Innovation Action

inteGRIDy

integrated Smart GRID Cross-Functional Solutions for Optimized Synergetic Energy Distribution, Utilization & Storage Technologies

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WP1 – inteGRIDy Domain Analysis, Specifications & Architecture

D 1.1. - Report on Obstacles & Barriers related to inteGRIDy Framework

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Abstract:	This document offers an insight into the estimated effects of key external factors (political, economic, social, legal, technological and environmental) to the proposed inteGRIDy challenges (Demand Response, Smartening the distribution grid, Energy Storage Technologies, Smart Integration of grid users from Transport) starting from the pilot's deployment activities. The goal is to analyse of the main drivers of R&D investment and obstacles to innovation in the energy industry in general and related to the foreseen inteGRIDy innovations in general. The content represents the results of an in-depth analysis conducted by all partners involved applying the following methods: brainstorming, focus groups, simple research work on focused subjects and PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis.
Keywords:	Energy, R&D drivers, electricity sector, electricity market, analysis, obstacles and barriers, inteGRIDy innovations, Demand Response, Smartening the distribution grid, Energy Storage Technologies, Smart Integration of grid users from Transport

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Executive Summary

The present deliverable named D1.1, entitled Report on Obstacles & Barriers related to inteGRIDy Framework is one of the first reports released in the context of WP1 - inteGRIDy Domain Analysis, Specifications & Architecture. This document starts the assessment of the inteGRIDy proposal, i.e. DoA, starting from the updated situations on pilot sites and pilots' deployment activities and considering the proposed innovations (Demand Response, Smartening the distribution grid, Energy Storage Technologies, Smart Integration of grid users from Transport).

In-depth analysis of obstacles and barriers of inteGRIDy innovations, main drivers of R&D investments, impact and estimated effects of key external factors and market factors in each pilot country are topics covered in this document.

The methodology used to elicit barriers and obstacles to inteGRIDy framework is a multi-structured approach including brainstorming, focus groups, simple research work on focused subjects and PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis [JAM10].

The document covers, the description of the methodology used regarding both the data gathering and analysis and the literature review for the identification of obstacles and barriers. Data gathering refers to internal information requested to Pilot partners and the way it is used to identify barriers, mostly related to the particular scenario in which the demonstrator is located. Literature review is used to assess technological barriers inherent to the use of the novel tools proposed by inteGRIDy.

The following areas are covered by this document:

- Assessment of main drivers of R&D investment and obstacles to innovation in energy industry. The study is conducted on a country basis, providing drivers for EU states in which inteGRIDy has presence.
- Analysis of the main Obstacles & Barriers related to inteGRIDy's Innovations.
    - In this particular case, the barriers are identified as potential obstacles for inteGRIDy implantation and from the perspective of DSO/Utility partners, which are the core focus of inteGRIDy's innovations. Therefore, the pilots in which such companies are involved in, are studied in detail.
    - In addition to the DSO/Utility perspective, this document provides also a PESTLE analysis to determine potential Political, Economic, Social, Technological, Legal and Environmental obstacles. This analysis is given from a high level EU perspective, aiming at identifying potential barriers to inteGRIDy's innovations implantation. Nevertheless, the study is complemented, where appropriate, with particular pilot-related considerations in case there are relevant aspects on a particular country.

All in all, this report summarizes the impact of main drivers and obstacles to R&D investment in energy sector and external factors influencing inteGRIDy innovation. The work started in this report will serve as basis for future WP1 (on the architecture and use case identification), WP2 (regulatory and market analysis) and WP3 (business model study) activities, being altogether the seed for inteGRIDy's core innovations and pilots.

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List of Acronyms and Abbreviations

Term	Description
AEEGSI	Italian Authority for Electricity Gas and Water System
ADEME	Agency for the Environment and Energy Management
ADMIE SA	Independent Transmission Operator of Electricity SA
ADMS	Advanced Distribution Management Systems
AMI	Automated Meter Infrastructure
ANRE	Romanian Energy Regulatory Authority
ANSSI	National Agency for Information Systems Security
BEIS	The UK Department for Business Energy and Industrial Strategy
CCC	Committee on Climate Change
CEI	Italian Electrotechnical Committee
CHP	Cogeneration of heat and power
CMBC	Centralized Market of Bilateral Contracts
CRE	French Energy Regulatory Commission
CRES	Centre for Renewable Energy Sources
CSP	Concentrated Solar Power
DCC	Data Communications Company
DG	Distribution Grid (DG
DGEG	Directorate-General for Energy and Geology
D&D	Demonstration & Deployment
DEDDIE SA	Hellenic Electricity Distribution Network Administrator SA
Di.T.N.E.	Energy National Technology District
DL	Decree-Laws
DSO	Distribution System Operator
EBRD	European Bank for Reconstruction and Development
EDP	Sistema Eléctrico Português
ESCO	Energy Services Companies / Electric Supply Companies
EAPs	Environmental Action Programs
EPC	Engineering Procurement Construction
ERSE	Entidade Reguladora dos Servicos Energeticos
ETP	European Technology Platform
ETS	Emissions Trading System
EV	Electric Vehicle
FAI	Innovation Support Fund
FCT	Fundação para a Ciência ea Tecnologia
FIRE	Italian Federation for the Rational Use of Energy
FIT	Feed-In Tariffs
GC	Green Certificates
GDP	Gross Domestic Product
GSRT	General Secretariat for Research and Technology
G2V	Grid-To-Vehicle

HVAC	Heating, ventilation and air conditioning
HEDNO	Hellenic Electricity Distribution Network Operator
HES	Head End System
HV	High Voltage
IEA	International Energy Agency
IEE	Institution of Electrical Engineers
LNEG	National Laboratory for Energy and Geology
MIBEL	Iberian Electricity Market
MISE	Italian National Minister For EconomicalEconomic Development
MIUR	Italian Minister for University Research and Innovation
MDMS	Metering Data Management System
MV/LV	Medium Voltage/Low Voltage
NREAP	National Renewable Energy Action Plan
NEEAP	National Energy Efficiency Action Plan
NTCs	National Technology Clusters
OECD	The Organization of Economic Co-operation and Development
OFGEM	Office of Gas and Electricity Markets
OMIE	Operador del Mercado Ibérico Español
OPCOM	Operatorul Pietei de Energie Electrica si de Gaze Naturale din Romania
NGO	Non-Governmental Organization
PHEV	Plug-in hybrid EV
PESTLE	Political, Economic, Social, Technological, Legal and Environmental
PLC	Power Line Communication
PPC	Public Power Corporation
PV	Photovoltaic
PVPC	Precio Voluntario al Pequeño Consumidor
PVT	Photovoltaic and solar thermal
RAE	Regulatory Authority for Energy
RCM	Resolutions of the Council of Ministers
RD&D	Research, Development and Demonstration
RD&I	Research, Development and Innovation
RE	Renewable Energy
RES	Renewable Energy Systems
R&D	Research and Development
RTE	National Transport Network
SMETS	Smart metering equipment technical specifications
ToU	Time of Use
TSO	Transmission System Operator
TURPE	Tarif d'Utilisation des Réseaux Publics d'Electricité,
VES	Vertical Electrical Sounding
V2G	Vehicle-To-Grid
VPP	Virtual Power Plant
SG	Smart Grid

1. Introduction

1.1 Scope and objectives of the deliverable

Fostering innovation in the energy industry is a challenge *per se*; yet the inteGRIDy project tackles four innovation challenges and proposes ten pilot deployments in eight European countries (United Kingdom, France, Spain, Portugal, Greece, Cyprus, Romania and Italy).

inteGRIDy will integrate cutting-edge technologies, solutions and mechanisms in a scalable Cross-Functional Platform, connecting energy networks with diverse stakeholders to achieve three outcomes:

1. Facilitating the optimal and dynamic operation of the Distribution Grid (DG),
2. Fostering the stability and coordination of distributed energy resources and
3. Enabling collaborative storage schemes within an increasing share of renewable energy.

D1.1 Reports on the Obstacles & Barriers related to inteGRIDy Framework presents the results of an in-depth analysis carried out by all partners involved. It offers a broad perspective on markets and key external factors in a both generic and specific manner, i.e. EU-28 and pilot countries.

1.2 Structure of the deliverable

To cover all these topics in a comprehensive manner, the document has the following structure:

Section 1 introduces the general framework and the scope of the document and describes the goals and main objectives of each project task.

Chapter 2 describes the approach chosen to evaluate related issues in Project and includes the methodology for data collection and analysis, together with the strategy adopted for literature review and references selection. Others instruments useful for framework evaluation are also described: such as brainstorming, focus group and PESTLE analysis.

Chapter 3 includes an assessment of main drivers of R&D investment and obstacles to innovation in the energy industry. It is divided in two main sections where a description of main drivers for R&D investments is described in those countries where inteGRIDy's partners are based, while later, obstacles and barriers have also been provided. Using brainstorming, focus group and think-tank tools, this section describes the investment climate for innovation in the energy industry, and also the major obstacles in this field.

Chapter 4 is devoted to analysing the general context through a PESTLE analysis, which identifies basic issues in a systematic and logical way. The pilots in the inteGRIDy project are analysed.

Finally, Chapter 5 summarizes the most important barriers and obstacles that prevent innovation in the energy industry, with particular regard to the inteGRIDy goals.

1.3 Relation to Other Tasks and Deliverables

This is the first technical report, together with D1.2, outputted by inteGRIDy. Therefore, it is used as input for next coming deliverables and tasks. The content of this document, especially Chapter 4, will be used on inteGRIDy D1.5 deliverable, which is covering the first architecture definition. Obstacles and barriers will be also assessed from the market and regulatory perspective in WP2 deliverables, and used as basis for the business model study conducted on D3.3 document.

2. Methodological approach

Large projects involving multiple partners and many actions and topics require a **multi-lateral** approach to identify framework peculiarities. The interaction between many participants with different roles and the number of tasks has consequences on a variety of issues in addition to the challenges in the energy system domain. Due to intrinsic complexity, of the inteGRIDy project, it is important that all sources and references have been exploited, in order to ensure that all subjects (like barriers and obstacles in this case) have been correctly assessed in their appropriate context. Thus, an extensive analysis has been undertaken in order to provide evidence and valuable information for the Consortium. Methodologies and tools adopted are described in following paragraphs.

2.1 Methodology of collecting and analysing data

In this stage of collecting data and information relevant to achieve an understanding of the specific obstacles, barriers and challenges related to inteGRIDy, choosing the appropriate method for collecting and analysing data is important.

For the stage a **multi-structured** approach has been used consisting of:

- Research work focused on the subject/domain topics
- Brainstorming
- Focus Groups
- PESTLE (Political, Economic, Social, Technological, Legal, Environmental) macro-environment analysis.

The themes for the discussion, debate and research were chosen according to the subjects of inteGRIDy project: Demand Response, Smartening the distribution grid, Energy Storage Technologies and Smart integration of grid users from transport.

The method for collecting and analysing data is described in the following sections. Like a scientific research base/guideline Annex I. Focus Group template presents an example of a Focus Group organized by the DSOs involved in the Project.

2.2 Search strategy and information sources

The review includes original articles, review articles, studies, websites, published standards, guidelines, best practices, white papers and innovation papers related to the reference domain (smartening the electricity grid) and the specific topics of the Project.

The research focused on several topics:

- website screening of EU Official Journals websites, EU roadmaps in energy websites, Smart Grid and smart metering solutions websites, Think Tank websites related to energy and electricity, websites of relevant organizations/institutions related to the reference domain
- professional publications specific for the domain of interest, tackling the subjects of inteGRIDy project of the last 5 years
- References of retrieved publications.

The collection of data was a continuous process, where the collected data itself influenced further research.

The research was mainly performed using search engines such as Google, starting with those websites with a recognized and high repute in technical and scientific communication and using appropriate keywords:

- Smart Grid investment in Europe,
- Economic barriers in the energy field,
- Incentive regulation in electricity,

- Increase of energy efficiency,
- Demand Response perspectives and challenges,
- R&D innovation for smart electricity network,
- Smartening the electricity grid,
- IT solutions based on flexible architectures in electricity,
- Impact of energy storage technologies on the environment,
- Smart Grids for smart markets,
- Market and regulatory factors influencing Smart Grids.

As concerns the selection of materials, this task was to extract relevant aspects regarding main drivers of R&D investment (needs, perspectives, interests, challenges, impact, etc.) and obstacles to innovation in energy industry and the major obstacles and barriers related to inteGRIDy's innovations.

- Moreover, other significant innovation approaches were explored such as EU roadmaps in energy (Energy 2020 [ENE20], Policies for 2030 [ENE30] and Energy Roadmap 2050 [EUC12]) which address factors outside the inteGRIDy's major subjects.

The selected material focused on:

- Articles, reports, papers, studies
- Guidelines, standards, best practices, projects or success stories about implemented solutions, directives and regulations
- Case examples
- Scientific views and opinions.

2.3 Brainstorming

In order to gather the most valuable information regarding the scope of the Project, brainstorming sessions were organised, as qualitative research methods.

The objective of these brainstorming sessions was to analyse use cases, scenarios, requirements and also similar solutions on the market, based on the experience knowledge of the experts involved.

For instance, one brainstorming session focused on identifying barriers and obstacles to inteGRIDy framework, particularly suited for Pilot 9 case – The Ploiesti use case was organized by SIVECO team.

The group consisted of experts and consultants from ELECTRICA (DSO) and also IT specialists – a technical assistant, business consultant and business analyst with experience in implementing smart IT solutions in Public Utility companies.

2.4 Focus Groups

Four DSOs (INNED, ASSEM, WVT, ELECTRICA) organised Focus Groups to evaluate aspects supporting investment in innovation in the energy industry (Pros) and the major obstacles to innovation (Cons). The focus groups also assessed the main drivers of R&D investment and obstacles to innovation in energy industry.

The objective of these Focus Groups was to elicit the DSO perspective on these issues.

The outcomes of these Focus Groups are represented by the *Pros* and *Cons* of matter under discussion. Examples of these Focus Groups, including relevant open questions, are presented in Annex I. Focus Group template.

2.5 PESTLE analysis

PESTLE analysis provides a framework for investigating and analysing the external environment for an organisation. The framework identifies six key areas (Political, Economic, Social, Technological, Legal and Environmental) as presented in *Business Analysis Techniques - 72 Essential Tools for Success* [JAM10].

The main obstacles and barriers related to inteGRIDy's innovations in the macro-environment was analysed through the PESTLE (Political, Economic, Social, Technological, Legal, Environmental) technique.

This research addressed the major obstacles and barriers related to the inteGRIDy innovations, towards the four challenges.

For each of these challenges, the partners explored interests, demands, expectations, investment, obstacles, issues, directives and legislation that are main obstacles and barriers related to inteGRIDy's innovations.

Details regarding the PESTLE research are presented in Chapter 4 along with an analysis of the main obstacles and barriers related to inteGRIDy's innovations.

2.6 Stakeholders

Preliminary information concerning the stakeholders in the inteGRIDy solution set was collected first.

Stakeholders in different sectors of the market include

- Public Utility companies
- Consumers/Prosumers
- Energy services companies
- IT companies
- Environmental agencies/institutions
- Non-Governmental Organizations (NGOs)
- Real estate agents/operators
- Networks / Associations e.g. IEEE association
- Think Tanks
- Government.

The final list of stakeholders chosen is presented in deliverable D1.2 inteGRIDy on Stakeholders and Market needs.

3. Assessment of main drivers of R&D investment and obstacles to innovation in energy industry

This section addresses the relevant aspects regarding the investment in innovation in the energy industry (Pros) but also the major obstacles to innovation (Cons) in this field, taking into consideration the strategies, policies, market demands, existing technologies etc. Via research approach: Brainstorming, focus-groups, think tanks we have looked for other innovation approaches like investment, EU roadmaps in energy (Energy 2020, 2030 and 2050) that may also address other perspectives.

Each pilot country provided information about:

- Energy market structure and R&D investment
- Smart Grid relevance in your country (e.g. status of smart meter roll-out)
- Emergent structures (private, NGO, universities) sustaining energy innovative investment (e.g. role of ESCO)
- Overall conclusions regarding the R&D investment in energy industry.

3.1 Main drivers of R&D investment in energy industry (PROs)

3.1.1 United Kingdom

Strategic Overview

In recent decades the UK government has spent considerable amounts on energy research, development and demonstration projects, as shown by 40 years of data from the International Energy Agency (IEA) in the Figure 1, below. Spending peaks reported in the 1980s were followed by a huge decline in the 1990s and early 2000s as the Central Electricity Generating Board and its associated laboratories were prepared for privatisation. A government intervention livens up the spending until the economic crisis when they slightly go down. In 2013 (the latest year for which data are available), total energy Research, Development and Demonstration (RDD) spending was £362m.

Figure 1. UK public spending on energy RDD 1974-2013 [Source: IEA]

An assessment of the market shows the context of the change that the UK energy sector is undergoing. OFGEM (Office of Gas and Electricity Markets) the UK regulator estimates

£200bn of investment is needed to deliver the dual challenge of decarburization and delivering security of supply over the next 10 to 15 years.

In terms of relevant policies and programmes pursued by the Coalition government over the past five years, there are a few that deserve special mention. In 2011, the government launched the first of a group of 'Catapult Centres' intended to improve links between academic research and industry.

Electricity liberalisation in the "British model", consists of six reforms: (1) creation of a competitive market for electricity, (2) the breakup of monopolized supply such that each consumer can select his provider, (3) separation of network maintenance from generation, (4) separation of direct supply from the generation of electricity and metering, (5) creation of an incentive structure to set market prices in monopolistic competition, and (6) the privatisation of formerly state-owned assets [EPW05].

Frontier Economics issued in January 2011 a report considering UK energy and the impact the energy liberalization had on customer engagement.

"Customer engagement is a clear success story of energy liberalisation in the UK. By 2008, at least 75% of customers had switched energy supplier at least once. This is equivalent to just under 20 million households. Further, of those who have never switched, a sizeable majority (83%) are aware that it is possible to switch" [FEC11].

Today there are a number of costs associated with entering this market, and then expanding to reach scale. These scale economies include investment in IT systems and call centres and the costs associated with building a brand and acquiring customers. There is an element of fixed cost to these activities, and therefore they can be expected to act as a barrier to smaller suppliers.

"To understand the future of competition in this market, we need to understand what we expect suppliers' role to be in delivering this vision. If Government wishes to use suppliers to deliver policy, it needs to recognise that entry into this market may well become harder"[FEC11].

UK and Smart Meters

The current expectation is that by the end of 2020, around 53 million smart meters will be fitted in more than 30 million premises (households and businesses) across Wales, Scotland and England.

The plan was to have different installation phases with the main installation phase starting in 2016. The majority of smart meters installed during the main installation phase were supposed to use the second version of the technical specifications SMETS 2 (Smart Metering Equipment Technical Specification), which have technical differences to SMETS 1. The plans stated that the "SMETS 1 meters will continue to be installed until 1 August 2017". Then it is expected that that "SMETS 2 meters will be installed from February 2017 until the roll-out is complete" but it's not sure this is happening yet. The main advantage of SMETS 2 meters is that they do not lock you into a particular supplier as they can be used in 'smart mode' if you Switch supplier. While the SMETS 1 meters revert to dumb meters if you switch to a different supplier. The rollout SMETS 2 meters is dependent on the Data Communications Company (DCC) which supplies the relevant IT infrastructure which was launched at the end of 2016 [SMR14].

Due to pressure to meet their 2020 deadline, energy suppliers say they are now forced to continue installing SMETS 1 meters despite knowing SMETS 2 meters are better. Energy Suppliers can't start rolling out the SMETS 2 meters until the new infrastructure is in place and the longer it's delayed, the more SMETS 1 meters will be installed. However the latest government information suggests that the bulk of the Smart Meters will be rolled out later than expected see Figure 2, below taken from Data Communications Company report published in August 2016. [DCC17]

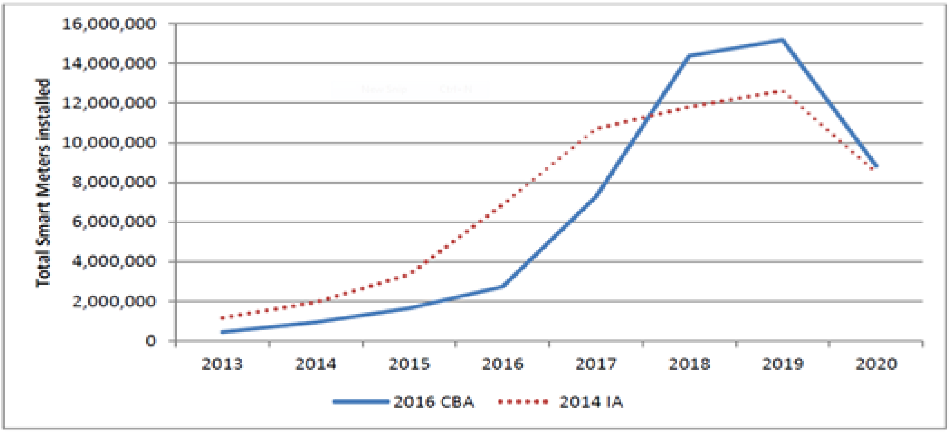


Figure 2. Timeline for the rollout of Smart Meters UK [Source www.gov.uk]

To reflect a continued policy expectation on suppliers to integrate changes in technology and consumer attitude into their roll-out efforts beyond the main installation stage of the Programme, current analysis assumes that smart meter deployment continues to grow after 2020 until a steady state is reached in 2022.

We believe that the introduction and strengthening of other energy supply companies (such as ESCOs and aggregators etc.) in the energy market will decrease the total cost of electricity. This is evidenced by the relatively recent introduction of Aggregators into the UK Energy Market. The UK is one of the most advanced in Europe when it comes to enabling the active participate of the entire value chain of end consumers, residential, commercial and industrial.

The government has made a concerted effort to create demand side products and programs within the wholesale electricity markets. This is now showing results with an increasing and active number of aggregators active in the markets: these include Enernoc, Kiwi Power, Flexitricity, Cpower and several more while the number continues to grow.

R&D Impact on Energy Innovation and Commercial Landscape

Figure 1, above, illustrates the UK governments increasing appetite for R&D investment in energy innovation. This was further emphasised with government announcements in late 2016 for a further £500m on energy innovation of which £250m was earmarked for micro nuclear. These investments are being managed through Innovate UK and directly through BEIS (The UK Department for Business Energy and Industrial Strategy). Both have been running competitive funding rounds with fairly strict scope and eligibility criteria.

These investments have stimulated a large amount of innovation manifest in the formation of a number of start-up companies, comprising a mix of university spin outs and those backed by angel investors. Broadly these can be categorised into the following sectors:

- Solar energy capture (Thin film PV, fabric PV, Solar thermal, PVT etc.)
- Energy storage (battery, phase change)
- Smart meters
- Energy management and demand response.

It's interesting to note that only a small investment has gone into new energy generation technologies, or improving heat pumps. The dominant theme has been in the digitisation of energy and energy management. This theme is also reflected in the funding provided by the Venture Capital market and Start up investors. For example energy management start up Origamie completed £13m pre-revenue funding mid-2016.

However we note the difficulty that most of these companies have in transitioning from start-up and getting their technology proven through to breaking into the market and building a sales pipeline. Most are promoting technologies with the potential for large scale renewable energy generation which require third party funding. This third party funding demands performance warranties and the like. Many small technology providers do not have the balance sheet strength to support such guarantees

Similarly although the government is keen to promote innovation, we find that the energy market is very risk averse. Energy is commodity and whoever can provide it the cheapest will get the business. Renewable energy and associated business models all have an initial high capital cost but with much lower running costs. We find that many customers strongly discount the value of future energy savings, or government subsidy. The initial capital cost becomes a hurdle for investors (as described in 3.3).

We are competing in a market in which the infrastructure investment in traditional energy sources (pipelines, power stations, electricity network) have been fully depreciated in a given energy price. While the infrastructure costs of renewables are fully carried by the new technology which inevitably puts them at a cost disadvantage to fossil fuel investments.

Capital costs are reduced when scale is achieved, but we need the low costs to break into the market in the first place.

We do not find the energy utility companies helpful in supporting innovative start-ups. This is not a surprise, as for the most part these start-ups are promoting business models that challenge the *status quo*. The utility companies use their dominant market presence to stifle any innovation. We have heard anecdotally that gas companies are providing gas boilers for free in order to secure customers to the gas network. Until renewables can compete on this basis, it's going to be hard work.

Still, there are also examples of UK Utilities acquiring energy start-up companies and subsequently failing to push forward or even sustain the innovation due to pressures from the slim margins of their commoditised core business (e.g. RWE/Npower acquired RUMM in 2015 and stifled). The best example of a successful acquisition is Matrix, who was acquired by Eon. Matrix were able to continue to innovate as they were left as a standalone business with little or no involvement from Matrix.

Overall conclusions regarding the R&D investment in energy industry in UK

In conclusion, the government does a lot to stimulate innovation, but does not support market access. In fact the innovations and technology exist today that can transform our energy mix to low carbon. The challenge is to deploy these technologies such that they become mainstream. We would rather innovation funds were focussed on deployment of existing technologies rather than developing new ones.

Pros:

- The UK government has invested a huge amount in Energy R&D
- This has stimulated a lot of innovation and new technologies and services.
- The liberalization of the electricity markets has opened the door to new business models and solutions.
- Customer engagement in both renewables and smart meters has been high.
- Government imposed deadlines on smart meter deployment has stimulated the market.

3.1.2 Spain

Electricity market

The electricity market in Spain has undergone a deep transformation in the last 20 years, because of two main elements: decarbonisation of the electricity system and the liberalization of the electricity market, which have not necessarily led to higher competitiveness in the sector.

The first element has been extremely important. The development of R&D policies, combined with a policy to increase the renewable energy share of the electricity market, created a structure of higher costs, though substantially improving the energy mix for Spain (Figure 3). This increase, together with an energy reduction trend caused by the economic crisis of 2010, imposed a strong weight on the electric system [IEA09].

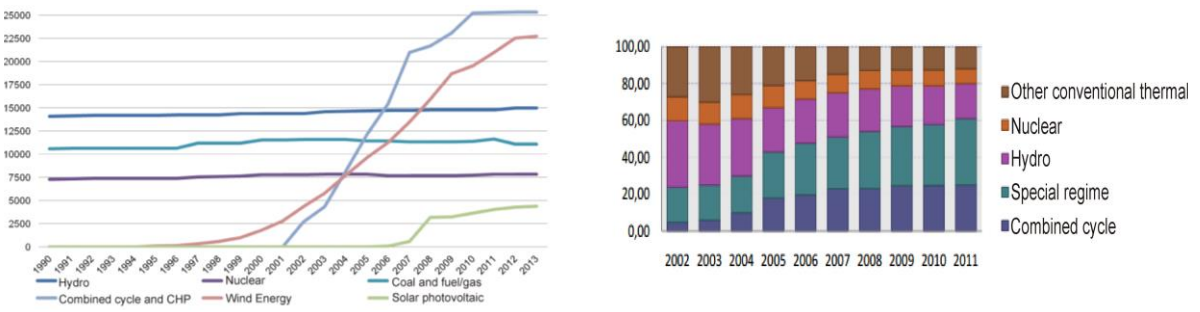


Figure 3. Energy mix evolution in Spain [REG12]

As a second point, it is important to state the historical consequences of a change in the market from 1998 (Law 54/1997), moving from a fully state controlled energy system to a liberalized system. Until 1997, the electricity supply was a regulated business. The government established the price the consumers had to pay, and thus the incomes of the electricity companies [REG12].

This liberalization has not brought a reduction in costs as initially expected. Users experienced greater than 80% cost increases. In Europe, only users in Germany, Ireland and Denmark pay higher prices for electricity.

The cost increase probably arose due to the poor regulation embodied in the legislation, and the structure of the electricity market in Spain, which is an oligopoly. As observed in Figure 4, 67% of the total generation capacity and 87% of the total electricity commercialization are controlled by 5 companies. The expected price reduction and cost optimization was not achieved.

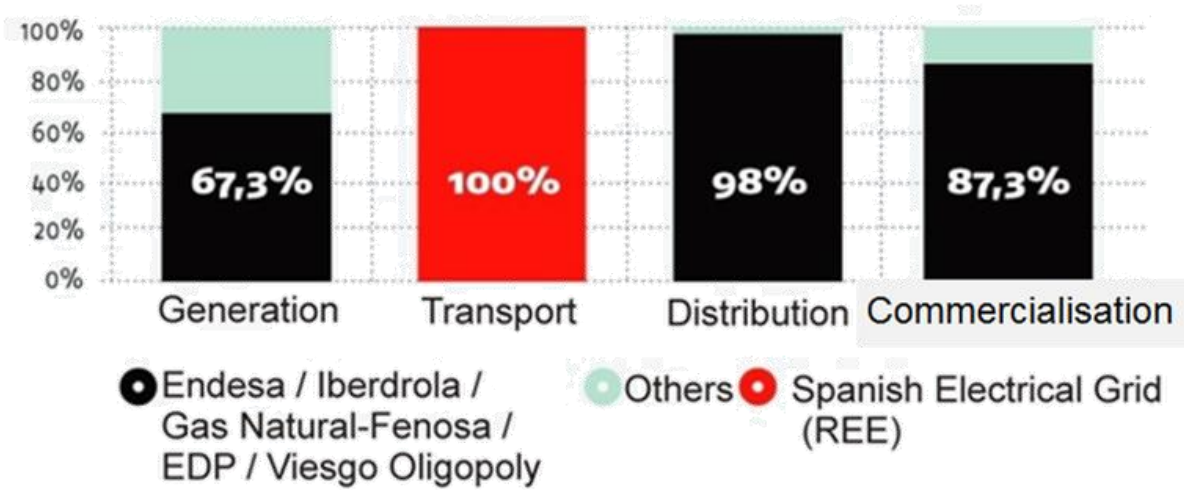


Figure 4. Structure of electricity market in Spain [Source: www.odg.cat]

The three mechanisms facilitating the transition from a regulated market to a liberalised market increased prices and did not help consumers.

The first was the cost of transition to the liberalised market (in which the companies had to fund to change their processes from the regulated market).The second was the tariff cap, through which the government established a regulated price. The DSOs, given their costs, required extra payment (converted into debt) from the administration. There were two main problems with this debt, i.e. it was unsecured and only covered part of the costs.

The second was the increase in the renewable energy production to accomplish the Kyoto objectives [KYP98], which implied a cost increase of the electricity production.

The third was the price setting mechanism, which made no difference between technologies. Big power plants that had had government investments, and with already amortised investments (hydro and nuclear mainly) competed under the same conditions as non-amortised installations. This market structure makes it quite difficult for new actors and new energy companies to enter the market, and the decrease in electricity cost is difficult. [ODG16].

Current structure of the regulated/non-regulated market

As a conclusion of the former, the legal and commercial structure of the Spanish electricity market is based on the separation between liberalised activities (generation and trading) and regulated activities (transport and distribution). Nevertheless, a part of the generation is under a regulated scheme (renewable energies, part of the national coal plants and the generation in islands).

In this aspect (regulated energy generation), a new decree (Real Decreto de Autoconsumo Energético 900/2015) supposed an important barrier for the inclusion of distributed generation on the grid, introducing strong barriers for the local production of solar PV and other small-scale renewable energies in the grid, via some taxes (cargo por autoconsumo) over the electricity produced by these sources and self-consumed by the user. Legal battles are taking place, some of which are resulting in changes of the legislation. As an example, one of the points of the decree, forbidding group self-consumption from the same generator, has been considered illegal by Spanish Supreme Court.

The regulated market is composed by a series of markets, where market agents buy and sell electricity. Most of the operations happen around the OMIE (Operador del Mercado Ibérico Español), where short-term operations take place. The geographical scope of the market is all the Iberian Peninsula, being Spain and Portugal an integrated market. It is all integrated in the Iberian Electricity Market (MIBEL) market.

As for the Smart Grid relevance in Spain, some measures have been undertaken in the last years. The most important one is the substitution of the conventional meters for smart meters. This substitution, in theory, had to be done in three phases, the first one with 35% of the meters to be changed between 2011 and 2014, 35% more between 2015 and 2016 and the last 30% between 2017 and 2018. Last numbers published, in the "*Informe de Seguimiento y Aplicación de los Datos Procedentes de Equipos de Medida Tipo 5 correspondiente al Segundo Semestre de 2015*" showed that at that moment, there were 14,4 million Smart meters (51%), lower but following quite closely the expected development.

Some barriers stop the Smart Grid development concepts in the Spanish electricity market. An important one is that in Spain, demand-side resources are not allowed to participate in the markets, or they are allowed to participate just in one programme. For example, loads can only participate in one specific scheme (interruptible contracts), which is rarely triggered. The rest of the balancing and ancillary services can only be accessed by generation. So the current flexibility of the Spanish electricity market is not very flexible.

Aggregation is not legal in the Spanish electricity system and there is only one scheme allowing Explicit Demand Response: the Interruptible Load programme. The scheme, which is reserved only for large consumers, is managed by the TSO, Red Eléctrica de España. The programme acts as an emergency action, in case the system is lacking generation and the balance resources are not enough. Though annual tests are conducted, this programme has not been called for consecutive years, raising questions whether it is a genuine interruptible load programme or a form of subsidy to the national industry. Proposals to open balancing services to Demand Response could lead to changes in 2016- 2018, especially given that a full smart meter roll-out is expected by 2018.

The legislation should include common rules for the internal market in electricity, in order to reflect the right value of flexibility and enhance participation of generators (conventional and RES), storage and demand response.

RES should be incentivized to obtain revenues based on participation in markets that would increase RES operational flexibility. RES should have full balancing responsibility and full participation in the provision of balancing and reserve services. RES support mechanisms should become more market compatible.

R&D in the energy sector

Energy R&D in Spain has received funds in the last few years, which placed the country in the middle of the Organisation for Economic Co-operation and Development (OECD) country ranking. Despite the step change in renewable energy investments (fostered by the feed-in tariff structure), and the development of renewable energy companies, the impact of energy R&D in Spain during 2000-2010 has been relatively low.

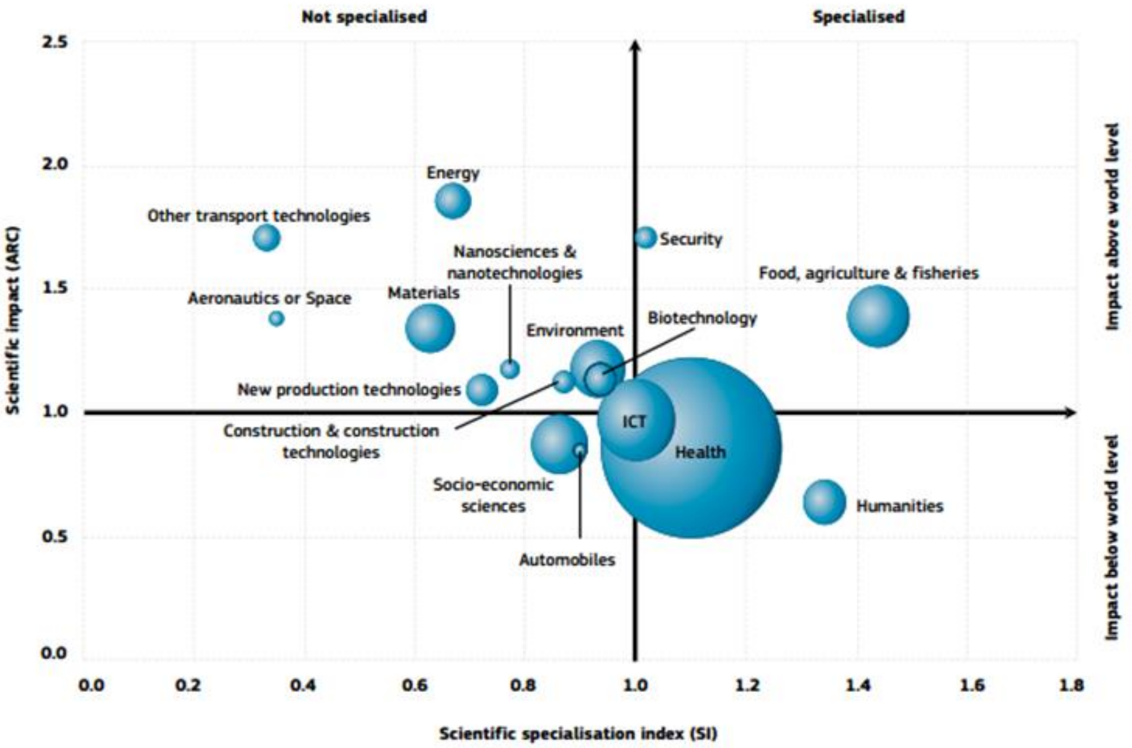
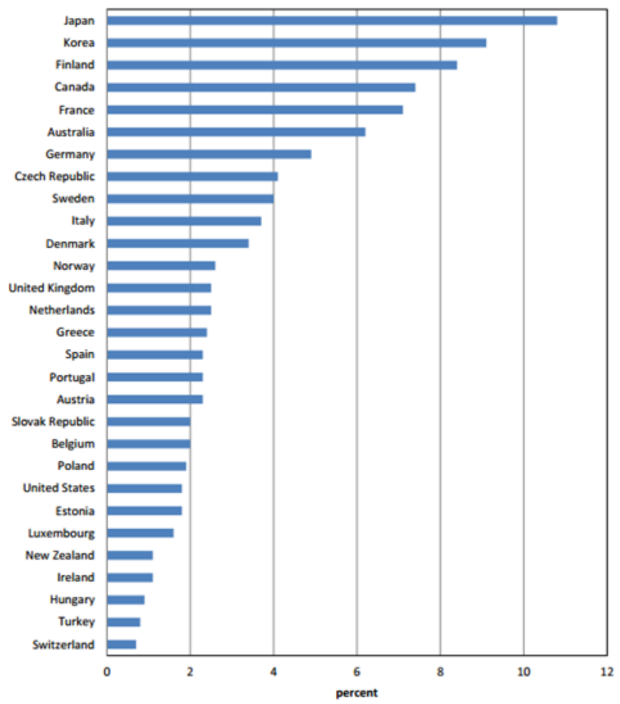


Figure 6 : Share of Energy in Total R&D in 2015



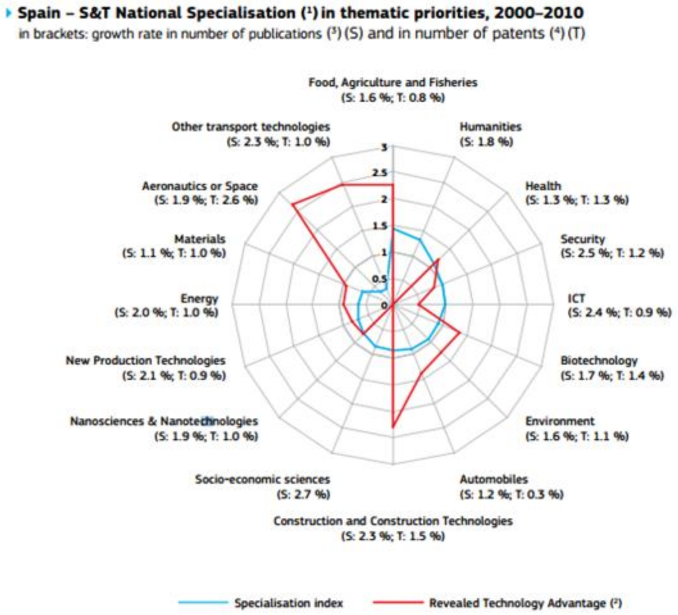


Figure 5. Level of energy investments and top priorities in Spain [Source: http://www.odg.cat]

Nevertheless, the rise *in regional technological centres dedicated to energy* in the recent years (CTAER, in Andalucía; Circe, in Aragón; the Instituto de Energías Renovables, in Castilla-La Mancha; el Instituto Tecnológico y de Energías Renovables, in Canarias; Ceder, in Castilla y León; ITE, in Valencia; Cener, in Navarra; el Centro Tecnológico del Medio Ambiente y la Energía, in Murcia, Tecnalia in the Basque Country, IREC in Catalonia, CARTIF in Castilla León and the Ciemat I IDEA in Madrid, amongst others) has pushed Spain to a very high rate of participation in the international programs of R&D in the European Commission.

Private companies have also led the pace to energy improvements. As an example, Gas Natural Fenosa, member of the inteGRIDy consortium, invested an overall sum of 59,2 Million Euros in technological innovation during 2016 [GNF16].

Referring to European Energy R&D specific activity, in the 2014-2015 program, Spanish entities participated in 124 of the 211 energy projects financed (58,8%). Moreover, within the 211 projects, 33 were coordinated by Spanish companies (15,6%) , totalling a 13,9% of the EU funds (2nd position after Germany). In the recent 2016 program, Spain decreased its participation to 10% of the funding made available by the European Commission [KEY16].

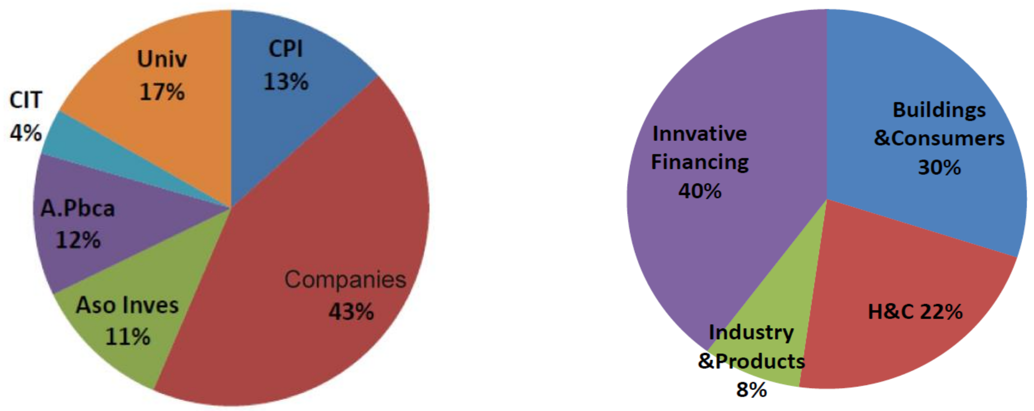


Figure 6. Investment roadmap in Spain [Source: Preparación WP2018-2020 ENERGIA H2020]

Customer engagement

Given the current market structure, the customer engagement has been difficult. The dominant position of the five firms in the market and the growing concern of the Spanish citizens towards these companies, means that cooperation between customers and companies is not usually welcome.

However, some interesting initiatives have started, driven by market liberalization, in which customers have become more involved and engaged in the electricity market.

The most interesting of these initiatives is probably Som Energia. Som Energia is Spain's first renewable energy cooperative. The organization sells electricity to its members, competing with the 'big' energy companies on the market. Som Energia produces their own renewable energy with relatively small scale projects, set up close to where their members live. They started as a small initiative focused around people at the University of Girona but soon spread towards Barcelona and the rest of Catalonia. Now almost 40% of their members live in other parts of Spain. Thirty local support groups have sprung up, holding regular meetings into the cities in order to explain the business model to other interested citizens. Their production/consumption model was based on an already well developed and successfully functioning REScoops in northern European countries such as Belgium (Ecopower) and Germany (EWS, Greenpeace Energy). The Som Energia cooperative is 100% owner of three limited companies. All projects are developed within these companies. Everybody invests within the cooperative, based on general criteria agreed on by the General Assembly, selects the projects and makes the investments. All members share the results [RES16].

Overall conclusions regarding the R&D investment in energy industry in Spain

The electrical market in Spain, with a very centralised structure under a strong oligopoly of distribution is not an easy structure to integrate Smart Grid concepts. The legislation should include common rules for the internal market in electricity, in order to reflect the right value of flexibility and enhance participation of generators (conventional and RES), storage and demand response.

RES should be incentivized to obtain revenues based on participation in markets that would increase RES operational flexibility. RES should have full balancing responsibility and full participation in the provision of balancing and reserve services. RES support mechanisms should become more market compatible.

If this legal barrier is overcome, which should be the goal for Spain in the upcoming years, a lot of developments can be done, considering the R+D in the energy sector is significantly important and is obtaining important funds from European R+D programs.

Customer engagement, as well, is significantly increasing, and some interesting initiatives, like Som Energia, are happening in Spain, that can help the involvement of the final users in the future smart electricity grid.

3.1.3 Italy

The electricity sector in Italy

In the 2015 the Italian Ministry of Economic Development (MISE) presented a report on overall evolution of energy sector in Italy.

Looking at the intensity of public spending on energy research, in 2013 Italy allocated 250M€ for financing these activities, 150 M€ more than the 2007, reaching a total amount of the Italian public and private expenditure for energy research and development of 785 M€; 39% of this total amount represented by privately-owned companies, 36% issued from public institutions and 25% issued from controlled public companies [MSE15].

Table 1, below, summarizes the amount spent from 2007 to 2013 in Italy for R&D activities in different energy research sectors.

Table 1. Spending on R&D for energy research areas (in k€) [Source: http://dgsaie.mise.gov.it]

	2007	2008	2009	2010	2011	2012	2013
Energy Efficiency	64.534	99.658	154.100	183.894	173.130	192.038	243.092
RES	73.925	83.499	133.596	136.700	165.061	180.260	151.143
Oil, Gas and Coal	158.675	116.311	112.979	115.077	106.238	91.348	135.223
Nuclear Fission and Nuclear Fusion	75.707	63.820	79.724	81.497	92.982	96.996	99.209
Other Technologies	69.117	94.086	115.365	92.733	61.893	81.722	73.788
Energy Conversion, Distribution, Transmission and Storage	40.065	41.082	64.181	63.699	48.754	54.597	61.499
Hydrogen and Fuel Cell	29.810	48.102	55.984	39.006	31.943	23.427	21.601

Data reported in Table 1, above, show that in 2007 fossil fuels excelled with more than 158M€ spent in technology development, however, from 2008 to 2012 investments on fossil fuels decreased by 40%, while investments on energy efficiency increased by 200% and investment in renewable energy rose by 150%. Moreover in 2013, comparing with the year 2012, Italy assists to a further increase of investment in energy efficiency of 25%, a decrease of investments regarding renewable energy of 15% and a rise in investment on fossil fuels by 50%.

A consistent part of the interventions in Energy Efficiency regarded investments supported by DSOs in order to upgrade existing 1st generation smart meters with the deployment of the 2nd generation meters. These new smart meters allow to improve power monitoring enabling more efficient control and management policies [AEE17].

As for e-mobility, on 9 March 2017, the Italian Government allocated around 27 M€ for expanding the electric vehicle charging infrastructure in Italy [DIR17].

In conclusion, a monopolistic situation for the electricity technical aspects and a competitive situation for the electricity market aspects is currently in force in Italy.

Beyond allocation of financial resources for investments, in recent years the various governments which have taken place in Italy, have followed a common strategy stimulating through financial and legislative instruments the promotion of R&D actions in the energy sector. In [CAP16] it is outlined the strategy depicted by Italian National Minister for Economic Development (MISE) for the promotion of technology Innovation in the Italian Energy Sector. This strategy intends to define financing support schemes ensuring economical sustainability for innovative solutions in accordance to European priorities programs as the Strategic Energy Technology Plan or Horizon 2020.

Moreover, in order to stimulate a profitable participation of both public and private entities in R&D activities, different organization have been created with the scope of sustaining investments in innovative technologies.

In 2008 was established in Italy the Energy National Technology District (Di.T.N.E.) participated by the main public and private entities in the national energy sector (CNR, ENEA, ENEL, ENIPOWER, etc.) constituted in the form of a consortium company. The main purpose of this entity is to foster scientific relationships and collaborations between research and industry systems, to strengthen the competitiveness and visibility of the industry in the international contest and to favour the qualitative growth of entrepreneurship and competences in the energy sector.

In 2012 the Italian Minister for University Research and Innovation (MIUR) promoted the creation and development of the National Technology Clusters (NTCs) according to the guidelines of the Horizon 2020 Framework Programme. NTCs are open and inclusive networks formed by the main public and private actors operating in national industrial research, training and technology transfer (businesses, universities, public and private research institutions, start-up incubators and other innovation actors). Each NTC focuses on a specific technological and applicative field considered strategic for the country, representing the most authoritative entity in terms of skills, knowledge, structures, networks and potential. The main objectives of NTCs include:

- the mobilization of the excellence of the industrial and research systems and public administration on shared, priority and strategic issues for the Country;
- the sharing and transfer of knowledge and skills;
- the optimization of public money while improving the ability to attract private investment and talents by favouring the Country's economic development.

With regard to the private sector, a key role to play in implementing energy efficiency technologies is covered by the Italian Federation for the Rational Use of Energy (FIRE). The FIRE is an independent and non-profit technical-scientific association whose purpose is to promote the efficient use of energy supporting institutional activities and services provided to those players operating in the energy sector through the development of an effective legislative and regulatory framework. The FIRE involves various stakeholders of the energy sectors: technology providers, service and engineering companies, energy managers, ESCOs, medium and large-scale end-users, professionals and people interested in sustainability. The main objectives of its activities are:

- the promotion of good practices for energy efficiency, renewable energy use and sustainability;
- the analysis and study of the various issues related to the use and generation of energy;
- the qualification of energy managers and ESCOs;

The ESCOs in particular are subjects that play a key role in spreading energy sector interventions by reducing the risk of investment through the mechanisms of third-party financing and EPC (Engineering Procurement Construction) contracts.

According to the latest Energy Efficient report by Energy & Strategy Group, in Italy there are 272 ESCOs certified UNI CEI 11352 (+90% on 2015), with 3bn€ of overall annual revenues. The framework is still highly fragmented, with a predominance of small companies with small margins (around 66% of the ESCOs have a turnover less than 11M€, with an EBT minor to 625.000€).

The Italian ESCOs can be clustered in relation to their target market into 3 main groups:

1. the industrial ESCOs, who operates in industrial buildings with production plants. They represent the 15% of the total ESCOs
2. the “buildings” ESCOs, who mainly operates on tertiary buildings (public or private), representing the 18% of the total number
3. the “full scope” ESCOs. They represent the remaining 67% of the total number and realizes interventions on both industrial and tertiary sector.

- Role of the energy regulator in Italy

The Italian Authority for Electricity Gas and Water System (AEEGSI) is an independent body established by national law no.481/95. Its main function is to protect the interests of consumers and promoting the competitiveness, efficiency and diffusion of services with adequate levels of quality through regulation and control.

The scope is the development of competitive markets in electricity, natural gas and water through tariff regulation, network access, market operation and end-user protection. The Authority also carries out an advisory role with regard to Parliament and the Government to which it may make representations and proposals. In addition, through intense collaboration with regulators from European and extra European countries, it promotes integration with neighbouring energy markets and achieves the goals of effective and efficient operation of the domestic market.

Concerning the regulatory framework on storage, Smart Grid, smart metering and e-mobility AEEGSI (Italian Energy Regulators) with its resolution 136/2004 stated an essential prerequisite for an effective energy ecosystem evolution: the idea of a non-discriminatory access to electricity networks. Within the Italian Electrotechnical Committee (CEI) a technical working group, composed of all stakeholders, was specifically constituted with the objective to define technical standards regarding connections to MV and LV distribution networks (today Technical Committee 316). The work of CEI led to the definition of a single set of connection requirements, valid for all the Italian DSOs, standard CEI 0-16 for MV distribution networks, issued in 2008, and standard CEI 0-21 for LV distribution networks, issued in 2011. Recently, such standards has been updated (from 2013 to 2015) in order to regulate Smart Grid services and Energy Storage Grid Integration.

With respect to the Smart Meter, Enel Distribuzione (the main Italian DSO) launched the Telegestore project in 2001, with the objective to build a comprehensive automated metering infrastructure. In 2006 AEEGSI foster smart meters deployment, adopting Telegestore project as a reference point. Consequently, in Italy, 32 million electronic meter are today in place.

The most impacting DR initiative was in 2010, with the mandatory introduction of a Time of Use (ToU) tariff for all LV customers, resulting to be the largest price-based DR project on the LV users. Today AEEGSI is working on the second generation of meters, identifying new services that might benefit consumers and, from these, deriving the technical characteristics that the new meters shall include.

Moving to e-mobility, the Italian regulatory authority took the official position that developing EV public recharging infrastructure is not part of a DSOs' licences. This has two consequences: first, DSOs should not have an exclusive role in developing recharging infrastructures, apart for providing the connection, second, the costs of building the infrastructure should not be managed by DSOs.

Overall conclusions regarding the R&D investment in energy industry in Italy

The following bar chart shows the data reported in Table 1, above, distributed by typology of investments in R&D for the energy sector for the period 2007-2013.

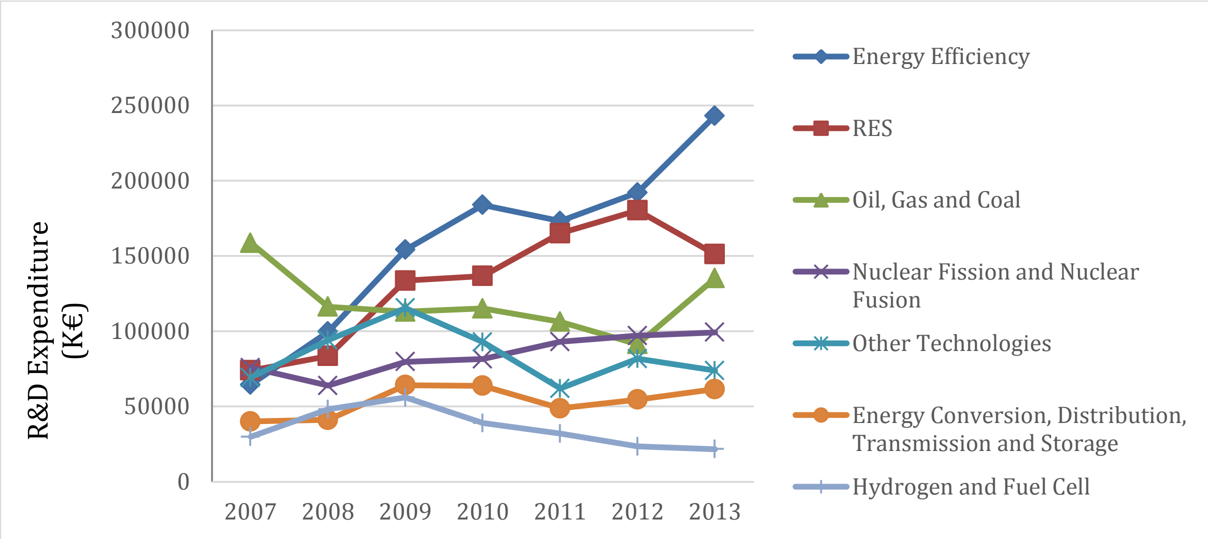


Figure 7. Distribution on R&D Investment in Energy sector for 2007-2013

Figure 7, above, shows that during previous framework programme, the most significant growth of investments was associated to energy efficiency and RES technologies. A more Gradual investment growth also involved nuclear technologies and energy conversion, distribution, transmission and storage systems. On the contrary, investments in Oil Gas and Coil decreased during the same observation period with exception for 2013. Finally, as regards Hydrogen and Fuel Cell technologies after initial investment growth, these technologies have experienced a slowdown after 2009.

In addition to investments in recent years Italy has started a virtuous path, based on Community directives, to strengthen the involvement of all actors in the energy sector through the establishment of organizations with the objective of promoting technology transfer, the dissemination of best practices and creating a favourable environment to attract private investments.

Considering legislative and regulatory aspects, in past years Italy has undergone a transitional process to promote the liberalization of the energy market through the creation of a market system supporting effective and transparent competition while favouring technological development.

3.1.4 Portugal

The electricity sector in Portugal

Starting from September 2006, the electricity sector in Portugal is fully open; all consumers are able to choose their electricity supplier. Entidade Reguladora dos Servicos Energeticos (ERSE) regulates the electricity and natural gas sectors and ensures customer protection.

The reduction in utility costs and the penetration of renewables have been the main trends in Portuguese energy policy.

The main driver of this policy is to comply with low carbon targets and to reduce energy import dependence and maintain an appropriate security of supply. Feed in tariffs is the method for renewable energy promotion, and, is one of the reasons for the economic un-sustainability of the energy system. There is a "tariff deficit", i.e. a shortfall of revenues in the electricity system because retail tariffs are set below their costs, including subsidies to renewables. [ENP16] This is creating stress in the energy sector, slowing or even blocking new public initiatives in innovative energy support to investment.

In this context, the private sector does not have any incentives to invest in innovative energy technologies. There is not a sustainable economic case for investing in innovative technologies. Despite this unfavourable environment for investment in energy in Portugal, there are still strong energy policy objectives. Private interest for investment has started growing, in renewable energy, with new photovoltaic plants, wind and hydro retrofit projects, and in the energy efficiency.

In Portugal, the investment in R&D is generally low, and the value of R&D spending is less than 8 million euro per year.

The National Energy Strategy for 2020 [ENE20] contains a commitment to invest in formal energy research and R&D, consistent with energy policy and the broader economic goals. Leadership and responsibility for delivery of the strategy will be provided by the Ministry of Environment, Spatial Planning and Energy in collaboration with other ministries, third-level institutions, the private sector and state agencies. The ENE 2020 R&D policies are aligned with the European policies for energy and climate change, engaging the FCT (Foundation for Science and Technology) and the Directorate-General for Energy and Geology (DGEG), setting,

The FAI (Innovation Support Fund) is another public effort that supports innovation, technological development and investment in renewable energy and energy efficiency areas. To achieve the energy targets there are two important plans that define the energy policy in Portugal.

1) National Renewable Energy Action Plan (NREAP)
2) The National Energy Efficiency Action Plan NEEAP,

Examples of projects supported by FAI are: renewable energy and on energy efficiency technologies through energy efficiency demonstration project like Smart Grids, efficiency in buildings, transports, Mobi.E (national electric mobility network), Windfloat (floating offshore wind platforms), solar generation (concentrated solar power or CSP) biofuels, energy management technologies and energy efficiency technologies in transport

The investment in research infrastructure is limited, under 2 million euro. Even though, successful projects like Smart Grid and Electric Vehicle Laboratory at the INESC TEC/FEUP at University of Porto (recognised as Excellent by the Ministry of Education and Science in Portugal), and the Research Infrastructure on Integration of Solar Energy Systems in Buildings at the National Laboratory for Energy and Geology (LNEG) (LNEG was the first Portuguese institution to be awarded Excellence logo on Human Resources Research by the European Commission).

Most of the research programmes in Portugal are open to the participation of the private sector.

It is not possible to quantify the research investment from the private sector but it will be near 50% of the total research investment. Private research is mostly done in collaboration between energy sector companies and the research national institutions. This collaboration aims to foster technology and innovation in national energy sector, helping to reduce the time to reach the market for the new energy technologies.

The encouragement for investment in innovation in Portugal is being done mainly from the supply side of technology development, through technology-push. This is a risky approach, because in many cases the results do not match market need and legislative support.

Considering the Smart Grid implementation in Portugal, the initiatives are restricted to few pilot financed by EU projects. The distribution sector in land Portugal is a monopoly and there are no opportunities for new companies or for municipalities, other than the DSO, to innovate in technologies or business related with the distribution grid.

All the innovation in Smart Grid, including the smart metering, must therefore be an initiative from the DSO. Thus initiatives for innovation will be triggered only by the DSO if the projects are economically viable or if there is a public financing and if there are obligations imposed by the regulator.

Despite this monopoly, the DSO is undertaking some important smart grid initiatives in Portugal. The transition to a smarter distribution grid is led by EDP Distribuição, the Portuguese DSO, starting in 2011 with the InovGrid project. This developed and implemented Smart Grid concepts and technology. The InovGrid project developed and installed smart grid equipment, smart meters, controllers and information systems. These have been rolled-out in a Smart Grid infrastructure in the Portuguese municipality of Évora, for 32 000 electricity customers.

According to EDP (Energias de Portugal) the outcome of this project demonstrated the benefits of Smart Grids, strengthening the interest in this business opportunity. The DSO is currently deploying the second-generation of smart meters for 100 000 customers throughout the Country, with the objective of developing the supply chain and improving the integration with existing business processes. The project is in-process for a future roll-out (currently the project is pending due to the government/regulator decision).

Overall conclusions regarding the R&D investment in energy industry in Portugal

Overcoming the barriers for investment in smart grids could be done based on the following strategies:

- Use public financing, from user tariffs, to finance the DSO to install smart grid equipment in the grid. Giving the actual situation of effort for reducing the “tariff deficit” in Portugal is not probable that this option will occur in Portugal.
- The DSO could invest in the Smart Grid technologies their self, if there are a real viability and direct economic benefits for the DSO in the grid operation. The real benefits could be difficult to evaluate in monopolistic operation, costs in losses and quality of service depend on the obligations imposed by the regulator. New services from Smart Grids could be explored by the DSO, but the new business opportunities need to arise from the clients of the grid. Some pilots of Smart Grids are been explored in Portugal in this context.
- Change the monopolistic model of the DSO, opening the concessions to new companies, small regional companies or municipalities. This will diversify the services provided at level of distribution, creating a competitive environment that could incentivize to integrate innovative solutions, but this is a disruptive change without guaranty of success. This is an option that is being studied by the regulator in Portugal.

- Create new grid codes by the regulator, opening opportunities for new business opportunities in the distribution grid. The new business opportunities could be driven by performance indicator converted in price signals, managed by the DSO, triggering a dynamic response from the client side. These performance indicators could be related with power or energy losses, power flow, voltage regulation, frequency response, demand response, storage response, etc. This approach, is a simple market base approach, not requiring changes in the DSO concessions, and motivating at same time the DSO and the users of the grid. This is an option with good potential to be explored in Portugal.

3.1.5 Greece

The R&D investment in the Greek energy industry

The Greek electric grid is not ready to adopt the inteGRIDy's innovations. The main obstacles are the coal consumption which has to be reduced and the monopoly of Public Power Corporation.

The indigenous coal fields have a dominant place in electric power production. For many years, coal was an easy low cost option, due to surface coal mines. The main disadvantage of coal power plants is the production of huge amounts of greenhouse gasses After Kyoto protocol [KYP98], Greece had to take actions in order to reduce CO_2 emissions. The Greek government offered economic incentives for establishment of renewable energy systems. Governmental programs subsidized energy production from "green" technologies (RES) through favourable energy pricing using a feed-in-tariff [IOT17].

The Regulatory Authority for Energy (RAE) is an independent regulatory authority, established by L.2773/1999, in the framework of 2003/54/EC and 2003/55/EC for electricity and gas, respectively. RAE is responsible to oversee the domestic energy market, by recommending to the relevant state bodies to achieve the goal of liberalising the electricity and gas markets. The role of RAE as national energy regulator has been upgraded in 2011, enhancing and strengthening its responsibilities for the regulation of the electricity and gas markets. The additional responsibilities the RAE requested from Third European Energy Package, obligates national energy regulators to be "guarantors" of a proper functioning energy market. Briefly the responsibilities of RAE are:

- Monitoring and supervision of the energy market
- Consumers protection
- Monitoring the security of Country's energy supply
- Licensing of energy activities
- Supervision of Independent Transmission Operators
- Approval of non-competitive invoices
- Exemption from third party access obligations
- Monitoring energy interconnections
- Take regulatory measures for the proper functioning of energy markets

The Public Power Corporation (PPC) was the only electricity company until 2001. After the spin-off from PPC, SA the Transmission and Distribution sectors, two 100% subsidiary companies of PPC SA, ADMIE SA (Independent Transmission Operator of Electricity SA) and DEDDIE SA (Hellenic Electricity Distribution Network Administrator SA) were created. ADMIE SA is responsible for the management, operation, development and maintenance of the Hellenic Power Transmission System and its interconnections. DEDDIE SA is responsible for the management, development, operation and maintenance of the Greek Electricity Distribution Network.

The First Memorandum [DGE10] in 2010, as a result of economic crisis in Greece, forced the Country to take crucial measures in order to create a competitive environment in energy market. Until now, PPC owned the 94% of Greek market and the commitment of the first memorandum was PPC to have about 50% of the market share. Now, there are more than ten electric energy providers in Greece. Recently, a market share of PPC also claimed by the ex-public utility companies (ELTA, EYDAP, OTE) who enter on the electricity market. Unfortunately, even the entry of ex-public utility companies in the energy market does not seem to be an effective way to reduce the PPC's market share until 2020.

The RD&D investments in the Greek energy industry and institutions

To overcome the problems in the Greek electricity market and network over the last decade, the development of innovative solutions is of high importance. The number of RD&D (Research, Development and Demonstration) projects was just above the European average. Greece is pioneer in Smart Grid Demonstration & Deployment among European countries. In Figure 8, below, the budgets for R&D projects (green line) and for D&D projects (red line) are shown, as well as the cumulative amount of them (blue line) [POM16].

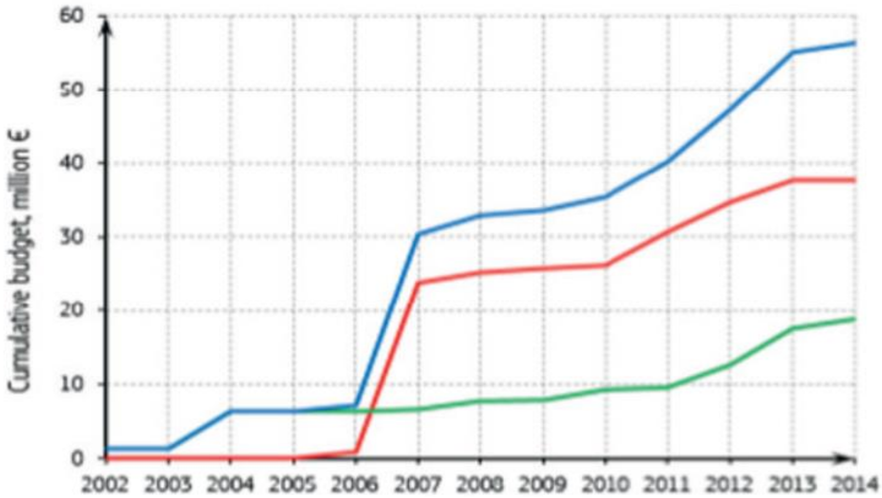


Figure 8. The cumulative budgets in million Euros from 2002 to 2014. Green line stands for Smart Grid R&D projects, red line for Smart Grid D&D projects and the blue one for the cumulative amount of the other two [Source: IEEE.org IEEE Xplore Digital Library]

The priority of publicly funded energy R&D in Greece were given in:

- Electricity production from renewable energy sources
- Fuel production from renewable sources
- Use of renewable sources for heating and cooling
- Hydrogen and fuel cells
- Clean coal technologies
- Smart energy networks
- Energy efficiency and conservation
- Support of policies

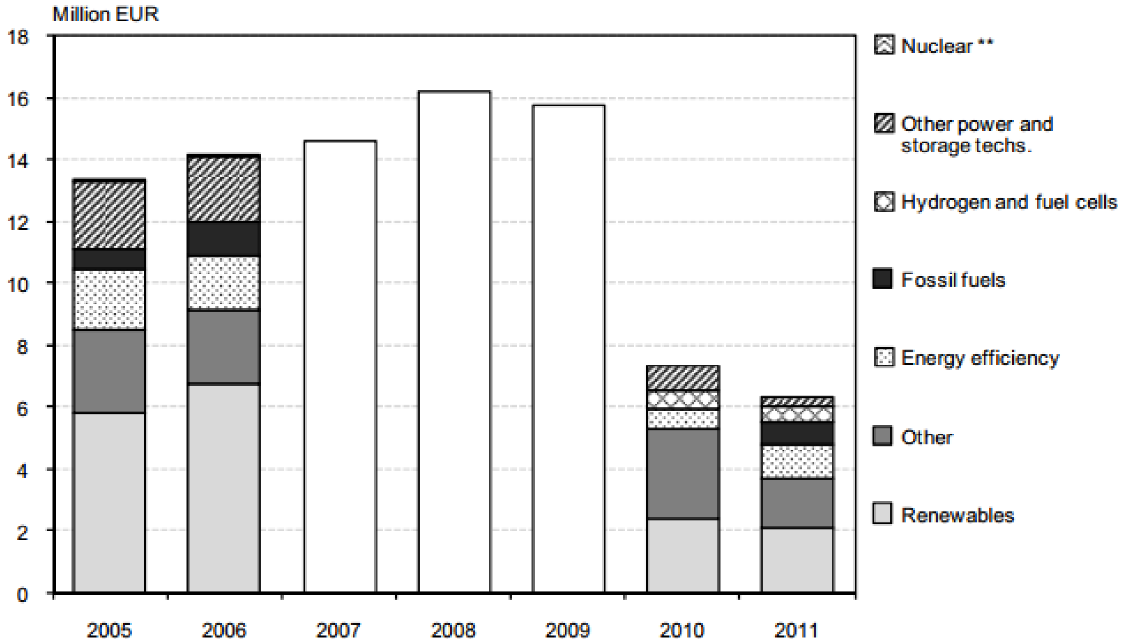


Figure 9. Greek government spending on energy RD&D, 2005 to 2011 [* Estimates for 2010 and 2011. ** Negligible. Note: breakdown by sector is not available for 2007, 2008 and 2009. [Sources: OECD Economic Outlook, OECD Paris, 2011 and country submission]

The General Secretariat for Research and Technology (GSRT), which belongs to the Ministry of Education, Lifelong Learning and Religious Affairs, is the main authority responsible for the development and implementation of R&D in Greece. GSRT supports the R&D activities of public research centres, universities and private sector through national programmes. The main research performers, in the field of identifying specific energy R&D policy priorities and implementing energy R&D research activities, are two public research centres, (i) the Centre for Renewable Energy Sources (CRES) and (ii) the Centre for Research and Technology Hellas (CERTH), but also the Country's 22 universities. Universities and public research centres are responsible for around 70% of total spending on all R&D (not only on energy), while the private sector share, is around 30%, and it is one of the lowest among the IEA and OECD member countries.

For the promotion of public-private partnerships, GSRT invested funds from Third Community Support Framework in:

- Introduction of the Technological Platform on Biofuels
- Introduction of the Technological Platform on Energy
- Promotion of research, development and innovation (RD&I) partnerships in areas of national priority

Smart Meters in Greece

According to European Commission requirements, Greece has to replace 80% of meters with smart meters by 2020. By a Ministerial Decision published on ΦΕΚ Β' 297/2013 in February of 2013, decided to:

- DEDDIE SA to take over the meters replacements
- begin the replacement by July 2014
- complete 40% of meters replacement by June 2017
- complete 80% of meters replacement by December 2020

The pilot project of DEDDIE SA includes the installation of 200,000 smart meters in homes and stores (170,000 mandatory and 30,000 optional). Now, the pilot is at the phase of competition for the smart meters. The total budget of the pilot project is €86.5 million euros. The study of the complete replacement of 7.5 million low-voltage meters will be based on the pilot and is going to cost more than 1 billion Euros. Until now, smart meters have been installed only to a small number of companies [FID17].

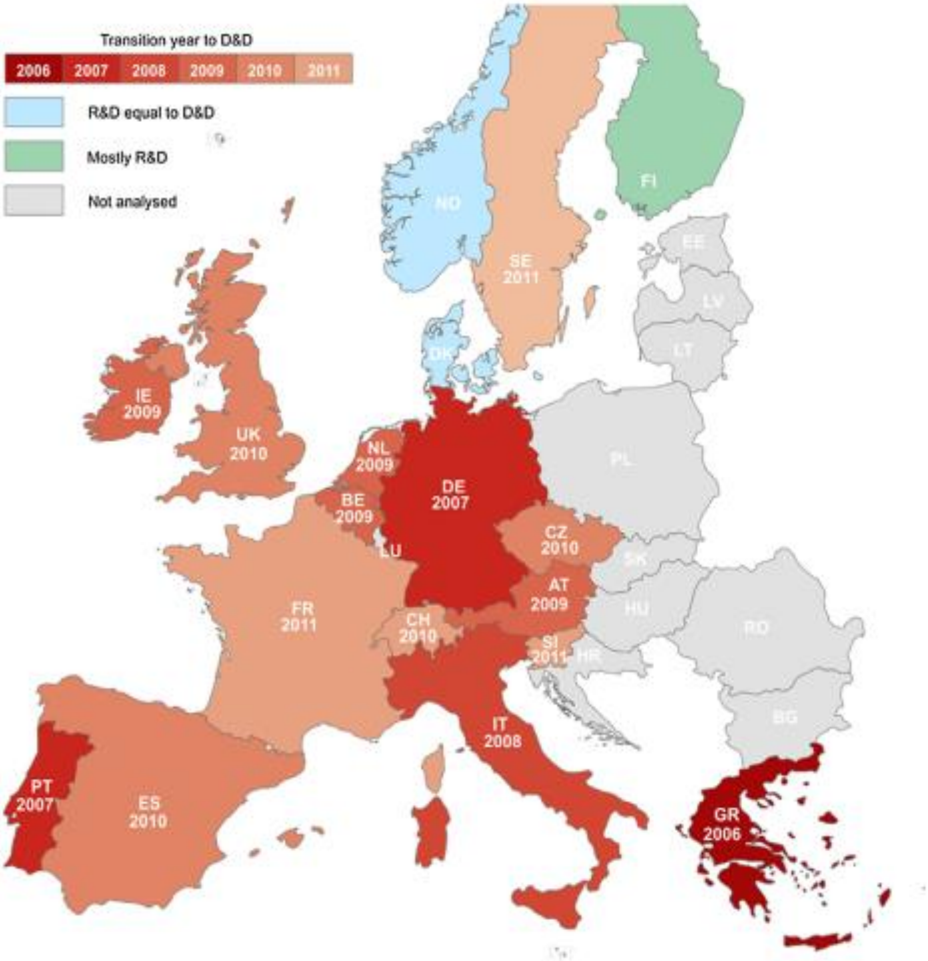


Figure 10. Estimated year when the Smart Grid sector made the transition from R&D to D&D phase [Source: Colak, Ilhami, et al. "Smart grid projects in Europe: Current status, maturity and future scenarios." Applied Energy 152 (2015): 58-70]

Overall conclusions regarding the R&D investment in energy industry in Greece

The R&D investment through the development of innovative solutions, gave impetus to an alternative electricity market and network in Greece. Different sources and methods in the production and distribution of electricity, such as renewable sources for heating and cooling, clean coal technologies, smart energy networks are only some of the subjects that focus in the development of innovative solutions for the future in the electricity field in Greece. Despite the fact that the implementation currently is restricted, it is expected to be widely used in the near future.

3.1.6 Romania

Romania has a population of approximately 19.51 million with a GDP of about USD 350,000 billions. Romania is a member of the European Union (EU) and as such is bound to comply with the EU energy *acquis*, which includes the improvement of the electric energy sector competitiveness, security of energy supplies and the protection of the environment.

Romanian electricity market

Since the beginning of the liberalisation process (2000 – the breakup of monopoles), OPCOM, the Romanian electricity market operator has administered *inter alia* the daily market. In 2005, a new spot trading mechanism (day-ahead market) Centralized Market of Bilateral Contracts (CMBC) was launched at OPCOM. This platform allows two-side bidding which will further ensure the best liquidity in Eastern Europe.

In 2007, by Governmental decision 638/2007 [GOV07], the market opened fully for both electricity and natural gas. On the competition retail market, suppliers sell electricity through bilateral contracts at negotiated prices or through standard offers.

At this moment 30% of the electric energy price is set by government (i.e. ANRE) and 70% is bought from the free market (bourse). Starting this year (2017) the government will set the price for only 20% of the electric energy and 80% will be set by the free market. By the beginning of January 2018 the price of electric energy will rely 100% on the free market.

Romania's market framework has one TSO (Compania Nationala Transelectrica SA), which also serves as the Balancing Market Operator; one Market Operator (OPCOM In 2015, in the Romanian electricity market have operated a total of 49 electricity distribution operators, from which 8 are serving over 100,000 customers. All 8 companies have completed the legal separation of the distribution activities of electricity supply. Electricity distribution operators with less than 100,000 customers do not have the obligation to legally unbundle the distribution activity from other company activities in accordance with Directive 72/2009/EC on common rules for the internal electricity market [NAR16].

In Romania there is not a large area of the energy legislation, considering that there are two major laws in force in this domain, updated in time (Electricity and Natural Gas Law no.123/2012 and Energy efficiency Low no 121/2014), which are not quite incentive for the stakeholders to begin the process of analysis and implementation of Smart Grid systems.

Although there is a project plan proposal, which implies regulations and provisions, it hasn't yet been approved by Romanian Energy Regulatory Authority (ANRE). The project plan proposal is on ANRE's priority list and planned to be approved by the end of June 2017.

The above mentioned Plan provides high important elements concerning the smartening electricity as:

- The National Plan of Smart Grid Implementation
- The General Smart Grid Architecture
- The Smart Meters Functionalities
- The Smart Meters interoperability with the existing measurements systems
- The personal data security and population health security
- The Evaluation and monitoring of the Smart Grid implementation
- Dissemination among the consumers.

R&D investments in energy sector

Romania is not part of International Energy Agency (IEA) and therefore the details on the energy investment are not published. The Organization of Economic Coo-operation and Development (OECD) statistics platform has published details concerning the investment in energy until 2013.

Table 2. Dataset: Gross domestic expenditure on R-D by sector of performance and socio-economic objective in NABS2007

Country	Romania							
Measure	PPP Dollars – Current prices							
Unit	US Dollar, Millions							
Year	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Sector of Performance								
Business enterprise		29.635	50.462	35.002	No data			
Government		26.808	22.508	14.98	30.336	9.064	29.98	
Higher education		23.994	1.725	0.87	1.154	2.19	2.613	
Private non-profit		0.043	..	0.084				
Total intramural		80.48	74.696	50.952				

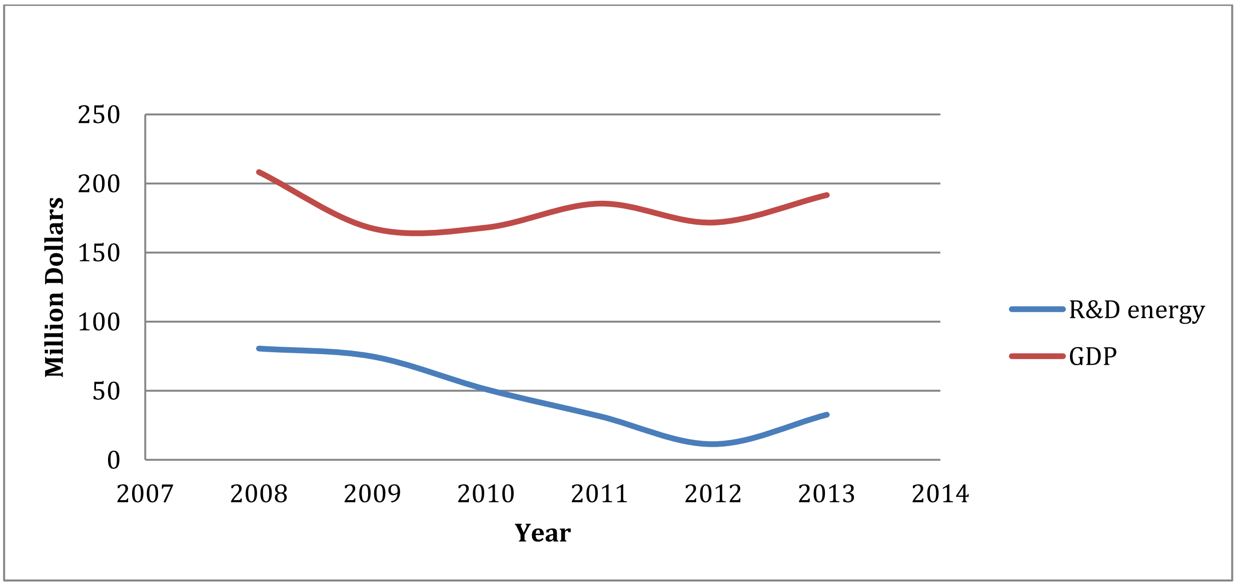


Figure 11. Romania public spending on energy R&D 2008-2013 vs overall GDP [Data extracted on 24 Apr 2017 16:42 UTC (GMT) from OECD.Stat]

As shown in Figure 11, above the investments in R&D energy sector dropped down in the economic crisis period and since 2012 it follows closely the curve of GDP even though it remains very low.

The signature of the Partnership Agreement 2014-2020 offers a potential infusion of funds dedicated to the energy sector through the Large Infrastructure Program (POIM) that has three energy-dedicated axes:

- Axis 6 – Promotion of the clean energy and energetic efficiency regarding sustainability of low carbon emission economy – allocated funds: 197.329.787,00 Euro
- Axis 7 – Growing the energetic efficiency of the centralized heating system in chosen cities – allocated funds: 249.478.723,00 Euro
- Axis 8 – Smart and sustainable systems for electric energy and natural gas transport – allocated funds: 68.026.596.00 Euro.

Emergent structures/companies in energy sector: ESCOs, aggregators, clusters, think tanks

In the latter half of 2014 in Romania there was also initiated an ESCO Project – EBRD Pilot project financed GEF) that aims at opening the market for ESCOs.

In Romania there are now around 30 ESCO companies most of them small and only few large companies. ESCO companies offer integrated solutions that may decrease energy spending and they are remunerated for the performance of the implemented solutions. They support investments in energy by facilitating the communication with partners and stakeholders; if on the traditional mode, a client must contact entrepreneurs, equipment producers, planners, energy suppliers, legal and financial institutions; in the ESCO mode clients have only one communication partner that intermediates the communication with all the other partners and offers tailor-made services. In this way, the customer shifts the technical/economical risk to the ESCO. In Romania this type of service is called EPC (Energy Performance Contracting).

Romania has also founded a Cluster (ROSENC CLUSTER) for energy domain in order to promote Romania as a leader in the renewable energy sectors, energy efficiency and the new sustainable energy. In this cluster are registered several types of members, which are interacting through three working groups (Energetic efficiency, Photovoltaic, Biomass).

Smart meter roll-out

In September 2012, A.T. Kearney, commissioned by European Bank for Reconstruction and Development (EBRD), released a market feasibility study on Smart Metering in Romania. This study indicated that implementation of smart metering in the electricity sector has a potential to be a profitable investment thanks to benefits coming from reduction of grid loses and reduction in the operational cost at utilities [ATK12].

Following this study, Romania adopted a policy of regulation driven introduction of smart meters and started the implementation of a large project in order to meet the European Commission requirements that by 2020 80% of customers are expected to be equipped with smart metering system and mentioned a full roll-out by 2022.

In March 2017 the National Plan of implementing Smart Metering [ANR17] (not yet approved) was published by Romanian Energy Regulatory Authority (ANRE) and the rollout was adjusted.

Starting with 2017 the requirements for starting the national plan for Smart Grid implementation in Romania were established and so was the implementation calendar.

The national plan for Smart Grid implementation will last ten years, starting with 2017.

The Romanian Energy Regulatory Authority (ANRE) will approve the Smart Grid implementation plans for each concession zone of the energy distribution service.

The national plan for Smart Grid implementation will run in two stages:

- **Stage I:** 2017– 2020. In this stage the DSOs will respect the following requirements:
    - Until 2020, in each concession zone of the energy distribution service will be installed smart meters for at least 30% from the total number of consumers

- The smart meters' investment value in the first year of implementation won't exceed 10% from the total value of the annual investments' plan approved by ANRE
- For each of the following years from stage I the smart meters' investment values won't exceed 20% from the total value of the annual investments' plan approved by ANRE
- The above-mentioned percentage will be applied for the values of the annual investments' programmes of Smart Grid implementation which will be financed from own sources or borrowed sources.

- **Stage II:** 2021 – 2026. In this stage the DSOs will project the implementation rhythm so that, by the end of the last year of Smart Grid implementation, the percentage of the integrated consumers would achieve 100%.
  - The annual investments value for smart meters' implementation won't exceed 25% from the total value of the annual investments' plan approved by ANRE [NAP17].

Overall conclusions regarding the R&D investment in energy industry in Romania

The R&D investment in energy industry in Romania is mainly sustained by the transposition of EU directives and recommendations via opening the energy market, implementing Smart Grids and allowing the ESCOs and clusters to provide tailor made services to consumers.

Romania assumes the targets of EU-28 in energy efficiency via regulating smart grids and implementing the calendar of fully opening the energy market by 1st of January 2018 and allowing competition in this sector fully closed until 2012.

By 2026, the Smart Grids will integrate 100% of customers and the expected outcome is reduction of commercial losses and meter reading costs.

ESCOs and clusters are emerging structures that assess consumer behaviour, acts like communication facilitators and promises lower costs.

3.1.7. France

Energy market structure and R&D investment

Operators of public transmission and distribution networks are primarily concerned with the challenges of integrating renewable energy sources, developing new uses of electricity and controlling demand for electricity. New technologies must be put in place to modernize the electricity grids. In this context, the research and development work of the network operators will play a key role.

The importance of the modernization of networks has set up a framework on the tariffs for the use of public transmission and distribution networks (TURPE);

The Commission of energy regulation has thus accepted a significant increase in the R&D budgets of the French distribution and transport network, with an allocation of 56 million Euros and 27 million Euros in operating costs on average per Year, between 2014 and 2017.

The budgets allocated to R&D and not used by the operators are resituated to the users. This mechanism is intended to encourage operators to carry out the announced.

Smart Grids will change the activity of network operators, and even revolutionize it over time. These operators are offered to interact with new economic markets, especially from the world of information technology. They also valued their expertise to offer new services. Therefore, the identification of regular and non-regular activities will be imperative in determining the share of the investments in the networks to be borne by the routing tariffs.

Once the investments supported by the routing tariffs are identified, it will remain the optimal allocation to other services between consumers and producers. This reflection must take France's environmental commitments into account and not limit the integration of markets.

The smart grids sector represents a major industrial challenge for France with the creation of nearly 25,000 jobs and an estimated turnover of 6 billion Euros for 2020. The stakes of the export sector are also considerable. With a global market for Smart Grids estimated at 30 billion Euros in 2015 and an expected annual growth of around 10%.

This is why, in September 2013, the French President of the Republic launched the "Intelligent Electrical Networks" plan in France. This strategic reflection is intended to determine industrial policy priorities for France.

The 20 May 2014, Dominique Maillard, Chairman of the Board of Directors of RTE (National Transport Network) and project manager of the industrial plan, published the road map for this industrial plan.

This roadmap proposes the implementation of 10 actions, including:

- To deploy on a large scale in 2017.
- To organize the long-term strategy in 2020 to maximize the benefits of smart grids, double the turnover of this sector and sustain the share of exports.

Role of the energy regulator in France

The Energy Regulatory Commission (CRE) is responsible for the regulation of the energy sector in France. It ensures the proper functioning of electricity and gas markets for the benefit of the final consumer and in line with the objectives of the energy policy, in particular the objectives of reducing greenhouse gas emissions, and renewable energy production.

The mission of the regulator is the regulation of network activities. It is therefore confronted with the various challenges faced by current networks: massive integration of electricity production from renewable, decentralized and intermittent sources of energy, development of the electric vehicle, control of the demand for energy that allows consumer to become active.

In particular the CRE is involved in a number of actions:

- Action aimed at maximizing the spin-offs in terms of job creation and value for the community in the deployment of Smart Grids in France and abroad;
- Action aimed at the organization at a large scale deployment of smart grids in France.
- Action dedicated to strengthening the effectiveness of French action on standardization on Smart Grids.

Energy Regulators involved at EU level will have a central facilitating role to play in the deployment of Smart Grids by adapting the regulation.

Emergent structures (private, NGO, universities) sustaining energy innovative investment (e.g. Role of ESCO)

IT operators: Smart Grids are a way for IT operators to value and share their experience gained during the Internet revolution by building what they call "the Internet of electricity". They have a real know-how in the management and exploitation of very large quantities of data. They also provide software for monitoring consumption or provide hardware (servers, switches, routers, sensors, etc.).

Telecom operators: they will play a major role in the deployment of Smart Grids as they will provide the technologies needed to make the electrical system smarter. Moreover, with the large-scale deployment of Smart Grids and the multitude of associated applications, data flows between electricity distributors, suppliers and consumers will be very large, requiring communication networks capable of supporting them while ensuring sufficient safety and reliability.

Aggregators: Concretely, aggregators remunerate intensive industrial consumers who agree to reduce electricity consumption, by delaying some of their activities from a few minutes to a few hours. Suppliers then pay for this electricity demand smoothing service from the aggregator.

Overall conclusions regarding the R&D investment in energy industry in France

Following EU perspectives on sustainable development, energy industry in France is in construction since many years in order to reach the objectives:

- A suitable regulation in line with investments issues and in accordance with EU requirements;
- A political wish through R&D to deploy at a large scale on national territory;
- The generation of a new economy with new services and actors.

3.2 Obstacles and barriers to innovation in energy industry (CONs)

This chapter offers a broad DSO and energy utility companies perspective on the obstacles and barriers to innovation in energy industry. Thus, two DSOs (ELECTRICA and ASSEM) and two utility companies (INNED and WVT) have assessed the situation on the own country and provided details about the issues they faced in implementing their business models. The following key-points where taken into account:

- The role of DSO
- The advantages of introducing renewable in the distribution chain
- Used/evaluated smart meters
- The relevance for the obstacles and barriers in energy innovation
- The interest of participating in DR smart grid schema and providing ancillary service to network operators.

St-Jean Pilot, France

In France, the role of the DSO is to manage the grid efficiently. The quality of the services provided to consumers is the major priority. Grid outages are of high importance and this is why the monitoring of substations should help to give the best information in order to make the interventions faster and to fix the potential issues easily.

Today, the majority of Smart Grid projects are R & D projects, with few examples of massive deployment. However, the consensus is that funding needs are considerable.

In that perspective, investments must be careful. It would appear that progressive deployments can better control costs and capitalize on learning effects, compared to massive deployment plans. It is thus essential to reduce uncertainty through effective stakeholder cooperation.

From a more technical point of view, one of the first steps for the grid to become smart is the analysis of the needs for smart meters. Considering the full deployment in cities, it becomes essential to define who can support this investment.

The possible obstacle resulting from that is the high cost of investments in the field of smart innovation.

As a DSO, renewable energies on the grid have to be undertaken because there is in France a purchase requirement for these types of energies. That way the prosumer has the insurance to sell its energy generated.

The role of the DSO is the distribution of electricity and the maintenance of the grid; and if the advantage for a DSO to manage the RE (Renewable Energy) does not come in an obvious way, we have to focus on another important factor of quality, which are the energy losses along the grid. Indeed, the nature of RES makes them disseminated geographically and it could give the opportunity to have less routing on the grid to distribute the electricity from one point to another and then it would allow the grid to limit the losses.

Expected benefits from DR Smart Grid

Two points for smart meters could be considered:

- Smart meters could give a lot of indications on the consumptions characteristics. One of the main is the phases (3 phases and neutral) balancing in current and voltage. If for instance we are able to observe a current inside the neutral phase we could thus easily detect an abnormal situation and a direct loss for the DSO because a part of this electricity is not sold.
- Another point is on the services provided to consumers. Today electrical bills are done through an estimated value, which is controlled only two times in a year. Smart meters should allow making a precise energy consumption bill day by day, minutes by minutes, which is for everybody a mean to make a better forecasting of its consumptions.

There are several expected benefits from DR but it has to be noted from the previous points that the amount of data to be processed considering RES from multiple prosumers along with data from residential buildings as well as fault detection data on the grid are quite a challenge in term of normalization and harmonization.

We will implement Demand Response schemes in the pilot use case 5 in order to meet the optimum performance of the grid in term of production and consumption.

To do that, we need to consider:

- Consumption behaviour of the participants (residential and commercial buildings)
- Knowledge on our grid technical specification to be in line with the optimums timings of local RE production.

By performing these actions, the efficiency of the electricity distribution would meet the conditions to offer cost reductions.

If the implementation of the Demand Response strategy fits directly with the needs of the DSO, it has to be noted that the grid efficiency will automatically bring benefit to the users.

Indeed, savings due to the technical optimization will enable the consumers to make savings in their turn essentially by having on their bill the direct repercussions from the lower infrastructure investments done by the DSO.

Thus, DR strategy should bring attractive benefits for both stakeholders.

On the pilot 5 use case, Demand Response strategy aims at reaching the following objective:

- Implementation of Human-Centric DR in Buildings (control of HVAC and lighting loads without compromising building occupants' comfort and health) and VES (through the application of Power-to-Heat solutions)

One aim of the project is that the implemented technologies will not restrict the levels of home comfort. Moreover, we aim at using non-intrusive technologies which maintain the freedom of user choice even though limiting freedoms within acceptable boundaries might be considered, i.e. space heating is reduced at periods of zero occupancy.

From our perspective, data should be collected by DSOs that are close to the end user.

Considering consumption behaviour of the consumers for DR as well as communication technologies that have to fit with EU and national requirements on freedom and data privacy, we have here a possible barrier to innovation.

It is needed to give the solutions to better balance electricity in order to smooth over the peaks of electricity. Indeed the demand during peaks period are the most critical to manage for a DSO because it requires not only to have the grid infrastructures to absorb the power peak but also to have a precise forecast of these demands.

This strategy should give us the opportunity to make a better use of RES and thus contribute to the peak mitigation.

The grid in St Jean de Maurienne is totally ready to get the improvements in order to provide new services for both DSO and end users.

Overall conclusions regarding the obstacles and barriers to innovation in energy industry in France

Limits in the implementation could come from the following aspects:

- The cost of investments remains high.
- Indeed, smarts grids must be implemented throughout the grid and involve all the players in order to be effective.
- The other obstacle is the diversity of actors, because they have to develop various communicating systems with convergent logics. In addition, the data collected are complex to manage and store, given the large amount of information to be processed.
- progressive deployments can better control costs and capitalize on learning effects, compared to massive deployment plans

Finally, information on the schedules or activities of consumers and producers is confidential. Standards on data protection must be applied.

San Severino Pilot, Italy

In Italy, the role of the DSO is to supply electric energy to final users ensuring the highest commercial and technical standards of quality of service, in compliance with the prescriptions of the Italian Energy Authority (e.g., with reference to continuity of service and voltage quality standards).

According to the legislative and regulatory framework evolution expected in the medium-short term, DSOs are foreseen to play two main roles in the Smart Grid services domain:

- recipients of the services collected at the MV and LV levels on final users;
- supervisors of the ancillary services provision devoted to manage grid’s technical constraints.

Regarding the first task, the DSO will have to interact with many small users in order to collect the ancillary services required for the effective operation of the distribution system: e.g. to mitigate congestions, to improve voltage profiles, etc. To this purpose, the availability of a communication channel enabling the exchange of information and commands (directly or with the interposition of an intermediary) with the final users is essential.

With respect to the second perspective role, the DSO is asked to check possible limits to the ancillary services provided by small users due to technical constraints on the distribution network (e.g. the provision of a service to support the transmission system, for instance to keep the power balance, could be bounded by the transport capacity of MV/LV lines and transformers).

All the trading activities related to the LV/MV user bids for ancillary services will be in charge to a new power system actor, typically named Aggregator.

In this framework, the main expected risks concern the need of a proper coordination between the assessment of technical requirements of the distribution system, motivating the provision of the services (activity arranged as a monopoly) and the resulting trading operations (liberalized).

Other risks foreseen are related to:

- the need to ensure a non-discriminatory treatment of users during the services' selection process based on competition principles;
- the coordination of the market at the distribution system level and the market at the transmission system level (time scheduling, etc.).

In Italy, according to the art. 9 of legislative decree 79/99 "Decreto Bersani", DSOs shall connect to their networks all the users that need to be connected to the power system. Therefore, the DSO must accept any request of connection of new power plants (from renewable or conventional energies) to the MV/LV grid. Moreover, the energy produced from RES has dispatching priority.

Incentive schemes fostered, especially in the past, a fast spreading of distributed generation on MV/LV networks. The production of electricity from renewable, if not commensurate to the load, can cause the reversing of the power flows along lines and, in some cases, also at the interface of the distribution grid with the HV system. In these scenarios, problems related to the management of voltage profiles and lines' ampacity are frequent. Most of advantages of renewable energy (RE) in the distribution chain are perspective, achievable by the DSO thanks to the collection of Smart Grid services on these power plants. In a Smart Grid future, the evolution of generators could allow the DSO to use them to solve some problems affecting the distribution networks. For example, generators can be useful for the regulation of voltage profiles along lines. Moreover, it could be possible, in case of emergency, use these plants in a proper way in order to supply the loads and avoid interruptions. Otherwise, in the short term, the main advantage obtainable by the distribution generation could be on energy losses: an adequate level of RE generation could reduce the amount of losses on MV/LV networks [DEL13].

Smart meters currently in use in Italy for MV/LV users (1G smart meters) provide only a small set of info (quarter-of-hour active/reactive absorbed/injected energy) for optimizing costs and services provided to the consumers. Moreover, an even more limiting factor is for LV users with contractual power not greater than 55 kW, subject to Time-of-Use pricing, i.e. not eligible for DR.

The second generation of smart meters (2G smart meters) for LV users (today under study/experimentation) is currently regulated in Italy by Resolutions 646/2016/R/eel and 87/2016/R/eel and will provide much more info about the user's behavior (e.g., quarter-of-hour absorbed/injected energy, supply interruptions, voltage quality indices, power limiter activation, trips of the user's main protection, etc.). In addition, a faster communication with the users and its smart appliances will be possible (base on PLC and 3G mobile network technologies). Nevertheless, a deep review of the Regulatory Framework will be required in order to promote a DR Service.

The extensive exploitation of DR schemes will contribute to improve the stability, efficiency and reliability of the distribution and transmission system operation. Theoretically, by increasing the availability of grid services, their cost on the market would reduce; however, prices on the Dispatching Services Market in Italy are often unpredictable, so it is very difficult to have a clear insight on that aspect.

If we consider direct and indirect benefits, the end user is the subject that will take more advantages from DR schemes. In fact:

- if the services provided by the end user will be remunerated, the user (i.e. a consumer connected to MV or LV network making available a given amount of flexibility to the power system) will have a direct economic remuneration that will, probably, strongly drive an effective service participation;
- the improvement of the quality of transmission and distribution services obtained thanks to DR strategies (perceived as direct benefit by the TSO and DSOs) would positively affect the quality of service of final users (e.g. fewer interruptions, etc.);

- all the users would benefit of the (theoretical) reduction of the total electricity cost.

As already introduced, in perspective, the DR schemes will give the opportunity to the DSO to improve the level of quality of service on its network. As a consequence, the DSO could obtain incentives according to the regulation in force, for instance, through the penalties/rewards scheme in force in Italy for the number and duration of supply interruptions. Nevertheless, such incentives are supposed to be limited.

ASSEM is the distribution system operator involved in the San Severino Marche pilot. Therefore, its role envisaged in the experiment will be to gather ancillary services on end users and to use them to support the grid operation.

Overall conclusions regarding the obstacles and barriers to innovation in energy industry in Italy

- In Italy, the implementation of DR techniques by consumers and the participation of RES and DERs to the Ancillary Services Market are prevented by the absence of a regulatory framework enabling them.
- The smart metering architecture in place in Italy does not provide the performance required to perform enhanced control/monitoring techniques.
- Technical rules for the connection presently in force in Italy only in few cases (new power plants with rated power equal to, or greater than, 1 MW) prescribe the generator to be equipped with devices enabling the remote control/monitoring needed for the participation to the Ancillary Services Market.

Thessaloniki Pilot, Greece

The Greek wholesale electricity market has been organized as a pure mandatory pool. The market design introduces a distinction between the day-ahead market and the balancing mechanism that follows.

Zonal pricing, intended to reveal congestion problems and signal the location of new capacity, has not been activated yet, although two zonal prices, applicable to generators, are explicitly derived, currently only as an indication. Participants may enter into bilateral financial contracts (CfDs), but physical delivery transactions are constrained within the pool and related contracts do not exist.

The re-structuring of the former TSO ended up in two discrete entities:

- The Market Operator (LAGIE), which solves the day-ahead market, conducts its clearing, and engages into contracts with renewable producers.
- The System Operator (ADMIE), which owns the network, conducts the real-time dispatch, the clearing of the imbalance market and the settlement of all other charges or payments.

Last but not least, Regulatory Authority for Energy (RAE) monitors the operation of all sectors of the energy market, assessing a restructuring of the market design, so as to reduce costs, enhance competition across the value chain, as well as compatibility with the European target model which will gradually replace the current Greek model and provide for market integration through development of a single European electricity market.

The Electricity Supply Code introduces a very formal procedure for the conclusion of supply agreements; it also regulates the necessary content of the supply agreements, the switching of supplier, the protection of the customer’s rights, the content of the electricity bills and their issuing, the price negotiation with bigger customers etc. The retail market is about to undergo significant changes due to the compulsory reduction of PPC’s share in the supply sector and the recent introduction of Nome Energy Hydromix which provide access to lignite and hydro generated electricity to the alternative suppliers. These expectations have already resulted in an increase of interest by companies active in other sectors for entering the electricity supply market.

The large-scale development of an approach such as the proposed in Greece would have to overcome certain challenges and barriers. The regulatory framework in Greece for demand – response services does not currently exist. Even in their simplest form of Load Curtailment programs being offered by electric utilities to appropriate energy consumers that meet certain requirements, are provided limitedly. Furthermore, smart metering has not yet been adopted full.

Telemetering methods are only applied for medium voltage consumers while low voltage consumption is measured by periodic indication reporting. Besides the investment for Smart Grid and sophisticated demand response services that is needed, the enhancement of awareness of such an opportunity is the crucial action that must be communicated and implemented.

WATT+VOLT was the 1st Utility company that installed energy meters in households and corporations. The energy meters installations servers the WVT energy management and customer engagement strategies, while WVT energy meters indications can't be used for billing purposes due to DSO's regulations.

Regarding the company's customer portfolio which is serving the Greek pilot sites, medium voltage supplies with already installed telemetry were carefully chosen. From the other hand in low voltage the households could accept batteries and energy meters installations for simulating real time Demand Response concepts from the Utility scope.

Applying simulated DR schemes to the end customers would have the following advantages:

- Differential Customer Pricing
- Engaging more customers
- Peak Demand optimization
- Optimized day ahead load declaration techniques for the utility companies
- Overall (if DR is applied wide) transmission and distribution systems quality improvement.

Overall conclusions regarding the obstacles and barriers to innovation in energy industry in Greece

In recent years, electricity prices have risen steeply in Greece, in response to the removal of price caps and market liberalisation. According to the average retail electricity price increased at an average annual rate of 3.2% between 2008 and 2015, while the energy part of the energy bill (i.e. the actual part of the price paid to the electricity retailer) declined by 15% during this period. Consequently, it is crucial that consumers are offered DR services and the ability to better control their costs. Some indicative examples of this framework in Greece are:

- A discount of 10% on PPC rates for companies with annual consumption of over 1,000 GWh, and
- An additional discount of 25% on its night and weekend rates for industries with annual consumption below 1,000 GWh.

Concerning the role of utilities, WVT will demonstrate the use of significant incentives to the consumers by utilizing time-of-use (ToU) tariff schemes. According to this pricing scheme, the consumers will have two different pricing zones within the day (peak-hours and not peak-hours).

However, the cost of building new energy infrastructure is substantial and companies and investors finance the bulk of this cost. Given the scale of energy projects, they are susceptible to global economic downturns, which may create price volatility to the resource and labour markets, as well as limit the availability of credit. Variability in the international capital markets, and the implications this may have for accessing Greek finance, is impossible to predict. In Greece political and economic instability have a particularly strong impact on energy investment, given the fact that it requires a degree of trust between Government and investors, that policies will be in place, to ensure investors a return on investment (e.g. revenue guarantees, risk underwriting).

Ploiesti Pilot, Romania

The Pilot of Ploiesti implies the following:

- to implement the EIIS (Energy Integrated Information System), a solution to automate the process of DR based on smart meters infrastructure;
- to evaluate and test the validity of the DR business model;
- to analyze and validate the integration of the proposed technical solution in the inteGRIDy framework.

In order to decrease the peak of power consumption for eight consumers equipped with smart meters with DR functionality in the Ploiesti Pilot, the DR operational programmes will be monitored and controlled. According to this situation, the following approaches will be considered:

- Incentive customer participation in DR programmes;
- Testing and validating the concept of "DSO as user of demand-side flexibility & its interaction with customers".

Encountered obstacles and barriers:

- Lack of regulations to offer incentives for consumers and DSO (political and economic factors)
- Reduced energy consumption of residential consumers has a significant impact on DR (i.e. no spectacular results under 100kWh/month) (economic factors)
- Reduced needs for heating (only a few months per year)
- Inconsistent regulations regarding data privacy protection and security (legal and political factors)
- Difficulties in accessing primary data (technological factors)
- Consumer resistance (not interested installing devices/equipment in their homes because the impact on the consumption is low) (social factor)
- Cost (the cost with smart meters is high and the medium consumption rate in Romania per domestic user is under 100 kWh/month. (economical factor)

Overall conclusions regarding the obstacles and barriers to innovation in energy industry in Romania

In Romania there is a significant degree of awareness considering the impact of implementing Smart Grids, but the overall impact on the customer invoice will be very low, so unattractive. Also, long-term strategies for prosumers have lots of incoherencies and inconsistencies and thus may block the decision of investment.

3.3 Pros and Cons to innovation in energy industry

This chapter aims to explore the generally valid conclusions regarding the innovation in energy industry (addressing the main drivers to innovation – PROS, and the barriers to innovation – CONS), based on the findings resulted from the pilots/countries research, as it stands in the previous sections.

PROS have been investigated for some countries and CONs for other countries.

Eight prospects concerning the innovation in energy industry were analysed in UK, Spain, Italy, Portugal, Greece, Romania and France, namely:

- The common EU development strategy in energy domain (EU acquis in energy)
- Political impact
- Legislation impact

- The role of the national energy regulation authority
- The impact of the economic factors
- The impact of the technological factors
- The role of the emergent structures (private, NGO, universities, ESCOs, clusters…)
- The role of the major actors involved in the supply chain for smart distribution networks.

We present in the following the results of this analysis.

Generally valid conclusions referring the main drivers to innovation in energy industry (PROS):

- The most important driver to innovation in energy industry is the common EU development strategy in energy (EU acquis in energy) for a long term.
- The R&D investment in energy industry is mainly sustained by the transposition of EU directives and recommendations in order to strengthen the involvement of all actors in the energy sector with the goal of promoting innovative technologies and technology transfer, the dissemination of best practices and creating a favourable environment to attract private investments.
- By pursuing the EU recommendations and policies on sustainable development in energy, each analysed country aims to achieve the following objectives:
  - Implementing a suitable legislation in the energy sector, in accordance with the EU requirements and the investment issues
  - Aligning the political challenge of the R&D investment in energy industry
  - Generating new markets in the energy sector with new services and actors.
- Political factor could be considered also a driver to innovation in energy industry, by outlining investment strategies and policies and by engaging governments to bring into force the decisions resulted from these strategies and policies. On this line, governments could stimulate innovation in energy industry and support also the access on the market of the new technologies and business models.
- Deadlines imposed by governments on the smart metering solutions deployment have stimulated the market.
- Considering legislative and regulatory aspects, the vast majority of the EU countries will undergo a transitional process to the liberalization of the energy market for the creation of a market supporting effective and transparent competition while favouring technological development.
- The liberalization of the energy market has opened the door to new business models and innovative solutions.
- The emergent structures (private, NGO, universities, ESCOs, clusters…) could be considered also drivers to innovation in energy industry due to the joint effort in financing new technologies, implementing smart solutions in the energy sector and providing tailor made services to consumers.
- Customer engagement within the emergent structures is significantly increasing as well, and some interesting initiatives have been implemented in the analyzed countries (Spain, Romania, Italy, France, UK, Greece, Cyprus, Portugal) supporting the involvement of the final users in the smart electricity grid.
- The new business opportunities in energy industry could be driven by performance indicators converted into reduced prices and savings for the customers.
- Investment in energy innovation is directly correlated with the specific requirements and provisions of the environment legislation and regulations.
- Concerning the role of economic factors as drivers to innovation in energy sector, it has been proven the positive impact of using significant incentives to the consumers by utilizing time-of-use (ToU) tariff schemes. According to this pricing scheme, the consumers, as proactive actors within the new technologies, will have access to

different pricing zones within the day (peak-hours and not peak-hours), influencing the demand and consumption.

Generally valid conclusions referring the obstacles and barriers to innovation in energy industry (CONS):

- The political factor interrelated with the economic instability have a significant impact on energy investment (new technologies, new business models, new approaches, new leads), due to the fact that it is required a high degree of trust between governments and investors concerning strategies, policies to ensure investors the return of investment and minimization of financial risks.
- Long-term strategies for prosumers still have a lot of incoherencies and inconsistencies and thus may block the decision of investment.
- Inconsistent regulations regarding data privacy protection and data security and confidentiality represent barriers to innovation in energy industry, due to the fact that a lot of information concerning the energy producers and consumers which needed to be accessed in the Smart Grid solutions is confidential. Specific standards and algorithms on data protection must be applied.
- Even though there is a significant degree of awareness considering the impact of implementing Smart Grids in the analysed countries, there are still delays in regulation of this approach. Lack of regulations to offer incentives for consumers and DSOs could be considered also barriers to innovation in the energy industry.
- Within implementing the Smart Grid solutions, the resistance of consumers which are not interested in installing devices/equipment in their homes to be “monitored” could also become a barrier to innovation in energy industry.
- The cost of investments in smartening the energy field remains high. There are significant cost barriers to the deployment of new technologies and to build new energy infrastructures in Smart Grid solutions.
- Regarding the economic challenges, different issues apply to the various actors involved in the supply chain for smart distribution networks:
    - For a DSO savings can be made in reinforcing their wider distribution networks by smartening parts of their distribution network. However, this is not the case for energy retailers who may however improve their customer retention rates. Moreover, the dominant players stifle innovation and are not interested in helping innovations that are going to challenge their position.
    - For a TSO the Smart Grid means a transfer of responsibilities for network reliability from them to the DSOs. One of the barriers to the implementation of Smart Grids is that the companies in the energy supply chain that need to make the investments in the network are not necessarily those that will reap the financial benefits. Or they find it difficult to estimate the savings that investment in Smart Grid solutions will enable in network reinforcement or from unleashing the potential of demand response, RES etc.
    - For consumers and prosumers the barriers related to innovation include disinterest and a lack of financial gain as compared to costs in terms of money and time.
- The technological challenge could become a significant issue for innovation in energy industry because as the technological complexity of new solutions is higher, the higher will be the costs of the investment. Costs of investment in technology could thus be an obstacle to the implementation of Smart Grid solutions.
- Difficulties in accessing primary data in the Smart Grid solutions represent also an important barrier in implementing this type of innovative solutions.
- It could happen that the implemented smart metering architectures do not provide the performance required for the control and monitoring the Smart Grid.

- The other major obstacle to innovation in energy industry is the diversity of actors, because they have to develop various communicating systems with convergent logics. Furthermore, the data collected are complex to manage and store, given the large amount of information to be processed and analysed.
- The lack of smart meters in many EU countries and issues with the ongoing roll-out of smart meters is another barrier.

4 Analysis of the main Obstacles & Barriers related to inteGRIDy's Innovations

This chapter is dedicated to analysing the general context through a PESTLE (political economic, social, technological, legal and environmental) analysis, which identifies basic issues in a systematic and logical way.

A general and a pilot country perspective are provided in the following sections. All the issues identified were assessed against the four inteGRIDy challenges:

Figure 12. PESTLE details [https://myassignmenthelp.com/]

4.1 Political impact on inteGRIDy' innovations

The Section 4.1analyzes political barriers and obstacles to the application of inteGRIDy-like solutions in current markets.

Since the considered area is vast and the number of participating countries is large this section provides general information at European level highlighting the most relevant issues for countries participating in inteGRIDy.

General overview

For decades, governments support energy production and consumption in order to meet social, economic and environmental objectives. Government intervention is twofold i.e. it may be useful and effective in helping meeting policy objectives, but considering own strategies may restrict access to innovation in energy sector. Country governments alone have only partial control as policies are dictated to an extent by World (UN, IEA, IRENA) and European (EU28, Ocean Energy Europe) level politics.

Policies have the potential to highly influence the future of energy, presenting opportunities alongside the risks.

A significant political risk to energy innovation challenges like the ones defined in inteGRIDy project lies at national level because the political parties running the Governments are in power for a limited period and they focus on their own agendas.

A short European overview of the political impact in terms of policies and further regulations needs focusing on the four challenges approached in inteGRIDy project is presented below.

The Energy Efficiency Directive (2012/27/EU) [EED12] is a programmatic document supporting the development of **Demand Response** in Europe. Articles 15.4 requires Member States to: "improve consumer participation in system efficiency, including Demand Response, depending on national circumstances" and Art. 15.8 of the Directive establishes consumer access to energy markets, either individually or through aggregation.

The transposition deadline was June 2014 and as a follow-up in 2016 the EC JRC Science for Policy Report published an assessment report on the implementation of Art 15 of Directive 27/2012. “Demand Response status in EU Member States” [JRC16] report revealed that “many national regulators see the process of opening markets to Demand Response, as complex and confusing” [BER16].

Considering the second challenge of the inteGRIDy project, **smartening the distribution grid**, IEA published a report in 2011 on Smart Grids [IEA11] where it states that “The smartening of grids is already happening; it is not a one-time event”. Even though some progress was done achieving the Energy Roadmap 2050 [EUC12] this vision of smartening the grid by 2050 requires governments, research, industry and financial organizations to work closely.

An European Commission report “Energy storage – the role of electricity” published in 2017 shows that the **energy storage** potential is yet to be revealed, “because, on the one hand some of the technologies were not widely developed, and on the other hand the regulatory framework was not in place to accommodate new flexible solutions.” Moreover, different regulatory frameworks across Member States and lack of a clear definition for energy storage in the regulatory framework resulted in lack of coherence in the classification of storage facilities into generation and/or consumption. [CMW17]

The ITRE Report “Towards a New Energy Market Design” [ITR16], proposed by MEP Werner Langen (EPP, DE), adopted in June 2016 “*Stresses the need to promote the deployment of energy storage systems and to create a level playing field on which energy storage can compete with other flexibility options, on the basis of a technology-neutral design of the energy market”*

Balancing the electric grid in real time and smartening the grid by **integrating users from transport** is a technical challenge across market structure. Electric vehicles have the potential o providing ancillary services. With the adoption of the Clean Power for Transport Directive (Directive 2014/94/EU), European policymakers have taken important steps to develop national policy frameworks for the market development of alternative fuels and their infrastructure.

Eurelectric published in 2016 a position paper in which mentions two important barriers in the implementation of large scale Electro Mobility limited charging infrastructure and standardization and interoperability. Eurelectric provisioned the EV charging infrastructure as a market activity that could be achieved via public tendering. In different member states where competition in this area has not yet started or where private investors are hesitant to invest have given DSOs the responsibility for owning and operating technically the infrastructure. Market maturity will most probably come with competition and the need of clarifying costs and assets cycle [EUR16].

- International agreements

International commitments (e.g. Kyoto Protocol [KYP98]) and agreements (e.g. EU legislation) influence and shape policy-making, and therefore, the energy system. Nevertheless agreements take long periods of time to draft, build consensus and finally agree upon.

- Geopolitical issues

Political instability, between and within nations, poses a risk to the security of energy supply materials (e.g. gas, oil, uranium) and resources (e.g. materials and skilled labour). Geopolitical instability may manifest in price volatility (leading to higher generation costs), disruption of supply chains (delaying Project completion) or degradation of international relationships. Return of national markets on the international scene may impact resource prices (e.g. oil market) [PRP14].

Particular issues

In **UK** successive governments supported the energy market liberalisation started by Margaret Thatcher's regime in the early 1980's. Governments and regulators have been supportive of renewable technologies and Smart Grids. However recent administrations have been overwhelmed by the pace of change and the rapid uptake of renewable technologies. Stimulated in part by generous subsidies.

Today, the regulator has not caught up with pace of change and is acting as a blocker to the continued growth in renewable energy.

In **Spain** the demand side flexibility is not accepted as a resource within the Spanish electricity market. The only program that allows Demand Response is the interruptible load service which is provided by electricity consumers connected to high voltage network and managed by the System Operator. The program acts as an emergency action in case the system is lacking generation and there are insufficient balancing resources. This program has not been called for several years.

The TSO and relevant stakeholders have started conversations for the future opening of these services to flexible demand. Spain is the first country in the world where the default price for households (i.e. Precio Voluntario al Pequeño Consumidor, PVPC) is based on hourly spot prices and could drive important progress for implicit demand response.

A full smart meter roll-out is expected by 2018 including telemetering.

The Government is designing a program to promote self-consumption including storage systems that will be launched soon this year. The Catalan Government has published a National Pact for Energy Transition which is in line with all strategic axes published at the Clean Energy for all Europeans legislative package

Today in **Italy** there is not an adequate legislative framework to support a large-scale DR services dissemination. The Italian Energy Authority is currently promoting different initiatives in order to define new regulations regarding the dispatching service (Testo Integrato Dispacciamento Elettrico) in line with the balancing European code.

The Italian legislative framework regulating users' connection (active or passive) to the grid in LV, MV, HV (CEI 0-21 e CEI 0-16), foresees the possibility to install electricity storage systems; therefore, in Italy there are no obstacles related to storage.

During the past years, the Italian Energy Authority promoted the development and the application of innovative technologies aiming at an active management of electricity distribution grids, throughout, also, the control of RES generators. As a direct consequence, several pilot projects on distribution grids have been developed, allowing the Italian Energy Authority to adopt specific measures (e.g. Deliberation 646/2015/R/eel) with the objective of large scale diffusion of innovative functionalities related to MV distribution grids characterized by a high-density RES distributed generation.

In **Portugal** (which is part of the EU since 1986) the promulgated European regulations, including current targets for 2020.

EV charging and storage infrastructure integration into the Smart Grid is one of inteGRIDy's innovations under any political reasoning. In fact, EV adoption greatly depends on state wide benefits such as tax exemption or reduction, subsidies and reduced cost for electricity to attract investment. In 2017 the Portuguese government gave a subsidy of €2.250 to the first one thousand EV buyers in Portugal. Plug-in hybrid EV (PHEV) owners can also benefit of a tax reduction in the vehicle owners tax (ISV). A transfer of €715.070 is foreseen in the 2017 state budget from the Environment Fund to Mobi.E, a smart EV charging network with nation-wide presence, to reinforce and expand the network. Mobi.E currently provides its electricity for free, as part of a transition plan to foster the EV market. It is intended to later apply public charging fees to the users, as soon as the EV market share grows significantly. As of 2017, there is some additional funding for new environment-friendly acquisition with an associated old vehicle retirement, with values ranging from €2250 for new battery EV (BEV) to €1125 for new PHEV [PRO07].

PV integration into the smart grid, also a major inteGRIDy innovation, was lately also a subject of policies, with the government setting regulations favouring household or small companies' PV mini and micro production by granting a tariff from DSOs per kWh deployed into the grid. These laws exist since 1988 but in 2013 were reviewed to favour self-consumption instead of market trade [MON14].

Cyprus, being a member of EU since 2004, has been granted the status of a small isolated electrical system, under EU Second and Third Energy Packages. Due to its isolation from the continental trans-European electricity network, there exists certain intrinsic and technical limitations that affect significantly the RES penetration in order to not jeopardize the reliability of the grid system. Therefore, following the EU Directives, Cyprus target is to have 13% of its energy consumption coming from renewables by 2020.

In order to promote the implementation of RES and dealing with Energy Savings issues, the Government of Cyprus issued a National Action plan in 2010 that implements various support schemes. This energy policy has created financial support for RES projects, while a special fund mainly supported by revenues derived from consumers paying a 'green tax' levied on electricity bills. Generally, Cyprus is exploring ways to facilitate the smartening of the electricity grid. For this reason, the Government has secured significant funding from European Investment Bank and the European Commission for the implementation of innovative renewable projects that are associated with energy storage technologies (EOS Green Project, Helios Power Project, Green+).

Obligatory provisions of the European Commission's Directives regarding the Demand Response reforms have been signed and transposed, although they have not been implemented yet. Cyprus is in process of transposing in national law the necessary adaptations to enable the operation of an electricity market and enable the participation of the demand side resources in this market. So far, there is no defined structure for the operation of a Demand Response (DR) aggregator, while there isn't any organized electricity market, where a consumer can sell its resources. Furthermore, Cyprus has not proceeded yet with a full smart meter roll-out, however Law N.149 (I)/2015 provides for the development of a national energy efficiency program and includes measures for the deployment of a "smart metering" initiative.

Concerning the liberalisation of the electricity market, Electricity Authority of Cyprus (EAC) is the only DSO of Cyprus, which had the monopoly on generation and supply of electricity across Cyprus until 2004 and still generates more than 90% of electricity in the island. The liberalisation of the electricity market is formally achieved by January 2014, however EAC still remains the owner of both transmission and distribution systems and is the sole supplier of electricity to consumers. Following the next steps, Cyprus Energy Regulatory Authority (CERA) has moved forward towards implementing full liberalization of the energy market and granting consumers the right to choose their own supplier, with expectation of full market operation by 2019. CERA's proposition for the operation of the future market is a 'net pool' model, where the operations of EAC are unbundled and the production and supply operations separated.

The **Greek** Association of Photovoltaic Companies emerged the need for the establishment of specifications required for the installation of accumulators in photovoltaic auto-production systems by the HEDNO (Hellenic Electricity Distribution Network Operator). While such specifications have not yet been established, the HEDNO decided in the meantime that "an electrical configuration of the parallel operation of the storage system (e.g. batteries) and the photovoltaic system within the self-production program with energy offset is not acceptable".

Greece participates in the feed-in tariff mechanism. The guaranteed price mechanism has made a decisive contribution to the development of significant installed capacity for the production of renewable energy sources.

The Greek government has incorporated the EU directive 20-20-20. In the energy sector the 2020 goals were based on the three pillars leading European energy policy: Security of supply, competitive markets and sustainability. The 2020 energy goals are to have a 20% (or even 30%) reduction in CO_2 emissions compared to 1990 levels, 20% of the energy, on the basis of consumption, coming from renewables and a 20% increase in energy efficiency.

Difficult access to PPC networks due to lack of networks (they are saturated) but also due to a lack of transparent procedures by the Network Operator.

There are no subsidies for battery energy storage systems.

In **Romania** definition of strategies, implementation of policies, recommendations and transposition of EU directives are highly influenced by the own agenda of the political party running the Government. Thus, due to huge instability and frequent changes of Govern long term strategies lose their shape.

As a rule, the energetic strategy is elaborated by the competent Ministry and approved by the Romanian Government. Before this, consultations with nongovernmental organizations, social partners and environmental business representatives take place and approach aspects like:

- building the appropriate institutional framework by defining the competent authorities for the compiling of this policy;
- the assurance of the security supply with gas and electric energy;
- the assurance of the environment protection and the ecological reconstruction;
- the pricing transparency for gas and energy
- the rising efficiency in usage of fuel and energy
- the development of the renewable sources of energy
- the development of the energetic international cooperation, the participation in the regional and European energy markets.
- 0.49% of gross domestic expenditure allocated for research and development

The national institutional framework that allows Demand Response and smart meter implementation is the National Plan of Implementing Smart Metering [ANR17] which is one of the priority measures in ANRE's strategy. All the pilot projects implemented until now have been approved by ANRE. In the 2016 annual report published by ANRE there is a list of 18 pilot projects approved in 2015. As the National Plan of Implementing Smart Metering is not approved the stakeholders from energy sector need to postpone business and investment decisions.

The market liberalization set on 1st January 2018 when the price of electric energy should rely 100% on the free market is also an obstacle for energy innovation as there is no public awareness considering the expected impact.

Smart Grid implementation in Romania faces with obsolete infrastructure, huge energy losses and lack of coherence in legislation framework.

The **French** government has been working for several years to develop and consolidate a French smart grid sector. To do this, it mobilizes its services, public institutions and administrative authorities, the Ministry in charge of industry, the Ministry in charge of energy, as well as the Agency for the Environment and Energy Management (ADEME) and the French Energy Regulatory Commission (CRE), which are working on the evolution of the legal framework for intelligent electricity grids.

France is actively involved in supporting R&D and Smart Grid demonstrators, with several financing programs, the most important is the Future Investments Program. Within the framework of a large national loan to encourage innovation and investment in France, a specific program has been entrusted to ADEME by the state for the implementation of demonstration projects on The Smart Grids. These demonstration projects include the pre-industrial experimentation of innovative technologies. They allow companies to assume technological and financial risk taking upstream of the industrialization phase.

«France's energy and climate targets are ambitious: cutting greenhouse gas emissions by 4% and energy consumption by 2050, reaching 23% of energy Renewable energy mix by 2020 and 32% by 2030, or generalize the positive energy building for new buildings by 2020. ADEME studies on energy and climate scenarios by 2030 and 2050 show that these objectives are achievable by adopting a proactive policy. The Smart Grids solutions currently being developed in France are one of the key links that will enable us to meet these challenges, by controlling energy demand, facilitating the integration of variable renewable energies into the network or by promoting the development of Mobility » Bruno Lechevin, President of the Environment and Energy Management Agency (ADEME)

An example of a roadmap to create a framework for the development of Smart Grid models is the French electric vehicle development plan.

It is expected that two million rechargeable electric and hybrid vehicles will run by 2020. A network of 4 million private charging points and 400,000 public charging points will be developed by 2020. These infrastructures will require an investment of 4.7 billion euros by 2020. Thirteen pilot communities have already committed to deploying recharging infrastructures since 2010: Bordeaux, Grenoble, Rennes, Nice, Angoulême, Aix-en-Provence, Orléans, Paris, Rouen, Strasbourg, Le Havre, La Rochelle and Grand Nancy.

4.2 Economic impact on inteGRIDy' innovations

The Section 4.2 analyzes economic barriers and obstacles to the application of inteGRIDy-like solutions in current markets.

Since the considered impact area is pretty vast, because of the complexity of inteGRIDy outcomes and pluralism of national markets, this paragraph provides general information at European level aimed at highlighting the most relevant issues.

After that, a final part with single country information includes specific considerations, where relevant, for those Nations participating in inteGRIDy.

General overview

Recent innovations in energy sector are deeply influencing business and economical pillars of energy industry. These innovations are mainly represented by: market liberalization (new producers and new retailers) and infrastructures digitalization and automation (smart metering and data management, etc.). Recent trends in European energy markets are listed as follows.

In such scenario, profitable data provided by Eurostat will help to define economic framework in energy sector at European level [EUR17]:

- In 2014 and 2015, the number of electricity producers, representing at least 95 % of national net electricity generation, remained stable in seven EU States and increases could be observed in 17 States, while the number went down most significantly in Austria and Denmark
- The EU-28's gross inland consumption of energy dramatically fell in 2014 to a very low level, replacing the previous minimum of 1994. Energy consumption in 2014 of EU-28 was 12.7% lower than its previous peak of 1,840 MTOE recorded in 2006, equivalent to an average reduction of 1.7 % per year;

- New installed generation, especially RES, between 2007 and 2015 denotes a high value of interconnected capacity around 2010 and 2012. The trend is globally smoothing, but it is still remarkable in Germany, Netherland and UK;
- The number of large retailers (selling energy for more than 5% of total national generation) in not increased from 2003 to 2015;
- Average energy price in Member Countries adopting euro, is stable in last two year for domestic customers, while denotes tiny reduction in industrial ones.
- In 2016, the average day-ahead prices in central and western European markets decreased to very low values in the first eight months and started to increase in the last part of the year. In those countries, the differences in overall price dropped at the beginning of the year, while afterwards, prices diverged into two zones. One price region contained Germany and the Netherlands, and the other included Belgium and France. At the same time, trading volumes on the intraday markets increased in Germany, especially for 15-minute products, whereas the trading volumes in the Netherlands decreased [TEN17].

Table 3. Average of Electricity Price in Europe (in euro) [Source: http://ec.europa.eu/eurostat/]

	Households			**Industry**		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**
EU-28	0.2040	0.2090	0.2052	0.0917	0.0917	0.0917
Euro Area	0.2168	0.2202	0.2184	0.0913	0.0913	0.0913

Many National markets are facing the challenge to integrate a growing number of small prosumers, while encouraging storage and demand response at the same time. This combination may require a new market design featured by a mix of short-term market and long-term prices, with RES participating in balancing (in this case no more subsidies are foreseen for RES). Meanwhile RES subsidies are still pushing the market in the most of the European Countries. Table 4 summarizes the main relevant subsidies still available in EU28 Countries (of course it does not include any possible loans, tariff or tax discount available and still in effect)

Table 4 Renewables subsidies in EU28 Countries[1]

	PV SUBSIDIES	WIND SUBSIDIES
Austria	max 375€. FiT 7,91 c€/kWh up to 5kWp	up to 30%of installation costs
Belgium	from 20% to 40% of the cost	calculated as % of extra investments needed to obtain a certain level of environmental protection
Bulgaria	-	-
Croatia	-	-
Cyprus	900 euro /kW (with a cap to 2700€ for household)	-

[1] The “cost” in the table refers always to the eligible costs in a RES investment submitted to a subsidy’s application. Elaboration based on data provided by http://www.res-legal.eu, visited in May 2017.

Czech rep.	-	-
Denmark	-	-
Estonia	-	variable
Finland	up to 40%	up to 40%
France	-	-
Germany	-	-
Greece	from 45% up to 65% of costs	variable depending on the legal entity
Hungary	-	-
Ireland	-	-
Italy	variable FiT	from 140 to 250€/MWh for small size
Latvia	-	up to 80% capped at 200,000€
Lithuania	up to 80% of costs	-
Luxemburg	up to 20% capped at 500€/kWp	up to 45% depending on extra-costs
Malta	up to 50% of costs, capped at 2300€/plant and 757€/kWp	-
Netherlands	-	-
Poland	different subsidies and measures	combined subsidy and loan programme up to 100%
Portugal	-	-
Romania	from 30% to 50% depending on plant size	from 30% to 50%
Slovakia	determined individually	determined in the individual call for applications
Slovenia	up to 50%of the costs	from 30% to 50%
Spain	-	-
Sweden	up to 30% for companies and 20% for privates	-
U.K.	“Strike Price” (115€/MWh in 2016/2017)	“Strike Price” (150€/MWh for off-shore and 95€ onshore in 2016/2017)

The Directorate General for Energy has highlighted some relevant distortions in energy markets originated by barriers to the participation of demand side resources in all market time-frames and for RES in intraday and balancing markets, as well as DR participation [TEN16].

Today’s electricity markets have moved forward to liberalization since last decade, but some issues need to be solved as well. Some obstacles are still running in terms of cross-border trading, customer protection and insufficient retail market competition. According to the European Parliament’s [EUP15], a more physically integrated internal energy market could deliver annual efficiency gains of at least €250 billion. New vision proposed in market renovation aims at balancing demand and supply for each kind of market participant that will now responsible in case of imbalances. On the other hand further efforts are needed to make intraday and day-ahead markets as close to real time as possible, with the possibility to develop new products and business for operators.

Must run generation (generally referred to old conventional power stations considered as “strategic” ones) and priority dispatch (especially for renewables, high efficiency CHP or biomass) is distorting today’s energy markets because “they do not enter the merit according to their actual cost of structure”. This kind of anomaly has been heavily stressed even in the so-called Winter Package, because in an ideal market there should be same rules in all time-frames for any kind of operators, even for producers [TEN16].

Some resources or technologies basically today do not have access to the markets, with particular refer to the balancing ones. In most cases this is due to some lack of regulations or legislations, while they can definitively represent a relevant portfolio that could contribute in those markets.

The electricity that is consumed of course needs to be produced in real-time. Any imbalance, or difference between consumption and production, incurs costs and can even result in national grid failures in the case of large discrepancies. New trends yield to a novel approach called "balance responsibility", where an electricity supplier must deliver as much electricity as its customers consume. This aspect was addressed as another market distortion that originates the aforementioned imbalances over the grid, affecting both the supply and the flexibility in intraday and balancing markets.

Since RES breakthrough, Demand Response is one of the most promising mechanism to balance power fluctuation on the grid. But it must not be taken for granted its effectiveness. Under certain conditions (the most important of which are rather low electricity prices, a well-developed network, and overcapacity in the generation system), the benefits are quite low compared to the costs [CON16][CBI13][CEA10]. [SED17] describes some evidences of increasing interests on Demand Response in the most of European Countries. This interest has originated regulatory changes in last years and further implementation planned in next future. In those countries where traditionally DR was never considered, like Estonia, Spain and Italy, there is a growing attention towards the potential of DR, but they are still missing any kind of legislation. The European countries that currently provide the most favourable framework for DR implementation are Great Britain, Belgium, Switzerland, France, Finland, and Ireland. Nevertheless, there are still market design and regulatory issues that exist in these well-performing countries.

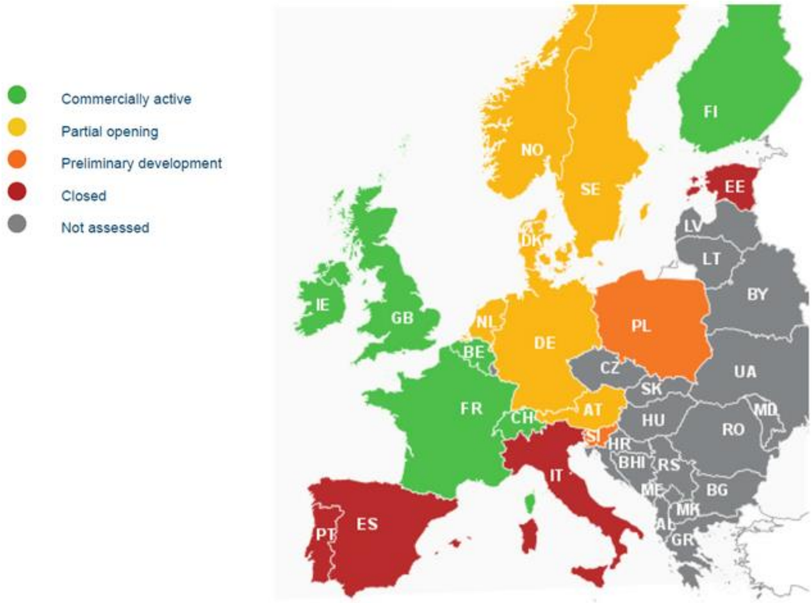


Figure 13. Explicit Development of Demand Response in Europe [SED17]

On the market side, the validity of business cases is closely linked to administrative and legislative aspects, since the electricity sector is a heavily regulated market. Regulatory adjustments that develop the market and thus strengthen business cases would be the prime area of intervention, as stronger and more reliable business cases will help to reduce many economic barriers.

- A way to overcome economic barriers is the externalization of investment costs and risks through innovative contracting or service models. In such a case, an external operator takes care of planning, installation and operation of the smart energy network.

- Another option would be the introduction of incentives to companies willing to exploit potentials for smart energy solutions, for example in the form of investment supports, tax concessions or reductions in energy-related fees. From a macroeconomic perspective, this may be an efficient way to quickly tap flexible potentials. As a side effect, it could lead to the additional creation of high-level jobs in knowledge intense business sectors and local installation companies, much alike the successful development of the renewable energy sector through feed-in tariffs. On the other hand, such measures usually imply a substantial bureaucratic overhead and may lead to suboptimal results, if applications mainly aim at fulfilling subsidy criteria instead of meeting market demands [HAM13].
- Advanced Metering Infrastructure (commonly referred to as smart meters) is also a key pillar to the implantation of new business models and, therefore, sustains the future economic growth around the energy sector. Europe offers an interesting case to explore as the policy context largely varies from country to country. Market penetration also differs strongly [ZHO16]. Large scale AMI deployments will allow enhancing energy efficiency, as confirmed in [EUC12]. The European Commission Electricity Directive 2009/72/EC [EUC09] requires EU member states to perform economic assessments and pave the way for at least 80% AMI roll-out by 2020. In this sense, most countries have started piloting smart meter use cases, including demonstrator programs and policies well in advance, to comply with EU requests. 2014 rates of AMI penetration ranked around 10% for most EU member states (including UK, Germany and the Netherlands). On the other hand, some countries such as Sweden, Italy and Finland already achieved 90% AMI market share, positioning themselves as leading states. Guaranteeing compliance with EU plans will also imply a considerable economic growth as a consequent adoption of novel revenue models based on Big Data and real time demand monitoring, enabled by the use of AMI.

Curtailment remains one of the most significant challenges for renewable energy integration into systems such as Ireland and the Iberian Peninsula, which are weakly interconnected to other electrical systems [KIE16][KYP98] or in countries with a presence of “must-run” generation, like Germany [WIN16], where negative prices are well known market distortion.

- The economic impact of curtailment in Spain was described as a loss of approximately 70 million Euro from January to March 2013, and the amount of curtailment is expected to increase to yearly 2.3 TWh (3.1% of renewable generation) in 2020. In Italy, the amount of curtailed wind energy was reduced from 10.7% in 2009 to 1.24% in 2013 due to a significant reinforcement of the transmission grid capacities. In Ireland, 110 GWh wind energy were curtailed in the year 2012. This is approximately 2% of the total wind generation. Congestion in the power transmission system was responsible for about 80% of the losses, while 20% was due to local network constraints.
- Energy Storage and V2G integration, together with optimal grid control procedures and Demand Response seems to be profitable solutions to keep RES dispatch as priority, while avoiding curtailments.

Storage systems also play a crucial role in order to accelerate market transition and increase res feasibility without support or incentive mechanisms. Improvements are needed to increase efficiency and reduce cost investments. In particular, manufacturing challenges with the assembly systems contribute to total system costs and introduce a significant opportunity area. Forecast analysis in United States indicates battery systems (most popular among distributed storage technologies) must achieve at least a cost reductions to USD 1000 per kilowatt (kW) by 2050 to achieve the deployment levels in the “breakthrough” scenario. Of course, it would be extremely positive if this price reduction target could be achieved earlier, possibly by 2035 [IEA16].

Continuous **integration of RES** in energy supply (characterized by near to zero marginal cost) will force market to evolve from actual mechanisms based on fossil remuneration, to RES efficiency competition, as well as Demand Side Management options may represent a profitable option compared with some capacity payment schemes. Both solutions have some barriers to overcome.

- The most of EU member states adopted policies to support RES-E market penetration, instruments are currently in use in the EU countries such as Feed-In Tariffs (FIT), Green Certificates (GC), investment subsidies, loans and tax cuts, where FIT and GC are the most common ones adopted at European level. FIT basically reduces in order to push the market in a first stage, while for the GC there is an imposed quota to be exchanged inside a specific regulated market with a natural value set by demand-supply. Generally, final users' bills have in charge extra cost to support both incentives mechanisms, with some kind of decreasing through years, gradually the electricity cost increased. Those countries that have funded high incentive, have later experienced drastic reductions, like in Spain in 2011 or in Italy with a severe cut in 2011 and a full stop in2012. Other countries followed: Bulgaria, Poland and lately Romania have reduced the number of GC [VEN16].
- On the other hand DR is generally characterized by a minimum bid size that is large enough to exclude small domestic users in those countries where Aggregators are still not available. This could be caused by technical constraints in some cases (impossibility to control a huge amount of loads at low voltage level) or regulation in others. Moreover the bids are not always symmetric because it is easier to increase loads than to shed them. Finally there could be some direct obstacles, like highest penalties in case of non-compliance, or indirect ones like a small difference between peak and off-peaks price, that do not encourage people in participating DR programs [VER16].

Estimated direct and indirect jobs in RES in 2014 were estimated in 1.17 million in Europe (8.1 million in the world). In a scenario of doubling the share of renewables in the global energy mix, it has been estimated that would triple jobs worldwide by 2030 [IRE16].

Following, additional considerations about market issues peculiarities in some European countries.

Particular issues

The energy market scenario in **UK** is basically in line with what described in the previous paragraph at European level, where UK market shows an advanced application of new business models (demand response, aggregators, etc.) while pushing towards a complete smart meters roll out.

Thus, it could be useful to provide specific information related to inteGRIDy, as the government recognizes the potential economic impact of innovations from this kind of projects, in particular in reducing energy prices and overall carbon foot print. However it is having difficulty reaping the benefits of these innovations, due the complexity of the interaction between the energy regulator (OFGEM) and the 'big 6' energy suppliers. Clearly inteGRIDy results in decentralized, decarbonized, and digital energy supply, all a threat to the major energy utilities who wish to maintain the status quo.

In **Spain**, after a period of exponential growing of RES installation, in 2010, the government launched several profound energy policy changes in order to eliminate support for RES, with the stop of registration of new RES installations in 2012 (Real Decreto ley 1/2012) and a new retribution scheme for RES in 2013 (Real Decreto 413/2014) which included retroactive cuts in economic support for existing plants. These policy changes have basically interrupted new RES investments and deployments in the Country [DGE10].

Wind energy represents Spain's third largest power generation source with a gross production of 48.1 TWh in 2016, covering around 20% of the country's electricity demand. The renewable energy target of Spain for 2020 requires more than 40% of the electricity generation to come from RE, mainly wind energy (source www.ree.es).

Regardless this relevant goal, the capacity to dispatch the whole wind potential, still represents an issue to be solved. The Spanish TSO (Red Eléctrica de España – R.E.E.) has pointed out that Spain could not use all the RE energy produced already in 2014 and 2% of this energy will be wasted. In fact, already from 2008 in several occasions wind farms are disconnected during the night due to low demand. REE has also expressed the necessity of maximizing pumped storage as a tool for the TSO to accommodate the wind energy.

Moreover it is interesting to compare the installed capacity with the peak demand; the gap between the two has been steadily growing in the last 10 years. Notwithstanding, the Spanish overcapacity problem has to be put in European context. However, the Spanish system has a larger excess capacity than other EU countries. The Spanish Ministry of Industry determined that the "demand coverage ratio" in 2011 of the Spanish system (1.73) was much higher than Italy (1.28), Germany (1.21), the UK (1.15), or France (1.09) [MIN13]. At the system level, overcapacity affects conventional assets with an underutilization, entailing a suboptimal allocation of economic resources. The main consequence for conventional electric utilities has been stranded assets and a considerable reduction in their cash flows. Furthermore, investments on new generation capacity were highly leveraged [DGE10].

From the demand point of view, Spain is still showing a poor flexibility in load management. Response mechanisms are still far to be adopted, even though TSO and relevant stakeholders have started conversations for the future opening of these services to flexible demand. The only program that allows a demand management is the interruptible service provided by R.E.E. The new regulation for this service introduces a competitive allocation mechanism managed by TSO. An auction system with face-to-face bidding is used in order to allocate the service. Two interruptible capacity products are auctioned: a first one consisting of reductions in consumption of 5 MW and another of 90 MW.

Spain can be considered a "dynamic movers" in smart meter deployment, with 3.5 million smart meters already installed (2013) and a plan to install 28 million by 2018 [CBI13].

Nowadays in **Italy** there are not granting subsidies for both Demand Response and Demand Side Management, as already mentioned in previous paragraph. On the other hand a recent regulation of May 2017 (Deliberation 300/2017/R/eel) allows a first opening to energy demand, RES and Storages with a nominal power of 1 MW and over, to participate to the service dispatching market.

Since 2007, a substantial impulse has been given by regulatory framework to promote RES power plant deployment. In 2016 Italian government, through GSE (Manager of Energy Services), has provided 12.5 billion € to producers installing a RES power plant. It is foreseen that from 2013 to 2032, the incentives amount for RES will be about 200 G€. In 2013, due to the huge number of producers involved (about 600,000) and reduced financial resources, the incentives program was reduced.

Thanks to incentives program, PV plants number in 2013 (596,355) was about 20-times greater than in 2008 (32,018).

Finally, Italian Authority evaluated that a standard domestic client, who consumes 2,700 kWh/year, will pay about 18.15 c€/kWh. In 2015, in the electric market, average unified national price has been 52.31 €/MWh [MEM15].

In **Portugal**, a recent economic innovations in the energy sector is the electricity market liberalization, with some new players emerging such as GALP Energias (previously an oil & gas retailer) foreign DSOs like Iberdrola, Endesa or Fenosa from Spain and many other smaller incomers. Also the smart metering has been recently introduced, with a reference to the relevant EDP (Portugal's major DSO, national before liberalization) project InovGrid, where the DSO installed 32.000 smart meters at clients' homes, during an initial project pilot. Besides the domestic smart meters, controllers and information systems were also deployed in order to implement a local Smart Grid infrastructure in the region around the city of Évora, where the pilot was located. EDP is currently working on the next phases to this project, planning to install 100.000 additional smart meters in Portuguese homes. Despite the above mentioned interesting and innovative project, only major DSOs currently have the economic power to invest in such technologies, with smaller players struggling to fight through a still recovering national economy, after a crisis which deeply affected all sectors of economy. Other smaller EU-funded projects are slowly implementing smaller scale Smart Grid solutions (just as inteGRIDy), a fact that denotes the big reliance of the Portuguese economy on these funds. The EV market share is expected to increase with the public support plans to buying new Evs, as mentioned in section 4.1, and the increasing viability and reducing price of batteries. Renewables are also expected to play an increasing role in the economic independence of the Country, reducing its energy dependence on importing trades with Spain.

In **Cyprus** the need for implementing the smartening of the electrical grid is within the targets of EAC (Electricity Authority) and for this reason EAC together with FOSS (Research Centre for Sustainable Energy) have already installed more than 350 domestic smart meters with dynamic prices in residential prosumers with PV installations for research purposes. The research has revealed the acceptance of the prosumer of new demand habits, which will be beneficiary both to the prosumers (reduce of the total cost of electricity) and the electrical grid (reduce of the peak demand).

Another possible analysis for implementing Smart Grid solutions lies within the transformation of the university campus into a living microgrid, which will operate exclusively by renewable energy sources (mainly PV systems). FOSS together with the Technical Services of the University of Cyprus currently carry out a market analysis in order to find the best techno-economic solution for the installation of a 10MWp PV park with at least 1MWh electrical storage. The cost-benefit analysis has shown that a larger energy storage system will be beneficiary for both the operation of the university microgrid and the utility grid (DSO, TSO) as well.

Regarding the energy efficiency, many studies have been conducted for increasing the energy efficiency of the public buildings, mainly in Nicosia district. The installation of cost-effective means for heating and cooling and the gradual evolution of the electrical grid to being smarter by introducing the right technologies and systems will certainly contribute to the increase of the energy efficiency in domestic areas.

Concerning the market actors, the DSO has provided significant incentives to the prosumers through the Time-Of-Use (ToU) tariffs, which will be valid from September 2017. According to this new pricing scheme, the prosumers will have two different pricing zones within the day (peak-hours and not peak-hours) and two different pricing categories within the year (October-May and June-September). This new energy pricing scheme is expected to help the prosumers to adopt grid-friendly energy consumption habits.

In recent years, electricity prices have risen steeply in **Greece**, in response to the removal of price caps and market liberalization. According to the average retail electricity price increased at an average annual rate of 3.2% between 2008 and 2015, while the energy part of the energy bill (i.e. the actual part of the price paid to the electricity retailer) declined by 15% during this period. Consequently, it is crucial that consumers are offered DR services and the ability to better control their costs. Some indicative examples of this framework in Greece are:

- A discount of 10% on PPC (Public Power Corporation) rates for companies with annual consumption of over 1,000 GWh, and
- An additional discount of 25% on its night and weekend rates for industries with annual consumption below 1,000 GWh.

Concerning the role of utilities, WVT will demonstrate the use of significant incentives to the consumers by utilizing Time-Of-Use (ToU) tariff schemes. According to this pricing scheme, the consumers will have two different pricing zones within the day (peak-hours and off peak-hours).

However, the cost of building new energy infrastructure is substantial and companies and investors finance the bulk of this cost. Given the scale of energy projects, they are susceptible to global economic downturns, which may create price volatility to the resource and labor markets, as well as limit the availability of credit. Variability in the international capital markets, and the implications this may have for accessing Greek finance, is impossible to predict. In Greece political and economic instability have a particularly strong impact on energy investment, given the fact that it requires a degree of trust between Government and investors, that policies will be in place, to ensure investors a return on investment (e.g. revenue guarantees, risk underwriting).

In **Romania** the implementation of the Smart Grids will have to contain advanced pricing structures, and, through the order regulation, the minimum structure will be forced to meet the following conditions [SEE06]:

- For the residential consumer there are seven types of tariffs (monomial, monomial with reservation, monomial with reservation differentiated by hour intervals), each type having differentiated values depending on the voltage level (Low and medium voltage
- For the industrial consumer there are seven types of tariffs (monomial, monomial differentiated by hour intervals, binomial, binomial differentiated by hour intervals), each type having differentiated values, depending on the voltage level (Low, medium and high voltage

The measuring systems will also have to allow the registration of the energy consuming according to the period of time and remote financial/pricing control, assuring the confidentiality of the parties' commercial data, corresponding to each consuming area.

Furthermore the measuring systems will have to allow the registration of the energy consuming according to the period of time and remote financial/pricing control, without being passed through the DSO / distributor's information system. In this case it will be used the registration of the total energy line by using the advanced pricing considering the correct calculation of the electric energy bill dependent to the chosen price.

- Annual inflation rate – 1,4
- 26.40 EUR/MWh average cost of electricity for domestic costumers, depending on the total energy consumption:
- 5.9% unemployment rate

In **France**, the current regulatory framework is particularly secure for network operators since capital expenditures are fully covered by the TURPE: Public electricity grid usage tariff.

In exchange for this secure framework, the regulator must ensure that investments in Smart Grids are made at the lowest cost. One of the tools available to the regulator is to condition the realization of investments that are both significant and risky to the success of experiments. Thus, on the basis of feedback from the experiment, the deployment of the

Linky meter of ENEDIS (National DSO) is submitted to the approval of the Minister in charge of Energy on the proposal of the CRE (National regulator).

An important communication and pedagogy role to play with consumers is to make them understanding the evolutions of the electricity system and the resulting tariff impacts. In addition, some regulators propose to smooth the evolution of tariffs over time. In France, the amortization period for investments is already 40 years.

4.3 Social impact on inteGRIDy' innovations

The Section 4.3 analyzes social barriers and obstacles to the application of inteGRIDy-like solutions in current markets.

Since the considered area is vast and the number of participating countries is large this section provides general information at European level and highlighting the most relevant issues for countries participating in inteGRIDy.

General overview

So far, there is no consensus within EU28 society as to the impact on inteGRIDy goals i.e., posing any obstacles or barriers. One could argue we're currently at a transition phase in general social awareness and public opinion over topics as Smart Grids, energy markets, energy sources, demand response or smart meters. On the optimistic side, we have, in recent years, witnessed a transition from a passive or "blind" end user, to an active and conscious customer among some more progressive segments of society. These customers are more conscious about energy generation, transmission, consumption and trading and can participate in the market through different options. Smart metering is increasing their awareness of consumption, which directly affects their behaviour, as described over a decade in [FIS08] and [WOO03]. On the other side, scepticism towards new technologies is still present and constitutes an important barrier to innovations. Lack of information about new technologies must also be considered. For instance, there is still some misinformation regarding EV. Misleading information related to short range, charging unavailability and other issues make the EV less attractive for the general uninformed public, affecting the potential to **integrate user from transport** into the grid. Despite what was previously mentioned, the power grid and market mechanisms are quite complex, with many stakeholders involved, pursuing different economic interests. Before the basic knowledge barrier is overcome, the concept of **smartening the distribution grid** might be especially abstract [GRE15]. Its mechanisms operate in the background, and it's not as "visible" as a PV system on the roof.

Energy market evolution has been characterized by liberalization and the appearance of new players (ESCO, Aggregators, Brokers, etc.) that encourage the customer to change behaviours and purchase new services (monitoring, load shifting, custom tariff, etc.). Moreover, new business models in the retail market have been developed such as tailored multi-tariffs, the possibility to buy and sell energy in virtual microgrid and peer-to-peer energy exchanges [STO16]. Although RES and Distributed Generation are slowly growing above distribution grids in every country in the EU, the market is evolving differently across the EU, affecting the effective potential of prosumers and new players (aggregators, **energy storage**, ancillary services, etc.) to participate actively.

The liberal market is today characterized by a lack of transparency for final users, causing a general lack of confidence towards retailers or operators, concerning billing accuracy and fear for extra costs [RUS16]. Besides that, the majority of consumers are not concerned with electricity supply, but rather focus on the running costs. Generally, the quality of grid power supply is still high and power outages do not currently significantly affect consumers. For industries and businesses, electricity costs are usually not the top priority for savings, compared to prices for other resources or other cost factors. Additionally, energy suppliers provide little incentives to change customers behaviour. The lack of awareness concerning smart energy solutions may therefore partially result from this passiveness on both sides.

These barriers may be reduced by stimulating public awareness for smart energy solutions and communicating their advantages, such as:

- Smart Grids contribute to stabilizing the power grid at a lower cost compared to storage options.
- For implementing **demand response** solutions, no new facilities must be planned, authorized or built.
- Intelligent controlling on generation and demand side also avoids bottlenecks on the local level, to the extent that costly extension and retrofitting of the distribution grid could be avoided in some cases.
- Throughout the whole life cycle, Smart Grids also cause less CO_2 emissions compared to electrical storage options or grid extensions, let alone new gas-fired reserve plants.

From a practical standpoint, implementing a smart energy solution and its acceptance can represent a barrier: from a company`s perspective, implementing a smart energy solution in a previously well-functioning environment may reduce reliability and evokes worries about a loss of control, if automatic switching operations are intended. Especially if industrial production processes are involved, which often consist of a series of finely tuned successive steps, companies may be concerned about potential production interruptions or quality issues. Experiences from practical applications show, however, that such problems can be avoided by meticulously planning and testing the smart energy solution. All participants must be clearly informed about the procedures in form of staff trainings, etc. Furthermore, even in a setting where devices are switched remotely and automatically by a pool operator, local staff has always the possibility to impede or override switching operations if the circumstances require [HAM13]. In a final user perspective, described technologies and solutions are quickly changing people's perceptions and uses of energy, where they not only care about cost saving, but reducing environmental footprint through sustainable solutions. Some of those, like heating and mobility, are today easily available as described in [KYR13].

Finally, privacy and data security are of course a major concern for customers, who may be worried about smart technologies affecting their data privacy. This area has been significantly improved over the past several years, with the emergence of successful privacy policies that protect consumers against unwanted third-party sharing of their energy usage and data. Customers' data and privacy must be secure for a Smart Grid to be considered a success. [BAR15].

Particular issues

In the **United Kingdom,** new house heating and cooling technology faces significant social challenges. New solutions based on RES (like solar PV or thermal and energy storage by means of electric batteries or hot and cold banks enabled by an appropriate DR, smart integrated management systems), face market penetration resistance due to lack of interest, proactivity or information from customers. Due to familiarity, and proven effectiveness, customers prefer gas heating or to switch on and off electric heating. The main issue is related to response time, these new RES-based systems perform optimally if energy is delivered at a low temperature (35ºC). Systems that deliver heat at lower temperatures require longer to heat a room and therefore should be left on all the time. However, people are used to switching the heating off when it's not in use and then switching it on again when they need heat. Renewable energy has been noted to result in behaviour changes. If people perceive they are getting 'free' energy' they will use more of it. Examples of social tenants leaving doors and windows open as the energy is free and low cost have been seen. Unfortunately, this puts pressure on the renewable energy technology that was not designed to support a significantly higher energy demand. Also, changing the source of heat from gas boilers to RES means that all the radiators also need to be changed as the UK heating systems is designed on a 82^{0}C flow and 72^{0}C return temperatures; this adds costs.

In **Spain**, the evolution of energy technologies and markets is changing the role of the final user. In recent years we are experiencing transition from a passive and end user, to an active and conscious customer that can participate in different ways to market. Furthermore, such recent events are changing public opinion:

- The increasing amount of distributing energy sources is drastically evolving the role of final users, that are now much more aware about power generation and energy grid exchange;
- Smart Grids technologies together with home and building automation allow the user to control their energy flows.
    - In particular, Smart Metering and home automation are changing the perception of final users who are now aware about their consumption. This consciousness has direct influence on energy savings behaviour and environmental footprint of prosumers. This behaviour has been well identified and described over a decade ago as in [FIS08] and [WOO03];
- Energy market evolution has been characterized by the appearance of new players (ESCO, Aggregators, Brokers, etc.) that encouraging customer to change their behaviour and require new services (energy diagnosis, monitoring, load shifting, multi tariff, etc.)
    - Moreover new business models in retail market have been developed thanks to new ICTs and liberalization. Some relevant practices concern tailored multi-tariffs, the possibility to buy and sell energy in virtual microgrid and peer-to-peer energy exchanges [STO16].
- Whether RES and DG are more or less growing above distribution grids in every country of the Union, market evolution is evolving differently across EU affecting the real possibility of an active participation of prosumers and new players (aggregators, storage, participation to ancillary services, etc.)
- Privacy and data security are of course a major concern for consumers. Moreover, by considering new AMI or data hub platform, privacy issues need to be carefully considered. Real time high granularity in smart metering is able to recognize single appliances or activities.
- In spite of some optimistic predictions in the past, market liberalization is characterized by some lack of transparency for final users. This tendency is also witnessed by a general lack of confidence from users towards retailers or operators, concerning billing accuracy and fear for extra costs [RUS16].
- Renewable technologies and solutions are changing people's perceptions and uses of energy, users do not only care about cost saving, but also reducing environmental footprint through sustainable solutions. Some of those, like heating and mobility, are today easily available as described in [KYR13].

In **Italy**, particularly concerning small customer realities, scepticism towards new technologies can constitute a significant barrier to innovations, especially when the economic advantage perception is missing. Additionally, the power system and the energy market mechanisms are complex with many stakeholders involved, pursuing different economic interests.

Summarizing, the main obstacles from a social point of view are:

- Low Interest in Energy Saving Behaviours amongst the Consumer
- Lack of Information for Industrial Consumers related to the development of Smart Grids and lack of trust about new systems reliability
- Lack of awareness and in some cases fears (data privacy) in relation to Smart Meters.

- Mistrust between Actors
- Understanding the concept of Smart Grid [GRE15].

In **Portugal**, people living in urban developed areas are aware of climate change and the basic daily life measures to reduce the impact through emissions or pollution. For instance, a developed usage state for urban waste recycling is now observed, despite recent minor concerns regarding its management and poor treatment. Recycling points are spread all over the cities and awareness is grown among the people.

There are some very active environmental and sustainable development NGOs and workgroups such as GEOTA, ZERO association or QUERCUS, with the latter having a daily 1 minute TV show airing during the prime-time newscast of the main public channel, RTP1. Environmental education is part of the public domain agenda, with other TV shows related with the topic, as well as periodic publications in big scale newspapers.

As mentioned in the previous section, the struggle to spread information and foster interest about Evs is noticeable in the Portuguese scenario, in a country which offers great conditions for the success of that technology, with small dimensions and distances to travel and a very large year-round sun exposure to integrate EV users into the Smart Grid, through PV charging or storage.

Finally, there is also an increasing social awareness about electricity consumption, with more people adopting greener lighting like LED lightbulbs, paying attention to unnecessary light switches on or unplugging equipment in standby. Sustainable mobility practices awareness has also increasingly been spread through society, with more people adopting bicycles, car sharing or rather using public transport over cars while commuting into the city. Efforts by organizations like Lisboa E-Nova (promoting the Bike to Work day) have had an impact and greatly influenced the two previously mentioned points.

The implementation of inteGRIDy solutions in **Cyprus** will provide more incentives to the prosumers to adopt ‘green’ energy and at the same time provide ancillary services to the DSO. The increased penetration of RES installed at prosumer premises and the production of cleaner energy with the consequent effect of reducing the greenhouse gas emissions are becoming a part of the everyday life. Especially in the south region of EU, where the contribution of solar energy is very high in the form of installing PV for producing electricity and solar-thermal systems for satisfying the needs of domestic hot water.

Furthermore, through smartening of the electrical grid, prosumers have access to their consumption data, and are able to control their loads more effectively. Therefore, they can be transformed from passive consumers (without any control capabilities) to active prosumers with enhanced control opportunities. Many houses within EU are equipped with smart meters, providing the close-to-real data acquisition for both the prosumer and the DSO.

Within this transition, new players will appear in the energy market, in order to contribute to this behavioural change. New services provided by ESCOs, Aggregators, BRPs, etc. can offer the direct access to the real market environment, where each prosumer will trade its own energy production from RES.

Another important factor for adopting more environmental-friendly habits is the gradual transition from the petrol engine vehicles to electrical ones. Many prosumers within EU own an EV affecting the electrical demand curve. In this changing landscape, many DSOs have seen the opportunity and installed EV charging stations, while there is significant research for providing services from the EV to the grid. In Cyprus, Electricity Authority of Cyprus have already installed 16 public EV charging stations within Cyprus, while one EV charging/discharging station will be installed within the University of Cyprus premises, where the discharging services will be for research purposes only.

A possible barrier for implementing this transition is the lack of willingness of the prosumers to use the digital tools (e.g. websites, smartphone applications, etc.) for implementing the provided Smart Grid solutions. Since usually the older people of the household stay for most of the day at home, they face many difficulties in adopting new habits and respond to the needs of the emerging Smart Grid.

How and when people use energy will have an impact on the future energy system. In Greece the energy system is currently able to meet peak energy demand. Changing people's behavior, regarding energy usage, may limit this stress. Energy companies are likely to provide what consumers want (e.g. affordability, security of supply) and this will influence how the energy system is constructed. Behavioral change will require a moral commitment to a common cause, clear and consistent long-term policy, and trust in government.

The public's perception regarding desirability and acceptance of different energy generation options plays an important role in the development of future energy systems.

Energy demand is rising, because societies are prosperous, have raised the standard of living of the residents compared to previous decades and require more energy consumption.

Privacy is another issue that become more relevant as home appliances get smarter and able to communicate. Anything connected to the web can be hacked and this thread includes the Internet of Things too. Online security and anonymity is already and incrementally will be an important issue for Smart Grid developers.

In **Romania**, In the process of assessing the technical solutions for data collection towards the SG, their transmission to the intermediary communication equipment and their elaboration in MDMs centres, DSOs have the duty to respect the legal provisions and the specific regulations considering the people protection according to the processing of personal data and their free circulation.

The DSOs and the energy suppliers have the obligation to take all the necessary technical and organisational measures to assure the security of the personal data collected by the smart meters and to make all the required updates according the law.

The consumers will be informed about the smart meters' benefits, about its standards and certifications, quality assurance and the safety of the population and the security of the personal data. Consumers will also have assured support regarding:

- usage of the smart meters;
- the monitor of the energy consumption;
- what displayed values mean;
- operating mode and;
- the communication of the recorded index;
- power restored when the energy is cut off;
- contact details for support.

Dissemination ways that are going to be used:

- Information published on its own website;
- organised information campaign
- user guides.

In **France**, giving an active role to consumers in defining future economic models for Smart Grids will involve several crucial initial steps:

- Provide better information on the nature of Smart Grids and the leverage offered to consumers when they have access to better information than at present;
- Guarantee the conditions for the preservation and sharing of information on uses and which are perceived as very sensitive by consumers;

- Provide access to information via multiple interfaces (Smartphones, computers, etc.) so as to enable responsiveness and make the use of services given by Smart Grids more common.

The regulator can also encourage network operators to better inform their consumers. For example, in France, the communication around the installation of the Linky meters was defined in consultation with the stakeholders in the framework of working groups organized by the CRE.

Moreover, in order to define "common visions" of technological deployment taking into account societal, regulatory and economic constraints and issues, ADEME develops strategic roadmaps in collaboration with external expert groups from industry, public research organizations and research funding and programming agencies.

4.4 Technological impact on inteGRIDy' innovations

The Section 4.4 analyses technological barriers and obstacles to the application of inteGRIDy-like solutions in current markets.

Since the considered area is vast and the number of participating countries is large this section provides general information at European level and highlighting the most relevant issues for countries participating in inteGRIDy.

General overview

The production and distribution of electric energy in Europe is still in a transitional phase. Each European country is facing different challenges. The technologies that are already implemented of each country differ in regulations and technical standards.

The Smart Grid is expected to revolutionize existing electrical grid by allowing two-way communications to improve efficiency, reliability, economics and sustainability of the generation, transmission, and distribution of electrical power. However, issues associated with communication and management must be addressed before full benefits of the Smart Grid can be achieved. Furthermore, how to maximize the use of network resources and available power, how to ensure reliability and security, and how to provide self-healing capability need to be considered in the design of Smart Grid [ABA14]. Transition to Smart Grid in each EU country is driven by standards and regulatory recommendations of EC. The EC, in order to assist EU countries, introduced the Smart Grids Task Force which acts as an advisor on deployment and development issues and is organized in five Expert Groups (EG): EG 1 – Smart grid standards, EG 2 – Regulatory recommendations for privacy, data protection and cyber-security in the Smart Grid environment, EG 3 – Regulatory recommendations for Smart Grid deployment, EG 4 – Smart Grid infrastructure deployment and EG5 – Implementation of Smart Grid industrial policy [COM17].

In many European countries, research and development in the Smart Grids area are constantly increasing aiming to support the transition to a secure, efficient and sustainable electricity grid of the future. In this context, the European national activities are in different stages of development, ranging from fundamental research (proof of concept) projects in some countries to the built up of large scale demonstration and pilot sites and finally starting with the implementation and roll-out of smart technologies and solutions. Regardless of the different development stages, national Smart Grid stakeholders share the common goal with the European Technology Platform (ETP) on SmartGrids: to advance the development and to facilitate the way to a smarter grid [NHA16]. One of the goals is to replace at least 80% of electricity meters with smart meters by 2020. Each EU country adopted its own policy to achieve this objective. The smart meters will allow new technologies to enter the energy market and new research perspectives on many scientific fields, especially on Smart Grids, artificial intelligence and data mining. inteGRIDy's research on Demand Response, Smartening the distribution grid, Energy Storage Technologies and Smart Integration of grid users from Transport are cutting edge technologies and many of the obstacle that have be to overcome are due to pre-existing differences on standards and regulations in EU countries.

An essential feature of a Smart Grid is the use of information and communication technology to gather and act on information in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production, transmission, and distribution of electricity [USD14].The definition and description of the Smart Grid are not necessarily unique, as its vision to the stakeholders and the technological complexities can be different [CEA10]. In this section, the main technological obstacles and barriers found nowadays for smartening the distribution grid, implement demand response techniques, implement energy storage technologies and the smart integration of grid users from transport will be described.

Obstacles and barriers that are related to security issues come from the public opinion. The main concern is about the data transmitted into Smart Grids through smart meters, which may contain sensitive personal information. On the one hand, the legal authorities are responsible for these issues but on the other hand, the implementation of the regulations is a technical matter. In many cases it creates obstacle not easy to overcome, especially when each country adopts different regulations.

Further on we will try to clarify the current condition of Europeans Union countries and its technological trends in the countries with pilots in inteGRIDy project.

Particular issues

In the **UK** domestic sector, two technologies have dominated renewable energy deployment to date – PV and bio mass. Both have been strongly supported by government subsidies. Deployment has slowed as the subsidies have reduced. In the case of bio mass, although not directly relevant to inteGRIDy, except of note, the market was entirely driven by subsidies – as subsidies were withdrawn so the market collapsed. With PV, although installations slowed following the cut back in government support, there is still an underlying economic case for deployment and the PV business remains secure, although at a lower base than before.

Wind is making a major impact on decarbonizing the electricity grid. However the increasing contribution from wind and PV (over 50% of electrical energy from renewable sources were reached on January 8th 2017) is placing pressure on the grid to cope with fluctuating supply. Battery and demand response services are at a premium.

In this environment of increasing intermittent renewable energy supply, the inteGRIDy solution set is timely.

In **Spain**, the integration of large capacity of RES with intermitting generation has evolved the traditional operating behaviour in networks, where unpredictable power peaks occur with no connection to the demand. Some Member States are prioritizing investments on grid reinforcement, while others are challenging flexibility issues. Of course, many technologies and innovative solutions must be adopted together with new interconnection lines.

- Spanish TSO developed an operation unit (called CECRE) integrated in the main control centre in order to manage RES generators with a minimum nominal power of 5MW. CECRE is equipped with sufficient control and command capacity to act as aggregators of information with nearly real-time communication (12 seconds) with facilities. This is definitely a powerful instrument to maximize renewables dispatch, but further steps are needed for a full implementation. Distribution Control Centres are implementing updated solutions for a better monitoring and control power sources and ADMS (Advanced Distribution Management Systems) are coming today tangible assets. Research is leading the way towards new control algorithm and artificial intelligence in order to support control centre operators through Optimal Power Flow, Volt/Var regulation, Conservative Voltage Regulation, Topology Processors or Storage Management. Micro and nanogrid optimal control represents as well a crucial step in tomorrow's distribution network management, where the transition towards a decentralized operational logic seems to be a potential trend.

- The availability of huge amounts of data coming from meters and sensors represents a challenge for their management and exploitation in a proper way. On the other hand this is leading to a scenario where Data Analysis is playing a central role in network operation thanks to new IT solutions as: Big Data, Data Mining, Artificial Intelligence. These tools may help to extract added values –than just monitoring- from such a large amount of information. Basically, algorithms like pattern recognition and very short term forecasting of generation and loads are fundamental tools for grid balancing. Further solutions are oriented to Revenue Protection through technical and non-technical losses estimation or resiliency enhancement through predictive analysis [DIA15].
- Smart Metering is of course one of the most challenging aspect towards a complete Smart Grid evolution. Its whole system denoted as AMI (Automated Meter Infrastructure) has not to be considered as remote reading only, but as a bidirectional communication channel between DSO/Supplier and Customer. Next steps concern the integration of a User Interface, mechanisms for multi-tariff, dynamic pricing (at least 6 times a day) or spot pricing, nearly real time reading. Further advanced implementation may include reactive power exchange or supporting demand response [EUR16]. There are three main DSOs today in Spain (Iberdrola, Endesa and Gas Natural Fenosa) and this market division has also affected the technology deployed for smart metering. Approximatively the 70% of meters are today installed in Spain and each DSO adopted its own protocols and standards for metering: PLC Prime, Meters and More, Cosem. This aspect could slow down inteGRIDy application in real application across different distribution grids
- Electric vehicle charging infrastructure is growing at different speed across European Union, but of course many steps need to be walked till a full accomplished infrastructure. It is commonly accepted that it is going to handle billing, scheduling and other intelligent features for smart charging (Grid-To-Vehicle or G2V) during low energy demand. In the long run, it is envisioned that large charging installation will provide power system ancillary services such as capacity reserve, peak load shaving and Vehicle-To-Grid (V2G) regulation. This will include interaction with both AMI and customer-side systems. In Spain the EV markets is increasing but it is below 1% of the total vehicles sold in 2016 and far away from other northern Countries in Europe. Main causes are: the lack of a precise roadmap at national level and recent economic crisis that affects purchasing power. Apart from that there are the well-known criticalities in distribution grids if powering a large amount of charging stations at the same time.

Over recent years the great interest in renewable energy and the advances in technology have led to a capital cost reduction of green energy production plants. Nowadays more and more people install in their homes renewable energy production plants even though they cannot satisfy their energy needs mainly because of intermittence of generation (e.g. PV arrays). The new challenge is to conceive a micro grid model that ensures the independence of its participants, integrating production and load by means of advanced management systems. Such modelling could lead to a situation in which it is no longer necessary to have people concentrated in a small area where energy is supplied, allowing them to take advantage of new rural areas, exploiting environmental resources. In such a context, it becomes crucial to improve and implement smart home systems, smart renewable energy management systems and cyber security.

In Italy, the current adopted meters (1G) are not suitable to sustain DR services; is therefore necessary their substitution with more sophisticated meters (2G).

Last but not the least, since interoperability is fundamental within Smart Grid technology, the definition of new standards is strictly necessary.

Since the solar capacity in **Cyprus** is very high, there is an increased penetration of PV installations, which will gradually need investments for new grid infrastructure. However, the transition from the net-metering scheme to more self-consumption (with the respective integration of energy storage systems) and the smartness of the electricity grid will lead to deferral of investments. Regarding the long-term electrical interconnections with other countries, new studies have been submitted for connections with Greece (Crete island) and Israel. The DSO has introduced into the local Grid Rules the utilization of all smart advanced features of inverters for dynamic response to system needs. The adaption of these advance features is helping the grid enormously.

Furthermore, the DSO in Cyprus is pushing the adaption of a roll out policy for smart meters to be completed by 2025. This policy approach together with the introduction of time of use tariff as from September 2017 in order to have access to real-time consumption and generation data will improve demand side management practices and create the possibility for aggregated demand response possibilities. In order to successfully deal with the high penetration of PV installations and the voltage profile violation issue, the installed inverters are obliged to have reactive power capability and more specifically they should operate at power factor 0.9, following an extensive study conducted by EAC.

Since the electrical grid of Cyprus is considered weak, the increased penetration of RES will provoke new grid problems, such as frequency deviations, voltage violation, increased harmonic injections, etc. In order to deal with the emerged issues, the prosumers should become more active and adopt more grid-friendly habits. The technological innovations of inteGRIDy will help in this direction by controlling more effectively the power generation and consumption, in order to contribute to the smartening of the electrical grid without needing further investments for new grid infrastructure. However, the market rules in Cyprus are still not covering procedures for the adaption of storage systems and more over they do not offer any financial reasons for such an investment. Things will improve slightly with the introduction of smart meters and time of use tariff but additional policy decisions are necessary the platform planned through inteGRIDy to be fully operational.

Greece follows the promulgated European regulations, while government is pushing the adaption of a roll out policy for smart meters to be completed by 2025. This policy approach together with the introduction of time of use tariff in order to have access to real-time consumption and generation data will improve demand side management practices and will create the possibility for aggregated demand response possibilities.

Another key part of the EU strategy, which will play an important role in further developments in the wider energy market in Greece, is the involvement of renewable energy sources in the energy mix. The target set by the European Union is that in 2020, RES will reach 20% and 27% by 2030. The conditions in Greece favor the exploitation and use of renewable energy sources (photovoltaics, wind farms) but despite the efforts made, the penetration of RES is not at the expected level, because only 22% of Greece’s energy needs are covered through RES. However, the trend that a few years ago used to install photovoltaic parks by individuals seems to have been abandoned. Something to be expected after the changes that have taken place lately, and especially following the change in the way producers are compensated. The current price has been significantly reduced and the profit margins and ROI have made such an investment less attractive for residential owners, while the prices cannot be considered as guaranteed.

The penetration of alternative energy sources in the energy mix in Greece is at early stage. The market rules in Greece are still not covering procedures for the adaption of batteries energy storage systems and more over they do not offer any financial reasons for such an investment.

Things are expected to be improved with the introduction of smart meters and time of use tariff, however additional policy decisions are necessary for the platform planned through inteGRIDy to be operational. Currently there are trials programs for installation smart meters in Greek households. For instance, the electricity provider WATT+VOLT installed 300 smart meters as a trial program at consumers, in order to gather valuable information and data on how residential consumers react and interact with devices. In addition, smart meters are empowering consumers to change their energy behavior. Therefore, energy information is key to penetration smart meters.

In **Romania**, according to a project of regulating Smart Meter implementation in Romania, the Architecture of the national SG implementation will contain:

- Embeddable meters in the SG for measuring the electric energy in the place of consumption
- Communication and data processing infrastructure which will assure the bound between the meters, equipment of the consumption place and the collection trading systems, the validation, DSO data repository and administration (communication lines for data transmission, concentrators, auxiliary gadgets for data transmission);
- Collection, validation, storage and processing data infrastructure.

The Smart Meters will include:

- The measuring sub-systems which contain at least the meter, measurement transformers and security systems of control access;
- The data transmission sub-systems;
- The meters' administration data sub-systems.

In **France**, making Smart Grids is also about instrumenting them to make them smart. This is why French players are also committed to manage the risks inherent to the use of telecommunications technologies. The French network is particularly safe, not only in terms of "security of electricity supply", but also in terms of cybersecurity. The French players are very involved in the field of infrastructure protection, as well as in the associated services and the network information system in the broad sense. The use of the EBIOS® method allows, for example, guaranteeing a high level of security of the Information Systems of French operators.

- Created and regularly updated by ANSSI (National Agency for Information Systems Security), this methodological approach provides a comprehensive and coherent view of the security of information systems. Thus, it provides a common vocabulary and concepts, allows to be exhaustive and to determine objectives and adapted safety requirements. The method takes into account all technical entities (software, hardware, networks) and non-technical (organization, human aspects, physical security). It makes it possible to involve all the actors of the information systems in the security problem and also proposes a dynamic approach that promotes the interactions between the different functions of the organization by studying the whole lifecycle of the system (design, realization, implementation, maintenance ...).

4.5 Legal impact on inteGRIDy' innovations

The Section 4.5 analyses legal barriers and obstacles to the application of inteGRIDy-like solutions in current markets.

Since the considered area is vast and the number of participating countries is large this section provides general information at European level and highlighting the most relevant issues for countries participating in inteGRIDy.

General overview

In the heavily regulated energy sector, legislative and regulative barriers have an enormous leverage on business cases and implementation strategies for smart energy solutions.

Smart energy solutions always have to be assessed in the context of the existing market mechanisms. At the moment in EU countries these still reflect the logic of a centralized electricity system: electricity markets are currently laid out to trade amounts of energy. Whether a producer or consumer is able to quickly provide a certain (positive or negative) load, is currently not valued. In a future power system mainly dependent on renewables, however, there will be an abundance of energy produced in some moments, and an acute shortage in others. This means that it will be essential to have flexible capacities on hand at all time to ensure this, it will be necessary to develop a market structure which rewards the provision of flexible potentials, regardless of how much they are actually called upon.

Markets for reserve capacity already do exist in the current market structure, but regulations are tailored to suit traditional production units like larger gas power plants. The minimum amount for offered load is often too high for flexible consumers, even within pooling concepts. A further barrier is the obligation to offer reserve capacity throughout a rather large time slice which excludes many potentials on the demand side. In order to exploit relevant potentials in the industrial or commercial sector, market access requirements should be adjusted so that smaller load amounts can be offered, and/or for a shorter time.

Besides from general market structures not favouring demand side potentials and flexible producers, there are other regulative barriers that are indirectly affecting business cases. In fact, even though the possibility exists to pool several smaller demand side potentials for the reserve capacity market, the operators of such pools face difficulties in the implementation. They mainly result from the unbundled structure of the energy sector, meaning that electricity generation, transmission, distribution and sales have to be conducted by individual companies. Demand Side Management measures have implications across these separated areas. Currently, there are no established procedures for that, so that a handful of separate contracts and agreements have to be concluded to connect a single consumer to such a pool (Aggregators) [HAM13].

Moreover, the deployment of Smart Grids opens up a large spectrum of new services related to flexibility and efficiency. However, in most European countries, small and residential consumers are limited in their ability to offer these services on designated markets, due to regulatory obstructions. These barriers are usually in place with the aim of protecting consumers against unfavourable market conditions or malpractices by competitive players [GRE15].

Regulations and infrastructure situations vary widely around Europe. In some cases, policies or incentives stimulate power generation, encouraging consumption rather than savings. In some states, energy suppliers are responsible for the installation of smart meters; in others, the grid operator is responsible. Some markets are regulated by flat tariffs, making it difficult for utilities to offer customized pricing schemes or demand response. In still others, regulatory incentives have led to largescale deployment of smart meters, but differences between the daytime and night-time cost of electricity are relatively small due to the abundance of hydro storage, reducing the incentives generated by dynamic pricing[VDZ11].

Implementing smart energy solutions in existing facilities and devices implies high costs, however, whenever facilities are newly constructed, remodelled or modernized, additional costs and planning requirements for Smart Energy Networks are modest. Legal standards that already require new buildings to use a certain share of renewable energies could be modified to make the implementation smart energy infrastructure obligatory, for example a smart metering and load management system for industrial properties. Also, in newly developed areas, zoning regulations could enforce the implementation of a district heating grid and decentralized CHP [HAM13].

GREAT project identifies a series of regulatory issues to entry into the marketplace that have a negative effect on the development of the Smart Grid Market.

- The current Regulatory Frameworks deliver uncertainty in relation to roles and responsibilities and the sharing of costs in the Smart Grid Sector.
- Regulations imposing minimum requirements for service for qualification for participation in Wholesale Markets
- Discouraging the development of Small Power Grids
- Regulatory uncertainty with many actors involved
- Securing Optimum Regulation to ensure optimum balance between cost and benefits. [GRE15]

Examples of how each country's regulations impact the deployment of INTEGRIDY are given in the following sections. Note in particular the contrast between the market regulation in UK, Romania and Greece as compared with how the challenges are being addressed in Italy.

Particular issues

In the **UK** market the legislative and regulatory frameworks have an enormous impact on the deployment of inteGRIDy thinking and approach. Consider the following three examples:

1) Sharing energy collectors – most renewable energy deployed in the residential are driven by solar energy. Energy is collected through the roof of a building (PV and solar thermal) or ground (ground source heat pump). In most cases its inefficient to have one collector for one building. The most efficient deployment of such technology is to maximize all south facing roofs or to maximize the available ground space, irrespective of who owns it.

The current legislative framework to allow for shared energy collectors while properties are bought and sold has not been put in place.

2) A further blocker to shared energy collector is the fact that a 'private wire' is not allowed in the UK under current regulations. This prevents electricity being collected from one house sold to another over a 'private wire'. All energy has to be bought and sold over the grid.
3) The amount of capital deployed to implement renewable energy systems requires many years of constant use to be recovered. Most energy projects are funded over a 20 year term. An energy sale would be the obvious way to fund the capital purchase. But the regulator will not allow the consumer to be locked into an energy sale contract for 20 years. Consumers can change after 30 days. In the commercial market such long term contracts are allowed, but not residential.

These three examples illustrate that the legislation around property law lags someway behind what is required. In the UK we have laws that are based on medieval concepts of property having to adapt to a 21st models of sharing energy. There is a bust.

It's true though UK property law is based on case law that has its origins back to Edward II (1300 ad). We are writing the energy legislation now to match the evolving new technologies. Clearly there is an issue relating property law and the rights of the freeholder to an energy market in which energy generating assets sit on a freeholders property

Similarly the regulator is designed to protect the consumer from dominant energy utility companies. The energy landscape is fragmenting into a number of smaller companies offering differing types of solutions. The regulator has not caught up.

In **Spain**, distributed generation active power curtailment requires the DSO to request the TSO to reject generation schedule from the market solution –obviously if such unit is taking part in it– as part of the network constraints solution process conducted by the TSO to the day-ahead market solution. In any case, the final decision to reject that DRES generation schedule belongs to the TSO.

Also and only under emergency situations, the DSO could remotely trigger a relay (compulsory for installed power above 5MW) isolating the distributed generation installation from the distribution grid.

In the same way, the Spanish regulation for reactive power injection defines a general calendar and timetable aimed to adjust distributed generation reactive power through incentives. Both calendar and timetable are defined at power system level irrespectively of the effect on the distribution network.

In Spain, demand-side resources are not allowed to participate in the markets, or they are allowed to participate just in one programme. For example, loads can only participate in one specific scheme (interruptible contracts), which is rarely triggered. The rest of the balancing and ancillary services can only be accessed by generation. So, the current flexibility of the Spanish electricity market is not very flexible.

Aggregation is not legal in the Spanish electricity system and there is only one scheme allowing Explicit Demand Response: the Interruptible Load programme. The scheme, which is reserved only for large consumers, is managed by the TSO, Red Eléctrica de España. The programme acts as an emergency action, in case the system is lacking generation and the balance resources are not enough.

The **Italian** main actors of regulatory framework are the Italian Regulatory Authority for Electricity Gas and Water and the Ministry of Economic Development. In detail, *the Authority core regulatory competences refer mainly to the definition and maintenance of a reliable and transparent tariff system – reconciling the economic goals of operators with general social objectives and promoting environmental protection and the efficient use of energy- the setting quality of service standards and the definition of a framework aimed at the protection and empowerment of consumers in competitive markets.* From the Smart Grids energy services point of view, although new economic actors (e.g. aggregator) and different strategies (e.g. DR) are born in the European energy market, they have not been defined and regulated by the Authority yet.

Otherwise, financial resources have been assigned to test DR strategies, storage at substation level and EV charging stations in eligible trial site. Resources have been deployed with resolution 39/10 [LAU10].

As for legal impact, innovative forms of remuneration are expected. Therefore, it is foreseen the definition of new services, offered by prosumer and DSO. Innovation expected are based on near to real time measures and a proper energy management system; refunding flexibility as a service.

As to the DSO, new businesses can be opened by the Smart Grid evolution and the microgrid flexibility integration in the local energy network; in actual fact, DSO shall operate as technical aggregator for existing facilities in which prosumers and customers, making up a micro grid, need to be correctly managed in order to efficiently run them. New tools managing power flow, saving energy and ensuring financial sustainability have to be developed to reach this goal. Regarding the ancillary energy services market, micro gird can offer flexibility to manage electric loads (e.g. CHP, electric storages) and primary resources (e.g. natural gas, biomass). Supplying flexibility to DSO the energy management system installed at the microgrid node can provide either an optimization of energy resources and, whereas it is necessary, ancillary services.

In **Portugal**, the buildings sector is responsible for approximately 30% of final energy consumption. DGEG estimates that 50% of this consumption can be reduced by 50% through energy efficiency measures. Energy efficiency requirements for residential buildings were first introduced in Portugal in 1990 and for non-residential buildings in 1998. In 2006, building codes were revised for all buildings as a result of the transposition of the Energy Performance of Building Directive (EPBD) 2002/91/EC, later replaced by the transposition of Directive 2010/31/EU, which entered in force on 1 December 2013.

More than 100 energy service companies (ESCO) are registered in the official DGEG (Directorate-General for Energy and Geology) database. This database, established in 2011, integrates information about companies that want to develop energy performance contracts (EPC) with the central government. In 2015, the Decree-Law 68-A/2015 of 30 April was published, establishing that all rules applicable to central government are also applicable for regional and local public bodies that decide to use energy performance contracts. The first EPC in the public sector is being implemented under this mechanism. It was developed by the Lisbon municipality, and will deliver the replacement of 20.000 incandescent lamps from the traffic lighting system to LEDs, resulting in approximately 94% energy savings.

For PV generation, the current legislation is the Decree-Law 153/2014 of 20 October, also known as a self-consumption law. This regulatory framework replaced the previous two regulatory frameworks, for micro-generation and the mini-generation. The micro-generation law (Decree-Law 363/2007), was applicable only to very small systems up to 5.75 kW (general regime) and 3.68 kW (special regime), this last one remunerated at quite high IT (feed-in-tariffs).

Many different Decree-Laws (DL) and Resolutions of the Council of Ministers (RCM) have been rolled out over the last 8 years to establish and define the objectives and new measures for electric mobility in Portugal, the incentives to stimulate demand, the regulation for market operators, as well as many technical and safety specifications as charging stations allowed power load, etc.

The Commercial Relations Regulation, approved by Regulation No. 561/2014 of September 22 states the obligation of definition of a Guide of Measurement. The Directive nº 6/2016, of February 26, establishes the Guide for Metering, Reading and Availability of Data of the electricity sector in Portugal. This measurement guide is a very detailed document, describing almost all aspects related with legal obligations about metering for the several agents: retail commercialization companies, DSO companies, TSO, producers, market operators, facilitators (aggregators), mobility network operator. Besides the metering guide, there is more legislation. The Directive no. 10/2012, of 5 July, details the monetary compensation for metering errors. The Ordinance no. 231/2013, of July 22, describes the technical and functional requirements of smart meters.

The most important law covering the subject is the Commercial Relations Regulation, approved by Regulation No. 561/2014 of December 22. The purpose of this Regulation is to lay down the provisions relating to commercial relations between the various parties involved in the National Electric System (SEN), as well as the commercial conditions for connection to public electric networks.

CERA (**Cyprus** Energy Regulatory Authority) promotes the smartening of the electrical grid by permitting the installation of smart meters in domestic prosumers. Furthermore, CERA has the responsibility of the energy tariffs and will implement a time-of-use (ToU) pricing scheme, which will be valid from September 2017. In this new pricing scheme, the adoption of more grid-friendly solutions is highly promoted.

Regarding the RES, the net-metering and self-consumption scheme is currently applied, where the energy from the RES will be either exported to the grid in order to meet the energy consumption or will be stored in order to be used in a more efficient way and / or increase self-consumption. Furthermore, many EV charging stations are agreed to be installed within Cyprus (till now there have been installed already 17 EV charging stations).

In this way, CERA's decision are fully in line with the proposed solution of inteGRIDy.

Regarding the Battery Energy Storage Systems (BESS) in **Greece**, there is lack of regulatory frameworks; therefore, they are normally treated as generation systems. Although several regulatory efforts have been conducted to ensure these systems are covered by a legislative framework, these actions have not given any thrust.

The European Directives about the smart metering and DR are: 2006/32/EC which is on energy end-use efficiency and energy services, 2009/72/EC which is concerning common rules for the internal market in electricity applying on the Greek Electricity Market and 2012/27/EU which on energy efficiency. Characteristic examples in Greece of this framework are: (i) a discount of 10% on PPC rates for companies with annual consumption of over 1,000 GWh, and (ii) an additional discount of 25% on its night and weekend rates for industries with annual consumption below 1.000 GWh.

The Law 3471/2006 of the Hellenic Parliament is the protection of fundamentals rights and privacy in particular, and the establishment of the conditions for the processing of personal data and the reservation of communication confidentiality in the electronic communications sectors. Also, the Law 2472/1997 protects citizens' rights compare with those who keep and process their personal data (Data Controllers).

In **Romania** energy legislation is still quite young. Given its relative immaturity, there has been little thought given to Smart Grid systems. Therefore there is no legislative support for Smart Grid thinking or for companies to make the investment in such processes:

- there is a lack of legal clarity regarding energy legislation
- the Power systems are regulated and are complex
- the introduction of the Smart Grid has the potential to increase taxation and possible impacts on energy price to the consumer
- the network operator and utilities have monopoly positions and have no incentives to take on these innovations.

Even so, Romania is driving in the renewables direction, as the president of Romanian Energy Regulatory Authority released a Decree, to be approved by the end of the September, 2017 which will apply for all the actors involved in the Smart Grid implementation process: the DSOs, energy suppliers and consumers and facilitates access to new business models for stakeholders.

4.6 Environmental impact on INTEGRIDY' innovations

The Section 4.6 analyses environmental barriers and obstacles to the application of inteGRIDy-like solutions in current markets from application and technologies used in harnessing power from RES point of view.

General overview

On the one hand, the InteGRIDy project sets out to integrate cutting-edge technologies, solutions and mechanisms and connects existing energy networks. This will enable a continual take up of renewable energy solutions. Note therefore that the focus for the project is integration and creating a platform for communication. In this context, there are no environmental barriers to InteGRIDy deployment. The creation of software systems and an integration platform is not prevented by environmental concerns.

Carbon reduction is a Key Performance Indicator that will be managed through the inteGRIDy project (see WP1.4). In particular the project will assess the annual and lifetime carbon reductions in delivered through each InteGRIDy pilot project. These will be presented against the embedded carbon within the technology components of the pilots. The quantification of carbon reduction for each pilot, summed at the regional, national and EU scale will be make an important contribution to helping understand the 'value of carbon' and the design of the optimal fiscal measures that are inevitable if the globe is to meet the COP21 climate change targets. At the national level inteGRIDy carbon abatement data will help each participant in lobbying their governments to tackle the barriers to deployment fully described elsewhere in this report.

On the other hand, considering technologies and the idea of adding RES to the GRID there are some environmental impacts that industry tries to mitigate. The usage of RES also has an impact on the landscape; in particular, the photovoltaic plants are reducing the land for agriculture. Also, the usage RES in a large scale effect on flora and fauna and cause electromagnetic fields [DIN11]. Finally, there is a visual change in the landscape and the countryside acquires an industrial image.

Considering [IPC11] report and issues raised by the Union of Concerned Scientists we have summarized in Table 5, below, the advantages, benefits and environmental impact of RES.

Table 5. Advantages, benefits and environmental impact of RES

	Wind power	Solar power	Geothermal energy	Biomass for electricity	Hydroelectric power	Hydrokinetic energy
Advantages and benefits	• Sustainable • Clean • No toxic pollution • No global warming emissions • Viable large-scale alternative to fossil fuels.	• Sustainable • clean • No toxic pollution • No global warming emissions	• Limitless potential • Health benefits (cooking, bathing, and therapeutic applications.) • Widely available • High efficiency	• Carbon neutral • Widely available • cheaper compared to fossil fuels • Reduces amount of waste in landfills	• Cheap source of energy • renewable resource • flexible (can be directed to meet variation in demand) • Boosts the electric grid • Eco-friendly	• Renewable • Predictable • Green • Effective at Low Speeds
IMPACTS						
Land use	• they use between 30 and 141 acres per megawatt of power output capacity	• concerns about land degradation • PV systems range from 3.5 to 10 acres per megawatt, • CSP facilities are between 4 and 16.5 acres per megawatt.	• approximately 13 acres per megawatt. • Land subsidence risk	• affect land use • Risk of deforestation	• Flooding land affects agricultural land, and scenic lands	• Tidal power plants needs to be constructed close to land.
Wildlife and	• most notably	• Habitat loss	n/a	n/a	• Flooding land	• Tidal

Habitat	on birds and bats	concerns			destroys forest, wildlife habitat and aquatic ecosystems. • fish and other organisms can be injured and killed by turbine blades.	barrages relies on manipulation on ocean levels
Public Health and Community	• Sound and visual impact • Partial community acceptance	n/a	n/a	n/a	• uses up valuable and limited natural resources	n/a
Water Use	n/a	n/a	• impacts on both water quality and consumption	• Requires a great deal of water	• uses up valuable and limited natural resources	n/a
Hazardous Materials	n/a	• hydrochloric acid, sulphuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane, and acetone. • PV Cells have gallium arsenide, copper-indium-gallium-dieseline, and cadmium-telluride[	• The water has high levels of sulphur, salt, and other minerals	• emits 16% more Nox as bituminous coal, 50-60% more CO2, 6 and similar levels of particulate matter – but biomass is worse for small particulate matter (PM10) and far worse for the finest	n/a	n/a

				and most dangerous particulate matter (PM2.5)		
Life-Cycle Global Warming Emissions	n/a	• between 0.07 and 0.18 pounds of carbon dioxide equivalent per kilowatt-hour.[2]	• In open-loop geothermal systems, 10%of the air emissions are carbon dioxide, and a smaller amount of methane, • In closed-loop systems, these gases are not released into the atmosphere,	• affects life-cycle global warming emissions.	• Global warming emissions are produced during the installation and dismantling of hydroelectric power plants	n/a
Air Emissions	n/a	n/a		• involve the combustion of a feedstock to generate electricity	n/a	n/a

[2] estimates of life-cycle global warming emissions for natural gas generated electricity are between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour and estimates for coal-generated electricity are 1.4 and 3.6 pounds of carbon dioxide equivalent per kilowatt-hour

EU is an influential actor regarding the environmental politics across its 28 member states. Official EU environmental actions are identified from 1972, where the Paris Summit of leaders of the nine member states took place, initiating the practise of developing Environmental Action Programs (EAPs). Currently, the 7th EAP articulated priorities for incentives of the targets of 2020 and outlines a broad vision of sustainability for 2050 [EUR14]. EU bodies rely on both command-and-control style approached and some market-based instruments, such as Emissions Trading System (ETS) for reducing GHG emissions. The EU also makes limited use of assuasive policy instruments, such as voluntary agreements and eco-labels [WUR13]. The EU environmental policy is guided by several principles, which include the principle of polluter pays (polluters should bear the burden of mitigation and clean-up costs), precautionary principle (cost-effective measures to prevent environmental degradation), subsidiary and proportionality principles [SEL15].

Clearly in each participant country there are environmental regulations within which renewable energy systems have to comply. However the deployment of individual technologies is not the concern of InteGRIDy and therefore an analysis of environmental regulations and their impact on individual technologies (wind, solar in particular) is not considered appropriate in this report.

Since the considered area is vast and the number of participating countries is large this section provides general information at European level and highlighting the most relevant issues for countries participating in inteGRIDy.

Particular issues

In **Italy**, installation and running of electricity generation plants, including RES, require specific authorizations from competent authorities (e.g. Municipalities, Region, etc.) in order to ensure environmental safeguard. Therefore, bureaucracy very often can complicate, slow down or stop the authorization process.

In **Cyprus** the high solar energy creates significant potentials in further promoting clean energy solutions for both producing electricity (e.g. through PV) and heating (e.g. hot water) from the sun.

Some events (e.g. nuclear accident, storm damage to a wind array) may not have precedence within the **Greece**. However, for some, future energy systems must be considered, to ensure the risks are not underestimated. Placement of future energy system infrastructure will need to consider the likelihood of accidents and their impact on local surroundings, as well as assess the impacts of climatic events (e.g. increased flood events, rising sea levels), to ensure safety of energy supply.

During the last decades in Greece, a great amount of government funding boosted the installation of large scale PVs sacrificing thus huge amount of cultivating land. Since then local communities retain negative attitude towards the installation of new PV infrastructures since they seriously damage the landscape. Moreover, considering that tourism is considered the heavy “industry” in Greece, the reactions of civilians towards installation of new PV parks and Wind Farms increase, since this infrastructure highly influence the local beauty of tourism destinations.

In **Romania**, the environmental performance has significantly improved since 2007. Although the environmental legislation is in line with the agreed directions of EU, their implementation remains a challenge, particularly in waste management and waste-water treatment. Regarding the installed smart meters and their corresponding electromagnetic field, the DSO will execute measurements in order to ensure that they will not exceed the non-hazardous limits. All installed smart infrastructure will comply with the EU electromagnetic compatibility rules.

France has delegated several environmental competences at regional and local level, while keeping the assessment of environmental impact at national level. In order to allocate more competence on sustainable development (e.g. more RES integration to the grid) to regional level, the “NOTRe” action (Act on the new territorial organization) has been started. The three main challenges are the improvement of the air quality (by taking effective actions to reach EU-based air pollution limit values), the improvement of water quality and the protection of biodiversity.

France draws up a national action plan on energy efficiency every year and the energy consumption reduction follows environmental policies concerning CO_2 reduction.

5 Conclusions

PESTLE analysis revealed that EU-28 roadmap and legal framework support inteGRIDy-like frameworks, mainly on political, environmental and social approach. On the other hand, considering the specific issues in the PESTLE the major obstacles come from legal, economic and technological perspective.

Anyhow, identifying obstacles and barriers does not prevent from an eventual full and successful deployment of inteGRIDy's innovations. On the contrary, early identification of these issues directs the development on the right direction so as to overcome them. Therefore, future inteGRIDy's deliverables and actions will use this input as basis so as to guarantee the proper adaptation to the already known obstacles.

Most of pilot countries mentioned that the political factor is supportive as strategies and lobby activities increase awareness and launch legal initiatives. Moreover, the EU policies are also in line with inteGRIDy's initiatives, which gives the project a full back up in this respect.

The environmental impact is also positive as it recognizes the advantages of implementing inteGRIDy-like solutions. There exist a wide plethora of national and international initiatives to cope with this environmental impact reduction, so the endorsement in this respect is expected to be high.

The social factor may have a negative impact if the public debate fails to be comprehensive and consistent, people tends to lose trust in controversial initiatives. Individuals and communities usually accept progress and believe in potential long-term benefit when the case is clearly explained and well argued. It is, thus, critical, to disseminate inteGRIDy's results properly and present the inherent social value of proposed innovations in a way that it proves their benefits clearly.

Approaching the Legal factor it has been noticed that the transposition of any new EU Directive is a fight against the existing market mechanism regulations and potential divergent interests. In any case, the long term trend should be alignment with such directives. The goal on inteGRIDy in this respect will be, thus, driving the change through clear market benefits and the adoption of profitable business models.

As the consumer becomes active in the value chain the economical factor needs to consider how to motivate consumer behaviour to create the desired trends. The economic factor may be a barrier considering the prioritization of investment and budget allocation. inteGRIDy, having the focus on the distribution grid, should aim at providing innovative solutions oriented to DSOs and Utilities, helping them engaging customers and enabling the use of models from which both parties could benefit.

Implementation of cutting-edge technologies comes together with a need for competences. Infrastructure and human resource costs are very high and weigh a lot in the decision of implementing large-scale solutions, like inteGRIDy. The process of collecting and processing of data (i.e. data mining) are also very expensive.

All in all, this document has served as placeholder for the initial analysis of obstacles and barriers. The information will be used from this point on to assure inteGRIDy's proposals are aware of such obstacles and prepared to overcome them.

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Annex I. Focus Group template

[Template card to be used in order to elicit specific issues of Ploiesti use case]

Subject / Topics

Implementing the EIIS (Energy Integrated Information System), a solution to automate the process of DR based on smart meters infrastructure in residential areas – Obstacles and barriers.

Objectives

- To elicit the approach / factual approach (ideas, opinions, attitudes, consumers behaviour…) about Demand Response (DR) use case in Ploiesti (Pilot 9)
- To elicit possible obstacles and barriers influencing the Pilot implementation

Type of focus group

- Traditional (F2F)

Actors engaged

- Moderator: Project Manager
- Participants (4): 2 electrical engineers, 1 consultant in energy field, 1 IT specialist
- Observers (2): 2 Business Analysts

Participants from ELECTRICA (DSO) and SIVECO Romania (Technological partner).

Discussion guide

Open questions

1: Determine the stakeholders / actors

2: Structured/regularized versus liberalized energy market (economic impact, legal impact, political impact)

3: Expected benefits from DR Smart Grid (economic impact, social impact)

4: Demand response profiles

5: Approach on critical pricing peak in DR

- Optimizing the process workflow from the data collection and metering to data processing based on DR methods and algorithms in order to improve the management of the energy consumption
- Appropriate forms of support to encourage flexibility
- Time-dependent pricing

7. Technical approach (innovative technologies, infrastructure, investment….).

Outcomes

Synthesis on agreements (PROs) and disagreements (CONs).

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