Retail prices in the Italian electricity market

Relatore
Prof. Andrea Ellero

Laureando
Dario Rosati
Matricola 821215

Anno Accademico
20012 / 2013
Tesi di Laurea

Retail prices in the Italian electricity market

Relatore: Prof. Andrea Ellero
Laureando: Dario Rosati
Matricola: 821215
Contents

Introduction 1

1 Electricity market 3
  1.1 Main electricity features 3
  1.2 Functions of electric industry 4
    1.2.1 Production 5
    1.2.2 Transmission 8
    1.2.3 Distribution 11
    1.2.4 Retailing 12
  1.3 Electricity market evolution 12
    1.3.1 Early stage - Monopoly 13
    1.3.2 Liberalization 15
    1.3.3 Single buyer 16
    1.3.4 Wholesale competition 18
    1.3.5 Retail competition 19

2 The Italian electricity market 22
  2.1 Spot Electricity Market (MGP, MSD, MD) 24
    2.1.1 Day-Ahead Market (MGP) 25
    2.1.2 Intra-Day Market (MI) 27
    2.1.3 Ancillary services market (MSD) 27
  2.2 Forward Electricity Market (MTE, CDE) 28
  2.3 Over-the-Counter Registration Platform (PCE) 28
  2.4 Electricity markets around the globe 29
    2.4.1 The Nord Poll Market 29
CONTENTS

3 Retail rate forms 31
  3.1 Elements of rate design .............................................. 33
  3.2 Single part rate forms ................................................. 36
  3.3 Two parts rate forms .................................................. 37
  3.4 Three parts rate forms ................................................. 38

4 Prices in the Italian retail market 40
  4.1 Trends in retail pricing schemes ................................... 40
  4.2 Bill components in Italy .............................................. 41
  4.3 Standard offer rates .................................................. 44
  4.4 Rates available in the Italian retail market ...................... 48
    4.4.1 Price predictability .............................................. 50
    4.4.2 Rate Simplification .............................................. 51
    4.4.3 Discounts on the standard offer rates ......................... 55
    4.4.4 Environmentally friendly options .............................. 58
  4.5 Market evidences ...................................................... 60
    4.5.1 Flat Rates .......................................................... 61
    4.5.2 Time of use rates ................................................ 61

Conclusions 65

Bibliography 68

A Energy demand and consumption 72
List of Figures

1 Consumer price index for electricity (base year 2010=100). Source: [27] 2

1.1 380 kV power lines in Italy. Source: [38, p. 6] . . . . . . . . . . . . . . 9
1.2 220 kV power lines in Italy. Source: [38, p. 7] . . . . . . . . . . . . . . 10
1.3 Monopoly. Source: [25] . . . . . . . . . . . . . . . . . . . . . . . . . . 14
1.4 Single buyer. Source: [25] . . . . . . . . . . . . . . . . . . . . . . . . . 17
1.5 Wholesale competition. Source: [25] . . . . . . . . . . . . . . . . . . . 18
1.6 Retail competition. Source: [25] . . . . . . . . . . . . . . . . . . . . . 21

2.1 Organization of the Electricity Market in Italy. Source: [19] . . . . . . 23
2.2 Organizational chart of the electricity market in Italy. Source: [18] . . 24
2.3 Clearing price for North Italy zone on July 25 at 12 AM. Source: [18] 26
2.4 Bidding from a single player for an hour during Day-ahead market. Source: [29] . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 30

4.1 Electricity prices in € (without vat and taxes) for industrial consumers during the 2nd semester of 2012. Source: [16] . . . . . . . . . . 43
4.2 Duration curve of the required hourly power in 2012 on the italian grid. Source: [38] . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 46
4.3 Variable component in €/mWh of the standard offer rates. Source: [3] 47
4.4 Average €/mWh charged for every all inclusive package in the market divided by utility. Source: [37] [14] [13] . . . . . . . . . . . . . . . . . 52
4.5 Average €/mWh charged for every all inclusive package in the market divided by utility with a 80% consumption. Source: [37] [14] [13] . . 53
4.6 Average €/mWh charged for every all inclusive package in the market divided by utility with a 70% consumption. Source: [37] [14] [13] . . 54
4.7 Average €/mWh charged for every all inclusive package in the market divided by utility with a 110% consumption. Source: [37] [14] [13] . . 55

4.8 Average €/mWh charged for green electricity and normal flat rate offers. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] . . . . . . . . . . . 59

4.9 Average €/mWh charged for green and normal time of use rate offers. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] . . . . . . . . . . . . . . 60

4.10 Average flat rate available in the market vs AEEG flat rate. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] [3] . . . . . . . . . . . . . . . . . 62

4.11 Gap between F1 and F23 charges for time of use rates. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] . . . . . . . . . . . . . . . . . . . . . 63

4.12 Average energy component in a time of use rate charged in the free market vs AEEG time of use rate. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] [3] . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 63

4.13 F1 and F23 charges for every time of use rates in the free market. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] . . . . . . . . . . . . . . 64
List of Tables

1.1 Capacity, efficiency and flexibility of generating plants. Source: [33][41][21][30] .................................................. 8
1.2 CAPEX and OPEX for different generating plants. Source: [33][41][21][30] .................................................. 11
1.3 Electricity consumptions per type of customer in Italy (2010). Source: [3] .................................................. 20
2.1 Summary diagram of the MPE. Source: [19] .................................................. 25
3.1 Rates charged by the AU during the 3rd quarter of 2013. Source: [3] .................................................. 35
4.1 Components of the generic system fees. Source: [3] .................................................. 44
4.2 Expenses distribution for a standard residential customer. Source: [3] .................................................. 45
4.3 customers in the liberalized and standard offer market. Source: [3] .................................................. 48
4.4 Energy provided to residential customers in 2012 divided by company. Source: [3] .................................................. 49
4.5 Distribution of the available rates .................................................. 49
4.6 Validity of the advertised rates .................................................. 50
4.7 Rates with a discount on the AEEG PED. Source: [14][11][26] .................................................. 56
4.8 Annual savings for a residential family with 2700 kWh consumption and a 3kW maximum demand. Source: [14][11][26] .................................................. 57
4.9 Usage profiles. Source: [3] .................................................. 57
A.1 Example. Source: [39] .................................................. 73
Introduction

Nowadays consumers, in most developed countries, are able to choose their electricity supplier and rate: as liberalization and technological evolution has given final users tools and options to control their energy expenses. The ability to understand these opportunities and benefit from them may be important for an Italian user as it allows him to mitigate the burden imposed by electricity prices that, with a steady growth over the last three years, continue to shrink consumer purchasing power (see Figure 1). Understanding the evolution of electricity markets around the globe and the organizational scheme adopted in Italy plays a major role in consumers willingness to embrace change and adjust their habits to benefit from opportunities offered by liberalization. The first part of this work aims to explain the evolutionary path followed in the last century by the industry; the second part focuses on rate formulation and prices in the Italian market with the purpose of giving an insight in today’s electricity market in Italy.

In Chapter 1 we introduce the basic theory about the industry: electricity features, allocation of functions in the system together with a review on organizational schemes proposed for the industry. A review on the fundamentals of the industry (production, transmission, distribution and retailing) is essential in order to understand the forces that shaped the industry as it is today. In Section 1.3 four possible organizational forms (monopoly, single buyer, wholesale and retail competition) are analyzed and then, in Chapter 2 we introduce the Italian market organization explaining how electricity is traded and how the national price - PUN - (*Prezzo Unico Nazionale*) is calculated.

In the second part, Chapter 3 introduces literature on rate formulations and pricing schemes, then in Chapter 4 a range of offers in the Italian retail market are considered with an overview on industry’s trends. Chapter 3, based on the Conkling’s book [9] on *energy pricing*, explains which are the basics tools available for
rate makers and the most frequent rate formulations developed during the history of the industry. In Chapter 4, we analyze a set of offers for residential use in the Italian retail market with the aim of finding schemes and trends in the market: 10 companies for a total of 66 different offers have been analyzed. In Section 4.3, four main characteristics stand out to be the key elements for marketing electricity in Italy: predictable prices, simple rates, discounts on the standard offer rate\(^1\) and environmentally friendly offers. Finally, in Section 4.5, we analyze the average charge for the energy component in the free market compared to the average component in the standard offer one. As we will argue at the end of Chapter 4, prices in the market at the moment are lower than the standard offer rates, so competition seems to produce reliable offers for customers at a relatively low price.

In a few years Italy may be ready to embrace a fully competitive market with the suppression of the standard offer rate if consumers and public opinion will be able to implement a large scale information campaign and gain the trust of consumers.

\(^1\)The standard offer rate is provided by the The Regulatory Authority for Electricity and Gas - AEEG - (Autorità per l’Energia Elettrica e il Gas) with a price set quarterly depending on market conditions and expectations.
Chapter 1

Electricity market

How does electricity work? How is electricity market organized and how are all the different functions in the market allocated? In this first chapter we are going to answer these simple questions by explaining all the traditional functions that form the industry. Given the fact that electricity is a commodity essentially equal around the world: electricity systems in different countries are physically and operationally very similar. The industry is composed by the physical functions of production (generation), system operation, transmission, distribution and the merchant functions of retailing and wholesaling. In this chapter we will see how the market structure evolved from vertical integration towards liberalization explaining how functions inside the market evolved to embrace competition among operators.

1.1 Main electricity features

Every industry structure depends largely on the type of commodity that is traded: although electricity is a very simple commodity, according to Hunt [25], it is important to point out some technical elements before going further ahead.

- *Electricity cannot be stored*: storage technologies have been improving since batteries have been introduced but, until today, it is not economically sustainable to store electricity from periods of low demand until peak periods. Electricity needs to be generated when it is needed; this important characteristic implies that, during the day, production needs to constantly follow demand fluctuations. The variations in demand affect prices volatility: during
low demand periods most of the system’s capacity is turned off; plants with higher operating costs are shut down and prices in the market consequently fall. During peak periods, for example during hot summer days when air conditioning is in full use, prices on the market rise rapidly as a consequence of higher demand and operating costs. This feature makes electricity market unique: for example, natural gas industry is organized similarly to electricity industry but natural gas can be stored so price volatility during the day can be controlled.

- *Electricity takes the path of least resistance:* this means that electricity flows in the transmission network according to the laws of physics. It is not possible to command electricity to go from a point to another in a grid: customers get the electricity that is flowing in the network at the time. Transmission management consist in arranging inflow of generation and configuring the network so that electricity flows to the customer who wants it. The balance in the network can easily be compromised by the addition of new lines: capacity may fall due to losses of electricity in the network.

- *Transmission network is very sensitive to changes:* the network is kept in balance through a complex system of physical interactions; so what happens in a place can affect the reliability of the system far away. For this reason, in order to maintain the system balanced, it is important to establish a network able to respond rapidly to external shocks on demand or production.

- *Frequency of the network has to remain stable:* should it fail, sophisticated appliances could fail and, in the long run, this could lead to blackouts. Since electricity travels at the speed of light, it is necessary to constantly match supply and demand to maintain frequency of work.

### 1.2 Functions of electric industry

Functions in the industry can be divided in physical and merchant: physical are those connected to generation and distribution; merchant are those connected with retailing electricity to customers. In this paragraph we will investigate both functions focusing on aspects that will be key elements in the definition of costs and prices of
electricity.

1.2.1 Production

Production is the main function involved in the electric system: generating electricity is a complex task and can derive from a variety of sources. Electricity is usually generated at a power station fuelled by chemical combustion or nuclear fission but also by other means such as energy of flowing water and wind. Electricity can also be generated by solar photovoltaic and geothermal power. As Hunt points out [25]: Generating from a source or another has an impact on efficiency, costs and productivity of the generating plant. We might be inclined to think that economies of scale plays a major role in the electricity generation process: bigger plants requiring bigger investment can produce cheapest energy; that was true until 1980 when combined cycle gas turbines (CCGTs) were introduced. Until the ’80s production derived in major part from fuel burning: cheapest plants to build were also less efficient so they tended to have higher variable costs while bigger plants used to benefit from economies of scale. CCGTs plants use natural gas as a fuel; they are today the technology of choice since they are: smaller, cheaper, more flexible and productive than previous plants. The introduction of CCGTs changed the industry and allowed competition in generation by lowering barriers to enter the market: independent producers were able to compete and sell their energy independently to retailers or directly to customers (see Hunt [24]).

Nowadays we are living an important revolution in energy production: wind power, photovoltaic, solar thermal power and tidal wave power - the green energy sources - are becoming an important source of generation in the electricity market. The transition towards these sources of clean energy will increase the need for flexibility in load management: renewable resources (e.g. wind power) are not available consistently over short time periods; this will increase the demand for instantly available capacity to compensate fluctuations in wind generation.

We are now going to give a brief description of different generating plants highlighting their characteristics:

- *Thermal power station:* in this generating plant the main source of movement is steam. Combustion is generated from different fuels used to heat water: nuclear power, carbon, natural gas, solid biomasses, wastes. Then energy
deriving from steam is converted into mechanical energy and, finally, into 
electricity. Therefore this type of plant is very flexible and can provide capacity 
from 200 kW to 1-2 GW with efficiency\(^1\) varying from 15% to 45% (see [33]) 
depending on the technology in use. Flexibility is not the main characteristic 
of thermal power stations because these plants may require a few hours to go 
into operation and provide the amount of energy required.

- **Gas turbine plants**: energy is produced through combustion, a compressor 
  linked to a combustion chamber pushes compressed air through a turbine where 
electricity is generated. Capacity can vary from 30 kW to 300 MW with 
efficiency between 30% and 40%. The use of these plants can be prearranged 
with short notice since they can reach peak load in few minutes.

- **CCGTs**: this technology, combining gas turbine together with steam turbine, 
  minimize wastes and reaches up to 60% efficiency. Plants capacity can vary 
  from 10 MW up to 400 MW with high flexibility in load control and possible 
  co-generation of heat and electricity.

- **Alternative methods**: these very flexible methods are based on traction motors 
  run by different fuels (e.g. mineral oil, natural gas and biofuels) producing up 
  to 20 MW with up to about 50% efficiency.

- **Wind**: wind turbines converts kinetic wind energy into electricity. Depending 
  on turbines, capacity can vary from 10 kW up to 5 MW, with different costs 
  depending on the location on-shore or off-shore (see Table 1.2). Betz’ law 
  is adopted in order to calculate the efficiency of the eolic plant; even if eolic 
  systems can reach a 59.3 maximum efficiency percentage, a 40 - 50% efficiency 
  is considered optimal.

- **Solar**: photovoltaic systems use solar panels to convert sunlight into electric-
  ity. Capacity depends on the size of the plant and can vary from few kW 
  (domestic use) up to MWs. Energy cost for photovoltaic is very high at the 
  moment, so governments tend to subsidize this industry to support technolog-
  ical development and decrease prices in the long term. The maximum level of

\(^1\)Energy conversion efficiency is the ratio between the useful output of an energy conversion 
machine and the input. In our case the “useful output” is electricity.
efficiency has been reached with concentrated solar panel technology mounted on solar tracking systems. Since solar systems for domestic use are cheaper than their efficiency range can vary from 10% up to 15% depending on the used materials.

- **Hydro electricity** is generated from hydro power: the most common and developed source of renewable energy accounts for 16% - 17% of total energy production in the world. Water simply flows into a turbine that generates electricity. This type of plant is characterized by low operating costs and considerable economies of scale: bigger plants can provide higher capacity lowering capital expenditure per MWh produced. Usually 65% - 75% of the capital expenditure is associated with civil engineering, 15% - 20% is associated with site development and environmental studies and the residual percentage is associated with turbines costs. It is difficult to quantify CAPEX\(^2\) for hydro electric power plants; these plants are cheaper than nuclear thermal power stations but still more expensive than CCGTs (see \[21\] \[30\]). Considering their low operating costs these plants (see Table 1.2) are the technology of choice for base load supply but their overall presence in the national energy mix is constrained by environmental issues and availability of flowing water.

It is important to understand differences in generation plants: Table 1.1 is a quick reference for non expert readers to the main features of the above listed generating plants.

In Table 1.2 we summarize different electricity sources and their costs: CAPEX indicates capital expenditure associated with the installation of the plant, OPEX indicates operating expenditures associated with the generation of electricity by the plant. Table 1.2 supports what previously said: electricity generated through thermal power stations and CCGTs is the cheapest; carbon and nuclear thermal stations will be the preferred source for base load\(^3\) and CCGTs will provide peak load electricity and a minor slice of the base load (capacity for CCGTs is constrained).

\(^{2}\)Capital Expenditure is the expenditure associated with the creation of fixed assets.

\(^{3}\)Electricity consumptions stable during the day; usually derived from household electrical appliances and industrial equipment running all the day long.
### Table 1.1: Capacity, efficiency and flexibility of generating plants. Source: [33] [41] [21] [30]

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity</th>
<th>Efficiency (%)</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal power</td>
<td>200 kW - 2 Gw</td>
<td>15 - 45</td>
<td>Low</td>
</tr>
<tr>
<td>Gas Turbine</td>
<td>30 kW - 300 MW</td>
<td>30 - 40</td>
<td>High</td>
</tr>
<tr>
<td>CCGTs</td>
<td>10MW - 400MW</td>
<td>up to 61</td>
<td>High</td>
</tr>
<tr>
<td>Alternative methods</td>
<td>up to 20 MW</td>
<td>up to 49</td>
<td>High</td>
</tr>
<tr>
<td>Wind</td>
<td>10 kw - 5 MW</td>
<td>40 - 50</td>
<td>Low</td>
</tr>
<tr>
<td>Solar</td>
<td>up to 250 MW</td>
<td>10 - 15</td>
<td>Low</td>
</tr>
<tr>
<td>Hydro</td>
<td>up to 20 Gw</td>
<td>up to 90%</td>
<td>High</td>
</tr>
</tbody>
</table>

1.2.2 Transmission

Electricity is transported over a network, placed underground or on towers, of copper and aluminium wires around the country. Transmission management in Italy is provided by Terna S.p.A. (see [38]) which controls high and medium voltage lines to carry electricity from generation plants to final consumer areas. Transmission management is a natural monopoly: from the economical and environmental point of view there is no point in building two different coexisting systems. Terna is responsible for both the development of the transmission system and for management of system operation: a delicate task that coordinates generation with consumption in the entire system. The system operator has the extremely important task to keep the whole system balanced avoiding congestions and, as a consequence, system overloads.

Figure 1.1 shows the Italian high voltage wire system: this system, together with medium voltage lines (Figure 1.2) is the backbone of the Italian power grid. The purpose of this system is to connect every power source to the grid integrating in the system enough capacity to satisfy demand and allowing energy produced to be allocated by system operator in the most efficient way. It is Terna’s duty to provide access to the system to every producer but, nowadays, this is a challenging task: the development of the green economy with a raising number of new plants built by
Figure 1.1: 380 kV power lines in Italy.
Source: [38, p. 6]
Figure 1.2: 220 kV power lines in Italy.

Source: [38, p. 7]


<table>
<thead>
<tr>
<th>Name</th>
<th>Fuel</th>
<th>CAPEX (€/MWh)</th>
<th>OPEX (€/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Power</td>
<td>Carbon</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Nuclear</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>Turbo Gas</td>
<td>Natural Gas</td>
<td>27</td>
<td>69</td>
</tr>
<tr>
<td>CCGTs</td>
<td>Natural Gas</td>
<td>8</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Carbon</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Wind</td>
<td>On-shore</td>
<td>46</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Off-shore</td>
<td>58</td>
<td>95</td>
</tr>
<tr>
<td>Solar</td>
<td>Sun</td>
<td>344</td>
<td>80</td>
</tr>
<tr>
<td>Hydro</td>
<td>Water</td>
<td>NA</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1.2: CAPEX and OPEX for different generating plants. Source: [33] [41] [21] [30]

Local communities with no national plan lead to problems in providing access to the grid within reasonable time.

1.2.3 Distribution

Electricity distribution consists in converting electricity from high-voltage to low-voltage and dispatching it into the local grid. This stage of the system is, together with generation, the phase that accounts for the major part of utility’s costs: wiring every customer and providing basic customer care services is expensive. Someone can argue that transmission and distribution are basically the same thing except for the voltage; this is partially true but there is a considerable difference between these two systems: transmission is usually a networked system, so electricity flows can reverse, instead distribution is a radial system and usually electricity flows in one way only. With the development of the grid the gap between these two definitions is narrowing: for example, in big cities transmission wires are integrated in the local distribution system to support the load required by metropolis.
1.2.4 Retailing

Retailing was part of the distributor’s tasks but today, after liberalization, is an independent part of the system, in fact, non-physical tasks are associated with it: procuring energy, pricing, selling to the final customer, billing and collecting payments. Since the 1990s practices in metering consumptions, pricing and billing evolved towards real time pricing with the aim of rewarding intelligent consumption and smoothing peak loads. Retailing electricity is considered by many authors a non profitable activity as Hunt [25] said:

“...retailing electricity is not a particularly profitable business. Retailing in other products generally is much more complicated than just reselling the product, but that is most of what it is about in electricity. If customers believe they are getting better electricity, or, more reliable service, they are misinformed. Electricity is just a commodity. It is exactly the same everywhere.”

After liberalization, electricity retailing evolved from a simple billing process to a complex task: defining pricing structures and metering consumptions is the core of competition in retailing nowadays. Since electricity is the same for every retailer and in liberalized markets prices for energy are set equally for everyone; retailer’s task is to create a pricing structure capable of providing profits and solidity to the retailer. Electricity retailers have to rely on marketing and customer services to provide perception of a different product to the customers because electricity flows indistinctly on the grid: what the single customer gets it is not what his retailer produced. For example some retailers offer 100% green energy packages for an higher price: this does not mean that the energy that lights up your living room is made by renewable resources it is simply a commitment from the retailer to buy or produce green energy in an amount at least equal to your share of consumption.

1.3 Electricity market evolution

We will now investigate the organization of the industry that evolved from vertical integration towards liberalization. Electricity industry started at the end of the 19th century when local suppliers produced electricity for consumers near the production site, public illumination and transportation. During the years and after the first
world war the electricity industry evolved in a more sophisticated network: transmission and distribution evolved starting to shape the industry like we explained in the previous paragraph. In order to develop the industry governments got involved in many ways in the industry: in Europe nationalization of the transmission and distribution systems became the most common way of acting after world war II. In 1946 in France and 1948 in the UK governments nationalized the industry in order to take control of the investments with the aim of providing the necessary service much needed for growth. In Italy nationalization arrived fifteen years after: in 1962 ENEL (Ente Nazionale Energia Elettrica), the energy society totally controlled by the Italian government, was established with the nationalization of existing firms in the industry. It is during late 1990s that, in order to adopt the european directive 96/92/CE, electricity market is liberalized: Decreto Legislativo 16 marzo 1999, n. 79 4 (the so called “decreto Bersani”) provided the foundations for a gradual liberalization of the electricity market. Today the market is in a developed stage of liberalization with competition in place and open access for customers to different suppliers.

In the next sections we are going to present four different organizational models for the industry: monopoly, single buyer, wholesale and retail competition and, in chapter 2 we will give an extensive overview of the Italian organization of the market.

1.3.1 Early stage - Monopoly

Since 1878, when electricity was commercialized for the first time, industry have been characterized by the presence of local monopolies controlled by vertically integrated companies. Production, transmission, distribution and retailing activities were exploited by a single company within a service area. Monopoly is usually created by imposing a supplier to customers rather than prohibiting independent generation since self-generation may be allowed for own use in a factory. The existence of a natural monopoly in the distribution and transmission market is not enough to require vertical integration; as Hunt [25] argues there have been three other reasons for vertical integration and monopoly in the industry:

- The complexity that the system operator had to face to coordinate generation

4Legislative Decree n. 79 issued on March 16th 1999.
CHAPTER 1. ELECTRICITY MARKET

and transmission, required vertical integration in order to control both sides of the system.

- The long-term planning of generation and transmission benefitted from coordination and single vision.

- Before the introduction of CCGTs economies of scale played an important role in generation; bigger plants produced cheaper electricity so vertical integration was the most efficient way to build generation plants with high capacity and low variable costs.

![Figure 1.3: Monopoly.](image)

Source: [25]

By lowering transaction costs involved in liberalization, technological development slowly made these three elements disappear and, nowadays they do not persist any longer. According to Getachew [20] until the next technological revolution (e.g. CCGTs) only the presence of natural monopolies in transmission and distribution is still in place creating the need for regulation. Local monopolies may still exist but with the liberalization and the development of the transmission network, we can expect a progressive spread of the benefits introduced by deregulation also in remote areas with low demand and transmission capacity constraints. The overall performance of the vertically integrated system needs to be assessed case by case.
depending on the geographic area: different systems may be well served and efficient under a monopoly. The performance of the monopolist depends on market conditions and on the type of regulation adopted by the government: creating an independent authority setting the rules is a common choice; what makes the difference is the type of regulation adopted. For example in the U.S. a rate of return regulation was adopted: setting prices in advance for the next year, companies were allowed to earn a reasonable rate of return on their assets in addition to recovery of expenses; variations from that goal deriving from efficiency/inefficiency were risk of the company. In the UK a different approach was implemented: in order to promote innovation and efficiency, prices were set and allowed to raise yearly following the RPI (Retail Price Index) with the deduction of a percentage calculated from the desired increase of efficiency gained by companies. Both these methods worked reducing risk for the utility but, according to Reedmand et Al. [34]:

"Both reduced risk to the utility, making it easy for the utility to raise capital for system assets that increased reliability for customers. In some sense, raising capital became too easy for the regulated utility. [...] This gave utilities incentives to invest in higher amounts of capital than a profit-maximizing firm might have; this phenomenon is known as the AverchJohnson effect [4]."

1.3.2 Liberalization

Liberalization was introduced as a consequence of changes in fundamentals of the industry: after technology lowered transaction costs caused by the three previously described situations, liberalization was set up in order to provide a better service at a lower cost. The major difference with the previous configuration of the industry is risks allocation: under regulation the customers take the most of the risks instead under liberalization the risk is mostly up to companies in the market. According to Hunt [25] It is possible to identify four relevant risks:

- Market demand and prices volatility
- Technological innovation inducing obsolescence of existing plants
- Management decisions about maintenance, manning, and investment
In a monopoly customers have to face these four risks instead in a liberalized market customers have to take only the risk involved in prices volatility. Market structure evolved towards liberalization with the disintegration of vertically integrated companies; we will see that the transition towards liberalization had to follow a path for progressive liberalization of functions inside the industry. The first step was liberalization of generation with a single buyer acquiring energy from independent producers followed by the liberalization of retail function. System operation, transmission and distribution remains regulated monopolies.

The basic principles of liberalization are: elimination of any possible conflict of interest between competing entities, coordination between competitive entities and the system operator, ensuring that new prices are set in a truly competitive market. Transition from old regime to liberalized market needs to be managed in a careful way; two issues may raise: first, buying out of the old regime may be difficult because, if the owner of the plants is private, it is possible to incur in stranded costs; second, preserving the reliability of the whole system may require a lot of efforts. Stranded costs are determined by a difference between the book value of assets and the market value of assets: in the old regime the value of the assets was strictly related to the regulated price of electricity; since competition may cause variation on prices this may lead to a depreciation of assets determining a difference between book value and market value of the assets. If the owner of the plants is private this question requires some important decision on compensation and on the method of implementation.

1.3.3 Single buyer

The first step required to implement competition in generation was to establish a system capable of providing the same results of command and control when the system operator is separated from the one who is running the generating plants. The new system had to set rules to replicate the traditional set-up of the system operator and also had to provide incentives to obey and produce the amount of energy required. To ensure the reliability of the system an incentive mechanism is necessary: since the system operator doesn’t have the time to negotiate its needs, producers need to know that they will get payed a profitable price if they obey
and produce what they are asked to produce. This system was set up progressively in every country taking the path of liberalization. In the single buyer model only the existing integrated monopolies in any area were allowed to buy energy from the competing generators. This system was the first stage of liberalization as it stimulated private investment in generation. Capacity is usually purchased by the utility with long term contracts with the IPPs at a regulated price set by auctions in order to determine the lowest offering above cost of service. The key element in this model is the duration of the contract: it has to be a long term one in order to lower the risk of the private investor. As Figure 1.4 shows, there are two possible versions of this model: the disaggregated version, popular in Asia (see Lovey [28]), where the buyer doesn’t own any plant and is not involved directly in the distribution management and the integrated version, popular in the U.S., that is an evolution of a pre-existing monopoly where IPPs are added to the generation capacity.

![Figure 1.4: Single buyer.](source)

According to Hunt [25], two major problems raised from the design of IPP contracts: on one hand, long term contracts used to be specific for fuel and type of plant, on the other hand, at the beginning contracts have been made *nondispatchable* (not

---

5 Independent Power Producers.
under the control of the system operator). The first problem causes competition created by technological innovation to be limited by contract standardization; thus translating the risk of technological obsolescence from the IPP to the single buyer. The second problem means that IPPs notify the system operator when they wanted to run causing capacity to be unreliable and not under control of the system operator.

1.3.4 Wholesale competition

The third model we are going to analyze is an evolution of the previous one: in this model the single buyer is substituted with a wholesale marketplace where single wholesaler can buy from IPPs. As we can see in Figure 1.5 distribution companies and large customers are allowed to buy directly from IPPs in a fully competitive generation sector: there is no regulation on prices. The only monopoly held in place is the distribution one, in fact this model allows only big purchaser to choose supplier: small final customers are forced to buy energy from their local distribution company.

![Wholesale competition](image)

Figure 1.5: Wholesale competition.

Source: [25]

This model is an efficient way to organize the sector: even if customers can’t
choose their supplier, efficiency is improved and a fully competitive generation market is in place. This type of organization is an easy and efficient way of implementing liberalization: as we can see in Table 1.3 that reports electricity delivery per type of customer in Italy in 2010, large customers and distribution companies account for most of the consumption instead small customers with a much lower consumption per unit account only for 22% of total consumptions. A system where 78% of the traded commodity is not regulated and where 22% is used by customers under regulated market is a good liberalized environment. Allowing a smaller number of acknowledged customers to enter the free market minimize transaction costs and allows large consumers to benefit from liberalization.

The main problem involved in this model is the definition of the minimum size for customers allowed to purchase directly on the market: the definition of consumer may create boundary problems especially if customers that are allowed to switch ended up paying considerably less for their energy. In theory, since the distribution company is buying large quantities on the market, small customers should be paying a price comparable with the one payed by big customers that have direct access to the market. Another problem in this model is the definition of the contract between distribution company and final consumer: the wholesaler is buying energy on the free market at price which is subject to volatility; instead, the consumer is more interested in a fixed price for energy. As we will see contracts need to mitigate price volatility and cover extra costs that may incur for the retailer (the distribution company in this case). According to Hunt [25], at the beginning of the implementation of this model, normally the market for small customers is still a regulated one, so the best solution for distribution companies is to buy 80-90% of their required capacity via long term contracts and utilize the spot market for the remaining amount. After some years of wholesale liberalization the market will be more efficient and reliable allowing policymaker to de-regulate domestic distribution contracts. In theory, this slow transition will mitigate and prevent hikes in prices for domestic customers.

1.3.5 Retail competition

Finally, in the most evolved model all customers are allowed to choose their supplier: small customers can buy directly from the generator. The complete liberalization
CHAPTER 1. ELECTRICITY MARKET

<table>
<thead>
<tr>
<th>Consumption points</th>
<th>Energy delivered (Gwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>28751947</td>
</tr>
<tr>
<td>% on total</td>
<td>79%</td>
</tr>
<tr>
<td>Non domestic</td>
<td>7830156</td>
</tr>
<tr>
<td>% on total</td>
<td>21%</td>
</tr>
<tr>
<td>Total</td>
<td>36582103</td>
</tr>
</tbody>
</table>

Table 1.3: Electricity consumptions per type of customer in Italy (2010). Source: [3]

of retail market allows the market to be more reactive and liquid allowing many customers to ask retailers for better prices.

The transition from the wholesale model to this fully competitive one requires two major efforts from operators and government:

- With the deregulation of the retail market, prices and consume plans evolved requiring the installation of a smart metering system. Investment in smart-meters enabled the subjects involved to provide and receive information about usage during the day.

- As we have seen in Table 1.3, domestic customers account for 79% of consumption points, meaning that 79% of customers is domestic. A major challenge is to educate those customers to understand the changes in the industry and allow them to benefit from liberalization.

In Figure 1.6 it is clear that this system is complex as well as full of opportunities: for example a customer or a group of organized customers can directly buy the electricity from a local producer or from an environmentally friendly producer⁶. Switching towards a fully competitive retail market involves dealing with different behaviors of customers: on one side, there are customers willing to change their habits to embrace the opportunities provided by competition and, on the other side, there are customers that won’t change their habits and don’t trust new offers fearing, for lack of information, power shortages and unreliable power supply.

⁶In Italy an example could be the ongoing campaign run by altroconsumo called “abbassa la bolletta” to create an ethical purchasing groups for electricity.
Figure 1.6: Retail competition.
Source: [25]
Chapter 2

The Italian electricity market

In Chapter 1 we introduced four organizational models for an electricity market; in this chapter we are going to take a close look at the Italian electricity market. Our goal is to explain how liberalization have been implemented in Italy after the adoption of the European directive 96/92/CE, in 1999. Who are the actors involved in the system? Which are the institutions that constitute the backbone of the system? In what degree retailing competition has been implemented? These are some of the questions we are going to answer in this chapter: initially, explaining the organizational pattern used in Italy and then focusing on the set of institutions required to make the system work. This chapter is based on the documentation provided by the Gestore dei Mercati elettrici, specifically on the “Vademecum of GMEs Electricity Markets” [19].

Figure 2.1 shows the organizational chart of the Italian electricity market; from the figure we can immediately recognize a pattern similar to Figure 1.6: a wholesale competitive market and a mostly open retailing market.

Energy sales from the producer to the customers can be managed through the electricity market or through bilateral transactions registered on a specific Over-The-Counter (OTC) section of the market. Buyers are: wholesalers, exporters, final customers and the acquirente unico (AU) which has the mission of procuring continuous, secure, efficient and reasonably-priced electricity supply for households and small businesses. The AU is the designated supplier for all houses and companies supplied at low voltage with less than 50 employees and a volume of sales up to 10,000,000 €. Every customers satisfying those requirements is supplied at a regulated price by the AU unless he decides to switch to the free market.
The exchanges of electricity take place in the electricity market created by the Gestore dei Mercati Elettrici S.p.A. (GME), a company owned by the Ministry for the Economy and Finance (MEF). The infrastructure created is divided as in Figure 2.2; the main distinction is between spot and forward transactions; we will see how these two branches works and how trading is regulated.

The electricity market consists of: Spot Electricity Market (MPE), Forward Electricity Market with delivery-taking/-making obligation (MTE) and of the platform for physical delivery of financial contracts concluded on IDEX\(^1\) (CDE). In the next sections we will investigate these components of the market and how they succeed in scheduling generation producing a national price of electricity (PUN).

\(^{1}\)Italian Derivatives Energy Exchange
2.1 Spot Electricity Market (MGP, MSD, MD)

The Spot Electricity Market is divided in three submarkets:

- **Mercato del giorno prima (MGP):** the *Day-Ahead Market* is where producers, wholesaler and eligible final customers may buy/sell electricity for the day after.

- **Mercato infragiornaliero (MI):** the *Intra-Day Market* is where all the participants may change the injection/withdrawal schedules determined in the MGP. This market is organized in four sessions: two are kept the day after the MGP closed and the remaining two take place during the day of delivery.

- **Mercato del servizio di dispacciamento (MSD):** the *Ancillary Services Market* is where the transmission manager (Terna S.p.A) procure all the services needed to balance the system. This market is divided into: an ex-ante session where services for congestion relief and reserve capacity are bought for three scheduling substages (MSD1, MSD2, MSD3) and five intraday sessions during which the bids/offers made in the previous ex-ante session are accepted for balancing purposes.

The market is organized in a set of market sessions where bids and offers are received in the “sitting” time determining the market results before the next session. During the sitting market participants express their willingness to buy (or sell) a volume of electricity specifying the maximum quantity and the bottom (or top) price they will accept. It is possible not to specify any purchasing price: if this happens,
the producer/seller is willing to receive/pay independently from the market price. Bids and offers are referred to a specific “offer point” (usually the access point of the generator/consumer) and to a specific hour during the day so that, for every delivery point, there will be a maximum of 24 bids in a day from a single participant. The organizational diagram of the MPE is summarized in Table 2.1, this can clarify to the reader how the market is organized and which is the function of each section.

<table>
<thead>
<tr>
<th></th>
<th>MGP</th>
<th>MI</th>
<th>MSD</th>
<th>MSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traded Resource</td>
<td>Electricity</td>
<td>Electricity</td>
<td>Electricity for congestion relief</td>
<td>Electricity for real-time balancing</td>
</tr>
<tr>
<td>Admitted units</td>
<td>All</td>
<td>All</td>
<td>All authorized for ancillary services</td>
<td>All authorized for ancillary services</td>
</tr>
<tr>
<td>Admitted parties</td>
<td>Market participants</td>
<td>Market participants</td>
<td>Dispatching users</td>
<td>Dispatching users</td>
</tr>
<tr>
<td>Price</td>
<td>Clearing price</td>
<td>Clearing price</td>
<td>Offered price</td>
<td>Offered price</td>
</tr>
</tbody>
</table>

Table 2.1: Summary diagram of the MPE.  
Source: [19]

### 2.1.1 Day-Ahead Market (MGP)

The Day-Ahead Market (MGP) hosts most of the transactions of purchase and sale of electricity: it opens at 8 AM of the ninth day before the day of delivery and closes at 9:15 AM of the day before the day of delivery. GME publishes preliminary informations and the final results of the MGP on its website before 10:45 AM of the day before delivery (simultaneously with the opening of the first session of the Intra-Day Market (MI)). When the market opens, participants can deliver their bids that must be consistent with the injection or withdrawal capacity of the offer point and must correspond to the real willingness of the bidder to inject or withdraw.
Bids and offers are selected under a merit-order criterion after the closing of the market under the constraints imposed by transmission limits between nineteen different zones in the country. Price is initially determined by the zonal intersection between supply and demand curve and will be different from zone to zone if transmission constraints are saturated. Afterwards, the single national price (PUN), is determined calculating an average weighted on consumptions. The foundation of this system is an algorithm associated with acceptance of bids: the goal is to accept bids maximizing the value of transactions without saturating transmission limits. Figure 2.3 taken from GME’s website shows the final results of demand and supply after the closing of MGP for the North of Italy on July 25th 2013, at noon. All the valid bids for supply and withdrawal are ranked in increasing/decreasing price order on two different curves: supply and demand. The intersection between these two curves gives the final zonal price and the quantity traded for a specific hour. At the end the clearing prices for constrained zones are calculated, the single national price is calculated and applied only to withdrawal points belonging to national zones; the
zonal clearing price is applied to all national and international injection points, as well as to the withdrawal from abroad. To calculate the zonal clearing price also registered information about transactions on the OTC market are used.

2.1.2 Intra-Day Market (MI)

The Intra-Day market (MI) was created in order to allow all the participants in the market to update their bids: MI opens at 10.45 AM of the day before delivery and it closes at 11:45 of the day of delivery. In this market all the participants are allowed to change their position previously defined during MGP. The MI is divided into 4 sessions and it produces, like the MGP, many zonal prices that are used as clearing prices for zonal injections and purchases without calculation of the PUN. Even if the PUN is not calculated the GME applies a system of non-arbitrage fees for each transaction in order to get the same result of the application of a single national price. If the PUN calculated in the MGP has been lower/higher compared with the zonal price calculated in the MI, every sale or purchase will pay or receive a fee to align the price to the MGP one.

2.1.3 Ancillary services market (MSD)

In this section of the spot electricity market the System Operator procures the resources needed to keep in balance the transmission network: in this market Terna S.p.A concludes purchase and sale contracts with the aim of balancing its need for resources. Remuneration for these bids/offers is done following the pay-as-bid methodology: Terna S.p.A pays to producers a non arbitrage fee determined by the GME. This market is split in two sections: a session for scheduling (ex-ante MSD) and a Balancing Market (MB). In the ex-ante MSD Terna S.p.A accepts bids to solve residuals congestions in the system and to accumulate reserve capacity. The sessions of the ex-ante MSD take place during the afternoon of the day before delivery; final results are made known by 20:40 of that day. Individual results divided for every MSD substage are published on the day of delivery.

On the Balancing Market demand bids and supply offers, specific to a certain period of hours, are registered and selected. During MB sessions, Terna S.p.A selects from the register bids/offers concerning a group of hours. The time space to bid for a certain MB period is from 22:30 of the day before delivery (or only after the
communication of final results for the ex-ante MSD session) until one prior to the period of delivery.

### 2.2 Forward Electricity Market (MTE, CDE)

The Forward Electricity Market is where all admitted participants can negotiate forward contracts with obligation of delivery or withdrawal of electricity. In this market the GME acts as the counterpart for contracts. The market is open every day from 9:00 to 17:30 and trading is continuous. Two types of standard contracts are traded in this market each with a 1MW base:

- **Base-load contracts** are contracts based on delivery of electricity during the entire period of the contract.

- **Peak-load contracts** are specific for energy delivery during the contract period from 9AM to 8 PM excluding saturday and sunday; these contracts aim to provide additional availability of energy and to cover peak demand.

Standardized contracts have monthly, quarterly or yearly delivery periods. Trading is arranged in the same way of a normal stock exchange title: an order book where opposite bids/offers are registered and matched is managed by the GME.

As an application of the electricity market reform made in 2009, law 2/09 gave birth to the “Platform of physical delivery of financial contracts concluded on IDEX (CDE)”, resulting from the cooperation between GME and Borsa Italiana S.p.a where the market of electricity derivates is held. Through this agreement derivate market participants may exercise a physical option requesting to settle their position through physical delivery in the GME’s market.

### 2.3 Over-the-Counter Registration Platform (PCE)

Counterparts may also conclude contracts outside the GME’s regulated market; in order to ensure a reliable transmission system, it is necessary to register these contracts on a specific platform in order to avoid unexpected congestions. Transaction referring to a period from the second day of flow to the sixtieth after the day of registration can be entered into the platform every day from 3 PM to 8 PM.
All these components of the electricity market cooperate to generate a flexible and controlled flow of electricity in the transmission system in a sustainable and efficient way. The important role of GME and Terna S.p.A is to administrate the system using all the informations gathered through these platforms.

2.4 Electricity markets around the globe

As we argued in Chapter 1, the main prescription for liberalized electricity market needs to be adapted to the local environment, in order to create a functional and reliable system. In this paragraph we will look at different applications of the “Standard Prescription” considering how pre-existing conditions affects the implementation of liberalization in the electricity industry. We will also see that, in same countries across Europe, liberalization and innovation in the industry organization of the lead to a new arrangement where the boundaries of the market move beyond national borders. A pool of countries involved in the same market and sharing their capacity is the actual goal to achieve: the limitation in capacity and in investment imposed by the existence of transmission constraints and national demand will limit the benefits generated by liberalization. In the same way as for international trade, lowering transaction cost between countries and enabling customers to choose producers in a large liberalized environment will decrease prices for the final customers in some areas (e.g. Italy) and provide a strong and dynamic market for electricity.

2.4.1 The Nord Pool Market

The first liberalized electricity market was introduced in Northern Europe; the Nordic electricity exchange Nord Pool Spot covers Denmark, Finland, Sweden, Norway, Estonia and Lithuania. Nord Pool Spot is an exchange primarily servicing the players at the wholesale market for electricity. Producers, retailers, and traders are the customers who choose to trade on the electricity exchange, in addition with large end users. This market is organized similarly to the Italian one (see), with a Day-ahead market and an intraday market but the bidding/offering mechanism is different. The Nord Poll market serve a wider area with 360 active operators in the market (192 in the MPE-MGP); every operator provides a set of bidding

\[2\text{One between: wholesale or retail competition} \]
and offering for every hour and for a precise location. Offers are a set of quantity and prices for buying and selling not just a single offer (quantity and price) and all together create system price. All the mechanisms of compensation and zonal pricing are similar to Italian experience. The Nord Pool market is the first attempt

![Graph showing bidding from a single player for an hour during Day-ahead market.](source)

Figure 2.4: Bidding from a single player for an hour during Day-ahead market.
Source: [29]

to develop an European electricity market before 2014 with the aim of providing low cost and reliable service to the European consumers market. The biggest challenge will be the harmonization of algorithm to calculate clearing prices among countries in Europe and establishing a single European market for energy and its derivates.
Chapter 3

Retail rate forms

After introducing energy markets theory in Chapter 1 and analyzing the Italian market structure in Chapter 2, we are now going to introduce the main topic of this work: rate design. In this chapter we shall analyze the basic rules reviewing the theoretical foundations for rate makers around the world.

First of all we have to define what a rate maker needs to remember when designing a new rate; as Conkling [9] argues:

"In making his evaluations and selections, the rate maker must realize that he is subject to the rules of a regulated market, and should keep in mind the objectives of that market."

These objectives are essentially three (see [9, 230]):

- Providing adequate revenues,
- Distributing in an equitable way the burden of bills among customers,
- Promoting/Discouraging the maximum economic use of the resources.

In the attempt to fulfill all these objectives there are, at least, three different approaches for rate making: cost approach, value approach and public/social engineering approach. Each of these three approaches differs for vision and priorities and, depending on the political and technological context, has been used since the origins of the industry.
**Cost approach** identifies the cost centers and promotes the fair allocation of costs to customers depending on their specific conditions. This approach is affected by a key problem: defining and allocating costs to the right center of imputation, since it involves subjective decisions, is a matter of judgment. Defining categories of customers and criteria for the allocation of costs affects the fairness of the allocation between consumers. This approach may also lead to promote undesired behaviours by customers, for example: if the cost of serving a customer is charged directly to the customers, large customers will benefit in a major part from their large consumption while domestic customers will have to pay the same amount and this will stimulate larger consumptions from domestic users.

**Value approach** is totally different: the price reflects consumer preferences and demand gauges. In this approach forecasting of demand gains a major importance: by studying demand for commodity, both direct and derived\(^1\) it is possible to derive price elasticity and set an optimal price for the category.

Although in theory these approaches are quite different, they can produce a comparable output in a competitive market: competition pushes prices toward costs and value is assessed on a much more elastic demand.

**Public/social engineering approach** to energy pricing and rate design is an evolution of the two previous. Rate design is used as a way to implement welfare policies or to pursue development towards certain goals (e.g. environmental policies, development of green economy, etc.) by the government or the utilities. Designing rates in order to push customers to act in a certain direction is the best way to implement policies in the country. For example: after the development of an environmental concern and a consequent policy, utilities adopted reverse blocking rates to prevent wastes in energy consumption by the consumers. The use of rate design in order to change customers behaviour, was also aimed to persuade them to move their consumption from peak periods to off peak periods. Nowadays the public/social engineering approach is the favorite one: cost and value approach are mixed together to create a socially fair set of rates capable to provide good and stable revenues.

---
\(^1\)Direct electricity demand comes from appliances and lighting, while derived demand comes from the market condition and the production in the period.
Before starting to discuss in deep the various forms of rate developed by the
theory it is important to explain the semantic difference between rate level and rate
form: the form of the rate is how the price is stated; the level of the rate is the
price itself. In the following paragraphs we will refer to both the terms with this
meaning. We also suggest to have a look at Appendix A for a brief guide on the
difference between energy demand and consumption that is going to be important
going further.

\section*{3.1 Elements of rate design}

To understand rate forms it is important to give an insight on the tools the rate
maker can adopt in order to get the needed results, as described by Conkling in his
book \textit{Energy Pricing: economics and principles} \cite{9}:

\textbf{Minimum charges} are a frequent element in rate design: defining a minimum
amount for the energy bill or for demand and consumption is frequent in
utility bills. There are two possible ways to incorporate a minimum in the
bill charge: either an explicit sentence stating that the minimum charge is a
certain amount, or its combination in the blocking form of a rate with a fixed
charge under a certain consumption level. From a cost point of view, it is
not clear which type of cost should be covered by the adoption of a minimum
charge therefore it can only be seen as a way to collect a minimum amount
of revenue by the utility. In the wholesale and in the consumer market, the
minimum charge usually is seen as the fee to pay at the utility for its readiness
to serve. Nowadays the minimum charge is becoming more and more criticized
because of its promotional nature: it does not encourage a responsible use of
resources at household level.

\textbf{Ratchets} work as a variable minimum charge; the minimum depends on a previ-
ous amount (the entire bill or the demand measurement). Setting a previous
bill (for example a peak month) as a minimum, is a common way to ensure a
stream of revenues capable of providing a return on the utility’s investment.
For instance setting the ratchet in december for a warehouse where heating to
prevent freezing is used only when temperature drops below 0°C may be the
best solution to ensure a solid stream of revenues for the supplier. Except for
these cases, this method is considered unacceptable for normal consumers. A second kind of ratchet, where the demand charge is adjusted, is more common: it consists in defining a minimum for demand charge based on a percentage of the maximum demand over a certain period. This is the best way for the utility to ensure that revenues will cover costs associated with the installed capacity; beside that, it is also considered acceptable in the wholesale and commercial segment as it can be associated with measurable costs.

**Adjustment clauses** are used to adjust prices in the contract in order to respond to unpredictable changes in the conditions underlying the contract. The most common adjustment clause is the fuel one: it shifts the risk of price shock from the utility to the customer.

**Penalties and discounts** sometimes are used in the wholesale and commercial electricity market and are a major tool in the hand of the utility. Penalties can derive from late payments or for some consumption behavior particularly onerous to the utility. Discounts can assume a large variety of forms; what matters most is to distinguish these discounts from the implicit quantity discount deriving from the application of a blocking rate.

**Frozen rates** are rates no longer available to the public but still in place for customers who subscribed before the expiration of the rate. These customers can benefit of the same conditions until they switch to a new plan: as in the telecommunication industry, customers who signed a contract with certain rules can’t be switched to other plans without their approval.

**Caps and Floors** are tools usually used in order to make the transition from an hold rate scheme to a new one preventing prices spikes. For example when California moved to a marginal cost pricing, the CPUC stated:

>“The use of caps which limit the amount by which the class average rate can increase is the standard technique for mitigating harsh bill impacts on customers. Caps are typically defined as the total of the system average percentage change (SAPC) plus a given percentage.”

\(^2\)California Public Utilities Commission
Caps and floors are usually designed to allow prices to fluctuate no more than a percentage calculated on the previous year.

**Blocking** rates are designed to encourage/discourage usage by decreasing/increasing unit price depending on quantity.

- The *downward sloping blocking* form has some major advantages: it allows quantity discount; it is consistent with the typical decreasing cost condition of the utilities; its form allows an high degree of flexibility in rate design.

- The *upward blocking* form became more and more used during the past years whit the raise of an environmental awareness in the society. The upward blocking systems are designed to provide the basic amount of energy at a lower price, as well as to charge an higher fee for consumption in excess, discouraging energy wastes. As an example of this kind of rate the *Acquirente Unico* standard rate for residential use is stated as a blocking rate: it provides cheaper energy for basic consumption, increasing its cost for additional use. Table 3.1 shows the rates for the 3rd quarter 2013 charged by the *Acquirente Unico* for the standard offer service in Italy.

<table>
<thead>
<tr>
<th>Usage per year (kWh/year)</th>
<th>Energy fee (€/kWh)</th>
<th>Fixed charge rate</th>
<th>Time of use rate €</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F1</td>
<td>F23</td>
</tr>
<tr>
<td>0 to 1800</td>
<td>0,13209</td>
<td>0,13672</td>
<td>0,12976</td>
</tr>
<tr>
<td>1801 to 2640</td>
<td>0,18774</td>
<td>0,19237</td>
<td>0,18541</td>
</tr>
<tr>
<td>2641 to 4440</td>
<td>0,25176</td>
<td>0,25639</td>
<td>0,24943</td>
</tr>
<tr>
<td>more than 4440</td>
<td>0,29852</td>
<td>0,30315</td>
<td>0,29619</td>
</tr>
</tbody>
</table>

Table 3.1: Rates charged by the AU during the 3rd quarter of 2013. Source: [3]

**Postage stamp vs zone rates** concerns the area of applicability of a certain rate: in the postage stamp model (derived from the american postal service) the rate is the same in the whole the area of service; in the zoning model the territory
CHAPTER 3. RETAIL RATE FORMS

is divided into different zones with a specific rates reflecting different costs in serving that area. The application of zone rates can cause boundary problems especially if rates of adjacent zones differ largely. The strict application of this criteria should lead to higher rates in the rural areas compared to rates in the urban areas: farming would be affected by the cost of serving the farm. In similar cases the public/social engineering approach to rate design has an important role of mitigating a pure cost approach.

**Seasonal** rates are also a tool for rate maker: if the usage patterns of customers in different periods of the year is inconsistent, it is better to develop specific rates for each period. These kind of rates are the precursors of the real time pricing rates that nowadays are entering the market.

It also important to notice that, after liberalization and in application of the rules imposed by the Regulatory Authority for Electricity and Gas, in Italy and around the world, the major trend is heading toward *unbundling* rates: all the services composing the final bill are charged as a separate element. Unbundling all the components of the final price gives to the consumer more information about the service itself and, for example, about the way his consumption behavior affects the final bill. In the introduction to Chapter 4 we will explain all the components of the Italian electricity bill.

We will now investigate some rates introduced by theorists during the last centuries: these rates are the foundation of today’s rates. As we will see in chapter 4, the schemes proposed are still in the market along with refinements made possible by technological innovation. Our overview of the rate forms will begin from the most simple form: the single part rate form; the most easy and basic method for billing introduced since the beginning of the industry. After we will introduce the most important theories concerning two and three part rate forms.

### 3.2 Single part rate forms

This type of rate is the most simple one: a single variable is measured and the billing is based on that variable. There are three types of single part rates:

- *Flat rates* are rates setting a charge which does not change with the use. This method was used at the beginning, when no meters were available, so charging
a fixed amount, that could vary for the kind of use made by the consumer was the most sophisticated method available. Refinements to this method have been developed during the years, such as: differentiation of charges between houses with electric water heating and gas heating, a fixed charge per room per month and others. This rate is easily victim of hard critiques due to its unfairness but it is still the most simple and easy way to set a rate in areas with lack of infrastructures; furthermore it is easy to manage and costless in term of metering and billing.

- *Metered commodity rates* are those that charge the customer depending on the amount of commodity consumed. The most simple one is the *straight-line meter rate*, which charges a fixed amount per unit consumed (e.g. $0.01€$/kWh). From a cost point of view, since this rate doesn’t recognize any difference between small and large users and between different load factors, it is considered a poor solution unless consumers are divided into homogeneous group with similar usage paths. To overcome these critiques a common solution is to apply the blocking principle to the metered commodity rate: as we discussed earlier this solution is more reliable from a cost point of view.

- If demand is seen as a more important issue, for example in a system where most of the capacity is provided by hydro power at a very low variable cost, a *metered demand rate* may be applied instead of a commodity rate. The amount of the bill will be based on the maximum demand (see Appendix A) of energy required during the month. This will discourage peak usage inducing consumers to arrange in a more efficient way consumptions.

### 3.3 Two parts rate forms

These rates charge separately for commodity and demand in order to create a more accurate result. In literature there are two principal rates belonging to this group:

- The first rate, introduced in 1892 by Hopkinson is a form that can be applied to the electricity market as well as to the gas and water industry. The *Hopkinson rate* has two separate charges: one for the demand and the other one for the commodity; their combination determines the total amount of the bill. A
large number of refinements can be made by the rate maker: a common choice is including blocking and minimum charges in the demand and commodity charges.

- **Wright demand rate** is a complex two part rate designed by Arthur Wright in 1886. This rate is a measured blocked commodity rate where blocks are chosen depending on the hours of usage of the maximum demand by the customer. This rate may appear like a single part rate but it is a two part rate because of the impact of the variable blocks. This rate is designed in order to allow all the customers with the same load factor to pay the same rate: as the load factor increases or decreases the customer can experience a direct effect on prices.

What appears clear is that, since these rates are very flexible and adaptable, they permit to include in the same rate a larger number of customers minimizing inequalities among them. Anyway, these rates may suffer from discrepancies between the cost charged to the final customer and the actual cost associated with that customer: from a cost perspective the rate form doesn’t guarantee a proper relationship.

It is also important to highlight that, even if the rate is flexible and more efficient than a single rate form, this rate was not implemented on a large scale for a long time: a rate form not clear enough may prevent customers from accepting it.

Another question is whether charging small customers for their demand is a practice to avoid or not: while for large customers it is a well accepted idea that higher demands should face higher costs, for residential use the common opinion is that charging for demand might be just an additional charge without costs fundamentals. Usually the solution to this problem was to establish a minimum with no charge for the demand part of the rate in order to avoid charging basic services.

### 3.4 Three parts rate forms

The three parts rates are rare and usually are utilized for special purposes. We will present three examples in this section:

- The **Doherty rate**, introduced in 1900, is the most cost related evolution of the Hopkinson and the Wright rates. This rate is composed by a customer, a demand and a commodity charge. The customer charge is a fixed amount
charged equally to every category of customers under the assumption that the cost of billing and metering is comparable over different customers and is not related to the actual usage. The demand charge is blocked upwards or downwards depending on the type of costs. The consumption charge is set to cover only variable costs.

- **Lester special-investment rate** was introduced in 1946 by Claude R. Lester in order to recover investment needed to extend the service to new outlying users. Together with the charge for demand and consumption the user was charged for a percentage of the seasonal investment needed to keep the system operative.

- **Zanoff gas pipeline rate** designed by Louis Zanoff in 1972 for gas pipelines introduced two new concepts in the rate designing world: the first one is the division of the demand charge into demand and capacity charge. The second innovation was the introduction of a reverse blocking criteria divided in two blocks: a *base use* and an *excess use*. To implement this rate the year had to be divided into off peak and peak season in order to apply the base use rate to the off peak season and the excess use rate to the additional share of energy consumed during peak season. This innovation, with the splitting in off peak and peak, is also applied to consumption, demand and capacity charge.
Chapter 4

Prices in the Italian retail market

In the previous chapters we introduced the electricity market (Chapters 1 and 2) and the theory underlying rate formulation (Chapter 3). In this chapter we shall, first, take a look to the trend in retail pricing schemes internationally adopted, then, we’ll take into consideration rate plans sold in the Italian retail market. We’ll investigate what a customer served by the standard offer set by the AEEG, is paying for electricity and we shall compare him with a customer served in the liberalized market. We will explain first how the bill is composed, how all the components are calculated and which kind of offers are proposed in the market; then we will compare different rates and options available in the market. To analyze how expenditure varies within rates in the market for different usage paths we will use a residential family model with a yearly consumption of 2700 kWh and a 3 kW maximum demand with different usage patterns for electricity.

4.1 Trends in retail pricing schemes

As reviewed by Perez [32], today’s prices offer in the retail market is divided in two main categories: static and dynamic prices. Static prices are those associated with the classic industry organization; due to their inefficiency in the future smart electrical system they are destined to obsolescence. Static prices are essentially the implementation of what we reviewed in Chapter 3 flat rates and time of use rates are the most common offers. These rates are called static because their level is

\[1\] These are the parameters used by the Regulatory Authority for Electricity and Gas (AEEG) for simulations on household consumptions.
updated on a quarterly basis with no capacity to respond according to customer’s consumption behavior. Flat rates are a fixed charge for kWh consumed; TOU rates define different charges depending on the consumption period. Dynamic pricing is one of the key elements of a smart electricity system: it is expected to smooth load profiles and avoid system overloads by reducing demand with faster changes in prices. Two forms of dynamic pricing are suggested by Perez: critical peak pricing and real time pricing; in the critical peak pricing the retailer, in order to cope with sudden lack of production to prevent power shortages, is able, under certain circumstances, to declare an higher price to customers through an informative system. With the real time pricing an informative terminal warns the consumer about the actual price of electricity: the customer is charged for the actual energy price at the time of use. Both these instruments require the development of a massive informative mechanism and a widespread smart metering system together with a massive informative campaign.

In the future, the implementation of smart grid solutions in the network and the integration of renewable independent generation plants as a key element in energy supply will appoint dynamic pricing as the standard rate at household level. This will lead to a more efficient and cost responsive system able to minimize energy wastes, to benefit from new energy sources and to lighten the environmental burden of energy production.

4.2 Bill components in Italy

Bills in Italy are composed of three sections, each one with a different amount of components: retailing services, network services and taxes. Some of these components are in direct control of the retailer, others are defined by the AEEG quarterly, depending on market trends and expectations for the upcoming months.

Retailing services fees account for the major part of the expense of a normal customer. Retailing charges are those connected to acquiring and reselling energy to the final customers. This charge consist of three components:

- Energy component: is the component covering the cost of procuring and reselling energy to the final customer. It is applied to consumption and

\(^2\)Regulatory Authority for Electricity and Gas
energy losses due to transmission and distribution. Since the energy component in the free market is not fixed by the AEEG, most of the competition takes place properly here: starting from July 2007 customers can choose either to remain in the regulated market or to switch into the liberalized one where a rising number of offers appears every year. For those who are still in the regulated market prices are set by the AEEG quarterly.

- **Sale and retail component**: its aim is to collect a fee based on costs that the utility had to face in order to serve customers in the free market; this fee is set independently by every retailer.

- The balancing component covers the cost of keeping the system in equilibrium and providing a stable and reliable service. This component in the liberalized market is calculated differently depending on the contract; in the standard offer one it is calculated by the AEEG as an average of the charges applied in the free market.

**Network services fees** are those connected to national energy transmission and local distribution, including costs involved in managing meters. The AEEG impose for these services a fare taking into account the inflation, the cost of investments and the future objectives. In this component competition is not in place: as we said in Chapter 1, the transmission and distribution system is a natural monopoly so fares have to be set independently by a market regulator. Network fees are stated in the bill separately and they include also the generic system fees, composed as in Table 4.1; these fees account for a 17.64% (source 3) on the average of the total bill for a customer in the regulated market; the component accounting for most of the cost is the A3 component. The A3 component aims to promote the installation of renewable energy sources with a fiscal cut on the expenses for the energy plants. Since this component is designed to grind on non domestic users, its existence is opposed by the private sector, pushing for a reduction of this component or for a redistribution of the burden. This component may be why electricity for industrial use in Italy is more expensive than in other European countries. According to the quarterly

\footnote{This quantity is usually calculated as a fixed percentage, decided by the AEEG, of the energy consumed}
EU Commission report on European Electricity Market, excluding Cyprus, Italy is the country with the highest price for electricity at an industrial level (See Table 4.1). But it is also true that, among other European countries, Italy has higher energy prices in the electricity market due to its production mix. Policies aimed to develop green and renewable sources are essential to the future of a competitive and more independent energy supply in order to change the composition of the national mix with the aim to escape gas dependancy.

Figure 4.1: Electricity prices in € (without vat and taxes) for industrial consumers during the 2nd semester of 2012. Source: [16]
### Table 4.1: Components of the generic system fees. Source: \[3\]

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>Incentives for renewable energy production</td>
</tr>
<tr>
<td>UC7</td>
<td>Energy efficiency promotion</td>
</tr>
<tr>
<td>A2 and MCT</td>
<td>Taxes to secure nuclear sites and restore the environment</td>
</tr>
<tr>
<td>A4</td>
<td>Duty to maintain special fare for the railway operators</td>
</tr>
<tr>
<td>UC4</td>
<td>Duty to sustain minor electric enterprises</td>
</tr>
<tr>
<td>A5</td>
<td>Tax to sustain research and development</td>
</tr>
<tr>
<td>As</td>
<td>Duty to sustain low wages and large families with discounts</td>
</tr>
</tbody>
</table>

**Tax**: Two taxes are added to calculate the final amount of the bill: the first is an excise tax on the service, charged to every energy quantity consumed (with a lower fee for residential customers consuming less than 1800 kWh yearly); the second is the VAT, calculated on the total amount of the bill, excise tax included (10% for residential usage or 22% for non-residential).

In Table 4.2, we give an example of the composition of a residential bill for the standard customer. As we can see, most of the expenditure is associated with PED\[^4\] with a 51.07% average share on the total bill amount; together with a 4.07% average expenditure associated with retailing, the average expenditure for the energy component counts up to 55.14%. This is the share of the bill where competition takes place and where customers may experience benefits from switching to the liberalized market.

### 4.3 Standard offer rates

In order to better understand the rates available in the market it is important to evaluate the standard offer of the AEEG and how it is managed. The standard offer is provided by the AEEG through every utility in Italy: all the utilities in the

\[^4\]PED is the sum of energy price and distribution costs: it is essentially composed by costs for energy production and management costs of generation.
Table 4.2: Expenses distribution for a standard residential customer. Source: [3]

country have to offer this service to domestic customers and small businesses. If the customer doesn’t want to subscribe a free market offer he is automatically served with the standard one. Rates are calculated by the AEEG based on the activity of the Acquirente Unico (see Chapter 2) on the electricity market during the previous months. customers are served with a flat rate or, where the installed meter permits it, with a time of use rate. A flat rate is a fixed consumption charge not varying depending on the usage period; the Time of Use rate (TOU) requires usages to be ranked according to their burden on the system: hours where capacity is fully used are called peak periods and, because of the high price involved in producing more energy, are usually charged more. In Figure 4.2 we can see the yearly consumption profile for 2012 divided in number of hours per demanded power: note that power requirement varied from 20975 MW up to 54113 MW, meaning that the difference in demand from off peak to peak periods is consistent and any attempt to reduce consumptions in the peak periods will avoid the need to build more capacity just to supply a small amount of peak hours.

In Italy the authority divides the week in three periods:

- **Peak period (F1):** monday through friday from 8:00 to 19:00,
- **Intermediate period (F2):** monday through friday from 7:00 to 8:00 and from

---

Small business are those with less than 50 employees and a turnover of less than 10 millions served in low-tension
19:00 to 20:00; on saturday from 7:00 to 23:00,

- Off-peak period (F3): monday through friday from 23:00 to 7:00; all holidays and sundays.

Figure 4.2: Duration curve of the required hourly power in 2012 on the italian grid. Source: [38]

The *time of use* rate proposed by the AEEG defines two different charges for consumptions respectively in F1 and in F2 plus F3 time slots. The merging of two non-peak rates, simplifying the rate itself, is aimed to incentivize off peak consumptions. As we will see, all the *time of use* rates in the free market define just two periods (F1 and F23) instead of using all the 3 periods to charge different rates following the standard introduced by the authority.
In Figure 4.3 it is possible to see the quarterly variable charge imposed by the authority: network services fees, generic system fee and energy charge compose it. As we can notice the flat rate level is higher than the off peak charge in the TOU but is less expensive than the F1 charge. The construction of the TOU rate is made to disincentive usage on peak periods: this kind of rate can end up in savings only when consumption is divided approximately in 70% off peak and 30% on peak. From Figure 4.3 it also possible to notice the evolution of the generic system fee: from 2010 the importance of this component in the final variable price is increased in large part to keep supporting renewable energy sources and green energy production.

Figure 4.3: Variable component in €/mWh of the standard offer rates. Source: [3]

From the 2007 liberalization of the domestic market an increasing number of customers switched to the free market option. Table 4.3 shows the evolution of the market from 2008 until 2011; as we can see the number of domestic customers in the free market increased every year. Even though no official data for 2012 is available, the number of domestic customers switching to free market offers is increasing together with user’s knowledge of the system.

In the following paragraphs we will identify opportunities in the liberalized market by analyzing different offers advertised by the main utilities in Italy. We will take
### Number of customers (in thousands)

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulated market</td>
<td>32.620</td>
<td>31.643</td>
<td>30.584</td>
<td>28.791</td>
</tr>
<tr>
<td>Domestic</td>
<td>27.155</td>
<td>26.458</td>
<td>25.424</td>
<td>24.016</td>
</tr>
<tr>
<td>Not domestic</td>
<td>5.465</td>
<td>5.185</td>
<td>5.160</td>
<td>4.775</td>
</tr>
<tr>
<td>Free market</td>
<td>2.997</td>
<td>4.277</td>
<td>5.946</td>
<td>7.700</td>
</tr>
<tr>
<td>Domestic</td>
<td>870</td>
<td>1.829</td>
<td>3.240</td>
<td>4.826</td>
</tr>
<tr>
<td>Not domestic</td>
<td>2.127</td>
<td>2.449</td>
<td>2.706</td>
<td>2.874</td>
</tr>
</tbody>
</table>

Table 4.3: customers in the liberalized and standard offer market. Source: [3]

a look into the rate structures proposed and we will explore the marketing strategy underlying these rates.

### 4.4 Rates available in the Italian retail market

Our analysis of the rates available in the Italian market begins with an overview on the contracts available in the market. Our research is focused on residential contracts provided by the major companies. Starting from the collected data on the energy provided to residential customers in 2012 by each utility (see Table 4.4), we analyzed 10 companies with a national energetic offer. Azienda Energetica Bolzano and Energetic Source have not been considered further in our analysis, for lack of information or for the restricted area served without any free market offer. The offers from Dolomiti Energia are commercialized by Trenta S.p.A...

We found 66 offers available based on: *fixed charge*, *time of use* and *all inclusive* rates. As per Table 4.5, *fixed charge* rates are the most common with 27 available offers; there are 21 offers for *time of use* and 18 *all inclusive*. As we will see further ahead in this chapter, these offers vary between each other but share a common choice from the utilities: adopt in the free market the same structures of the standard offers even if with different prices because these rate are more easy to be understood by the consumers. This idea is also sustained by the major presence of all inclusive offers (27%) seeking to attract skeptical customers looking forward to
CHAPTER 4. PRICES IN THE ITALIAN RETAIL MARKET

<table>
<thead>
<tr>
<th>Company &amp; Household consumption (Gwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enel 47875  Eni 1287  Dolomiti Energia 432</td>
</tr>
<tr>
<td>Acea 2556  Iren 1065  Azienda Energetica Bolzano 207</td>
</tr>
<tr>
<td>Edison 1728  Hera 754  E.On 196</td>
</tr>
<tr>
<td>A2A 1594  Sorgenia 651  Energetic Source 73</td>
</tr>
<tr>
<td>Other 2840</td>
</tr>
<tr>
<td>Total 61260</td>
</tr>
</tbody>
</table>

Table 4.4: Energy provided to residential customers in 2012 divided by company. Source: [3]

fix their expense for energy in an easy bill where everything is bundled in a single price. What seems to be the trend is the consumer’s request for a reliable service at a reasonably predictable price, in order to avoid excessive bills; fearing what happened a couple of years ago, in 2011 and 2012 when utilities, in compliance with the law, started to change domestic meters with smart meters and because of technical problem a lot of miscalculated bills were charged.

<table>
<thead>
<tr>
<th></th>
<th>Fixed charge</th>
<th>Time of use</th>
<th>All inclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>27</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Percentage</td>
<td>41%</td>
<td>32%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Table 4.5: Distribution of the available rates.

Since prices in the standard offer market are set quarterly by the authority and are subject to changes depending on market conditions, utilities are focusing their offers on:

- Price predictability (price blocked for 1 or 2 years),
- Rate simplification,
- Discounts on the standard offer rates,
• Environmentally friendly options.

We will now discuss further these elements providing some evidences of this trend from our market research.

### 4.4.1 Price predictability

Price predictability seems to be the most important feature: out of the 66 offers analyzed, 33% had a price blocked for two years or more and 55% for one year; only 9% of prices is set quarterly with a discount on the price set by the AEEG. Just two offers (3%) by Hera S.p.A. follow a different path, allowing customers to benefit from prices traded in the wholesale market: the utility charges a fixed fee while rates are updated monthly calculating the average PUN of the previous month. This is the only attempt to reduce the gap between electricity wholesale market and residential retail market, pushing towards real time pricing. It is easy to understand that such contracts in Italy may be unpopular due the unpredictability of prices: consumers, after experiencing financial turbulence in the last few years, may be unwilling to expose their bills to a variable market.

Fixing a price for two years implies that the utility takes the risk of a spike in prices; this will lead to rates with a premium charge calculated on the risks involved. Depending on market conditions the utility may end up paying more than what it is actually charging for energy: for example, since Italian electric capacity in major part depends on gas burning plants, a crisis in gas supply may lead to higher electricity prices.

<table>
<thead>
<tr>
<th></th>
<th>2 years</th>
<th>1 year</th>
<th>1 Quarter</th>
<th>1 Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat rate</td>
<td>13</td>
<td>10</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Time of use</td>
<td>9</td>
<td>8</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>All inclusive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>36</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>36%</td>
<td>53%</td>
<td>9%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 4.6: Validity of the advertised rates.
The most long term and interesting rate in the market is provided by Trenta S.p.A. time of use rate called *smile offer*: the price is blocked for three years and after the first year an increasing discount on the rate is calculated (5% after one year and 10% after the second year). The price for the first year is 0.07920 €/kWh for F1 and 0.06890 €/kWh for F23 a rate level below the market average (see Paragraph 4.5) that may expose the utility to great risks but, in this specific case, the risk for the utility is lower because Trenta S.p.A. produce energy only through renewable resources (in prevalence hydro power) so energy cost is very low with the result of lowering risk for long term contracts.

### 4.4.2 Rate Simplification

To allow skeptical customers to embrace change and switch to a free market offer simplification is an useful tool. customers served in the standard offer market are used to a bill where everything is unbundled; for someone this may be confusing. So bundling together all voices and presenting a simple offer is the best tool to gain the trust of customers. In our analysis of the market we found two examples of simplification:

- **All inclusive consumption rates**, in this way the customer will not worry about network, transmission, balancing, service and other fees. In this bill, quite different from the standard one, everything is bundled into a single rate for an easy and simple approach. An example is the offer advertised by ENEL as *Semplice luce*, an all inclusive consumption rate with just two items on the bill: consumption and taxes. As these rates are usually blocked for one year the utility is taking the risk of a spike in PED or in distribution and retailing costs.

- **All inclusive packages** offer a fixed monthly amount for consumptions under a defined maximum with no differentiation between peak and off-peak charges. Three out of nine retailers in the Italian market offer these packages: depending on the maximum monthly allowance an higher fee is payed but, as Table 4.4
CHAPTER 4. PRICES IN THE ITALIAN RETAIL MARKET

shows, the actual average price per mWh consumed follows a trend with lower average charges for the most common consumed quantity (2700 kWh\(^6\)). In Figure 4.4 we have also reported the average all inclusive expenditure per kWh for a customer served with the standard flat rate: as we can see if a customer consumed exactly the maximum amount of the all inclusive package he would have saved an important amount of money per kWh for consumptions above 1800 kWh.

![Figure 4.4](image)

Figure 4.4: Average €/mWh charged for every all inclusive package in the market divided by utility. Source: [37][14][13]

If the customer at the end of the year consumes a lower percentage of the maximum energy available, he will end up paying more per kWh actually consumed: at the end, as Figure 4.5 shows, the all inclusive offers will be not as competitive as for the full usage scenario (Figure 4.4). In the 80% scenario\(^7\) the offers from Sorgenia result in an higher per kWh expenditure than the flat

---

\(^6\)This consumption level is the level indicated by the AESEG as a model for family consumption; other studies [12] suggest that the average yearly family consumption in Italy is 3229 kWh but, since this study was developed in 2004 and it was focused in the north of Italy we are more willing to consider an average consumption level 2700 kWh/year.

\(^7\)A consumption at the end of the year equal to the 80% of the maximum allowance.
standard rate for almost every yearly cap while for higher consumption the
offers from Enel and Edison appears to be still competitive.

Figure 4.5: Average €/mWh charged for every all inclusive package in the market
divided by utility with a 80% consumption. Source: [37] [14] [13]

In the 70% scenario (see Figure 4.6) we see no advantage in subscribing an all
inclusive offer with any of these suppliers; in fact the blue line is always lower
than the other.

We should take into account that a customer consuming 70% of the maximum
margin during one year might decide to switch to the lower block for the fol-
lowing one; this choice, because of the 10 available blocks and a compensation
mechanism, might be the right one with Edison but it could result in even
higher bills with Enel and Sorgenia. Infact these two utilities offer only 4 max-
imum quantities, with a large gap among each other, meaning that switching
from a quantity to the lower one may result in consuming extra energy than
in the contract.

Charges for extra energy consumed are very high: for example ENEL charges
an all inclusive rate of 0,283 €/kWh (for the 1800 kWh package), 0,333 €/kWh
(for the 2700 kWh package), 0,352 €/kWh (for the 3600 kWh package) and
Figure 4.6: Average €/mWh charged for every all inclusive package in the market divided by utility with a 70% consumption. Source: [37] [14] [13]

0.408 euro/kWh (for the 4500 Kwh package). In addition to the extra charge ENEL presents another problem: the maximum allowance in the contract is not stated on a yearly basis but on a monthly basis: for example, the small package is a 225 kWh monthly package (1800 kWh yearly). Having a monthly cap might be dangerous and could lead more easily to exceed the maximum allowance (e.g. during hot summer days, with the air conditioning in full use, energy consumption is really high; an high percentage of the total yearly consumption may be concentrated in the summer months).

In Figure 4.7 the scenario with a 10% over-consumption is presented: compared to the full usage scenario it is possible to notice a difference in the low consumption area where the over-consumption decrease the gap between the standard rate scenario and the all inclusive package.

Even if these rates prove to be a good solution for customers with the ability to choose the right consumption limit, they are breaking one of the objectives defined by Conkling [9] (see Chapter 3) for rate makers: they do not promote the maximum economic use of the resources, in fact customers with consump-
Figure 4.7: Average €/mWh charged for every all inclusive package in the market divided by utility with a 110% consumption. Source: [37] [14] [13]

...tion below the maximum allowance will not be discouraged to consume an additional share of energy even if is not needed (except for the Edison offer that, with a reward mechanism, incentive energy saving).

4.4.3 Discounts on the standard offer rates

In our market research we found that three companies out of nine propose a plan with a fixed percentage discount on the PED defined by the AEEG. These offers are quite different from one another: Edison proposes a fixed 10% discount on the AEEG flat or TOU rate for bills varying from 20€ to 200€ in a two-month period with some restrictions (payment is allowed only by direct withdrawal on the customer’s account and the bill is delivered exclusively by email); the contract mentions a sale component of 19,62€ per point of delivery\(^8\) which is in line with what the AEEG charges. The strategy here is to reduce costs of billing and credit risk in order to charge lower rates.

Eni and Iren propose smaller discounts decreasing after the first year: in Table 4.7

\(^8\)Estimates based on a model residential family (2700 kWh/year with 3 kW demand).
we can see these offers.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Type</th>
<th>1st Year</th>
<th>2nd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edison</td>
<td>Flat rate / TOU</td>
<td>10 %</td>
<td></td>
</tr>
<tr>
<td>Iren</td>
<td>Flat rate</td>
<td>5.48%</td>
<td>2.74%</td>
</tr>
<tr>
<td>Eni</td>
<td>Flat rate / TOU</td>
<td>8.22%</td>
<td>4.11%</td>
</tr>
</tbody>
</table>

Table 4.7: Rates with a discount on the AEEG PED. Source: [14] [11] [26]

Both utilities advertise their offers by calculating the number of days the customer is not paying, compared to a standard offer bill. The offer presented by Eni seems to be competitive with no extra charges hidden in the contract; while the Iren offer hides a 30€ fixed sale component and a 23€ fixed component at the subscribing of the contract or for any modification. The average saving on the entire annual bill for our model residential family is reported in Table 4.8. We can conclude that these contracts offer a good solution to save a low percentage on the bill but the customer has to pay attention to the hidden costs that may cancel the benefits deriving from the discount.

Note that, in accordance to the AEEG Resolution 8 Luglio 2010 n. 104/2010, each utility has to provide, together with the contract offer, a comparison table where the total expenditure for the offer is calculated based on different consumption levels (1200, 2700, 3500, 4500 kWh), different demands (residential or non residential under 3kW and client with 4,5kW demand) and different usage profiles. There are three profiles, as reported in Table 4.9, aimed to represent usage pattern of different families, in order to allow a better understanding of the possibilities introduced by TOU rates. We used comparison tables available in the utility’s websites (see [14] [11] [26]) to compile Table 4.8.

---

9Prices calculated following the instructions on the Resolution AEEG 8 Luglio 2010 n. 104/2010 and later (published on the website www.autorita.energia.it on July the 12th 2010).
CHAPTER 4. PRICES IN THE ITALIAN RETAIL MARKET

Table 4.8: Annual savings for a residential family with 2700 kWh consumption and a 3kW maximum demand. Source: [14]

<table>
<thead>
<tr>
<th></th>
<th>Offer</th>
<th>Flat AEEG</th>
<th>Savings</th>
<th>Offer</th>
<th>Profile 2 TOU</th>
<th>Savings</th>
<th>Offer</th>
<th>Profile 3 TOU</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iren</td>
<td>426,22</td>
<td>449,39</td>
<td>-23</td>
<td>430,65</td>
<td>454,37</td>
<td>-24</td>
<td>422,28</td>
<td>444,97</td>
<td>-23</td>
</tr>
<tr>
<td>Eni Bio</td>
<td>432,01</td>
<td>449,39</td>
<td>-17</td>
<td>427,96</td>
<td>444,98</td>
<td>-17</td>
<td>436,59</td>
<td>454,37</td>
<td>-18</td>
</tr>
<tr>
<td>Eni Mono</td>
<td>432,01</td>
<td>449,39</td>
<td>-17</td>
<td>432,01</td>
<td>444,98</td>
<td>-13</td>
<td>432,01</td>
<td>454,37</td>
<td>-22</td>
</tr>
<tr>
<td>Edison Bio</td>
<td>423,93</td>
<td>449,39</td>
<td>-25</td>
<td>419,95</td>
<td>444,97</td>
<td>-25</td>
<td>428,41</td>
<td>454,37</td>
<td>-26</td>
</tr>
<tr>
<td>Edison Mono</td>
<td>423,93</td>
<td>449,39</td>
<td>-25</td>
<td>423,93</td>
<td>444,97</td>
<td>-21</td>
<td>423,93</td>
<td>454,37</td>
<td>-30</td>
</tr>
</tbody>
</table>

Table 4.9: Usage profiles. Source: [3]

<table>
<thead>
<tr>
<th></th>
<th>F1</th>
<th>F23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile 1</td>
<td>33.4%</td>
<td>66.6%</td>
</tr>
<tr>
<td>Profile 2</td>
<td>10%</td>
<td>90%</td>
</tr>
<tr>
<td>Profile 3</td>
<td>60%</td>
<td>40%</td>
</tr>
</tbody>
</table>
4.4.4 Environmentally friendly options

What appears to be a major trend in today’s market is the presence of environmentally friendly offers and options: in our research seven out of ten utilities had a green offer or option in the free market. This trend started in the U.S. and in Europe in the late ’90s when, after the first implementation of liberalizations in the energy markets and the rise of an environmental concern, utilities started to understand the added value in a green offer. At that time a proliferation of studies regarding consumer’s willingness to pay for green electricity in various markets were published; as an example in 1998 Fouquet [17], introducing the idea of an extension for the non-fossil fuel obligation (NFFO) to promote renewable technology development, said:

“In 1998, when UK electricity markets are liberated, a small price differential between renewable and standard electricity certainly less than 20% and clear, credible and captivating information about the external costs of electricity generation could create a considerable demand for renewable electricity.”

From that time literature evolved and market research were developed everywhere liberalization was spreading: in the U.S. Roe [35] commenting a survey stated that

“[...] the results suggest that consumer driven purchases can, in part, support the future of renewable generation capacity in the United States”

meaning that there is a class of consumers that is willing to pay an extra charge or a premium price for green electricity. Similarly did Rowlands [36] in Canada where, in a study conducted in the major metropolitan areas, mapped the customers with a willingness to pay for green electricity focusing on social characteristics specific to these class. In markets where competition was embraced before Italy results on green energy pricing started to appear: as Birb [5] reports, in a study conducted from the U.S. National Renewable Energy Laboratory in 2006:

“utilities green power programs continued to exhibit strong growth selling 3.8 billion kWh of green power to more than 560,000 customers; the top 10 utility green pricing programs exhibited participation rates ranging from 5% to 17%.”
Nowadays the *green offer* in the Italian retail market is well established and prices are reaching a level where the differential for green energy is small. This trend was already reported in the U.S. by Bird [5] when in 2006 wrote:

“The average price premium charged for green power through green pricing programs continued to decline, falling to 2.12/kWh from 2.36/kWh in 2005, and 2.45/kWh in 2004. Since 2000, the premium has declined at an annual average rate of more than 8%.”

In Italy (See Figure 4.8), the average price premium for flat green offers is just 0.007€ (less than a 10% increase on the average flat rate).

![Figure 4.8: Average €/mWh charged for green electricity and normal flat rate offers. Source: 37 14 13 26 2 1 23 15 40](image)

For what concerns time of use offers, the average premium price for peak consumption is negative -0.004€ (4.5% lower than the average flat rate) while for off peak consumptions the difference is 0.015€ (more than 26% higher than the average normal rate). A possible explanation for these results may be that in the free market time of use rates are designed to incentive customers to move to off peak consumption so, in a large amount of offers, rates for off peak consumption is set very low.
and, to balance revenues, peak charge is very high\textsuperscript{10}. Instead, when designing green time of use rates, this difference is not as important to attract customers because they are more concerned about the environmental aspect of the rate.

Figure 4.9: Average €/mWh charged for green and normal time of use rate offers. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40]

4.5 Market evidences

In the previous section we analyzed some particular aspects of the offers available in the market; we are now going to assess the average price level for the energy component in the free market for the flat rate and for the time of use rate. Our analysis will compare the average price offered in the market with the price of the standard offer provided by the AEEG. Our database is based on a selection of the public electricity offers available on the web: rates and conditions of these offers

\textsuperscript{10}For example the peak charge for the offers \textit{eLight} by Enel, \textit{Web Luce} by Edison and \textit{Luce Click} by E.On is higher than the F1 rate set by the AEEG for the 3rd Quarter of 2013. See Table 4.11
have been catalogued in order to provide an accessible source. The presence of an institutional central database as a reference for methodology or as a reference to assess the accuracy of the collected data may have helped but, for what concerns the Italian retail market, no database is available. We also should warn the reader that the collected data may suffer from another condition: as Harrison [22] find out in his market research in Australia, prices advertised online may be lower than what is the actual charge. Harrison [22] in his work compares quotes obtained on the phone by 462 residential and 157 small business and finds out that quotes received on the phone are on average higher than advertised quotes. The risk to get unreliable data in our case may lower because in 2009 Australia, years after the liberalization, was facing the next phase of liberalization: when the free market was considered reliable they decided to abolish standard rate offers in order to make competition work properly. In our case standard offer rates are still in place and they work as a benchmark and a safe choice for customers.

4.5.1 Flat Rates

Assessing the level of the energy component for flat rates in the market we can see that the market seems to offer lower rates. In Figure 4.10 the difference from the average flat rate and the standard offer flat rate is evident: on average, the consumer served in the standard offer market is paying 0,019 €/mWh more than one served in the free market. This gap seems to be very wide but we have to take into account that advertised rates for the energy component may be low on purpose hiding extra charges for retail or costs for modification.

In conclusion there is an evidence that flat rates in the market are lower than what offered from the authority; it is also true that with the spread of smart meters customers served from the standard rate have been switched to time of use rates so flat rates are destined to vanish.

4.5.2 Time of use rates

Time of use rates present a more diverse scenario: Figure 4.13 reports all the time of use rates available in the market divided between peak and off peak charge. As we can notice price variability is very high: there are rates with high on-peak charge and low off peak charge and rates with little differences: Figure 4.11 plots the price
gap between peak and off-peak charges for every offer. An high variability in the charges is thus confirmed. These diverse scenarios are connected to the type of use made by consumers; referring to Table 4.9 we can understand that a consumer that is more likely to consume on-peak (profile 3) will more likely choose a rate with lower F1 charge and higher F23 (see Section 4.3); on the other hand a consumer with an high off-peak consumption will look for a very cheap off-peak charge that is likely to have an higher charge for peak consumption.

The energy component for Time of use rates in the market is, on average, lower than the one imposed by the Authority (See Figure 4.12).

Our conclusion is that liberalization created new opportunities for consumers in Italy: prices for the energy component which are lower and opportunities more adapt to consumers behavior may be found in the market.
CHAPTER 4. PRICES IN THE ITALIAN RETAIL MARKET

Figure 4.11: Gap between F1 and F23 charges for time of use rates. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40]

Figure 4.12: Average energy component in a time of use rate charged in the free market vs AEEG time of use rate. Source: [37] [14] [13] [26] [2] [1] [23] [15] [40] [3]
Figure 4.13: F1 and F23 charges for every time of use rates in the free market. Source: 37, 14, 13, 26, 2, 1, 23, 15, 40
Conclusions

Before turning to the implication of what has been assessed in Chapter 4, it is important to recap which are the limits of this analysis and the aim of this work. First of all, this analysis is based on publicly available offers on utilities websites: it is assumed that these information are reliable and there is not a tendency to advertise lower rates as it was in the Australian case, as exposed by Harrison [22]. I think that, being Italy in an earlier stage of liberalization we cannot compare it to Australia, in fact in 2009 the standard offer in Australia was suppressed and this lead to a “war” to attract customers in the retail market. Secondly, we decided to analyze only residential unbundled offers: doing so, rates with discounts for bundled gas and electricity supply, associated insurance policies, required memberships or associated other services were excluded; this choice was important to create a database with 66 comparable rates. Thirdly, this work focuses on residential offers because they are publicly available, easier to understand and usually not subject to negotiation. If the analysis had to deal with industrial rates, the method would have been different: in the industrial world prices are usually negotiated through bilateral contracts with the supplier and rates are tailored to the demand. An analysis on this side of the industry would have been impossible without the open access to bilateral contracts. To conclude, the choice of including only main utilities, providing energy in the entire country, based on the amount of energy provided as in Table 4.4 reflects the fact that smaller companies serving specific areas in the country may have specific prices and offers; for example, if an area is affected by constraints in the transmission capacity, local producer may have a competitive advantage that can lead to higher prices than the national average.

These choices are connected to the aim of this work: as discussed in the Introduction, in order to benefit from the opportunities that liberalization is producing in the Italian retail market, it is important to know how the market is structured and
assess that competition is producing better conditions. The focus on residential is also a matter of target: residential consumers are more vulnerable when dealing with essential services so a study on the Italian retail market was aimed to assess the opportunities created nowadays and explain the mechanism that has led to them. From the developed analysis it is possible to conclude that, for customers with ability to understand the offers, the Italian retail market is producing opportunities that may lead to savings on the total annual expenditure. What is critical in my opinion, for a consumer who approaches the available offers in the market, is the accurate knowledge of his personal consumption behavior: this helps in finding the right offer and avoiding unexpected charges.

From the analysis it is also clear that the market is still tied to the offers proposed by the AEEG: flat rates and time of use rates account 73% of the market and prices predictability still plays a major role in defining the offer. The future challenge is creating a system capable of minimizing energy wastes and promote responsible consumption through a dynamic pricing process: the national implementation of a smart distribution system and the development of a flexible renewable capacity, together with pricing schemes capable of mitigating demand on a real time basis, will, according to Delfanti et Al. [10], create a more sustainable energy supply system. This thesis is also sustained by Borenstein et Al. [6] in their work “A vision for dynamic pricing”, where they argue that:

“All customer classes should be exposed to time-based prices associated with ex anteestimates of generation procurement costs in combination with specific consideration of system operating conditions around system peak or other stressed conditions.”

This transition will be fundamental to overcome some of the major changes that our society is about to face (e.g. electric cars are expected to enter the market in the next decade together with an additional demand for electricity). In the future the Italian retail market will have to accept real time pricing for household use and consumption behavior will need to adjust in order to become more sustainable. The first step towards this scenario will be the complete liberalization of the market with the suppression of the standard offer rate.

The overall finding is that, in the retail market, liberalization is creating good opportunities for cheaper energy component supply. In my opinion in the next few
years we will see a steady growth of the retail market: at the moment it is hard for consumers to understand all the available offers and there might be some skepticism towards the free market but, when the offered advantages are going to be clear and customers will start to benefit from them, the standard offer rate will be surpassed by a more efficient market that will slowly evolve towards different rate formulations in order to embrace the opportunities provided by the smart system.
Bibliography


[37] Sorgenia, Sorgenia website. [https://www.sorgenia.it](https://www.sorgenia.it)


[40] Trenta S.p.A, Trenta website. [http://www.trenta.it/content/home](http://www.trenta.it/content/home).


Appendix A

Energy demand and consumption

This appendix will explore the different meanings of energy demand and consumption. To a non-expert reader these two terms may seem synonyms; but they are not and it is very important to understand the difference before dealing with rate structures.

Energy demand is measured in kW (Kilowatt); it indicates the rate at which energy is used.

Energy consumption is measured in kWh (Kilowatt hour); it measures overall consumption.

We will use an example to explain better the difference between these two indicators: think about a light bulb working for 10 hours in your home with a power of 100 watt, its consumption after the 10 hours will be 1000 watt-hours (1 kWh). The demand from this light bulb for the 10 hours of use is 100 watt (0.1 kWh). Now think about 10 of the same bulbs working together for just one hour: their consumption will be 100 watt * 10 pieces * 1 hour = 1 kWh but their demand will be also 100 watt * 10 pieces = 1 kW! In A.1 we summarized this example.

In terms of consumption the situation is the same (1 kWh of consumption) but in terms of instant demand the second scenario requires bigger capacity by the supplier (1 kW vs 0.1 kW). As we will see, this difference will play a major role in rate design for bigger consumers: energy consumption and demand must be charged separately in order to face the investments required to meet peak loads in energy demand.

In addition to the above two elements the rate structure may contain also a customer charge: a fixed amount, which is not influenced by demand or energy con-
APPENDIX A. ENERGY DEMAND AND CONSUMPTION

<table>
<thead>
<tr>
<th>Power</th>
<th>Time</th>
<th>Energy consumption</th>
<th>Energy demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 1 Light bulb</td>
<td>10 hours</td>
<td>1 kWh</td>
<td>0.1 kW</td>
</tr>
<tr>
<td>B 10 Light bulbs</td>
<td>1 hour</td>
<td>1 kWh</td>
<td>1 kW</td>
</tr>
</tbody>
</table>

Table A.1: Example. Source: [39]

sumption, made to cover utility’s cost associated with billing, reading meters and collecting payments. If this fixed amount includes also part of the demand cost it’s often called service charge.