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Competition and regulation in the energy and water sectors: the French and the Italian case

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Alla mia famiglia
A Davide

Summary

This thesis examines the functioning of both the French and the Italian water and electricity markets.

The first chapters analyse both the legislative framework under which all the players have to operate and the level of competition in the retail markets. In order to evaluate the effective degree of competition in these markets, we identified and assessed a set of appropriate indicators.

Particular attention is also devoted to the analysis of the main electricity and water tariff structures because of their key role in encouraging the adoption of sustainable behaviours. In this context, we try to assess the impact that different pricing policies have on customers' habits. Since research has revealed that consumers are sometimes irrational, we try to study, through the lens of Behavioural Economics, which are the aspects that influence their choices.

As far as tariff schemes are concerned, we present, in the last chapter, an experimental study that aims at investigating customers' preferences and perceptions regarding different pricing structures. This will allow us to understand how to design pricing policies that achieve the desired outcomes.

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Chapter 1

Introduction

In recent years there has been growing attention towards environmental issues because of problems related to climate change and increase in pollution levels. It is important to highlight that massive energy and water consumption has a negative impact on the environment, so it is necessary to avoid waste as much as possible. Economic research has an active role in analysing which are the most suitable tools to incentivise final user not to overconsume. Especially, efforts have been dedicated to the study of the impact of different pricing policies aiming at reducing the consumption level of water and electricity. Since many authors have stressed that people often misunderstand difficult price structures, particular attention should also be devoted to issues concerning customer perceptions towards pricing policies.

Prior to any analysis, it is necessary to highlight that the main difference between water and electricity lies in the fact that reduction in electricity consumption is necessary to avoid imbalance between supply and demand that would cause the need to have excess capacity available to face peak demand, while reduction in water consumption is vital because it is a scarce resource.

The aim of this study is to examine how different pricing policies can have an impact on consumers' behaviour. First of all, there will be a section devoted to the analysis of the main features of both the electricity retail market and the water retail market; this will be essential in order to understand their actual functioning and then being able to find which pricing policy can be best suited. In this thesis, focus will be primarily put on the household market because it is the residential sector that represents an increasing share of the total energy and water use. Furthermore, it is also important to realise and stress that individual behaviour has a significant impact on stocks of natural resources, climate change and environmental quality; this is the main reason why governments and policy makers have shown an increasing interest either in better understanding the drivers of households' consumption patterns and in studying how to design effective strategies to promote greener habits. In order to better analyse households' decision making in energy and water consumption, a framed field experiment will be conducted; its results will be investigated to figure out which are the tools that efficiently foster energy and water conservation. It is important to note, however, that price is not the only factor that affects individual decisions: information and awareness of behaviour implications on the environment have a complementary role that can lead to preferable outcomes. In fact, evidence highlights that these aspects can effectively facilitate the implementation of new policies. In this analysis, tools needed to make people aware of their actions are not investigated; only price incentives will be taken into account because it is easier to quantify their impact on households' habits.

Chapter 2

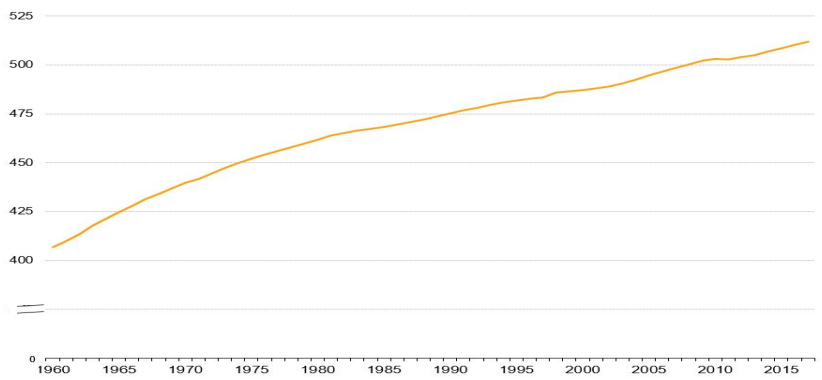
Water market

In the last years, water management and public policies related to this precious resource have received considerable attention. The reason is that it is necessary, on the one hand, to ensure water safety and quality and, on the other hand, the sustainability of its supply. For this purpose, assessing freshwater resources utilisation becomes essential. Differently from other World areas, at a European level, water is still enough to cover demand; however, in the last years, an increasing number of countries is experiencing water scarcity and droughts. The most affected regions are those with a high population density which leads to a remarkable demand level.

In order to assess whether a EU region is experiencing water stress, the Water Exploitation Index plus (WEI +) indicator should be considered: it is obtained as the percentage of total freshwater used with respect to the renewable freshwater resources available, for a given time scale and territory. If the aforementioned index has a value smaller than 10% it means that water stress is low; a value between 10-20% indicate a moderate water stress and thus the need of investments in order to provide adequate supply. If the value is larger than 20%, the examined area is facing a condition of moderate to high water stress and both supply and demand need to be managed properly. In EU, Mediterranean countries are the ones showing the highest values for this index: during summer period the most severe conditions are detected and WEI + reaches, on average, a 80% level thus revealing an inefficient and unsustainable use of resources.

Several factors cause water stress conditions: reduced water availability can be due to increasing environmental pollution, urbanisation trends and higher living standards which generate greater consumption. Data shows that, over the time interval 1987-2015, not only European population increased by around 117 million, corresponding to a percent increment of 24%, but also urban population has increased by around 120 million. The following chart shows the EU population growth from 1985 to 2017.

Figure 2.1: Population, EU-28, 1985-2017(at 1 January, million persons)

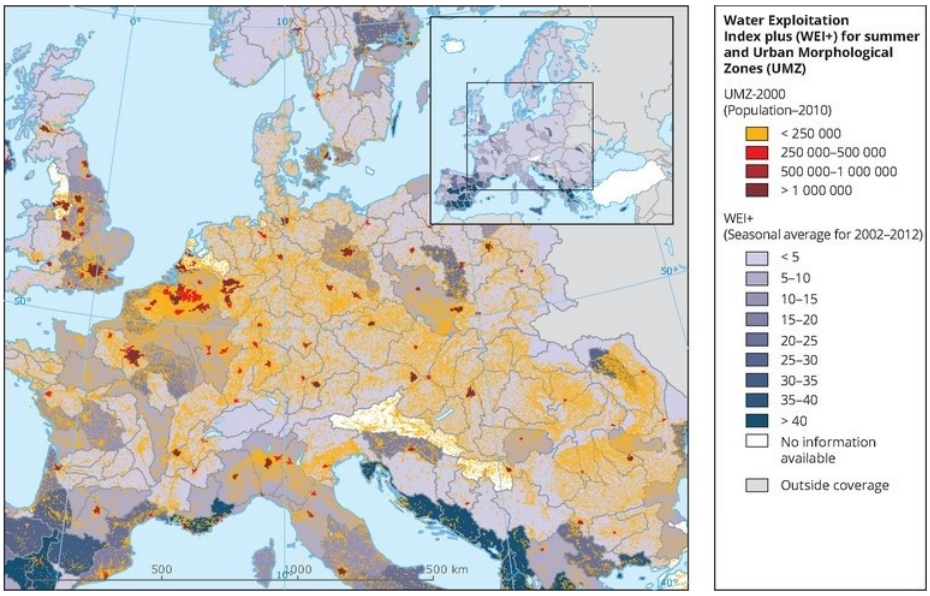


Source: Eurostat

As we can see, population is increasing and this circumstance makes it more challenging to match supply and demand properly. To adequately face population's needs, for instance, big cities rely even more on adjacent regions for their water supplies, by means of networks extending over more than 200 km.

According to a study conducted in the last years by the European Environment Agency, on average, 30 million EU inhabitants, corresponding to 6% of the total population, face water scarcity during the winter season; this number raises to 70 million, 14% of the total population, if summer is considered. The following figure presents either the population densities and the distribution of the WEI + value for every country: this allows us to understand which areas are mainly affected by water stress.

Figure 2.2: European map displaying the population density and WEI + index



Source: European Environment Agency

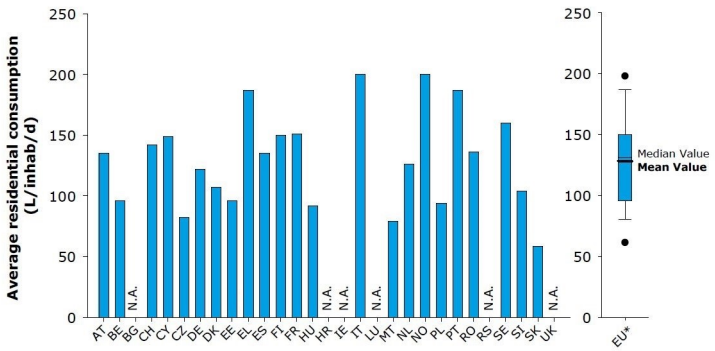
The figure reveals that countries of southern Europe are the ones facing the most severe conditions. To overcome the problem of declining water availability, countries adopt several measures:

- water is usually stored in dams and reservoirs. Since the 1950s a huge number of new dams and reservoirs have been constructed to store a larger amount of water;
- water is withdrawn mainly from the ground;
- water undergoes a desalination process and in the last years investment have been made in building desalination plants in countries such as Malta, Spain and Cyprus.

Analysis found that, in the Mediterranean region, the main drivers of water consumption are agricultural activities while only a thirty percent of the overall water use is attributable to public supply services which aim to deliver water to users for commercial, residential and industrial purposes. Among all the final customers, households represent a relevant share of total water consumption.

At a European scale, data reveal that the per capita residential consumption is, on average, 128 L/day. It is necessary to highlight that sometimes residential water use is calculated including also the consumption of small commercial and industrial entities: because of this issue, efforts have been made in order to find households' water effective consumption. Furthermore, some countries are used to display consumption levels that include also distribution losses but the latter are not considered in the data withdrawn for the following analysis. The following chart displays data on household water consumption in different European countries, where available.

Figure 2.3: Chart of the average household water consumption in different EU countries



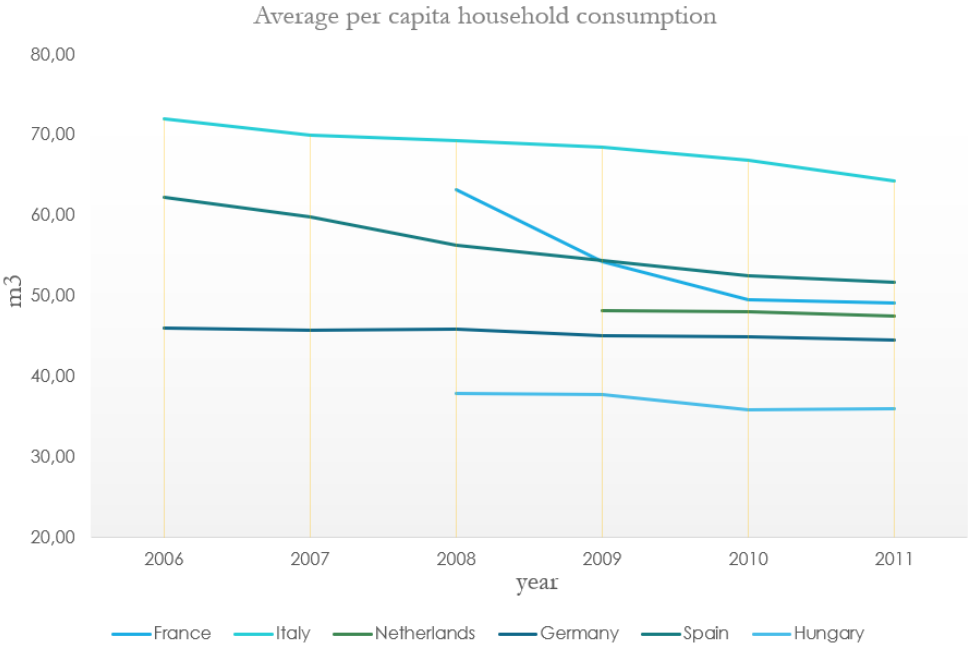
Source: The European Federation of National Water Services

Although data of some nations are not present in the chart, it is possible, however, to draw some general conclusions:

- the highest consumption levels are recorded for Norway(NO) and for many Mediterranean countries such as Italy(IT), Portugal(PT) and Greece(EL) ;
- the lowest consumption levels are recorded for Belgium(BE), Czech Republic(CZ), Hungary(HU), Malta(MT), Poland(PL), Slovenia(SI) and Slovakia(SK). It is important to point out that most of these countries are located in the East Europe.

To better quantify the households' pressure on water resources it is also important to investigate their consumption pattern. The following histogram shows how household consumption in several EU countries has changed over the period 2006-2011.

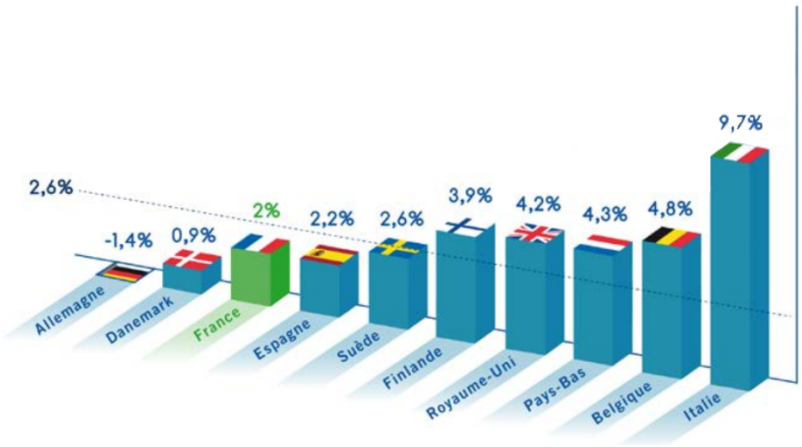
Figure 2.4: Average per capita household water consumption in different EU countries in time interval 2006-2011



Source: European Commission-Joint Research Centre Institute for Environment and Sustainability

From the chart, it is possible to detect a slightly decreasing trend in the consumption pattern, for the following countries: Italy, France, Hungary. For the other nations in the sample it is possible to assume that consumption is stable. The decreasing trend may be due either to an increasing level of awareness in people towards environmental issues and to pricing policies aiming at decreasing customers' demand. A relationship between demand pattern and price can be assumed if we consider not only the consumption trend but also the water price evolution. Research analysis has detected an increasing trend in water prices evolution in the last ten years. In the following figure we show the annual price variation in the period 2013-2015, to have a better overview of the current price growth trend.

Figure 2.5: Annual water price variation in different EU Countries



Source: Water survey by the Nus Consulting Group

It is possible to notice a upward trend in the price pattern for almost all the considered countries except Germany. The reason why prices have increased may be due to to the fact that tariffs are increasingly adopted as a tool to signal, to the final customer, either that water is a scarce resource and that there are many costs associated to its supply.

The role of price in determining consumption levels among households can be relevant but there are other drivers of water use that cannot be completely influenced by changes in tariffs. For instance, in the last years, data have revealed that tourism is having an increasing impact on total water consumption but it would be rather difficult to influence tourists consumption habits, given that, most of the times, they do not bear the direct costs of their water use. Apart from this fact, however, it is necessary to consider that, as highlighted in the OECD Environmental Outlook to 2030, in the next years the number of people living in areas affected by water stress or scarcity conditions will increase, reaching a 47% of the whole world population in 2030. Within this context of ever decreasing water availability, an effective management of water that seeks to avoid inefficiencies plays a key role. This aim can be pursued not only by means of investments in infrastructure but also through policies and regulations. Every tool is, in fact, valuable in order to create a sustainable system in which resources are optimally allocated and waste and overconsumption is minimised.

The following analysis will therefore examine which are the main challenges the different market players face every day and which are the tools adopted to pursue the predefined goals. Prior to any analysis, there will be a section of this report devoted to the study of water market and its organisation; only the French and the Italian water markets will be considered in this work. We would like to highlight that this analysis will be focused on the household sector for the following reasons, that all the players should take into account, when designing and implementing water policies:

- domestic and human needs are considered as having the highest priority use;

- residential water consumption is expected to increase in the next years, as stated above;
- water is an essential good and it has no substitute for most of the residential uses such as personal hygiene, cooking and cleaning.

As reported in 2002 in an initiative by the United Nations Committee, water is considered as a human right, a social and cultural good beyond being an economic commodity and this is the reason why its everyday conservation is crucial.

2.1 EU policy and legislation

EU environmental policies have always been largely focused on water management, given that it represents one of the European Commission priorities. The main focus of these EU Directives is to ensure that the drinking water supplied to final customer respects a predefined quality level in order to effectively protect human health. It is necessary to highlight that all the EU policies have, in any case, a relevant impact on national water strategies although Member Countries have direct responsibilities on several areas such as water and wastewater management. For instance, it has been requested to all the EU nations to ensure that the designed pricing policies could effectively act as an incentive for final user to reduce consumption.

2.2 French water market

In this paragraph we describe the French water market functioning both for what concerns the management mode and the competitive mechanisms, with a particular focus also on the legislative framework under which the different players have to operate.

2.2.1 Legislative framework and management

Water services typically consist of activities performed either to supply drinking water to the final consumer and to collect it after its use; the latter is called "grey water" and must undergo a series of sanitation treatments in order to allow its consequent discharge into the environment.

Drinking water supply services, as defined in the Article L. 2224-7-1 [1] of the CGCT Code (*Code général des collectivités territoriales*) that contains norms concerning municipalities, consist of three activities:

- Water production, that consists in water withdrawal from various sources;
- Water treatment, that consists in a series of different processes aiming at purifying water from impurities;
- Water supply and customer management: this stage includes all the activities at the interface with the final user.

Wastewater sanitation services consist of three activities, as stated in the Article L. 2224-7-2 [2] and then further defined in the Article L2224-8 [3] of the CGCT Code:

[1] ≪ *Tout service assurant tout ou partie de la production par captage ou pompage, de la protection du point de prélèvement, du traitement, du transport, du stockage et de la distribution d'eau destinée à la consommation humaine est un service d'eau potable.* ≫

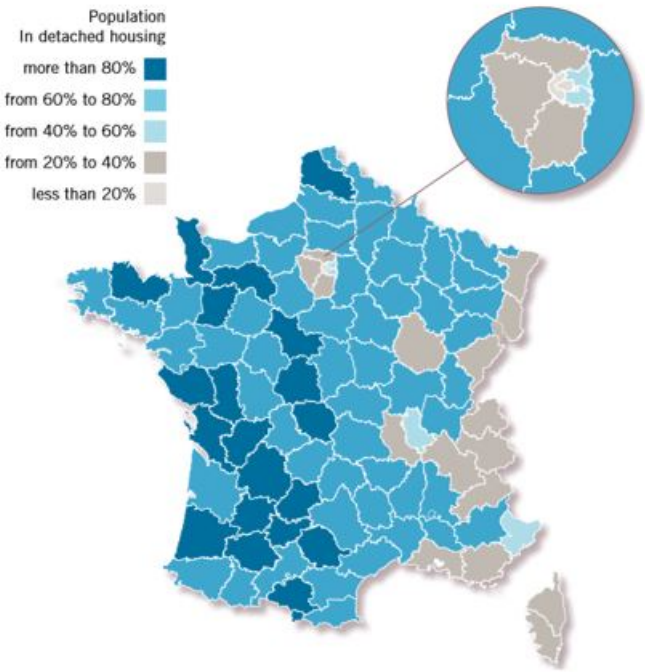
[2] *Code général des collectivités territoriales*

[3] *II.-Tout service assurant tout ou partie des missions définies à l'article L. 2224-8 est un service public d'assainissement.*

- Wastewater collection: water leaving homes is withdrawn and dispatched to a treatment plant;
- Wastewater decontamination with proper purification treatments;
- Water release back to the environment;
- Management of the network connections and customer management.

For what concerns wastewater sanitation services, two different organisation modes exist: the collective sanitation or the independent one. The choice between the two is not left to the final user but it depends on the number of houses located in a certain area and hence on the population density. It is important to say that the collective wastewater sanitation and the independent one are not equally widespread within the country: the first one is the most common organisation mode. In fact, only when it is not possible to connect a house to the collective wastewater sanitation network it is necessary to equip it with an independent sanitation facility. As can be seen in the following figure, which displays the population distribution based on the type of occupied houses, in the west of France there is a higher density of population living in detached housing; this means that, in these areas, independent wastewater sanitation is the prevailing mode.

Figure 2.6: Population distribution based on the type of housing occupied



Source: BIPE according to INSEE census

In France, water and sewerage services are under local authorities' responsibility. Local authorities can be either municipalities or groups of municipalities known as *Établissements Public de Coopération Intercommunale*(EPCI). These entities have the power to choose how to manage water services: they can operate directly, i.e. "gestion en régie", indirectly by means of delegation contract, i.e. "*gestion déléguée*" or they can choose to adopt a hybrid management in which only some services are delegated.

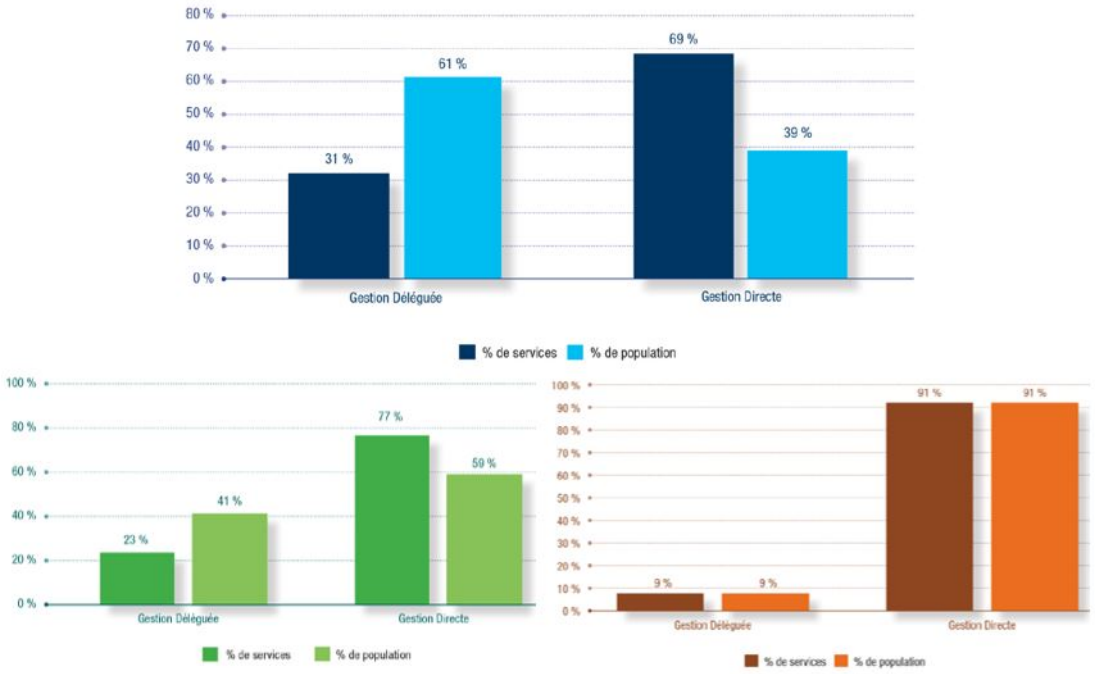
In the first case, local authorities provide the various services with their own resources or by means of a service provider's contribution. In the second case, a third party is selected to supply the services they are in charge of. Delegation can occur in two different ways: it can be a concession when the operator finances the infrastructure or it can be a lease if the municipality

itself must finance the infrastructure. It is necessary to highlight that, even if the service is not directly performed by the local authority, the latter remains ultimately responsible of the public service: it has to maintain control over the operations in order to guarantee the highest quality for the consumer. It is important to stress the fact that the municipalities own the infrastructures whichever management option they choose.

The choice between different management modes depends mainly on the service size and on its extension. In fact, a delegated drinking service is usually 3 or 4 times larger in size, considered as the number of inhabitants to whom the service is provided, with respect to one where municipalities act directly.

In 2014, the average size of a drinking water service was 9507 inhabitants, if delegation management is considered, and 2799 inhabitants if direct management is taken into account. Instead, for what concerns water collective sanitation services, the delegated ones are only 2,5 times larger in size with respect to the directly managed ones. The average size of a water sewerage service is 5781 inhabitants in case of delegated management mode and 2428 in case of direct management. In the following figure it is possible to see which is the allocation between the "*gestion déléguée*" and the "*gestion en régie*" for what concerns either water and sewerage services in 2014.

Figure 2.7: Share of water and wastewater services (collective and non-collective) provided either directly by the municipality or indirectly through delegation



Source: SISPEA (Onema)- 2014

As the first histogram shows, in 2014, 69% of the water services are directly managed and they cover a population of close to 25 million people which accounts for 39% of French overall population. In contrast, only 39% of all the drinking water services are indirectly managed although they cover 61% of the whole French population.

For what concerns water collective sewerage services, as it is possible to notice in the left bottom figure, 77% of the these are managed "*en régie*" and for the remaining ones a delegated management is chosen. In terms of covered population, delegation management provides wastewater sanitation services for almost 23% of French people while direct management is in charge of providing 59% of French population with the same services.

For what concerns non-collective water sanitation services, the prevailing management mode is the one "*en régie*". In fact, direct management provides its services to more than 90% of the French people whose house is not connected to a collective water sewerage network. The reasons why direct management is so widespread are the following:

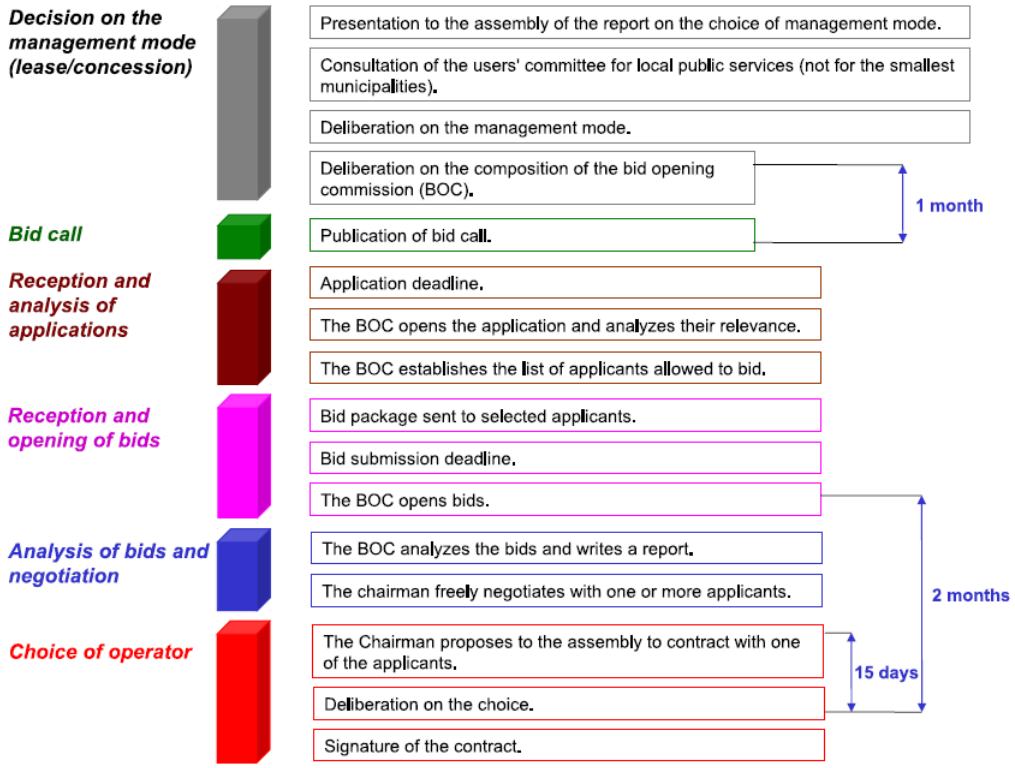
- there is no need to have highly sophisticated skills to provide independent sanitation services which mainly consist of activities performed in order either to monitor all the new and already existing installations and to advise and accompany private individuals who must install a new non-collective sanitation system;
- it is not possible, when providing non-collective water sewerage services, to share resources in order to gain in efficiency.

These are the two of the most important requirements that have to be satisfied to influence the choice in favour of delegated management. Therefore, the local public service named "SPANC" is the entity mainly entrusted with the aforementioned responsibilities.

Delegation contracts are regulated by the "*Loi Sapin*", a law of 1993 aimed at improving transparency and reducing corruption in public procurement. This law defines the procedures that must be followed in order to properly select, through a tender process, a private operator to whom to delegate the service.

According to the Sapin Act, the delegation procedure must follow some specific steps, as summarised in the following figure.

Figure 2.8: The delegation procedure



Source : Guérin-Schneider et al. 2003

Municipalities must first present a report in which the choice of management mode is communicated and, then, they must publish a bid call containing the major service characteristics. From this moment onwards, it starts the period for the interested companies to submit their application, in which they emphasise their technical know-how and financial capacity that allows them to properly manage the potentially delegated services. Among the applicants, only a subset, corresponding to the ones whose application is accepted by the municipality, have the right to submit a bid. Once determined the accepted applications, the local entity sends these companies a detailed bid package which includes also the delegation agreement model. From this moment on, the interested companies are allowed to submit their bid. Once closed the reception of the bids, the municipality analyses them and then it can start a negotiation process with the selected companies. The winner of the bid is then determined on the basis either of their bid and of the negotiation process. After all these steps, the choice of the operator is deliberated and then the signature of the Delegation Agreement is made. The whole procedure can be executed in eight to twelve months; municipalities must therefore work on the issue in advance in order to properly complete the delegation process on time.

It is important to highlight that delegation contracts assume a key role in defining most of the aspects of the relationship between the private company and the municipality. At the basis of the agreement there are some general obligations; furthermore, within its framework, are set and defined not only a price structure and formulas useful to revise the price but also clauses concerning exceptional conditions, i.e. *force majeure*. While designing the contract it is necessary to take into account either the interest of the parties and also its consistency with respect to the economic or social policies. Furthermore, it is important to remind that a contract is the outcome of a negotiation process and the relative bargaining power of the parties have a key role in determining its content especially for what concerns the price structure: this will not reflect the social welfare maximisation if the private operator has a greater capacity to negotiate on its own terms. Negotiation and, eventually, renegotiation of the contractual terms occur because delegation agreements, just as all the real contracts, are incomplete: this feature allows the operator to opportunistically take advantage of the ambiguities.

As it is possible to notice from the delegation process design, the Sapin Act aims at fostering competition although it is not the only one that contributes to achieve this objective. In fact, under the 1995 Barnier Law[4], the delegation contracts duration in the water sector should be limited and cannot exceed twenty years, except in cases which are duly justified. The resulting increase in contract renewal frequency allows to reach a better level of competition among different private operators who want to co-operate with local authorities.

It is important to highlight that, to determine the contract duration, different aspects must be taken into account. The local entities must consider, in fact, not only the size of the delegated services but also the amount and nature of the required investments because the duration must not exceed their normal depreciation period, as highlighted in the Article L. 1411-2 of the CGCT[5]. At present, average contract duration is 11 years but to have a better overview on the real level of competition it is not sufficient to analyse this factor, but it is necessary to investigate whether, in the moment of a contract renewal, a new operator is effectively able to win the contract.

[4] ≪ *Dans le domaine de l'eau potable, de l'assainissement, des ordures ménagères et autres déchets, les délégations de service public ne peuvent avoir une durée supérieure à vingt ans sauf examen préalable par le trésorier-payeur général, à l'initiative de l'autorité délégante, des justificatifs de dépassement de cette durée. Les conclusions de cet examen sont communiquées aux membres de l'assemblée délibérante compétente avant toute délibération relative à la délégation. [. . .]* ≫

[5] ≪ *Les conventions de délégation de service public doivent être limitées dans leur durée. Celle-ci est déterminée par la collectivité en fonction des prestations demandées au délégataire. Lorsque les installations sont à la charge du délégataire, la convention de délégation tient compte, pour la détermination de sa durée, de la nature et du montant de l'investissement à réaliser et ne peut dans ce cas dépasser la durée normale d'amortissement des installations mises en oeuvre. Dans le domaine de l'eau potable, de l'assainissement, des ordures ménagères et autres déchets, les délégations de service public ne peuvent avoir une durée supérieure à vingt ans sauf examen préalable par le trésorier-payeur général, à l'initiative de l'autorité délégante, des justificatifs de dépassement de cette durée.* [. . .] ≫

2.2.2 Pricing of water services

In France, prices must be fixed in accordance with two principles. The first one is called "*L'eau paie l'eau*" ("water pays water"): this means that any charges incurred in providing the water and sanitation services must be entirely reimbursed by the income arising from the water bills that are payed by the customers. These expenses that must be refunded will therefore include all the investments on the network and the costs linked to the supply of the services, to the support and management activities and to the tasks which must be performed at the interface with the final consumer. The second principle is called "*Le pollueur est le payeur*" ("polluter pays") and it is stated in the Article L110-1 [6] of the French Environmental Code. Under that provision it is mandatory that people bear the costs to fund anti-pollution measures, since they are responsible of the pollution resulting from their habits.

When we talk about water it is necessary to stress that the underlying idea is that this natural resource has not a price; however, water and sanitation services have an associated cost. Furthermore, it is necessary to afford these expenses in order to ensure to everyone the access to clean drinking water.

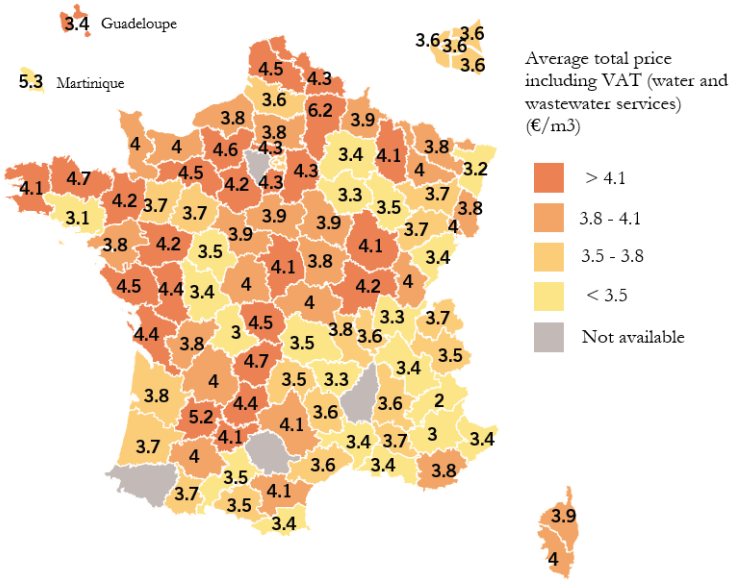
Water cost depends mainly on variables linked to the local context and in particular on the following factors:

- Effective water availability in the area and type of source (underground or surface). The first aspect has an impact on the extension of the network while the second will influence the choice among various type of technologies needed to treat it properly before its supply. It is necessary to remind that each source is exposed to different contaminants. Data reveal that surface water treatment activities cost, on average, 20% more than the ones that must be performed for groundwater;
- Total amount of population to be served and its density. This variable has a huge impact on the infrastructure characteristics in terms of size of the water supply network and of extension of the wastewater collection system;
- The geography of the area where the network is deployed.
- The effective quality of the abstracted water;
- The features of the environment where the wastewater will be discharged. This influences the treatment that the water will undergo in order not to pollute;
- Service level provided by the local entity or the company who is in charge of the service;
- Socio-economical aspects such as average consumption levels or the presence of very strong seasonal trends in total local consumption due to tourism, for instance.

We can conclude that price will therefore differ across the regions and this is the main reason why water and wastewater services are considered as local services. In the following figure the average water price by department is displayed. Data refers to 2012 but it is necessary to say that in absolute terms it is possible to detect price variations over the years but, for what concerns relative terms, the situation has remained, on average, almost the same.

[6] ≪ *Le principe pollueur-payeur, selon lequel les frais résultants des mesures de prévention, de réduction de la pollution et de lutte contre celle-ci doivent être supportés par le pollueur.* [...]≫

Figure 2.9: Average total price including VAT for water and wastewater services by department in 2012



Source: FP2E annual report

As we can see from the picture, the departments associated with a higher total water price are the northern ones, the central ones and the western ones. This may be due to the fact that many of them are rural areas. On the contrary, when we consider large urban areas, we have to remind that the drinking water that is distributed to city centers is, most of the times, abstracted from the surrounding areas and the resulting distribution costs are higher because of the network's extension that leads to a situation in which average prices are necessarily higher.

As we may notice once again, prices reflect either the operating costs and the required investments. According to the management mode, water tariffs are fixed and revised in different ways. For the municipalities who choose a direct management, responsibility for price fixation is assumed by the local entity which is in charge of the service. Price has to be determined every year on the basis of the planned expenditures. For the municipalities who opted for the delegation of water services, price is set in accordance with the corresponding clause in the delegation agreement. This clause, however, can be revised every five years in order to make the appropriate changes.

To have a complete overview on the price determination it is necessary to analyse the water bill and its components, in accordance with what is stated in the Article L2224-12-4 [7] of the CGCT Code. The water bill is made up by three distinct parts:

- A section relating to the collection, the purification and distribution of water. The corresponding sum is divided into a fixed component, depending on the water meter size, and a variable one which depends on the amount of water actually consumed;
- A section relating to wastewater collection, treatment and final discharge into the environment. Likewise, the corresponding sum is divided into a fixed component and a variable one which depends on the amount of water that the customer has consumed;
- A section relating to taxes and user fee. The corresponding sum is intended for the local water agency (*Agence de l'Eau*) who determines it in accordance with legal prescriptions. This amount is used to financially sustain the conservation of such a vital resource. It also includes the Value Added Tax, where applicable.

[7] ≪ *Toute facture d'eau comprend un montant calculé en fonction du volume réellement consommé par l'abonné et peut, en outre, comprendre un montant calculé indépendamment de ce volume en fonction des charges fixes du service et des caractéristiques du branchement, notamment du nombre de logements desservis.* [...] ≫

Moreover, it is necessary to highlight that, since 1992, water pricing is based on the customers' real consumption and this information is recorded in the water meter. It is therefore no more allowed to use flat tariffs because these do not provide a sufficient incentive to reduce consumption levels. To this purpose, municipalities can also adopt a progressive pricing or different prices depending on the season. The latter is particularly suitable for areas where water is a scarce resource in order not to overconsume it during periods of high demand.

In accordance with the French law named "LEMA"[8], the total fixed component cannot exceed the following amount:

- 30% of the total price billed to customer[9], in case of urban areas;
- 40% of the total price billed to customer, in case of rural areas and/or touristic ones.

What has just been described is a standard water bill for water services that have not been delegated by the municipality. It is, in fact, necessary to highlight that if we consider delegated services, the corresponding water invoice has some differences. The section corresponding to the service that has been delegated shows, in fact, a sum which is divided into two parts: the first is called the "*part délégataire*" and it is intended for the company which is charge of the service while the second, "*part collectivité*" is intended for the municipality. In this case, the municipality will be only responsible for the fixing of the latter. It is necessary to say that both parts include either a fixed and a variable component and are useful in order to fund the expenses and investments.

To better evaluate the relative weight of its components, we now consider a bill issued in 2014 for a delegated service. As we can see from the following table, the total water price billed to this customer was equally distributed between the drinking water component and the wastewater one while the taxes and the user fee accounted only for 23% of the whole invoice.

Figure 2.10: Breakdown of the water bill in its components, 2014

		Part collectivité	Part délégataire	Total
Drinking water service	%	27	73	100
	Sum	52€	140€	192€
Collective wastewater sanitation service	%	45	55	100
	Sum	89€	111€	200€
Taxes	120.82€			

Source: Services Eau France

As it is possible to see, the part intended for the private company is significantly higher for what concerns the drinking water services (73%) with respect to the one (55%) concerning the collective wastewater sanitation service.

According to latest recent available data, relating to year 2014, an average annual water bill was 477,60 € corresponding to a monthly bill of 39,80 €, both computed on the basis of a 120 m3 average consumption. In the same year, the average water price was 3,98 €/m3 including 2,05 €/m3 for drinking water and 1,93 €/m3 for wastewater sanitation service.

It is necessary to say that average water prices have considerably increased over the last years. If we consider the average total water price including taxes, it has increased by 9,9 percentage points,

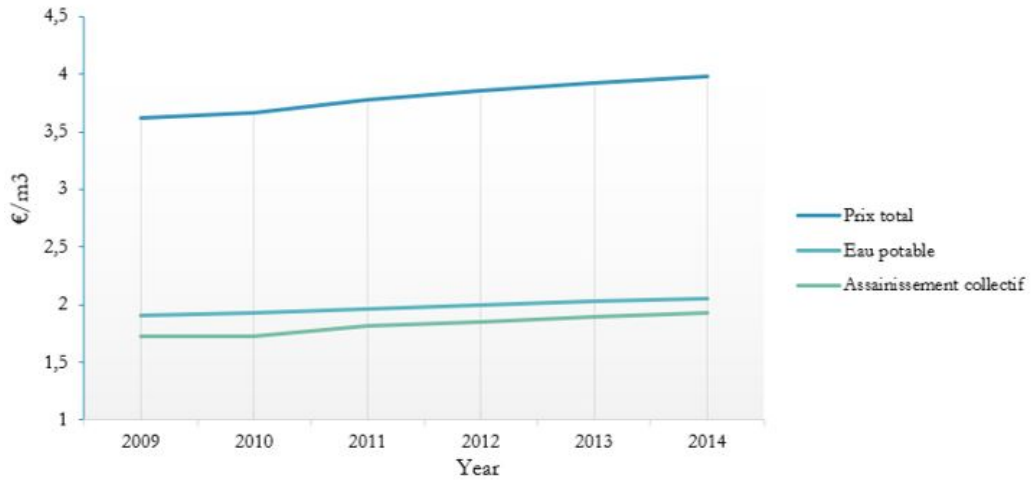
[8] *Loi n°2006-1772 du décembre 2006 sur l'eau et les milieux aquatiques*

[9] Considering an annual use of 120 m3 which is the INSEE reference value for household water consumption

in relative terms, over the period 2009-2014. If we break down the price into its components, we can conclude that the one relating to water abstraction, treatment and distribution has grown by over 7,7 percentage points while the other one, relating to wastewater collection and treatment, has grown by over 12 percentage points; both increments have been computed in relative terms.

In the following figure the price evolution over the period 2009-2014 is displayed. As it is possible to see, the sewerage service price is the one that has made a greater contribution towards raising the total water price.

Figure 2.11: Average total water price increase and price components increase during the period 2009-2014



Source: Services Eau France

The argument made by municipalities to justify the price raising is that TVA has significantly increased in the period (from 5,5% in 2011 to 10% in 2014) but this is not, of course, the only explanation. Another reason can be linked to the fact that some cities decided to raise prices in order to induce consumers to reduce their consumption levels; this is clearly the case where price is used as a tool to impact on water use and to fight against water overconsumption.

2.2.3 Social tariffs

As stated in the first Article L210-1[10] of the LEMA law, water is a limited natural resource and it must be ensured the right of citizens to have access to this precious good. It is also established that access to water must be allowed under economically acceptable conditions. Furthermore, water access must be ensured also for insolvent customers. In fact, according to Brottes law, corresponding to Article L115-3 [11] of the of the Social Action and Family Code, operators responsible of water distribution are not allowed to suspend the service towards people who don't pay their bills.

It is necessary to say that, usually, 1% of an average family income is used to pay water bills but this percentage raises if we consider low-income population groups and this is the main reason why increasingly more attention is payed towards ensuring effective access to water for everyone.

[10] ≪ *Dans le cadre des lois et règlements ainsi que des droits antérieurement établis, l'usage de l'eau appartient à tous et chaque personne physique, pour son alimentation et son hygiène, a le droit d'accéder à l'eau potable dans des conditions économiquement acceptables par tous.* [...] ≫

[11] ≪ *Du 1er novembre de chaque année au 31 mars de l'année suivante, les fournisseurs d'électricité, de chaleur, de gaz ne peuvent procéder, dans une résidence principale, à l'interruption, y compris par résiliation de contrat, pour non-paiement des factures, de la fourniture d'électricité, de chaleur ou de gaz aux personnes ou familles. Les fournisseurs d'électricité peuvent néanmoins procéder à une réduction de puissance, sauf pour les consommateurs mentionnés à l'article L. 337-3 du code de l'énergie. Un décret définit les modalités d'application du présent alinéa. Ces dispositions s'appliquent aux distributeurs d'eau pour la distribution d'eau tout au long de l'année.*[...] ≫

Nevertheless, despite the provisions of national law, there are still several people who say that they experience difficulties in accessing water resource.

In order to implement an efficient social tariff policy, since 2013 several municipalities are running an experiment in which they adopt some sort of social tariff policy and they analyze the outcomes resulting from the application. They can decide either to provide financial support, in the form of an allowance called "*chèque eau*", to low income families or to adopt a progressive tariff structure in which the first tier, corresponding to vital water consumption, is provided free of charge. The municipality will be responsible to identify people who have the right to access these options but the communal or inter-municipal social welfare centres (CCAS, CIAS[12]) are the entities involved in the procedure for granting such financial aid. Moreover, for the ones who cannot bear the cost of water bills it is possible to request a financial support, depending on the total family's income, through the so called "*fonds de solidarité pour le logement*".

Given that the social tariffs testing phase will not be completed before April 2018, it may be advisable to evaluate whether some sort of coordination at a national level can lead to a better procedural efficiency. Moreover, municipalities might opt for the integration of the chèque eau with the other existing subsidies such as the one called "*chèque énergie*" that will be implemented from January 2018 and will be concerning the expenses linked either to electricity and gas bills.

2.2.4 Level of competition in the French water market

The water sector, for a given territory, can be considered as a natural monopoly which can be described as « [a]n industry in which multiform production is more costly than production by a monopoly », according to Baumol's definition. The reasons why water industry can be thought of as a monopoly are the following:

- its network management requires huge investments in technical infrastructure: this situation constitutes a barrier to entry for any potential or actual competitors. This is the reason why no company would compete in the market building up a new infrastructure that would be a duplicate of the already existing one;
- it is possible to exploit economies of scale given that it is a sector with a high fixed cost structure. In order to have a profitable investment, a company operating in public utilities should have a significant number of customer otherwise it would not gain the minimum level of revenues that allows to reach the break-even point.

Therefore, due to infrastructural aspects, it would be difficult to create a competitive environment in the water market because it would generate inefficiencies in the overall management and maintenance of the pipe network.

As highlighted in economic theory, in case of natural monopolies, it is suitable a competition for the market instead of the usual competition in the market, given that the latter is impractical. The underlying idea is that competition is desirable in order to provide a better service to final customers either in terms of quality and price but it is necessary to ensure that procedures effectively lead to the creation of a competitive environment.

As Canneva and Garcia (2010) show, it is possible to identify some factors, concerning the delegation process, that can be good proxies of competition. It is possible to list the following ones:

- the total number of applications submitted to the municipalities;
- the total number of bids submitted to the municipalities;
- the municipalities' perception about the real level of competition during the delegation procedure.

[12] *Centres Communaux d'Action Sociale, Centres Intercommunaux d'Action Sociale*

The first information can be considered a good proxy if we assume that every application is submitted because the company is really interested in the contract and it does not send it in order to acquire some more detailed information usually contained in the bid package which is sent to the ones whose application has been accepted. However, this assumption is rather simplistic as it does not take into account that submitting an application is a relatively easy process and, therefore, it does not require much effort, so it is not realistic to consider it as a completely accurate proxy.

The second information could be considered as a good measure of the level of competition if we consider that it requires a lot of time to draw up appropriate bids. However, it is necessary to consider that in a very concentrated market, as the one of water services, the risk of collusion is relatively high and, therefore, a part of all the submitted bids can be considered as "cover bids".

The third information is subjected to personal impression and thereby it is not possible to consider it as an objective measure of the level of competition. However, it is important to highlight that, by analysing perceptions, it is possible to better understand if some sort of collusion exists and how much it is widespread: this information is therefore useful in order to have a better estimate on the effective number of the applicants who are really interested in competing for the market. Moreover, to assess the degree of competition, it is possible to consider the rate with which an operator change occurs, when renewing the contract. In fact, at the end of the delegation agreement contract, the municipality must choose whether to change the operator or not and this is not a simple task because there are a lot of factors that influence this decision.

For instance, the municipality might not be interested in changing the current operator because it is satisfied with the quality of the work performed by the incumbent but it is necessary, however, to highlight that this could not be the only reason that justifies this choice. In fact, even in presence of an attractive bid, in some cases the municipality may prefer the existing operator because of a risk-adverse attitude. Another factor that influences the decision is related to transaction costs that the municipality has to bear when an operator change occurs; this aspect clearly constitutes a disincentive to switch from awarding the contract to a new company.

It is necessary to say that an operator change might not occur not only because of aspects that are directly related to the municipality itself but also because of the fact that, since the incumbent has already operated the network, he has a good knowledge of the following elements:

- features of the service that must be provided;
- quality of the existing infrastructure;
- operating and investment costs;
- information about customers and their needs.

For this reason, the incumbent can therefore benefit from such asymmetric information which is known, in economic theory, as the "common value". In such a situation, it happens that an outside company, while submitting its bid, will tend to overestimate the value of the contract, thus generating an inefficient condition, known as the "winner's curse". In this case, it is very likely that a new operator wins the contracts only in the case of a wrong prediction of costs or revenues. Given that operators are aware of this phenomenon, they do anticipate that profits would be low and this fact threatens and limits competition.

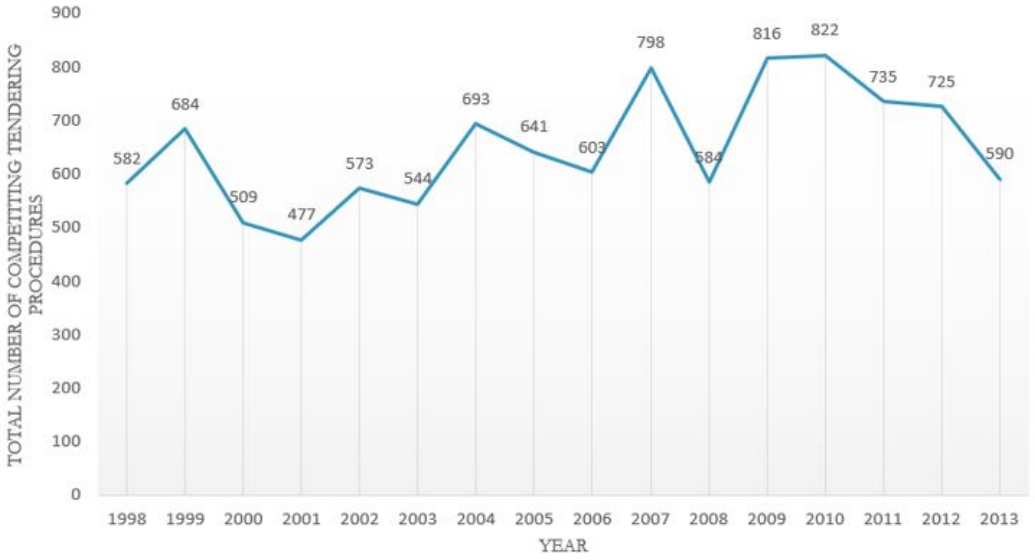
At is point of our analysis it is necessary to investigate statistics concerning the abovementioned parameters that we consider as proxies of the degree of competition. In this way it will be possible to better assess the French water market functioning and to examine whether or not inefficiencies exist and which are the main causes that generate them.

According to several analyses conducted by ONEMA organization (*Agence française pour la biodiversité*) and the ENGREF (*École nationale du génie rural, des eaux et des forêts*) engineering school, since the introduction of the Sapin law and the Barnier law, the degree of competition in water sector has increased although it still remains rather low.

The factors that allow to say that competition has increased are several. First, it is possible to consider the number of competitive tendering procedures for the delegation of water and sewerage

services. As it is shown in the following chart, this amount has on average increased in the period 1998-2007 and then it has rapidly decreased. The lowest values, recorded in 2001, 2008 and 2013, could be linked to the fact that elections took place and usually, on that occasion, municipalities tend to delegate a smaller number of services.

Figure 2.12: Total number of competitive tendering procedures for the delegation of water and sewerage services

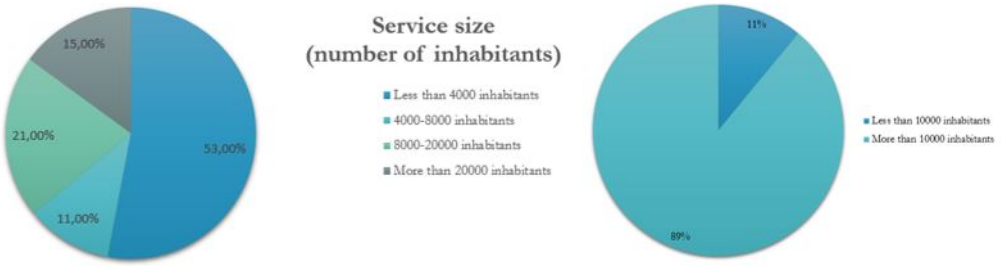


Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

If we only analyse the year 2013, the largest share of total tendering procedures was concerning services with a size smaller than 4000 inhabitants while only the 15% was related to services with a very large size, namely 20000 inhabitants. It is necessary to highlight that, even if the number of larger services is low, it makes up more than half of the total amount of inhabitants served by a service for which a delegation procedure has been carried out. In fact, in terms of volume, the 89% of the total amount of services delivered to customers are the ones which serve more than 10000 inhabitants. It is possible, therefore, to conclude that municipalities tend to delegate larger services rather than smaller ones.

In the following figure it is possible to see the relative distribution of the procedures as a function of the service size, as has been recorded for the year 2013. Analyses have shown that the percentage presented here has not substantially changed over the last years.

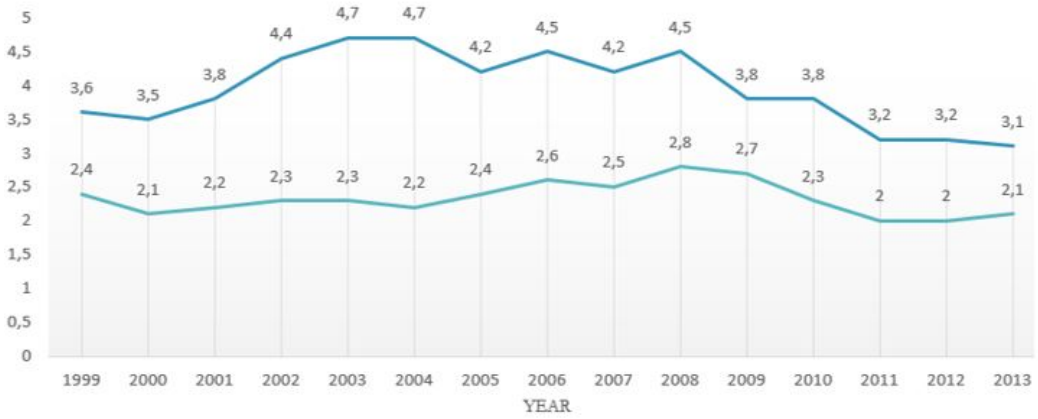
Figure 2.13: Distribution of the tendering procedures for delegation as a function of the service size



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

As highlighted at the beginning of the chapter, two further parameters that can be considered as proxies of the degree competition are the number either of the application and of bids submitted to municipalities. Considering the time period 1999-2013, the average amount of application submitted has not substantially changed in the period 1999-2008 while, after that, it has significantly decreased. For what concerns the average number of bids submitted after the application approval, it has remained stable in the period 1999-2004 then it has increased in the time interval 2004-2008. After 2008, a net decrease in the number of bids has been detected. The following chart shows the trend in the number of applications and bids from 1999 to 2010.

Figure 2.14: Average number of application and offers submitted to municipalities for a single delegation procedure



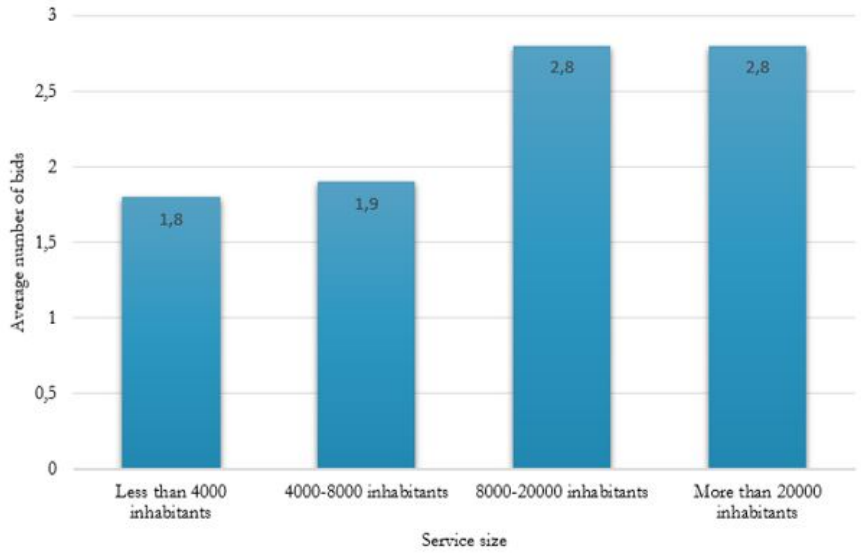
Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

As can be seen from the figure, in the period 1999-2013 the average number of applications ranges from 3,1 to 4,7 while the average number of bids ranges from 2 to 2,8. If we only consider the year 2013, 12% of the total number of tendering procedures have received at least four bids and only 36% have received at least three bids. It is necessary to highlight that these percentages are lower than the ones recorded in 2012.

In addition, 31.8% is the percentage of applicants that do not thereafter submit a bid and this may be due either to the fact that their application has been rejected or because they withdraw from the procedure: in fact, sometimes, after the analysis of the detailed required specifications an investment in that field may be considered unprofitable. With respect to 2012, the abovementioned no-show rate has decreased by 6,6 percentage points thus indicating that companies show a more active interest in submitting their proposal on the basis of the requests of the municipalities.

Moreover, as data reveal, the number of participants submitting bids is directly correlated to the size of the service, thus suggesting that this element constitutes the main driver behind the choice of presenting a tender. As it is possible to see in the following image, the number of bids submitted in 2013 for a service with more than 8000 inhabitants is definitely higher than the one relating to smaller size services.

Figure 2.15: Average number of bids submitted in 2013 as a function of the service size

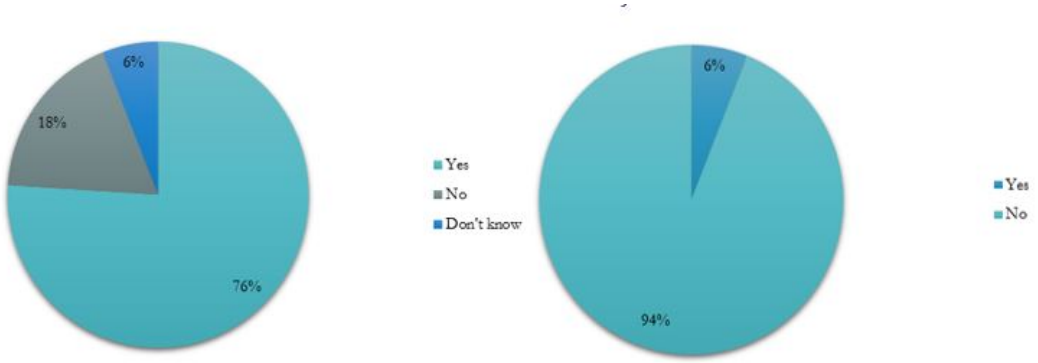


Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

Therefore, it is possible to conclude that competition increases as the service that the municipality has chosen to delegate is more relevant in terms of amount of customers served. The same trend has been detected in the years prior to 2013, even if, as highlighted before, some differences can be found from year to year in the average amount of bids submitted.

As mentioned at the beginning of this chapter, a further measure of the level of competition in the context of the water services delegation can be represented by subjective perceptions of the municipalities on the effective presence of competition. For what concerns small size services, in 2013, 76% of the local entities who have delegated the management thought that the market was competitive while 18% didn't feel the same. For what concerns the services with more than 10000 inhabitants, in the same year, more that 90% of the municipalities perceived that competition was real. The following figures summarises the output, that has just been described, of the survey conducted in 2013 by the Observatoire Loi Sapin which is an organisation which concentrates its efforts in assessing the impact of the legislative framework on the water market functioning.

Figure 2.16: Perception of real competition in the market (left: service size<10000 inhabitants; right: service size>10000 inhabitants)



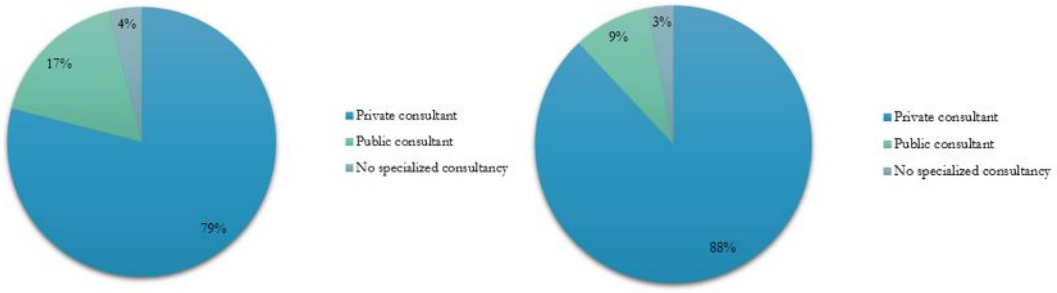
Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

As we highlighted above, as the service size increases, not only the average number of bids submitted increases but also the perception that competition is effective. This may therefore suggest that there is a positive relation between the number of bids submitted and the perception of competition on the market. This also indicates that following the Sapin Act procedure is not a sufficient condition to consider that an environment is truly competitive.

To foster the competition on a market and, therefore, the active participation of a much greater proportion of companies who submit their bids it is necessary to reduce the benefit that comes from the private information held by the incumbent operator. It is hence advisable to call upon an outside consultant. Analyses show that this is a consolidated practice, when the municipalities apply the Sapin procedure. This situation allows the outside companies to have a better assessment on the overall quality of the existing infrastructure, thus enabling them to precisely evaluate economic profitability. In addition, the presence of an outside consultant ensures that there is an equal and fair treatment of all the applicants who can, therefore, prepare a more reasonable bid that takes into account information on multiple characteristics either of the network and of the service that would be otherwise impossible to gather.

As we can see from the following figure, in 2013 almost for all the procedures, no matter the size of the corresponding service, the municipalities used the services of a specialised consultant (most of the times a private consultant is used, however also public ones are chosen even if less frequently).

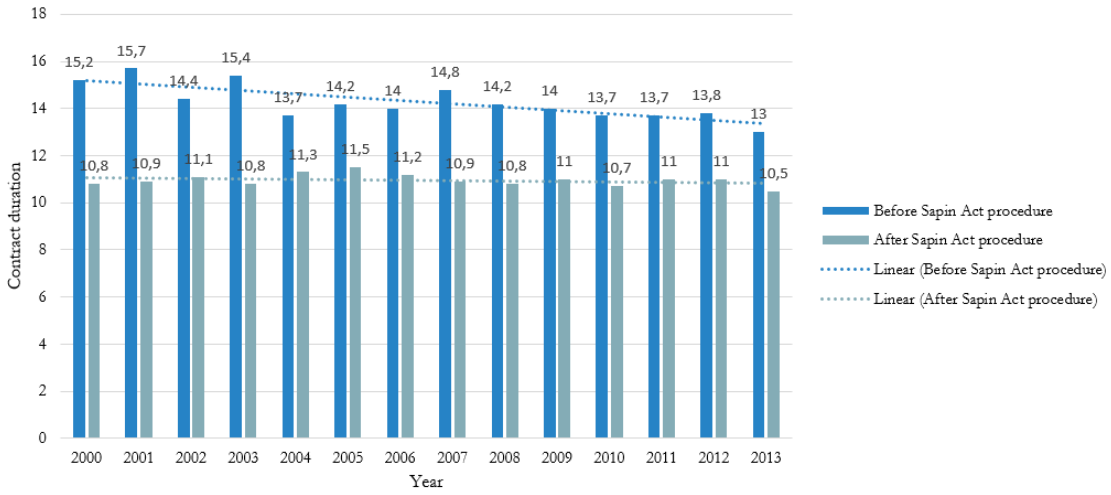
Figure 2.17: Use of consultancy services (left: service size<10000 inhabitants; right: service size>10000 inhabitants)



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

Over and above what has already been said, a further objective of the Sapin and Barnier laws concerns the fact that the contracts must have a limited and shorter duration in order to increase the contract renewal frequency and thus allowing to reach a better degree of competition. As available data show, the average duration of the contracts signed before the entry into force of these two acts is progressively decreasing: in 1998 the average duration of a delegation agreement signed before the Sapin Act procedure was 17 years and then it has decreased over time reaching a mean value of 13 years in 2013. It is moreover necessary to remind either that the Sapin and Barnier law do not have a retrospective effect and that, after that a "old" contract has reached the expiry date, it must be awarded following the Sapin procedure. Instead, for what concerns the more recent contracts, they have an average duration of only 11 years and this value has remained almost constant over the years since the introduction of the Sapin Act. What has just been described is summarised in the following chart which also displays either the average contract duration in the period 2000- 2013 and its corresponding decreasing trend along the years.

Figure 2.18: Average contracts (divided into the ones signed before and after the entry into force of the Sapin Act) duration in the period 2000-2013

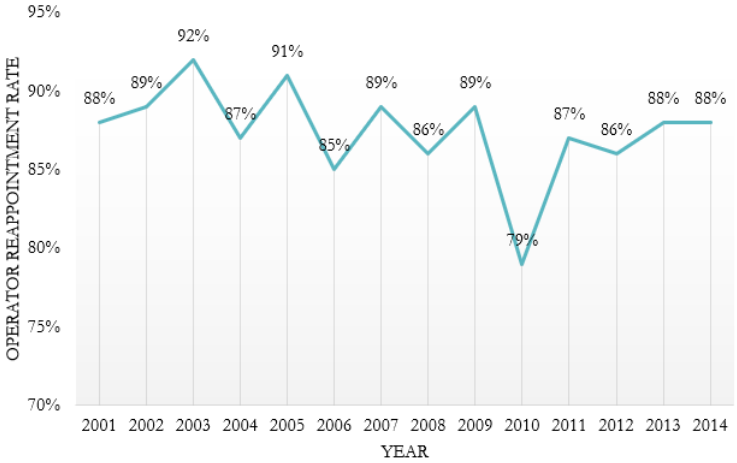


Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

From the figure it is possible, on average, to detect a linear decreasing trend; however we see that sometimes, as it happens for the year 2007 with respect to 2006, the duration increases: this may be due to the fact that a large amount of delegation agreements have reached the expiry date and the remaining ones still have a long residual life. This condition leads, when computing the average that takes into account only the contracts that are still in force, to a higher mean value with respect to the one computed for the previous year, calculated considering also the agreements with a duration of one year or less.

At the end of its term, the delegation agreement can be renewed with the same company who has already operated the network, if the municipality does not decide to switch to another operator. As we already mentioned, the level of competition depends not only on the duration of the contracts themselves but on the effective possibility for outside and new firms to win the contract. As data concerning year 2013 reveal, the incumbent continues to operate the service in 88% of cases; it is necessary to say, however, that this percentage has not significantly changed since 2000. In the following figure it is displayed the rate with which a reappointment of the same operator occurs.

Figure 2.19: Operator reappointment rate



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

From the graph we can conclude that an operator change does not often occur and this can be a signal of poor competition but to evaluate whether a sector is really competitive we can extend our analysis investigating another important element: the price trend. As economic theory highlights, in competitive environments prices tend to be lower. In this particular case, the price we are going to consider the so called "*part délegataire*" which is the one that is paid to the company to whom the service has been delegated. The main reason behind this choice is that the "*part délegataire*" is the the only portion of the total price that can be negotiated between the municipality and the operator.

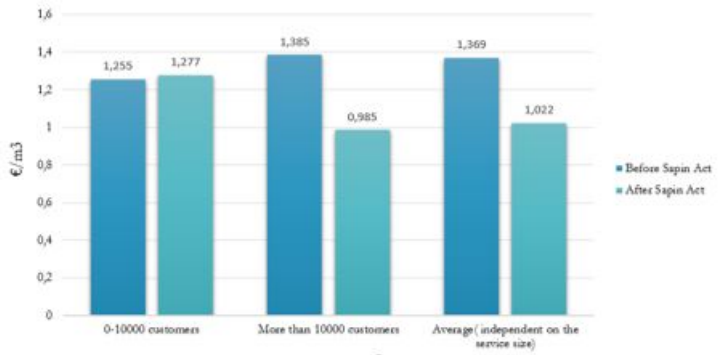
It is however necessary to remind that, when a municipality decides to delegate a water service, there are several parameters that need to be considered and the price, although important, is only one of these. For instance, quality plays a key role because the distributed water is intended for human consumption and therefore it must comply with the corresponding requirements in order to ensure that it will not harm health. However, it is really difficult to negotiate and define all the quality issues in advance so, for what concerns these aspects, it is increasingly more common to insert some clauses in the contract where not only some important requirements are established but it is set also a minimum level of investments that must be made by the company; this is particularly useful because operators are sometimes reluctant to invest even if it is essential in order to ensure water quality.

If we focus our attention on the water price payed to the companies it is possible, first, to analyse whether these have decreased after the introduction of the Sapin procedure and how these have evolved over years.

If we want to compare the average price paid to the private company before and after the entry into force of the Sapin Act we can consider, for instance, data from the year 2013; we can highlight that it is not particularly relevant to take into account a precise year because we are only interested in investigating whether there are quantitative differences between the price payed in the case of a contract signed before or after the entry into force of the Sapin Act. On the contrary, if we are interested in estimating the amount of price difference it is necessary to remind that it may obviously change from one year to another.

We will first consider the average price payed to the private company for the drinking water services and, then, we will consider the price payed for the wastewater sanitation services. According to data relating either to the contracts signed before the entry into force of the Sapin Act and to the ones signed after the entry into force of the Sapin Act, in the year 2013 the average price payed to the company for drinking water services is, on average, equal for what concerns small services (0-10000 customers) while it is considerably different if we take into account larger services. If we do not distinguish on the basis of the service size, we can conclude that the average prices of the two different types of contracts greatly differ. In the following chart are shown the average prices of the contracts, the latter divided into two categories: before Sapin Act and after Sapin Act.

Figure 2.20: Average price ("*part delegataire*"), payed to the private company for the drinking water services, either considering it as a function of the service size and then considering it independently of the service size.



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

Starting from the plotted data, it is possible to detect that difference in the mean price values. It is however advisable to evaluate whether this difference is statistically significant or not. To this purpose we will consider 2 samples:

- the first which relates to the contracts signed before the Sapin Act;
- the second which relates to contracts signed after the entry into force of the Sapin Act.

Both samples have a size of 61 delegated services and we assume that:

- the first sample follows a normal distribution with estimated parameters $\mu = 1{,}369$ and $\sigma^2 = 0{,}5142$
- the second sample follows a normal distribution with estimated parameters $\mu = 1{,}022$ and $\sigma^2 = 0{,}435$

In order to assess whether the difference between the two means is statistically significant or not we can run a Student's t-test because we do not have the real value of the variances but we only have estimates. It is necessary to remind that, to run a t-test it is first necessary to assess the equality of the variances of the two samples. To this purpose it is possible to run a Fisher's F-test where we test the following hypothesis:

$$H0 : \sigma_{ContractssignedbeforeSapinAct} = \sigma_{ContractssignedafterSapinAct}$$
$$H1 : \sigma_{ContractssignedbeforeSapinAct} \neq \sigma_{ContractssignedafterSapinAct}$$

We therefore compute the F statistic in the following way:

$$F = \frac{s_1^2}{s_2^2} = \frac{0{,}514^2}{0{,}435^2} = 1{,}396$$

And we determine the critical values and the corresponding rejection region for a significance level $\alpha = 0.05$. The critical values of the two-tailed test are the following:

$$F(1 - \frac{\alpha}{2}, N_1 - 1, N_2 - 1) = F(0.975, 60, 60) = 1.67$$
$$F(\frac{\alpha}{2}, N_1 - 1, N_2 - 1) = F(0.025, 60, 60) = 0.59$$

Therefore, we will reject H0 if F is smaller than 0.59 or F is larger than 1.67. Given that in our case 0.59<F < 1.67 we fail to reject the null hypothesis $H0 : \sigma_{ContractssignedbeforeSapinAct} = \sigma_{ContractssignedafterSapinAct}$. If we assume that variances are equal, we can run the Student's t-test in order to assess whether the means of the two samples significantly differ. We will therefore test the following hypotheses:

$$H0 : \mu_{ContractssignedbeforeSapinAct} = \mu_{ContractssignedafterSapinAct}$$
$$H1 : \mu_{ContractssignedbeforeSapinAct} \neq \mu_{ContractssignedafterSapinAct}$$

We therefore compute the t statistic in the following way:

$$t = \frac{\bar{x_1} - \bar{x_2}}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}} = \frac{\bar{x_1} - \bar{x_2}}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where s_p is the pooled standard deviation and the corresponding pooled variance is computed in the following way:

$$s_p^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

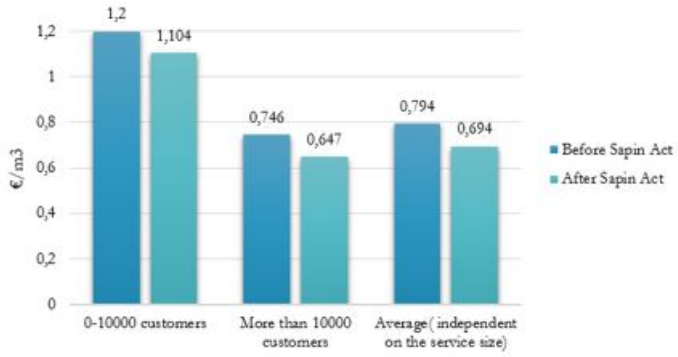
In our case, s_p^2 is equal to 0.226 and the t statistic is equal to 4.05. We can then determine the critical values and the corresponding rejection region for a significance level $\alpha = 0.05$. The critical values of the two-tailed test are the following:

$$t(1 - \frac{\alpha}{2}, n_1 + n_2 - 2) = t(0.975{,}120) = 1{,}9799$$
$$t(\frac{\alpha}{2}, n_1 + n_2 - 2) = t(0.025, 120) = -1{,}9799$$

We have to reject H0 if the t statistic is smaller than -1.9799 or larger than 1.9799. Given that in our case $t = 4.05 > 1{,}9799$ we reject the null hypothesis $H0 : \mu_{Contractssignedbe fore SapinAct} = \mu_{Contractssignedafter SapinAct}$. We therefore can conclude that, thanks to the introduction of the Sapin procedure, the average price payed for drinking water services to operators is significantly lower than the one payed for contracts signed before 1993, as it can be seen from the Figure 2.19.

If we now consider wastewater sanitation services, we can apply the same procedure in order to assess whether the average price payed to operators have changed significantly after the entry into force of the Sapin Act. In the following plot, average prices for these contracts are displayed, either on the basis of the service size and independently of it.

Figure 2.21: Average price ("part delegataire"), payed to the private company for wastewater sanitation services, either considering it as a function of the service size and then considering it independently of the service size.



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

As we can see from the figure, average prices do not substantially differ if we compare the old contracts and the more recent ones. However, it is possible to detect a very slight price decrease in the contracts concluded according the Sapin procedure. To assess whether these average prices significantly differ we can apply the same procedure used in the case of drinking water services. To this purpose we will consider two samples:

- the first one which relates to contracts signed before the Sapin Act;
- the second one which relates to contracts signed after the entry into force of the Sapin Act.

Both samples have a size of 53 price observations and we assume that:

- the first sample follows a normal distribution with estimated parameters $\mu = 0.794$ and $\sigma^2 = 0.6042$
- the second sample follows a normal distribution with estimated parameters $\mu = 0.694$ and $\sigma^2 = 0.4972$

Before running the Student's t-test, we run a Fisher's F-test, to assess the equality of the variances of the two samples. We will therefore test the following hypothesis:

$$H0 : \sigma_{ContractssignedbeforeSapinAct} = \sigma_{ContractssignedafterSapinAct}$$
$$H1 : \sigma_{ContractssignedbeforeSapinAct} \neq \sigma_{ContractssignedafterSapinAct}$$

We therefore compute the F statistic in the following way:

$$F = \frac{s_1^2}{s_2^2} = \frac{0{,}604^2}{0{,}497^2} = 1{,}477$$

And we determine the critical values and the corresponding rejection region for a significance level $\alpha = 0.05$. The critical values of the two-tailed test are the following:

$$F(1 - \frac{\alpha}{2}, N_1 - 1, N_2 - 1) = F(0.975, 52, 52) = 1.75$$
$$F(\frac{\alpha}{2}, N_1 - 1, N_2 - 1) = F(0.025, 52, 52) = 0.57$$

Therefore, we will reject H0 if F is smaller than 0.57 or F is larger than 1.75. Given that in our case 0.59¡F¡1.67 we fail to reject the null hypothesis $H0 : \sigma_{ContractssignedbeforeSapinAct} = \sigma_{ContractssignedafterSapinAct}$. If we assume that variances are equal, we can run the Student's t-test in order to assess whether the means of the two samples significantly differ. We will therefore test the following hypotheses:

$$H0 : \mu_{ContractssignedbeforeSapinAct} = \mu_{ContractssignedafterSapinAct}$$
$$H1 : \mu_{ContractssignedbeforeSapinAct} \neq \mu_{ContractssignedafterSapinAct}$$

We then compute the pooled standard deviation s_p and the corresponding pooled variance. In our case, s_p^2 is equal to 0.306 and the t statistic is equal to 0.931. We can then determine the critical values and the corresponding rejection region for a significance level $\alpha = 0.05$. The critical values of the two-tailed test are the following:

$$t(1 - \frac{\alpha}{2}, n_1 + n_2 - 2) = t(0.975{,}104) = 1{,}984$$
$$t(\frac{\alpha}{2}, n_1 + n_2 - 2) = t(0.025, 104) = -1{,}984$$

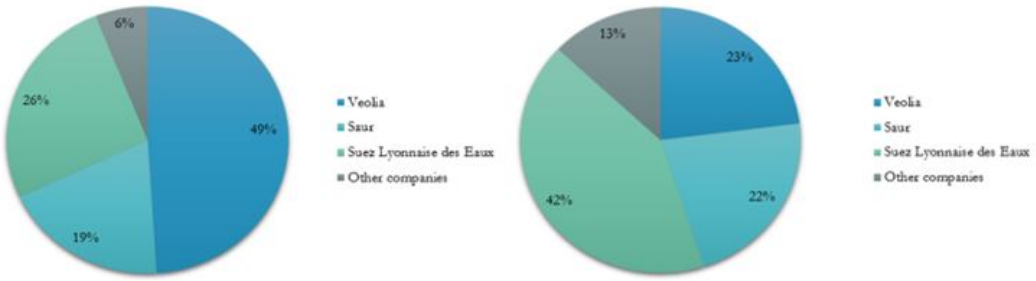
We have to reject H0 if the t statistic is smaller than -1.984 or larger than 1.984. Given that in our case $-1.984 < t < .984$, we fail to reject the null hypothesis $H0 : \mu_{ContractssignedbeforeSapinAct} = \mu_{ContractssignedafterSapinAct}$. We therefore can conclude that the average price payed for drinking water services to operators has not significantly lowered with respect to the one payed for contracts signed before 1993, as it can be seen from Figure 2.21.

2.2.5 Market players

After having analysed the impact of legislation on the level of competition in the water sector, at this point of the analysis it is necessary to put the focus on which are the companies who operate in the water sector. The leading companies who manage most of the services to be provided are Veolia, Saur and Suez Eau France which is the result of the merger between Lyonnaise des Eaux and Suez. Other companies who are most focused on the management of small to medium sized services are the following: Agur, Aqualter Exploitation, Nantaise des eaux, Oehc, Sefo, Semerap SPL, Sogedo and Stgs.

Available data of the year 2013 reveal that, for what concerns delegation agreements signed before the entry into force of the Sapin Act and concerning services delivered to less than 10000 inhabitants, Veolia managed almost half of all the services on the French territory, followed by Suez Eau France (previously known as Suez Lyonnaise des Eaux) and Saur, a water utility company established in France since 1933. The other operators listed above were more active for larger services, as we can see in the following figure.

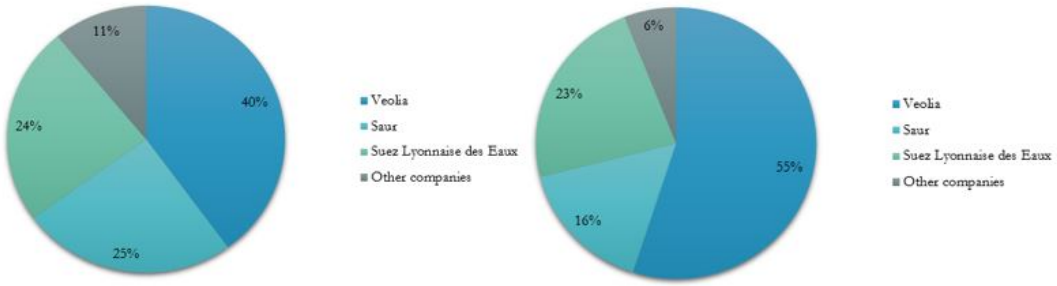
Figure 2.22: Distribution of water services (left: service size<10000 inhabitants; right: service size>10000 inhabitants) among different operators in 2013 for agreements signed before the entry into force of the Sapin Act



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

On the contrary, for what concerns agreements signed after the entry into force of the Sapin Act, the distribution of water services among different operators is slightly different from what has been stated above. In fact, the smaller the service is, the more will be the presence of a small firm operating the network. Moreover, whatever the size of the service is, Saur and Suez Lyonnaise des Eaux are active to the same extent while Veolia is the leading operator. What has just been described can be better recognised by means of the following chart.

Figure 2.23: Distribution of water services (left: service size<10000 inhabitants; right: service size>10000 inhabitants) among different operators in 2013 for agreements signed after the entry into force of the Sapin Act

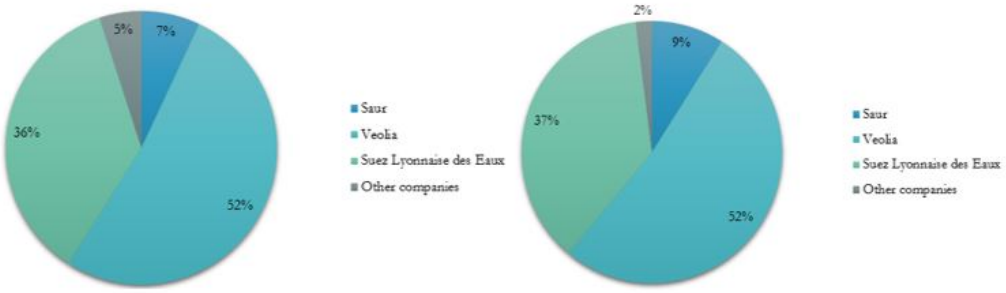


Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

If we compare the contracts signed before and after the Sapin Act, we can notice that the "other companies" gained a larger share of smaller services but lost a relevant one corresponding to large services. Veolia, on the contrary, is the only one who won most of the contracts with larger size, among the ones signed after the entry into force of the Sapin Act. Saur, on the contrary, specialised more on smaller size services while Suez Lyonnaise des Eaux is present to the same extent either on the market of small services and in the market of the large ones.

So far we have discussed of market share in terms of number of services managed by the different operators; it is therefore necessary to redefine it in terms of revenues collected by each of the companies, in order to better quantify their effective presence on the market. In the following chart, the distribution of revenues among the different operators is displayed.

Figure 2.24: Distribution of revenues among different operators in 2013(left: contracts signed before the Sapin Act; right: contracts signed after the Sapin Act)



Source : Observatoire Loi Sapin-observatoire des services publics d'eau et d'assainissement

This is further evidence of the fact that Veolia is the company who holds the largest market share either for what concerns the old contracts and the more recent ones, followed by Suez Lyonnaise des Eaux. Saur's presence on the market has slightly increased with the new contracts but it still remains low. The other companies, on the contrary, generated more income in the management of the services delegated before the entry into force of the Sapin Act and they lost a relevant portion of income in the market of the services delegated in accordance with the Sapin procedure.

It is possible to conclude, therefore, that the competition is stiffer among the three most important operators and almost nonexistent between large firms and smaller ones, who try to specialise in the management of services with limited size. However, another source of competition is becoming increasingly more important: the opportunity, for local entities, to take the service back and to manage it directly. This can be intended not only as a bargaining tool, a credible threat, to put pressure on private companies during the negotiation process but also as a real alternative in order to provide a better service, in terms of quality and/or price, to customers.

In recent years, a trend towards a return of water and sanitation services to public management is largely present in the whole Europe. In France, for instance, re-municipalisation happened several times. Among these we can list the following which are also the most relevant ones:

- In Rennes, local authorities decided to re-municipalise water services in 2013, after a 120-year management carried out by the Veolia company;
- The Communauté Urbaine de Bordeaux decided in 2011 to put to vote the decision to end the contract signed with the "Lyonnaise des Eaux" because of the excessive profits gained by the private operator;
- Nice and the surrounding municipalities had opted for a switch from private to public management, after 150 years in which Veolia has been in charge of the control of water services;
- The City Council of Paris decided in 2008 not to renew the contracts with Veolia and Suez who were jointly in charge of water supply services since 1985;

- The municipality of Montpellier decided in recent years to re-municipalize the water services which have been managed by Veolia since 1990. This has been recognized as a significant issue by the private operator because Montpellier represented one of its largest services.

The reasons behind the choice of re-municipalisation are mainly linked to the following facts:

- Maintenance of the network was considered poor and investment in upgrading the water infrastructure were not judged sufficient by the municipality, according to what had been defined in the delegation agreement. The lack of investments led to a situation in which part of the population had only access to low quality water that didn't meet the requirements and that potentially constituted a health hazard, due to the presence of contaminants such as heavy metals;
- The company in charge of the management abused of its dominant position and enjoyed of substantial profits. Municipalities were able to understand that there was a lack of sound financial management and transparency because, when the decision to switch from private to public management was communicated to the company, the latter was able to promise very large reductions in the price, sometimes up to 50%. Moreover, significant price increases led to strong suspicion that the company in charge of the management was acting improperly. What has raised further concerns it is the fact that the firm, sometimes, didn't let the municipality to carry out the necessary control activities on the service provided to the final customer. In such cases, local authorities were dependent only on the data reported by the private operator and this clearly constituted a problem of asymmetric information generating serious drawbacks.

It is moreover necessary to say that municipalities who choose to take over their water services can decide to adopt a management mode characterised by the presence of a *Société publique locale* (SPL) which is a rather new legal status identifying, as highlighted in the Article L1531-1[13] of the CGCT Code, a public limited company whose capital is owned by at least two communities or by a grouping of local entities organised in the form of syndicates. If this management mode is chosen, the SPL becomes responsible for providing and operating the network infrastructure and the related services. One of the major concerns about this system is that it cannot be considered ad a "pure" public management because, contrary to the provisions for the *Sociétés d'économie mixte* which are corporate forms in which the capital is held not only by public entities but also by private shareholders, the SPLs are not obliged to comply with any advertising requirements when they outsource some activities. It is therefore possible that the influence of private companies still remains significant because some services can be delegated to private companies without the need to make a public tender. This is what happened in the city of Brest, located in Britanny, where the municipality took over the water service by means of a SPL but Veolia is still involved in operating it. This is the main reason why municipalities have to properly control the implemented operations in order to monitor the efficiency either of the management and of the service that is delivered to customer.

[13] ≪ *Les collectivités territoriales et leurs groupements peuvent créer, dans le cadre des compétences qui leur sont attribuées par la loi, des sociétés publiques locales dont ils détiennent la totalité du capital. Ces sociétés sont compétentes pour réaliser des opérations d'aménagement au sens de l'article L. 300-1 du code de l'urbanisme, des opérations de construction ou pour exploiter des services publics à caractère industriel ou commercial ou toutes autres activités d'intérêt général. Ces sociétés exercent leurs activités exclusivement pour le compte de leurs actionnaires et sur le territoire des collectivités territoriales et des groupements de collectivités territoriales qui en sont membres. Ces sociétés revêtent la forme de société anonyme régie par le livre II du code de commerce et sont composées, par dérogation à l'article L. 225-1 du même code, d'au moins deux actionnaires. Sous réserve des dispositions du présent article, elles sont soumises au titre II du présent livre.* ≫

2.3 Italian water market

In this paragraph we describe the Italian water market functioning both for what concerns the management mode and the competitive mechanisms, with a particular focus also on the legislative framework under which the different players have to operate.

2.3.1 Legislative framework and management

The Italian Integrated Water Supply System, as defined in the Art. 141[14] of the Legislative Decree n. 152/2006 (the so called Environmental Code), consists either of those activities related to the collection, purification and distribution of water for civil use and of those related to sewerage and wastewater treatment for both mixed-use residential and industrial customers. Water services can be broken down into three categories:

- Aqueduct services: these consist of all those tasks related to the construction, operation and maintenance of the infrastructures used to collect water, to purify it and to transport it to the final customer. Moreover, these services include also the activities performed to supply drinking water to users.
- Sewerage services: these consist of all those tasks related to the construction, operation and maintenance of the wastewater (either storm water and urban wastewater) disposal infrastructures. It is necessary to say that the system which collects either urban wastewater and storm water is known as combined sewer. In all other cases, the system is known as sanitary sewer and it is designed in such a way that there are distinct pipes for black and white waters.
- Sewage treatment services: these consist of all the activities related to the construction, operation and maintenance of the treatment plants used to purify the waste water that can be subsequently discharged into the environment.

It is necessary to say that, in the last thirty years, the Italian water industry has undergone many changes. From a legislative standpoint, many reforms have been accomplished in order to overcome the high degree of fragmentation that has always characterised the sector. It has indeed been noted that either the presence of a relevant number of microenterprises and the prominent role of public entities have been a hindrance to the improvement of the overall industry performance. This is mainly due to the fact that such companies and the local entities were not large enough to achieve economies of scale and, therefore, it was really hard for them to ensure an efficient management of the resources. Moreover, it is necessary to highlight that for a small-sized operator it is rather difficult to have all the financial means required to ensure an adequate level of investments. Therefore, given that all these aspects had a negative impact on the quality of the service provided to customers, it was essential to reorganise the whole water industry in such a way as to improve the efficiency.

For this purpose, in 1994, the Italian parliament enacted and started to implement the so called "Galli Act"[15] that promotes the conditions for an effective regulation of the industry. This law is based on the following general principles:

- Either groundwater and surface water are public and should be preserved and used in accordance with the criteria of equity;

[14] ≪*Il servizio idrico integrato è costituito dall'insieme dei servizi pubblici di captazione, adduzione e distribuzione di acqua ad usi civili di fognatura e di depurazione delle acque reflue, e deve essere gestito secondo principi di efficienza, efficacia ed economicità, nel rispetto delle norme nazionali e comunitarie. Le presenti disposizioni si applicano anche agli usi industriali delle acque gestite nell'ambito del servizio idrico integrato.*≫

[15] The Galli act is the law 36/1994

- Water use must be done in such a way as to safeguard the right of the following generations to benefit from a well-preserved environmental heritage;
- Water use should follow the principle of water protection and resource renewal and it must not compromise the environment;
- Water use for human consumption has priority over other uses. The latter are allowed only when the resource quantity is sufficient, provided that these do not harm the environmental quality.

Great emphasis was put on the importance of water conservation and environmental protection. As we previously mentioned, the aim of the Galli Act was to reorganise the water services management. First of all, this law provides for the vertical integration of the water services (drinking water service, sewerage service and wastewater treatment service), thus establishing an "Integrated Water Service", IWS. This condition allowed companies to exploit economies of scope and, therefore, to achieve a better performance.

Under the Galli Act, the national territory has been divided into "optimal areas", called "*Ambiti Territoriali Ottimali*"or ATO, within which the Integrated Water Service is implemented. The law delegates to the regions the duty to identify the boundaries of each ATO, taking into account that these must be consistent with the river basin borders. Moreover, as provided for by the Galli Act, for each optimal area only one operator has to be entrusted with the management of the IWS. In this way, either the industry fragmentation is reduced and also the companies' scale efficiency is improved.

Furthermore, in order to ensure that the service provider fulfils all the obligations specified in the contract, the law 36/1994 has provided for the establishment of an authority, called "*Autorità d'Ambito Territoriale*" (AATO), which is made up by the local entities that are part of the ATO. The main function of this authority is to monitor the quality of the service delivered to customers. Other functions of the AATO, as stated by the Galli Act, are the following ones:

- It has to carry out the analysis of the overall state of the infrastructure;
- It has to draw up the investment plan and the tariff plan;
- It has to entrust water management to an industrial company and to negotiate with it the content of the delegation contract;
- It has to evaluate and monitor the quality of the service provided to customers;

Once the ATO have been defined, the municipality can therefore decide how to manage the water services. The latter can be delegated to the following entities:

- A public entity known as "*Azienda speciale*", which is a corporate form that is wholly owned either by the municipality or by the province that is responsible for the service provision. In this case, the AATO can entrust the services without recourse to competitive tendering;
- A mixed-ownership company. Only for those companies whose capital is majority-held by the state, the AATO can entrust the services without recourse to competitive tendering;
- A private operator. In this case, the AATO must conduct a competitive tendering procedure.

It should be noted, however, that the Article 22 of the law 142/90 also allowed local entities to directly manage the water services in all those cases in which the service size was very limited or the service characteristics were such that it was inefficient to set up a "*Azienda speciale*". This provision has therefore limited the resort to this management form. Research has shown that, after the law 142/90, the Galli law, by providing for the aggregation of operations on a territorial scale, has implicitly prevented municipalities from having recourse to direct management.

Referring back to the type of entities to which water services can be entrusted, it is necessary to highlight that, in any case, the company that is in charge of the service delivery acts as a

concessionaire. To govern the relationship between the local authority and the "*Azienda speciale*" a contractual agreement, the so-called "*Contratto di Servizio*", is used. According to the Article 4.1 of the law 95/95, this document has to contain either the obligations of the parties, the price levels, the quality standards and the technical specifications. Moreover, another document known as "*Carta dei Servizi*" is used to specify the service standards that the "*Azienda Speciale*" has to comply with. On the contrary, to govern the relationship between the local authority and the private operator, a template contractual agreement known as "*Convenzione tipo*" is used. In such a document the parties have to specify several aspects. Among these, we can list the following ones:

- The contractual obligations;
- The contract duration. As established by law 36/1994, it cannot exceed the maximum duration of thirty years;
- The minimum service quality that must be delivered to users;
- The criteria used for determining the service price;
- The penalties that might arise from non-compliance with the contract obligations;

For what concerns the water price setting procedure, the Galli Act provides for the establishment of a single tariff for each ATO. The tariff shall be determined in such a way as to ensure full coverage of either operating costs, i.e. the ones related to water supply, sewerage and wastewater, and investment costs. The tariff is the result of a procedure that takes into account the following factors:

- Quality of the resource and quality of the service provided;
- Quality of the network infrastructure;
- The level of planned investments and the maintenance that must be performed on the network;
- The amount of operating costs.

It is important to state that, as provided for by law 36/1994, such tariff must be adjusted over time by using a reference tariff that is computed according to the so-called Normalized Tariff Method (*Metodo Tariffario Normalizzato*, MTN), as foreseen in Article 1 of the Ministerial Decree dated August 1st 1996. We remind that this method has been applied till the end of 2012.

Under the MTN method, the reference tariff at time n is determined in the following way:

$$T_n = (C + A + R)_{n-1} * (1 + \pi + k)$$

where:

- C= operating costs;
- A= depreciation;
- R = return on investments. The associated rate of return has been fixed at 7%;
- π= retail price index for the current year;
- k= price cap, i.e. maximum rate of price increase.

We remind that, in order to obtain the overall price per cubic meter, it is necessary to divide each cost component for the total amount of water supplied. In order to achieve better operational performance, as stated in the 1996 Ministerial Decree, the local authorities have to set a coefficient for the improvement of efficiency and then the operator has to cut operating costs by the given coefficient. The value of this coefficient depends on the ratio between the actual operating costs and the costs that are used to compute the reference tariff; it ranges from 0,5% and 2%. For the sake of clarity, if the authority sets a coefficient equal to 2% it means that the service provider has to reduce the operating costs of at least 2% compared with the costs incurred in the previous year.

The tariff is designed in such a way as, on one side, to improve the efficiency and, on the other side, to boost the investments. Furthermore, it is necessary to say that, on the user side, tariffs have to be designed in order to facilitate essential human consumption, particularly for low-income customers[16]. Then, in order to ensure an equitable redistribution of costs among different customers it also possible to charge a higher price for second properties, as stated in the Article 13 of the Galli Act. As you might notice, there are several factors that have to be taken into account when setting prices. Nevertheless, the key idea is that tariffs mainly depend on local service characteristics (e.g. the specific hydrogeological situation); it is therefore possible that different ATOs charge different prices for water services.

It is necessary to say that, despite all the differences among ATOs, the Galli Act has established for the creation of a national regulator, the so-called "*Comitato per la vigilanza sull'uso delle risorse idriche*" (COVIRI), whose function was either to define minimum quality targets and price setting rules and to ensure that ATOs operated in compliance with these provisions.

After the Galli Act, an important legislative intervention occurred in 2001, when the Ministry of the Environment issued a decree regulating how local authorities should award water services delegation contracts to third parties. Up to that moment, delegation contracts that were awarded to external companies (excluding the so-called *aziende speciali*) had to comply with either the provisions contained in the EU Directives and those applying to the award of public services contracts. This law, which is the law 448/2001, compelled municipalities to select service providers through an open public tender. Moreover, according to these provisions, the authority had to take into account qualitative and technical aspects as well as price, when evaluating the submitted bids. This is known as the criterion of the most economically advantageous tender. For what concerns the in-house providing (i.e. the contracts awarded to municipally-owned enterprises), the decree established that it was not compulsory to carry out an open tender procedure, provided that the following conditions were met:

- The company was held by the municipalities that were part of the same ATO;
- The contract duration had to be shorter than 5 years;
- The company had to sell, within two years from the award date, at least the 40% of the share capital to private investors.

The deadline for selecting an operator through direct award was 18 months from the entry into force of the law 448/2001.

Law 448/2001 established that it was mandatory to carry out an open tender procedure because it was the only tool that ensured transparency; however, at the same time, it also granted the possibility, albeit for a limited period of time, to directly award a public company without the need to follow an open and public tendering procedure. This was in contrast with what stated in the EU directives which aimed at boosting competition among potential service providers. For this reason, in 2002, the European Commission decided to launch infringement proceedings against Italy. After that, Italy carried out a revision of the norms concerning the in-house providing. In

[16] ≪[...] *Nella modulazione della tariffa sono assicurate agevolazioni per i consumi domestici essenziali nonché per i consumi di determinate categorie secondo prefissati scaglioni di reddito. Per conseguire obiettivi di equa redistribuzione dei costi sono ammesse maggiorazioni di tariffa per le residenze secondarie e per gli impianti ricettivi stagionali.* [...]≫

order to comply with EU legislation on competition, it has been decided that non-competitive award of concessions is only allowed if the two following conditions are met:

- The local authority exercises over the concessionaire "a control which is similar to that which it exercises over its own departments";
- The concessionaire carries out "the essential part of its activities with the controlling local authority or authorities".

The main reason why direct award is allowed is because, in practice, there is a no clear distinction between the local entity and the public company; a distinction can only be found on a formal point of view.

New standards for the organisation and control of water services have been provided, in 2006, by the law 152/2006 that has been designed in order to achieve full implementation of the Galli Act. Indeed, law 152/2006 has incorporated the objectives of the law 36/1994 and, at the same time, it has better defined the activities of all the players who are involved in the water industry. Among all the provisions contained in the law 152/2006, we can list the following ones:

- The COVIRI committee is in charge of defining, at national level, the legal and operational framework under which all the players have to operate;
- The Local Authority (the AATO) is in charge of supervising the company to whom the services have been delegated;
- The entrusted water utility company is in charge either of delivering the service to users and making the necessary investments.

As the law highlights, the AATO acts as an intermediate between the National Regulatory Authority and the entrusted water utility company. Indeed, on the basis of the provisions set forth by the National Authority, every AATO draws up a plan, the so-called "Piano d'Ambito", in which it defines either the structural and organisational changes that are needed to achieve some predefined goals. Moreover, it is necessary to say that these reorganisations are negotiated in detail with the water utility company that is in charge of the service delivery.

The Decree that entered into force in January 2008 has amended some provisions contained in the law 152/2006. The most important change that has been introduced by the Decree is that, from there onwards, it was possible to entrust water services to more than one water utility company for the same ATO.

It is necessary to highlight that in 2008, although 15 years have passed since the entry into force of the Galli Act and other reforms were introduced, the provisions of the law 36/1994 had still not been fully implemented. For this reason, the Italian Parliament approved in 2009 a new law[17] on public utilities, including water and wastewater services, whose aim was to encourage the industry reorganisation.

The main objective of this legislative intervention was to boost the Integrated Water Supply System performances through the introduction of private investors that are considered to be more focused on efficiency compared to public investors. The relevant provisions of the Ronchi Decree are the following:

- Water and wastewater services have to be entrusted to private or private-public utility companies in which the participation of local authorities must be lower than 60%. To award the contracts it is mandatory to follow a competitive tendering procedure;

[17]This law is the Decree Law 135 dated 25/09/2009; it is also known as "Decreto Ronchi".

- No service can be entrusted to a public enterprise, except those exceptional circumstances where awarding contracts to private firms is proven to be inefficient. This can be due to the specific nature of the local context that includes geomorphological and environmental aspects as well as socio-economical aspects. In such exceptional cases, the local authority has to draw up a report in which it justifies the choice. This report is then sent to the Antitrust Authority that expresses an opinion in this regard.
- For what concerns the existing contracts that have been awarded to public companies, all these delegation agreements cease to exist on the date 31/12/2011. However, if at least the 40% of the public company's share capital is sold to private investors by that date, the contract continues to produce its effects till the agreed expiry date.
- The participation of local entities in mixed-ownership companies that are quoted on the Stock-Exchange must be lower than 40% by the date 30/06/2013 and lower than 30% by the date 31/12/2015. In other words, local entities have to sell part of their shares, within a given deadline, if they hold more than 30% of a water utility company's share capital. If these conditions are not met, the delegation contracts cease to exist.

However, even though Ronchi Decree's provisions[18] state that water services management should be carried out by private or mixed-ownership companies, it doesn't mean that these operators are entitled to manage such services at their own discretion. In fact, as provided by the Decree, the ownership of the water resource is, in any case, retained by the State. It is therefore necessary that the operators that are entrusted with public services provision act in compliance with law provisions. For instance, as regards price fixing, it still applies the principle according to which tariffs levels must ensure the affordability of water services.

The provisions laid down in the Ronchi decree prompted wide debate in Italy. Some people believed that private provision of water services could be better in terms of efficiency and quality. Other thought that the existing pricing scheme didn't encourage performance improvement, provided that it granted a 7% rate of return on investment, whatever the overall efficiency level of the company. Still others were concerned about the risk of price increases.

Because of these highly conflicting viewpoints, two referendum were proposed in 2011. On that occasion, people were asked the following things:

- Whether or not to repeal the Article in the Ronchi Decree that required water supply to be managed exclusively by firms in which private investors held at least 40% of the share capital;
- Whether or not to repeal the Article in the 1/8/1996 Ministerial Decree that granted a minimum remuneration of 7% on investment to water utilities operators.

For the 2011 Referendum, a turnout of 55.5% has been recorded. Results have shown that approximately 95% of the people who went to the polls voted to repeal both Articles that were subjected to Referendum. From that time onwards, municipalities had to act in compliance with the referendum outcomes and, therefore, with the legislative provisions that were already in force before the Ronchi Decree.

Meanwhile, in 2010, the Law 42 further changed the water sectors' organisation, providing for the deletion of all the AATOs. The Regions have therefore transferred their functions to another local Authority called *Ente di Governo dell'Ambito* (EGA). The reason behind this choice is that the AATOs were no longer considered to be effective and efficient while the new local entity was thought to be a better alternative. It is important to notice that this organisational change had to

[18] ≪ [...]*tutte le forme di affidamento della gestione del servizio idrico integrato devono avvenire nel rispetto dei princìpi di autonomia gestionale del soggetto gestore e di piena ed esclusiva proprietà pubblica delle risorse idriche, il cui governo spetta esclusivamente alle istituzioni pubbliche, in particolare in ordine alla qualità e prezzo del servizio, in conformità a quanto previsto dal decreto legislativo 3 aprile 2006, n. 152, garantendo il diritto alla universalità ed accessibilità del servizio*≫

be implemented within one year after the entry into force of the Law 42. However, this deadline has then been extended to December 31/2012.

After the decision to delete the AATOs, another important organisational change occurred in the water industry. Indeed, with the entry into force of the Law 142/2011, the functions previously performed by the CoViRi Authority have been conferred on the *Autorità per l'Energia Elettrica e il Gas* (AEEG) which was the independent regulatory body of energy markets (including either electricity and gas market). Given that new regulatory duties in the Integrated Water Service were attributed to the AEEG, the latter changed its name accordingly and became the so-called *Autorità per l'energia elettrica il gas e il sistema idrico* (AEEGSI). For the sake of completeness, it is necessary to notice that, as of 1st January 2018, the Italian Regulatory Authority for Electricity Gas and Water became the *Autorità di regolazione per Energia, Reti e Ambiente* (ARERA).

It is important to highlight, however, that there were several responsibilities, regarding the Integrated Water Service, that have not been transferred to the AEEGSI. We are referring to those of the Ministry of Environment, that is in charge of the following tasks:

- It has to set the quality standards for water resources, in compliance with either national and European provisions;
- It has to define criteria that can effectively promote water savings and, more generally, a more efficient usage of the resource;
- It defines the criteria that can be used to determine the environmental cost associated with water resources;
- It defines the general quality objectives that the Integrated Water Service has to achieve.

For what concerns the AEEGSI, its main functions are the following ones:

- It has to define the criteria that can be used to determine water prices. It is necessary to highlight that the tariff system must be fair, transparent and non-discriminatory. Moreover, the tariff system must be designed in such a way as to comply with either the "full cost recovery" principle and the "polluters pays" principle;
- It has to supervise the water sector, ensuring that services are managed in an efficient, fair and transparent way;
- It has to ensure that the service meets the statutory service-quality standards;
- It has to ensure that users' rights and interests are respected.

For what concerns the pricing system, the AEEGSI introduced in 2012 a new tariff method for determining the rate of water services. This tariff model, known as *Metodo Tariffario Transitorio* (Transitional Tariff Model, MTT), was designed to replace the model that had been in force since 1996, which was the MTN. The main difference between the previous tariff model and the MTT is that the first one was based on ex-ante regulation while the latter is based on ex-post regulation which means that only those costs related to actual investments are taken into account.

The MTT pricing formula is the following:

$$VRG = Capex + Opex + FNI + CO_{EE} + COws + CO_{others} + MT + AC$$

Where:

- VRG = this is the total sum that is owed to the operator. It is intended to cover either operating and investment costs;
- $Capex$ = this component is intended to cover capital expenditures;

- $Opex$ = this component is intended to cover operating expenditures;
- FNI = it is the share of the total tariff to be used to finance investments;
- CO_{EE} = this component is intended to cover electricity costs;
- $COws$ = this component is intended to cover wholesale costs;
- CO_{others} = this component is intended to cover pass-through costs such as fees paid for licenses to divert water flows;
- MT = this component is intended to cover the value of all the loans instalments that the water utility company has to reimburse to the owner for those goods that are held under concession;
- AC = this component is intended to cover the total amount of money (except the sum that is already included in the MT component) that the water utility company has to reimburse to the owner for those goods that are held under concession.

An additional parameter that has great importance in the tariff-setting procedure is a multiplication factor, the ϑ coefficient, that can be applied to the VRG of the previous year's tariff scheme in order to obtain the VRG for the current year. The ϑ coefficient represents the tariff's increase and it is defined by taking into account the inflation rate for the current year.

Under this tariff model, either depreciation, borrowing costs and fiscal charges are included in the cost component Capex. For what concerns the depreciation rates, these are reviewed yearly in order to take into account the residual useful life of the assets. For what concerns the borrowing costs, these are defined according to several parameters that take into consideration some aspects such as the market risk and the debt/equity ratio. For what concerns the fiscal charges, these are defined taking into consideration either the IRES (corporate tax) and the IRAP (regional tax) rates.

It is important to notice that the MTT was applied only in 2012 and 2013. In 2013, in fact, the AEEGSI was already examining a new pricing system that has then replaced the existing one. The new pricing method was the so-called *Metodo Tariffario Idrico* (MTI).

The new tariff formula at time n is defined as follows:

$$VRG_n = Capex_n + Opex_n + FoNI_n + ERC_n + R_{c_n}$$

Where:

- $Capex$ = this component is intended to cover capital expenditures. It includes borrowing costs, depreciation as well as fiscal charges;
- $FoNI$ = this component is intended to cover not only those costs that are related to realised investments but also those spent to finance price subsidies to poor customers;
- $Opex$ = this component is intended to cover operating expenditures;
- ERC = this component is intended to cover the environmental and resource costs that have not yet been included elsewhere. In order to determine the ERC component it is necessary to take into account all those costs of the interventions required either to improve the water resource quality and to prevent environmental damages. It is necessary to say that such cost components have been included in the tariff setting procedure, in compliance with EU Directives' provisions;
- R_c = this component is intended to cover the price adjustments for the tariffs of the preceding years.

In the same way as for MTT, in order to obtain the value of the VRG for the current year it is necessary to use a ϑ coefficient that takes into account not only the inflation rate but also the operating circumstances under which each operator has to manage the service. Furthermore, the ϑ coefficient changes also in accordance with the objectives that each operator is supposed to reach. In order to determine the maximum limit to the variation of the tariff multiplier it is possible to consider the MTI Regulatory Matrix, which is displayed in the following figure.

Figure 2.25: MTI Tariff method-matrix

	NO VARIATIONS IN THE OPERATOR'S OBJECTIVES OR ACTIVITIES	VARIATIONS IN THE OPERATOR'S OBJECTIVES OR ACTIVITIES
$\frac{\sum_{2014}^{2017} IP_t^{exp}}{RAB_{MTT}} \leq \omega$	SCHEME I $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + K)$	SCHEME II $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + K)$
$\frac{\sum_{2014}^{2017} IP_t^{exp}}{RAB_{MTT}} > \omega$	SCHEME III $\frac{\vartheta^a}{\vartheta^{a-1}} \leq [1 + rpi + (1 + \gamma) * K]$	SCHEME IV $\frac{\vartheta^a}{\vartheta^{a-1}} \leq [1 + rpi + (1 + \gamma) * K]$

Source: AEEGSI (2013), 'Approvazione del metodo tariffario idrico per il primo periodo regolatorio MTI', Delibera 643/2013/R/IDR

As it is possible to notice, the Regulatory Matrix is composed of four Schemes. Each operator is associated to one of these Schemes according to its operating circumstances. Each Scheme is determined according to two factors: the first one is the ratio between the planned investments, defined as IP, for the period 2014-2017 and the value of the existing assets, defined as Regulatory Asset Base, while the second one depends on whether there are variations in the operator's objectives or not. If the ratio is above a certain threshold, i.e. higher investments are required, it is possible to apply the Scheme III or the Scheme IV whose associated cap to ϑ variation is equal to 6.5%. For all other cases, it is possible to apply either the first or the second Scheme whose cap to ϑ variation is equal to 9.0%. Moreover, it is necessary to highlight that each Scheme is associated to a specific set of rules that must be used to determine the tariff components that we mentioned above, in the MTI tariff formula. For the sake of clarity, we highlight that, under the MTI tariff scheme, all the costs related to realised investments are entirely reimbursed. However, the higher the amount of investments, the higher is the applied tariff multiplier and consequently the higher are the cash flows that the company is able to generate.

If we compare the MTI and the MTN tariff models it is possible to conclude that the main difference between an ex-ante regulation and an ex-post one lies in the fact that the first one doesn't provide enough incentives to make investments, given that the operator is reimbursed for the planned investments even when not realised. As Guerrini et al. (2011) show, under the MTN tariff model, many utilities in Italy have experienced a low level of investments, despite the high prices. In such cases, users were often unwilling to pay for investments planned and not yet realised while operators asked for full recovery of costs.

As data reveal, the implementation of the MTI tariff method has proven to be very effective. In fact, for the years 2014 and 2015, the investments have shown a relevant growth. For instance, in 2015 the investments have increased of 55% compared to those realised in 2012. It is however necessary to say that the overall amount of investments that were realised in those years was considerably below the average recorded for other EU countries. Therefore, it was still necessary to improve this condition.

The MTI pricing model was only applied in 2014 and 2015; then, it has been replaced by another method which is known as the MTI-2, that is applied from 2016 till 2019.

The MTI-2 tariff formula for the year n is defined as follows:

$$VRG_n = Capex_n + Opex_n + FoNI_n + ERC_n + R_{c_n}$$

As you might notice, the pricing formula has remained unchanged, compared with the one that was applied under the MTI model. However, it is necessary to highlight that the MTI-2 model has been designed in order to achieve either a higher level of industry integration and a better quality of water services. For this purpose, the MTI-2 tariff method provides considerable incentives to those companies which will strive to reach these goals. Operators are therefore distinguished on the basis of their operational circumstances. Each category is then associated to a different element, called

Schema, in the so-called Regulatory Matrix. This tool is used in order to determine the limit set to price variation. The Regulatory Matrix, as shown in Figure 1, is composed of six Schemes, and each Scheme is determined according to two factors. The first one is the ratio between the planned investments for the years 2016-2019 and the value of the already existing infrastructure, which is defined as RAB. If the ratio is below a certain threshold, defined as ω (which is equal to 0.5), it means that the underlying Schemes (I, II, III) are suitable for those operational circumstances characterised by lower investment needs going forward. On the contrary, Schemes IV, V and VI are suitable for those circumstances characterised by higher investment needs. The second factor that is used to determine the Schemes is the operational efficiency, defined as the per-capita Opex, which is the ratio between the total operational expenditures and the population served (pop). If the per-capita Opex is above the national average value, defined as OPM (which is set equal to 109), it means that the operator is efficient and the suitable Schemes are the II and the V. On the contrary, less efficient operators are associated with Schemes I and IV. For what concerns Schemes III and VI, it is necessary to highlight that these do not take into account the operational efficiency. These are in fact applicable only in cases where there is a relevant change in the service either in terms of served area or in terms of service quality.

Figure 2.26: Tariff method-matrix

		$\frac{Opex^{2014}}{pop} \leq OPM$	$\frac{Opex^{2014}}{pop} > OPM$	VARIATION IN THE OPERATOR'S OBJECTIVES OR ACTIVITIES: • WATER SYSTEM INTEGRATION • QUALITY IMPROVEMENTS
INVESTMENTS	$\frac{\sum_{2016}^{2019} IP_t^{exp}}{RAB_{MTI}} \leq \omega$	SCHEME I LIMIT TO PRICE VARIATION $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + K - X)$	SCHEME II LIMIT TO PRICE VARIATION $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + K - 2X)$	SCHEME III LIMIT TO PRICE VARIATION $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + K)$
	$\frac{\sum_{2016}^{2019} IP_t^{exp}}{RAB_{MTI}} > \omega$	SCHEME IV LIMIT TO PRICE VARIATION $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + 1{,}5 * K - X)$	SCHEME V LIMIT TO PRICE VARIATION $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + 1{,}5 * K - 2X)$	SCHEME VI LIMIT TO PRICE VARIATION $\frac{\vartheta^a}{\vartheta^{a-1}} \leq (1 + rpi + 1{,}5 * K)$

Source: AEEGSI (2015), 'Approvazione del metodo tariffario idrico per il secondo periodo regolatorio MTI-2', Delibera 664/2015/R/

As you might have noticed, the limit set to price variation is different for each Scheme. Moreover, it is defined on the basis of the following elements:

- The estimated retail price index variation, defined as rpi;
- A factor, defined as K (which is set equal to 0.05, that represents the price limit. This parameter takes into account information regarding, for example, the investment needs;
- An efficiency-sharing factor, defined as X, that puts a limit on price variation. The higher are the per-capita operating costs, the lower is the limit to price increase. However, it is necessary to say that this is not merely an incentive to reduce operating costs. This parameter is in fact used in order to avoid that costs inefficiencies are entirely passed on to customers

It is important to highlight that the price charged to users has to grow according to the tariff multiplier. The maximum growth for each scheme is displayed in the following figure.

Figure 2.27: Limit to price variation in the MTI-2 Tariff Model

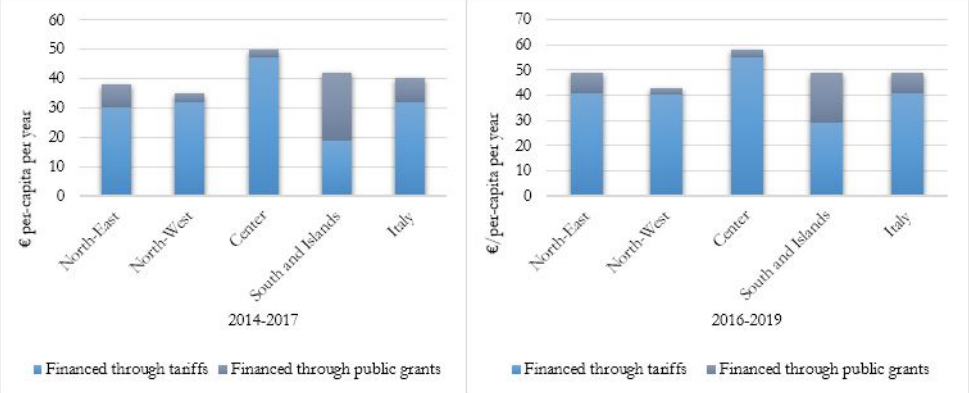
		$\frac{Opex^{2014}}{pop} \leq OPM$	$\frac{Opex^{2014}}{pop} > OPM$	VARIATION IN THE OPERATOR'S OBJECTIVES OR ACTIVITIES: • WATER SYSTEM INTEGRATION • QUALITY IMPROVEMENTS
INVESTMENTS	$\frac{\sum_{2016}^{2019} IP_t^{exp}}{RAB_{MTI}} \leq \omega$	SCHEME I 6,0%	SCHEME II 5,5%	SCHEME III 6,5%
	$\frac{\sum_{2016}^{2019} IP_t^{exp}}{RAB_{MTI}} > \omega$	SCHEME IV 8,5%	SCHEME V 8,0%	SCHEME VI 9,0%

Source: AEEGSI

As shown in the table, the highest values are found for those schemes that are associated with a higher investment need and for those associated to operators that have considerably changed their service.

Data have shown that the MTI-2 is proving to be very effective in boosting investments. According to research findings, planned investments are higher in the second regulatory period (2016-2019) compared to the ones that were planned for the first regulatory period (2014-2017). A study (Berardi et.al 2016) carried out by the "REF Ricerche" Institute on a sample of 65 operators highlights that planned investments have increased of about 20%. In the following figure the key findings of this study are displayed.

Figure 2.28: Planned Investments in the period 2014-2017 and in the period 2016-2019

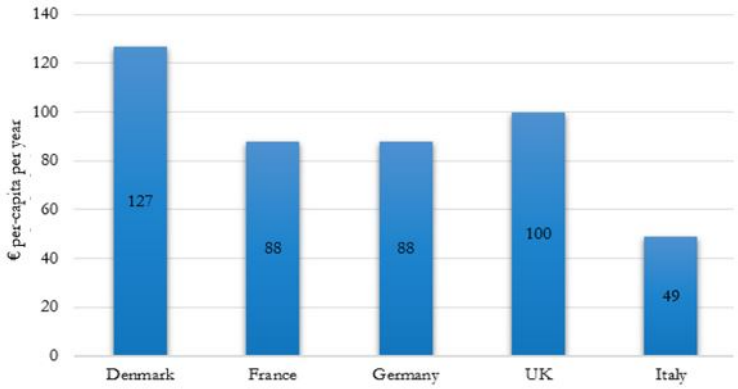


Source: REF Ricerche

As the figure shows, in Italy, average planned investments have increased from around 40 € per-capita per year to 49 € per-capita per year. The North-Est is the area where the highest increase has been recorded. Moreover, it is necessary to notice that, in relative terms, the amount of the investments that is financed through public grants has decreased over years, meaning that operators are increasingly able to finance the investment needs through tariffs. If we consider the South of Italy and the Islands, for instance, the amount of public grants required to finance investments in the second regulatory period are lower, about 40 percent of the overall amount of investments, compared with those needed, about 54 percent, for the investments planned in the first regulatory period.

Despite the increase in planned investment, if we compare the Italian average planned investments with those of other EU countries we see that the former ones are much lower. The following figure shows the total planned investments for some EU Countries: Denmark, France, Germany and UK.

Figure 2.29: Average annual planned investments for some EU Countries



Source: Utilitatis-Blue Book, 2015

It is therefore possible to conclude that Italy still invests too little in the water system and this becomes even more evident if we consider the fact that not all the planned investments are then realised. In fact, as data show, in 2015 only the 80% of the total planned investment have then been realised. Furthermore, it is necessary to highlight that this percentage is not the same throughout the different Italian regions. For instance, in 2015, the value of the ratio between the realised investments and the planned ones ranged from 57%, recorded in the south of Italy, to 97%, recorded for the central regions.

2.3.2 Pricing of water services

According to what is provided for by the Regulatory Authority in the Resolution 665/2017/R/idr, as from 1st January 2018 end-user charges have to be designed as follows.

In the water bill, each water service (Aqueduct service, Sewerage service, Sewage treatment service) shall be associated to either a variable component, whose sum depends on the consumption level, and a fixed component, that does not vary with consumption.

For what concerns the Aqueduct service, its variable component shall be structured as an increasing block tariff. On the contrary, the variable component of either the sewerage service and the sewage treatment service shall be structured as a constant volumetric tariff. What has just been described is summarised in the following figure.

Figure 2.30: End-user tariff scheme

Variable component for aqueduct service (€/m3)			
	€/m³	Water Consumption blocks	
		From	To
«Lifeline block» tariff	T_a^a	0	q_a
Base tariff	T_b^a	$q_a + 1$	q_b
First block tariff	T_{e1}^a	$q_b + 1$	q_{e1}
Second block tariff	T_{e2}^a	$q_{e1} + 1$	q_{e2}
Third block tariff	T_{e3}^a	$q_{e2} + 1$	$> (q_{e2} + 1)$
Variable component for sewerage service (€/m3)			
Variable component for sewerage service	Tf^a		
Variable component for sewage treatment service (€/m3)			
Variable component for sewage treatment service	Td^a		
Fixed component (€/year)			
Fixed component for aqueduct service	QF_{ACQ}^a		
Fixed component for sewerage service	QF_{FOG}^a		
Fixed component for sewage treatment service	QF_{DEP}^a		

Source: ARERA

As stated in the Resolution 665/2017/R/idr, the variable component for the Aqueduct service shall consist of a lifeline block, a base block and a minimum of one additional block up to a maximum of three additional blocks. Moreover, each block shall be defined on the basis of the actual number of family members. However, if accurate information about the actual numbers is not yet available, until 2022 tariff blocks can be determined assuming that households are made up of three individuals. The so-called lifeline block is associated with a volume of water that corresponds to the essential minimum human consumption. The latter has been fixed at 50 liters per-capita per day, which corresponds to 18,25 cubic meters per-capita per year. It is necessary to say that the lifeline block too shall be set in such a way as to take into account the actual size of each household. If the size is unknown, then this block will be fixed at 150 liters per household per day. The tariff that is associated to this volume of water is set below cost and it is computed as follows:

$$T_a^a = T_b^a(1 - sub\%)$$

Where

- T_b^a is the base tariff that is computed by applying the multiplier factor to the base tariff that was previously in force;
- $sub\%$ is the value of the subsidy that is applied to the lifeline block. It is expressed as a percentage and its value ranges from 20% to 50%, depending on the local entity's decision.

We remind that such subsidised rate is not applied to those users who are non-resident. Moreover, it is necessary to highlight that the ratio between the tariff of the lifeline block and the one of the last block shall not exceed the one-to-six ratio in order to comply with the provisions set out in the Resolution.

For what concerns the variable components (Tf and Td) for the either the sewerage service and the sewage treatment service, we already said that these shall increase linearly with consumption. It is important to highlight that the actual value of such components is computed by multiplying the value that these had in the previous year by a coefficient that allows for tariff adjustments over time.

As we previously stated, the water bill is made up of either a variable and a fixed component. Moreover, when setting prices, it is important to define these charges in such a way as to ensure that, for each service, the amount of the associated fixed fee does not exceed the 20% of the overall service price (which is computed as the sum of the variable and the fixed component).

As data show, for a household composed of three members and an annual consumption of 192 cubic meter, the average annual water bill in 2015 amounted to 376 € and it was composed as follows:

- the variable component for the aqueduct service amounted to 0,997 €/m3.
- the variable component for the sewerage service and the sewage treatment service, that were therefore considered jointly, amounted to 0,796 €/m3.
- the fixed component amounted to 30 €/year. Please note that this datum refers to a household composed of three members and an annual consumption of 192 cubic meter.

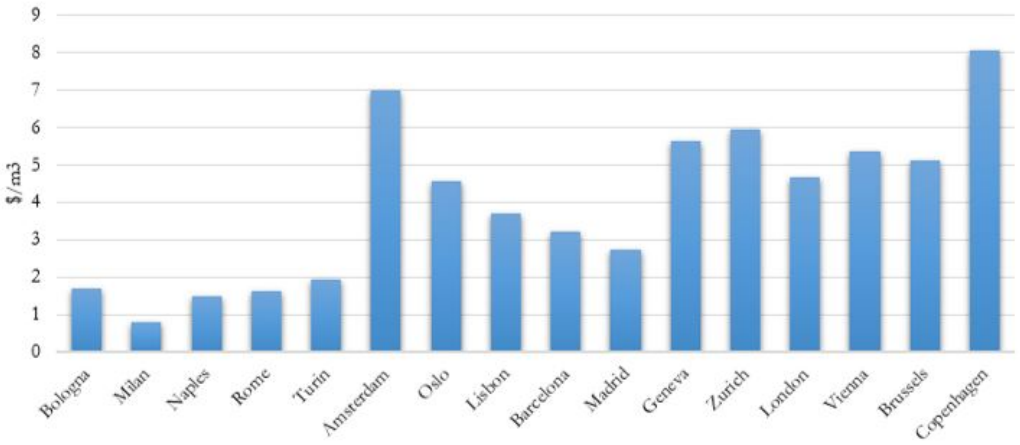
It is necessary to highlight that all the three components include a VAT rate of 10%.

For the sake of completeness, it is important to stress that the water price is not the same all over the country: tariffs are the highest in the center of Italy, reaching an average annual bill of 511 € for a household composed of three members, while rates are the lowest in the south, where the annual bill for an household of three members amounts to 327 €. Moreover, water tariffs have strongly increased over the years. For what concerns the period 2007-2015, for example, the average water bill has increased by more of 60% in the period. It is necessary to say that further increases are expected in the next years.

Although the average water bill in Italy may seem, at first sight, expensive, it is not, actually. In fact, if we compare it with those of other countries we notice that it is one of the lowest in Europe. As the latest analyses carried out by the International Water Association show, in 2014 the price per cubic meter in Italy ranged from 0,71 € in Milan to around 3 € in other cities such as Grosseto and Siena while in other EU countries, such as Netherlands and Denmark, water costs more than 7 € per cubic meter.

In the following histogram the water tariffs of several EU countries are compared. The data displayed in the figure have been gathered by the International Water Association.

Figure 2.31: Water price per cubic meter in 2014(expressed in $/m3)



Source: International Statistics for Water Services - 2014

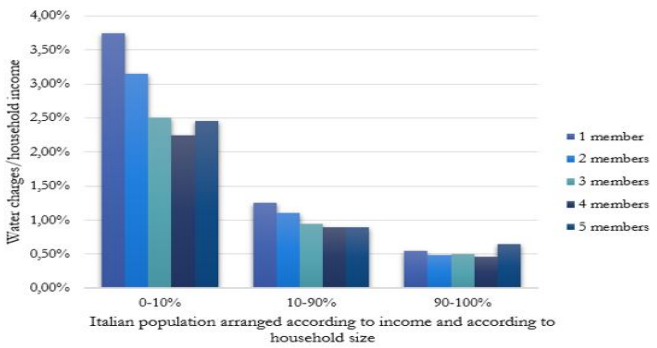
Besides the fact that the Italian water changes are considerably lower compared with those of other countries, another conclusion that can be drawn from the figure is that water price in Mediterranean countries is cheaper than that of the Northern countries.

2.3.3 Social tariffs

As we already emphasised, water services must be accessible and affordable for anyone. A good indicator that allows us to understand whether these services are really affordable or not is the impact that bills have on households' income.

If we consider, for example, one of the analyses carried out in 2012 by the REF Institute we can notice that Italian households spent on average from 0,5% to 3,75% of their income to pay water bills in that year. The higher is this value, the more is difficult for the household to bear the expenses related to water supply. When this indicator exceeds two percentage points, it means that this household is starting to experience difficulties in meeting his water bills. In the following histogram it is possible to see how the ratio between water charges and income varies according to the household size and to the level of household income. It is crucial to point out that, in such histogram, the Italian population has been divided into three groups (0-10 percentile range, 10 -90 percentile range, 90 to 100 percentile range) according to the level of household income (low, medium, high). Moreover, for each group, households have been further divided according to the household size (from one to 5 members).

Figure 2.32: Water charges expressed as a percentage of household income, Italy, 2012



Source: ISTAT statistics and Bank of Italy data

The main conclusion that can be drawn from the analysis of this histogram is that, on average, 10% of the Italian population spent more than 2% of the overall household income for water-related expenditures. Moreover, it is possible to notice that, within each group, the ratio water charges/household income decreases as the household size increases and this trend may suggest the presence of some sort of economies of scale in water consumption.

For the reasons set out above, the Regulator has decided to adopt the so-called "*Bonus Idrico*" as a measure to financially support low-income families. The *Bonus Idrico* is a social bonus, i.e. an amount of money that is reimbursed to those users who are eligible to obtain such a subsidy (people who face severe economic difficulties). Under this social bonus, the amount that shall be refunded is the sum that is associated to the lifeline block., i.e. the volume corresponding to the essential minimum consumption. Moreover, it is necessary to say that it is possible for local entities to introduce an additional subsidy that is called *Bonus Idrico Integrativo*. We remind that the amount of both bonuses depends on the actual household size.

As provided for by the Resolution No. 897/2017/R/idr, all the costs resulting from the implementation of this measure will be entirely covered by the introduction of a new tariff component in the water bill.

For the sake of completeness, we highlight that, as provided for by the Decree dated 29 August 2016[19], in no case can the service provider suspend the service towards those people who, facing severe economic difficulties, don't pay their bills. It shall be in fact ensured that they still have access to the minimum amount of water that is essential for human life.

2.3.4 Level of competition in the Italian water market

Since 1990's it has been stressed the importance to promote the private sector provision of water services. It was in fact considered as a possible solution to the problems that were recorded in the water system. It is indeed important to highlight that the water system in those years was characterised by low coverage rates, high loss rates and significant inefficiencies. At the same time, water supplied to users was of low quality and this situation was mainly caused by the lack of investments. In this context, it was thought that private companies were able to increase the overall industry efficiency by bringing their technical know-how and their specialised management experience.

Data have shown that, before the entry into force of the Galli Act, water services were managed by more than 12000 different operators. Municipalities provided water services to almost 50% of the overall Italian population while private companies served only the 8% of all the population. As you might guess, multinational companies were almost absent in the water services industry. The only exception is Venice, whose water services were managed, from the end of the XIX century till 1973, by the French company Générale des Eaux.

Twenty years after the enactment of the Galli Law the situation has radically changed. In 2014 the number of operators was about 2300. However, there are still 2000 municipalities that manage water services directly. The first ten water utility companies account for more than 50% of the whole market and among them there are either mono and multi-utility companies. As defined by Arnaudo (2011), most of these companies "established themselves as industrial inheritors of the former companies entitled by the municipalities to manage their local public utilities". Such

[19] ≪*In nessun caso è applicata la disalimentazione del servizio a:*
a) gli utenti domestici residenti che versano in condizioni di documentato stato di disagio economico-sociale, come individuati dall'Autorità per l'energia elettrica, il gas e il sistema idrico in coerenza con gli altri settori dalla stessa regolati, ai quali è in ogni caso garantito il quantitativo minimo vitale pari a 50 litri ad abitante al giorno;
b) le utenze relative ad attività di servizio pubblico, individuate dall'Autorità per l'energia elettrica, il gas e il sistema idrico in coerenza con gli altri settori dalla stessa regolati.
2. Fatto salvo quanto previsto dai commi 1 e 2 del presente articolo, a tutti gli utenti domestici residenti è garantito l'accesso al quantitativo minino vitale a tariffa agevolata. Sono altresì previste adeguate forme di comunicazione all'utenza e di rateizzazione anche in caso di morosità al fine di garantire l'accesso al quantitativo minino vitale e di salvaguardare l'equilibrio economico e finanziario del gestore e la copertura dei costi efficienti di esercizio e di investimento e dei costi ambientali e della risorsa.≫

operators underwent several reorganisations over the years in order to comply with the changes occurred in the legislation.

In the following table are presented the key players in the Italian water services industry.

Figure 2.33: Key players in the Italian water market, 2014

Company Name	MONO/MULTI UTILITY	Value of production year 2014 (€)	Number of inhabitants served by the company
ACEA ATO 2 S.P.A. (ROME)	MONO	556.013.802	3.655.000
ACQUEDOTTO PUGLIESE S.P.A.	MONO	478.862.000	4.061.000
HERA S.P.A. (EMILIA ROMAGNA)	MULTI	430.231.000	3.651.000
SOCIETA' METROPOLITANA DELLE ACQUE TORINO S.P.A.	MONO	309.665.000	2.254.907
CAP Holding S.P.A. (MILAN AREA)	MONO	245.156.821	2.243.500
PUBLIACQUA S.P.A. (FLORENCE)	MONO	218.337.903	1.243.819
GORI SPA GESTIONE OTTIMALE RISORSE IDRICHE (NAPOLI AREA)	MONO	192.590.543	1.437.380
IREN ACQUA GAS S.P.A. (IREN GROUP) (EMILIA ROMAGNA/LIGURIA)	MULTI	157.670.000	2.400.000
ACQUE S.P.A. (PISA)	MONO	142.919.432	788.541
MEDITERRANEA DELLE ACQUE S.P.A. (IREN GROUP) (GENOA)	MULTI	120.653.000	700.000
ABC- ACQUA BENE COMUNE NAPOLI	MONO	101.379.665	1.650.000
METROPOLITANA MILANESE S.P.A.	MULTI	137.777.000	1.342.337
ABBANOA S.P.A. (SARDINIA)	MONO	248.172.000	1.629.941
AMAP S.P.A. (PALERMO)	MONO	82.820.044	700.000
ACQUEDOTTO DEL FIORA S.P.A. (GROSSETO)	MONO	103.756.090	411.110

Source: Utilitatis

As you might notice, Acea ATO 2 S.p.A. is deemed to be the largest water services provider in Italy. It is part of the Acea S.p.A. multiutility company that provides water services to almost 8.500.000 customers located in the central Regions of Italy. It is the former utility company of the municipality of Rome; as of today, after having undergone a privatisation process, it is a Suez Environment subsidiary (since 2016 Suez holds a stake of more than 23%). However, it is necessary to say that it is still controlled by the municipality of Rome. Acea S.p.A. is then followed, in terms of market share, by the Acquedotto Pugliese S.p.A., which is controlled by the Apulia Region, by the company Hera S.p.A., which is controlled by the municipality of Bologna, and by Iren S.p.A., which is a firm jointly controlled by the Genoa, Parma, Piacenza, Reggio Emilia and Turin municipalities.

As stated in one of the Italian Competition Authority's reports, as of 2010, Acea S.p.A. had a market share between 5% and 10% while its direct competitors had a relative share of approximately 5%.

As already emphasized, before the entry into force of the Galli law, water multinationals had

a minor presence in the industry. In this context, the enactment of the Galli law was seen as an opportunity for expansion. For instance, if we consider the Suez company, it is possible to notice that since 1989, the year in which the first draft of the Galli law was presented, its presence started growing through a series of acquisitions. In June 1989, the Suez subsidiary Acque Toscane was entrusted with the water services management for the city of Montecatini Terme. In 1991, the company was awarded the concession to provide water supply services for the Fiesole municipality and in 1992 it was awarded the concession to provide water services for the city of Ponte Buggianese. As it is possible to notice, Suez decided to expand in the Tuscany Region. A further expansion then occurred after 1999, when Suez acquired a minority stake in Acea's capital. For what concerns the French company Générale des Eaux (it changed its name twice, first becoming Vivendi and then Veolia Environment), it started to expand in the early 1990s through several acquisitions of firms located throughout the country. Among them we can list the following ones: Acqualatina, Siciliacque S.p.A. and Società dell'Acqua Potabile di Sestri Levante S.r.l..

In order to have a better overview on how the industry and its degree of competition have evolved over time, it is also necessary to consider the way in which water services have been organised. After the entry into force of the Galli Act, the national territory has been divided into 92 ATOs; this number has then decreased over years and, as of today, there are 72 ATOs. It is important to highlight that this situation had a relevant impact on water utility companies which had to reorganise their structure accordingly, in order to adapt to the changing environment. Despite many attempts to reach a better level of integration, the water industry is still very fragmented and the reason may also be found in the fact that, as highlighted in the 2010 National Water Agency report, local administrations often resisted the implementation of the reforms. However, in this context, few big companies quickly gained ground and, alongside this trend, several competition problems have arisen.

Since 2003, the Italian Competition Authority issued several warning notes because it found some irregularities in the tendering procedures. Furthermore, in 2007-2008, two antitrust proceedings have been carried out. In order to provide a more detailed view on the competition-related problems we can briefly describe some cases referring to the major antitrust infringements that occurred in those years.

In 2006 the Italian Competition Authority opened an investigation proceeding against Acea S.p.A., and Suez Environment S.A. for alleged infringements of the Article 101[20] of the Treaty on the Functioning of the European Union (TFEU). The investigation concerned the fact that the two companies made a joint bid in several public tenders in order to win the contracts for the supply of water services in the Tuscany Region. We remind that the legislation allows independent companies to jointly participate to tenders and this can be done by constituting a temporary association called *Associazione Temporanea di Imprese (ATI)*. The idea behind the possibility to make joint bids is to foster competition by giving the opportunity to participate in tenders to those companies, e.g. small firms, that would be otherwise excluded. However, as interpreted by the Italian Antitrust Authority, the joint bids of Acea S.p.A. and Suez were anticompetitive because, actually, these were two big market players that were able to participate alone to public tenders. However, they decided to coordinate themselves in such a way as to eliminate the competition among themselves and to influence tenders' outcomes. Because of this infringement, the two companies were fined. However, Acea and Suez decided to appeal and then the Lazio Administrative Court, because of an erroneous definition of the relevant market[21], quashed the Italian Competition Authority's

[20] ≪The following shall be prohibited as incompatible with the internal market: all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the internal market, and in particular those which:
(a) directly or indirectly fix purchase or selling prices or any other trading conditions;
(b) limit or control production, markets, technical development, or investment;
(c) share markets or sources of supply;
(d) apply dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage;
(e) make the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts. [...] ≫

[21] ≪[...] *L'Autorità, nel provvedimento finale, arriva a sostenere che il coordinamento tra ACEA e SE avrebbe*

decision to fine the two firms. The Competition Authority then presented an appeal against the Administrative Court and the Supreme Court finally quashed the Administrative Court's decision.

Another case refers to the company Acquedotto Pugliese S.p.A. that was accused of having infringed the Article 102[22] of the TFEU. In 2007, the Italian Competition Authority opened an investigation proceeding against the company because of some complaints filed by users. As customers revealed, the firm didn't allow them to build their own connections between their house and the general pipeline system; moreover, the company charged customers, for such building activities, a fixed price of about 850 € (for connections spanning from zero to seven meters) and a series of extra-fees that had to be paid in advance. It is necessary to highlight that all these sums didn't reflect the real costs incurred to execute the works. As you might guess, the Competition Authority considered this situation as an abuse of dominant position. The proceeding was then closed in 2008, when the company Acquedotto Pugliese proposed, and the Competition Authority accepted, to settle the case by means of the following committments:

- First, it proposed to modify the local regulation in order to allow the users to build their connections. In any case, the company continues to have the right to check the overall quality of the work done;
- Second, if the works were executed by the Acquedotto Pugliese S.p.A., customers were not asked, as a precondition for receiving water services, to pay the entire sum in advance.

Nevertheless, it is necessary to say that unfair practices have occurred also in more recent years. We can, for example, consider the fact that the Liguria Region adopted a law that allowed local authorities either to grant wholly publicly owned companies exclusive rights to manage the IWS and to extend the overall duration of their concession. Even if, on one hand, this choice allows the operators to completely recover the costs incurred to make the required investments, on the other hand, it seriously undermines competition. It is therefore possible to conclude that, in order to have a higher level of competition, it is necessary to design effective monitoring activities that ensure a correct implementation of all the legislative interventions that are drawn up at a national level.

interessato il mercato nazionale della gestione dei servizi idrici, concretizzandosi nell'ambito della partecipazione a gare interessanti un numero significativo di ATO e dalle dimensioni complessivamente rilevanti a livello nazionale: assumendosi, al riguardo, che una simile ricostruzione sia palesemente errata, in ragione della carenza di dimostrati elementi che inducano a qualificare come "nazionale" il mercato rilevante. L'estensione ad operatori europei della legittimazione a partecipare a procedure ad evidenza pubblica bandite in Italia per l'affidamento del servizio idrico integrato (o per la scelta del socio privato di un gestore a prevalente partecipazione pubblica) rappresenterebbe un elemento che depone inconfutabilmente nel senso di un allargamento, anche sensibile, dei confini geografici del mercato rilevante, il quale non può che assumere una dimensione comunitaria. [...] ≫ Judgement n. 6238/2008.

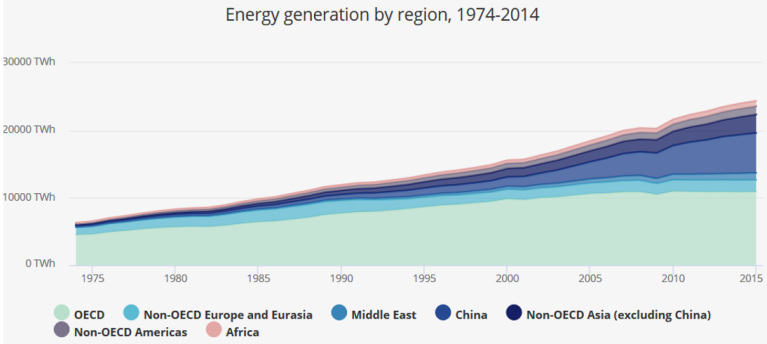
[22] ≪Any abuse by one or more undertakings of a dominant position within the internal market or in a substantial part of it shall be prohibited as incompatible with the internal market in so far as it may affect trade between Member States. Such abuse may, in particular, consist in:
(a) directly or indirectly imposing unfair purchase or selling prices or other unfair trading conditions;
(b) limiting production, markets or technical development to the prejudice of consumers;
(c) applying dissimilar conditions to equivalent transactions with other trading parties, there by placing them at a competitive disadvantage;
(d) making the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts. ≫

Chapter 3

Energy market

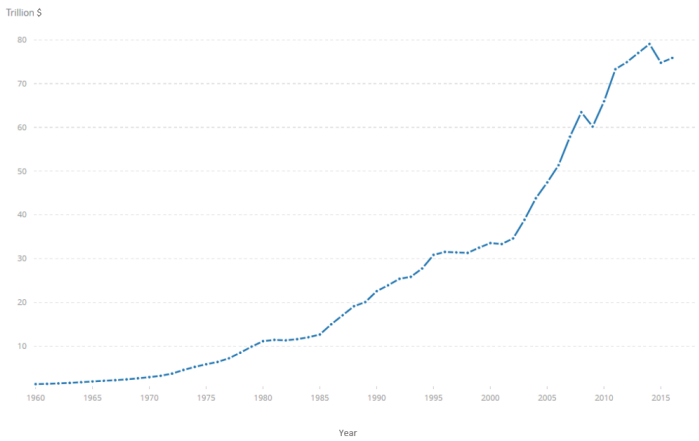
It is generally acknowledged that a reliable and affordable delivery of energy is of key importance for modern economies. Several studies – surveyed below - have in fact revealed that economic development is usually associated with an increased provision and use of energy services. If we consider, for instance, the period 1974-2014 we can observe that the growth trend recorded for energy generation, shown in the figure 5.1, is in line with that recorded for the GDP growth, shown in the figure 5.2.

Figure 3.1: Energy generation by region in the period 1974-2014



Source: International Energy Agency

Figure 3.2: GDP 1974-2016



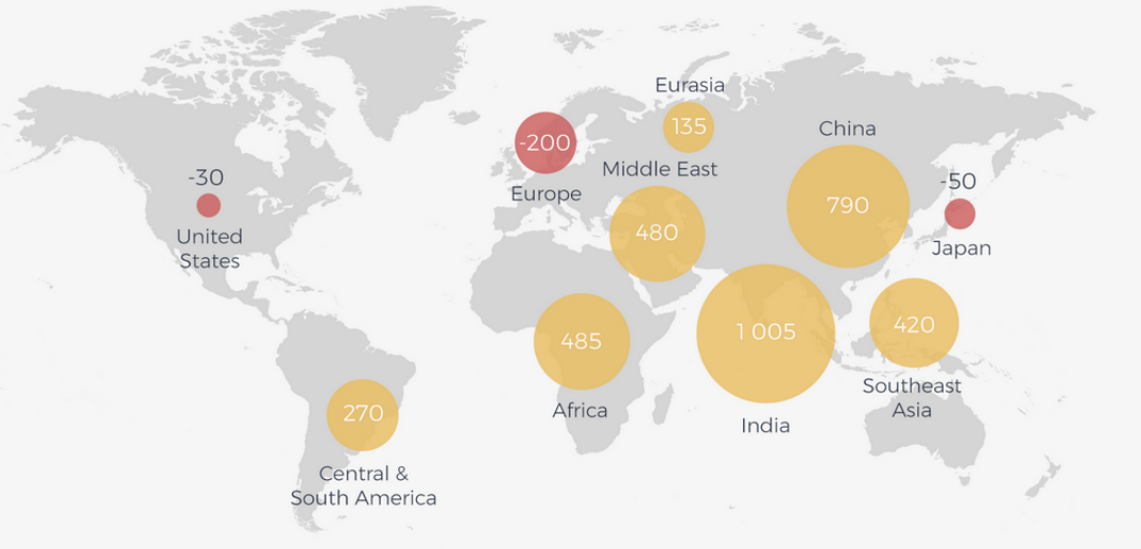
Source: World Bank and OECD

Both the energy generation and the GDP have exhibited stable growth over years. The only exception is represented by the period corresponding to the Great Recession, in which either the GDP and the energy consumption declined.

The literature on the nexus between economic growth and energy consumption dates back to the late 1970s. Different studies have ascertained that there is a relationship between these two quantities. Some of them, such as such Kraft and Kraft (1978), showed that the economic growth leads the energy consumption, as a unidirectional causal relationship. Others, such as Soytas and Sari (2003), revealed instead that there is a unidirectional causality, with energy consumption leading GDP growth. Still others, such as Huang et al. (2008) who used the panel data of energy consumption and GDP for 82 countries from 1972 to 2002, have discovered a bi-directional causal relationship between the two quantities. The reason why these analyses have produced antithetical results is twofold: different econometric methods have been applied and data relating different countries have been examined separately. As clearly explained by Huang et al. (2008), if data for all countries are considered as a whole it is possible to identify a bi-directional relationship; on the contrary, if data are classified into different income groups, it is possible to detect either no causal relationship or a unidirectional causal nexus that differs according to the group.

Until now we have just considered the amount of energy generation that has been recorded over the past 40 years. However, it is of paramount importance to take into account what is going to happen in the next years. According to the International Energy Agency (IEA) forecasts, global primary energy needs are expected to rise by 30 percentage points in the period 2016-2040. In figure 3 we show how the expected change in primary energy demand differs across the world. It is important to remind that the so-called primary energy includes the overall amount of energy harvested from fuels (e.g. coal, natural gas, uranium) and flows (i.e. those natural processes that have energy associated with movement). In other words, the primary energy takes into account the total sources needed to produce a fixed amount of end-use energy, which includes either electricity, gasoline and natural gas.

Figure 3.3: Change in primary energy demand, 2016-2040 (expressed in million tonnes of oil equivalent)



Source: World Energy Outlook 2017

As shown in the figure, there are some countries, such as India or China, that will considerably increase their energy demand and there are other areas, such as the Europe or USA, that will record a decrease in their energy needs. Looking ahead, this trend may suggest that, for some countries, the relationship between GDP and energy consumption will gradually disappear. Besides the variation in the energy demand, it is also important to consider that the way in which the world will satisfy these growing energy needs is expected to change over the next years. Several studies have, in fact, pointed out that there will be a transition to a low-carbon power system in which:

- the renewable sources will rapidly increase their share in the energy mix, reaching a 60% value by the year 2040;
- as highlighted by the European Commission[1], the "electricity will play a key role".It is in fact thought that it will partially replace fossil fuels in transport (let us consider, for instance, the switch to electric cars) and heating.

On the basis of what we have just stated, it is possible to conclude that, in the future energy system scenarios, there will be new drivers that will cause an increase in the electricity demand. However, it is important to highlight that for some countries, such as the European or the American ones, the increase in electricity consumption will be more moderate, compared with that of emerging countries, because great attention will be put on efficiency improvements.

A key aspect that should be taken into account is that, as the share of power generated from renewable resources rises, it is increasingly more difficult to ensure the security of supply; this is due to the fact that the output of such sources is weather-related and, therefore, variable and less predictable. Because of these reasons, their contribution to meeting the peak demand is rather limited. If we consider, for instance, the solar production, it is generally acknowledged that it reaches its maximum during the morning hours and that it is absent during the evening hours, when people come back home and the electricity demand rises. In those periods when generation from renewables exceeds the demand, the surplus carbon-free electricity is curtailed. On the contrary, in those cases when power from renewable sources is not available or insufficient, power systems need to rely on other, carbon-intensive, sources of generation.

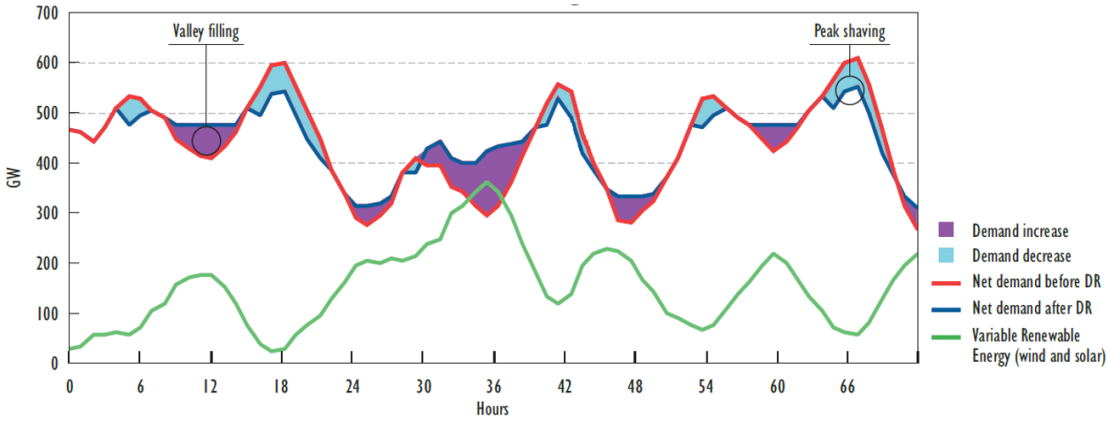
As you might guess, the high degree of uncertainty resulting from the penetration of renewables will have a relevant impact on the future energy system scenarios; the latter ones will have to adapt in such a way as to be able to effectively respond to the increased variability. For this purpose, one of the solutions that can be adopted is represented by demand-response programs. Such measures allow for adjusting the overall load according to system conditions. In this way, it is easier to match demand with supply without the need to invest in additional flexible capacity that would be used just to meet peak demand. It is important to say that Demand Response measures can be deployed either at an industrial level, by shifting production to non-peak hours, and at a residential level, by encouraging small consumers to shift their consumption in such a way as to alleviate the power system stress conditions. Under a Demand Response program, the load can be balanced in different ways:

- by peak shaving: peak consumption is reduced in such a way as to release pressure on generation and on grid capacities;
- by valley filling: consumption is increased or shifted to hours in which the production from renewable resources reaches its peak.

In the following figure it is possible to see how the Demand Response measure can smoothen the electric load curve.

[1] Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions: "A roadmap for moving to a competitive low carbon economy in 2050". Brussels, 8.3.2011. (COM (2011) 112 final)

Figure 3.4: Load balancing under a Demand Response



Source: International Energy Agency

As reported in the World Energy Outlook (2017) publication, the theoretical potential of DR today is estimated to be around 4000 TWh per year, corresponding to 15% of the global electricity demand. This value is calculated as the sum of all the loads than can be shifted for every hour of the year. It is important to highlight that, in the next years, the theoretical potential of DR is expected to increase, until reaching 7000 TWh by 2040. In this context, enabling technologies such as smart meters and smart appliances will contribute to the DR potential growth.

In addition to Demand Response measures, another solution that can be adopted to improve the security of electricity supply is represented by the deployment of energy storage systems. Among them we can list the following:

- the pumped-storage hydropower (PHS) which consists of pumping water from a lower reservoir to an upper reservoir for storage and later generation;
- the compressed air energy storage (CAES), that consists of compressing air and storing it under pressure. When electricity is required, the pressurized air is heated and expanded in a turbine that drives a generator for power production. It is necessary to highlight that CAES systems are less widespread that PHS ones;
- battery storage installations. This solution will grow in importance over the coming years, as the cost of battery systems continues to decline. Barriers to the large-scale deployment of such systems is represented by the relatively high cost of implementation and by the issues concerning either the batteries recyclability and safety.

On the basis of the elements that we have described above, we can conclude that there are ways that facilitate the integration of larger shares of variable generation sources. However, it is worth noting that the increased penetration of renewables will have an impact not only on the system's variability but also on its overall structure. The power system will tend, in fact, to be increasingly more fragmented and decentralised because of the rise of smaller-scale distributed generation points connected to the grid at medium or low voltage level. In this context, in order to achieve the required degree of system reliability, it will be essential to exert an adequate level of control also on these distributed resources, that are critical for the proper functioning of the grid. Furthermore, in order to smooth out the variations and forecast errors associated with renewable production, it will be necessary to strengthen the market integration over larger regional areas. For instance, if we consider the European case, we can notice that energy markets have been designed in order to enable cross-border trade of electricity. The promotion of cross-border trade is of paramount importance because it contributes to an increase of the overall efficiency level by exploiting the complementarities between demand patterns and cost differences associated with different national electricity systems. A better level of integration can be achieved, on one side, by making the necessary investments in transmission networks and, on the other side, by establishing

common cross-border allocation mechanisms. In this regard, we can mention the so-called Market Coupling as an example of market integration measure that is implemented at a European level.

In order to have a better understanding of the functioning of electricity markets, we will now briefly describe the structure of power systems. After that, we will analyse in detail both the French and the Italian electricity markets.

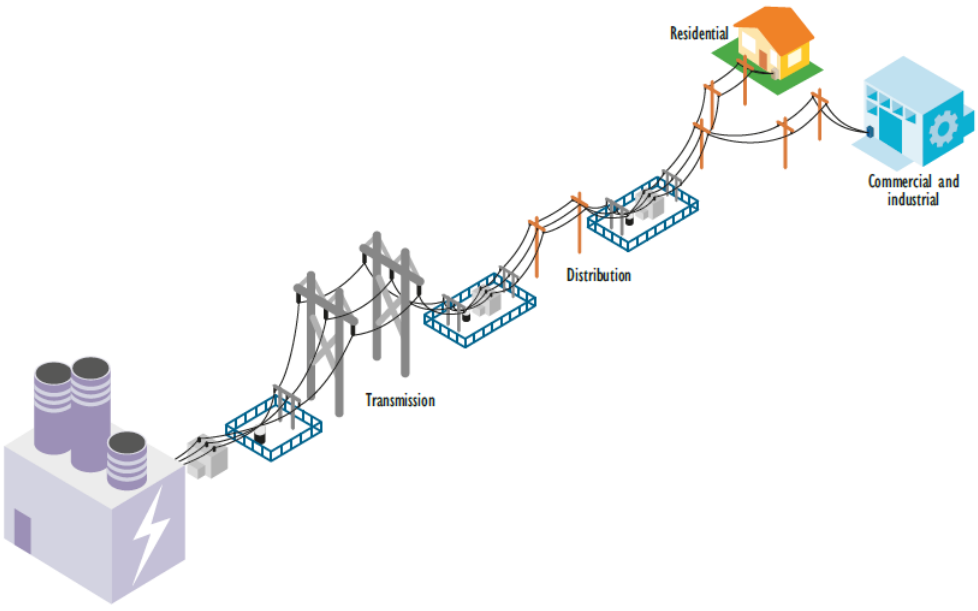
3.1 Power systems

Power systems are those infrastructures that are deployed to supply, transfer, store, and use electric energy. We remind that, while the power sector may differ from one country to another, the operational structure of the sector is essentially the same everywhere in the world. The power sector is composed of the following functions:

- generation, which is the production of electricity at power stations or generating units where a form of primary energy is converted into electricity;
- transmission, that consists in carrying energy over long distances. During this phase, the electric energy flows over high voltage (HV) transmission lines to a series of substations in which the voltage is stepped down by transformers to a certain level that is appropriate for the distribution system;
- distribution, which is the delivery of power to the final loads, also called consumption points, via intermediate steps at which the voltage is converted down to lower levels. It is worth noting that the majority of final loads are supplied at low voltage level.

The following figure shows the operational structure of the electricity sector.

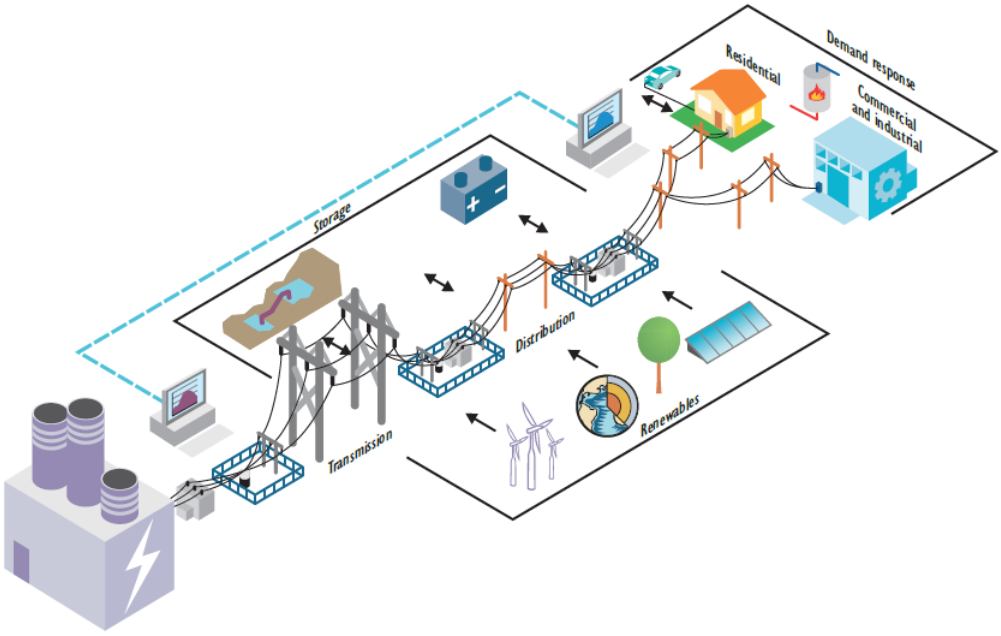
Figure 3.5: Operational structure of the electricity sector



Source: International Energy Agency

For the sake of completeness, we also show, in figure 5.6, how the power system will look like in the future.

Figure 3.6: Operational structure of the future electricity sector



Source: International Energy Agency

As you might notice, the overall structure will deeply change and it will become increasingly more complex. As we previously stated, this transformation is due to the growing number of distributed energy resources (DER) and of distributed energy storage systems (DESS).

3.2 French electricity market

In this paragraph we first describe how the French electricity market has evolved over the years. Then, we analyse its functioning both for what concerns the management and the competitive mechanisms, with a particular focus also on the legislative framework under which the different players have to operate.

3.2.1 Evolution of the French electricity market

Up until 1946, the electricity sector has been managed by a large number of small operators. In that year, the French authorities decided, with the enactment of the Law No. 46-628, to nationalise most of the enterprises that had operated the electric services up to that moment and to grant a state monopoly to the company Électricité de France (EDF) with regards to the production, transportation and distribution of electricity. It is important to highlight that, since the local publicly-owned enterprises had the right to choose whether or not to be nationalised, there were some firms (accounting for approximately 5% of the overall market, expressed in terms of served population) that decided to continue to operate without changing their status. These firms are the so-called Entreprises Locales de Distribution d'Electricité et de Gaz (ELD). The reason behind the choice of nationalising the sector was due to the fact that, after the World War II, it was necessary to rebuild the overall electricity infrastructure and the network; in this context, the nationalisation was thought of as the most effective way to create a nationally integrated system.

After 1946, for half a century the overall structure of the electricity sector did not undergo any relevant change. After that period, the first big reorganisation that has been implemented is represented by the liberalisation process which started in 1999.

The opening of the electricity market was formally provided for by a Directive, dated 1996, that has been adopted by the European Commission in order to improve the efficiency of the sector. Such Directive has then been transposed into French national law in 2000. It is important to notice that these legislative interventions have also provided for the unbundling of the generation and transmission activities performed by EDF. As a result, the EDF transmission division has been transformed into the so-called RTE (*Réseau de Transport d'Électricité*), thus becoming an independent function attached to EDF. Then, in 2005, the RTE changed its status and became a limited company wholly owned by EDF. It is important to stress that either the accounting and the financial independence of RTE have been enforced by the law[2] in order to ensure better transparency in matters concerning competition.

Going back to the analysis of the liberalisation process, it has been gradual and its main steps are the following ones:

- at the beginning, in 1999, only the larger industrial customers (i.e. those with an annual consumption of at least 100 GWh) became eligible to choose their supplier. At the end of this phase, a share of around 20% of the market was open to competition;
- in 2000, all the customers with an annual consumption of at least 16 GWh became eligible to choose their supplier. At the end of this phase, a share of around 30% of the market was open to competition;
- in 2003, all the customers with an annual consumption of at least 7 GWh became eligible to choose their electricity supplier. At the end of this phase, a share of around 34% of the market was open to competition;

[2] Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity states that ≪Integrated electricity undertakings shall, in their internal accounting, keep separate accounts for their generation, transmission and distribution activities, and, where appropriate, consolidated accounts for other, non-electricity activities, as they would be required to do if the activities in question were carried out by separate undertakings, with a view to avoiding discrimination, cross-subsidisation and distortion of competition. They shall include a balance sheet and a profit and loss account for each activity in notes to their accounts.≫

- in 2004, all the professional customers and the local administrations became eligible to choose their electricity supplier. At the end of this phase, a share of around 70% of the market was open to competition;
- in 2007, at the completion of the liberalisation process, also the residential consumers became eligible to choose their supplier.

For the sake of completeness, it is necessary to stress that the same organisational changes that have occurred in the electricity sector have also been recorded for the gas industry.

Following the liberalisation of the electricity market, either residential and industrial customers could choose between two types of contracts:

- regulated contracts, whose tariff is fixed by the French public Authority. Only the historic suppliers (the EDF company and the ELDs) could offer such regulated rates;
- market contracts, whose tariff was fixed by the energy supplier.

Of course, regulated tariffs differed depending on whether the customer was industrial or residential. In the first case, the proposed tariffs were the following ones:

- the so-called *tarif jaune*, was proposed to those consumption sites with subscriptions of electricity ranging between 36 and 240 kVA;
- the so-called *tarif vert*, was proposed to those consumption sites supplied at high voltage levels.

For what concerns residential customers, the regulated tariff was the so-called *tarif bleu*.

In order to increase the competition among retailers, on 31/12/2015 all the regulated tariffs for non-residential customers have been abolished. The reason behind this choice is due to the fact that regulated fares were on average below the wholesale electricity market prices and, thus, it was impossible for alternative suppliers to offer retail prices competing with the regulated ones without incurring in relevant losses. For what concerns the residential customers, on the contrary, the regulated tariff that was offered to them still continue to exist because it is considered as a measure to protect vulnerable consumers.

Further opening of the market occurred in 2010, with the enactment of the so-called Loi NOME[3] that is still in force today. This law allows alternative suppliers to access, at a regulated price, the nuclear energy produced by EDF power plants[4]. EDF must therefore sell a pre-defined portion (up

[3] This is the ≪ *LOI n° 2010-1488 du 7 décembre 2010 portant nouvelle organisation du marché de l'électricité*≫.

[4] ≪ [...] *Afin d'assurer la liberté de choix du fournisseur d'électricité tout en faisant bénéficier l'attractivité du territoire et l'ensemble des consommateurs de la compétitivité du parc électro-nucléaire français, il est mis en place à titre transitoire un accès régulé et limité à l'électricité nucléaire historique, produite par les centrales nucléaires mentionnées au II, ouvert à tous les opérateurs fournissant des consommateurs finals résidant sur le territoire métropolitain continental ou des gestionnaires de réseaux pour leurs pertes, à des conditions économiques équivalentes à celles résultant pour Electricité de France de l'utilisation de ses centrales nucléaires mentionnées au même II.*
≪ II. — *Pendant la période définie au VIII, Electricité de France cède de l'électricité, pour un volume maximal et dans les conditions définies au III, aux fournisseurs d'électricité qui en font la demande, titulaires de l'autorisation prévue au IV de l'article 22 et qui prévoient d'alimenter des consommateurs finals ou des gestionnaires de réseaux pour leurs pertes, situés sur le territoire métropolitain continental. Les conditions d'achat reflètent les conditions économiques de production d'électricité par les centrales nucléaires d'Electricité de France situées sur le territoire national et mises en service avant la publication de la loi n° 2010-1488 du 7 décembre 2010 portant nouvelle organisation du marché de l'électricité.*
≪*Les conditions dans lesquelles s'effectue cette vente sont définies par arrêté du ministre chargé de l'énergie sur proposition de la Commission de régulation de l'énergie. Il en est de même des stipulations de l'accord-cadre mentionné au III du présent article.*
≪ *Le volume global maximal d'électricité nucléaire historique pouvant être cédé est déterminé par arrêté des ministres chargés de l'économie et de l'énergie, après avis de la Commission de régulation de l'énergie, en fonction notamment du développement de la concurrence sur les marchés de la production d'électricité et de la fourniture de celle-ci à des consommateurs finals. Ce volume global maximal, qui demeure strictement proportionné aux objectifs poursuivis, ne peut excéder 100 térawattheures par an.* [...]≫.

to 100 TWh/year, corresponding to around 25% of the total production) of his nuclear generation to other operators. Since 2012, the regulated price has been fixed at 42€/MWh. The mechanism that we have just described is known as *Accès Régulé à l'Energie Nucléaire Historique* (ARENH) and it is aimed at reconciling the following two objectives:

- the first one is to allow final customers to benefit from low end-user electricity tariffs. This is possible because, at the wholesale level, prices are capped by rather low electricity fares.
- The second one is to allow new entrants to compete with either EDF and the ELDs and to expand in the retail market.

As data have shown, the quantities bought by alternative suppliers under the ARENH mechanisms have increased from 30.9 to 41.4 TWh over the 2011- 2017 period.

3.2.2 Structure of the French Electricity sector

As stated in the Electricity Directives and in the French Energy Code (FEC), all the activities related to the production, transport, distribution and supply of electricity should be performed by different entities in order to ensure an effective level of competition.

Generation Sector

For what concerns generation sector, it is necessary to highlight that it is entirely liberalised, meaning that any company may build and operate a generating station, provided that it obtains the required authorisations, including environmental and planning permits. As of today, if we consider the production market it is possible to notice that EDF enjoys a position of economic strength because of the fact that, since 1946, it owns and operates all the French nuclear power plants. As data reveal, in 2015, most of the installed capacity was owned by the following operators in the following percentages:

- 87% was owned by EDF which is the incumbent supplier;
- 2.7% was owned by the Compagnie Nationale du Rhône (CNR), which is a French electricity generation company that mainly supplies renewable power from hydroelectric facilities. It is important to highlight that CNR is a 49% subsidiary of ENGIE (formerly GDF Suez) which is the historical gas supplier in France;
- 2.3% was owned by ENGIE;
- 1.9% was owned by Uniper, which is a multinational energy company that has been active on the French market for more than 15 years.

As you might notice, the production market is dominated by the historical national energy utility company. It is therefore possible to conclude that it is a highly concentrated market; this is also confirmed by the Herfindahl-Hirschman index (HHI) whose value, computed with the previously reported data, is equal to more than 7622.4.

Transmission sector

For what concerns the transmission system, RTE is the firm that is vested with exclusive rights to operate the it. The main functions of the Transmission System Operator are the following ones:

- It is in charge of operating, maintaining and developing the transmission grid;
- It is in charge of maintaining a continuous, real-time, balance between electricity supply, on one side, and electricity demand, on the other side;

- It must guarantee transparent and non-discriminatory access to the transmission grid;
- It is in charge of ensuring the security and reliability of the system.

For what concerns the access to the transmission grid, it is worth noting that the TSO is remunerated by the suppliers through the so-called tariff for third-party access to the transmission system (*Tarif d'Accès des Tiers au Réseau de Transport*, TURPE). Each four years, the Energy Regulatory Authority Commission sets the TURPE in accordance with the following principles:

- The tariff must cover all the costs that are incurred by the operator as a result of the operation, development and maintenance of the network;
- The tariff must be identical throughout the territory (such principle is known as *péréquation tarifaire*);
- The tariff must be identical regardless of the distance between the production site and the consumer's site. This is known as *Tarification «timbre-poste»*.

Moreover, we highlight that the Regulatory Authority has included some monetary incentives in the tariff in order to reward the efficiency improvements that are achieved by the TSO.

Going back to the analysis of the transmission system management, it is important to stress that, over the years, the TSO underwent a series of changes in order to comply with the provisions set out in the Directives. For example, following the entry into force of the first liberalisation directives (known as the First Energy Package) that provided for the accounting unbundling of the energy markets, the functional independence of the Transmission Division of EDF has been realised. Then, following the entry into force in 2003 of the Directives (Second Energy Package) which provided for the legal unbundling of the energy markets, the Transmission Division has been transformed into a limited company 100% owned by EDF. Finally, following the entry into force of the Third Energy Package, France had to choose among three different unbundling models which one to realise in the internal electricity market. The alternatives presented in such legislative intervention were the following ones:

- full ownership unbundling: under this unbundling model, the vertically integrated company (EDF, in our case) had to sell off the electricity network. In this case, neither the supply or the production company were allowed to hold a majority share in the TSO company;
- independent system operator (ISO): under this unbundling model, energy supply companies could still formally own the electricity network but they had to outsource the entire operation, maintenance and development to an independent company;
- Independent Transmission Operator (ITO): under this unbundling model, energy supply companies could still own and operate the electricity networks but they had to do so through a subsidiary. Moreover, all important decisions had to be taken independently of the parent company.

France opted for the ITO model. In this context, in order to comply with the provisions set out in the legislative framework, it was necessary for the TSO to obtain a certification that proved its independence from the parent company. In 2012, RTE was finally certified by the National Regulator.

Besides the aspects related to the unbundling process, another element that has to be taken into account when we talk about the RTE is that it cannot be privatised[5], according to what has been provided for by the French Energy Code. The reason behind this norm is due to the fact that, in this way, it is easier to exert an adequate level of control over the transmission activities, which are considered to be of strategic importance for the country.

[5] *« Le capital de la société mentionnée à l'article L. 111-40 est détenu en totalité par Electricité de France, l'Etat ou d'autres entreprises ou organismes appartenant au secteur public ».*

Distribution sector

The distribution of electricity is usually performed under public concessions regime or, more rarely, under direct management by the local authorities. In fact, according to the provisions contained in the French Energy Code, exclusive rights to operate the distribution grid are granted to the following Distribution System Operators (DSO):

- Enedis (formerly Electricité Réseau Distribution France, ERDF), which is the EDF subsidiary that operates, within metropolitan France, 95% of the distribution grid;
- Local distribution companies (the so-called ELDs), which are those non-nationalised distributors that operate the remaining 5% of the national grid;
- EDF Système électrique insulaire, which is in charge of managing the distribution network for the overseas territories.

The main functions of a DSO are the following ones:

- It is in charge of maintaining the balance between demand and supply of electricity;
- It must guarantee that third parties have access to the distribution grid;
- It is in charge of performing all the required maintenance activities and all the necessary investments.

It is worth noting that DSO has to operate in compliance with the specifications of the concession contract (*Cahier des charges de la concession*).

For what concerns the distribution charges, it is important to highlight that the tariff for third-party access to the transmission system is also meant to remunerate the DSO and to compensate him the charges arising from operating, developing and maintaining the distribution grid.

Supply sector

As we previously stated, since 2007, the electricity supply sector is completely open to competition, meaning that all French customers may choose their supplier. In order to become an energy supplier, a company must be granted an Authorisation that is normally released by the Ministry of Energy. In order to acquire such authorisation, the company has to send an application that is then reviewed based on the following aspects:

- The technical, economic and financial capacity of the applicant;
- The compatibility of the applicant's project with the legislative provisions.

Once the company has obtained the authorisation, it can start providing the service. It is important to take into account that, in some cases (i.e. failure to pay the tariff for third party access to the transmission system), the above-mentioned authorisation can also be suspended.

As data reveal, in 2017, the number of active suppliers in France is 160. Among them there are not only those suppliers that operate at a national level, but also those firms that offer their services only at a regional or at a local level. It is important to highlight that, in our analysis we will just take into account those companies that operate at a national level.

For what concerns residential customers, the available suppliers are the following ones: Engie, Direct énergie, Total Spring, Planète Oui, Butagaz, Proxelia, EDF, Enercoop, Energie d'Ici, GreenYellow, Cdiscount Energie, Mint Energie, Electricité de Provence, Eni, Ilek, ekWateur, Plüm Energie, Alterna, Energem, Lucia, Energies du Santerre, Energies du Santerre, Dyneff, GEG, Gaz de Bordeaux, Sowee.

For what concerns non-residential customers, the available suppliers are the following ones: Direct Energie, Planète Oui, Proxelia, EDF Pro, Enercoop, Energie d'Ici, Engie Energies France, Alterna, Lampiris, Energem, Lucia, Energies du Santerre, Vattenfall, Energies Libres (ex- Enel France), Enalp, Alpiq, Uniper, Edenkia, Enovos, Energy TI France, Solvay Energy France.

The five largest suppliers are the following ones:

- EDF, the historic electricity supplier for electricity is the biggest electricity supplier in France with over 26 million customers (residential and business customers);
- ENGIE: it is the French historic supplier for natural gas. It supplies electricity to more than 3.5 million residential and business electricity customers;
- Direct Énergie: it is one of the largest alternative energy suppliers in the domestic customer segment. In 2017, it had 2.2 million customers.
- Uniper France, formerly known as E. ON France, produces and supplies renewable electricity to industrial customers, small and medium-sized enterprises and industries;
- Alpiq: it supplies over 10 million MWh of electrical energy to more than 300 industrial and commercial customers each year;

There are more than 20 firms that compete to provide electricity to customers. However, in order to assess the effective degree of competition in the supply sector, it is necessary to study it more deeply; this analysis will be carried out later in the chapter.

Electricity trading – Structure of the trading market

The French market operates in two levels:

- the wholesale market, where the electricity is bought and sold, prior to its supply to the end customers;
- the retail sector, where electricity is sold to end customers.

The players on the wholesale market are the following ones:

- the electricity producers: they sell the amount of electricity that is generated in their power stations;
- the electricity suppliers: they trade and buy electricity in order to deliver it to the final customer;
- brokers or traders, who act as intermediaries between different market players. Their role is to purchase power for resale.

The electricity trading can take place in the following locations:

- on European stock exchanges (for example, the Epex Spot France for spot products and the EEX Power Derivatives France for future products);
- via direct negotiations;
- via brokers, that act as an intermediary.

It is important to highlight that transactions can be either physical, if these involve the physical delivery of electricity to the grid, or financial, if the product is purchased and then sold.

If we now analyse the products traded at energy exchanges, it is possible to distinguish between the following two categories:

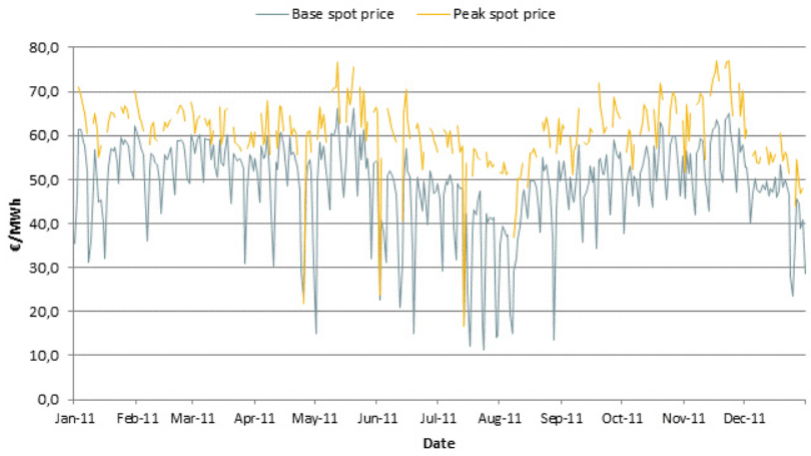
- spot products: these are purchased for the delivery on the same day or on the following day;
- forward products: these are purchased for the delivery during a given period in the future.

For what concerns the first category, the trade of such products is done via day-ahead auctions. The trading process can be summarised as follows:

- the producers who want to sell their production have to send their sale offer (that must be limited to the effective amount of electricity that they are prepared to deliver during the 24 hours of the following day) to the power exchange by 12 noon on the day before the power is delivered to the grid;
- meanwhile, the electricity suppliers have to send their purchase orders (that correspond to the overall amount of electricity that the customers are expected to consume during the 24 hours of the following day);
- Supply and demand will therefore determine the market price, that will be then used to set the price charged to the final customer.

It is important to highlight that the prices of the spot products are highly volatile because of the fact that electricity cannot be stored and, therefore, any factor influencing either supply or demand (e.g. unforeseen events or weather conditions) directly impacts on the price level. In the following image it is possible to see how the spot price has varied over the period January 2011 – January 2012 on the Epex Spot.

Figure 3.7: Electricity Spot Prices



Source : Commission de Régulation de l'Énergie

In order to minimise the exposure to risk resulting from the variability of spot prices, suppliers usually sign contracts for future deliveries of electricity. Since the price of such contracts (known as forward contracts) is computed as the average of the expected spot prices over the delivery period, these will be less volatile compared with those of spot products.

In the following image it is possible to see how the base annual product price (for a supply in the year n+1) has varied over the period January 2011 – January 2012 on the EEX Power Derivatives France.

Figure 3.8: Electricity Spot Prices

Source: Commission de Régulation de l'Énergie

For the sake of completeness, we highlight that, in 2014, the volumes traded in the wholesale market amounted to 960 TWh. It is necessary to consider, however, that not all the electricity delivered to customers is exchanged on the wholesale market. For instance, if we consider the electricity produced by vertically integrated companies, we can notice that it is directly supplied to final users.

3.2.3 Electricity retail prices

In this paragraph we analyse the determinants of retail electricity prices and the structure of the electricity bill. We remind that, from this moment on, our analysis will be focused exclusively on the household sector.

As we previously said, customers can choose between historic suppliers, that offer either regulated contracts and market contracts, and alternative suppliers, that can only propose market contracts.

Whatever the chosen supplier, the price associated with the electricity supply contract has to cover the following types of costs:

- Operating costs related to the electricity generation;
- Investment costs and maintenance costs (either those related to power plants and those related to the network infrastructure);
- Costs associated with the transmission and distribution of electricity;
- Costs related to ancillary services;
- Costs related to meter reading, billing, customer service and account maintenance;
- Costs related to taxes that are applied to electricity consumption.

Besides the costs that we have just listed above, electricity tariffs should, of course, remunerate the supplier for the service provided.

Structure of the electricity bill

Electricity bills consist of the following components:

- A monthly subscription charge (*abonnement*) whose amount depends on the subscribed power. Since it does not vary with consumption, this represents the fixed component of the bill;
- A variable charge, whose amount depends on the effective consumption level;
- Taxes.

In France, several types of taxes are applied on domestic energy consumption. Among them we can list the following ones:

- CSPE (*Contribution au Service Public de l'Electricité*). This component is intended to finance the energy transition and to allow for tariff equalisation on the whole territory (this principle is known as *péréquation tarifaire*). It also helps financing price subsidies to poor customers;
- TCFE (*Taxe sur la consommation finale d'électricité*). This tax is levied by local municipal authorities; for this reason, it may vary by region;
- CTA (*Contribution Tarifaire d'Acheminement*). This tax is intended to finance the monetary contributions related to the retirement plans of those employees working for the electric industry;
- VAT (*Taxe sur la valeur ajoutée*). Two VAT rates are envisaged. The first, equal to 5.5%, is applied on the subscription rate and the second, equal to 20%, is applied on the per-unit price of electricity.

As data show, in 2016, taxes represented more than 30%, on average, of the total electricity bill.

Electricity rates

As we previously stated, residential customers can choose between regulated tariffs (*Tarif bleu*) and market offers.

For what concerns the regulated tariffs, it is important to highlight that these are set by the public authorities in such a way as to ensure the possibility, for the alternative suppliers, to offer equal or lower prices, without incurring financial losses. As you might guess, this measure aims at preserving competition on the market. In compliance with the provisions contained in the French Energy Code[6], regulated tariffs are computed as the sum of the price paid under the ARENH mechanism plus a quantity that includes either the normal profit and all those costs incurred to deliver the energy to the final customer (i.e. the costs related to the purchase of additional electricity in the wholesale market, the costs related to energy transportation, the costs related to marketing expenses).

If we now consider the market offers, we can notice that the customer can choose among the following options:

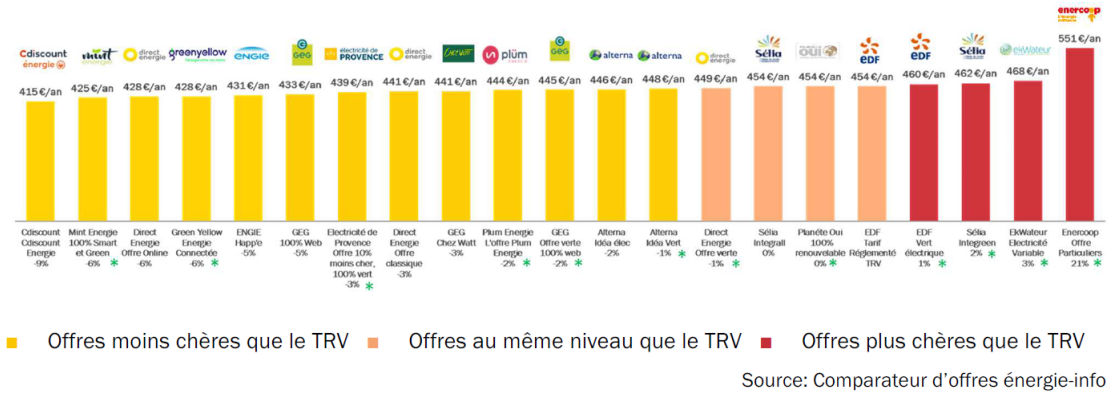
- Fixed-price offers. Under these tariff plans, the pre-tax price of electricity does not vary over the contract duration period (usually 1 or 2 years);

[6] Article L337-6 : ≪ *Les tarifs réglementés de vente d'électricité sont établis par addition du prix d'accès régulé à l'électricité nucléaire historique, du coût du complément d'approvisionnement au prix de marché, de la garantie de capacité, des coûts d'acheminement de l'électricité et des coûts de commercialisation ainsi que d'une rémunération normale de l'activité de fourniture.* ≫

- Indexed-price offers. Under these tariff plans, the supplier grants a discount off the pre-tax regulated price. Under such offer, the pre-tax price follows the changes in the regulated tariffs;
- Green energy offers. Under these plans, the delivered energy is sourced from renewables. It is important to highlight that these offers can include either fixed or indexed-prices;
- Dual-energy offers. Under these tariff plans, the same operator supplies both electricity and gas.

The following figure shows the main offers (regulated tariffs and indexed price offers) available on January 10, 2018. The prices displayed are computed for a customer whose annual consumption is equal to 2400 kWh.

Figure 3.9: Comparison of Deregulated and Regulated Electricity Rates



Source : Commission de Régulation de l'Énergie

As you might notice, most of the market offers (around 80%) are cheaper than the regulated tariff, that amounts to euro 454 €/year.

Social tariffs

Since electricity is an essential good[7], the French law states that it is important to ensure that everyone has access to it. A measure that has been envisaged in order to make electricity supply more affordable for vulnerable customers is represented by the so-called chèque énergie, which is a financial support in the form of a allowance. The amount of such financial aid ranges from 48€to 227€; the actual value that is granted to a given household is determined on the basis of the annual income and on the basis of the household size.

[7] Law No. 2000-108 10 February 2000, Article 1 : ≪ [...] *Matérialisant le droit de tous à l'électricité, produit de première nécessité, le service public de l'électricité est géré dans le respect des principes d'égalité, de continuité et d'adaptabilité, et dans les meilleures conditions de sécurité, de qualité, de coûts, de prix et d'efficacité économique, sociale et énergétique.* [...]≫

3.2.4 Regulatory Authorities

Created in 2000, the public body that is in charge of regulating and supervising the functioning of the electricity market is the Energy Regulatory Commission (*Commission de régulation de l'énergie*, CRE). Its main functions are the following ones:

- It must ensure that all the producers and the suppliers have access to the grid;
- It must ensure that the electricity sector is managed in compliance with EU energy policies;
- It is responsible for overseeing the wholesale electricity market and, in particular, it must supervise the transactions that take place in the electricity market.

It is worth noting that the CRE does not regulate the financial markets on which the electricity is traded; this function is attributed an independent public body, the Financial Market Authority (*Autorité des marchés financiers*, AMF).

Furthermore, apart from those functions delegated to the CRE, there are other regulatory responsibilities (e.g. regulated tariff setting and the determination of the price paid under the ARENH mechanism) that are retained by the Minister for Energy.

The Energy Regulatory Commission also cooperates with the French Competition Authority, which is the independent public body that is in charge of ascertaining and imposing sanctions for anti-competitive practices in the electricity sector.

Besides the Energy Regulatory Commission, there is another authority, the Regulations Committee of Disputes and Penalties (*Comité de Réglements des Différends et des Sanctions*, CoRDiS), that plays an important role in the French energy market. Even though this body is part of the CRE, it is independent from its executive direction. We highlight that the CoRDiS has been created in 2006 in order to settle disputes between grid users, i.e. suppliers, and transmission and distribution operators. Moreover, it is also in charge of imposing sanctions and penalties for breaches of the rules governing the electricity sector.

For what concerns the disputes between customers and energy suppliers, the competent Authority is the so-called National Energy Mediator (*Médiateur National de l'Énergie*, MNE).

3.2.5 Level of competition in the electricity supply market

When we have analysed the supply sector we have noticed that there are several firms that compete to provide electricity services. However, a high number of firms is not necessarily a sign of high competition. In fact, if we look more in detail at the electricity supply market, we can observe that it is highly concentrated, even though there are more than 20 enterprises that operate at a national level.

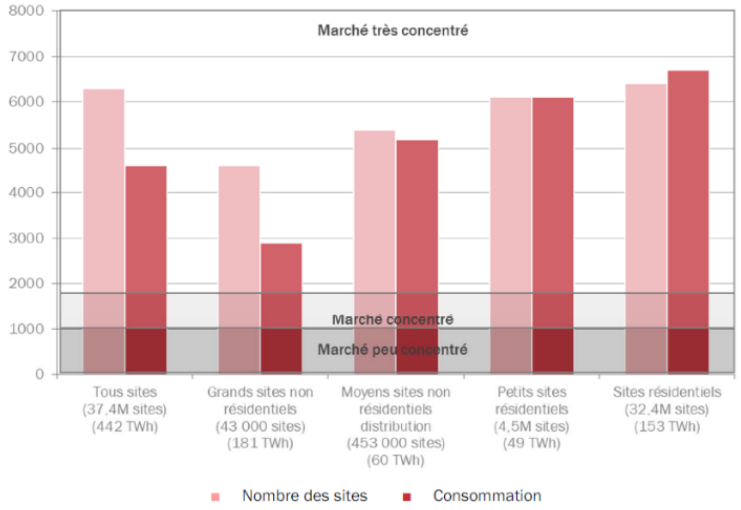
In order to assess the degree of competition in this sector, we consider the following indicators:

- Herfindahl-Hirschman Index (HHI): it is a measure of market concentration. The higher is the value, the lower is competition;
- Market share of the alternative suppliers: this parameter allows us to evaluate the degree of competition between alternative suppliers, that offer market contracts, and historic suppliers, that offer regulated contracts;
- Switching rate: this can be considered as a measure of the sector competitiveness because a switch normally occurs either when there are more advantageous prices or when there is one other company that offers a better service.

For what concerns the first indicator, its value for the year 2017 exceeds 6000. It is therefore possible to conclude that the market is highly concentrated. Moreover, if we compare the HHI computed for the residential sector with the HHI computer for the other customer segments, we

can notice that the former has the highest value; this result suggests that the residential sector is the one with the lowest degree of competition. The following figure shows the HHI computed for the following customer segments: residential customers, small business customers, medium-sized business customers, industrial customers. We highlight that, for each customer segment, the market shares that are used to compute the HHI are valued either in terms of number of customer served and in terms of volumes supplied.

Figure 3.10: Herfindahl-Hirschman Index in of the electricity retail market, 2017



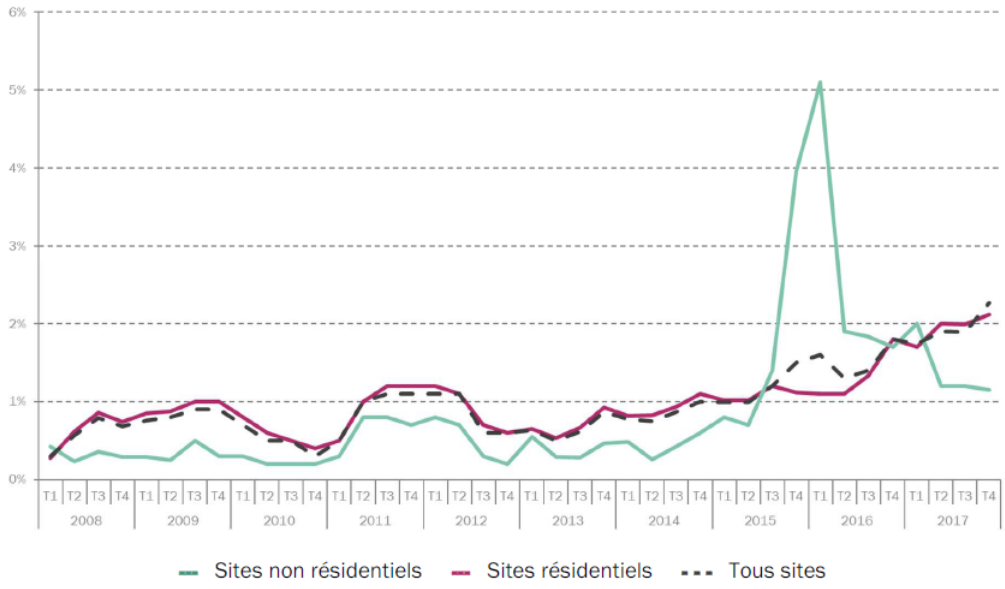
Source : Commission de Régulation de l'Énergie

The main conclusion that we have just drawn from the analysis of the HHI is that the retail market is highly concentrated. We can now try to identify which are the suppliers having the largest market shares.

As the most recent data reveal, in 2014, EDF supplied electricity at regulated prices to more than 80% of the residential customers. It is therefore possible to conclude that, in the household sector, alternative suppliers have a marginal presence. Moreover, it is necessary to highlight that, among the alternative suppliers, the two largest firms (Engie, Direct énergie) have a combined market share of 98%. These data suggest, on one side, that competition between historic and alternative suppliers is very limited and that, on the other side, nearly all alternative suppliers find it difficult to compete with the other "giants".

If we now consider the switching rate as a metric of retail energy market competitiveness we can notice that its value confirms the conclusions set out above. As data show, in fact, the switching rate recorded in 2017 for the household sector is lower than 3%. However, if we analyse its evolution over the years, we can notice that it has increased; this trend may suggest that the degree of competition in the electricity supply market is gradually increasing and this can be due to the fact that regulated prices have risen considerably in the last years and, therefore, consumers have switched to market offers because they found them more advantageous. The following figure shows the evolution of the switching rate over the period 2008-2017 both for what concerns the residential and the non-residential sector.

Figure 3.11: Switching rate recorded over the years 2008-2017 for both the household sector and the non-residential one



Source : Commission de Régulation de l'Énergie

For the sake of completeness, we highlight that the peak recorded in 2016 for the non-residential sector is due to the end of the regulated tariffs.

On the basis of what we have stated above, we can conclude that there is still much to do to effectively open up the retail market to competition. Moreover, it is necessary to consider that the largest barrier to competition, in the household sector, is represented by the fact that, sometimes, customers are not even aware that they are free to choose their supplier. If we want to increase the competition it would be therefore important to clearly inform the customer; only in this way can the consumer make a conscious choice.

3.3 Italian electricity market

In this paragraph we first describe how the Italian electricity market has evolved over the years. Then, we analyse its functioning both for what concerns the management and the competitive mechanisms, with a particular focus also on the legislative framework under which the different players have to operate.

3.3.1 Evolution of the Italian electricity market

Until 1962, the Italian electricity sector has been managed by more than 1000 local operators. Then, in 1962, in order to overcome the high level of industry fragmentation and the resulting inefficiencies, the Italian Authorities decided, with the enactment of the so-called *Legge di nazionalizzazione*[8], to nationalise most of the enterprises that had operated the electric services up to that moment; the Law therefore provided for the creation of the so-called Enel (*Ente nazionale per l'energia elettrica*) that was entrusted with the management of the whole system .The only firms that were not nationalised are the municipal undertakings and the self-producers.

For more than 30 years, the Italian electric power industry has been managed, under a monopoly regime, by Enel. In that period, many investments have been made in order to develop and upgrade the grid. Then, following the entry into force of the EU Directive[9] concerning common rules for the internal market in electricity, a substantial reorganisation aimed at improving the system performance has been undertaken. This organisational change is represented by the liberalisation of the sector, which started with the entry into force of the Legislative Decree No. 79/1999[10] that transposed Directive 96/92/EC into Italian law.

Following the Bersani Decree, the electricity generation, import, export and supply activities were opened to competition. The transmission and the dispatching activities, on the contrary, were reserved to the state that granted a concession, for the operation of such services, to a dedicated company. For what concerns the electricity distribution, several companies were entrusted with the management of the distribution network, through the grant of a concession released by the Minister for Industry, Commerce & Handicraft (now Ministry of Economic Development). Moreover, the Bersani Decree also provided for the vertical separation of the activities in the supply chain. Due to this provision, in 1999, Enel has established the following three subsidiaries: Enel Produzione, Terna (that was then sold in 2005) and Enel Distribuzione. In the same year, the incumbent company has been privatised.

As happened in France, on the demand side, the liberalisation process of the Italian electricity market has been gradual and its main steps are the following ones:

- at the beginning, in 1999, only the large industrial customers (i.e. those with an annual consumption of at least 30 GWh) became eligible to choose their supplier;
- in 2000, all the business customers with an annual consumption of at least 20 GWh became eligible to choose their supplier;
- in 2002, all the business customers with an annual consumption of at least 9 GWh became eligible to choose their electricity supplier;
- in 2003, all the non-residential customers with an annual consumption of at least 100 MWh became eligible to choose their electricity supplier;
- in 2007, at the completion of the liberalisation process, also the residential consumers and small business customers became eligible to choose their supplier.

[8] This is the Law No. 1643 of 6 December 1962

[9] Directive 96/92/EC

[10] It is also known as Bersani Decree

As we just said, in 2007, all customers became eligible to choose their supplier. However, either the small business customers (LV connected, <50 employees, turnover <10 MEuro/year) and the residential ones still had, after that date, the possibility to choose between the free market and the protected market, known as "*servizio di maggior tutela*"[11]. By choosing the second option, the customers were served by local distribution companies (or by their unbundled companies).

For what concerns the customers other than small business and residential, the law provided for the establishment of a safeguard market ("*servizio di salvaguardia*"), that was open to all those consumers who didn't have a seller on the free market. Under this type of market, the customers were served by retailers selected with public tenders. Both the protected market and the safeguard market still exist today. However, the Italian law has provided for the end of the protected market regime as of 1st July 2019. On the contrary, the safeguard market will still exist but it will be open to any type of customer who will not choose a market offer.

3.3.2 Structure of the Italian Electricity sector

As stated in the Electricity Directives and in the Bersani Decree, all the activities related to the production, transport, distribution and supply of electricity should be performed by different entities in order to ensure an effective level of competition.

Generation sector

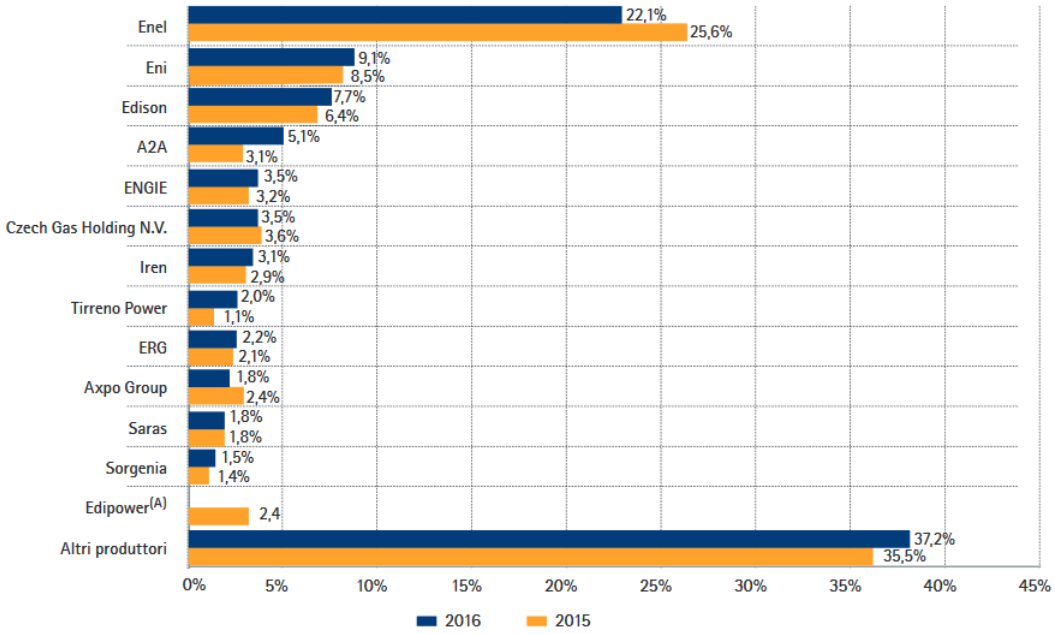
The Italian electricity generation sector is entirely liberalised, meaning that any company may build and operate a generating station.

In order to increase the level of competition in the market, the Bersani Decree provided that no electricity utility is allowed to generate or import, directly or indirectly, more than 50% of the aggregate electric energy generated by or imported by Italy as a whole. As a result, Enel was required to sell an aggregate capacity of at least 15000 MW. Due to these provisions, Enel established the following three generation companies (GenCo): Eurogen S.p.A., Elettrogen S.p.A. and Interpower S.p.A. The first one was sold to Edipower S.p.A., in 2002. The second one was taken over, in 2001, by a consortium formed by Endesa and ASM Brescia. Interpower S.p.A. was acquired in 2002 by a company composed of Acea e Electrabel Suez S.A..

As of today, data reveal that the historical national energy utility company still dominates the generation sector, with a market share of around 22%, and that the first six electricity operators (Enel, Eni, Edison, A2A, ENGIE, Czech Gas Holding N.V.) produce more than 50% of the Italian power generation. The following figure shows the electricity production market shares for the years 2015 and 2016.

[11] Decree No. 73 of 18 June 2007 states that: *≪A decorrere dal 1° luglio 2007 i clienti finali domestici hanno diritto di recedere dal preesistente contratto di fornitura di energia elettrica come clienti vincolati, secondo modalità stabilite dall'Autorità per l'energia elettrica e il gas, e di scegliere un fornitore diverso dal proprio distributore. In mancanza di tale scelta, l'erogazione del servizio per i clienti finali domestici non riforniti di energia elettrica sul mercato libero è garantita dall'impresa di distribuzione, anche attraverso apposite società di vendita, e la funzione di approvvigionamento continua ad essere svolta dall'Acquirente Unico Spa di cui all'articolo 4 del decreto legislativo 16 marzo 1999, n. 79. Le imprese connesse in bassa tensione, aventi meno di 50 dipendenti e un fatturato annuo non superiore a 10 milioni di euro sono comprese nel regime di tutela di cui al presente comma.≫*

Figure 3.12: Electricity production market shares in 2015 and in 2016



Source: Autorità di Regolazione per Energia Reti e Ambiente

As you might notice, there are many small producers that account for around 37% of the electricity generation market. At first sight this doesn't seem a concentrated market and this is confirmed also by the HHI whose value is lower than 1000.

Transmission sector

In the Italian electricity system, the Terna group owns more than 99% of the transmission lines. Since 2014 the transmission network is managed by 11 operators: Terna Rete Elettrica Nazionale, Terna Rete Italia, Rete, Agsm Trasmissione, Mincio Trasmissione, Edyna Transmission, Arvedi Trasmissione, Seasm, El.It.E., Nord Energia and Eneco Valcanale.

The main functions of the operators that carry out the transmission activities are the following ones:

- they are in charge of operating, maintaining and developing the transmission grid;
- they are in charge of maintaining a continuous, real-time, balance between electricity supply, on one side, and electricity demand, on the other side;
- they must guarantee transparent and non-discriminatory access to the transmission grid;
- they are in charge of ensuring the security and reliability of the system.

For what concerns the access to the transmission grid, it is worth noting that the TSOs are remunerated by the distributors, through the so-called CTR transmission tariff; the DSOs are in turn reimbursed by the final customers either through the so-called TRAS tariff (applied to business and industrial customers) or through a component (TD rete) that is included in the household bills. These tariffs are set each year by the Regulatory Authority in such a way as to cover all the transmission costs and to remunerate the operator. These rates are identical throughout the territory.

Going back to the analysis of the transmission system management, it is worth noting that, over the years, it underwent a series of changes in order to comply with the Directive's provisions concerning the unbundling requirements. For example, following the entry into force of the First Energy Package, Enel created Terna S.p.A. as a separate company. The latter owned, developed and maintained the transmission network. The grid management, on the contrary, was entrusted to a public operator, the Gestore della Rete di Trasmissione Nazionale (GRTN), that was controlled by the Ministry of the Treasury, the Budget and Economic Planning. Then, following the entry into force of the Second Energy Package which provided for the legal unbundling of the energy markets, both the ownership and the management have been re-bundled and transferred to Terna S.p.A.. In the same year, Enel S.p.A. reduced its shareholding in Terna by selling part of its share capital to the Cassa Depositi e Prestiti S.pA., a joint-stock company in which the Italian Ministry of Finance has a 70% shareholding. Italy has therefore opted for a "full ownership" unbundling model.

Distribution sector

The main function of a distribution system operator is to supply electricity to all local customers, regardless of who is their provider.

In the Italian electricity system, energy distribution is performed by few operators. Some of them had to change their status in order to comply with legislative provisions. In fact, following the entry into force of the Law No. 125/07, all those companies supplying energy to more than 100.000 consumers had to separate, both at the functional and at a corporate level, the distribution activities from the supply ones. This is what happened for large companies such as Enel, which created Enel distribuzione (that changed its name to e-distribuzione) and Enel Energia, and A2A which created A2a Reti Elettriche (that recently changed its name to Unareti) and A2A Energia. The main distribution companies in the Italian market are the following ones:

- E-distribuzione that belongs to Enel group. It holds a market share of 85%;
- Unareti that belongs to A2A group. It holds a market share of 4.2%;
- Areti that belongs to Acea group. It holds a market share of 3.7%;
- Ireti that belongs to Iren group. It holds a market share of 1.3%;
- Other distributors that account for around 6% of the total distribution market.

These companies operate on the basis of public concessions that are due to expire on 31 December 2030. After that date, the distribution market will be opened to competition and specific tendering procedures will be introduced.

For what concerns the distribution charges, these are set each year by the Regulatory Authority. For household customers the distribution charge is included in the "TD rete" bill component while, for industrial consumers, a specific rate, known as DISTR, is applied.

Supply sector

As we previously stated, since 2007, the electricity supply sector is completely opened to competition, meaning that all Italian customers can choose their supplier. As data reveal, the Italian electricity supply market in 2016 was composed as follows:

- 135 firms operated in the protected market;
- 2 firms operated in the safeguard market;
- 481 firms operated in the free market. In the same year, the largest suppliers were the following ones:

- Enel, the incumbent operator. It had a market share of 35.3%;
- Edison, an Italian company founded in 1884. Since 2012, the French company EDF is the controlling shareholder of Edison. The Italian firm had a market share of 4.7%;
- Eni group, which is a multinational company founded in 1953. It had a market share of 4.3%.

Apart from the companies listed above, there are many other firms (such as Acea, Hera, A2A, Sorgenia, Iren) that have smaller market shares.

As you can see, there are a lot of firms that compete to provide electricity to customers. However, in order to assess the effective degree of competition in the supply sector, it is necessary to study it more deeply; this analysis will be carried out later in the chapter.

Electricity trading – Structure of the trading market

The Italian electricity market operates in two levels:

- the wholesale market, where the electricity is bought and sold, prior to its supply to the end customers;
- the retail sector, where electricity is sold to end customers.

The players on the wholesale market are the following ones:

- the electricity producers: they sell the amount of electricity that is generated in their power stations;
- the electricity suppliers: they trade and buy electricity in order to deliver it to the final customer.

The electricity trading can take place in the following locations:

- on the Italian Power Exchange (IPEX), which is the physical market for trading energy. This market is organised and managed by the so-called Gestore dei Mercati Energetici S.p.A. under criteria of neutrality, transparency and objectivity;
- via over-the-counter bilateral agreements. According to the Regulatory Authority's provisions, such bilateral agreements must be registered on a specific platform known as Forward Electricity Account Trading Platform (PCE).

The Italian Electricity Market consists of the following markets:

- the Spot Electricity Market, known as Mercato Elettrico a Pronti (MPE). Spot products, i.e. those that are purchased for the delivery on the same day or on the following day, are traded on this market;
- the Forward Electricity Market, known as Mercato Elettrico a Termine (MTE). Forward products, i.e. those that are purchased for the delivery during a given period in the future, are traded on this market;
- the Platform (known as Consegna Derivati Energia, CDE) for physical delivery of financial contracts concluded on IDEX which the segment of Borsa Italiana S.p.A. where financial electricity derivatives are traded. The contracts executed on the CDE platform are those for which the participant has requested to exercise the option of physical delivery (of the underlying electricity) in the Electricity Market. Since the most relevant part of the market is represented by the MPE, we will analyse its structure in more detail.

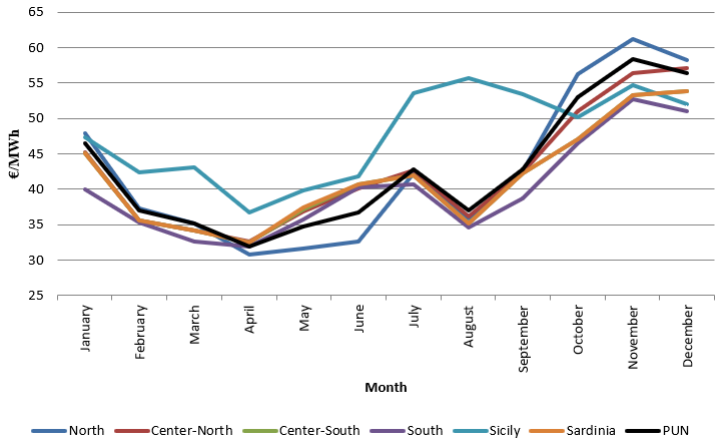
The Mercato Elettrico a Pronti includes the following markets:

- The Day-Ahead Market, known as Mercato del Giorno Prima (MGP), where market players (producers, wholesalers, eligible customers) can sell and purchase electricity for the next day;
- The Intra-Day Market, known as Mercato Infragiornaliero (MI), where market players (producers, wholesalers, eligible customers) can modify the schedules defined in the Day-Ahead Market, by submitting additional supply offers or demand bids;
- The Ancillary Services Market, known as Mercato del Servizio di Dispacciamento (MSD), where Terna S.p.A. procures the resources required to solve grid congestions, to build up an operational reserve and to balance the power system in real time. The MSD consists of the scheduling stage, the ex-ante MSD, and of the Balancing Market (MB).

Since most of the electricity sale and purchase transactions occur in the Day-Ahead Market, we will analyse how the trading process, that takes place in this market, is carried out. The trading process can be summarised as follows:

- Participants submit their bids where they indicate the quantities and the minimum/maximum price at which they are willing to sell/buy;
- All the bids for supply and withdrawal are accepted based on the economic merit-order criterion, i.e. the supply ones are ranked in increasing order and the withdrawal ones are ranked in decreasing order. In this stage, also the transmission capacity limits between zones[12] are taken into account;
- The supply offers are valued at a price that is determined, for each zone, by the intersection of the demand and the supply curve. These prices (Prezzo zonale) can be different from zone to zone;
- The demand bids are valued at the "*Prezzo Unico Nazionale*" (PUN) that is computed as the average, weighted for the quantities purchased in the different zones, of the prices (*Prezzi zonali*) determined for each zone.

Figure 3.13: Evolution of the prices in the wholesale electricity market, 2016



Source: Autorità di Regolazione per Energia Reti e Ambiente

As shown in the graph, the price for Sicily tends to be higher compared to that of the other zones and this may be due to the fact that the generation plants located in this region are, most of the times, old and, therefore, inefficient. For the sake of completeness, we highlight that, in 2016, the volumes traded in the MGP market amounted to 290 TWh.

[12] The Italian electricity system is divided into different zones, depending on the transmission capacity limits existing throughout the territory. These zones are six: North, Center-North, Center-South, South, Sicily, Sardinia.

3.3.3 Electricity retail prices

In this paragraph we analyse the determinants of retail electricity prices and the structure of the electricity bill. We remind that, from this moment on, our analysis will be focused exclusively on the household sector. As we previously said, customers can choose between the protected market, that offers regulated prices, and the free market. For what concerns the protected market, the energy supplied to these customers is purchased by the so-called Single Buyer (*Acquirente Unico*, AU) on the wholesale market and it is then re-sold to the local distribution companies that are in charge of delivering it to the final users. The price, known as *Prezzo di cessione*, that is paid by local distribution companies to buy electricity from the Single Buyer consists of three components:

- The first one is intended to cover all the costs incurred by the Single Buyer to purchase energy in the market (or via bilateral agreements);
- The second one is intended to cover all the costs incurred by the Single Buyer as a dispatching user;
- The third one is a fee that is owed to the Single Buyer for the activities performed for the protected market.

All the costs borne by the local distribution companies to purchase from the AU are then transferred to the final customers in their electricity bills.

Going back to the analysis of electricity retail tariffs, we highlight that, whatever the chosen market, the price associated with the electricity supply contract has to cover the following types of costs:

- Operating costs related to the electricity generation;
- Investment costs and maintenance costs (either those related to power plants and those related to the network infrastructure);
- Costs associated with the transmission and distribution of electricity;
- Costs related to ancillary services;
- Costs related to meter reading, billing, customer service and account maintenance;
- Costs related to taxes that are applied to electricity consumption.

Besides the costs that we have just listed above, electricity tariffs should, of course, remunerate the supplier for the service provided.

Structure of the electricity bill

Electricity bills consist of the following elements:

- A component that covers the expenses related to the electricity itself. The corresponding sum is divided into a fixed charge, expressed as €/year, and a variable one, expressed as €/kWh. The fixed component is intended to cover the commercial costs while the variable one is intended to cover the costs related to the electricity purchase and the costs of the ancillary services. For the "protected market" customers, the variable charge also includes a component that allows for adjusting the price on the basis of the effective costs borne by the AU to supply energy;
- A component that covers either the expenses related to the electricity transport and the expenses related to meter reading. The corresponding sum is divided into a fixed component, expressed as €/year, a variable charge, expressed as €/kWh, and a component, expressed as €/kW/year that depends on the subscribed power;

- A component that covers the general system charges, such as those related to renewable energy support schemes or those costs related to the introduction of social tariffs (such as the so-called *Bonus Elettrico*). The sum associated with this component is divided into a fixed charge, a variable charge and a charge that depends on the subscribed power;
- Taxes. There are two taxes: the first one is applied on the electricity consumption and the second one, the Value Added Tax, is applied on the total electricity bill. The VAT rate is equal to 10%, for residential customers, or to 22% for non-residential customers.

As data show, in 2017, the first component (the one that covers the expenses related to the electricity itself) accounted, on average, for 48% of the total bill while taxes accounted for 13% of the total bill.

Electricity rates

As we previously stated, residential customers can choose between regulated tariffs and market offers.

For what concerns the protected market, the corresponding tariffs are set by the Regulatory Authority in such a way as to cover all the expenses incurred by the AU to purchase the electricity and the costs incurred by the suppliers to deliver it. If we now consider the market offers, we can notice that the customer can choose among the following options:

- Fixed-price offers. Under these tariff plans, the pre-tax price of electricity does not vary over the contract duration period (at least 12 months);
- Indexed-price offers. Under these tariff plans, the supplier grants a discount off the pre-tax regulated price. Under such offer, the pre-tax price follows the changes in the regulated tariffs;
- The so-called *offerte a taglie* which are three-part tariffs that consist of a fixed fee, an included allowance of kWh at zero marginal price and a positive marginal price for additional usage beyond the allowance.

By using the "TrovaOfferte" search engine on the ARERA website, it is possible to compare the main offers (either regulated tariffs and market prices) available in the market, at a given moment. For an annual consumption equal to 2200 kWh, the electricity supply contracts available in March 2018 have an estimated price that ranges from 370.71 €/year (fixed-price offer with ENGIE ITALIA S.p.A.) to 504.38 €/year (fixed-price offer with Eni gas e Luce S.p.A.). The estimated value of the regulated price is 453 €/year. By comparing the different offers, we notice that around 60% of the market offers are cheaper than the regulated tariff.

Social tariffs

Since electricity is an essential good, it is important to ensure that everyone has access to it. A measure that has been envisaged in order to make electricity supply more affordable for vulnerable customers is represented by the so-called Bonus Elettrico, which is a social bonus, i.e. an amount of money that is reimbursed to people who face severe economic difficulties. For the current year, the amount of such financial aid ranges from 125€(household size: 1-2 members) to 184€(household size>4 members); the actual value that is granted to a given household is determined on the basis of the annual income and on the basis of the household size.

3.3.4 Regulatory Authorities and market institutions

Set up in 1995 by Law No. 481/1995, the independent public body that is in charge of regulating and supervising the functioning of the electricity sector is the Italian Regulatory Authority for Energy Networks and Environment (*Autorità di Regolazione per Energia Reti e Ambiente*). Its main functions are the following ones:

- It is in charge of protecting the interest of customers, while promoting competition and efficiency in the sector;
- It is in charge of establishing a tariff system that, on one side, remunerates operators for their work done and, on the other side, promotes an efficient use of electricity;
- It must monitor the electricity supply activities and it must verify that market players operate in compliance with the imposed quality standards;
- It is in charge of setting the requirements that operators have to fulfil in order to obtain a licence or a concession, which is then released by the Ministry of Economic Development.

Moreover, the Italian Regulatory Authority can cooperate with the Italian Competition Authority in order to better supervise the electricity market functioning and to detect possible anti-competitive behaviours of operators. Despite this joint initiative, the Competition Authority is the only one that is in charge of setting the competition policy.

Other relevant institutions that operate in the Italian electricity market are the Electricity Market Operator (GME) and the Electricity Services Operator (*Gestore dei Servizi Energetici*, GSE). The first one is in charge of organising and supervising the energy trading market while the second one is in charge of designing schemes that aim at supporting production from renewable sources.

3.3.5 Level of competition in the electricity supply market

When we have analysed the supply sector we have noticed that there are many companies that compete to provide electricity services. However, as we already said, a high number of firms is not necessarily a sign of high competition.

In order to assess the effective degree of competition in the household sector, we consider the following indicators:

- Percentage of customers on the protected market: this parameter allows us to understand to what extent the overall energy supply market is open to competition;
- Herfindahl-Hirschman Index (HHI): it is a measure of market concentration. The higher is the value, the lower is competition;
- Switching rate: this can be considered as a measure of the sector competitiveness because a switch normally occurs either when there are more advantageous prices or when there is one other company that offers a better service.

For what concerns the first indicator, the most recent data reveal that, in 2014, around 64% of the household customers were on the protected market; this means that less than 40% of the whole residential sector was actively engaged in the free market. Over the years, the number of customers supplied under a regulated contract has been progressively decreasing.

Since that in 2019 the regulated tariffs will be abolished, all those customers that are still on the protected market will have to choose a new supplier. In order to facilitate the transition from the regulated to the liberalised market, it has been introduced the so-called *Tutela Simile* which is a type of market contract whose contractual terms and conditions (set by the Regulatory Authority) are standardised, whatever the chosen supplier.

We can now continue our analysis by considering the HHI Index, that allows us to understand the level of market concentration. As data show, for the year 2016, the HHI value exceeded 5300, meaning that the market is highly concentrated.

We can now try to identify which are the suppliers having the largest market shares.

As the most recent data reveal, in 2014, Enel supplied more than 74% of the total volume of electricity sold to residential customers; more than 88% of this quantity has been delivered to

"protected" customers. Enel was then followed by Eni, whose market share was equal to 5.1 %, by Acea, whose market share was equal to 4%, and by other companies (each of them has a market share<than 3%).

In order to have a broader overview on the real level of competition in the electricity retail sector we can now focus our attention on the liberalised market. As data show, in 2014, the deregulated market was dominated by Enel, whose market share was equal to 16.8%. It was then followed by Eni, whose market share was equal to 5%, by Edison, whose market share was equal to 2.8%, and by other companies (such as Hera, Sorgenia, Iren), each with a market share smaller than 2%. We can therefore conclude that the free market is not concentrated.

If we now consider the switching rate, we can notice that the Italian consumers are relatively active in changing supplier. As data show, in fact, the switching rate recorded in 2016 for the household sector is equal to 8.6 %. Moreover, if we analyse its evolution over the years, we can see that it has increased; this trend may suggest that the degree of competition in the electricity supply market is progressively increasing.

On the basis of what we have stated above, we can conclude that the level of competition in the whole market is still rather low and this is the main reason why the Regulatory Authority provided for the end of the protected market.

Chapter 4

Behavioural economics and environmental policy design

In our analysis we have highlighted that the main goal of environmental public policy interventions is to preserve and promote factors and practices that contribute to the quality of the environment on a long-term basis. In this context, economics can give a huge contribution to the identification of the most suitable measures that can encourage environmentally friendly habits among customers.

First of all, in order to ensure that these measures bear fruit, it is necessary that people become completely aware that their water and energy consumption choices have negative impacts, the so-called externalities, on the environment. In this context, the most relevant problem lies in the fact that people, when adopting an environmentally costly behaviour, are conscious that they will never bear the whole cost associated to their actions. This situation is what economists call "tragedy of the commons" (Hardin, 1968). However, in our analysis, the standard version of the problem, where some herdsmen sharing a common pasture have to decide how many cows to buy and to let graze on that area, could be revised in the following ways:

- We could consider people who, by drawing from water finite sources, make their water consumption choices;
- We could consider people who make their electricity consumption choices and, thus, have an impact on the environmental quality. In this case we are assuming that there is no constraint on the maximum availability of electrical energy.

As you might already know, the main difference between water and energy lies in the scarcity of the first one. Therefore, policies shall be drawn up whilst bearing in mind this aspect. Nevertheless, if we do not take into account environmental aspects, water and energy can be considered as any other economic good. As Briscoe' analysis (1996) shows, water has an intrinsic value and customers are willing to pay for that and to consume it as long as the benefits associated from the use of an additional cubic meter exceed the costs so incurred. In order to properly estimate the water value, we have to take into consideration that this resource has no substitute for most of the residential uses. Similar considerations apply also to electricity.

Either for what concerns water and electricity, consumption levels can be viewed as the outcome of a decision-making process, as it happens for any other type of good. People can indeed choose whether and to what extent they are going to consume, according to their personal preferences, needs and budget constraints. They can also decide whether to consume immediately or to postpone consumption. It is thus possible to note that there are many factors influencing consumption choices and, therefore, it is not an easy task to have a clear overview on them.

As highlighted by recent economic studies, among the various determinants of consumption choices, we have also to consider the psychological aspects because their impact on behaviour is really relevant and, therefore, these should not be neglected in order to obtain valid results. It is

important to say that, in the last years, economic theory has devoted increasingly more attention towards the analysis of people's actions under certain situations. The integration of psychological insights into economic models has given birth to the so-called behavioural economics. Richard Thaler, the American economist who has been awarded with the 2017 Nobel prize, has given a relevant contribution to the development of this emerging research field. In his first pioneering work "Toward a positive theory of consumer choice" (1980) he argues that, under certain conditions, human behaviour deviate from what is described in standard neoclassical economics and this is the main reason why traditional economic theory, in these cases, makes systematic errors in forecasting customer's choices.

As highlighted by Thaler when speaking about his latest book "Misbehaving: The Making of Behavioural Economics"(2015), most people, in real situations, tend to show a way of acting that does not comply with economics standards. In other words, it means that they misbehave. The author has always put a strong emphasis on the distinction between the real people, called "Humans", and the picture of human beings offered by economists, called "Econs". As Richard H. Thaler and Cass R. Sunstein say in the book "Nudge: Improving Decisions About Health, Wealth and Happiness" (2008), "if you look at economics textbooks, you will learn that homo economicus can think like Albert Einstein, store as much memory as IBM's Big Blue, and exercise the willpower of Mahatma Gandhi. Really. But the folks that we know are not like that. Real people have trouble with long division if they don't have a calculator, sometimes forget their spouse's birthday, and have a hangover on New Year's Day. They are not homo economicus; they are homo sapiens". The underlying idea behind this sentence is that there are three aspects which have a strong influence on people's choices and actions:

- The first is that consumers have cognitive limitations. In their daily life, people are "boundedly rational" meaning that they prefer simplicity and they rely, when needed, on mental shortcuts, rules-of-thumb and heuristics in order to bypass more intensive information processing. This happens especially when they face situations with high levels of complexity. These findings stand in stark contrast to traditional economic assumptions which predict that people's decision-making process can be improved by providing them with more information, thus increasing their knowledge, or with more alternatives, thus widening the range of available options.
- The second refers to self-control problems. Empirical evidence shows that, often, people find it difficult to do what they know is right. Contrary to what it might be expected, this happens very frequently; even when individuals intend to behave in a particular way, it is very likely that, in spite of everything, they will not act accordingly.
- The third refers to the fact that social preferences play a key role in the decision-making process. In fact, behavioural economics researches highlight that agents, when making their choices, do not only pursue their self-interest but there are also some situations in which individuals tend to conform to social values such as fairness and altruism. Given this aspect, it will be necessary to consider the individual as a part of a broader context in which shared principles are of great importance.

Starting from these findings it is possible to conclude that we are influenced by several irrational tendencies which inevitably alter our behaviour.

Developments in behavioural economics field are of great importance because their findings can be extended to many different contexts. In our analysis, for example, these insights from psychology are very helpful because they allow a better understanding of the water and energy consumption choices. As many researches reveal, there are many cognitive biases that influence energy and water related practices. It will be therefore necessary to take them into consideration in order to draw up policies that really encourage environmental sustainability.

As Frederiks, Stenner and Hobman (2014) show, some of the cognitive biases with the highest impact on energy usage are the following ones:

- Status quo bias. People are generally not willing to change and, when they have to make a choice, they often select the default option even in the presence of better alternatives.

The main reason behind this behaviour lies in the fact that it allows for time savings. It is necessary to say that there are also some consumers who think that the default option is the best one because it is the one recommended by the service provider, thus revealing that the customer has confidence in the operator.

However, as you might expect, this attitude poses some problems because it discourages the adoption of a pro-environmental behaviour. For example, as highlighted by Daniel Pichert and Konstantinos V.Katsikopoulos (2008), people do not generally buy green electricity, the one that comes from sources that cause a small environmental impact, even if they say that they would prefer it over the grey energy, which is the one produced starting either from fossil fuels or nuclear fission; this happens because the latter is usually the default and people are not willing to switch operators, not only because of distrust towards a new service provider but also because it would be costly in terms of time, effort and, in some cases, money.

- Temporal discounting. People tend to undervalue what is further away in time meaning that they prefer smaller immediate rewards over larger future compensations. Because of this attitude, consumers do not usually buy energy efficient appliances although it will offer them long-term benefits in terms of economical savings on the future electricity bills. To encourage people to change their habits it will therefore necessary to make them aware that future rewards will be relevant; this will make them more focused on future gains rather than on immediate costs.

- Social influence. People usually tend to "follow the herd" and to conform to social norms, either explicit or implicit ones. As many researches highlight, communicating how most people are used to behave in certain situations is a very effective tool that motivates conformity. The reason why this happens is that individuals tend to compare their performance with respect to the one of other people because they are willing to achieve better results.

  This psychological aspect is very important because it can motivate people not to overconsume energy and water. As some studies show, people become more willing to reduce their usage levels if they are informed about the fact that many other individuals are already engaged in several water and energy-saving activities. Nolan et al. (2007) reveal that people become motivated to significantly lower their consumption levels if they are given information about neighbours' actual electricity usage. They also show that the effect of this measure is significantly greater than the case where people are only provided with some energy saving tips. In any case, however, it is necessary to draw the attention not only to people who overconsume but also to the ones who already save a considerable amount of energy because it is necessary to avoid the so-called "boomerang effect" which would cause the latter to feel free to higher, even slightly, their consumption. In this situation it could be therefore important to envisage some kind of reward for these people in order to strengthen their commitment towards environmental sustainability.

- Motivation through rewards and incentives. It is generally known that rewards and incentives have an impact on human behaviour; these can indeed change people's habits. It is important to say that not only extrinsic rewards, such as financial incentives, can have huge effects on people's habits but also intrinsic motivation can largely influence actions. However, it is important to take into consideration that, as Deci (1971) shows, extrinsic rewards can have a counteractive effect on intrinsic motivation and this can be due to the fact that, if people get a monetary reward for an action, they tend to re-evaluate it in terms of the financial gain arising therefrom.

As we stated above, the findings we have just shown are related to researches focused on the energy sector. However, these results can be extended to the water sector, given that the nature of electricity and the one of water can be considered similar.

Thanks to the contribution of behavioural economics and social science findings, it is possible to conclude that, whatever the choice, people will always be influenced by certain psychological aspects that do not let them be completely rational when making their choices. The loss of rationality is the element that prevents people from making decisions that maximise the utility either in the short and in the long run. For instance, if we consider the choice of adopting environmentally

friendly habits it is possible to say that this decision requires high effort in the short run but the advantages are spread out over the years; it is therefore really important to encourage people not to be short-sighted. As highlighted by Thaler, it is essential to design policies that are inspired by the principle of libertarian paternalism. Although it may sound as an oxymoron, this concept has an unambiguous meaning. The libertarian aspect lies in the fact that people's freedom of choice must be preserved and no option must be banned; the paternalistic aspect lies in the fact that the primary goal of policies is to influence people's behaviour in such a way as to improve their lives.

Thaler and Sunstein in the book *"Nudge: Improving Decisions About Health, Wealth and Happiness"* suggest the use of nudges as a tool for enhancing policies effectiveness. As defined by the authors, a nudge identifies *"any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives."*. When they talk about the choice architecture, they refer to the context in which individuals make their decisions. As stated in the book, the power of nudges comes from the fact that the context has a relevant influence on the decision-making process and, therefore, if the context is changed it is very likely that the resulting choice will vary accordingly. Moreover, it is very important to highlight that the nudge theory has a wide range of applications and therefore many policies areas can take inspiration from it.

For instance, in the environmental area, many energy conservation strategies, that have been introduced throughout the years, are based on the adoption of nudges. In 2004, the electricity supply company Southern California Edison (SCE) decided to give customers a small device, called Ambient Orb, that changes its colour, in a spectrum of green to red, according to the energy usage level. The following figure shows the Orb, which has proved to be a very effective tool in encouraging people to reduce energy consumption.

Figure 4.1: Southern California Edison's Energy Orb

Source: International society for optics and photonics

Data have revealed that, thanks to this glowing ball, customers have reduced their energy consumption by 40% in peak periods. This device allows people to better estimate their consumption and, consequently, to better monitor their energy use.

Clive Thompson (2007), who analysed the measure that we have just described, noted that people find it really difficult to realize the amount of electricity they usually use because it is invisible; this is the reason why it is advisable to provide customers with tools like the Ambient Orb that allow them to see their energy consumption level.

We can conclude that providing updated information to customers is of key importance because they feel that they are more personally responsible for their own consumption choices. Feedback can also be given through the use of In-Home Displays(IHD) which are devices that can be installed

to gather detailed consumption data from the smart meter and to enable people to take a look at their actual consumption. The following figure shows a IHD displaying the amount of energy used and the associated price either for the current day and for the preceding one.

Figure 4.2: In-Home Display

Source: Rainforest Automation

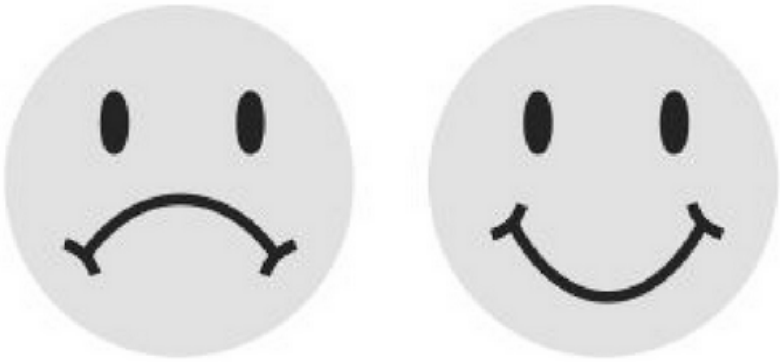
As Lynham et al. (2014) show, the provision of real-time consumption data contributes to energy conservation. Their research goal was to investigate the amount of energy that can be saved by providing customers with In-Home Displays. To this end, they carried out a randomised control experiment where 65 households in Honolulu were randomly assigned to one control group and two treatment groups. Only the ones that were assigned to the treatment groups received a IHD device. Moreover, one of the treatment groups, called "the Saliency treatment group", had access to the IHDs for the entire duration of the experiment, that lasted for 90 days; the other one, called "the Learning treatment group", had access to these devices only for the first 60 days. It is necessary to say that the experiment was designed in this way in order not only to estimate the amount of energy conservation that can be attributable to the adoption of the IHDs, but also to better understand whether the energy consumption reduction is due to a learning effect, or to a saliency effect. The researchers stress that it is important to distinguish between these two effects because the first one refers to the fact that information enables people to better know the amount of energy required to perform some kind of activity while the second one refers to the fact that these devices make the energy use salient by constantly reminding customers about their consumption. Experiment results show that people who had access to a IHD significantly reduced their electricity use up to 11% between 06.00 and 09.00 am and between 06.00 and 09.00 pm; however, they also reveal that the overall daily effect is not statistically significant because people didn't reduce their energy consumption at other times of the day. Moreover, they found that the effect of having a IHD installed at home gets weaker over time because people get accustomed to having the information available at hand. According to their analysis results, the reduction in energy consumption is found to be driven by the learning effect, and to a lesser extent it can be attributable to the fact of having a constant reminder of electricity usage.

Based on these findings, it is possible to conclude that people must be able to access information because it makes them aware of their actual consumption. Furthermore, as Thompson suggested, it would also be advisable to make people's energy use visible to everyone because it would permit people to compare their usage level and that of others. This would indeed generate a competition among customers to consume less. For this purpose, Thompson highlighted that the use of social networks as a tool to make consumption data public could yield even greater results because these platforms are getting increasingly more popular among people. Social networks have not hitherto been used for this aim however, nowadays, there are some on-line portals, such as the "Wattson anywhere", that allow either to monitor energy consumption and to share data with the community of users.

As we previously stated, when people compare their consumption level with that of others it is because of the fact that they are willing to overperform them. The problem arises when someone's actions are better than the social norm because, in this case, this individual will not be incentives to further improve himself. In this case too, nudges can help overcome this counterproductive effect, known as "the boomerang effect".

As highlighted by Schultz et al. (2007), a possible solution could be to give people a non-verbal sign that makes them aware whether their actions are socially approved or not. For instance, in their study, they showed that the boomerang effect disappears if you give a unhappy emoticon, as the one in figure 3a, to the people who had a consumption higher than the norm and a happy emoticon, as the one in figure 3b, to the households who consumed less than the average.

Figure 4.3: Emoticons that households received on the basis of their energy consumption level



Source: Wesley Schultz et. Al, "The Constructive, Destructive and Deconstructive Power of Social Norms"

As we stated, the nudges we have just analysed are related to electricity consumption. However, researches have highlighted that equivalent measures can also be applied to encourage people to reduce water use.

Saugato Datta, et Al. (2015) carried out an experiment in Belén, a municipality in Costa Rica, to test the outcomes of various measures intended to encourage water conservation. One of these was the following: people received in their bill a coloured sticker, as the ones in the figure 4, comparing their actual consumption to that of the average household in their neighbourhood. As you might guess, the smiley face was given to people whose consumption was smaller than the average recorded in the neighbourhood and the frowny emoticons to all the others.

Figure 4.4: Sticker Designs, Neighborhood Comparison Intervention

Source: Saugato Datta, "A Behavioral Approach to Water Conservation: Evidence from a Randomized Evaluation in Costa Rica"

The results of this experiment have shown that this intervention was effective because the average monthly water consumption has significantly reduced by between 0.98 and 1.47 cubic meters per household. Another measure that led to a statistically significant reduction in water

use is the following: people were given, in addition to the water bill, a worksheet that they had to fill out with data about their current consumption and about the consumption of the average Belén household. They were also asked either to specify a target level for water reduction and to select, among some water saving behaviours, which one to adopt in order to reach the desired goal. The objectives of this intervention were the following:

- to make people aware of their actual consumption;
- to prompt people to set clear intentions about water conservation;
- to establish an action plan that makes it possible to achieve the predefined goals.

The authors show that this measure led to a statistically significant reduction, in the average monthly water usage, by between 0.90 and 1.47 cubic meters per household.

As we can see, there are plenty of nudges that can be used to encourage people to change their behaviours. For instance, the City of Cape Town has been working for many years with the Environmental Policy Research Unit(EPRU) of the local University in order to study which methods can encourage a prudent water use by the inhabitants. Researches decided to conduct a randomised control trial in order to test whether the inclusion of some messages in the water bill could be regarded as an efficient solution to fight water wastage. Messages were framed in the following way:

- some of them provided information about possible economic savings that could have been achieved by cutting consumption;
- others provided some useful tips for water conservation;
- others promoted water conservation through social incentives.

As the results show, the message that have produced the best results was the one that notified people that the names of the top water savers would have been published on the city's website. This measure led to a per-capita reduction in water usage by 2 percentage points.

On the basis of these findings it is thus possible to conclude that nudges can have a relevant impact on human behaviour. However, generalizability of these results does not appear to be entirely correct because energy and water consumption patterns vary very widely from one country to another. It would be indeed misleading to say that the amount of energy and water use reduction would be the same whatever the country. What can be considered valid in different nations is that nudges lead to a change in habits, also the ones related to energy and water consumption. Moreover, similar nudges can also apply to encourage people to reduce waste and to recycle it whenever possible. What it is important to stress is that the potential benefits arising from nudges should be fully exploited in order to address environmental problems.

Chapter 5

Pricing policies

Policymakers who are seeking to reduce consumer's demand for water and energy can adopt either non-price based interventions, such as behavioural interventions, or price-based measures. In any case, it is important to ensure that these generate robust and persistent effects.

To this purpose, Koichiro Ito et al. (2015) investigated whether policies targeting intrinsic motivation were able to generate robust and persistent effects, in terms of energy consumption reduction, to the same extent as policies targeting extrinsic motivation. To answer this question, they used a randomised field experiment designed in this way: 691 households were assigned to one of three groups. The three groups are the following: a control group, a moral suasion group and an economic incentive group. These groups are different because the first one didn't receive any treatment, the second one received a message requesting voluntary energy conservation during peak demand hours on peak demand days and the third one was charged high prices during peak hours. As the authors reveal, the key findings of this experiment are the following ones:

- moral suasion interventions induced usage reductions in the short run but these effects disappeared after the first interventions;
- economics incentives generated larger effects that were persistent over repeated interventions;
- although the treatments were targeted to electricity usage during peak demand hours, these interventions had an impact also on energy usage in non treatment hours on the treatment days. This is what is known as spillover effect. Such effects have not been detected for the moral suasion group.
- After they withdrew the treatments, the economic incentives group continued to conserve energy. On the contrary, the moral suasion group didn't continue to practice electricity conservation. This means, therefore, that the economic incentives led to changes in behaviour.

As you might notice, pricing policies are of great importance because of their relevant impact on people's behaviour.

Either for what concerns the electricity and water sector, although it may seem trivial, it is essential that pricing policies are drawn up in such a way as to ensure that goals are met.

For instance, in the electricity sector, several inefficiencies are originated from the fact that prices do not fully reflect the marginal costs of the energy supply. It is indeed important to stress that costs vary according to the time of day: these can be very high during peak hours reaching. Costs reach their maximum during peak demand hours on peak demand days.

It is important to highlight that inefficiencies can be found in the water sector too. In some countries, pricing systems are distorted and this condition leads to a non optimal use of the resource among customers. In some cases, in fact, it doesn't even exist a clear link between the investment level in the sector and charges invoiced to consumers because, in several EU countries,

the investment needs are partially subsidised either by the national funds or by the European Commission structural funds.

In order to draw up an efficient water pricing policy, a solution put forward by Jihad Elnaboulsi (2008) could be the following: extra water supplies should not be further considered as an essential public good. On the contrary, any additional demand should be regarded as an economic commodity because of the fact that the investments required to face it are very costly and prices should therefore incorporate such cost increases.

5.1 Water pricing structures

According to economic theory, water pricing structures have to meet the following criteria:

- allocative efficiency. This identifies a situation in which people are provided with a service at the lowest possible social cost and where the only way to make someone better off is to make someone else worse off;
- equity, which means that prices must be fixed in order not to prevent customers from accessing and using those services;
- financial viability, which means that tariffs should allow for cost recovery;
- simplicity, meaning that pricing schemes should be easily understandable.

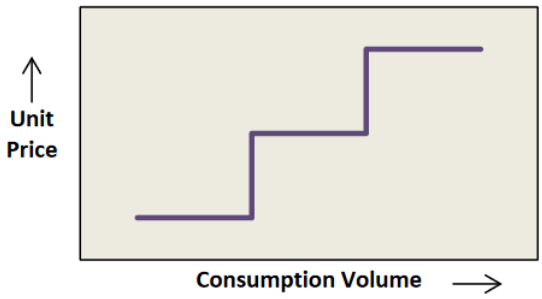
As research shows, in the water sector, the pricing structure that has been adopted by most of the water utilities is the two-part tariff which includes either a non-volumetric part that covers the service fixed costs and a volumetric component that varies with consumption.

However, it is necessary to highlight that a two-part tariff may only be applied if water meters are installed in every single apartment; in all other cases, in fact, metering is often done collectively and then charges are based either on the number of people living in the flat or on the apartment surface. It is therefore essential to point out that, when the tariff is not directly linked to consumption, people have no incentive to reduce their consumption.

Although the two-part tariff offers some advantages, such as the fact that these are relatively easy to understand, it is necessary to note that there are other pricing schemes, such as the increasing block tariffs, that have a greater impact on consumption levels.

Block tariffs, or progressive tariffs, are volumetric charges. Under a block tariff structure, the per-unit price of water changes according to consumption. There are two types of block tariffs: the increasing block tariffs in which, as shown in the figure 5, the unit price of water goes up as consumption increases and the decreasing block tariffs in which the unit price of water decreases as consumption increases.

Figure 5.1: Unit price versus consumption volume for increasing block tariffs



Source: Nancy Ross and Paula Luu (2013)

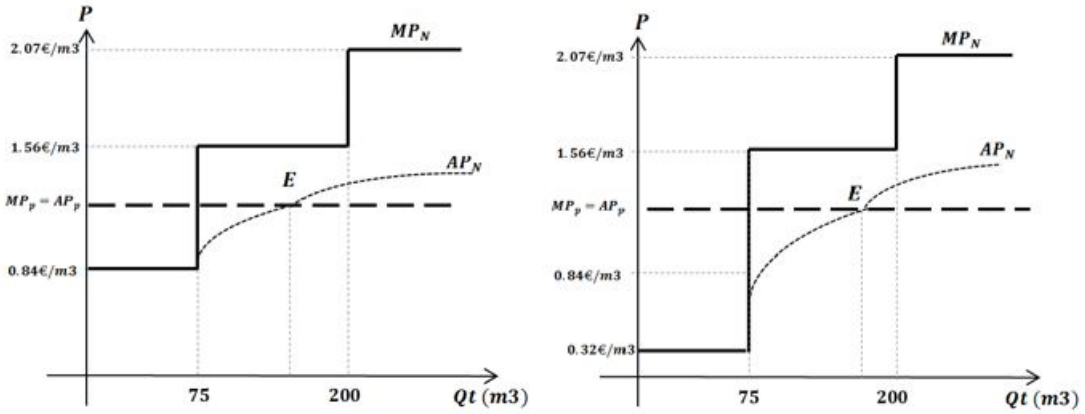
It is necessary to stress that, between these two types of block tariffs, the increasing one is the price structure that gives more incentives to reduce consumption. When designing progressive tariffs, in order to send a clear signal that encourages people to save water, it is important to properly specify the following elements:

- the number of blocks;
- the volume of water use associated with each block;
- the unit price associated with each block.

Moreover, block tariffs can be designed in such a way as to ensure that also social goals are taken into account. For instance, it is possible to charge low-income people a lower first-tier price in order to provide them with inexpensive water.

At this point of the analysis it is important to investigate how do people respond to increasing block tariffs. Many researches aimed at evaluating whether this type of pricing scheme could effectively reduce water demand. For instance, Mayol, in his study (2017), analyses the impact that the transition from a linear tariff to an increasing block tariff has on the amount of water consumption. For this purpose, he examines the experiment conducted in the city of Dunkerque, France, where in 2012 the water service operator introduced a new pricing structure that is called "tarif éco-solidaire" because it pursues either social and environmental goals. The new pricing scheme is a nonlinear three tier tariff backed with a social tariff on the first tier. It is important to highlight that the social tariff is automatically assigned to the beneficiaries of the universal health care coverage ("couverture maladie universelle", CMU). In the following image it is possible to see either the previous tariff and the new one; the first is the one represented by a horizontal line because the marginal price does never change while the block tariff scheme is the one represented by a continuous line. It is necessary to highlight that the curved dotted line represents the average price for the nonlinear pricing system. It is also worth noting that these graphs do not include the fixed component of the tariff.

Figure 5.2: Previous and new price schemes for standard consumer (on the left) and "social" consumers (on the right)



Source: Nancy Ross and Paula Luu (2013)

As the key findings of this study reveal, the introduction of the new tariff led to a decrease in the total water demand, while creating some distortions. The distortion of this tariff structure is mainly due to the fact that to decrease the first-tier price it is necessary, at the same time, to increase the marginal price of the other tiers. Moreover, results have shown that, under a block tariff scheme, different types of customer respond to price signals in different ways. The findings of the Dunkerque's experiment are the following:

- small consumers (the ones who consume less than 75 m3) increase their consumption because the first-tier price is smaller than the price they were used to pay under the previous tariff;

- medium consumers (the ones who consume between 75 m3 and 200 m3) slightly reduce their consumption because the price has not considerably changed;
- large consumers (the ones who consume more than 200 m3) substantially reduce their consumption;
- social consumers increase their consumption for the same reason as given above with regard to small consumers;
- large families are adversely affected by the new tariff because they have to pay higher prices even though they cannot reduce the total household consumption.

It is therefore possible to conclude that this tariff has some limitations that should be addressed. For instance, in order to correct the distortion generated by the introduction of the new tariff on large families, the municipality decided to introduce a flat-rate subsidy, called "chèque eau", in order to compensate these households for the losses incurred.

Another issue to be considered is that the nonlinear tariffs are more complex than the linear ones. In such a situation, many consumers show a sub-optimal reaction to the price signal because, as Carter and Milon (2005) reveal, the cognitive effort required to fully understand complex pricing is sometimes substantial. Moreover, researches have shown that people, when faced with complex tariffs, respond to average price rather than marginal price. However, this sub-optimising behaviour causes several inefficiencies. As Ito (2014) highlights, if consumers respond to average price, the adoption of nonlinear pricing schemes in the electricity sector may not be effective in reducing aggregate energy consumption; on the contrary, it might even lead to an overall increase in demand. It is therefore necessary to take into account all of these distortions in order to design pricing policies that can effectively reduce water and energy consumption.

5.2 Electricity pricing structures

As we have previously stated, electricity pricing policies have slightly different objectives compared with the ones of water pricing policies. Tariffs are indeed designed to reduce the demand during peak periods.

Electricity pricing policies can be either static or dynamic. In the first case, prices do not change according to the demand level; on the contrary, dynamic prices vary with a change in demand. Examples of pricing schemes are the following:

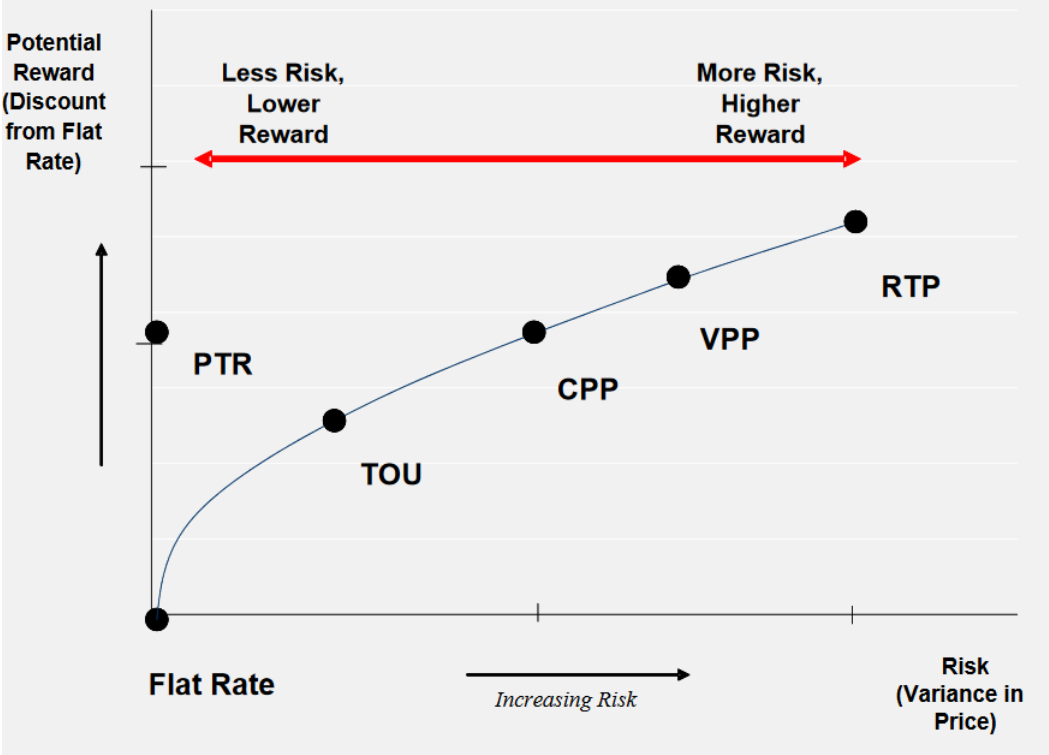
- flat tariffs: price remains constant event though the aggregate demand changes. This is the reason why, under such a pricing scheme, consumers have no incentive to reschedule their consumption;
- block tariffs: this type of tariff charges a different per-unit price depending on the amount of electricity consumed. Block tariffs can be either inclining or declining. In the first case, the per-unit price of energy increases as the energy consumption increases. On the contrary, under a declining block tariff, the per-unit the per-unit price of energy decreases as the energy consumption increases;
- seasonal tariffs: under such tariff scheme, the rate changes between peak season and off-peak season;
- time-of-use tariff (TOU): this structure applies different prices at different times of day. Time is divided into the following periods:
  - Peak periods, in which demand reaches its maximum and electricity price is high;
  - Off-peak periods, in which demand reaches its minimum and electricity is cheap;
  - Shoulder periods: these identify the time interval between a peak period and a off-peak period. During shoulder periods, electricity price is usually lower than that of peak periods.

Such pricing scheme is also known as time-of-day tariff;

- super peak time of use tariffs: these are similar to time of use tariffs except for the peak window which is shorter in duration;
- critical peak pricing (CPP): it is a tariff structure in which prices are high during the peak hours and discounted during the rest of the day. It is necessary to highlight that the peak price is the same for all days;
- peak time rebate (PTR): under this tariff scheme customers are paid for load reductions during peak hours. If they do not reduce their consumption they simply pay the existing rate. It is necessary to highlight that there is no rate-discount during non-event hours;
- variable peak pricing (VPP): it is similar to critical peak pricing. The only difference lies in the fact that, in variable peak pricing, peak prices can change every day;
- real time pricing (RTP): under this tariff scheme, prices change at regular intervals in order to better reflect the actual cost of supply. It is important to say that, in order to efficiently implement a dynamic pricing system, it is necessary to use advanced technology devices which communicate and manage data about price changes and consumption.

Faruqui and Lessem (2012) analysed the risk, expressed in terms of price variance, and the reward, expressed in terms of economical savings on bills, associated with each of the time-varying rates that have just been described. According to their study, the real-time pricing is the scheme with the maximum uncertainty and maximum reward for the customer. It is followed by variable peak pricing, critical peak pricing and time of use tariffs. By contrast, neither flat rate tariffs nor peak time rebates present additional risks to customers; the first one, however, do not even offer any reward. These findings are summarised in the following figure.

Figure 5.3: Risk-reward trade off in electricity time-varying pricing structures



Source: Faruqui and Lessem (2012)

As we just stated, under most of the time-varying rates the customer is exposed to uncertainty. However, it is necessary to say that there are some strategies that can be very effective in reducing the risk that consumers face under TOU, CPP and RTP. As research shows, examples of such risk mitigation measures are the following:

- consumer baseline: the idea behind this strategy is that only the incremental or decremental energy usage, measured with respect to a baseline, are exposed to dynamic pricing. The baseline is usually set as the historical hourly load data. This approach ensures that the bill remains unchanged if the usage does not change. A limitation of this approach is that, in some cases, it may be difficult to calculate the baseline because of load variability.
- price ceilings and price floors: this approach ensures that a minimum and a maximum price are fixed. This strategy is very effective because it limits the exposure to price variability.
- bill protection: this measure ensures that the electricity bill does not exceed a certain percentage above the baseline level, adjusted for differences in energy use.

As you might notice, it is possible to implement a dynamic pricing policy under which the customer has a limited exposure to risk. According to the analysis conducted by Faruqui and Lessem(2012), among all the price structures mentioned above, real-time pricing is the one that can ensure the best outcomes either in terms of economic efficiency, since it absorbs consumer surplus and enhances total revenues at existing costs, and in terms of retailer revenue stability since, under such tariff scheme, prices always reflect actual supply costs. Moreover, as research reveal, real-time pricing has proven to be the one that achieves the best outcomes in terms of peak load reduction. Faruqui (2010) shows that the implementation of a real-time pricing can reduce the peak energy demand by between 10% and 14%. Furthermore, as Gillan (2017) reveal, peak load can be further reduced if people are provided with smart devices that can automatically break the circuit between the plug and the appliance in order not to draw additional load from the socket. Devices such as the ones that we have just mentioned would be very helpful because they would automate the decision to reduce consumption, thus reducing, at the same time, the effort required to respond to frequent price changes.

Chapter 6

Consumer perception and preferences regarding electricity and water tariffs: an experimental study

In the previous chapter we have highlighted that tariffs, both the electricity and water ones, are increasingly considered as potential solutions to encourage the adoption of sustainable behaviours. This aim can be achieved through pricing schemes that are designed in order to effectively reflect the actual production and supply costs of the good. As we already said, in fact, price changes can be used as signals to which the customer responds by adjusting his consumption level.

Customers, however, do not always show optimal reactions to price signals. As studies reveal, this may be due to the fact that tariffs are sometimes complex, and people may have difficulties in understanding such pricing schemes.

The key idea, when setting tariffs, is that there are two conflicting goals: the first one is that the tariff should accurately reflect the costs incurred to produce and supply the good while the second one is that the tariff should be easily understandable. It is however generally acknowledged that the more accurate the pricing scheme is, the more complex it is. Consequently, this aspect can generate a negative impact on understandability and on the way in which customers perceive the tariff.

In recent years particular attention has been given to the study of customers' perceptions and preferences regarding different tariff schemes (electricity, mobile phone, gas). Several studies, such as Lambrecht and Skiera (2006) and Kridel et al. (1993), have highlighted that people, when faced with tariff choices, usually prefer paying a fixed monthly fee in return for unlimited usage of a good mainly because they are not always able to accurately estimate their future consumption levels. Among the people who prefer flat tariffs there are those risk-averse consumers who want to avoid variations in the monthly billing rate and others who, unconsciously, overestimate their demand for the good. The first ones want to insure against the risk of considerable costs in periods of higher consumption and this is known, in the economic literature (Lambrecht and Skiera 2006), as the "insurance effect". The second group of people, on the contrary, estimates that their minimum and maximum usage levels will be particularly high and, therefore, they think that the most advantageous tariff is the flat one. This is known, in the economic literature (Lambrecht and Skiera 2006), as the "overestimation effect". Of course, apart from those who prefer flat tariffs, there are also several consumers who would find other tariff schemes, albeit complex, more attractive. As studies reveal, there are users who, when faced with a choice between a flat tariff and an increasing block tariff, would choose the second one because they think that they are able to effectively decrease their usage level as desired and, therefore, they are convinced that they will never end up paying the price associated to the highest block. As has been well documented both

in the psychology and in the economic literature, there is a tendency among some customers to underestimate the variance of their future demand, when choosing a tariff. Grubb (2009) shows that overconfidence among customers is the reason why mobile phone service providers offer three-part tariffs (consisting of a fixed fee, an included allowance of units- either minutes or data or SMS- at zero marginal price and a positive marginal price for additional usage beyond the allowance) and users accept them. Furthermore, this analysis reveals that a large proportion of users select sub-optimal tariffs. In fact, as data show, many of them who choose the non-linear tariff schemes actually overshoot allowances and paid a rather expensive bill. The author has stressed the fact that similar considerations can be applied also in the analysis of other markets, e.g. gas and electricity markets, in which customers choose their contract without knowing ex-ante their future consumption.

It is therefore possible to conclude that choosing among different pricing schemes can be a pretty complicated task, not because there are plenty of alternatives available but because the uncertainty associated with future consumption behaviour generates some biases that influence the decision.

6.1 The experimental study

In this chapter we propose an experimental study that aims at investigating people's preferences and perceptions regarding different tariff schemes for water and electricity services.

6.1.1 Aims and objectives

The main objective of this experiment is to study how people behave when faced with tariff choice for the electricity and water services.

First of all, we are interested in finding out which is the tariff scheme that people prefer, when they have to choose among some available alternatives. This enables us to understand customers' preferences and perceptions regarding the proposed pricing structures. It is necessary to consider that either perceptions and preferences may depend on many factors. Among them we can list the following ones:

- characteristics related to the tariff itself such as the structure, the complexity and the associated risk;
- individual or household characteristics such as the attitude towards risk and uncertainty or the willingness to adjust consumption levels over time;
- features related to the dwelling and to the home appliances.

Then, we are interested in finding out whether consumers are able to choose the pricing structure that minimizes the total bill. This enables us to figure out whether people have clearly understood the proposed tariff structures or not.

For the sake of completeness, we highlight that a secondary objective of the experiment is to elicit people' preferences towards the adoption of pro-environmental behaviours.

6.1.2 Experimental protocol

The present research investigates the decision-making process by means of an experiment designed either to elicit individual preferences regarding water and electricity tariffs and to identify the presence of biases behind the tariff choice.

The experiment will be conducted in the experimental laboratory of the Paris School of Economics (Laboratoire d'Economie Expérimentale de Paris, LEEP) and several experimental sessions

will take place. The number of subjects taking part in the experiment is set to 200; these are recruited through the LEEP database. It is necessary to highlight that the sample is selected in such a way as to ensure that it is representative.

The experiment will be conducted using a computer interface. A copy of the interfaces will be displayed in the following pages of this chapter.

During the experimental session, participants will be asked to reply to several questions and, on the basis of their answers, they will receive a monetary reward. The total payment owed to each participant is computed as the sum of the monetary rewards obtained during the experimental session plus the fixed amount of money due as a contribution for having participated in the experiment.

The experiment is incentive-compatible meaning that all the participants will know in advance the rules concerning the payments and, at the end of the experimental session, each of them will be paid according to such pre-specified payment rules.

Before beginning the experimental session, all the enrolled subjects are welcomed and they are assigned a place in the laboratory. Everyone who takes part in the experiment must sign an informed consent document outlining the rules under which the experiment is carried out. This states that participation is voluntary and anyone has the right to withdraw at any time. Moreover, it highlights that the records of this study will be kept strictly confidential and that, in any report on the results of this research, the identity will remain anonymous.

The experiment consists of seven successive stages, as listed below:

- Stage I: participants are first asked to answer several questions regarding their socio-economic status and then they are asked to provide some general information that allows to determine their average annual energy use and the average annual water use;
- Stage II: participants are asked to make six choices between two alternative tariff structures; three of these choices concern electricity services while the other concern water services;
- Stage III: several pro-environmental behaviors are presented and each participant has to state the frequency with which he intends to adopt each of them;
- Stage IV: on the basis of the answers provided in the third stage it is computed the consumption reduction potential both for water and energy and, then, participants are asked to make again the six tariff choices that were proposed in the Stage II;
- Stage V: two tests are proposed. The first test is used to measure the participants' risk-attitude while the second one is used to test the participants' cognitive abilities;
- Stage VI: a brief survey of the motivations behind tariff choices and the adoption of sustainable behaviors is conducted;
- Stage VII: all the participants receive their monetary compensation.

It is necessary to remind that, during the experiment, no communication among the participants is allowed.

The data gathered in the experiment will be examined trough descriptive statistics and econometric analysis.

It is important to highlight that the expenses related to the experiments' activities are funded by the Labex OSE-Ouvrir la Science Economique.

Stage I: Estimation of average annual electricity and water consumption

The experiment starts with a series of questions useful to characterize the socio-economic status of the individual. Participants will be therefore asked to provide the following information:

- Age;
- Sex;
- Socio-professional category;
- Household composition (number of children);
- Zip code of the residence;
- Net monthly income of the household.

Later on, participants are asked some questions that are useful for estimating either the average electricity and water annual consumption. This estimate is then used, in the next stages, to determine the price associated with each of the proposed tariff structures.

In order to estimate the average annual water consumption, participants are asked to provide information about the following aspects:

- Household size;
- Average number of showers and/or baths that the household takes per week;
- The frequency with which, during the week, the participant runs the dishwasher, if present, and whether this is a new dishwasher or not;
- The frequency with which, during the week, the participant runs the washing machine, if present, and whether this is a new washing machine or not;
- Number of dual-flush toilets and number of single-flush toilets;
- In case they have a garden, they are also asked to say the watering frequency.

In order to estimate the average annual electricity consumption, participants are asked to provide information about the following aspects:

- Household size;
- Dwelling size;
- Whether the dwelling is equipped with an independent electrical heating system or not;
- Whether the dwelling is equipped with an electric hot water heater or not;
- The frequency with which, during the week, the participant runs the dishwasher/ the washing machine/ the laundry dryer, if present, and whether these are new appliances or not;
- Whether the dwelling is equipped with a chest or an upright freezer;
- Whether the dwelling is equipped with a vacuum cleaner;
- Number of LCD TVs and plasma TVs;
- Number of desktop computers and number of laptops.

To estimate the average consumption for energy and water we use two calculators. The one for electricity has been modeled on the basis of the one proposed by the EDF (Électricité de France) enterprise while the one for water has been modeled on the basis of that proposed by the INC Institute (Institut National de la Consommation).

Stage II: Electricity and water tariff choice

In this stage, six tariff choices are proposed. Three of them relate to water services while the other ones relate to electricity. The following figure shows the choices that are proposed in the experiment.

Figure 6.1: Tariff choices proposed in the second stage of the experiment

Good	Choice	Tariff 1	Tariff 2
Electricity	Choice 1.1	Linear tariff with constant marginal price and without a fixed fee	Two-part tariff (fixed fee + linear price)
Electricity	Choice 1.2	Two-part tariff (fixed fee + linear price)	Non-linear tariff (Increasing Block Tariff)
Electricity	Choice 1.3	Non-linear tariff (Increasing Block Tariff)	Linear tariff with constant marginal price and without a fixed fee
Water	Choice 2.1	Linear tariff with constant marginal price and without a fixed fee	Two-part tariff (fixed fee + linear price)
Water	Choice 2.2	Two-part tariff (fixed fee + linear price)	Non-linear tariff (Increasing Block Tariff)
Water	Choice 2.3	Non-linear tariff (Increasing Block Tariff)	Linear tariff with constant marginal price and without a fixed fee

The tariff components are determined on the basis of the estimated consumption that is computed in the previous stage. We highlight that all the tariff components are determined in such a way that the bill does not vary according to the chosen pricing scheme. By doing so, we can effectively understand which are the real preferences, since there is no monetary incentive that influences the choice.

For what concerns water, prices are calculated on the basis of the SEDIF (Syndicat des Eaux d'Île-de-France) standard rate.
This is as follows:

$$\text{Fixed component} = 22.64\ €/\text{year}$$
$$\text{Variable component} = 3.81\ €/\text{m3}$$

For example, if we consider an annual consumption of 57 m3, the three tariffs will be defined as follows:

- Two-part tariff: fixed fee= 22.64 €/year and variable component= 3.81 €/m3 . The resulting sum invoiced is equal to $22.64 + 3.81 * 57 = 239.8€$;
- Linear tariff with constant marginal price and without a fixed fee: fixed fee=0 €/year and variable component called as p1= 4.20€/m3. The resulting sum invoiced is equal to $4.207 * 57 = 239.8€$;
- Non-linear tariff: it is composed of two blocks (the first one goes from 0 to 2/3 of the total consumption while the second one covers the remaining consumption). The tariff for the first block is computed as $t1 = 2/3 * p1 = 2.804€$/m3 and the tariff for the second block is computed as $t2 = (1 + (2/3)) * p1 = 7.01€$/m3. The resulting sum invoiced is equal to $2.804 * 38 + 7.01 * 19 = 239.8€$.

For what concerns electricity, prices are calculated on the basis of the EDF standard rates, which are shown in the following table.

Figure 6.2: EDF Standard rate

Subscribed power	Standard rate	
kVA	Fixed component (€/year)	Variable component (€/kWh)
3	56.07	0.16
6	96.50	0.14
9	111.35	0.15
12	172.78	0.15
15	199.95	0.15
18	228.56	0.15
24	491.85	0.15
30	594.30	0.15
36	698.64	0.15

Source: EDF

We remind that the subscribed power is the maximum amount of electricity that can be consumed at any one time in a dwelling, in other words, the capacity to connect various devices simultaneously. As highlighted by the EDF, to determine it is possible to consider the following general rules:

- 3 kVA corresponds to a small apartment non-equipped with an independent electrical heating system;
- 6 kVA corresponds to :
  - A small apartment (ex: 20-80 m^2) equipped with an independent electrical heating system;
  - A large apartment (ex: 80-120 m^2) non-equipped with an independent electrical heating system;
- 9 kVA corresponds to a very large apartment (>80 m^2) equipped with an independent electrical heating system;
- 12 kVA corresponds to a big independent house equipped with an independent electrical heating system.

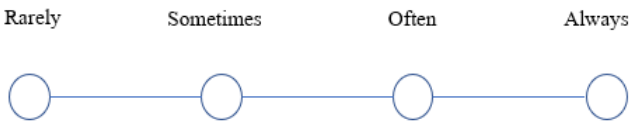
For example, if we consider an annual consumption of 4790 kWh, the three tariffs will be defined as follows:

- Two-part tariff: fixed fee= 56.07€/year and variable component= 0.16 €/kWh. The resulting sum invoiced is equal to 56.07+0.16*4790=822.47€;
- Linear tariff with constant marginal price and without a fixed fee: fixed fee=0 €/year and variable component called as p1= 0.1717€/kWh. The resulting sum invoiced is equal to 0.1717*4790= 822.47€;
- Non-linear tariff: it is composed of two blocks (the first one goes from 0 to 2/3 of the total consumption while the second one covers the remaining consumption). The tariff for the first block is computed as $t1 = 2/3 * p1 = 0.1145$€/kWh and the tariff for the second block is computed as $t2 = (1 + (2/3)) * p1 = 0.286$€/kWh. The resulting sum invoiced is equal to $0.1145 * 3193 + 0.286 * 1597 = 822.47$€.

In this stage, several pro-environmental behaviors are proposed. For each behaviour we also specify the maximum consumption reduction potential, in terms of percentage as compared to the total consumption.

Each participant has to say whether he already adopts such behaviors or not. If so, he is asked to state the frequency with which he adopts them and, then, he is asked whether he is willing to engage more strongly or not. In all other cases, each participant is asked to state to what extent he intends to engage in such pro-environmental behaviors. For this purpose, we decided to use a non-comparative Itemized Rating Scale. For the sake of completeness, we highlight that we use a 4-points unbalanced frequency scale, as shown in the following figure.

Figure 6.3: Itemized Rating Scale



The proposed behaviors for saving water are the following ones:

1. I do not leave the water running for rinsing when washing dishes by hand or I do not keep the water running while brushing my teeth;
2. In the shower, I turn off the water while soaping up or, if I don't have a shower, I decide to reduce by one the number of baths;
3. I decide to use water-efficient showerheads and flow tap aerators and regulators;

The proposed behaviors for saving energy are the following ones:

1. I decide to lower the thermostat of two degrees or I defrost the fridge and the freezer;
2. I do not leave my appliances in stand-by mode so I switch them off when I do not use them;
3. I decide to buy energy-saving light-bulbs rather than incandescent light bulbs.

As you might notice, we created three groups for both water saving end energy saving behaviors. Within each group, behaviors have approximately the same consumption reduction potential.

It is necessary to highlight that the last groups are slightly different from the other ones because, theoretically, the participants are expected to spend a small amount of money to buy devices that allows for energy and water savings. Therefore, for these behaviors, the scale is designed in such a way as to understand whether or not the participant is willing to buy, for example, flow tap aerators for all the taps in the house or to buy energy saving light bulbs for all the lamps and chandeliers.

Stage IV: Choice of the tariffs that minimize the total energy and water bills

Based on the answers given in the previous phase, the total potential consumption reduction is computed for both water and electricity. It is important to say that we compute the total potential consumption reduction as the sum of the potential consumption reduction associated with each of the groups of behaviours. Moreover, for each participant, the potential consumption reduction associated with each group depends on the frequency of adoption of the different behaviors.

It is important to stress that, at this stage, we assume that all the participants adopt the proposed pro-environmental behaviors.

We therefore notify the participants about either their total estimated consumption and their total consumption reduction potential; then, we propose them the same six tariff choices that we

already presented in the second stage. In this phase, however, participants are not simply asked to choose among tariffs. In fact, they are asked to select the tariffs that minimizes the water and the energy bill. For each correct answer, the participant receives a reward of 1 €and, for each wrong answer, he will not receive such reward.

In order to identify the correct answer, the participant has to compute the bill on the basis of the new consumption level, which takes into account the usage reduction resulting from the adoption of the pro-environmental behaviors. Let's consider the following example:

- estimated total water consumption level of 57m3;
- total consumption reduction potential of 10%;
- Two-part tariff with a fixed fee equal to 22.64 €/year and variable component equal to 3.81 €/m3;
- Linear tariff with fixed fee=0 €/year and variable component equal to 4.20 €/m3;
- Non-linear tariff where the tariff for the first block, that goes from 0 m3 to 38 m3 , is t1=2.804 €/m3 and the tariff for the second block, that goes from 38 m3 onwards, is t2=7.01 €/m3.

In this case, the new water consumption level is equal to 0.9*57=51.3 m3 and the bill amounts, computed under the three different pricing schemes, are the following ones:

- $Bill_{Two-parttariff}$ = 218.093 €;
- $Bill_{Lineartariff}$ = 215.46€;
- $Bill_{Nonlineartariff}$ =199.652€.

As you might notice, $Bill_{Nonlineartariff} < Bill_{Lineartariff} < Bill_{Two-parttariff}$. The same ranking also applies to the electricity case.

Stage V: Tests on individual's characteristics

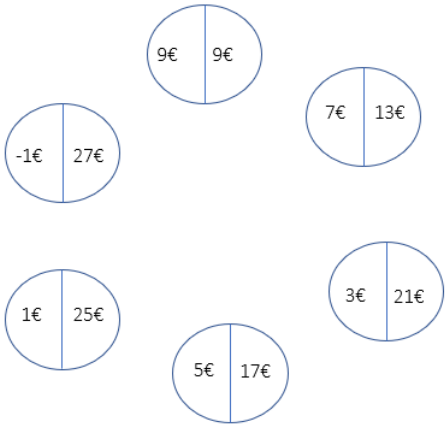
At this stage, we decided to use two tests in order to elicit the following individuals' characteristics:

- The attitude towards risk;
- The rationality.

In order to measure the risk-attitude of participants we use the test suggested by Eckel et al. (2012). The test procedure is designed in the following way:

1. each participant has to choose, among six different gambles, the one that he is willing to play. The six gambles are shown in the following figure:

Figure 6.4: Risk attitude test



Source: Eckel et al (2012)

Each gamble has two possible outcomes: LOW, HIGH. These outcomes have the same probability of occurring. The proposed gambles range from a gamble with a certain outcome equal to 9€to the riskiest gamble which is the one associated with the outcomes -1€, +27€;

2. At the end of the test, a draw takes place and this will determine the realized outcome. If the realized outcome is the HIGH one, the participant earns an additional reward equal to 1€.

Once the participants have completed this step, we propose them the following three-item Cognitive Reflection Test (CRT) in order to assess their rationality.

Figure 6.5: Cognitive Ability Test

(1) A bat and a ball cost 11€ in total. The bat costs 10€ more than the ball.
How much does the ball cost? _____ cents
(2) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take
100 machines to make 100 widgets? _____ minutes
(3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size.
If it takes 48 days for the patch to cover the entire lake, how long would it
take for the patch to cover half of the lake? _____ days

Source: Frederick (2005)

The CRT has been introduced by Frederick (2005) as a "simple measure of one type of cognitive ability—the ability or disposition to reflect on a question and resist reporting the first response that comes to mind". The key idea behind this test is that all the cognitive processes can be broken down into two categories:

- the "System 1" processes. These occur spontaneously and intuitively and thus do not require much attention;
- the "System 2" processes. This type of thinking requires effort, concentration, reasoning and analysis.

As research highlights (Kahneman and Frederick, 2002, Stanovich and West, 2000), both of them have an influence on our behaviour and, therefore, on our decision-making processes. In this context, the CRT is important because, by evaluating people's tendency to override an immediate response and engage in further reflections that lead to the correct answer, it allows to assess the degree of rationality in people's choices (Toplak, West et Stanovich, 2011).

Stage VI: A survey of the motivations underlying tariff choices and pro-environmental behaviour adoption

In this stage we ask participants to answer to a brief survey of the motivations underlying tariff choices and green behaviour adoption. More specifically, we ask people to respond to a series of statements about these topics, in terms of the extent to which they agree with them. For this purpose, we decided to use a Likert-type scale because, as highlighted by Bowling (1997) and by Burns & Grove (1997), it is particularly suitable to measure attitudes or opinions.

For the sake of completeness, we highlight that we use a 5-points symmetric scale that ranges from 1(strongly disagree) to 5(strongly agree).

Participants have to rate how strongly they agree or disagree with each of the following statements:

- I chose the tariff that seems to be easier;
- I chose the tariff that allows me to better forecast my future bills;
- I chose the tariff that allows me to make savings on energy and water bills;
- In everyday life, I seek to cut back on energy usage;
- In everyday life, I seek to cut back on water usage;
- I want to cut back on energy usage because I want to save money on my energy bills;
- I want to cut back on energy usage because I want to avoid energy waste;
- I want to cut back on energy usage because I want to participate in the fight against global warming;
- I want to cut back on water usage because I want to save money on my water bills;
- I want to cut back on water usage because I want to avoid water waste;
- I want to cut back on water usage because I want to participate in the fight against drought;
- When it comes to saving energy, I am willing to accept less comfort and I am willing to change my habits;
- When it comes to saving water, I am willing to accept less comfort and I am willing to change my habits;
- The efforts made must be accompanied by a reduction in the bill amount.

Stage VII: Compensation of research participants

Once the participants have completed the test, they receive the corresponding compensation that includes the following elements:

- A fixed sum, equal to 8 €, paid as a compensation for the participation.
- A variable sum that depends on the answers given during the experiment.

We remind that the compensations are set in such a way as to have an average payment of 15 €/hour.

Annex 1 : Research Participant Consent Form

Formulaire de consentement pour la participation à une expérience en économie

Vous étés invité-e à participer à une étude de recherche sur la tarification de l'électricité et de l'eau. Nous vous remercions de votre participation.

Votre participation est complétement volontaire et vous êtes totalement libre d'arrêter votre participation à n'importe quel moment, sans préavis.

Au cours de cette étude, vos réponses seront collectées de façon confidentielle et anonyme (l'expérimentateur ne pourra faire le lien entre votre identité et vos réponses).

Si vous signez le présent formulaire, vous attestez avoir lu les informations qui précèdent, et que vous acceptez de participer à l'étude.

Nom, Prénom : _____

Date : _____

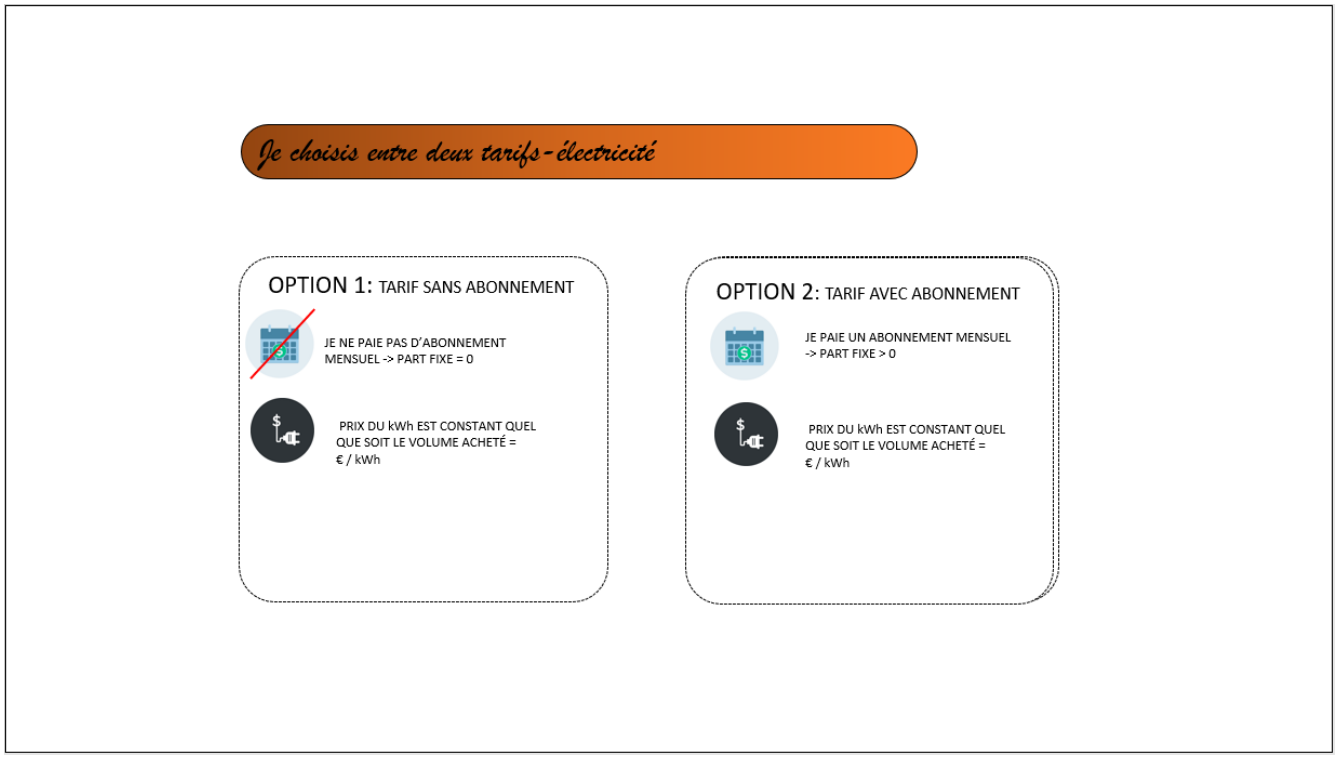
Signature : _____

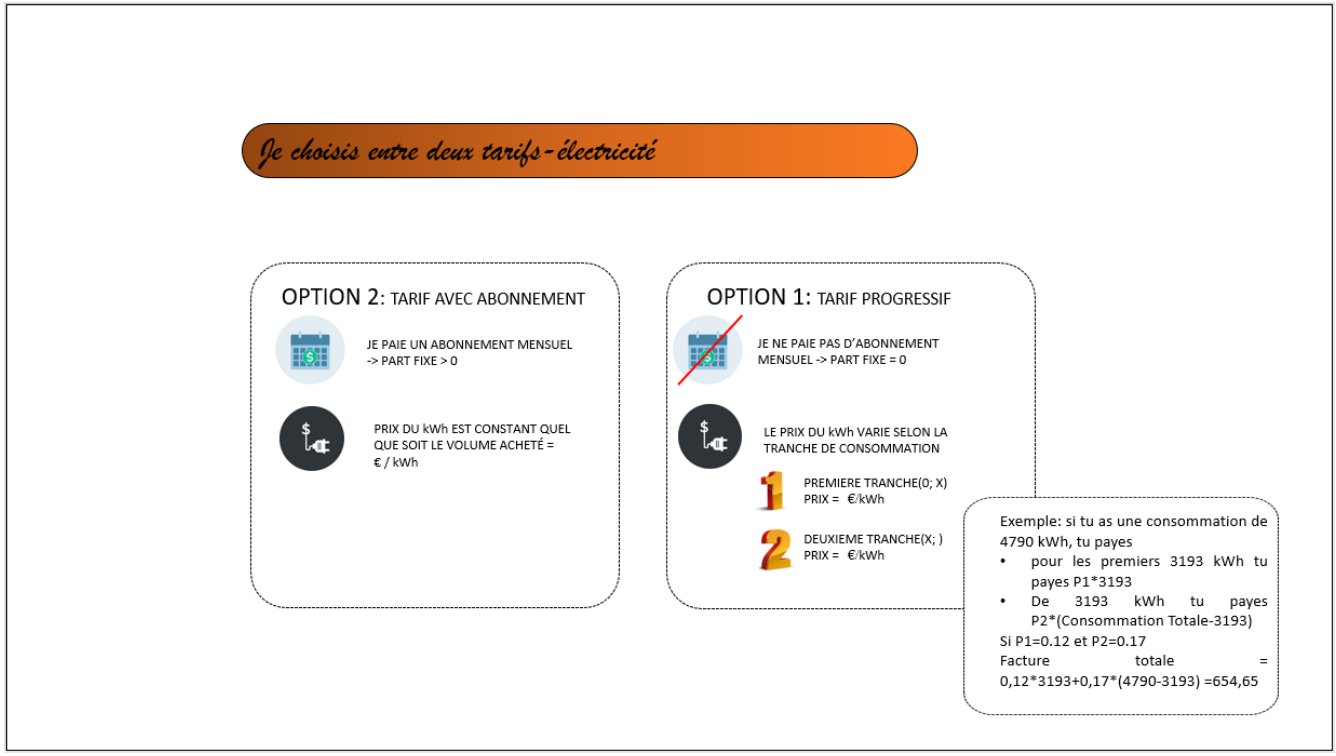
Annex 2: Survey of the motivations underlying tariff choices and pro-environmental behaviour adoption

Pour chacune des questions suivantes veuillez choisir une réponse entre l et 5 selon que ne vous êtes « pas d'accord du tout » ou « tout à fait d'accord ».

	Pas du tout d'accord	Plutôt pas d'accord	Ni en accord ni en désaccord	Plutôt d'accord	Tout à fait d'accord
1 Comment expliquez-vous vos choix de tarif :					
Celui qui vous semble le plus simple	1	2	3	4	5
Celui qui est le plus prévisible	1	2	3	4	5
Celui qui permet de faire des économies de facture…	1	2	3	4	5
2 Au quotidien, vous cherchez à réduire votre consommation d'électricité	1	2	3	4	5
3 Au quotidien, vous cherchez à réduire votre consommation d'eau	1	2	3	4	5
4 Quelle est votre motivation pour réduire votre consommation d'électricité :					
Réduire votre facture	1	2	3	4	5
Eviter le gaspillage	1	2	3	4	5
Participer à la lutte contre le réchauffement climatique	1	2	3	4	5
Autre…	1	2	3	4	5
5 Quelle est votre motivation pour réduire votre consommation d'eau					
Réduire votre facture	1	2	3	4	5
Eviter le gaspillage	1	2	3	4	5
Participer à la lutte contre la sécheresse	1	2	3	4	5
Autre…	1	2	3	4	5
6 Vous êtes prêts à accepter une baisse de confort ou un changement d'habitude pour réduire votre consommation d'eau	1	2	3	4	5
7 Vous êtes prêts à accepter une baisse de confort ou un changement d'habitude pour réduire votre consommation d'électricité	1	2	3	4	5
8 Votre effort doit se traduire par une économie sur votre facture	1	2	3	4	5

Annex 3: Graphical interface of Stage II Tariffs Choices





Je choisis entre deux tarifs - électricité

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

LE PRIX DU KWH VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIERE TRANCHE(0; X)
PRIX = €/kWh

2 DEUXIEME TRANCHE(X;)
PRIX = €/kWh

Exemple: si tu as une consommation de 4790 kWh, tu payes

- pour les premiers 3193 kWh tu payes P1*3193
- De 3193 kWh tu payes P2*(Consommation Totale-3193)

Si P1=0.12 et P2=0.17
Facture totale = 0,12*3193+0,17*(4790-3193) =654,65
Si P1=0.12 et P2=0.17
Facture totale = 0,12*3193+0,17*(4790-3193) =654,65

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

PRIX DU KWH EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / kWh

Je choisis entre deux tarifs - Eau

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

OPTION 2: TARIF AVEC ABONNEMENT

JE PAIE UN ABONNEMENT MENSUEL -> PART FIXE > 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

Je choisis entre deux tarifs - Eau

OPTION 2: TARIF AVEC ABONNEMENT

JE PAIE UN ABONNEMENT MENSUEL -> PART FIXE > 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE= 0

LE PRIX DU m^3 VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIERE TRANCHE(0; X) PRIX = €/ m^3

2 DEUXIEME TRANCHE(X;) PRIX = €/ m^3

Exemple: si tu as une consommation de 61,469 m^3, tu payes

- pour les premiers 40,979m^3 tu payes P1* 40,979 m^3
- De 40,979 m^3 tu payes P2*(Consommation Totale- 40,979m^3)

Si P1=0,5 et P2=2

Facture totale = 0,5*40,979+2*(61,469-40,979) =61,4695

Je choisis entre deux tarifs - Eau

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE= 0

LE PRIX DU m^3 VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIERE TRANCHE(0; X) PRIX = €/ m^3

2 DEUXIEME TRANCHE(X;) PRIX = €/ m^3

Exemple: si tu as une consommation de 61,469 m^3,

- pour les premiers 40,979m^3 tu payes P1* 40,979 m^3
- De 40,979 m^3 tu payes P2*(Consommation Totale- 40,979m^3)

Si P1=0,5 et P2=2

Facture totale = 0,5*40,979+2*(61,469-40,979) =61,4695

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE= 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

Annex 4: Graphical interface of Stage III Sustainable behaviours adoption

Je change de comportement

Il existe des habitudes quotidiennes qui permettent de réduire votre consommation d'eau. Pour chacune des propositions suivantes veuillez indiquer si vous pensez adopter le comportement proposé, ou si c'est déjà votre habitudes, si vous pensez maintenir ce comportement, et avec quel niveau d'engagement (une seule réponse par proposition).

EAU

- JE NE LAISSE PAS COULER L'EAU PENDANT QUE JE FAIS LA VAISSELLE:JE REMPLIS LE BAC DE RINCAGE
- ou JE FERME LE ROBINET PENDANT LE NETTOYAGE DES MAINS, LE BROSSAGE DES DENTS, LE RASAGE

POTENTIEL DE REDUCTION DE CONSOMMATION = MAX 6% (par rapport à la consommation de référence)

- JE COUPE L'EAU DE LA DOUCHE PENDANT QUE JE ME SAVONNE
- SI JE N'AI PAS DE DOUCHE, JE DÉCIDE DE SUPPRIMER UN BAIN PAR SEMAINE.

POTENTIEL DE REDUCTION DE CONSOMMATION = MAX 10% (par rapport à la consommation de référence)

J'UTILISE UN ÉCONOMISEUR D'EAU SUR LE POMMEAU DE DOUCHE ET SUR LES ROBINETS

POTENTIEL DE REDUCTION DE CONSOMMATION = MAX 22% (par rapport à la consommation de référence)

Je change de comportement

Il existe des habitudes quotidiennes qui permettent de réduire votre consommation d'eau. Pour chacune des propositions suivantes veuillez indiquer si vous pensez adopter le comportement proposé, ou si c'est déjà votre habitudes, si vous pensez maintenir ce comportement, et avec quel niveau d'engagement (une seule réponse par proposition). ->

EAU

- JE NE LAISSE PAS COULER L'EAU PENDANT QUE JE FAIS LA VAISSELLE:JE REMPLIS LE BAC DE RINCAGE
- ou JE FERME LE ROBINET PENDANT LE NETTOYAGE DES MAINS, LE BROSSAGE DES DENTS, LE RASAGE

JE LE FESAIS DÉJÀ
JE NE LE FAIS PAS

à quelle fréquence? → De temps en temps / Tout le temps

- JE COUPE L'EAU DE LA DOUCHE PENDANT QUE JE ME SAVONNE
- SI JE N'AI PAS DE DOUCHE, JE DÉCIDE DE SUPPRIMER UN BAIN PAR SEMAINE.

JE LE FESAIS DÉJÀ
JE NE LE FAIS PAS

à quelle fréquence? → De temps en temps / Tout le temps

J'UTILISE UN ÉCONOMISEUR D'EAU SUR LE POMMEAU DE DOUCHE ET SUR LES ROBINETS

JE LE FESAIS DÉJÀ
JE NE LE FAIS PAS

à quelle fréquence? → De temps en temps / Tout le temps

Si JE LE FESAIS DÉJÀ de temps en temps

Je m'engage à le faire Tout le temps

EAU

- JE NE LAISSE PAS COULER L'EAU PENDANT QUE JE FAIS LA VAISSELLE:JE REMPLIS LE BAC DE RINCAGE
- ou JE FERME LE ROBINET PENDANT LE NETTOYAGE DES MAINS, LE BROSSAGE DES DENTS, LE RASAGE

POTENTIEL DE REDUCTION DE CONSOMMATION = MAX 6% (par rapport à la consommation de référence)

OUI NON

- JE COUPE L'EAU DE LA DOUCHE PENDANT QUE JE ME SAVONNE
- SI JE N'AI PAS DE DOUCHE, JE DÉCIDE DE SUPPRIMER UN BAIN PAR SEMAINE.

POTENTIEL DE REDUCTION DE CONSOMMATION = MAX 10% (par rapport à la consommation de référence)

OUI NON

J'UTILISE UN ÉCONOMISEUR D'EAU SUR LE POMMEAU DE DOUCHE ET SUR LES ROBINETS

POTENTIEL DE REDUCTION DE CONSOMMATION = MAX 22% (par rapport à la consommation de référence)

OUI NON

SI JE NE LE FAIS PAS

Pour chacune des propositions suivantes veuillez indiquer si vous pensez adopter le comportement proposé et avec quel niveau d'engagement (une seule réponse par proposition)

- JE NE LAISSE PAS COULER L'EAU PENDANT QUE JE FAIS LA VAISSELLE:JE REMPLIS LE BAC DE RINCAGE
- ou JE FERME LE ROBINET PENDANT LE NETTOYAGE DES MAINS, LE BROSSAGE DES DENTS, LE RASAGE

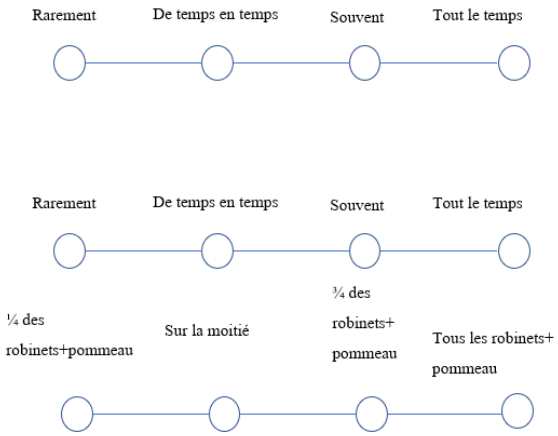
POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 6% (par rapport à la consommation de référence)

- JE COUPE L'EAU DE LA DOUCHE PENDANT QUE JE ME SAVONNE
- SI JE N'AI PAS DE DOUCHE, JE DÉCIDE DE SUPPRIMER UN BAIN PAR SEMAINE.

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 10% (par rapport à la consommation de référence)

J'UTILISE UN ECONOMISEUR D'EAU SUR LE POMMEAU DE DOUCHE ET SUR LES ROBINETS

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 22% (par rapport à la consommation de référence)



Je change de comportement

Il existe des habitudes quotidiennes qui permettent de réduire votre consommation d'eau. Pour chacune des propositions suivantes veuillez indiquer si vous pensez adopter le comportement proposé, ou si c'est déjà votre habitudes, si vous pensez maintenir ce comportement, et avec quel niveau d'engagement (une seule réponse par proposition).

ÉLECTRICITÉ

- JE DÉCIDE DE BAISSER DE 2°C LA TEMPÉRATURE DE CHAUFFAGE DE MES PIÈCES OU JE DÉGIVRE LE FRIGO ET LE CONGÉLATEUR ET JE NETTOYE LA GRILLE ARRIÈRE

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 12% (par rapport à la consommation de référence)

JE DÉCIDE DE NE PAS LAISSER LES APPAREILS EN VEILLE ET JE LES ÉTEINS LORSQUE JE NE LES UTILISE PAS

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 10% (par rapport à la consommation de référence)

J'UTILISE DES AMPOULES À BASSE CONSOMMATION PLUTÔT QUE DES AMPOULES À INCANDESCENCE CLASSIQUE

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 4% (par rapport à la consommation de référence)

Je change de comportement

Il existe des habitudes quotidiennes qui permettent de réduire votre consommation d'eau. Pour chacune des propositions suivantes veuillez indiquer si vous pensez adopter le comportement proposé, ou si c'est déjà votre habitudes, si vous pensez maintenir ce comportement, et avec quel niveau d'engagement (une seule réponse par proposition).

ÉLECTRICITÉ

- JE DÉCIDE DE BAISSER DE 2°C LA TEMPÉRATURE DE CHAUFFAGE DE MES PIÈCES OU JE DÉGIVRE LE FRIGO ET LE CONGÉLATEUR ET JE NETTOYE LA GRILLE ARRIÈRE

JE LE FESAIS DÉJÀ
JE NE LE FAIS PAS

à quelle fréquence? → De temps en temps / Tout le temps

JE DÉCIDE DE NE PAS LAISSER LES APPAREILS EN VEILLE ET JE LES ÉTEINS LORSQUE JE NE LES UTILISE PAS

JE LE FESAIS DÉJÀ
JE NE LE FAIS PAS

à quelle fréquence? → De temps en temps / Tout le temps

J'UTILISE DES AMPOULES À BASSE CONSOMMATION PLUTÔT QUE DES AMPOULES À INCANDESCENCE CLASSIQUE

JE LE FESAIS DÉJÀ
JE NE LE FAIS PAS

à quelle fréquence? → De temps en temps / Tout le temps

JE LE FESAIS DÉJÀ de temps en temps

Je m'engage à le faire Tout le temps

ÉLECTRICITÉ

- JE DÉCIDE DE BAISSER DE 2°C LA TEMPÉRATURE DE CHAUFFAGE DE MES PIÈCES OU JE DÉGIVRE LE FRIGO ET LE CONGÉLATEUR ET JE NETTOYE LA GRILLE ARRIÈRE

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 12% (par rapport à la consommation de référence)

OUI NON

JE DÉCIDE DE NE PAS LAISSER LES APPAREILS EN VEILLE ET JE LES ÉTEINS LORSQUE JE NE LES UTILISE PAS

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 10% (par rapport à la consommation de référence)

OUI NON

J'UTILISE DES AMPOULES À BASSE CONSOMMATION PLUTÔT QUE DES AMPOULES À INCANDESCENCE CLASSIQUE

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 4% (par rapport à la consommation de référence)

OUI NON

SI JE NE LE FAIS PAS

Pour chacune des propositions suivantes veuillez indiquer si vous pensez adopter le comportement proposé et avec quel niveau d'engagement (une seule réponse par proposition)

ÉLECTRICITÉ

- JE DÉCIDE DE BAISSER DE 2°C LA TEMPÉRATURE DE CHAUFFAGE DE MES PIÈCES OU JE DÉGIVRE LE FRIGO ET LE CONGÉLATEUR ET JE NETTOYE LA GRILLE ARRIÈRE

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 12%

Rarement De temps en temps Souvent Tout le temps

JE DÉCIDE DE NE PAS LAISSER LES APPAREILS EN VEILLE ET JE LES ÉTEINS LORSQUE JE NE LES UTILISE PAS

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 10%

Rarement De temps en temps Souvent Tout le temps

J'UTILISE DES AMPOULES À BASSE CONSOMMATION PLUTÔT QUE DES AMPOULES À INCANDESCENCE CLASSIQUE

POTENTIEL DE RÉDUCTION DE CONSOMMATION = MAX 4%

¼ des ampoules Sur la moitié ¾ des ampoules Toutes les ampoules

Annex 5: Graphical interface of Stage IV Tariff Choices

Phase 3

SUR LA BASE DU QUESTIONNAIRE NOUS AVONS ÉVALUÉ VOTRE CONSOMMATION DE RÉFÉRENCE À :

kWh

m^3

Supposons que vos comportements de consommation sont ceux que vous avez annoncez précédemment. Dans ce cas, vos consommations d'électricité et d'eau baisseront selon les proportions suivantes :

% SUR LA CONSOMMATION DE REFERENCE D'ELECTRICITE

% SUR LA CONSOMMATION DE REFERENCE D'EAU

Partant de cette situation, nous allons vous proposer des couples de tarifs. L'un des deux tarifs proposés est plus avantageux pour vous.

Si vous choisissez le tarif avantageux vous recevrez une prime d'un € +1€

Si vous choisissez le tarif le moins avantageux vous n'avez pas de prime. +0€

Je choisis entre deux tarifs - électricité

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

PRIX DU kWh EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / kWh

OPTION 2: TARIF AVEC ABONNEMENT

JE PAIE UN ABONNEMENT MENSUEL -> PART FIXE > 0

PRIX DU kWh EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / kWh

Rappels :

kWh

% d'économies possibles

m^3

% d'économies possibles

Je choisis entre deux tarifs-électricité

OPTION 2: TARIF AVEC ABONNEMENT

JE PAIE UN ABONNEMENT MENSUEL -> PART FIXE > 0

PRIX DU kWh EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / kWh

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

LE PRIX DU kWh VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIÈRE TRANCHE(0; X) PRIX = €/kWh

2 DEUXIÈME TRANCHE(X;) PRIX = €/kWh

Exemple: si tu as une consommation de 4790 kWh, tu payes

- pour les premiers 3193 kWh tu payes P1*3193
- De 3193 kWh tu payes P2*(Consommation Totale-3193)

Si P1=0.12 et P2=0.17
Facture totale = 0,12*3193+0,17*(4790-3193) =654,65
Si P1=0.12 et P2=0.17
Facture totale = 0,12*3193+0,17*(4790-3193) =654,65

Rappels :

kWh

% d'économies possibles

m^3

% d'économies possibles

Je choisis entre deux tarifs-électricité

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

LE PRIX DU kWh VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIERE TRANCHE(0; X) PRIX = €/kWh

2 DEUXIEME TRANCHE(X;) PRIX = €/kWh

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

PRIX DU kWh EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / kWh

Exemple: si tu as une consommation de 4790 kWh,

- pour les premiers 3193 kWh tu payes P1*3193
- De 3193 kWh tu payes P2*(Consommation Totale-3193)

Si P1=0.12 et P2=0.17
Facture totale = 0,12*3193+0,17*(4790-3193) =654,65
Si P1=0.12 et P2=0.17
Facture totale = 0,12*3193+0,17*(4790-3193) =654,65

Rappels :

kWh

% d'économies possibles

m^3

% d'économies possibles

Je choisis entre deux tarifs - Eau

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE = 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

OPTION 2: TARIF AVEC ABONNEMENT

JE PAIE UN ABONNEMENT MENSUEL -> PART FIXE > 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

Rappels :

kWh

% d'économies possibles

m^3

% d'économies possibles

Je choisis entre deux tarifs - Eau

OPTION 2: TARIF AVEC ABONNEMENT

JE PAIE UN ABONNEMENT MENSUEL -> PART FIXE > 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE= 0

LE PRIX DU m^3 VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIÈRE TRANCHE(0; X) PRIX = € / m^3

2 DEUXIÈME TRANCHE(X;) PRIX = € / m^3

Exemple: si tu as une consommation de 61,469 m^3,

- pour les premiers 40,979m^3 tu payes P1* 40,979 m^3
- De 40,979 m^3 tu payes P2*(Consommation Totale- 40,979m^3)

Si P1=0,5 et P2=2

Facture totale = 0,5*40,979+2*(61,469-40,979) =61,4695

Rappels :

kWh

% d'économies possibles

m^3

% d'économies possibles

Je choisis entre deux tarifs - Eau

OPTION 1: TARIF PROGRESSIF

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE= 0

LE PRIX DU m^3 VARIE SELON LA TRANCHE DE CONSOMMATION

1 PREMIÈRE TRANCHE(0; X)
PRIX = €/ m^3

2 DEUXIÈME TRANCHE(X;)
PRIX = €/ m^3

Exemple: si tu as une consommation de 61,469 m^3,

- pour les premiers 40,979m^3 tu payes P1* 40,979 m^3
- De 40,979 m^3 tu payes P2*(Consommation Totale-40,979m^3)

Si P1=0,5 et P2=2

Facture totale = 0,5*40,979+2*(61,469-40,979) =61,4695

OPTION 1: TARIF SANS ABONNEMENT

JE NE PAIE PAS D'ABONNEMENT MENSUEL -> PART FIXE= 0

LE PRIX DU m^3 EST CONSTANT QUEL QUE SOIT LE VOLUME ACHETÉ = € / m^3

Rappels :

kWh

% d'économies possibles

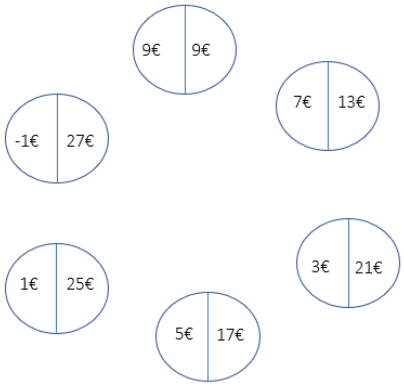
m^3

% d'économies possibles

Annex 6: Graphical interface of Stage V Tests

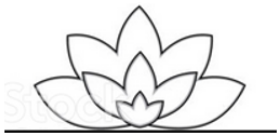
Choix de loterie

Je choisis une loterie parmi les 6 loteries proposées



VOUS DEVEZ CHOISIR UNE LOTERIE PARMI LES 6 LOTERIES PROPOSÉES. CHAQUE LOTERIE A DEUX RÉSULTATS POSSIBLES QUI ONT AUTANT DE CHANCE D' ÊTRE TIREÉS AU SORT (COMME DANS UN JEU DE PILE OU FACE). POUR LA LOTERIE QUE VOUS AVEZ CHOISIE, UN TIRAGE AU SORT SERA RÉALISÉ. LE GAIN OBTENU SERA AJOUTÉ À VOTRE GRATIFICATION POUR CETTE SÉANCE.

Le lac



DANS UN LAC IL Y A UNE ÉTENDUE DE NÉNUPHARS. CHAQUE JOUR, L' ÉTENDUE DE NÉNUPHARS DOUBLE SA SURFACE. IL FAUT 48 JOURS POUR QUE TOUT LE LAC SOIT RECOUVERT DE NÉNUPHARS. COMBIEN DE JOURS FAUT-IL POUR QUE L' ÉTENDUE DE NÉNUPHARS RECOUVRE LA MOITIÉ DU LAC?

La raquette et la balle

UNE RAQUETTE DE TENNIS ET UNE BALLE COUTENT 11 € AU TOTAL. LA RAQUETTE COUTE 10 € DE PLUS QUE LA BALLE. COMBIEN COUTE LA BALLE DE TENNIS?

La machine

S'IL FAUT 5 MINUTES AVEC 5 MACHINES POUR PRODUIRE 5 OBJETS, QUEL TEMPS FAUT-IL À 100 MACHINES POUR PRODUIRE 100 OBJETS?

Chapter 7

Conclusion

As we have seen so far, policy makers are increasingly more interested in analysing and understanding customers' behaviour because it provides them the knowledge required to design policies that are really effective.

In this context, behavioural economics gives a great contribution because it allows policy makers to realise that people are not as rational as one might expect. Research has in fact revealed that there are several cognitive biases that influence our decision-making processes and this is the reason why customers' choices (either consumption choices and tariff choices) are often sub-optimal. Since customers' decisions have an impact on the system performance, it is important not to neglect the psychological aspects that lie behind these decisions.

For what concerns tariffs, the experiment that we presented in this thesis can produce important results because it aims at investigating which are the preferences and perceptions that determine the choice of a given pricing scheme. On the basis of the results derived from this study it will be possible to figure out how to design tariffs schemes that are easily understandable, while still being cost-reflective. In fact, we remind that pricing schemes for water and electricity services are not only intended to cover all the costs incurred by the operators to supply the good but they are also used as signals to encourage pro-environmental behaviours. The key findings obtained from this experiment may also be generalised to other sectors, such as the gas one.

As far as prices and pricing schemes are concerned, another aspect that should be taken into account is that these will tend to change, as the sector competition increases, in order to reflect people's preferences. It is therefore possible to conclude that tariffs and tariff structures will also be partially determined by the inherent dynamics of the market.

Chapter 8

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Chapter 9

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