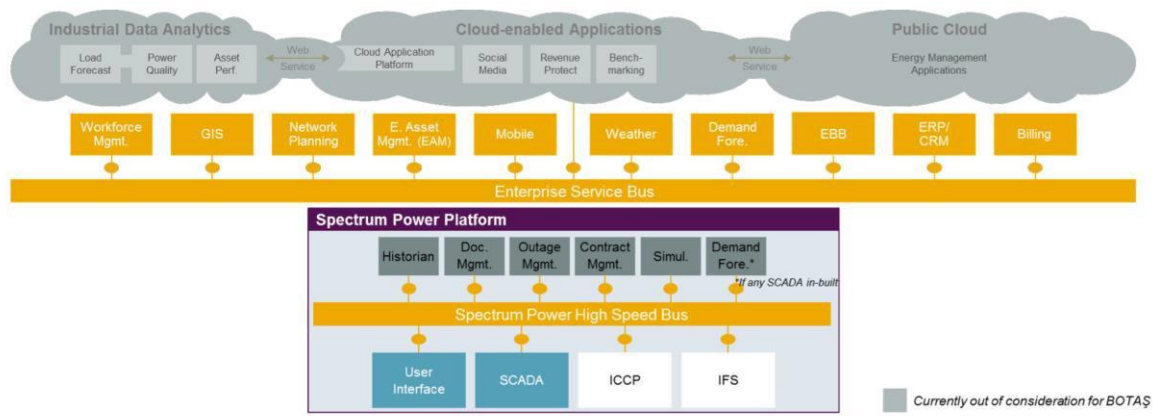


Figure 18: BOTAS' SCADA System Architecture

The main conclusions in the EU-IPA Project as far as the SCADA Design System focused on a suggested higher degree of centralization, since a fully integrated SCADA is very useful for a TSO with a complex network and a large amount of monitoring and controlling services in place, as is the case of BOTAS TSO.





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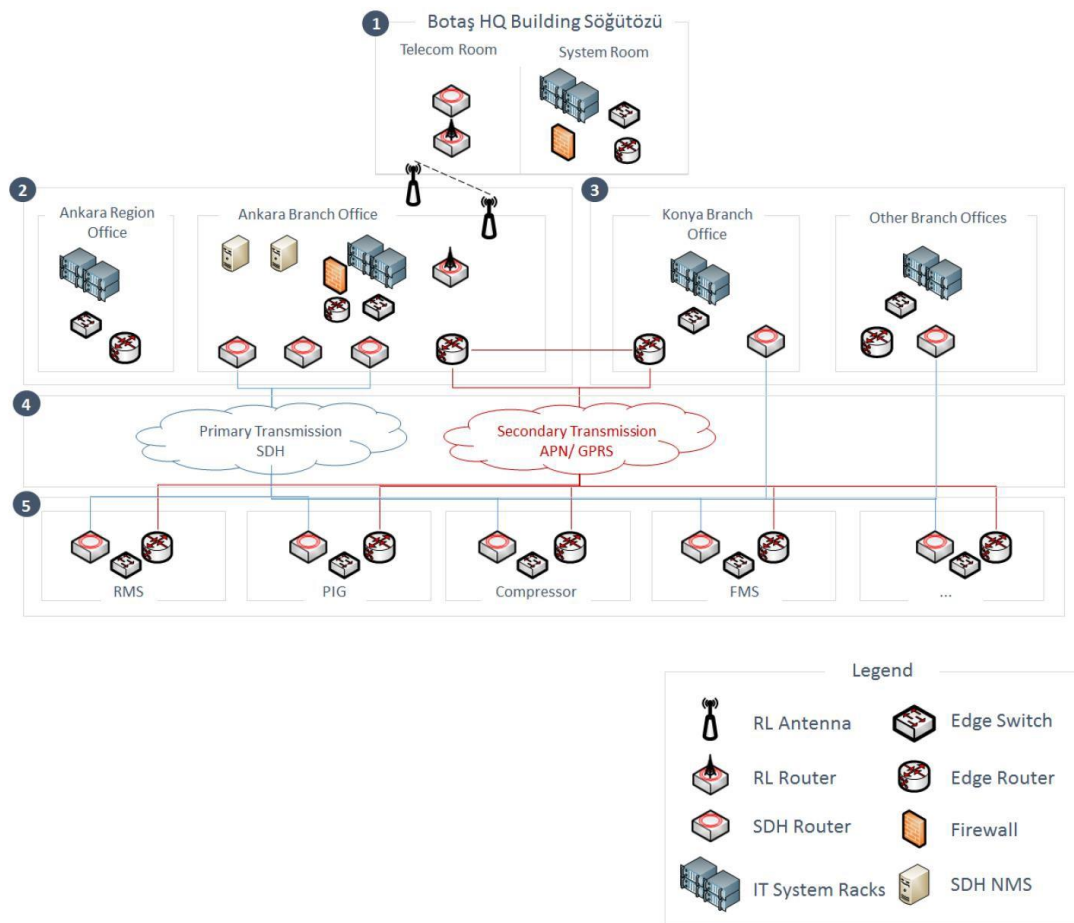


Figure 19: BOTAS Enterprise ICT System Architecture<sup>34</sup>

The proposed integrations will strengthen in particular the data exchange between SCADA modules and the Geographical Information System (GIS), simulation and demand forecasting tools.

Table 10: Suggested Key SCADA and Module Integrations

Suggested Module Implementations and Integrations		Rationale and benefits
<b>Recommended GIS Integrations</b>	GIS and Enterprise Asset Management	This provides control over all assets, for the full life cycle (design, construction, commissioning, operation, maintenance, decommissioning and renewal) of the assets defined on GIS and in the Enterprise Asset Management (“EAM”) software. It also allows to be fully compliant with respect to mandatory legislation, with respect to asset safety, monitoring, etc. Combining as-built network data with financial data for projects and investments can justify tariff propositions for BOTAS.
	GIS and Outage Management	Static data can be visualized; hence outages can be detected over the asset data and outages can be removed more swiftly; which would result in improved Key Performance Indicators (KPIs) such as System Average Interruption Duration Index (“SAIDI”) and System Average Interruption Frequency Index (“SAIFI”).

<sup>34</sup> EU\_IPA Project, BOTAS SCADA System Assessment and Design





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Suggested Module Implementations and Integrations		Rationale and benefits
	GIS and Workforce Management, Mobile	Based on the GIS data and outage location, and taking work force proximity to the affected location, crews can be sent rapidly to the incident site. Further Mobile integration with IP phones, tablets, etc. enhances quality and speed.
	GIS and Document Management	Documents are linked to the GIS assets, so that any construction work, as-builts, operation manuals and other technical documentation can be found.
<b>Recommended Simulation Integrations</b>	Simulation and Outage Management	This integration will help dispatchers predict critical situation and the network behaviour in such situations, especially for the area of interest. Dispatcher decisions will hence be supported via Simulation scenarios.
	Simulation and Contract Management	Simulation results will take existing contracts into consideration. This is especially important for long-term contracts rather than day-to-day operations of nomination, allocation and confirmation.
	Simulation and EAM	Simulation can be utilized for theoretical scenarios for strategic planning. Design and test changes can be applied over the existing assets in the network.
<b>Recommended Demand Forecast Tool Integrations</b>	Short-term Demand Forecasting and Electronic Bulletin Board (EBB)	Short-term demand forecasting shall be integrated with the EBB to allow Demand Forecast Tool to capture the nominations entered by the market participants. This will allow Gas Control Management to track nominations / re-nominations on a near real-time basis to update their forecasts, arrange line pack calculations and perform operational management of contractual obligations. According to the outcome of demand forecasting, confirmations can be sent to nomination holders.
	Long-term Demand Forecasting and Enterprise Asset Management (EAM)	to provide forecasts up to 15 years and coordinate output of GIS, EAM and Demand Forecasting to prioritize asset risks and needs into an optimised investment plan.





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### 3.9 Proposed Smart Grid RoadMap for BOTAS

Based on the analysis of the previous section and considering the best practices adopted by the European TSOs, the following RoadMap is proposed to increase BOTAS planning and operational efficiency:

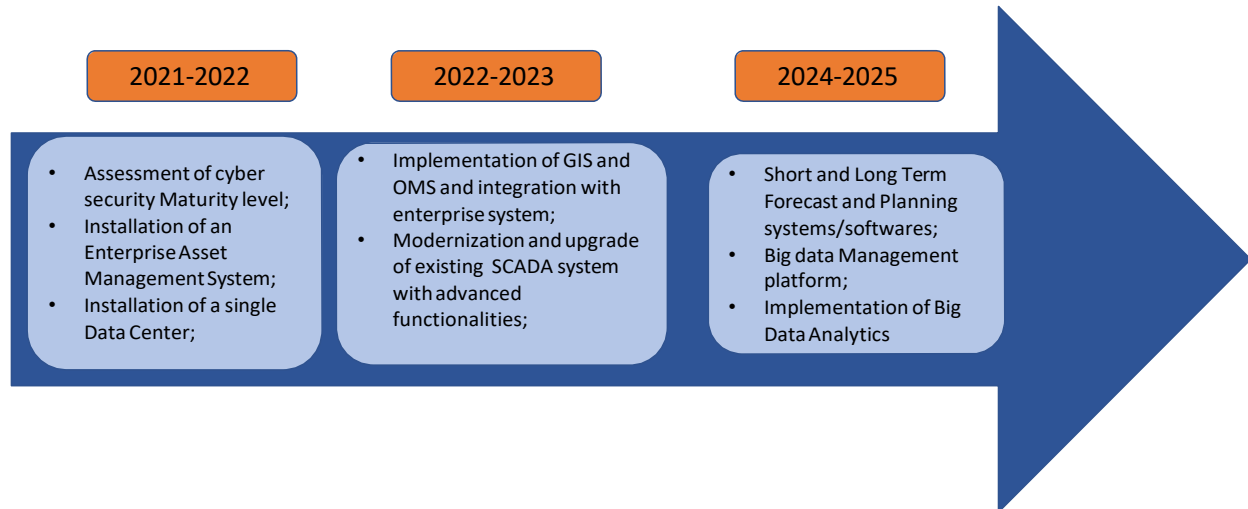


Figure 20: Proposed RoadMap for BOTAS

#### 2021-2022

##### a) Assessment of Cyber Security Maturity level

As mentioned by the Energy Expert Cyber Security Platform in 2017 for the European Commission, digital technologies are playing an increasingly important role in the energy sector. A smarter energy system can perform transmission, network management and market related tasks with better precision and faster response times than a human-dependent system, thereby optimising energy management, prioritizing usage, and setting policies for quick response to outages.

Energy control systems include a hierarchy of interconnected physical and electronic sensing, monitoring, and control devices, mostly acting in real-time and typically connected to a central supervisory station or a control centre. Control systems encompass supervisory control and data acquisition (SCADA) systems used to monitoring and control operations that in case of energy transport and distribution networks are widely dispersed. Distributed control systems (DCS) are used for single facilities or small geographical areas. Control systems are connected to remote components such as remote terminal units (RTU) and programmable logic controllers (PLC) that monitor system data and initiate programmed control activities in response to input data and alerts. SCADA systems collect, display and store information from remotely located data collection transducers, sensors, control equipment, devices and automated functions. They form part of the process control systems that are used to manage in real-time, for example, the transmission and distribution of electricity or transmission and distribution along gas pipelines.

Currently, the energy sector consists of both legacy and next generation technologies. New technologies are introducing new intelligent components (e.g. gas meters, digital valves or pumps) to the energy infrastructure that communicate in more advanced ways (two-way wired and wireless communications) than in the past. These new components are typically based on information and communication technology (ICT) that can be interconnected to





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local networks. Typically, 'analog' components are replaced by new digital systems as spare parts are not available anymore or obsolete.

Ensuring resilience of the energy supply systems against cyber risks and threats are becoming increasingly important as wide-spread use of ICT and data communication is becoming the foundation for the functioning of infrastructures underlying the energy systems.

The digitalisation of the energy sector also raises the question of how to face the risks and threats of cyber incidents and attacks affecting personal data and strategic energy infrastructure data, which are sometimes crucial for the security of the energy supply.

The focus of cyber security in the energy sector is to support the reliability and resilience even in the event of a cyber-attack. Unlike IT systems, a control system in the energy sector that is under attack cannot be easily disconnected from the network as this could potentially result in safety issues, brownouts or even blackouts.

In cyber security, three commonly accepted protection goals are defined: Confidentiality, Integrity and Availability (CIA). In the energy sector, the highest priority objective depends on the industry specific applications. For example, in generation and transmission, availability and integrity are the most important. Altered or delayed data could result in misconfiguration of a device that eventually could impact system reliability. For the advanced metering infrastructure, confidentiality of customer personal data is the most critical.

It is therefore very important for BOTAS to assess the security of its systems against cyber-attacks, to counter any attempts to the availability and integrity of data.

#### **b) Installation of an Enterprise Asset Management System**

Given the increasing relevance of investments in the new gas model, it becomes essential to manage efficiently the entire lifecycle of BOTAS' physical assets.

As in the case of Snam Rete Gas, who has chosen SAP Enterprise Asset Management, an Enterprise Asset Management System should provide:

- Asset information management
- Risk and criticality assessment
- Failure modes and effects analysis.

The system will maximize asset performance with real-time analysis, simulations and predictive maintenance. It can also be integrated with work order management (to handle work orders and notifications, time parts, etc) and with geographic information system.

#### **c) Installation of a Single Data Centre**

We recommend the creation of a single Data Centre, which should consolidate different server system in one location, to avoid data misalignment, conflicting data and other possible data distortions. A single Data Centre would also make it easier to check for completeness of data and would allow to perform data analytics in a more efficient way.

The data centre planning should aim to provide:





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- Maximum uptime
- High energy efficiency
- Full scalability
- Utmost security and safety.

Besides, as discussed in the cyber security section, a unique data centre would reduce the risk of cyber-attacks.

## 2022-2023

### a) Implementation of GIS and OMS and integration with Enterprise System

See section above for rationale for integration between

- GIS and Enterprise Asset Management, Outage Management, Workforce Management Mobile and Document Management,
- OMS and simulation.

### b) Modernization and Upgrade of Existing SCADA System with Advanced Functionalities

Information and Communication Technologies (ICT) has caused a paradigm shift in all the energy system by enabling advanced functionalities to ensure its safe and reliable operation; thus, giving rise to smart grids. Consequentially, the Supervisory Control and Data Acquisition (SCADA) system is also undergoing a transition.

Traditional SCADA systems constantly monitor equipment at a site or pipeline and record sampled data to a local historian. The real-time data is visually represented on operator screens and is used to evaluate alarm conditions. Most systems provide a summary of the collected data to show trends and identify anomalies, as well as showcase design queries and reports that summarize the data for operational maintenance and management. The data is exported from the historian regularly for further analysis in other data management systems, where it is augmented with rate schedule details, maintenance management data, modelled data, weather data and more.

Since a SCADA system already stores plant operational data, it might make sense to incorporate advanced analytics and performance management functionality into the same SCADA system rather than add external systems, reducing overall operation complexities and costs. On top of this, collecting data in real time allows for performance issues at plants or pipelines to be more readily addressed.

An effective SCADA system could incorporate the following functions:

- Weather forecasts: By integrating weather forecast service support, along with expected performance, the SCADA system can provide accurate gas consumption forecasts, providing insight into data and device calibration.
- Device-level analysis: When performance is analysed at the individual device level, a SCADA system can alert operators and maintenance technicians of device performance issues and the level of impact for quick analysis.



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With comprehensive, real-time analysis, operators don't need to constantly and actively look for issues in managing gas transportation. The SCADA system can provide performance-based alarms to alert operators when individual devices are not performing optimally. When managing multiple locations, resource owners and operators greatly benefit from the automated alerts from advanced SCADA systems.

Introducing integration to a gas transportation management system enables the utility to monitor critical functions in real-time and to incorporate Automated Generation Control (AGC) to control the functioning of the system. Advanced SCADA systems may include:

- Satellite weather/forecasting: Integrating one or multiple weather services to augment network information with area weather observations and forecasts helps to estimate better gas consumption levels,
- Meter settlement: Integrating meter reading systems ensures accuracy in settlements.
- Billing systems: With complex gas transportation rates and components, the billing process can produce wrong or late invoices. Having to export the SCADA system data into a separate, complex spreadsheet and then enter that data into an accounting system is time-consuming. However, when integrating billing into a SCADA system, this process can be automated, creating invoices without manual manipulation.
- Document management: Rather than storing engineering, contract, compliance and procedure documents in a document management system, the system can be integrated into the SCADA system. Documents can be easily accessed from the SCADA system for ease of organization and control.

More generally, the rising complexity of smart grids has caused a paradigmatic shift in SCADA and its architecture. Data is now gathered with different Operation Technologies (OT) devices, such as Smart Meters and Remote Terminal Units (RTU). The increase in the number of digital devices in the network has led to an increase in the amount as well as the rate of data flowing from the field to control room.

This might bring new requirements for communication networks, that should be managed centrally or distributed to ensure that the SCADA applications receive the requested data at the right time. Data aggregators (DA) placed in the field can collect data from several sources to process them, thereby reducing the volume of data flowing to the control room. Also, Big Data Technologies could aid in fast and efficient processing of the data (see below).

## 2024-2025

### a) Short- and Long-term Forecasting and Planning/Simulation Software

Most of European TSOs include market and network studies in their National Development Plans.

- Market studies cover projections of gas market fundamental data: supply, demand, peak demand capacity and prices.
- Network studies i.e. hydraulic simulations carried out to determine the ability of the network to flow gas and to cover stress in high demand situations. The network studies are carried out using software solutions and are based on detailed network topology data. Such network modelling is used, in some cases, for both routine network operations and for simulating network developments under different scenarios (physical volumes and entry/exit flow configurations).

To develop such studies, the most used modelling software are:



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- Simone (Belgium, Croatia, Germany, Hungary, Slovak Republic),
- Pipeline Studio (Ireland Greece),
- Sire200 (Italy),
- Sinergi Software (UK).

At European level, ENTSOG has developed a modelling approach since 2010, based on a specific structure facing the need to consider simultaneously network and market dimensions. The network model represents the gas market within the geographical scope of the TYNDP. The tool used by ENTSOG to perform the TYNDP assessment is the ENTSOG NeMo Tool. The tool reflects the physical characteristics of the gas infrastructure relevant from the Union-wide TYNDP perspective.

NeMo Tool It is both a Network and Market Simulation Model. It

- Builds on TSO expertise and hydraulic modelling of national infrastructure.
- Models the European infrastructure with the most relevant accuracy.
- Enables the national assessment of relevant risks affecting the security of gas supply.
- Considers the Union wide simulation of supply and infrastructure disruption scenarios.

NeMo is used in the TYNDP in order to verify the feasibility of different flow situations, handle the supply adequacy outlook, assess the resilience of the system, identify the infrastructure gaps and assess projects.

#### b) Big Data Management Platform

The degree to which smart devices have become pervasive is exponential rather than linear, resulting in a deluge of data from so many assets. This can become overwhelming for fledgling digital transformation efforts. To help make sense of the data and provide the structure for curating the most important data, create and evolve a smart asset model or template that normalizes tagging and assets characteristics in order to enable a rollout of this model at scale when ready. The best approach is to start small and with some forethought in mind to handle the massive amounts of data.

The various types of data which are generated, stored, and analysed can be in different sizes and formats (text, image, audio or video). In a more technical way, they can be classified as:

- Structured data: the majority of oil and gas generated data from SCADA systems, surface and subsurface facilities, drilling data, and production data are structured data. These data could be time series data which have been recorded through a certain course of time. Another source of structured data includes the asset, risk, and project management re- ports. There would be also external structured data sources such as market prices and weather data, which can be used for forecasting.
- Semi-structured data: The sources of semi- structured data include processed data as a result of modelling and simulation. There are various practices of experimental and computer simulation in the oil and gas industry to generate data for further analysis. These data can be categorized as semi-structured data and later to be used with Big Data tools
- Unstructured data: the sources of unstructured data in oil and gas industry include well logs, daily written reports of drilling, and CAD drawing





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Defining how the data is now stored to support the organization’s digital transformation initiatives is imperative. While early implementers of a digital transformation strategy believed that all data would be poured into a massive ‘data lake’ in the cloud, the reality is that this unorganized approach could become a ‘data swamp’ where users get bogged down.

Best practices suggest that a hybrid data lake strategy — in which data is thought of as an asset and can therefore be contextualized, organized in an assets hierarchy, and managed through an “operational chart of accounts” model — enables the flexibility to access data, regardless of whether it is stored on-premise or in cloud-based locations. A fit-for-purpose hybrid data lake strategy stores the data where it makes the most sense.

### c) Implementation of Big Data Analytics

Turning operation data into intelligence requires a range of analytical approaches. Successful digital transformation implementers have found that a framework built by adopting a “layer of analytics” is most effective.

Among the tools and technologies which are available for Big Data analytics we can list:

- Apache Hadoop: This tool is an open-source framework, initially written in Java and it uses distributed processing through enormous clusters of computers. Hadoop has the capability of parallel processing of huge data sets, which results in scalable computing. Apache Hadoop is comprised of two major layers: Hadoop distributed file system (HDFS) and MapReduce. In fact, Apache Hadoop is a framework to implement MapReduce programming model. The tasks are handled in two major phases. The first phase, which is storing data, is done under HDFS layer with its master/slave architecture by a master server called NameNode and clusters of slaves which are called DataNodes. (see the architecture of the HDFS layer in the following figure).

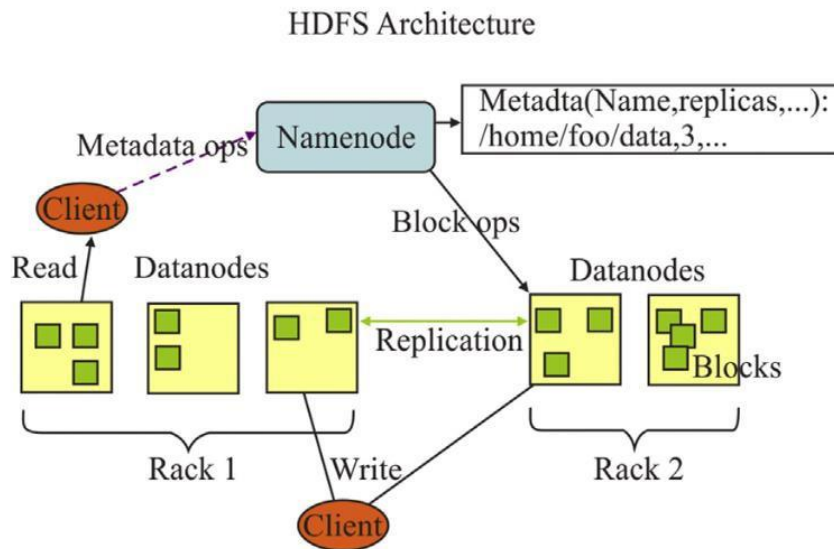


Figure 21: HDFS Architecture with Namenode and Datanodes



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- **MangoDB:** This is a NoSQL (non-relational) database technology which is document-orientated, based on JSON and written in C++. JSON is data processing format based on a JavaScript and is built on a collection of name/value pairs or an ordered list of values. NoSQL database technology can handle unstructured data such as documents, multi- media, and social media. Moreover, MangoDB provides a dynamic and flexible structure to be customized to fit the requirements of various users,
- **Cassandra:** This is another NoSQL database technology which is key, and column orientated. Cassandra was first a Facebook project that became open sourced few years later. It is especially efficient where it is possible to spend more time to learn a complex system which will provide a lot of power and flexibility.

Big data sets which are collected need to be analysed to extract the valuable underlying information. There have been different processing tools which translates the large data sets into meaningful results and outcomes. Among the most used, we can signal R, Datameter and IBM BigSheets.

### 3.10 Roles and Responsibilities for Implementation of the Roadmap

To be aligned with what it is happening in Europe (and elsewhere) regarding the new gas model and the role that the gas TSOs should play in this changing environment, the following roadmap is proposed.

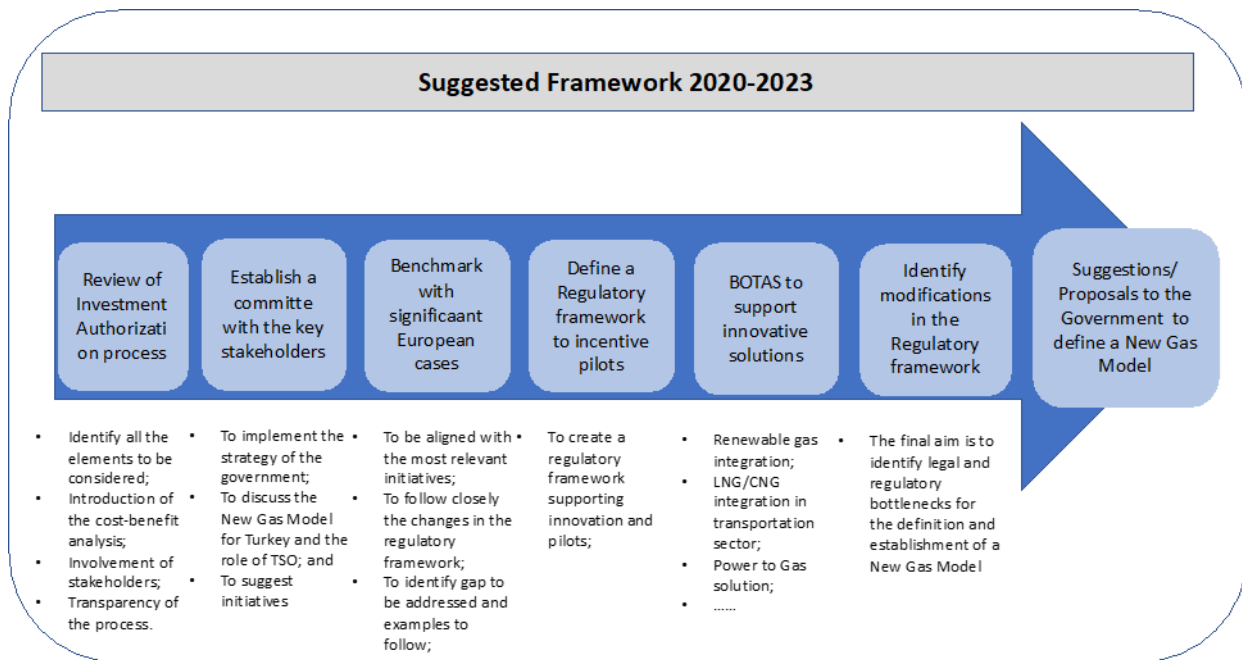


Figure 22: Suggested Roadmap for the New Gas Model and the New Role of TSOs



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### **Step 1 – Review of the Investment Authorization Process**

The first step of the roadmap, as a pre-condition for all the other initiatives, is a review of the investment authorization process managed by EMRA, in order to be sure of the effectiveness and efficiency of the investment proposed by the TSO and to avoid the risk of under-utilization of the assets.

The investments should also be put in a multi-annual framework. (10 years as in Europe, for instance, with regular updates in order to take into consideration all the required modification) and should be published by the TSO, in order to increase the transparency of the process and the involvement of all the key stakeholders.

As an example, the Italian Regulator requires the TSO to publish a Ten-Year Plan with the following information:

- a) A detailed description of the status of transportation network three year before the presentation of the Plan, to highlight the criticalities and existing congestions,
- b) The main infrastructure to be built, upgrade or renew in the following next ten years, and their correlation with the criticalities mentioned above,
- c) The main maintenance interventions to be carried out on the infrastructure in the next ten years,
- d) The projects which will be considered PICs projects,
- e) The investment decided and the new investments to be realized, with a proper justification in the next three years,
- f) The expected results (costs, benefits and other impacts) with the realization of the development plan,

The operators should present together with the plan:

- a) An annex containing the details for each of the investments contained in the plan,
- b) A report monitoring the developments already carried out in the Plan or contained in previous Plans.

The details to be provided for each of the investments are:

- a) Context information,
- b) The information about the intervention,
- c) The results of the CBA (carried out also to consider how the uncertainties have been evaluated and to show contributions already received),
- d) The quantitative indicators.

The Regulator also specifies the elements of the CBA to be performed:

#### **Benefit analysis**

- a) Variation in the social welfare connected with the reduction of the cost of gas supply,
- b) Variation in the social welfare connected with fuel switching,
  - i. For connection of new areas to the supply of gas
  - ii. For the thermoelectrical sector,





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- c) Increased safety and certainty of the supply
  - i. In normal condition,
  - ii. In stress disruption conditions,
- d) Avoided costs:
  - i. Costs due to inefficiencies,
  - ii. Other costs,
- e) Reduction of the negative externalities for CO2 emission,
- f) Reduction of the negative externalities for emissions non-CO2 related,
- g) Greater integration of production from renewable sources in the electrical sector

#### Cost analysis

- a) Capital expenses, also considering any contingency,
- b) Operational expenses to manage and maintain the infrastructures,
- c) Social and/or environmental expenses,
- d) Level and detail of the estimate,
- e) Expenses already paid,
- f) Indication of any capital contribution received and any exogenously compensated costs.

Besides CBA, the following indicators of economic performance should be provided:

- a) NEV – net economic value
- b) B/C – cost/benefit relation
- c) PBP – payback economic period,

As well as other quantitative indicators (N-1 Indicator; IRDI – indicator of diversification of the sources of supply; BPI – index of bidirectional capacity).

This approach has been applied by Snam, in its “Ten Year Network development plan 2014-23”, where the Italian TSO has analysed the investment proposed and the risks connected, according to the European and Italian legislative and regulatory framework, the National Energy Strategy, ENTSOG Ten Year Network Development plan, ten year scenarios to meet natural gas market development , information submitted by third parties and the general strategy of Snam.

#### **Step 2 – Establish a Committee with the Key Stakeholders**

As shown in Section 4, the discussion under way in the European Union about the new Gas Model to implement to achieve the decarbonizing targets and the New Green Deal and Hydrogen Strategies is in its early phase, with the changes in the regulatory framework under development.

Therefore, the main suggestions behind the suggested roadmap are:





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- To follow closely what it is happening within the European Union,
- To identify the regulatory and technological solutions gaining acceptance and relevance,
- To check whether it is possible/desirable to transpose them in the Turkish regulatory framework and in the operational activities of the TSO,
- To identify possible regulatory bottlenecks to innovation and operational pilots.

The uncertainty in the future new Gas Model which will prevail in the European Union suggest also the timeframe to implement this roadmap, which is quite short (3 years), in order to allow EMRA and all the other stakeholders to quickly adapt to any changes in the aforementioned discussion.

To transpose/modify what it is happening in the European and international energy markets in the Turkish framework and to define the new Gas Model for Turkey and the role of TSO, we suggest the establishment of a Committee, led by EMRA, with all the key Turkish energy stakeholders:

- To discuss proposals,
- To build a consensus on the way forward,
- To analyse the future scenarios of the Turkey energy markets.

### ***Step 3 – Benchmark with Significant European Cases***

We suggest increasing the relationships between EMRA and BOTAS and the equivalent European institutions, in order

- To understand better the transformation under way both at the regulatory and operational level,
- To be aligned with the most relevant initiatives,
- To follow closely the changes in the regulatory framework,
- To identify gaps to be addressed and examples to follow

### ***Step 4 – Define a Regulatory framework to incentivize pilots***

In this phase of building the new Gas Model, EMRA should incentivize innovations and support pilots proposed by the TSO, allowing the Transporter to recover the costs and providing “regulatory sandbox” to perform experimental activities.

A special funds might be created (like in the UK case) to award the two best innovative projects by energy stakeholders (TSOs, DSOs, but also Suppliers and Shippers) in order to foster an innovative climate and spur stakeholders to propose initiatives.

### ***Step 5 – The Role of BOTAS to actively support the deployment of innovative solutions***

In addition to the overall roles and responsibilities proposed in the roadmap, BOTAS shall also have an active role in the deployment of innovative solutions for the gas sector. The level of maturity of some of these technologies is not enough to propose a detailed roadmap but the participation of BOTAS is likely to be crucial.



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Innovation Area	Activities of BOTAS
Renewable gases integration	<ul style="list-style-type: none"> <li>- Network expansion and upgrading for easing biogas integration and the connection of biogas facilities.</li> <li>- Ensuring quality standards of biogas and safety of the network.</li> <li>- Undertake Pilot projects and external R&amp;D studies.</li> </ul>
LNG/CNG integration in transport sector	<ul style="list-style-type: none"> <li>- Network expansion: refuelling stations, storage facilities, etc. (construction and/or operation).</li> <li>- Undertake R&amp;D expenditures: pilot projects and external R&amp;D studies (research centres) related to CNG and LNG use in the transportation sector.</li> </ul>
Power to Gas Solutions	<ul style="list-style-type: none"> <li>- Network expansion and upgrading for easing P2G facilities integration.</li> <li>- Quality standards for hydrogen blends.</li> <li>- Participate on the development of PSG facilities – gas side.</li> </ul>
Guarantees of Origin	<ul style="list-style-type: none"> <li>- Develop and operate the national register for biogas GoO ensuring non-discriminatory access.</li> </ul>
Carbon Capture, Storage and Transportation	<ul style="list-style-type: none"> <li>- Network development and/or conversion of existing facilities to enable CCS.</li> <li>- Operate the CCS infrastructure ensuring non-discriminatory access.</li> </ul>

### **Step 6 – Implement Modifications in the Regulatory Framework**

The final aim is to identify legal and regulatory bottlenecks for the definition and establishment of a New decarbonized Gas Model. Modifications might be required in the regulatory framework, eliminating bottlenecks that stifle innovation and introducing new regulations to manage the new scenarios.


Also, in this case we recommend the active involvements of all stakeholders and to establish a transparent process. The associations of TSOs and the Regulators have been and are particularly active in participating in the decision-making process, advancing proposals and suggesting regulatory changes.

### **Step 7 – Suggestion/proposals to the Government to define a New Gas Model**

EMRA should work to consolidate these different proposals and innovations into a coherent New Gas Model, to be presented to the Government as base for future legislative actions.

The interrelations and the constant flow of information between EMRA and the stakeholders involved in these discussions should prepare and inform the Government and the other legislative bodies involved in the definition of the energy legislation of the challenges that the Turkish energy sector is facing and of the suggested options coming from the energy sector.





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