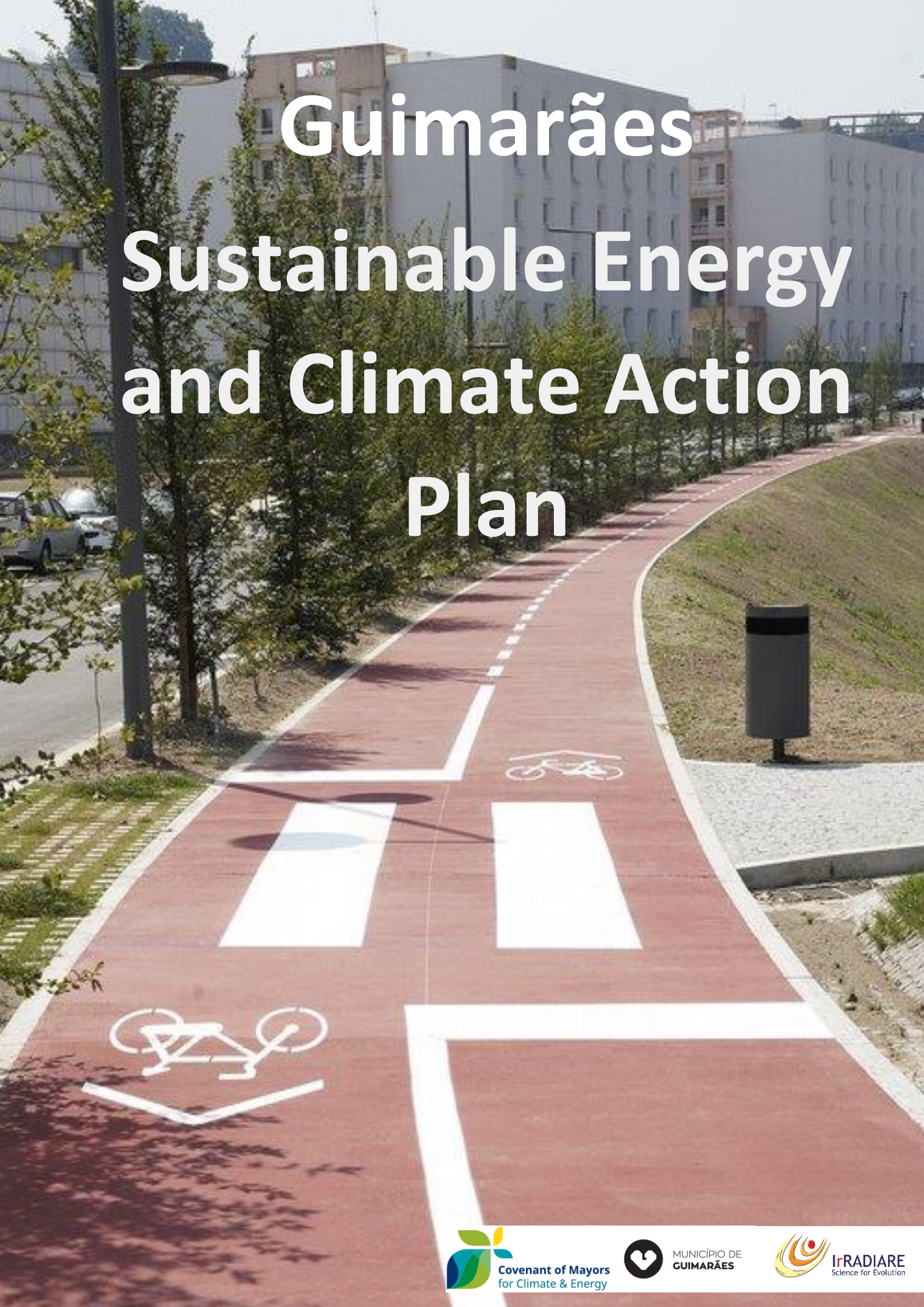
Guimarães Sustainable Energy and Climate Action Plan



Covenant of Mayors for Climate & Energy

MUNICÍPIO DE GUIMARÃES

IrRADIARE Science for Evolution

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1. Introduction

Climate change is one of the greatest threats human population is facing in this era. If the emissions of greenhouse gases continue to grow on a same level, the climate on our planet will exceed a critical point within several decades. In the whole world, businesses, institutions, governments and citizens are tackling this enormous challenge. In Europe, Covenant of Mayors is one of the most relevant and ambitious initiatives in the context of combating climate change. Guimarães is a signatory of Covenant of Mayors since 2013.

Guimarães as a "Birthplace of Portuguese Nationality ", is succeeding in using history as an opportunity to reinvent itself and improve, by engaging the population in being proud of the past, while adopting more sustainable paths for the future. Guimarães has been promoting healthier life style, and a sustainable coexistence between man and nature, using new and existing green spaces, housing new and environmentally friendly, creative industries.

The Municipality of Guimarães signed the Covenant of Mayors on November 21, 2013. After meeting its targets of Sustainable Energy Action Plan 2020, city of Guimarães now established new goals for 2030 in a new Sustainable Energy and Climate Action Plan (SECAP). The implementation of SECAP will allow the municipality to achieve a 39% reduction in energy consumption and 42% of the respective emissions in 2030, boosting production and export of high value-added solutions which reduce the dependence from fossil fuels and the emissions of CO_2.

Guimarães Sustainable Energy and Climate Action Plan is part of a continuous and integrated strategy for climate change adaptation mitigation. In this sense, the action plan now presented assimilates tools, commitments, plans, strategies, policies and projects already been developed or implemented in the municipality of Guimarães as identified in figure 1.

Figure 1: Illustration of tools, commitments, plans, strategies, policies and projects integrated in Guimarães Sustainable Energy and Climate Action Plan.

2. BACKGROUND

Guimarães has a significant importance in Portuguese history, being called the "Birthplace of Portuguese Nationality ". The city's history is renowned and well preserved. In 2001, the historic centre with its innovative housing construction methods was inscribed on the UNESCO World Cultural Heritage list.

In 2012, city became European Capital of Culture and in 2013, Guimarães was the European City of Sport.

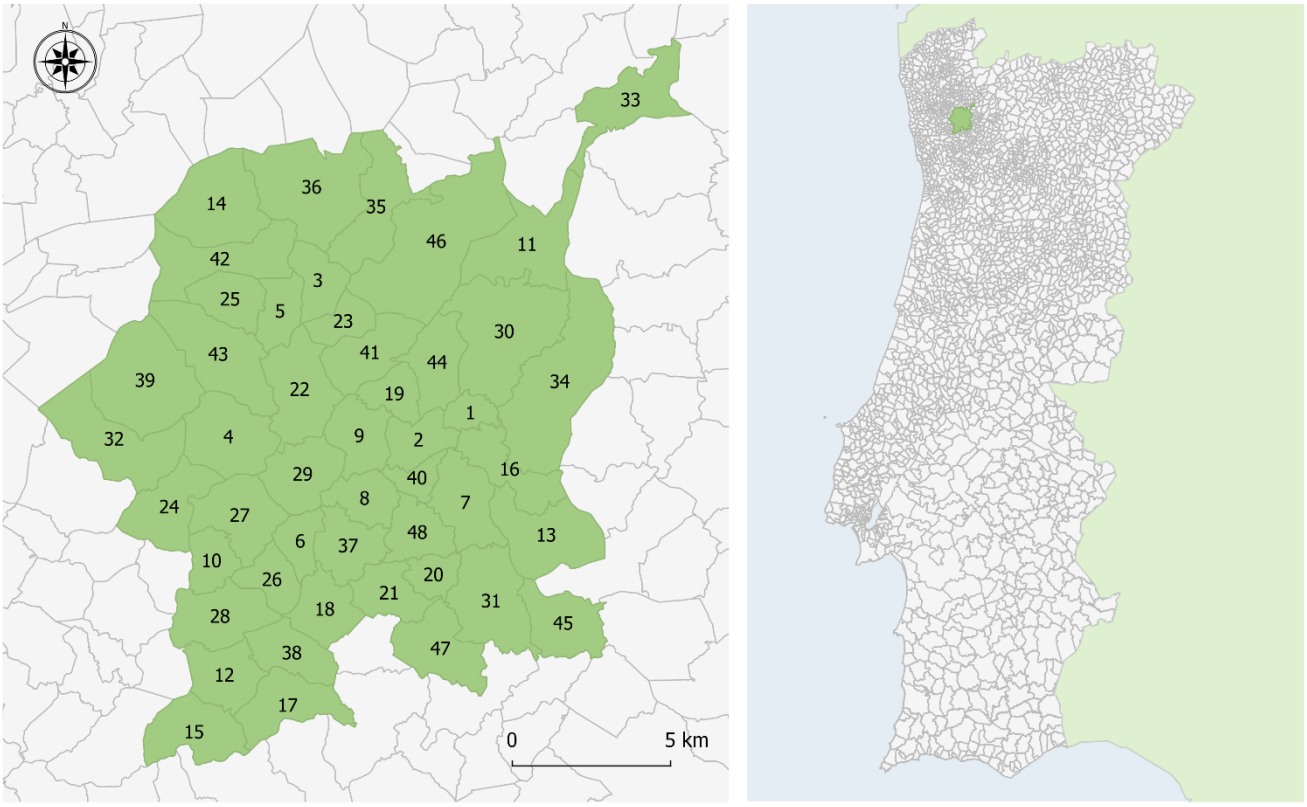
This continued external recognition, which increases and strengthens civic pride and identity, demonstrates that Guimarães has the courage to dream, the will to mobilize resources, and to nurture aspirations among people and organizations to build an increasingly inclusive and sustainable territory.

Important in this process is the continuous restoration of public spaces. Such an approach gains particular importance through emphasising architectural quality and heritage, increasing community enjoyment, and attracting people and sustainable services.

In order to provide a dedicated space for studying and interpreting the city landscape, the Landscape Lab was established in Partnership with the University of Minho, to improve urban planning and environmental control in an historical city.

2.1. About the city

The city of Guimarães is located in the in the northern Portugal, in district of Braga, belonging to the subregion of Ave, being a part of Norte region. The municipality extends in an area of 241.3 km^2, bordered by the municipality of Póvoa de Lanhoso to the north, Fafe to the east, Felgueiras, Vizela and Santo Tirso to the south, Vila Nova de Famalicão to the west and Braga to the northwest. City is administratively divided into 48 civil parishes (freguesias).



Legend:

Parishes of Guimarães Municipality

- 01- Aldão
- 02- Azurém
- 03- Barco
- 04- Brito
- 05- Caldelas
- 06- Candoso (São Martinho)
- 07- Costa
- 08- Creixomil
- 09- Fermentões
- 10- Gondar
- 11- Gonça
- 12- Guardizela
- 13- Infantas
- 14- Longos
- 15- Lordelo
- 16- Mesão Frio
- 17- Moreira de Cónegos
- 18- Nespereira
- 19- Pencelo
- 20- Pinheiro
- 21- Polvoreira
- 22- Ponte
- 23- Prazins (Santa Eufémia)
- 24- Ronfe
- 25- Sande (São Martinho)
- 26- Selho (São Cristóvão)
- 27- Selho (São Jorge)
- 28- Serzedelo
- 29- Silvares
- 30- São Torcato
- 31- União das freguesias de Abação e Gémeos
- 32- União das freguesias de Airão Santa Maria, Airão São João e Vermil
- 33- União das freguesias de Arosa e Castelões
- 34- União das freguesias de Atães e Rendufe
- 35- União das freguesias de Briteiros Santo Estêvão e Donim
- 36- União das freguesias de Briteiros São Salvador e Briteiros Santa Leocádia
- 37- União das freguesias de Candoso São Tiago e Mascotelos
- 38- União das freguesias de Conde e Gandarela
- 39- União das freguesias de Leitões, Oleiros e Figueiredo
- 40- União das freguesias de Oliveira, São Paio e São Sebastião
- 41- União das freguesias de Prazins Santo Tirso e Corvite
- 42- União das freguesias de Sande São Lourenço e Balazar
- 43- União das freguesias de Sande Vila Nova e Sande São Clemente
- 44- União das freguesias de Selho São Lourenço e Gominhães
- 45- União das freguesias de Serzedo e Calvos
- 46- União das freguesias de Souto Santa Maria, Souto São Salvador e Gondomar
- 47- União das freguesias de Tabuadelo e São Faustino
- 48- Urgezes

- Portugal
- Spain

Figure 2: Municipality of Guimarães location.

2.2. Population

The city is populated by 153.995 inhabitants (2016) with population density of 639 inhabitants/km^2 (2016), which is higher than country's average of 106 inhabitants/km^2 (2016), reflecting the high urbanisation of municipality.

According to INE (Statistics Portugal), the resident population in the municipality has decreased slightly in the last decade. Figure 3 shows the evolution of the resident population in the municipality from 2000 to 2016.

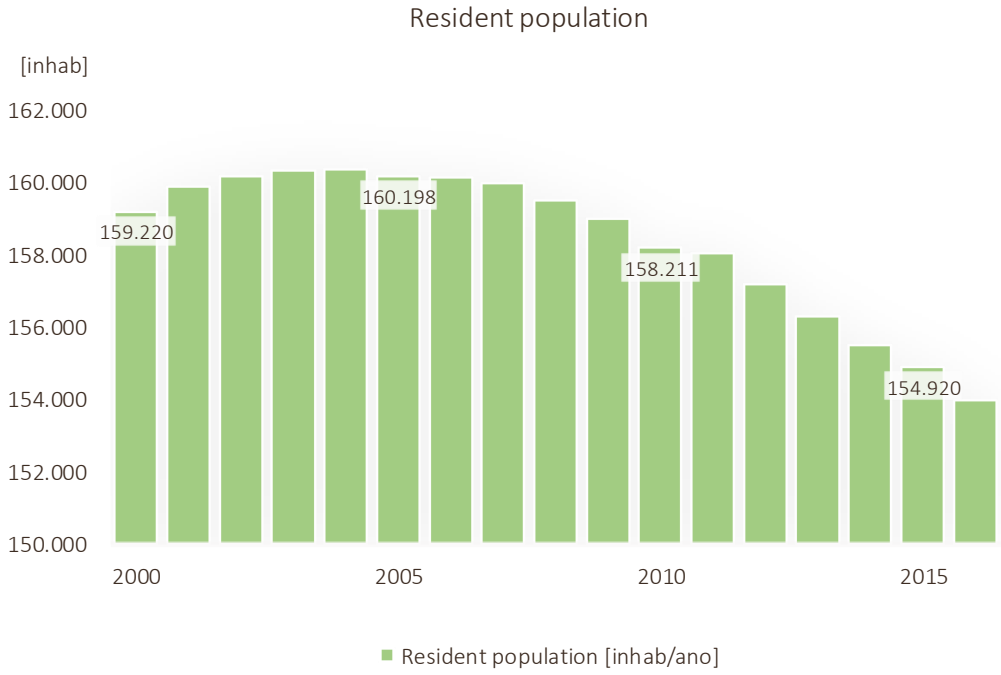


Figure 3: Resident population in the Municipality of Guimarães.

2.3. Economy

Since 1884, when Guimarães hosted the first Industrial Exhibition in Portugal, it is one of the most industrialised municipalities in Portugal. The city is part of the association of industrialised municipalities of the Ave Valley. While city is maintaining its original secondary sector industries, such as textiles, shoe industry and metalomechanics, in the present day, creative industries in the central area are gaining importance. The tertiary sector is represented by banking and insurance, social, recreational and cultural services and domestic

services, which are the sectors with the highest occurence. In contrast to importance of the terciary sector, agriculture is still present in Guimarães.

Industry plays a fundamental role in the dynamics of mobility, and goods transport is done almost exclusively by road. Most industrial areas in the municipality are less than 30 minutes away from the main port and airport infrastructure in the northern region of Portugal. However, some industrial nodes are accessed by roads that present some degree of saturation, which have forced the construction of high capacity roads dedicated to heavy traffic to reduce the impact on populations.

2.4. Transport

In recent years, the municipality has been integrating the best environmental practices, with the clear contribution of the Mission Structure for Sustainable development, established in 2015, which includes an Operational Unit for Sustainable Mobility and Local Transportation.

Public transports

Public transport in the city is operated by ARRIVA company with a fleet of 28 buses. Since 2018, 100% of these buses are electric.

There are two important interfaces (road and rail) near the city centre. The Bus Central Station offers nonurban PT service (express and international) and includes 34 bays. The Guimarães Train Station is a rail terminal of the Porto-Guimarães line, serving the municipality with 4 other stations, offering urban, long distance and national services.

The municipal bus network has 21 lines (255.3 km), covering 27 parishes, with 500 sheltered stops.

Road network

The municipality of Guimarães is served by a dense road network, facilitating access to the municipality from any point in the country. The Baixo Minho Motorway (A11), located west of Guimarães, connects to Barcelos and Braga to the west, and Vizela, Felgueiras, Lousada and Penafiel to the south. The A11 also connects to the Trás-os-Montes and Alto Douro motorway (A4).

The municipality of Guimarães is also served by the Douro motorway (A7), with connection to the Entre-Douro-e-Minho motorway (A3), which allows access to Porto and Lisbon via the

connection to the Norte motorway (A1). Access to the Spanish border in Valencia is also facilitated through the A7 and A3. With a railway station located about 1km from the historic centre, the municipality of Guimarães is served by Intercity trains with direct connection to Lisbon and by urban trains from Porto that allow the transfer between Guimarães/Porto. Both options ensure rail access to other destinations.

Sustainable mobility

City Hall has launched a carpooling platform "**Guimarães a boleia**" and a Car-sharing programme with electric vehicles, "**ZENCAR**". In addition, the city has installed the first urban rapid charging point in Portugal in view of having a decarbonized transport sector. Electric vehicles are exempted from parking fees until 2020 at the 18 charging points that are part of the Mobi.e network. City Hall has acquired 13 electric vehicles aiming to convert the 124 vehicles of municipal fleet to electric vehicles. The PAYT' vehicles of waste system implemented in the Historical Centre are already electric.
By sponsoring public-private relations, the City Hall is committed towards supporting private entities in the development of innovative projects: **EducaBicla** was set up with a local company to promote soft mobility. **UBIKE** is a programme for long-term bicycle rental for members of the local academic community.
Special emphasis was given to the construction of the first **bicycle paths** in the municipality, especially in inter and intra-municipal connections. The process was difficult and required coordinated actions in the creation of cycling tracks with special focus on the connections of the city of Guimarães with other urban areas, using previously existing channels, examples of which are the bicycle paths, totalling 12.2km.

Action has already begun within the **Guimarães mais verde** Commitment and **PEGADAS**. Since 2015, awareness is being accomplished in particular among the youth but also for the entire population, and since then Guimarães has actively participated in the European Mobility Week with the involvement of the whole community.

2.5. Green spaces

In addition to their social function, providing spaces for leisure and interaction with nature, green spaces also play an important role in the mitigation of ambient temperature by intervening at the level of air infiltration, convection of heat and the transmission of radiation and contributing to increase the relative humidity of the air.

The green urban spaces together with water areas take up 436 ha (1.81% of the total area of the municipality). Private green spaces and the forest areas account for 33.4% of green areas.

Share of population residing within a radius of 300m of green and water areas over 5.000m^2 is 21.6% for the total city. For the inner city, this figure accounts for 76.8%, reflecting the greater density of urban public green areas and water areas in the most urbanized area of the municipality.

2.6. Sustainability

Using history as an opportunity to reinvent itself and improve, to raise its standards and quality, Guimarães has been promoting healthier life styles, and a sustainable coexistence between man and nature. By developing green spaces, housing new and environmentally friendly, creative industries, engaging the population in being proud of the past, while adapting and adopting more sustainable paths for the future.

A survey conducted about the environmental consciousness of its inhabitants shows that the population is behind the city governors in supporting access to green areas (agricultural, forest and public parks), using of public transport demanding inter-modality and systems integration, and showing concern about excessive traffic, particularly in the historic centre and the surrounding area. Ecological Footprint of Guimarães, and its carbon footprint, are lower than the national rates although our per capita income is higher.

Today, Guimarães is already a model and an inspiration for others with its the pioneering spirit, its strategy, priorities, projects and investments. One prime example is the construction of the first near-zero carbon building in Portugal. In 2017, the Gymnastics Academy was built, a self-sustainable building with recovery of heat and energy, due to its unobstructed solar orientation. In addition, the building was equipped to reuse all water after treatment.

Guimarães already managed to implement several actions towards more efficient building in both public and private sectors. In municipal buildings, a reduction of 10% in the costs relating to energy consumption in municipal buildings had already been achieved between years 2016-2018, together with an increase in the consumption of natural gas. School buildings were restructured through active and passive building solutions, 12% of schools already have central heating that operate through the burning of biomass. In municipal sports facilities, electronic ballasts and 4-track heat pumps were installed, together with thermal insulation in the building envelope and an intelligent power management system. Social housing buildings were restructured, in order to improve their energy performance by adding thermal insulation in the building envelope, replacing existing windows and installing solar thermal equipment and photovoltaic systems.

Guimarães has received the national recognition for its environmental policies towards sustainable development that have resulted in the award of various distinctions and awards, as shown in Figure 4.

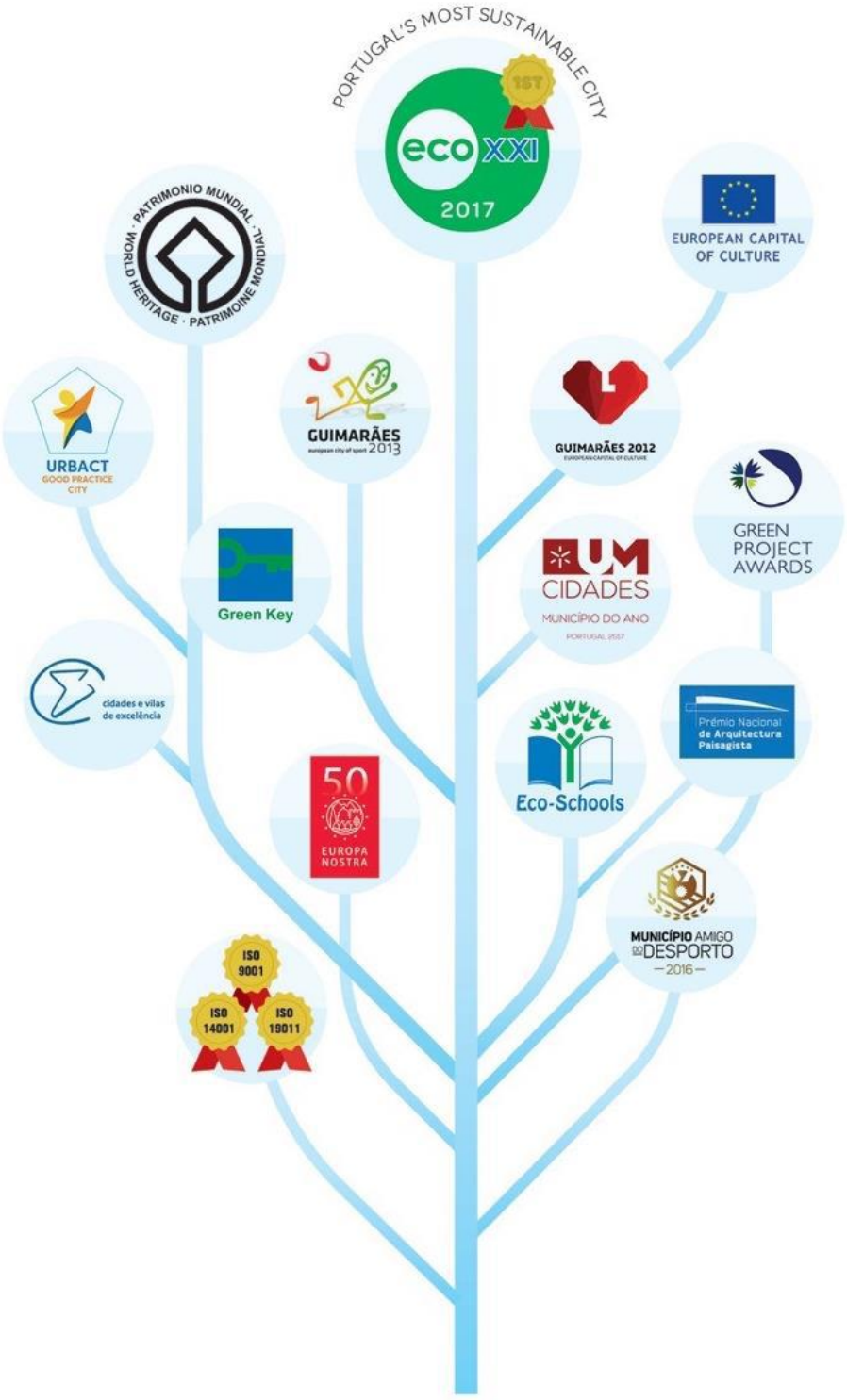


Figure 4: Guimarães Eco awards (source: CM Guimarães).

3. CLIMATE ACTIONS

Climate Change is one of the greatest environmental, social and economic challenges that society faces. Despite the controversy over the temporal scope and the severity of the consequences of global warming, the international community agrees on the need to undertake preventive measures aimed at reducing energy consumption and emissions of greenhouse gases.

These strategies are also in line with the efforts dedicated to undertake a sustainable path of development, which must be characterized by rational use of resources and the minimization of the environmental and socioeconomic impacts. This chapter offers a brief overview of the different policies, commitments and initiatives that have been taking place for decades in the institutional sphere in favour of Sustainable Development and the fight against Climate Change.

3.1. International actions

Kyoto Protocol (2005)

During the III Conference of the Parties of the UN Framework Convention on Climate Change (UNFCCC) held in Kyoto with the representation of 125 countries, the "Kyoto Protocol" was adopted. It entered into force on February 16, 2005 and implemented the objective of the UNFCCC to reduce the onset of global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system".

The European Emissions Trading Scheme (ETS)

The European Emissions Trading Scheme (ETS) is now, at European level, the main policy instrument to mitigate greenhouse gas emissions. The implementation of the ETS scheme began in 2005, with the first period between 2005 and 2007, considered by the European Commission as experimental and essentially learning for the following period: 2008-2012, which coincided with the period of compliance with the Protocol of Kyoto. In the first two periods of application of the ETS scheme (2005-2007 and 2008-2012), the basic rules of the scheme were, in general, the free allocation of emission allowances (EA), the obligation to monitor, verify and report emissions and return of EA in the corresponding amount. The

European Council of 23 and 24 October 2014 adopted the EU Climate and Energy Framework 2030, which states that the sectors covered by the ETS regime will have to reduce their emissions by 43% by 2030 compared to 2005.

Europe 2020 (2010)

Europe 2020 is a 10-year strategy proposed by the European Commission on 3 March 2010 for advancement of the economy of the European Union. It aims at "smart, sustainable, inclusive growth" with greater coordination of national and European policy. One of the main targets is to reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are right, increase the share of renewable energy in final energy consumption to 20%, and achieve a 20% increase in energy efficiency.

Paris Agreement (2016)

Another important document adopted within UNFCCC is the Paris Agreement ratified in 2016. The agreement for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. The Paris Agreement central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1,5°C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. As of July 2018, 195 UNFCCC members have signed the agreement, and 180 have become party to it.

3.2. National and Regional Actions

National Strategy for Adaptation to Climate Change ENAAC 2020 (2010)

In 2010 Portugal approved its National Strategy for Adaptation to Climate Change (ENAAC) with the first phase taking place between 2010 and 2013. From the experience gained, ENAAC's review was promoted, filling the gaps and capitalizing on the identified strengths and opportunities. Resolution of the Council of Ministers in 2015 approved ENAAC 2020, within the scope of the Strategic Framework for Climate Policy (QEPiC), which establishes the vision and objectives of the national climate policy in the year 2030, reinforcing its commitment to the development of a competitive, resilient and low carbon economy, contributing to a new paradigm of development for Portugal. ENAAC 2020's vision is: "A country adapted to the

effects of climate change, through the continuous implementation of solutions based on technical-scientific knowledge and good practices".

National energy strategy

The energy policy options adopted in the National Energy Strategy - ENE 2020 are seen as a factor of economic growth, of promoting competition in the energy markets, of creating value and of qualified employment in sectors with high technological incorporation. The aim is to keep Portugal at the forefront of the technological component of renewable energies, by boosting the production and export of solutions with high added value, which will also reduce energy dependence from abroad and reduce greenhouse gas emissions.

The preparation of this PASEC had to guideline the trace efficiency levels of improvement objectives in energy consumption and increased renewable penetration. At the same time, objectives of national interest are served: improving the country's energy sustainability, reducing external dependence on energy supply and reducing the energy intensity of the national economy. The objectives of national interest are in line with the National Energy Strategy, ENE2020, previously mentioned.

The intervention now described is also in line with the objectives of the regional OP.

National Program for Climate Change PNAC 2020/2030

The National Program for Climate Change 2020/2030 (PNAC 2020/2030) aims to ensure the achievement of national targets for climate change within the cross-cutting and integrated intervention areas, with a view to more effective organization of measures. It is considered a "2nd generation" plan that focuses on the integration of climate policy in sectoral policies and greater accountability of the sectors based on the level of maturity achieved by the national climate policy. It is supported by a dynamic implementation process, giving the sectors the opportunity to identify policies and measures (P & M) that contribute to the establishment of emission reduction targets, supported by the Policy and Measures System (SPM).

PNAC 2020/2030 aims to promote the transition to a low-carbon economy, generating more wealth and jobs; ensure a sustainable path to reduce GHG emissions in order to reach a target of -18% to -23% in 2020 and -30% to -40% in 2030, compared to 2005, ensuring compliance with national and putting Portugal in line with the European objectives and with the Paris Agreement; promote the integration of mitigation objectives into sectoral policies.

The National System for Policies and Measures (SPM)

The National System for Policies and Measures (SPM) is a mandatory implementation system, essential to the assessment of progress in climate and reporting policy, which demonstrates compliance with the obligations under the United Nations Framework Convention on Climate Change for Climate Change (UNFCCC) and Community. This includes the applicable institutional, legal and procedural arrangements for assessing policies and preparing GHG emission projections on the establishment of a monitoring and reporting on greenhouse gas emissions and communication at national and EU level of other relevant information on climate change (MMR).

Low-Carbon National Roadmap (2012)

The Low Carbon Roadmap 2050 (RNBC) was published in 2012 and its main goal is to study the technical and economic viability of Greenhouse Gases (GHG) emission reduction pathways up to 2050 consistent with EU overall objectives. The Roadmap concludes that it is possible to achieve emission reduction of 50% to 60% by the year 2050, compared to levels of 1990. The study also concludes that all sectors of activity have the potential to reduce emissions, particularly in the energy sector.

AEdoAVE (2010)

Looking to promote a sustainable development in the county and the region in which it is inserted, Guimarães is one of the associated municipalities of the Ave Energy Agency (AEdoAVE). AEdoAVE was established in October 2010 and is a non-profit private law cooperative. Its scope includes the entire NUT III Ave region, which consists of 8 municipalities. The Agency's corporate purpose is to contribute to energy efficiency, the rational use of energy and the use of endogenous, renewable and non-polluting natural resources. AEdoAVE contributes to sustainable development by enabling solutions with a lower environmental impact and by introducing concepts of energy and environmental efficiency into planning and spatial planning processes.

3.3. Local Actions

Strong commitment of Guimarães towards mitigating impacts of climate change and towards use of sustainable energy is shown in its participation in multiple international agreements. The city of Guimarães committed to the Aalborg Charter, the implementation of Agenda 21 Local, to the Basque Declaration, the initiatives Covenant of Mayors and ClimAdaPT.local,

which contributed significantly to combat climate change through processes of mitigation and adaptation.

Aalborg Charter (1994)

The Aalborg Charter is an urban sustainability initiative approved by the participants at the first European Conference on Sustainable Cities & Towns in Aalborg, Denmark in 1994. The Charter is based on the consensus of individuals, municipalities, NGOs, national and international organisations, and scientific bodies. More than 3 000 local authorities from more than 40 countries have signed the Charter. This has resulted in the largest European movement of its type and started the European Sustainable Cities and Towns Campaign. After over 20 years, the spirit of the Aalborg Charter remains. It prepared the ground for a variety of schemes and movements for local sustainability, such as the Aalborg Commitments and eventually the Sustainable Cities Platform.

Agenda 21 Local

A management tool for the sustainability of a site, based on a diagnosis of the current situation of reference, establishes goals to be achieved in the areas of environmental protection, socio-economic development and social cohesion, developed by local actors in partnership with citizens and civil society, promoting citizenship.

Covenant of Mayors

The Covenant of Mayors initiative was launched by the European Commission in 2008, with the objective of engaging and supporting mayors to commit to reaching the EU climate and energy targets.

The Municipality of Guimarães signed the Covenant of Mayors on November 21, 2013. As part of the adhesion to this initiative, the Sustainable Energy Action Plan (SEAP) of Guimarães was carried out. Several energy sustainability actions have been defined in order to achieve the commitment assumed with the signing of the Covenant of Mayors, namely a reduction of 20% of the municipal emissions by 2020.

In 2014 the state of implementation of the energy sustainability measures foreseen in the SEAP is approximately 108%. The results already achieved and Guimarães commitment to the continuous improvement of local environmental sustainability motivate the municipality to commit to new municipal targets for the improvement of municipal energy sustainability, namely a 40% reduction of CO_2 emissions by 2030.

ClimAdaPT.Local (2014)

The goal of ClimAdaPT.Local project is starting a continuous process leading to the elaboration of Municipal Strategies for Adaptation to Climate Change (Estratégias Municipais de Adaptação às Alterações Climáticas – EMAAC) and its integration in municipal planning tools in Portugal. In order to achieve this goal, it is intended to capacitate municipal staff persons in climate change adaptation, to raise awareness of local stakeholders, and to develop tools and products which will enable the formulation and implementation of the Municipal Strategies for Climate Change Adaptation.

The Basque Declaration (2016)

The Basque Declaration outlines new pathways for European cities and towns to create productive, sustainable and resilient cities for a liveable and inclusive Europe. The document aims to support and accelerate socio-cultural, socio-economic and technological transformation. The Basque Declaration was acclaimed by the participants of the 8th European Conference on Sustainable Cities & Towns held in the Basque Country in 2016, and it is an important step following the Aalborg Charter (1994) and the Aalborg Commitments (2004). The Declaration acknowledges the need for transformation in order to decarbonise energy systems, create sustainable urban mobility patterns, protect and enhance biodiversity and ecosystem services, reduce the use of greenfield land and natural space, protect water resources and air quality, adapt to climate change, improve public space, provide adequate housing, guarantee social inclusion, and strengthen local economies. The Basque Declaration aims to inspire cities and towns to develop and create their own local transformative actions.

Sustainable Urban Mobility Plan

Sustainable Urban Mobility Plan is a strategic and operational document adopted by Guimarães promoting soft modes (SM), public transport (PT) and reducing individual transport (IT), while simultaneously ensuring levels of accessibility and mobility, social inclusion, competitiveness, quality of life and preservation of historic buildings and environmental heritage. The municipality has recently implemented measures to reduce carbon emissions, through the promotion of hybrid and electric vehicles and alternative means of transport.

Guimarães mais verde

City Hall promotes ecocitizenship through Guimarães mais verde commitment. At a political level, all the parties and Parish Council presidents are committed to local sustainable development - Declaration of Political Consensus. The mission structure has a very broad and multidisciplinary character, with a shared responsibility among technical, scientific and political elements at the highest level and where there is also a lack of external supervision and advice, guaranteed by some personalities who are global references in this area.

4. COVENANT OF MAYORS

4.1. About Covenant of Mayors

The Covenant of Mayors is the world's largest movement for local climate and energy actions bringing together local governments committed to implementing climate and energy objectives.

The Covenant of Mayors was launched in 2008 in Europe with the ambition to gather local governments voluntarily committed to achieving and exceeding the EU climate and energy targets. In June 2016, the Covenant of Mayors entered a major new phase of its history when choosing to join forces with another city initiative, the Compact of Mayors, forming "Global Covenant of Mayors for Climate and Energy".

The initiative gathers more than 7.700 local and regional authorities across 53 countries globally. The Global Covenant of Mayors wants to tackle three key issues: climate change mitigation, adaptation to the adverse effects of climate change and universal access to secure, clean and affordable energy.

Figure 5: Covenant community

As of September 2018, there were 140 signatories of Covenant of Mayors in Portugal covering over 6 million out of 10 million inhabitants in total. Portugal is one of the countries with the highest stage in the Covenant of Mayors process.

Figure 6: Covenant Community in Portugal

The commitments for Covenant signatories are linked to the EU's climate and energy policy framework: the 2020 climate and energy package for signatories who have joined between 2008 and 2015 and the 2030 climate and energy framework as well as the EU Strategy on Adaptation to Climate Change for signatories joining after 2015.

4.2. Commitments

Covenant of Mayors for Climate and Energy signatories endorse a shared vision for 2050: accelerating the decarbonisation of their territories, strengthening their capacity to adapt to unavoidable climate change impacts, and allowing their citizens to access secure, sustainable and affordable energy.

To achieve this vision signatories commit to reduce CO_2 emissions on its territory at least 40% by 2030 and the adoption of a joint approach to tackling mitigation and adaptation to climate change.

In order to translate their political commitment into practical measures and projects, the signatories commit to submitting a Sustainable Energy and Climate Action Plan (SECAP), outlining the key actions they plan to undertake. Signatories also commit to report SECAP implementation progresses every two years.

4.3. Action Plan

The SECAP is based on a Baseline Emission Inventory (BEI) and a Climate Risk & Vulnerability Assessment(s) (RVAs) which provide an analysis of the current situation. These elements serve

as a basis for defining a comprehensive set of actions that local authorities plan to undertake to reach their climate mitigation and adaptation goals. SEAP should cover areas where local authorities can influence energy consumption on the long term (as land use planning), encourage markets for energy efficient products and services (public procurement), as well as changes in consumption patterns (working with stakeholders and citizens).

The methodology endorsed by the Covenant of Mayors relies on an integrated and inclusive climate and energy planning, in which local stakeholders have an active role to play.

The Action Plan now presented follows the methodology proposed by the Covenant of Mayors with the appropriate adaptations to the reality of the municipality of Guimarães, using as a reference the results obtained in the Baseline CO_2 emissions inventory, with regard to the reference situation and with regard to forecasts of its evolution.

In the implementation of SECAP, the municipality of Guimarães will develop several actions to mobilize local, business, social and institutional agents. Among other initiatives, the municipality will promote the formation of a Local Support Group for the implementation of SECAP, a group that will play a fundamental role in the dissemination of good energy efficiency and renewable energy integration practices in order to achieve the goals set.

The municipality of Guimarães will also pay a particular attention to the youngest population, recognizing the important role of children and young people in the awareness of society, in its global.

5. BASELINE EMISSION INVENTORY

The Baseline Emission Inventory supports decision-making processes at local and regional levels and monitoring the progress both regarding increasing sustainability and improving population's quality of life.

5.1. Scope

The Baseline Emission Inventory (BEI) was developed under the context of Covenant of Mayors for Climate and Energy, which concerns its action at local level within the competence of the local authority. Thus,

The baseline CO_2 inventory should essentially be based on final energy consumption, including both municipal and non-municipal energy consumption in the local authority's territory. The main target sectors are buildings, equipment/facilities and urban transport and local renewable electricity production.

Emissions not related to energy, such as CH4 or N2O from wastewater treatment, solid waste treatment, agriculture, livestock and others, were not included. Industrial plants covered by the European CO_2 Emission Trading Scheme should also be excluded.

5.2. Methodology

With the execution of the baseline emissions inventory of the Municipality of Guimarães it is intended to quantify the energy consumptions and the CO_2 emissions inherent to the activity developed in the territory of the municipality, taking as reference the year of 2008.

The baseline emissions inventory has as tools the energy inventory and the CO_2 emission inventory.

Energy inventory

Municipality's energy inventory includes the calculation of energy consumption and production, as well as respective local evolutionary trends. Thus, in this analysis, scenarios of

evolution of energy demand for a time horizon that ends in 2050 are proposed. The endogenous production of renewable energy is also quantified.

Scenarios are calculated using a mathematical model based on available projections, through international organizations and public bodies responsible for planning and prospective study. These projections refer to macroeconomic and demographic variables. Complementarily, the scenarios of evolution of the national energy system, estimated for the national space, are considered.

Among the group of entities whose references were considered, Eurostat, the European Environment Agency, the International Energy Agency, the European Commission's General Directorate for Mobility and Transport, the European Commission's General Directorate for Energy, The Joint Research Centre of the European Commission (JRC), the Organization for Economic Cooperation and Development and of course the relevant national bodies, such as the General Directorate of Energy and Geology, the Portuguese Environment Agency, the Entity for Regulating Energy Services and the National Statistics Institute stand out.

The macroeconomic and energy scenario proposed by the European Commission in 2016 during "EU Energy, transport and GHG emissions – trends to 2050" stands out among the elements considered as reference of the proposed scenarios. These scenarios used the PRIMES model as a resource, supported by some more specialized models and databases, such as ones that guide the evolution of international energy markets. The POLES model of the global energy system, GEM-E3, and some macroeconomic models are also considered as a reference.

The proposed results are derived from the use, for the considered territory, of a specific model developed by IrRADIARE, Science for Evolution®.

CO_2 emissions inventory

The methodology used to determine CO_2 emissions is based on the recommendations of the *Joint Research Centre* for the implementation of the Sustainable Energy Action Plans.

As such, the scenarios are determined by applying emission factors to scenarios resulting from the implementation of the energy matrix, having chosen to use standard emission factors in line with the principles of the IPCC.

In the framework of the implementation of the emissions matrix, scenarios are proposed for the evolution of energy demand and respective emissions for a time horizon ending in 2050.

5.3. Energy Inventory

Energy vectors

The following figures illustrate energy consumption per energy vector for the years 2016, 2020 and 2030 and 2050. Consumption is distributed by the following energy vectors: electricity, natural gas, butane, propane, gasoline and auto gas, diesel for road transport, coloured gas oils (coloured diesel and coloured fuel for heating) and other industrial fuels (fuel oil, petroleum and petroleum coke). In this way, the evolution of proportion for the consumption of each energy vector in the total consumption of energy consumed in the municipality is visualized.

In the year 2016 (figure 7), there is a relatively varied and distributed use of energy vectors used in the municipality, with electricity consumption (34%), natural gas (26%) and diesel fuel (24%) being the most prominent.

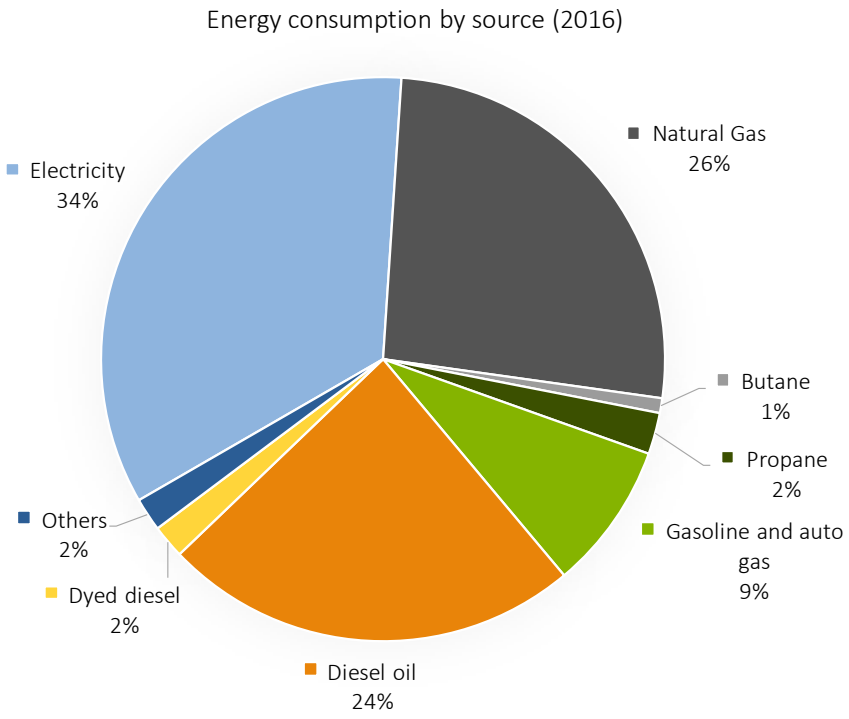


Figure 7: Energy consumption by energy sector in 2016 [%]

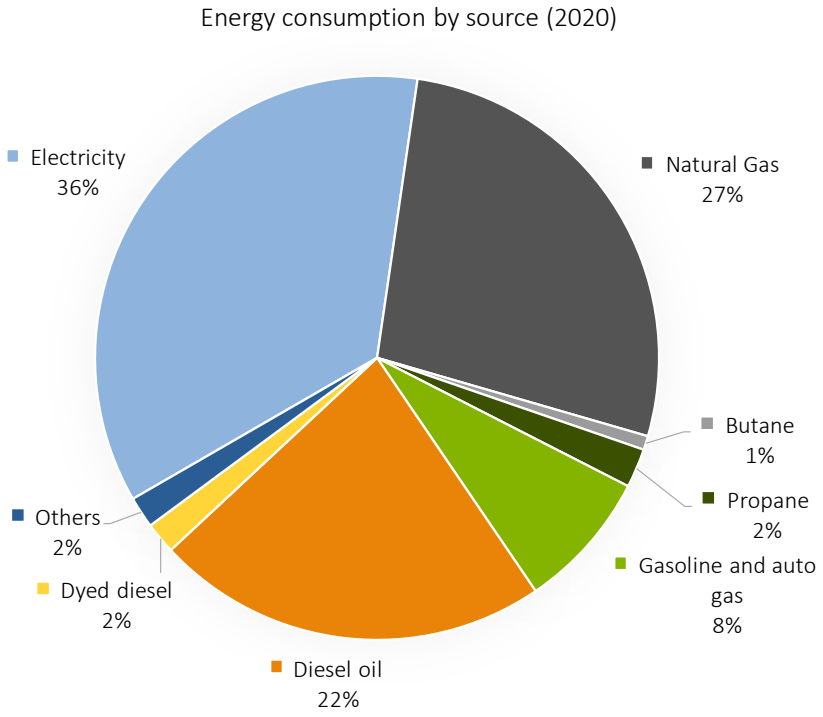


Figure 8: Energy consumption by energy sector in 2020 [%]

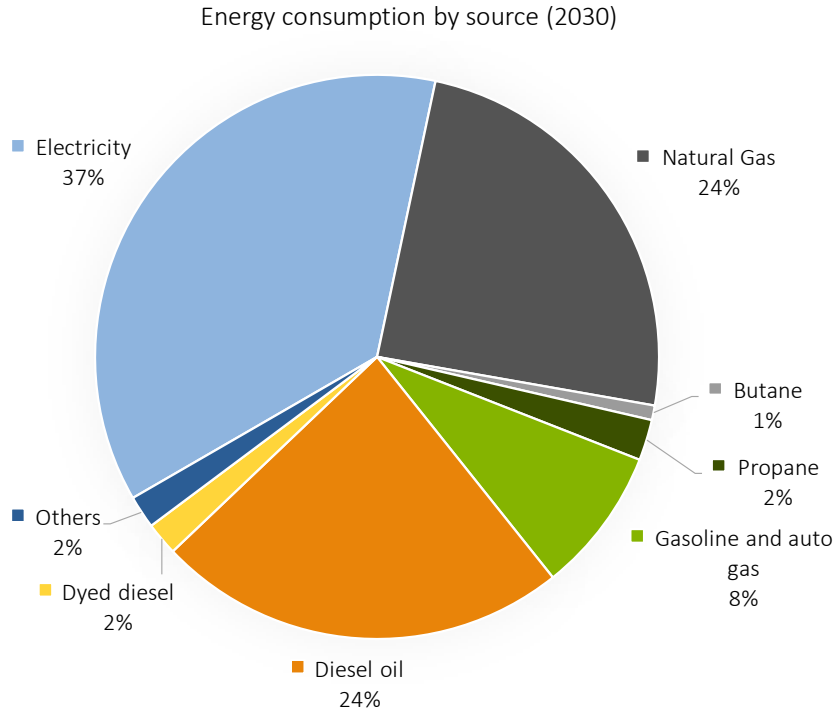


Figure 9: Energy consumption by energy sector in 2030 [%]

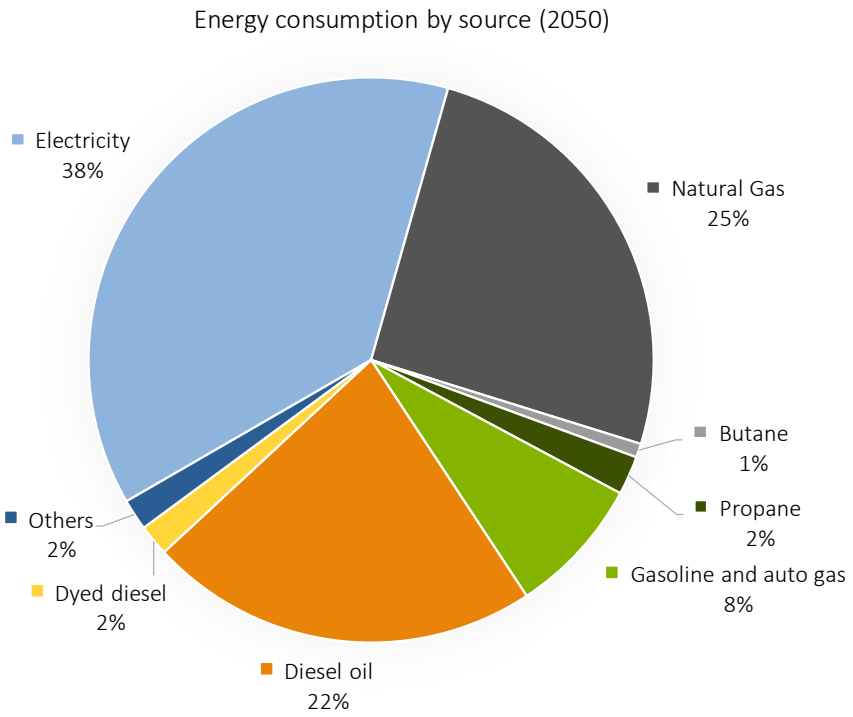


Figure 10: Energy consumption by energy sector in 2050 [%]

Consumption by Sector

Figures below show the consumption of electricity by activity sector for the years 2016, 2020 and 2030 and 2050. The energy consumption presented refer to the main electricity consuming sectors: domestic, industrial, agriculture, services, water supply services, tourism and public lighting. This way, it is possible to observe the evolution of the energy proportion of each sector in the total consumption of electric energy of the municipality, during the projection period.

The graph of figure 11, referring to the consumption of electric energy by sector in 2016, highlights the high electrical needs of the industrial and domestic sector, which consume respectively about 45% and 25% of the total electric energy used in the county. A significant share of consumption (21%) is shown in service sector.

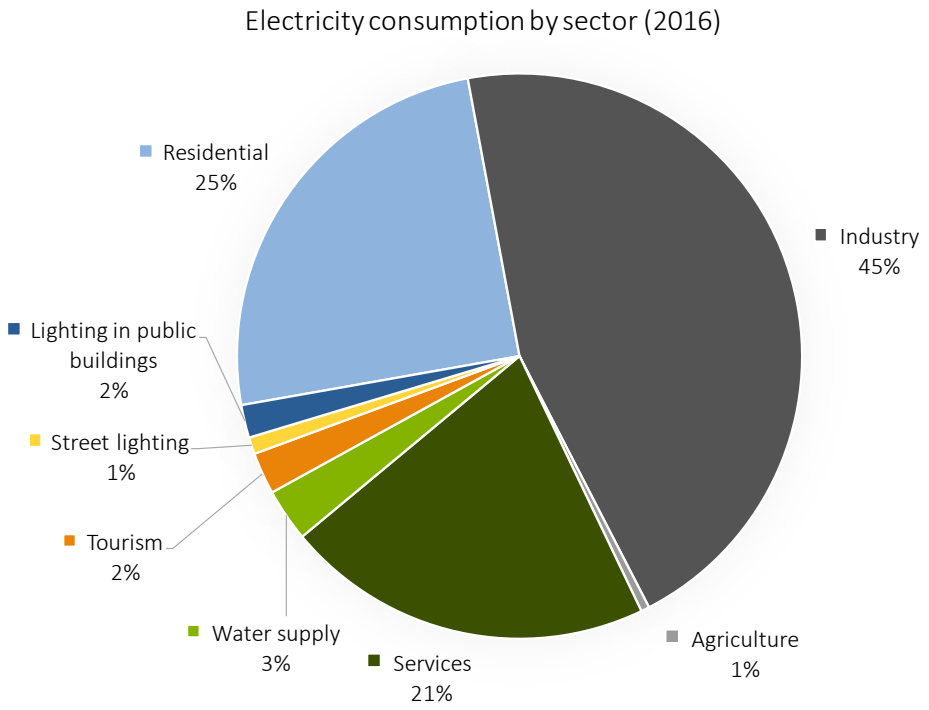


Figure 11: Consumption of electric energy by sector of activity in 2016 [%]

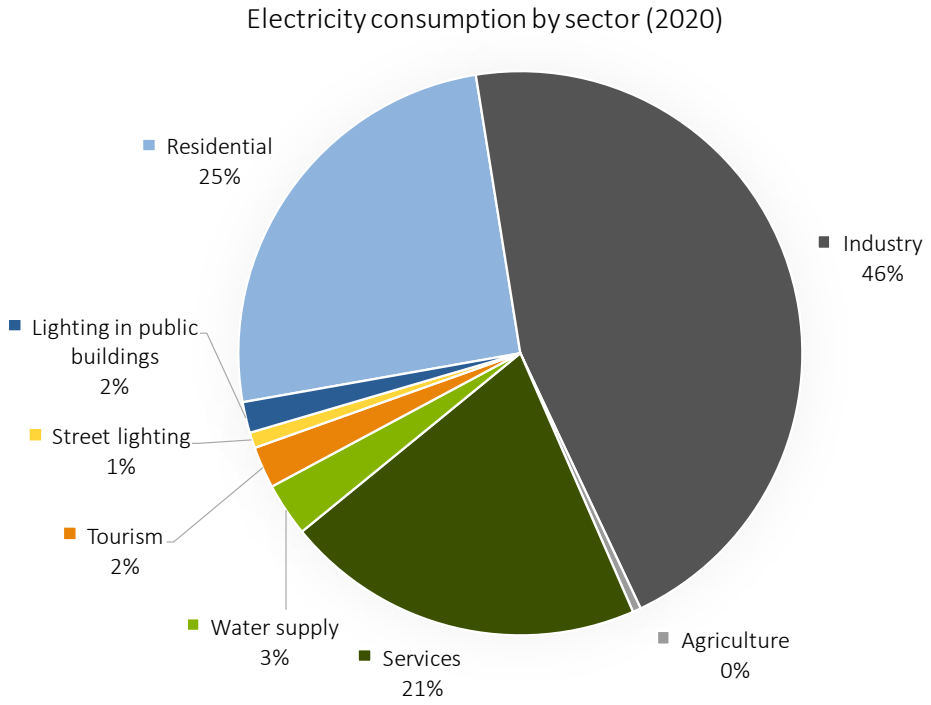


Figure 12: Consumption of electric energy by sector of activity in 2020 [%]

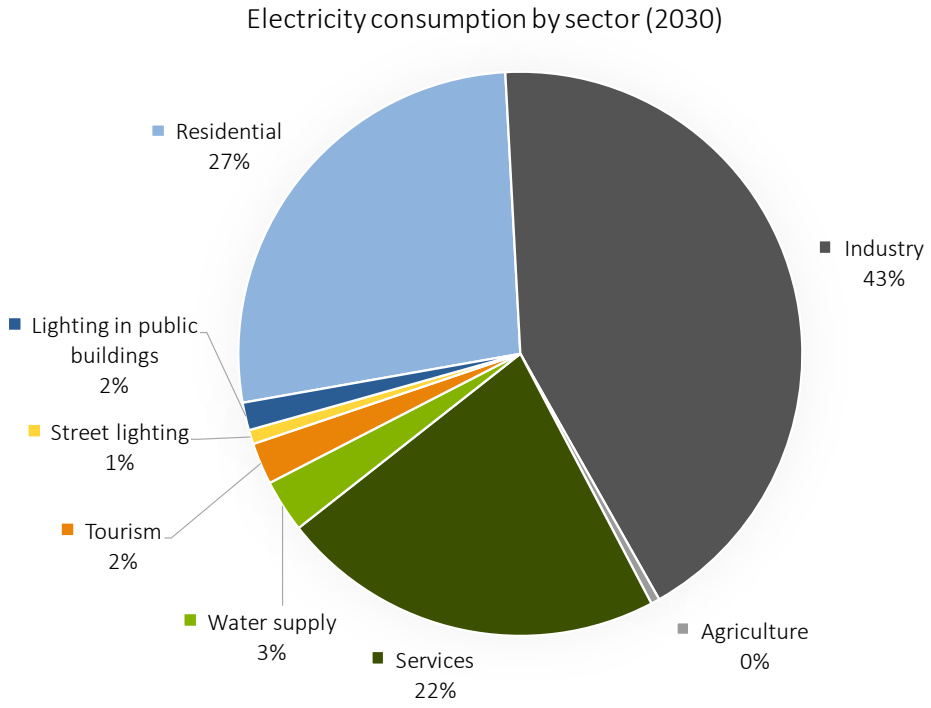


Figure 13: Consumption of electric energy by sector of activity in 2030 [%]

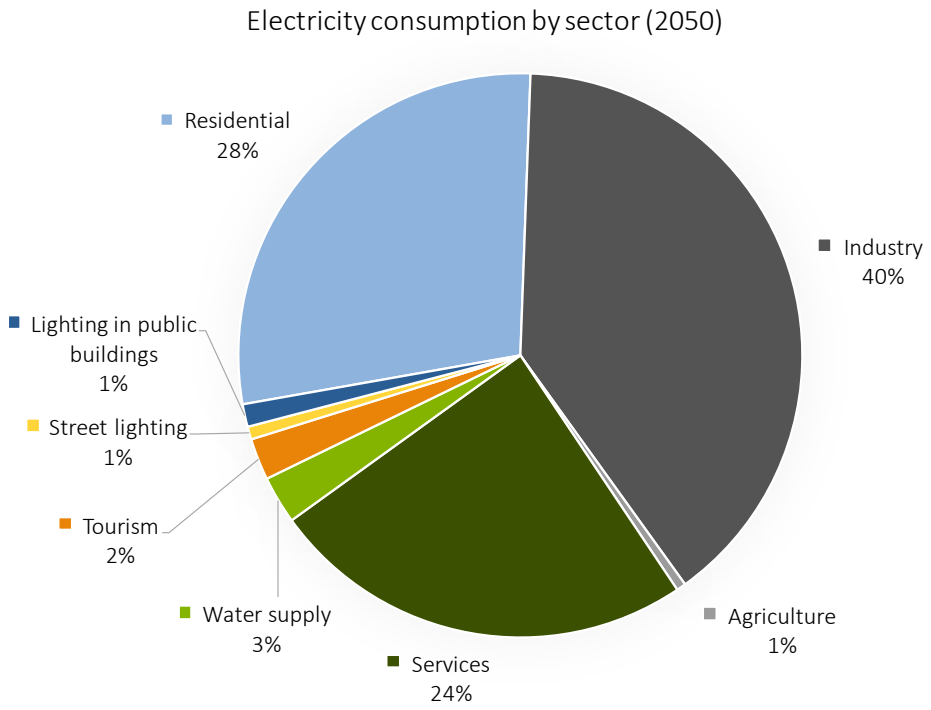


Figure 14: Consumption of electric energy by sector of activity in 2050 [%]

The following figures illustrate the consumption of fossil fuels by sector for the years 2016, 2020 and 2030 and 2050. The consumption represents the main sectors of this type of fuel, namely the domestic, industrial, agriculture, services and transport sectors. That way, it is possible to observe the evolution of the proportion of the demand for fossil fuels of each sector in the total consumption of the municipality, over the projection period.

Looking at the graph on the demand for fossil fuels by sector in the year 2014 (figure 15), the demand for the transport sector is identified, corresponding to 48% of consumption, followed by the industrial sector, which represents 38% of consumption.

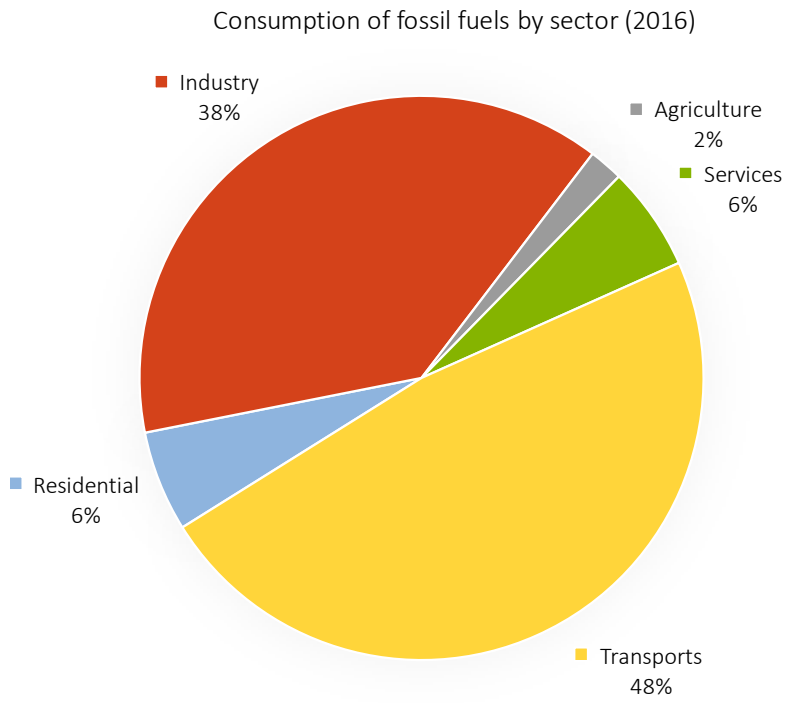


Figure 15: Total fossil fuel consumption by sector of activity in 2016 [%]

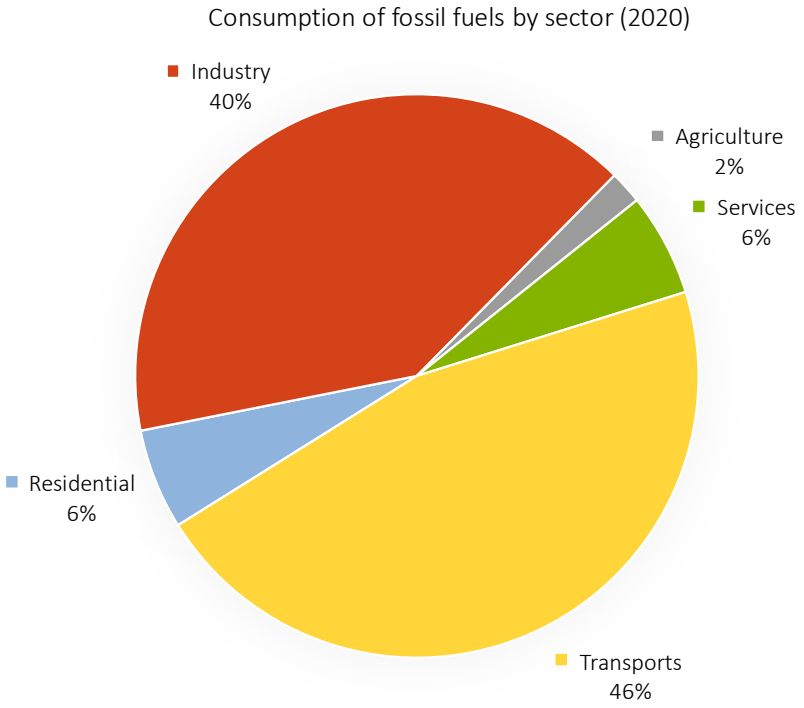


Figure 16: Total fossil fuel consumption by sector of activity in 2020 [%]

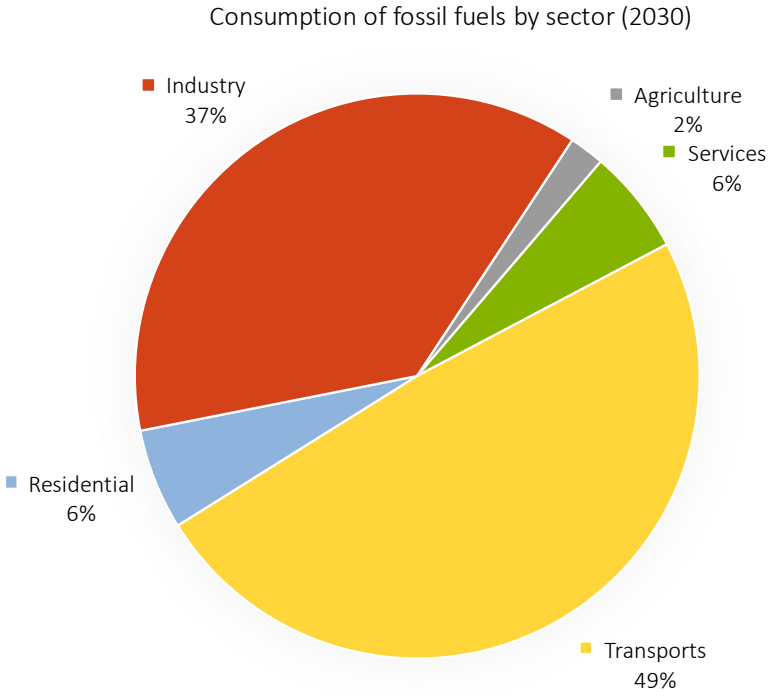


Figure 17: Total fossil fuel consumption by sector of activity in 2030 [%]

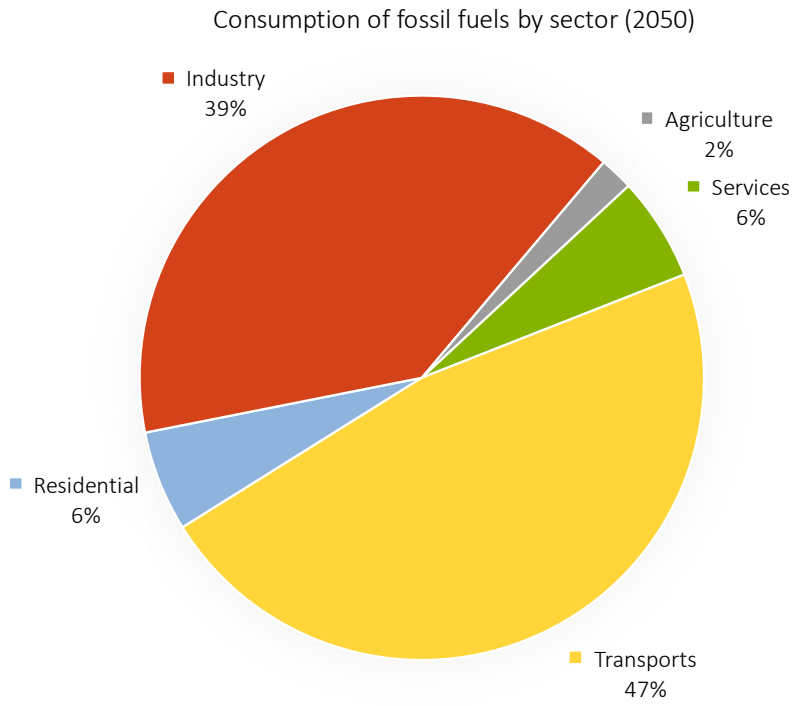


Figure 18: Total fossil fuel consumption by sector of activity in 2050 [%]

The figures below illustrate the total energy consumption per sector for the years 2016, 2020 and 2030 and 2050. The total energy consumption presented are related to the main energy consuming sectors in the municipality, namely the domestic, industrial, agriculture, services and transport sectors, and it is possible to observe the evolution of the energy proportion of each sector in the total energy consumption of the municipality, over the analysis period.

Looking at the graph shown in figure 19, in 2016 there is a predominance of energy demand in the industry sector, 41% of energy demand, followed by the transport sector, with 31% of consumption.

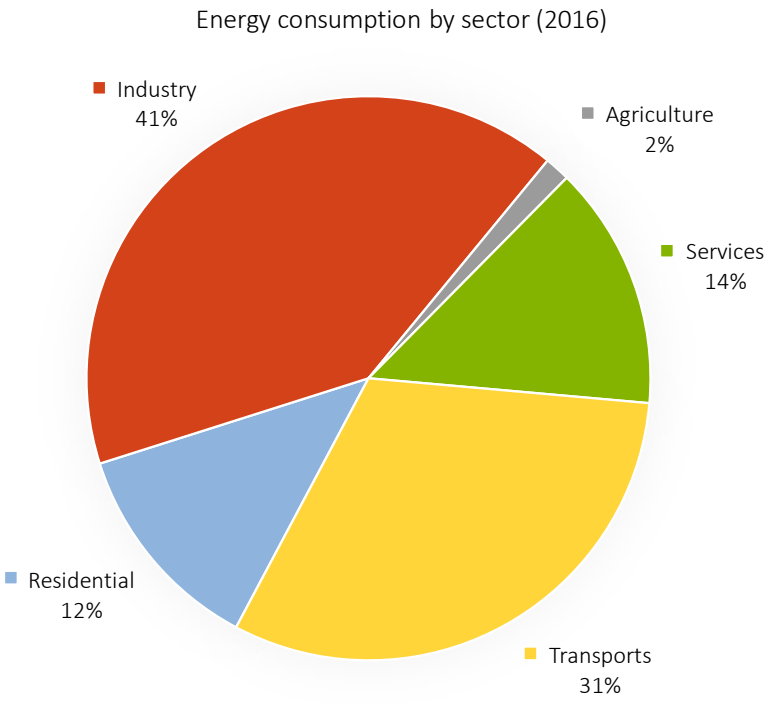


Figure 19: Total energy consumption by sector of activity in 2016 [%]

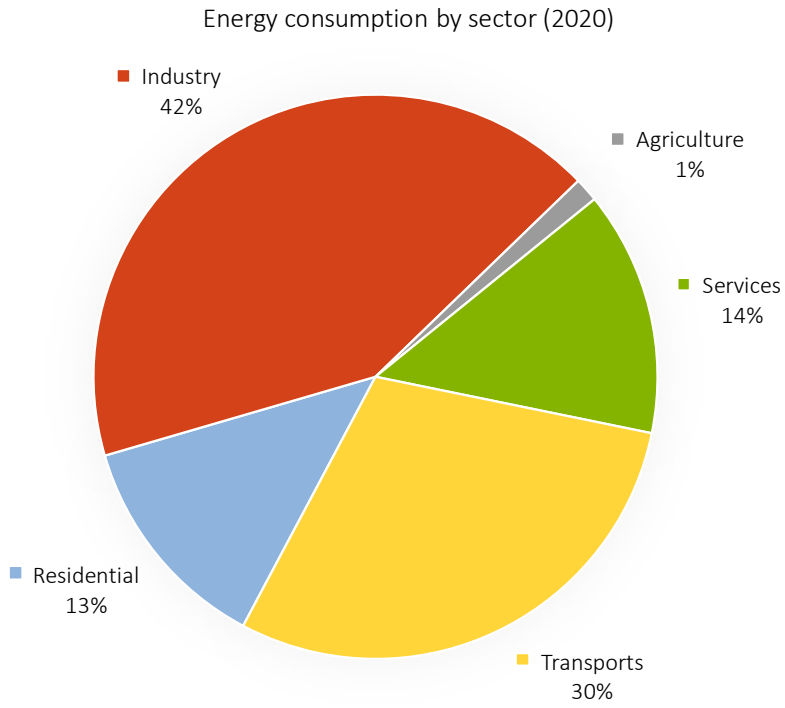


Figure 20: Total energy consumption by sector of activity in 2020 [%]

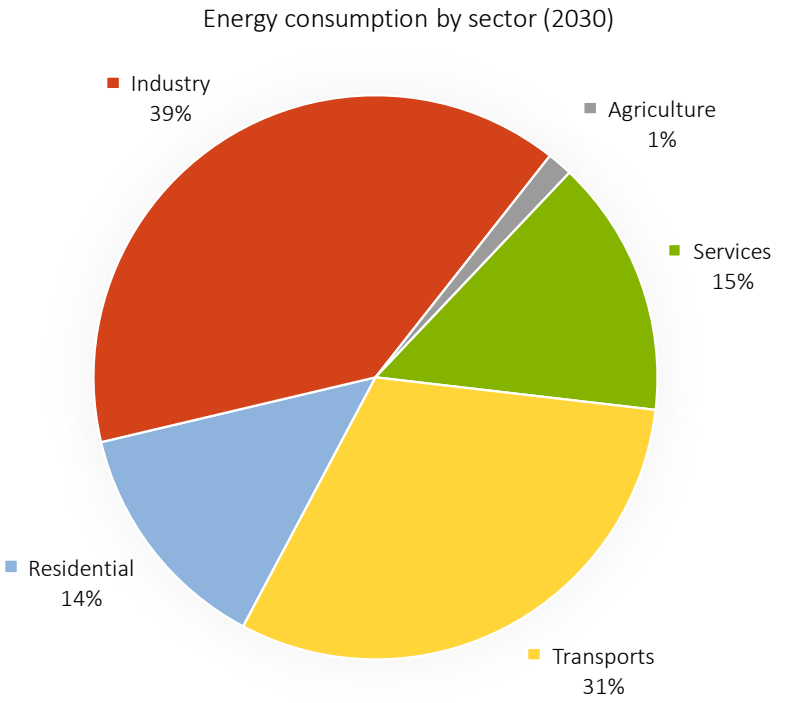


Figure 21: Total energy consumption by sector of activity in 2030 [%]

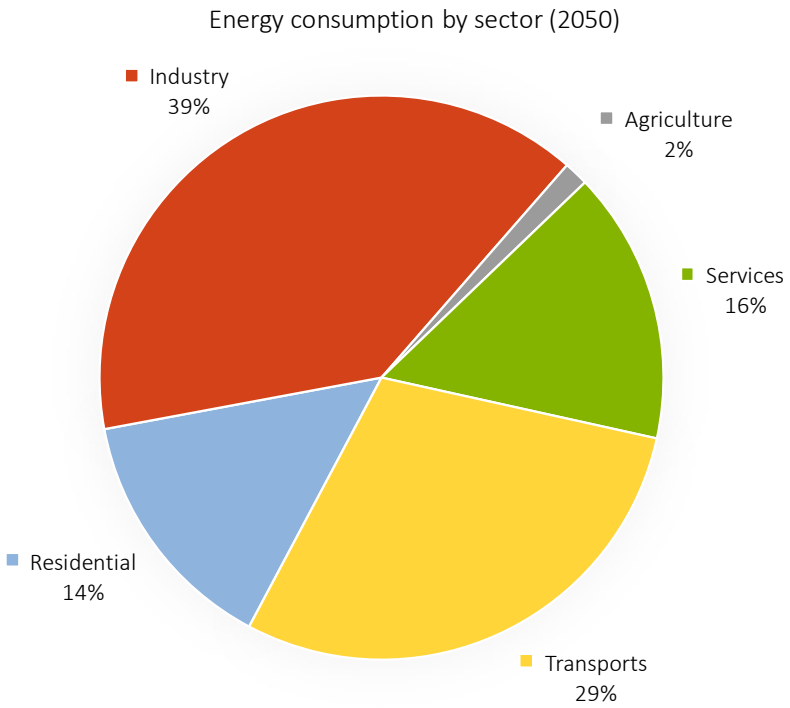


Figure 22: Total energy consumption by sector of activity in 2050 [%]

Energy Density and Intensity Indicators

The following pictures illustrate the evolution of several energy density and intensity indicators for the municipality of Guimarães, inthe period from 2000 to 2050.

Figure 23 shows the variation of final energy consumption over the period considered. The consumption represented is the sum of all energy consumption in the municipality, regardless of the energy source and the consumer sector. That way, for the calculation of the final energy consumption, the sum of the local consumption of electric energy and petroleum fuels for each year was summed.

According to the example, there is an increase in the municipality's energy demand from 2000 to 2002. In the following period there is a general downward trend up to the year 2014, despite some one-off periods of increase. In 2015, there is a slight increase in energy use, followed by a slight downward trend until 2030.

The scenario presented is characterized by accelerated implementation of energy efficiency measures, with a particular focus on the period 2010 - 2020.

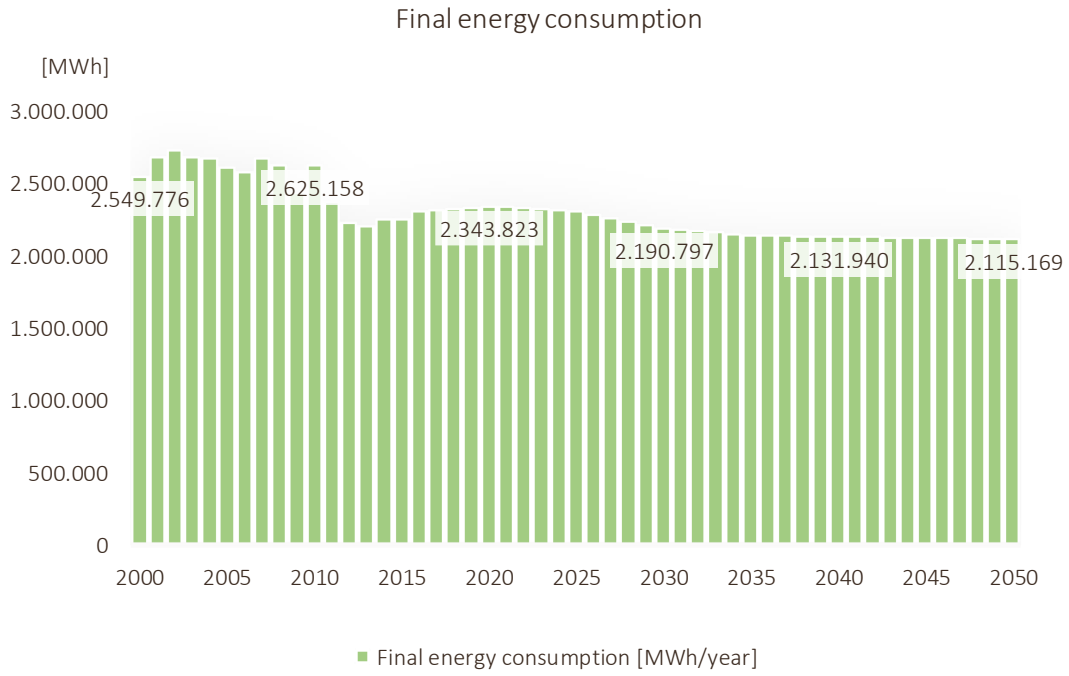


Figure 23: Final energy consumption [MWh/year]

The graph below represents the evolution of energy intensity, an energy indicator defined by the quotient between energy consumption and local GDP. It should be noted that the energy intensity was determined considering the final energy and not the primary energy. The approach adopted reflects the local nature of consumer management measures, favouring action, in the sense, for example of energy efficiency, in the demand for energy services.

By the global analysis of the presented graph there is a tendency of decrease of the energy intensity of the municipality by about 50% between 2000 and 2050. This fall is driven by the decrease in the energy intensity of the industrial and transportation sectors, as shown in the figure below.

Nevertheless, the energy intensity of the municipality should reduce significantly as a result of a possible increase in energy efficiency in the activities carried out.

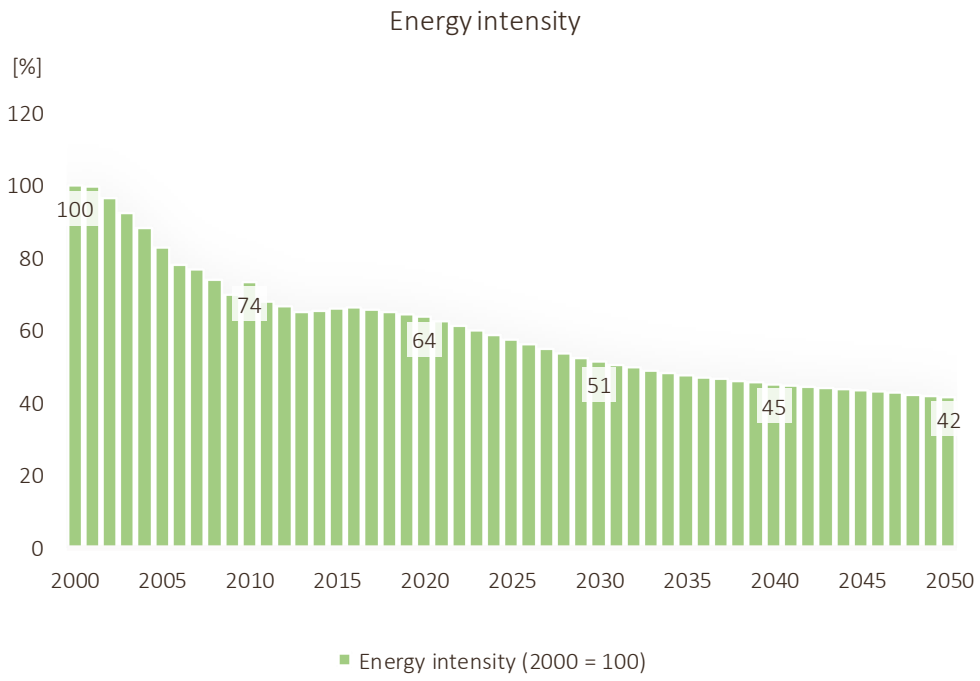


Figure 24: Energy intensity [2000=100%]

In the next figure we present the variation of the energy intensity by sector of activity. The energy intensity of the industrial, services and agricultural sectors corresponds to the quotient between the total energy consumption of the sector and the GVA of the sector to

which it refers. The energy intensity of transport is determined by the ratio of total energy consumption of the sector to local GDP.

The agricultural sector shows increase in energy intensity from 2000 to 2002. After this year there is a marked decrease until 2003. From 2003 to 2011 there is an increase in energy intensity in the sector, although with some fluctuations. After 2011, this indicator decreases, until 2014. After this period, it remains stable up until 2050.

Looking at the curve of the transport sector, there is an overall decrease in energy intensity between 2000 and 2050.

Energy intensity of the industry shows decrease in the period 2000 - 2012. After 2012, there is an increase in this indicator until 2020, a year after which the energy intensity of the industry decreases again, until 2035, tending to stabilize in the following years.

In the services sector, there is a slight increase in energy intensity between 2000 and 2020. It is worth to note the reversal of this trend in the later period, during which the energy intensity of the sector tends to decrease.

The decreasing trend in energy intensity is one of the main indicators of increasing energy efficiency in the various economic sectors, considering not only the sectoral energy needs but also evolution of the activity carried out.

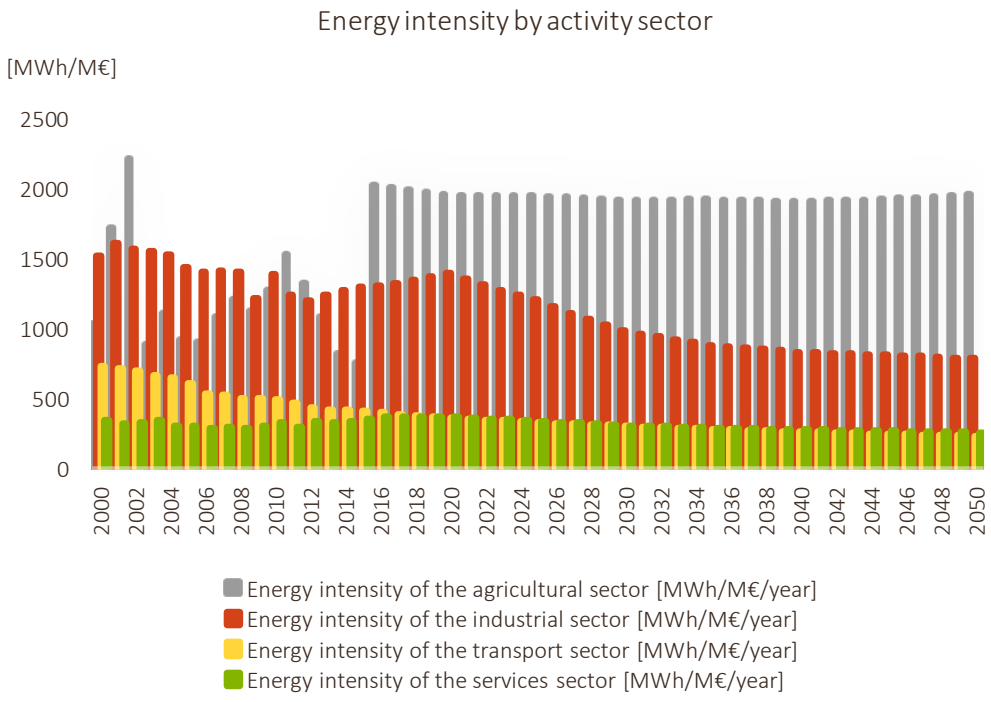


Figure 25: Energy intensity by sector of activity [MWh/M€/year]

The graph below shows energy consumption per capita. This energy indicator was determined from division of the final energy consumption by the resident population in the county.

The following graph shows an increase in energy consumption per capita in the period from 2000 to 2002. After 2002 there is a decline in energy use per capita by 2012, followed by a further increase until 2020. After 2020, reduction of the analysed indicator is expected by 2050.

In the recent years, there has been a growing trend of energy efficiency improvement solutions covering all sectors, particularly in the post-2012 period, resulting in a more efficient use of energy and, consequently, a reduction in energy consumption per capita. This tendency is expected to remain at least until 2020, driven by the implementation of local, national and European energy efficiency improvement policies.

However, a slight increase in the demand for energy in the medium term, in particular electricity, is expected, mainly due to the increasing use of electrical and electronic equipment and the increasing improvement of comfort.

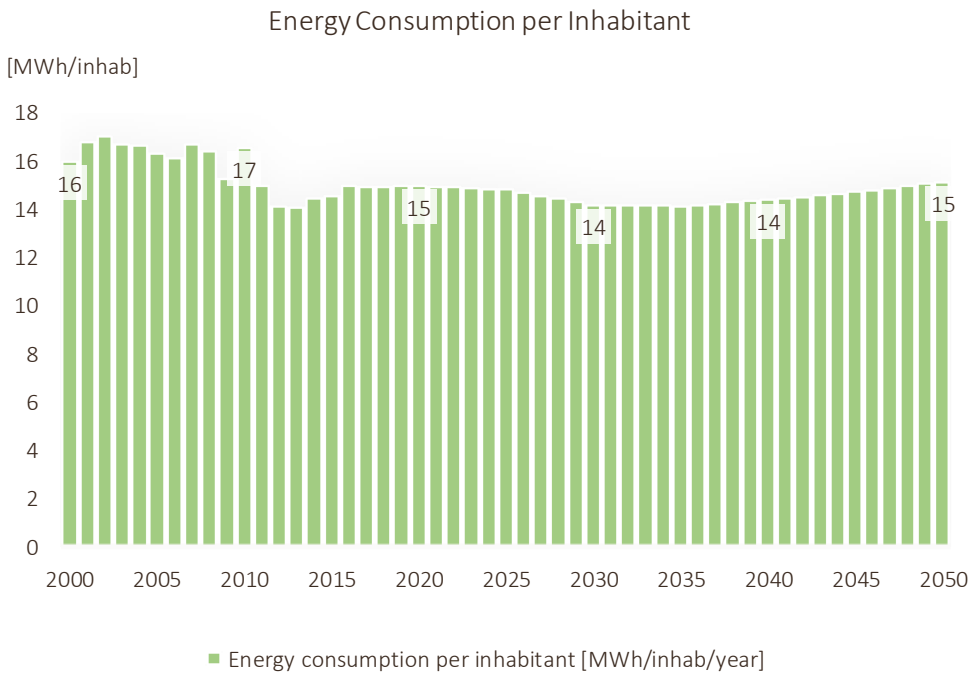


Figure 26: Energy consumption per capita [MWh/inhab/year]

The figure below represents total consumption of energy consumed in domestic sector, which is a result of sum of domestic consumption of electricity, natural gas and fuels of petroleum origin, for each year of the period under analysis.

The graph shows an increase in total energy consumption until 2011. In the subsequent period a decrease in domestic energy consumption is observed, until 2015. The results presented mainly result from the implementation of measures to improve energy efficiency in residential buildings, integration of renewables and adoption of more efficient behaviours.

However, a slight reversal of this trend is expected over the period 2016-2050, in line with the increasing demand for high levels of comfort and quality of life. Changes in the family structure, such as the increase in single-parent households and only one element, result in an increase in the number of households, according to demographic forecasts, which is reflected in an increase in household energy consumption. These increases are fundamentally related to air conditioning needs, heating of sanitary waters and energy consumption of equipment typically associated with buildings.

Despite this slight increase at the end of the period under review, domestic energy consumption in 2050 should remain below the 2010 values.

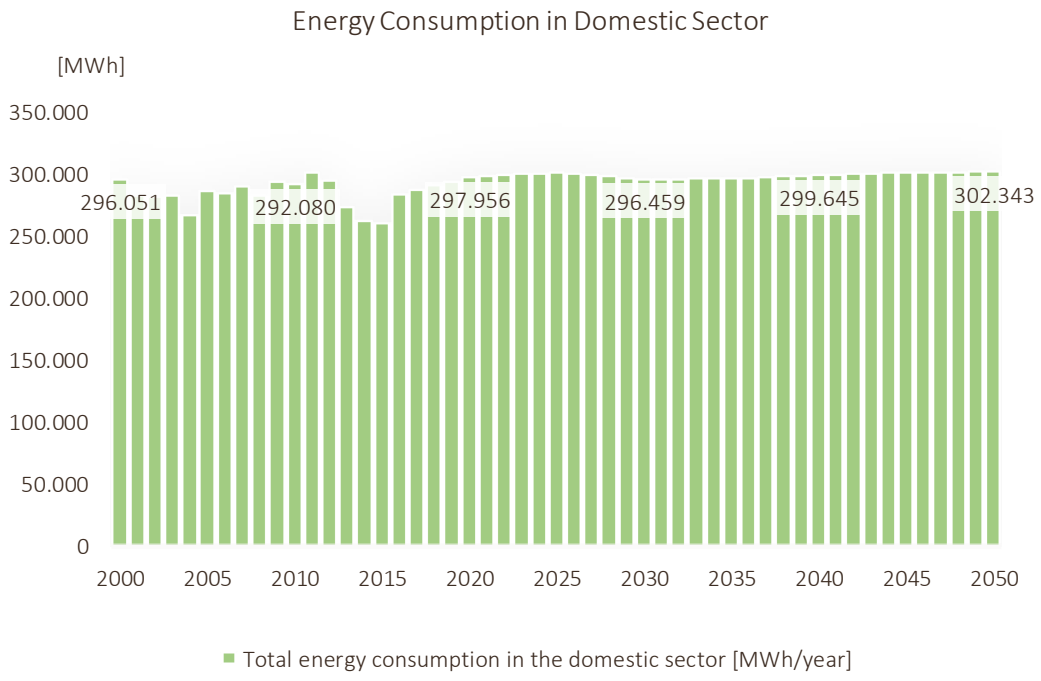


Figure 27: Total Consumption of Energy in the Domestic Sector [MWh/year]

The next graph shows the total energy consumption in industry sector and was obtained by summing the consumption of electric energy, natural gas and petroleum-based fuels in this sector.

Analysing the curve, there is a reduction in industrial energy consumption between 2000 and 2012, despite some oscillations. This evolution leads to infer about a possible decrease of industrial activity in the municipality in this period.

After 2012 energy consumption in industry sector increases until 2020 and after 2020 there is a trend of decreasing energy consumption in the sector.

By 2020 it is expected that the power consumption increases, which can be associated with an eventual recovery in economic activity in the sector and the strengthening of mechanization and automation of processes such as factor of promotion of quality and productivity, mitigate the increasing trends of energy efficiency in the industry.

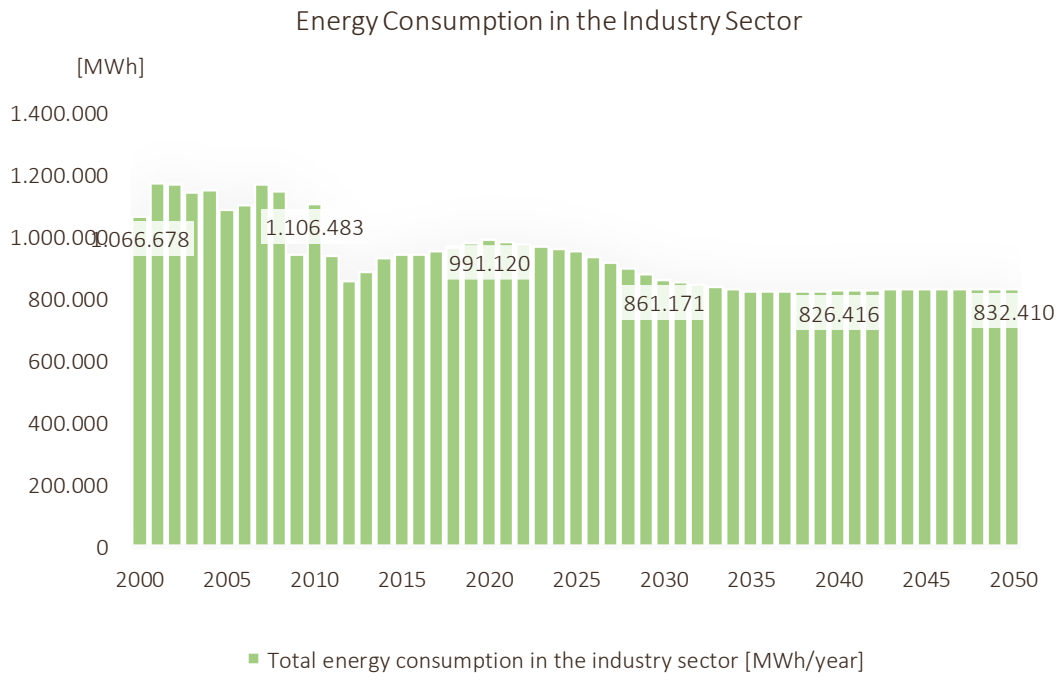


Figure 28: Total energy consumption in industry sector [MWh/year]

The figure below illustrates demand for energy by the services sector, consumption resulting from the sum of the consumption of electricity, gas and oil fuels for each year.

As for energy demand in the services sector, the curve shows an increase in consumption by the year 2020. From 2020 to 2030, energy demand in this sector has declined steadily, remaining relatively constant from 2030 to 2050.

Gains in energy efficiency resulting from eco-design measures, improvement of the energy performance of buildings, implementation of efficient technologies and changing behaviour, outweigh the effects of increased sector activity by 2050, leading to a final energy demand in 2050 remains similar to 2016 values.

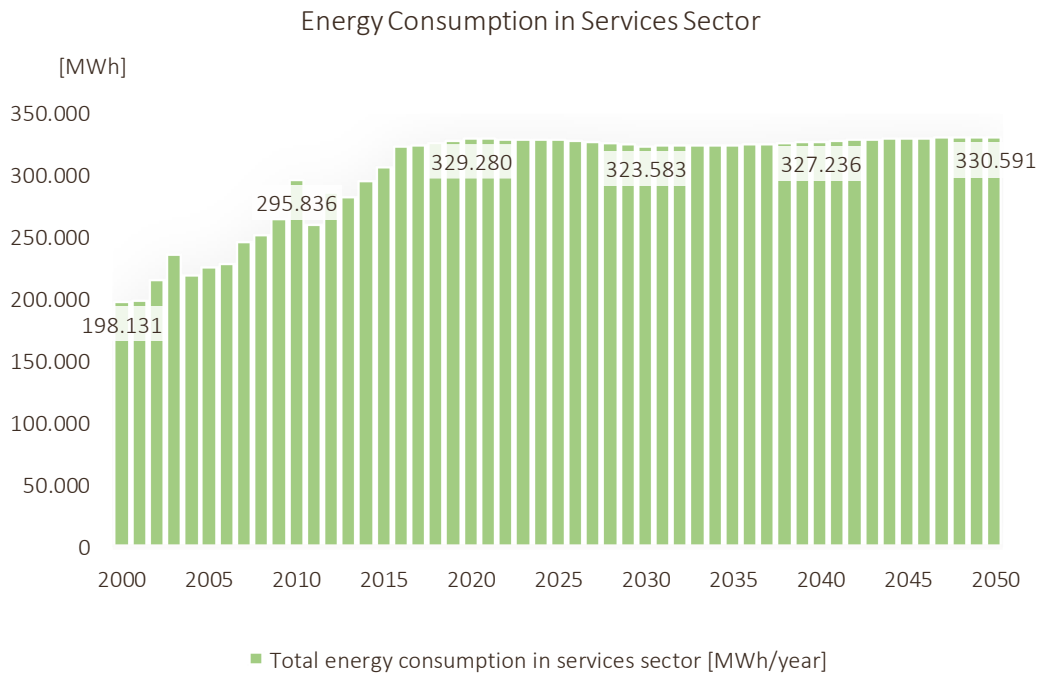


Figure 29: Total consumption of energy in services sector [MWh/year]

The next figure shows the evolution of total energy consumption in the agriculture sector, for the reviewed period, from 2000 to 2050. The curve presented was obtained through the sum of the annual consumption of electricity, gas and fuels of petroleum origin verified in the sector.

The next figure shows significant fluctuations in energy consumption in the agricultural sector, highlighting an increase in consumption from 2000 to 2002, followed by a sharp decline in 2003. From 2003 to 2011, the agricultural sector presents an increase in energy demand, albeit with some fluctuations, and there is a reduction in energy use in the following years up until 2014. After the year 2016, the energy needs of the sector decrease very slightly until 2050.

The implementation of initiatives to improve energy efficiency in the agricultural sector has a significant impact on consumption in the sector, particularly in terms of reducing energy requirements in irrigation (pumping systems) and traction.

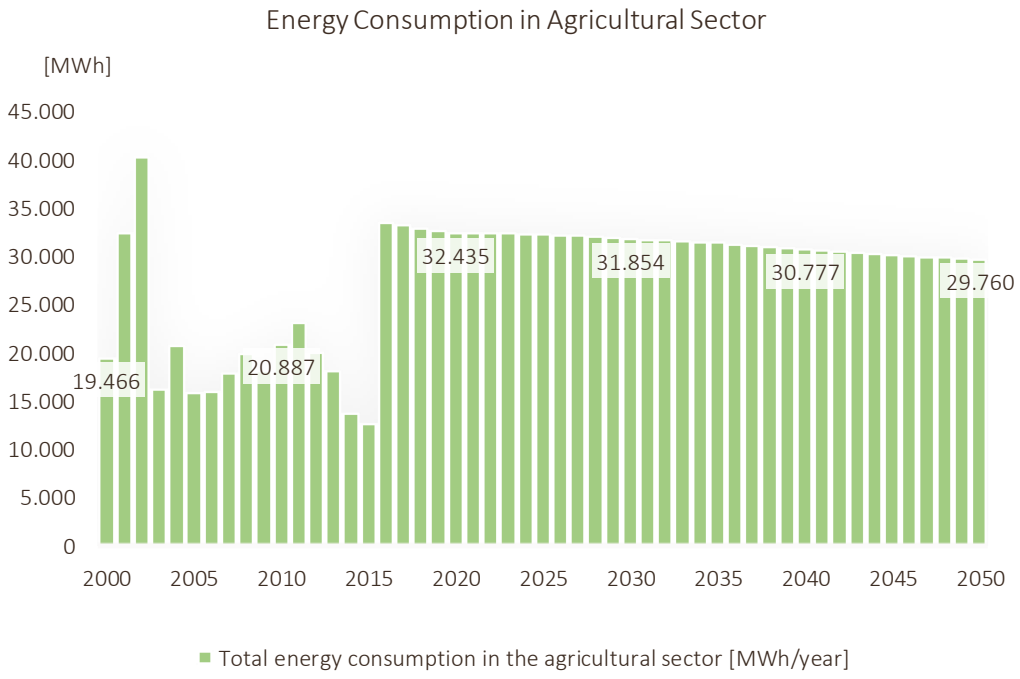


Figure 30: Total energy consumption in the agricultural sector [MWh/year]

Next figure shown is illustrative of the total energy consumption of the transport sector, representing the sum of the annual consumption of electricity and fossil fuels industry.

The presented curve reveals a reduction in energy demand over the period from 2002 to 2050, with a period of stabilization between 2020 and 2025.

Despite the continuous increase in the activity of the sector, the demand for energy for transport decreases to levels lower than those observed at the beginning of the period under analysis.

These results are influenced by the instability of oil fuel prices - particularly in the last decade - by significantly improving the efficiency of transport vehicles and introducing energy efficiency measures - eco-driving training, energy performance reduction of fuel consumption.

The stabilization of energy use at the end of the period under review could be associated with a possible saturation of the sector at the end of the period under analysis.

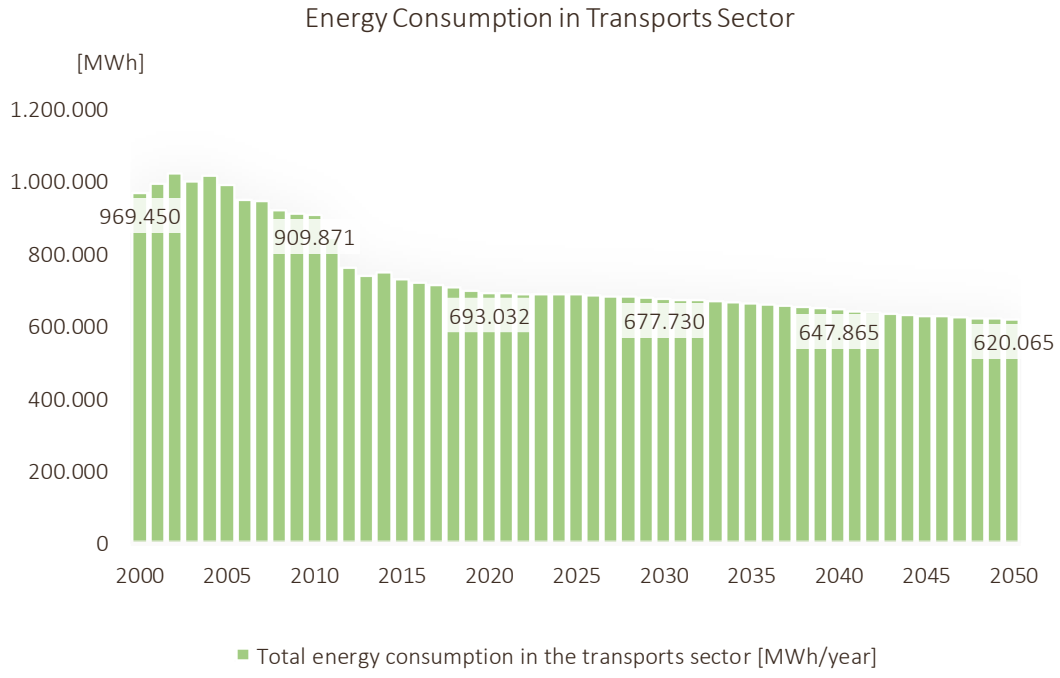


Figure 31: Energy consumption in transports sector [MWh/year]

In the next figure is presented the total electric energy consumption of the municipality, defined by the sum of the sectoral consumptions of electric energy.

By analysing the presented data, it is observed that the demand for this energy vector shows a decrease from 2000 to 2012, associated with a possible reduction of the activity of the industrial sector, as illustrated by figure 28.

After 2012 there is an increase by 2020, with demand falling in the period 2020 to 2035. After 2035, electricity consumption remains relatively stable until 2050.

Parallel to the progressive implementation of energy efficiency measures there is a trend towards greater use of electricity over other energy sources. This electrification trend is mainly driven by the substitution of the use of fossil fuels in heating and cooling, as well as in the transport sector, by the increase in the use of electrical and electronic equipment.

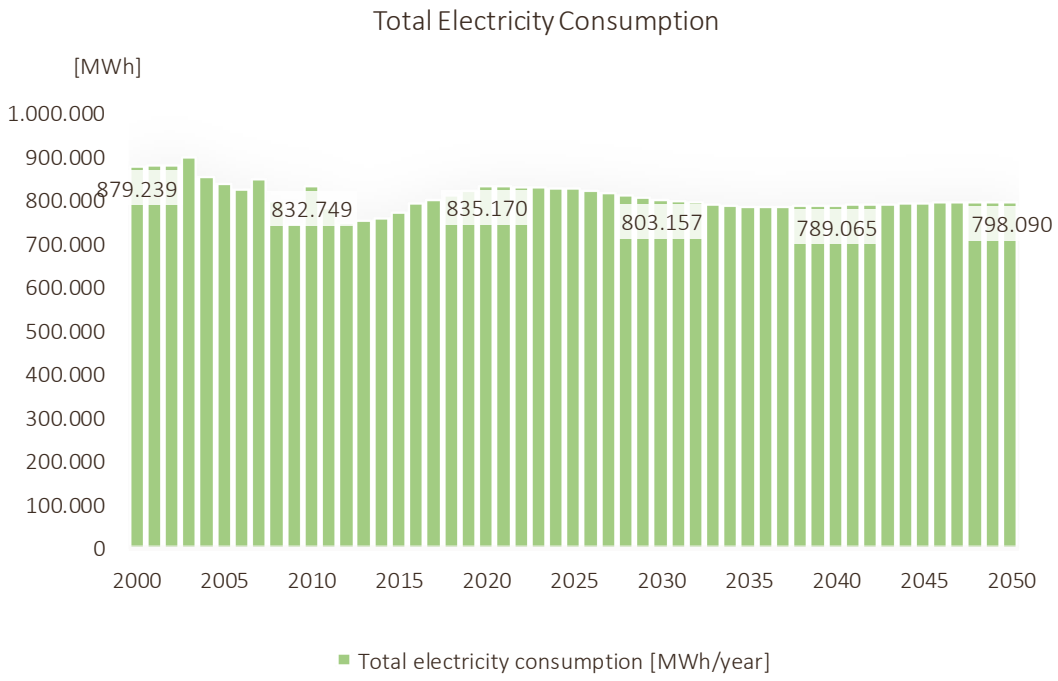


Figure 32: Total consumption of electric energy [MWh/year]

Following figure shows the expected evolution of the consumption of electricity in the domestic sector, for the period from 2000 to 2050.

The curve presented illustrates the increasing use of electricity in the domestic sector, with an increase of around 42% over the period 2000-2010. Between 2010 and 2014, this trend reverses, with a decrease of 13%. Between 2014 and 2050, domestic demand for electricity is increasing, albeit slightly, with a 23% increase over that of the period.

The implementation of measures to improve energy efficiency and energy performance of buildings, integration of renewables and behaviour change, with greater incidence in the period 2010-2020, contributes to a reduction and subsequent moderation of the use of electricity in the domestic sector.

The increasing demand for comfort in the dwellings leads to a new increase of the use of electricity, at the end of the period under analysis. The use of air conditioning systems for residential buildings, for example, as well as greater use of domestic electronic equipment and communication and information technologies, which independently of the place of use may have batteries typically charged at home, induce an increase of domestic electricity consumption per capita.

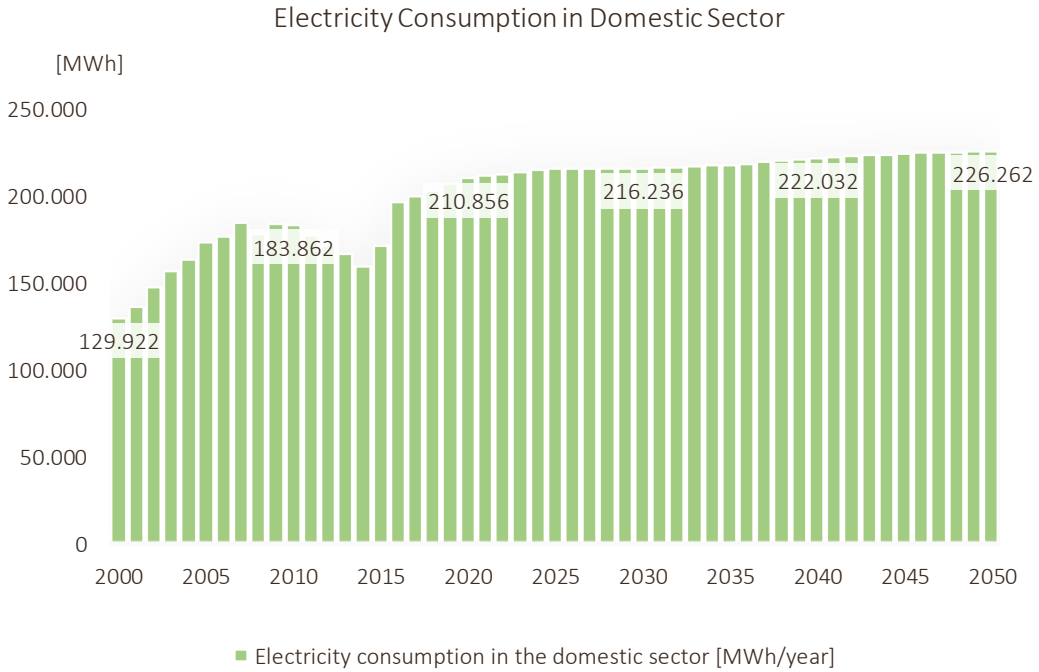


Figure 33: Total consumption of electric energy in domestic sector [MWh/year]

The next figure shows the evolution of the consumption of electric energy in the industrial sector, for the period from 2000 to 2050.

From the consumption curve presented, it is observed that the demand for electric power by the industrial sector decreases from 2000 to 2012, however, showing some oscillations. This drop-in consumption leads to infer about a possible decrease in industrial activity in the municipality in this period.

From 2012 to 2020 the consumption of electricity in industry increases. This increase can be driven by the growing trend of mechanization and automation of processes, associated to an eventual recovery of economic activity.

After 2020 there is a decrease by 2035 and from 2035 to 2050 the consumption of electricity in the sector remains relatively stable, at consumption levels similar to those observed in 2012.

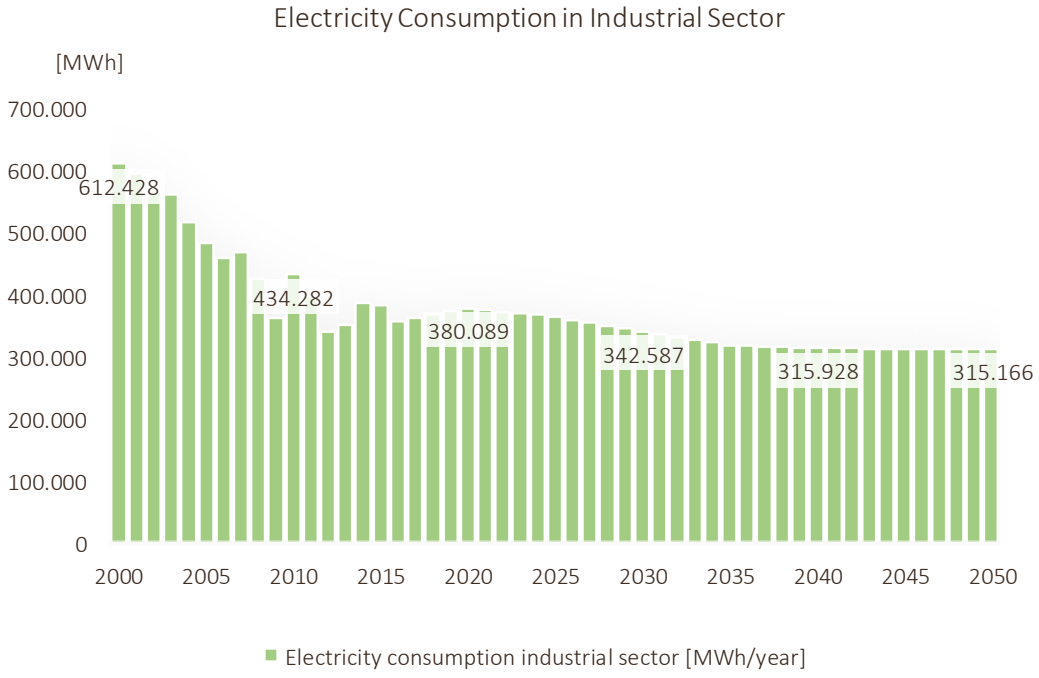


Figure 34: Total consumption of electric energy in industrial sector [MWh/year]

The graph shown in figure 32 refers to the consumption of electricity in the service sector.

Observing the curve, there is an increase in the use of electricity in the services sector from 2000 to 2012. In the following period, energy demand in this sector decreases until 2014, increasing again in subsequent years, until 2050.

The evolutionary trend of consumption in this sector shows that, despite the increase in the quality of energy use, with new energy efficiency requirements to be integrated into investments in new buildings and infrastructures, electricity consumption continues to increase. The increasing use of electric energy for heating and cooling environment is one of the main drivers of this trend.

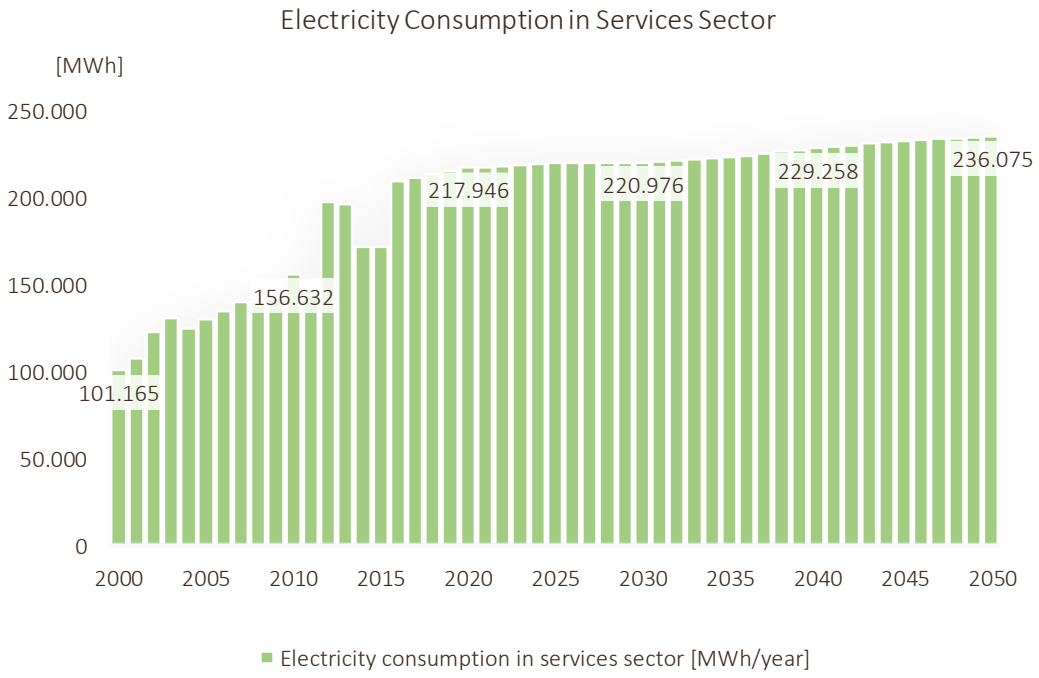


Figure 35: Total consumption of electric energy in the services sector [MWh/year]

The graph below illustrates the total electricity consumption of the water supply services sector.

There is a sharp increase (around 135%) in energy consumption from 2000 to 2020, despite a drop-in consumption in the year 2011 and some fluctuations. After 2020 the consumption of electricity in water supply services tends to decrease until the end of the period under analysis, presenting a decrease of approximately 16%.

The growing concern about the quality of the water supply and the restructuring of the system in terms of abstraction, transport and distribution, coinciding with the trend towards mechanization and automation of supply systems, is a major contribution to demand for electricity. The increasing implementation of energy sustainability actions in the sector could make a significant contribution to moderating the use of electricity by water supply services.

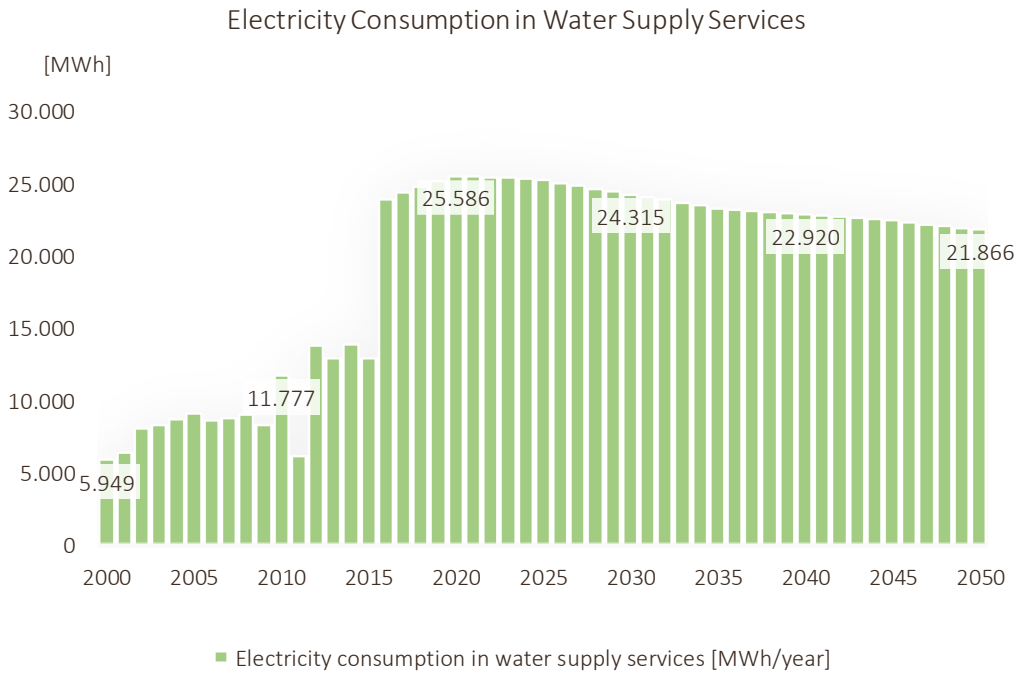


Figure 36: Total Consumption of Electricity in Services of Water Supply [MWh/year]

The figure below illustrates the expected evolution of electricity consumption in the tourism sector, in catering.

By the analysis of the graph it is observed that the consumption of electric energy increases from 2000 to 2002. From 2002 to 2015 there is a marked reduction in the use of electricity in the sector (around 50%).

After 2015, there is a slight increase in consumption by 2020. Between 2020 and 2035, the use of electricity in the hotel sector declined slightly and tended to stabilize in the following period up to 2050. Improving energy efficiency in the sector results in a moderation in the growth of electricity use in catering services. The growth in the energy demand of this subsector of tourism comes from the predictions of a balance between the consolidation of the size and type of supply and the reinforcement in quality, comfort and diversity.

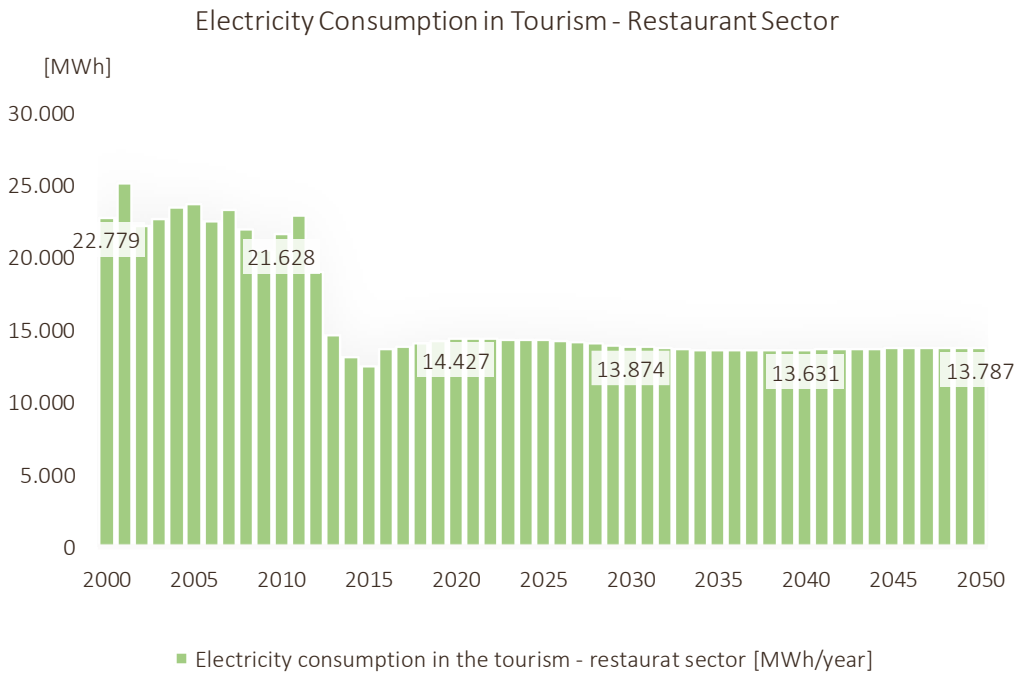


Figure 37: Total consumption of electric energy in the tourism– restaurant sector [MWh/year]

The figure below shows the expected evolution of the consumption of electric energy in the tourism sector, in the hotel industry.

The graph shows a significant increase (92%) in electricity consumption in hotels from 2000 to 2010, indicating a positive evolution of the sector's activity. After 2010 the use of electricity decreases about 28% by 2013.

From 2013 to 2020, an increase in the evolution of consumption is noticeable. This moderate increase in consumption will eventually be related to the need to respond to the demand for comfort and increasing automation.

After 2020, there is a reduction in the use of electricity in the sector until 2035, possibly associated with the moderation of the increasing consumption of this energy vector through actions to improve energy efficiency. The use of electricity in the hotel sector tends to stabilize at the end of the period, namely from 2035 to 2050.

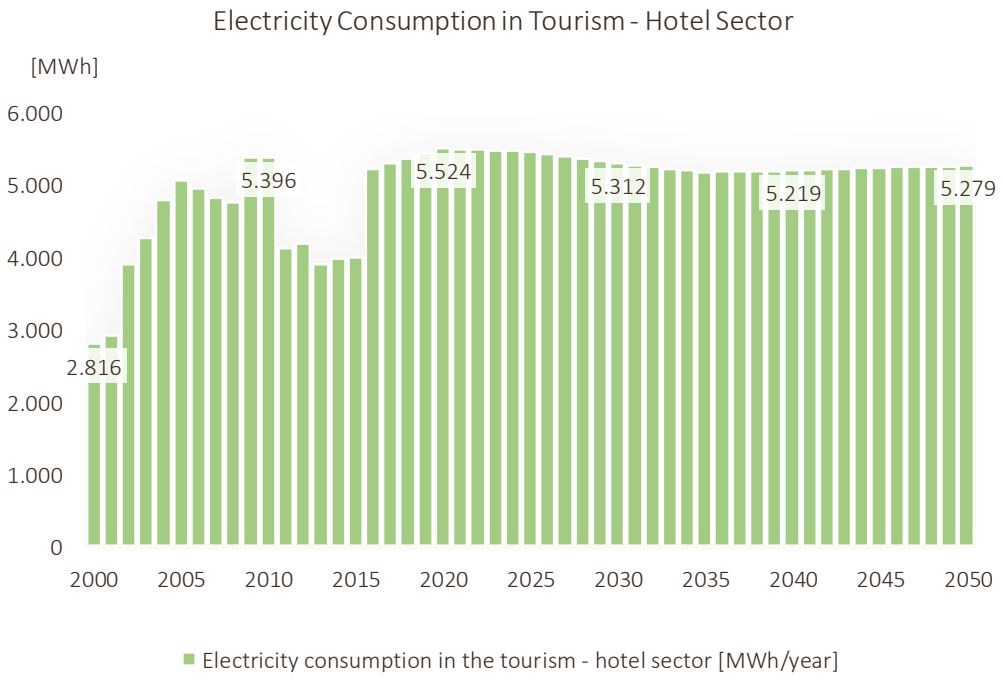


Figure 38: Total consumption of electric energy in the tourism– - hotel sector [MWh/year]

The graph shown in the next figure illustrates the evolution of total per capita electricity consumption. This energy indicator is defined by the quotient between the total electric energy consumption in the county and the number of residents.

The graph below shows a decrease in electricity consumption per capita from 2000 to 2012. This reduction may be associated with a possible decrease in economic activity at the end of this period.

From 2012 to 2020 there is an increase in the consumption of electricity per capita. After 2020 a reduction of this indicator is observed, until 2035, highlighting an increase in the per capita efficiency of electricity use, possibly associated to the improvement of the efficiency of electricity use.

From 2035 to 2050 a new increase of the indicator under analysis is observed. This behaviour is driven by increasing individual demand for comfort, by changing housing styles and by recovering economic activity.

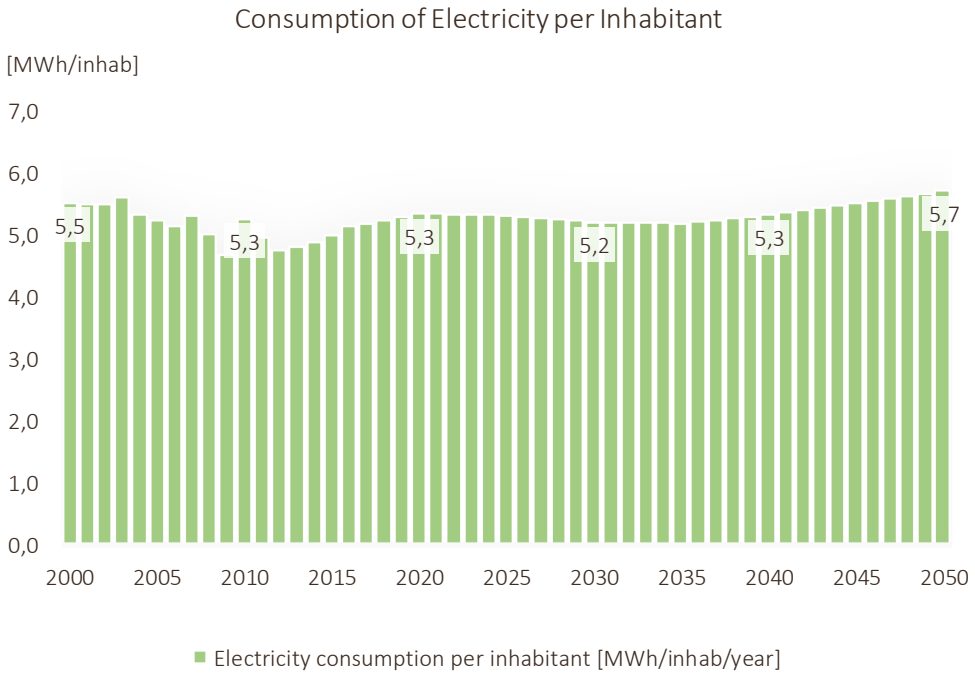


Figure 39: Total consumption of electric energy per capita [MWh/inhab/year]

Figure below refers to the evolution of the total consumption of electric energy in the domestic sector per inhabitant. This energy indicator results from the quotient between the total consumption of electric power in the domestic sector of the county and the number of residents.

From the graph, increase in the domestic consumption of electricity per inhabitant from 2000 to 2010 can be seen. From 2010 to 2014 there is a decrease in this indicator, followed by a new period of increase, until 2050.

As already mentioned, this trend stems from the growing demand for electricity in the domestic sector. Improving the quality of life and increasing comfort drives the increase in household energy consumption per inhabitant. The change in housing styles, especially the reduction of the average number of residents per housing also induces a higher consumption of electric energy in the domestic sector, per inhabitant.

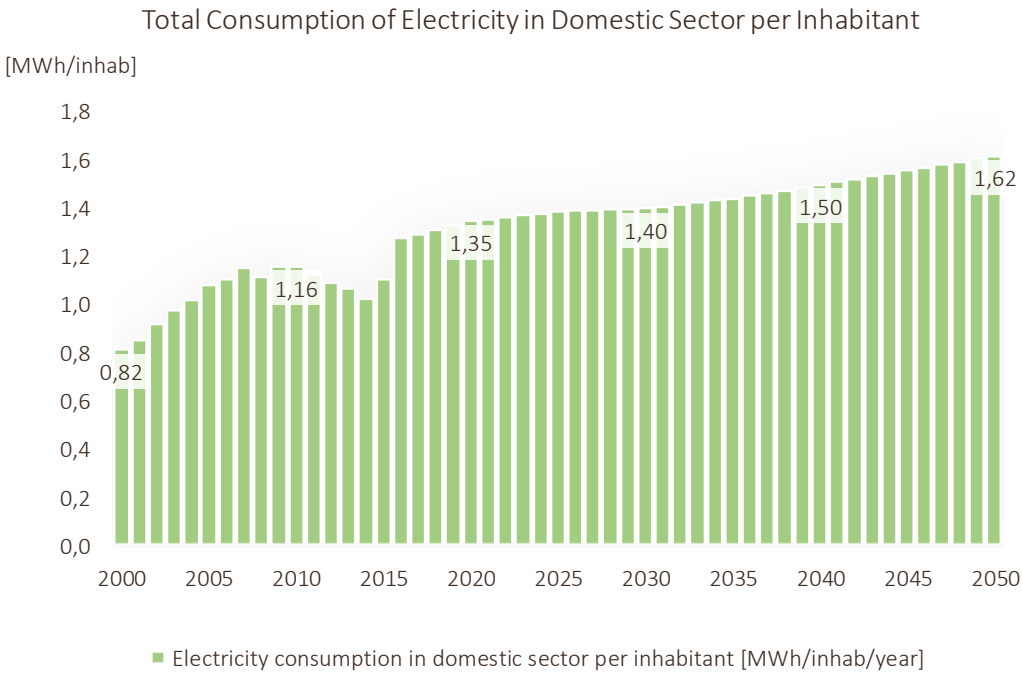


Figure 40: Consumption of electric energy in domestic sector per capita [MWh/inhab/year]

The next figure shows the evolution of the electricity consumption by industrial consumers for the period 2000-2050.

After 2002 there is an increase in demand for electricity by 2010. From 2010 to 2013 the consumption of electricity by industrial consumers decreases.

In the following period, demand for electricity is expected to increase moderately by 2050. However, in 2050, this indicator remains lower than in 2010.

The increase in demand for electricity from the industrial sector per consumer is indicative of the tendency towards mechanization and automation of processes, as a mechanism to increase productivity and quality. The observed trend for moderation of demand also indicates the effect of increased energy efficiency and the emergence of saturation effects of growth of specific consumption in the industrial sector.

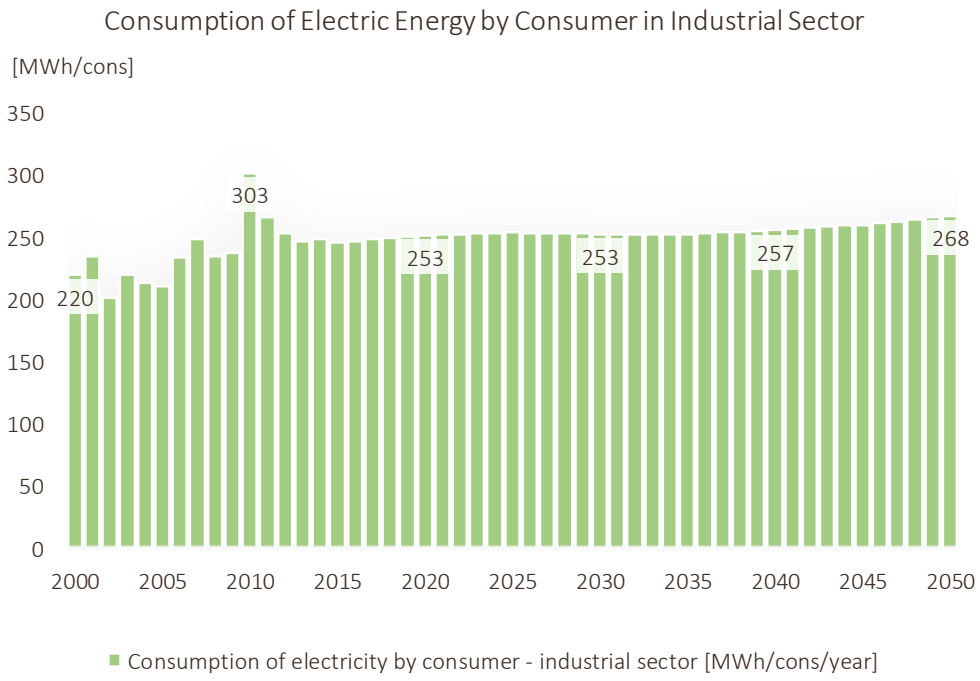


Figure 41: Consumption of electric energy by industrial customer [MWh/cons/year]

In following figure it is possible to compare the evolution of the demand for butane gas and propane gas, over the period under analysis.

Looking at the graph, it is verified that propane consumptions decrease by about 65% from 2000 to 2013. From 2013 to 2050 the displayed curve shows slight decrease. Noteworthy are the domestic and services sectors as the main users of this energy source.

The consumption of butane gas declines significantly from 2000 to 2014 by about 72%. After 2014 the curve shows a more moderate decrease, which lasts until 2050. Butane gas is mainly used in the domestic sector.

The decreasing behaviour evidenced in the curves presented reflects the tendency of replacing these fuels with safer and more comfortable ones with lower environmental impacts, namely with regard to CO_2 emissions such as natural gas or electricity.

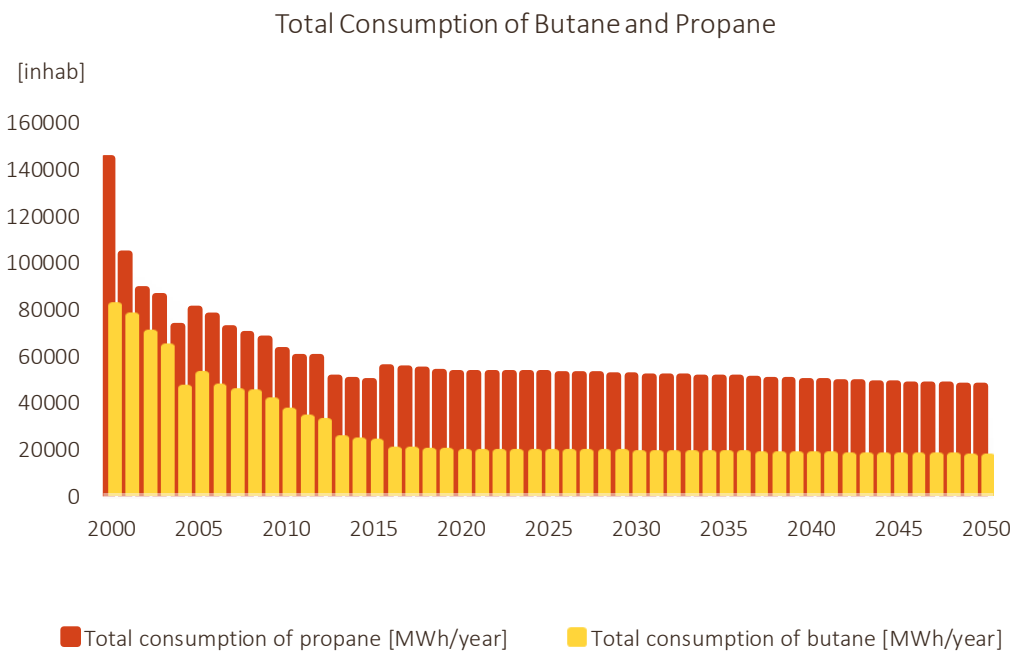


Figure 42: Total consumption of butane and propane [MWh/year]

The figure below shows the total consumption of natural gas over the period 2000 to 2050.

As illustrated, demand for natural gas increased by more than 20% from 2000 to 2008, with some variation in subsequent years up to 2011.

From 2011 to 2020 the use of this energy source tends to increase, observing a reversal of this trend in the following period, until 2035. From 2035 to 2050 the use of natural gas is expected to increase again, albeit with a more moderate growth.

The demand for natural gas is driven by the fact that it is a cleaner fuel than petroleum fuels, being used as a substitute for butane and propane gas in domestic and service uses and gas oils and fuel in thermal and industrial uses.

The trend towards moderation in demand observed in the post-2020 period is likely to be the result of forecasts of a considerable increase in fossil fuel prices.

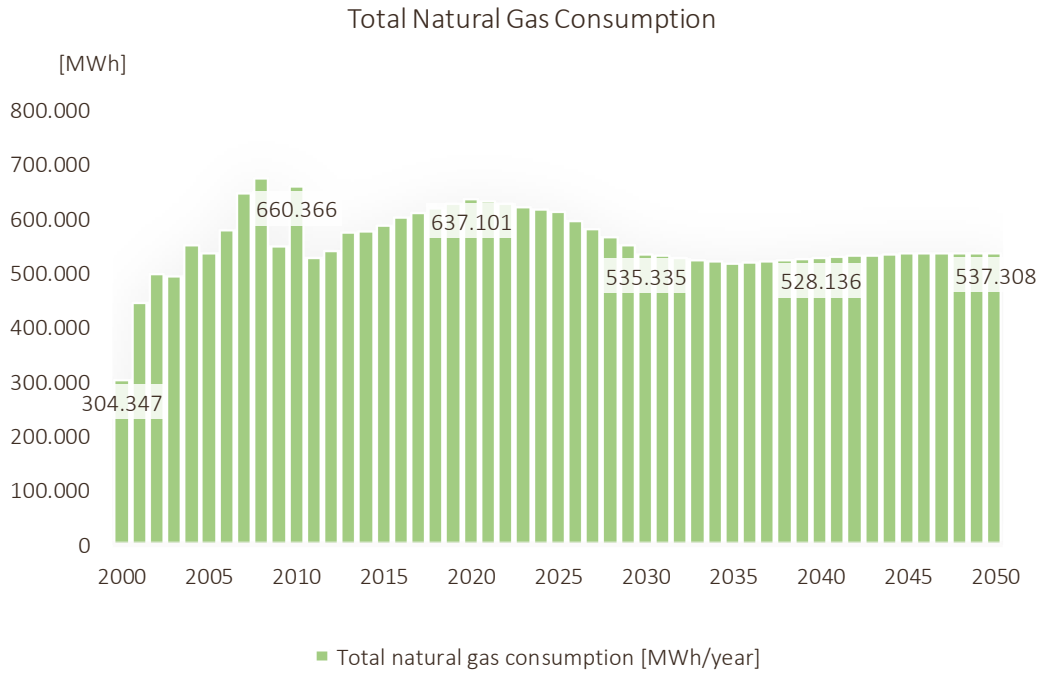


Figure 43: Total natural gas consumption [MWh/year]

The curve shown in the following figure refers to the total consumption of gasoline and auto gas in the county and results from the sum of the total consumption of gasolines and the total consumption of auto gas. The total consumption of gasolines includes intakes of unleaded gasoline 95, unleaded gasoline 98 and gasoline additive.

As shown in the graph below, consumption of gasoline and auto gas decreases sharply from 2000 to 2013. After 2013 the use of these fuels decreases moderately.

This trend reflects changes in the demand for petroleum fuels as a consequence of the increase in oil prices and the demand for more sustainable and safe fuels, highlighting the growing increase in the transport sector of hybrid and electric vehicles, replacing conventional vehicles driven only by gasoline.

The saturation of the transport sector - standing out the individual road vehicle - is also a possible factor that influences the decrease in demand.

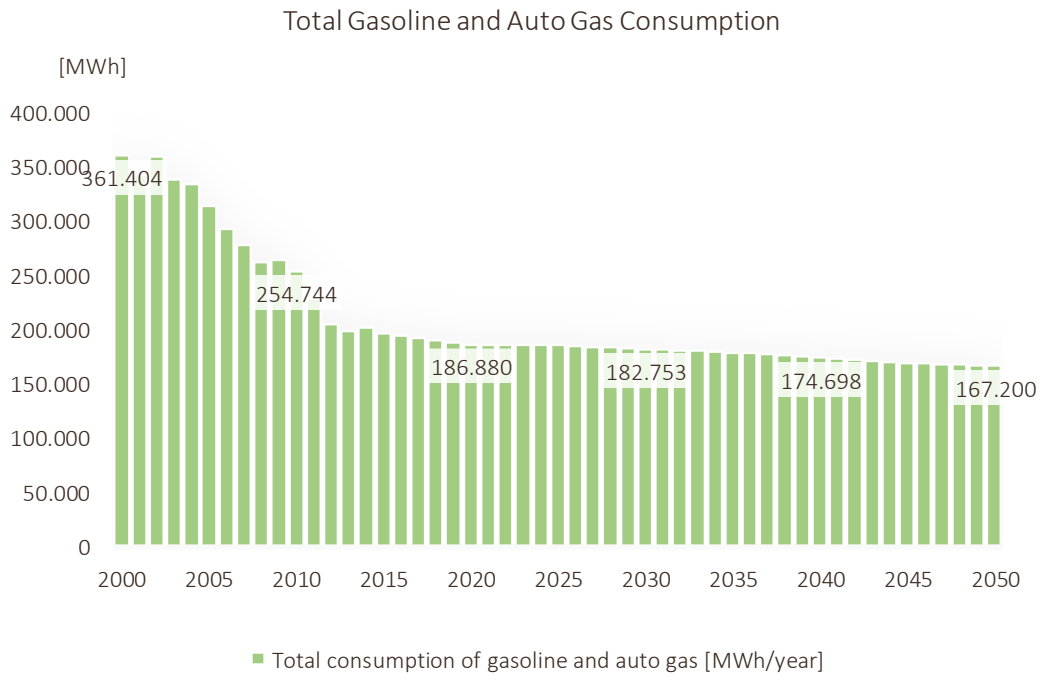


Figure 44: Total gasoline and auto gas consumption [MWh/year]

The graph of figure below shows the evolution of the diesel consumption in the city of Guimarães.

This graph shows an increase in demand in the period 2000 to 2004. Over the period from 2004 to 2050 the consumption of diesel fuels decreased.

This behaviour is driven by rising fuel costs, replacing safer and more sustainable energy sources, implementing energy efficiency policies and eventually saturation of the transport sector.

Also, worthy to note is the growing market for electric vehicles, replacing conventional diesel or gasoline vehicles.

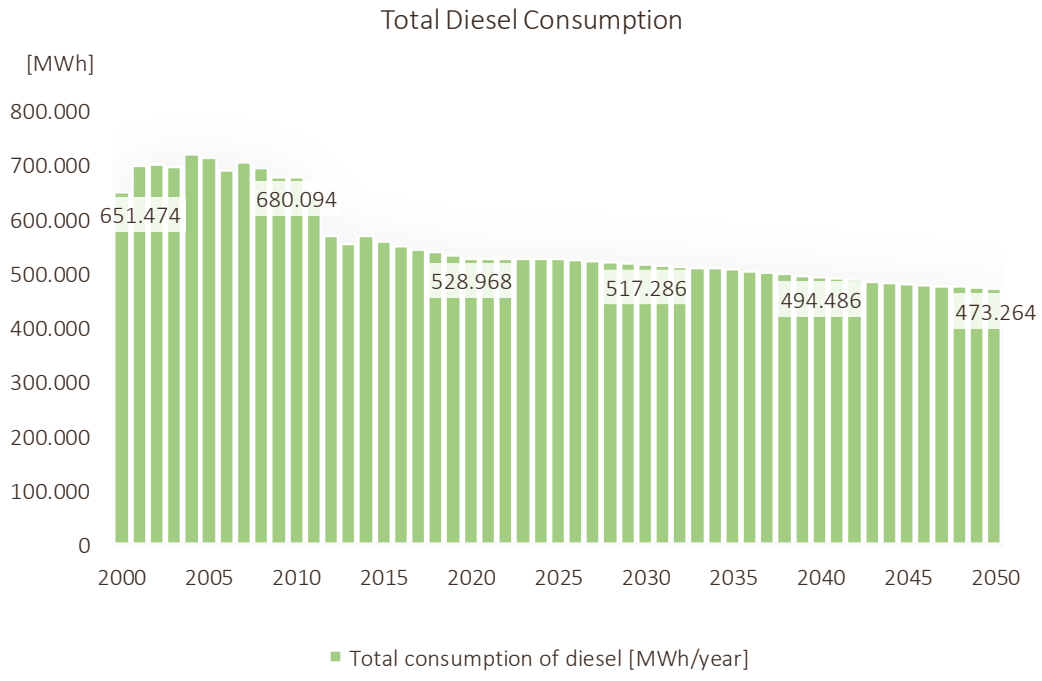


Figure 45: Total road diesel consumption [MWh/year]

Next figure shows the evolution of the consumption of other gas oils for the period 2000 to 2050.

Analysing the graph presented, it can be observed that the consumption of other gas oils presents strong oscillations between 2000 and 2015, with peak consumption in 2002, 2008 and 2010, followed by sharp falls. After 2016, the use of these fuels decreases moderately.

The tendency of increasing the costs of petroleum fuels and of replacing these fuels with others with lower environmental impacts in terms of CO_2 emissions, as well as the implementation of energy efficiency policies, justify the evolution in the medium-long term in this typology.

The increase in the penetration rate of renewable energies in all sectors of activity also promotes a reduction in the use of other gas oils, particularly in the industry sector.

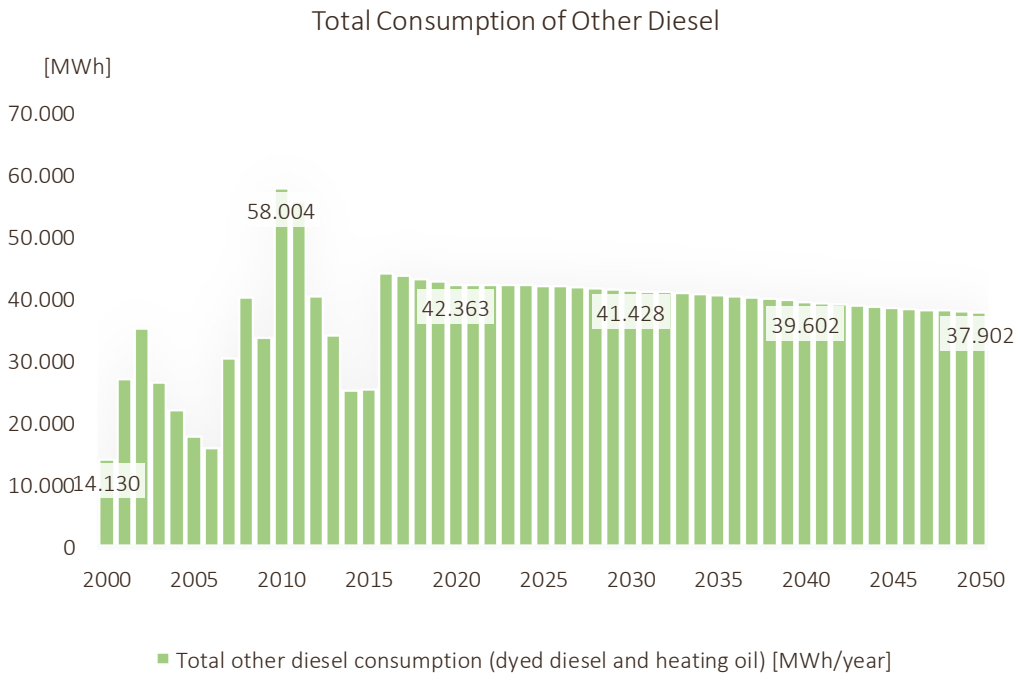


Figure 46: Total consumption of other diesel [MWh/year]

The next figure shows the graphical representation of the total consumption of petroleum fuels in the municipality, which results from the sum of the consumptions of the energy vectors: butane gas, propane gas, auto gas, gasoline, road diesel, other gas oils and other petroleum fuels (fuel oil and petroleum).

Analysing the curve presented, there is an overall decrease in the use of petroleum fuels over the period under analysis.

The replacement of the use of conventional petroleum fuels by lower cost, safer and more sustainable fuels has a significant impact on the evolution of total consumption of petroleum fuels, particularly in the transport sector, the main consumer of this type of fuels.

Increased penetration of renewable energy production in industry and the domestic sector, as well as the electrification of environmental heating systems in the domestic and service sectors, also contribute to a decreasing trend in the use of petroleum.

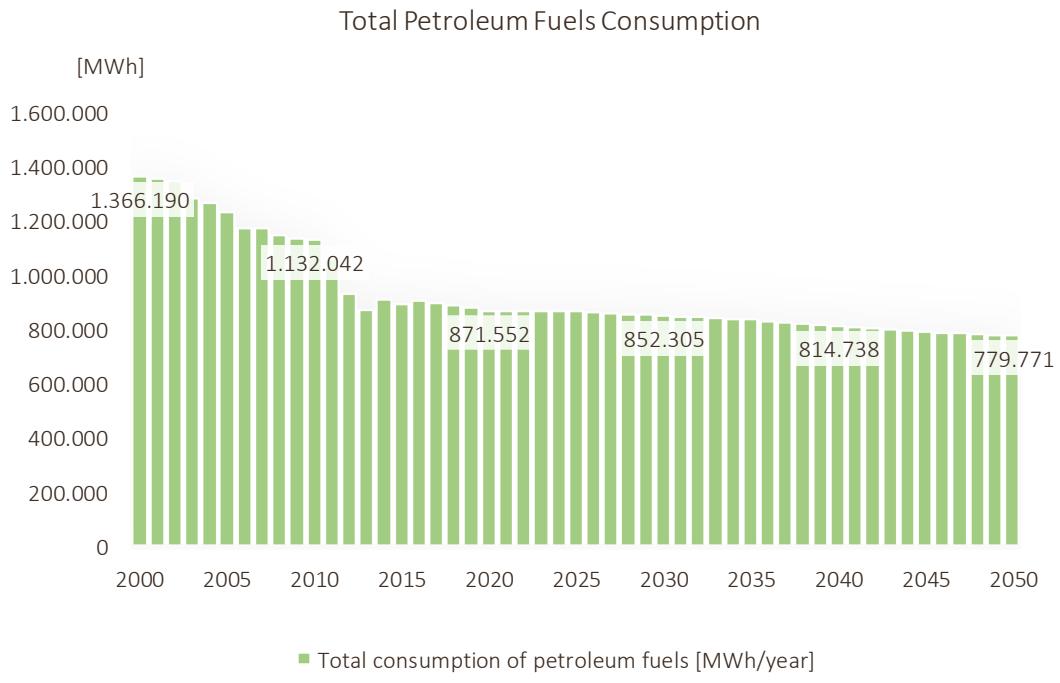


Figure 47: Total fuel oil consumption [MWh/year]

Figure below shows the graphical representation of the total consumption of energy of petroleum origin consumed by the transport sector.

According to the graph presented, there is a general trend of reduction of demand in the period under analysis, reflecting a lower use of these fuels in transportation and a possible saturation of the sector.

The increase in prices of fossil fuels, together with the limitations on emissions from transport vehicles imposed by the European Commission, has motivated the automotive industry to reduce energy consumption. Although efficiency improvements in automotive technology tend to be more visible in the long term, the significant weight of fuel costs in the transport vehicle operating costs accelerates the fleet renewal rate. In this way, improvements in energy efficiency in the transport sector, covering both passenger transport and freight transport, have moderated the impact of the increasing activity in the sector in terms of energy demand.

The replacement of vehicles powered by conventional fuels by electricity and other less polluting fuels also contributes to the evolution of consumption presented in the previous figure.

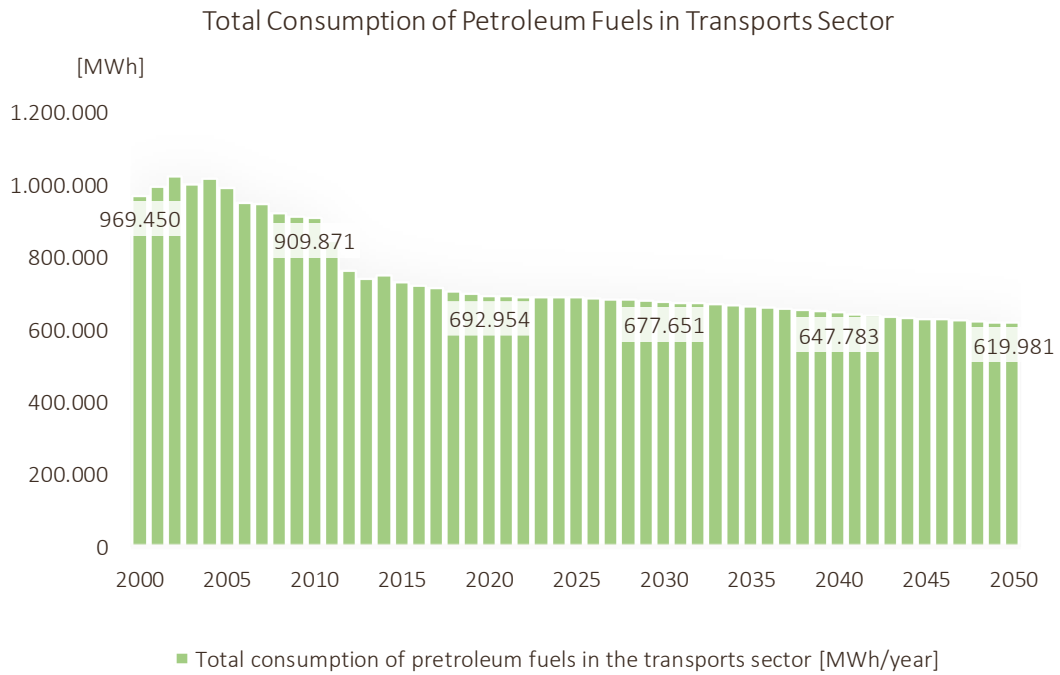


Figure 48: Total consumption of petroleum fuels in transports sector [MWh/year]

By the analysis of the next figure it is possible to compare the evolution of the total consumption of energy of the domestic sector by buildings and by housing.

The curves presented show a trend of decreasing the total energy consumption of the domestic sector by housing and housing building between 2000 and 2004, followed by an increase up to 2011. In the prospective period (2011 - 2050) is expected a decrease in consumption.

Increased improving energy efficiency and housing quality as well as the adoption of more energy efficient behaviour, tend to mitigate the energy increases associated with the growing demand for comfort and increasing introduction of electrical and electronic equipment in the sector can promote increased energy demand evidenced by these indicators.

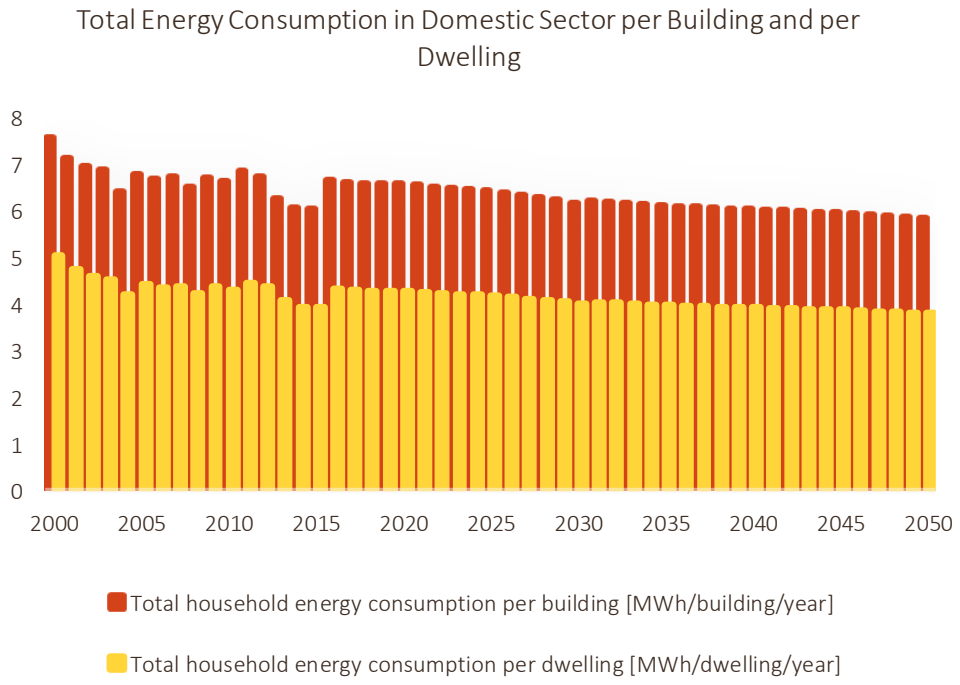


Figure 49: Domestic sector energy consumption by building and dwelling [MWh/building /ano] [MWh/dwelling/year]

The graph now presented is illustrative of the evolution of the consumption of electric energy in public lighting, distinguishing two curves, one referring to the consumption of electric energy in lighting of public buildings and another to the consumption of electric energy in lightning of public roads. This distinction is justified by the fact that there are significant differences between lightning of public buildings and public roads, such as conversion technology, rigid usage, costs, correlation with spatial planning and interconnection with other priorities - safety, in the case of public roads, attractiveness, in the case of public buildings.

The consumption of electric energy in street lighting increased between 2000 and 2011, with a fall in consumption in the following year. In 2013 there is a slight increase in demand by 2015. After 2016 and until 2050 the use of electricity for public roadway lighting decreases.

The consumption of electric energy in lighting of public buildings increases from 2000 to 2010, showing a decrease until 2013. After 2013, the use of electricity in public buildings increases again. From 2016 to 2050 consumption of electric energy in lighting of public buildings is expected to decrease.

This trend of decreasing municipal consumption of electricity is possibly associated with the implementation of more efficient equipment and the change of procedures and behaviours, favouring the rationalization of energy use in the municipal sector.

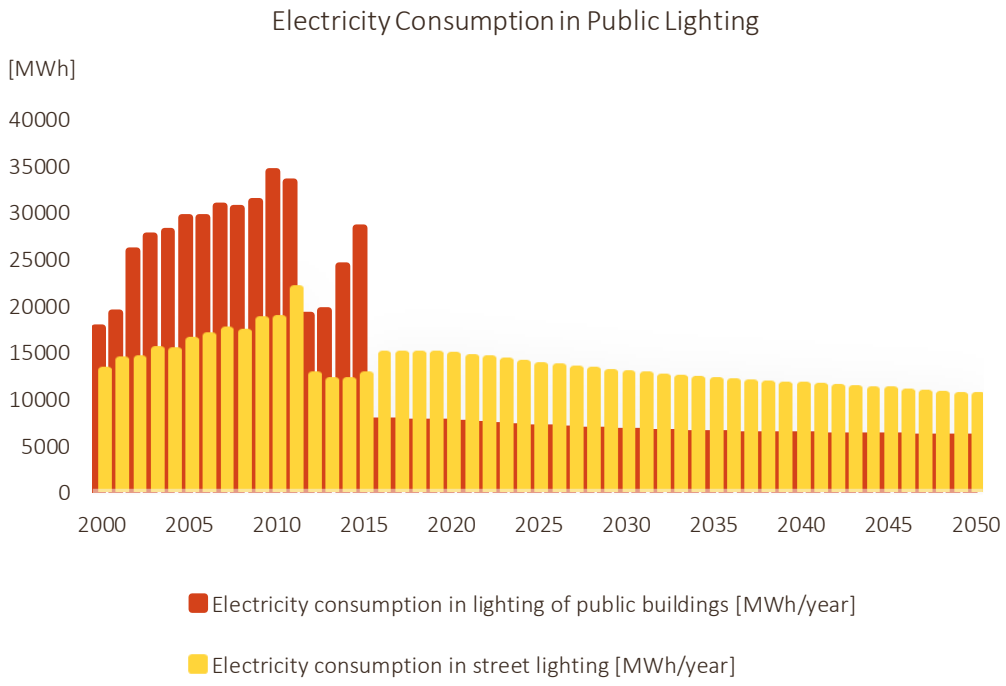


Figure 50: Electricity consumption in public lighting [MWh/year]

Figure below shows the graphical representation of the cost of electricity consumed in public lighting in total municipal expenses. The curves were created determining the percentage that corresponds to the costs associated with the consumption of electric energy for street lighting, public roads and buildings, in relation to total municipal expenses.

The graph below illustrates the weight of the cost of electricity in street lighting in total municipal expenses, in terms of street lighting and public buildings.

Although both indicators show fluctuations over the period 2000 to 2015, it is observed in a global analysis that the cost of electricity in street lighting increases from 2000 to 2011, decreasing in 2012. From 2012 to 2025 there is a slight increase, followed by a stabilization of the indicator, up until 2050.

Regarding the cost of electric energy in lighting of public buildings, it is observed that the weight of this bill in total municipal expenses increases until 2011. From 2011 to 2012, there is a significant decrease, reaching values similar to those observed in 2001 - 2002. After 2012, there is a significant increase in the cost of electric energy in the illumination of public buildings and from 2016 to 2050 the indicator under analysis shows moderate growth.

The trend of growth over the forecast period leads to conclusion about the increase in electricity costs, associated to the medium-term trend of decreasing municipal expenditure, given the growth of the curves presented and considering that energy consumption tends to decrease (figure 50).

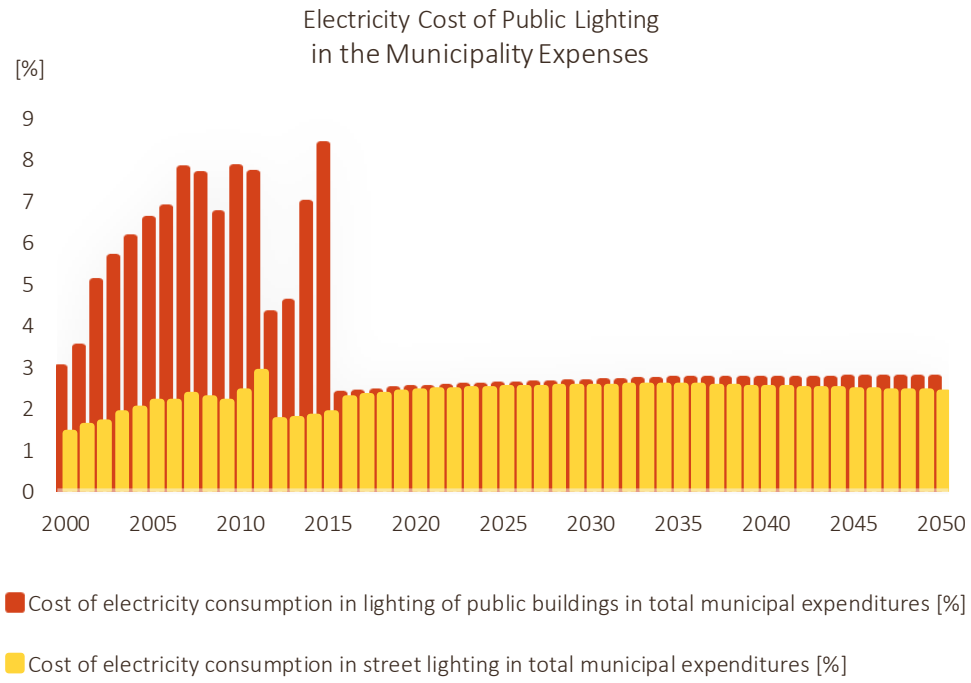


Figure 51: cost of electricity consumption in public lighting in total municipal expenditure [%]

The next figure shows the evolution of total energy consumption by average annual expenditure of employees in the industrial and services sectors. Both energy indicators are obtained by the quotient between the total energy consumption of the respective sector and the number of employees in each of the sectors.

Analysing the curve presented, it can be observed that the total energy consumption per employee in industrial activities shows a significant variation from 2000 to 2012. In the period from 2012 to 2020 there is an increase in the indicator, followed by a sharp decrease from 2020 to 2050.

Regarding the total energy consumption per employee in service activities, this indicator declines from 2000 to 2008. After 2008, the consumption of energy in services per employee increases until 2015, showing a tendency of reduction in the remaining period under analysis.

The trend of decreasing these indicators over the forecast period reflects the expected reduction in energy intensity in both sectors, associated with the use of new, more efficient technologies.

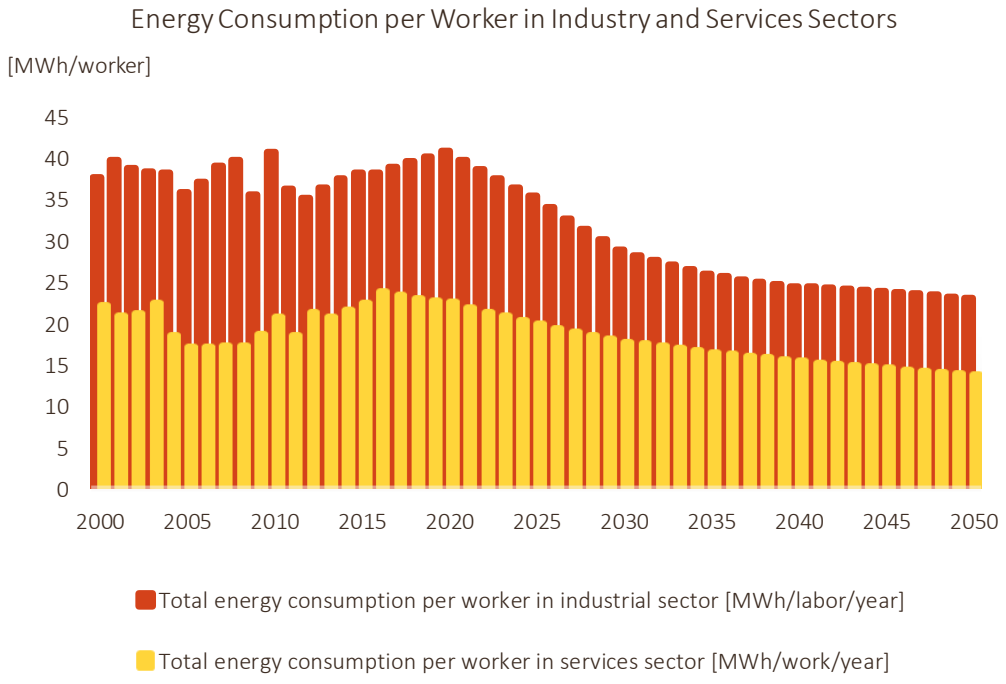


Figure 52: energy consumption per worker in industrial and services sectors [MWh/work/year]

Figure below shows the evolution of total energy consumption in the agricultural sector, by labour cost.

The graph shows a peak of consumption in the year 2002, decreasing about 85% in the following period, from 2002 to 2005. After 2005 some oscillations are observed, until the year 2015.

In the post-2015 period, there is a slight decrease in total energy consumption in the agricultural sector, due to labour costs. This decreasing trend should be motivated by the expected increase in energy efficiency in the agricultural sector.

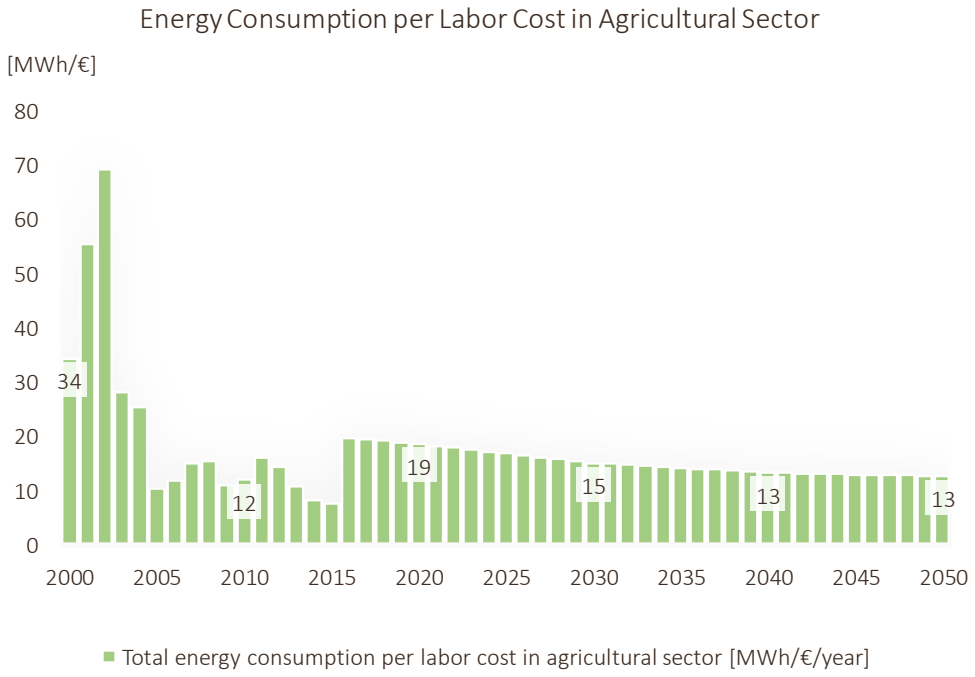


Figure 53: Energy consumption in the agricultural sector per labour cost [MWh/€/year]

Following figure shows the total energy consumption in the services sector by labour cost.

Graph analysis shows a sharp reduction in energy consumption in the services sector by labour cost from 2000 to 2008, interrupted by a period of increase, between 2008 and 2015. After 2015 there is a marked reduction of this indicator. Overall, there is a reduction of more than 75% in energy consumption in the services sector by labour cost between 2000 and 2050.

This downward trend is likely to be driven by increased energy efficiency in the services sector.

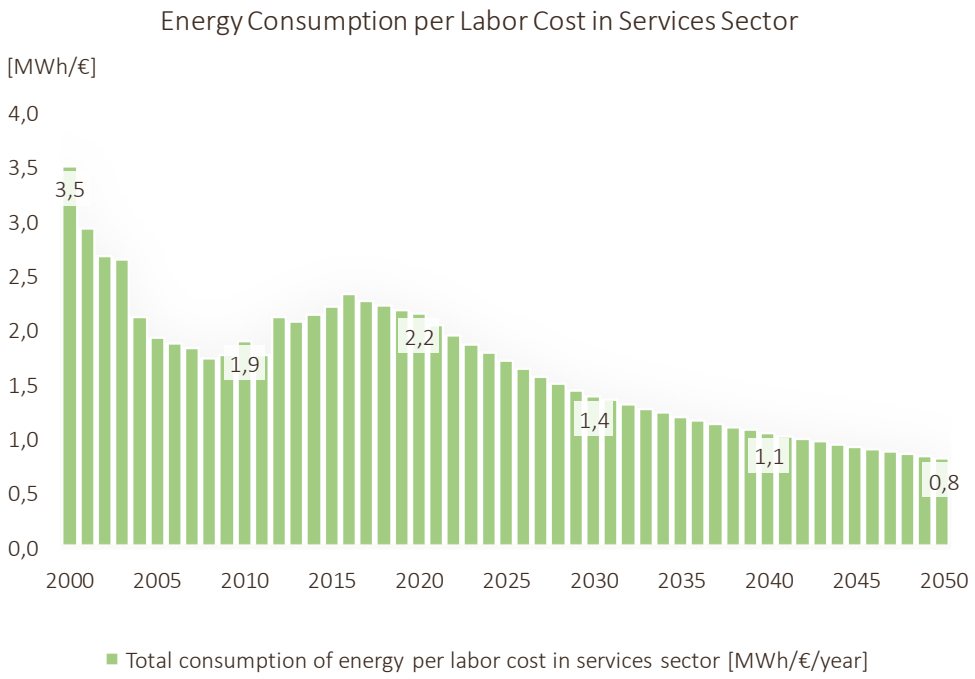


Figure 54: Energy consumption in the services sector per labour cost [MWh/€/year]

This figure represents the total energy consumption in the industrial sector by labour cost.

By the graph shown there is a general trend of decreasing consumption in industry sector by labour cost from 2000 to 2009. After 2009 there is an increase in the indicator under analysis that remains stable until 2020. In the period from 2020 to 2050 the consumption in industry sector by cost of labour decreases significantly.

Overall, between 2000 and 2050 there is a reduction of more than 70% in energy consumption in the industrial sector by labour costs.

As mentioned, the sharp reduction in energy consumption observed in the industrial sector in the period from 2000 to 2009 should be associated to a possible decrease in the activity of the sector.

After 2020 the reduction of this indicator should be associated to the increase of the energy efficiency, seeking a lower energy use, with greater activity developed.

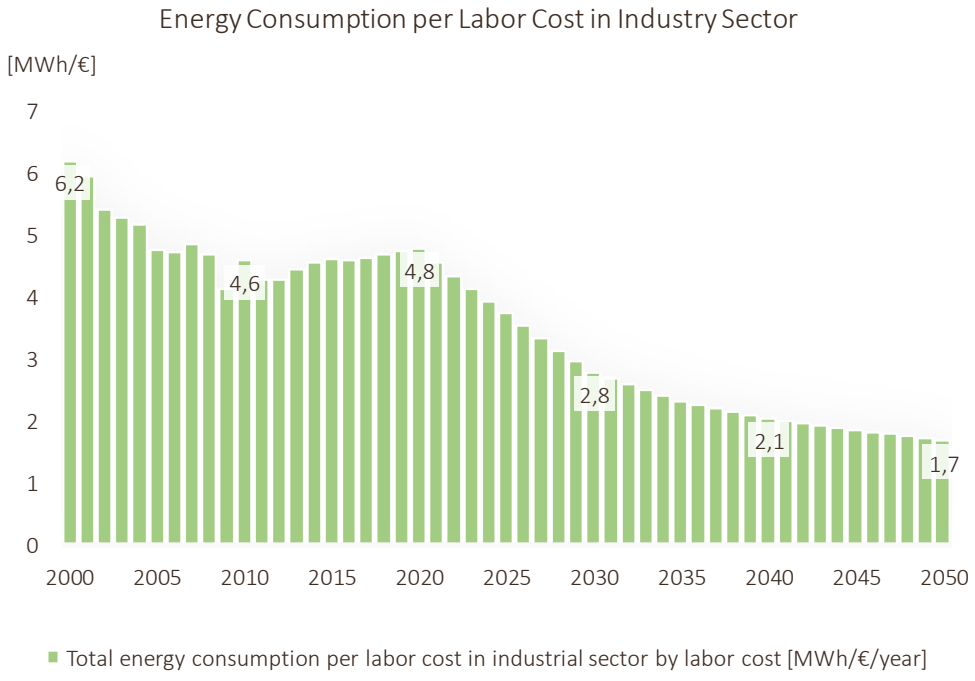


Figure 55: Energy consumption in the industrial sector per labour cost [MWh/€/year]

The figure below shows the cost of electricity in the industrial sector by labour cost.

From 2000 to 2009, there is a reduction in the cost of electricity in the industrial sector by labour cost. After 2009, this indicator shows a growth until 2020, a year in which there is a reversal of this trend, which continues until 2050.

The reduction of the cost of electricity consumed in the industry by labour cost may show a possible increase of efficiency in the industrial sector and/or a possible reduction of the cost of electricity.

Compared to figure 55, it can be observed that the cost of electricity in the industrial sector per labour cost increased sharply (37%) in the period 2009-2020 in relation to the increase (16%) in industry consumption by cost of observed in the same period. This leads to infer the high sensitivity of the industry to changes in electricity tariffs.

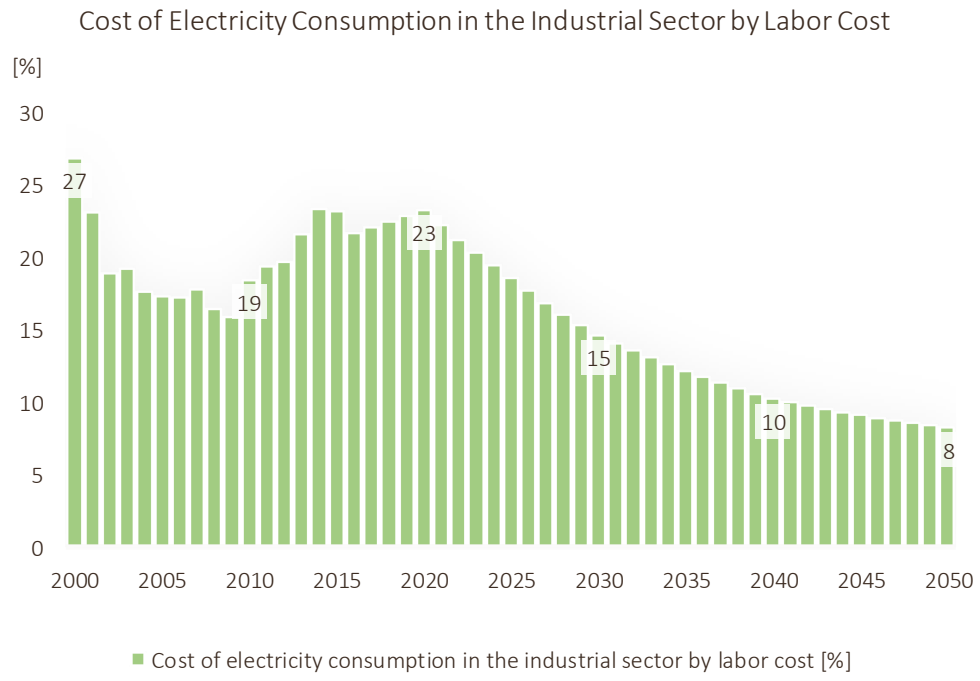


Figure 56: Cost of electricity consumption in industrial sector per labour cost [MWh/€/year]

Subsetorial consumptions

The subsetorial energy consumption and fossil fuels for the year 2016 is shown below.

Table 1 refers to the electricity consumption by subsector. This breakdown highlights the high energy requirements for the *manufacture of textiles* subsector.

Table 1: Electricity cconsumption by ssubsector (2016).

Sector	Electricity Consumption [MWh/Year]
Manufacture of textiles	247.839
Housing	196.943
Real estate activity	37.024
Retail, except of motor vehicles and motorcycles	36.610
Other personal service activities	18.721
Food industry	18.076
Manufacture of rubber and plastic products	16.613
Wholesale trade, except motor vehicles and motorcycles	16.298
Clothing industry	14.938
Activities of membership organisations	14.889
Street lighting and traffic lighting	14.876
Collection and treatment of wastewater	14.814
Food and beverage service activities	13.697
Manufacture of fabricated metal products	11.744
Manufacture of leather and related products	10.440
Education	10.045
Human health activities	9.252
Collection, purification and distribution of water	9.146
Public administration, defense and compulsory social security	7.637
Other extractive industries	6.270
Wood and cork industries	5.249
Accommodation	5.244
Telecommunications	4.733
Social care with housing	4.403
Manufacture of other non-metallic mineral products	4.163
Agriculture and Livestock	3.792
Sports, entertainment and recreational activities	3.763
Manufacture of machinery and equipment, n.e.	3.595
Pulp, paper and paperboard industry	3.409
Specialized construction activities	2.891

Sector	Electricity Consumption [MWh/Year]
Beverage industry	2.811
Trade, maintenance and repair of cars and motorcycles	2.798
Printing and reproduction of recorded media	2.679
Financial services activities	2.114
Social care without housing	1.959
Energy production sector	1.902
Property development and construction	1.851
Manufacture of chemical products	1.461
Other manufacturings	1.332
Manufacture of motor vehicles	1.106
Repair and installation of machinery and equipment	895
Civil Engineering	752
Storage and auxiliary transport activities	710
Administrative and business support services	707
Land transports and pipeline	536
Manufacture of furniture and mattresses	513
Financial services and insurance auxiliary activities	500
Cinematographic, video activities	394
Legal and accounting activities	354
Basic metallurgical industries	353
Services to buildings and landscape activities	330
Mining of metal ores	267
Postal and courier services	234
Wast managment sector	201
Architectural, engineering and related technical activities	192
Other scientific, technical and consulting activities	150
Insurance, pension fund, except compulsory social security	114
Repair of computers and personal and household goods	111
Social headquarters activities and management consulting	89
Travel agencies, tour operators	85
Advertising, market research and opinion polls	81
Water transport	75
Scientific research and development activities	58
Radio and television activities	52

Sector	Electricity Consumption [MWh/Year]
Own consumption	52
Computer consulting and programming	49
Veterinary Activities	49
Libraries, archives, museums and other cultural activities	47
Theatre, music and dance	44
Manufacture of computer equipment	43
Manufacture of electrical equipment	41
Rental Activities	30
Activities related to extractive industries	27
Gambling and betting activities	23
Manufacture of pharmaceutical products and preparations	22
Manufacture of other transport equipment	15
Information services activities	14
Editing activities	7,9
Forestry and logging	5,7
Tobaco industry	4,7
Research and security	3,6
Decontamination and similar activities	3,0
Employment activities	2,2
Activities of international organizations	0,11

Table 2 presents the breakdown of consumption of natural gas by subsector by the year 2016. As illustrated, the subsector of manufacture of textiles represents the main consumer of this energy source.

Table 2: Natural gas cconsumption by ssubsector (2016).

Sector	Natural Gas Consumption [MWh/Year]
Manufacture of textiles	508.997
Housing	34.104
Manufacture of fabricated metal products	28.167
Food industry	3.516
Social care with housing	3.431
Sports, entertainment and recreational activities	3.303
Activities of membership organisations	2.772
Real estate activity	2.581
Other personal service activities	2.411
Food and beverage service activities	2.252
Accommodation	2.220
Education	1.752
Public administration, defense and compulsory social security	1.689
Manufacture of leather and related products	1.678
Human health activities	1.540
Social care without housing	722
Manufacture of machinery and equipment, n.e.	584
Retail, except of motor vehicles and motorcycles	531
Wholesale trade, except motor vehicles and motorcycles	435
Financial services activities	361
Clothing industry	234
Specialized construction activities	149
Manufacture of other non-metallic mineral products	85
Property development and construction	53
Agriculture and Livestock	42
Trade, maintenance and repair of cars and motorcycles	11
Storage and auxiliary transport activities	11
Legal and accounting activities	11
Wood and cork industries	11
Postal and courier services	11

The consumptions of petroleum fuels by subsector in 2016 are shown in table 3. As illustrated, the subsector *land transports and pipeline* is the main consumer of this typology of energy sources.

Table 3: Petroleum fuels cconsumption by ssubsector (2016).

Sector	Petroleum Fuels Consumption [MWh/Year]
Land transports and pipeline	750.185
Housing	53.357
Retail, except of motor vehicles and motorcycles	36.073
Agriculture and Livestock	29.688
Civil Engineering	15.047
Other personal service activities	10.002
Trade, maintenance and repair of cars and motorcycles	5.381
Pulp, paper and paperboard industry	4.997
Manufacture of textiles	4.566
Manufacture of other non-metallic mineral products	3.231
Wood and cork industries	3.057
Public administration, defense and compulsory social security	2.174
Social care without housing	2.004
Food industry	1.990
Sports, entertainment and recreational activities	1.973
Social care with housing	1.620
Manufacture of fabricated metal products	1.544
Wholesale trade, except motor vehicles and motorcycles	1.542
Food and beverage service activities	1.499
Beverage industry	1.277
Specialized construction activities	937
Manufacture of machinery and equipment, n.e.	859
Education	839
Accommodation	718
Clothing industry	484
Activities of membership organisations	415
Manufacture of leather and related products	411
Printing and reproduction of recorded media	210
Manufacture of chemical products	191
Energy production sector	124

Sector	Petroleum Fuels Consumption [MWh/Year]
Property development and construction	122
Manufacture of rubber and plastic products	119
Human health activities	60
Manufacture of coke and refined petroleum products	30
Manufacture of motor vehicles	29
Forestry and logging	12

5.4. Energy benchmarking

A brief comparative analysis of Guimarães energy performance with Continental Portugal is presented below.

Table 4: Comparison of the main energy indicators of Guimarães with Continental Portugal (2016)

Setor	Municipality of Guimarães	Portugal
Energy intensity [MWh/M€]	1.288	812
consumption of electric energy per ininhabitant [MWh/inhab]	15	14
Household total consumption of electric energy per ininhabitant [MWh/inhab]	1,3	1,3
Household total consumption of electric energy per housing [MWh/house]	3,0	2,3
Household total consumption of natural gas per ininhabitant [kWh/inhab]	221	301
Service energy intensity [MWh/M€]	373	183
Total service consumption of electric energy per worker [MWh/work]	24	17
Service electric energy cost per labour cost [%]	23	13
Service natural gas consumption per GAV in the terciary sector [MWh/M€]	30	25
Industrial energy intensity [MWh/M€]	1.307	1.429
Total industrial consumption of electric energy per worker [MWh/work]	38	70
Industrial electric energy cost per labour cost [%]	22	28
Transport energy intensity [MWh/M€]	404	280
Transport energy consumption per ininhabitant [MWh/inhab]	4,7	5,0
Public lighting energy consumption per municipality income [MWh/1000€]	0,33	0,54

5.5. Energy production

The scarcity of fossil fuels associated with market instability emphasizes the need to use renewable energy sources. In Portugal, electricity production from hydropower, wind, solar and biomass (cogeneration) stand out from the rest at the level of annual energy production, has already reached a state of maturity that allows these sources to be competitive.

The renewable electricity production in Portugal in 2016 (table 5) and their respective breakdown by energy source are shown below (**Error! Reference source not found.**).

Table 5: Renewable electricity production[1] by energy source in Portugal (2016).

	Portugal
Hidropower [MWh/year]	16.773.221
Wind power [MWh/year]	12.316.523
Biomass [MWh/year]	4.317.424
Municipal Solid Waste [MWh/year]	558.000
Biogas [MWh/year]	693.150
Photovoltaic power [MWh/year]	788.302
Total [MWh/year]	35.446.621

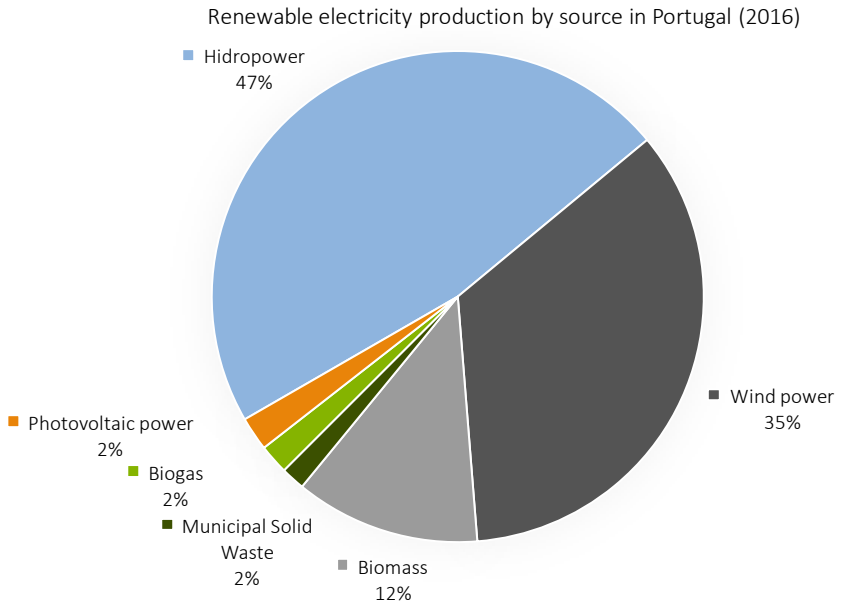


Figure 57: Renewable electricity production by energy source in Portugal

[1] Renewable energy production excluding microproduction and microproduction power plants.

The potential of endogenous renewable energy production in In Guimarães should also be highlighted. In 2017 were operational six hydroelectric small power plants (figure 58).

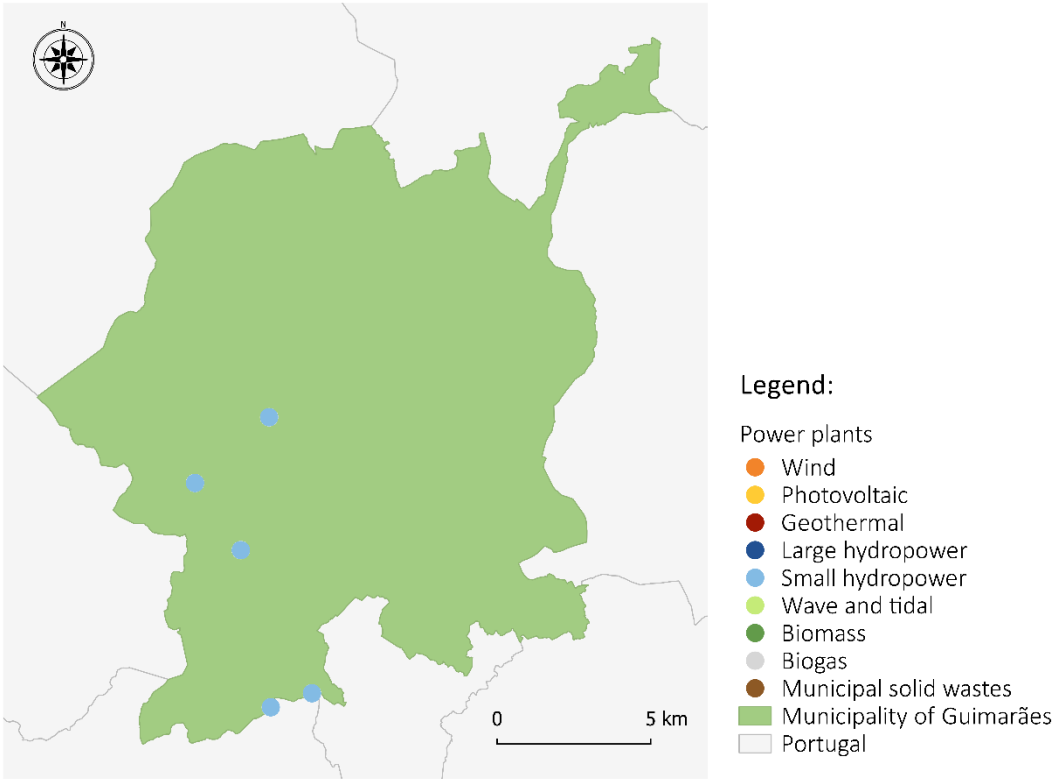


Figure 58: Renewable power plants located in Guimarães (adapted of INEGI, 2017)

The renewable electricity production in the year 2016 was 11.758 MWh/year, totally from hydropower (table 6 and figure 59).

Table 6: Renewable electricity production[2] by energy source in Guimarães (2016).

	Municipality of Guimarães
Hidropower [MWh/year]	11.758
Wind power [MWh/year]	0,00
Biomass [MWh/year]	0,00
Municipal Solid Waste [MWh/year]	0,00
Biogas [MWh/year]	0,00
Photovoltaic power [MWh/year]	0,00
Total [MWh/year]	11.758

[2] Renewable energy production excluding microproduction and microproduction power plants.

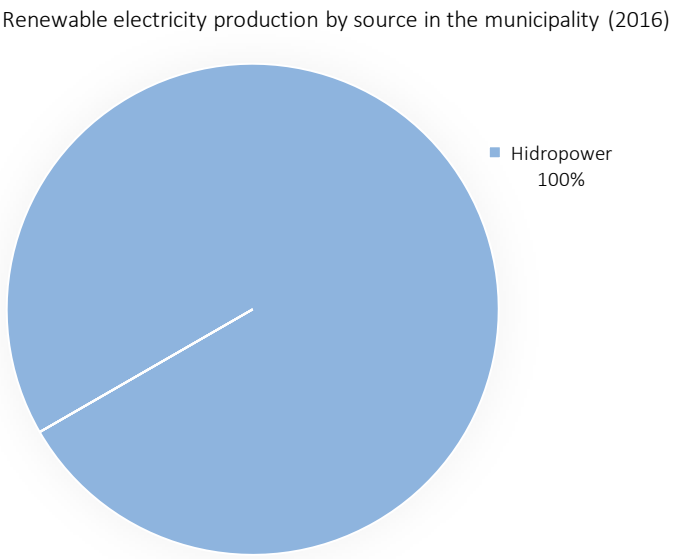


Figure 59: Renewable electricity production by energy source in Guimarães

As Portugal is one of the European countries with the highest levels of solar radiation, the municipality has a high potential for the production of photovoltaic energy, with potential of generating indexes higher than 1.300 kWh/year by kWp installed, in ideal conditions (figure 60).

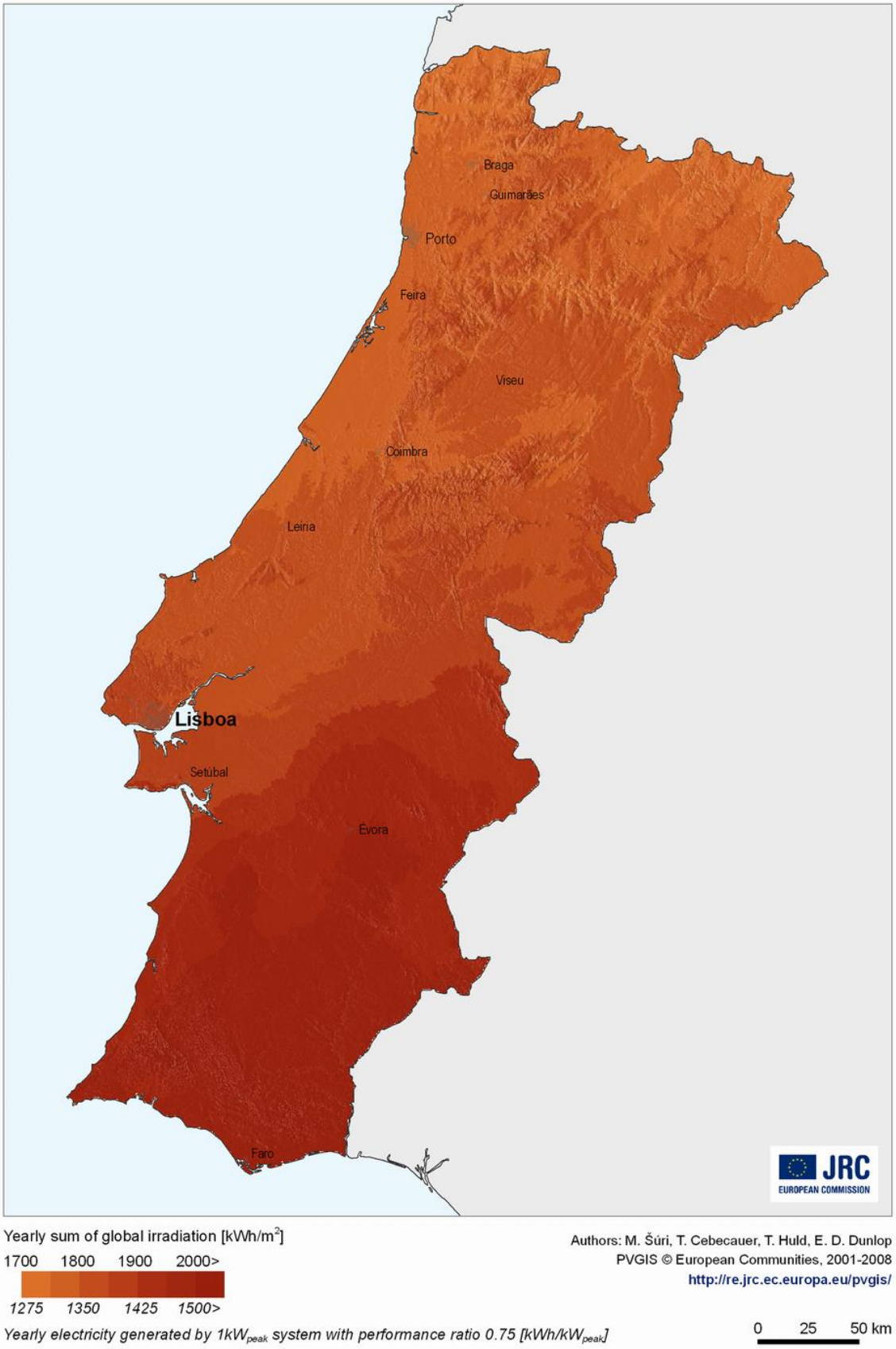


Figure 60: Global irradiation and maximum potential of photovoltaic electric energy production in Continental Portugal (Source: JRC, 2010)

5.6. CO_2 emissions

In this chapter are presented the CO_2 emissions resulting from the energy consumption occurring in the geographical area of the municipality of Guimarães.

Emissions by sector

The emission values presented refer to the sectors: domestic, industrial, agricultural, services and transport. The figures below illustrate the CO_2 emissions by energy consuming activity sector for the years 2016, 2020 and 2030 and 2050. Thus, it is possible to observe the evolution of CO_2 emissions for each sector, over the projection period.

Observing the graph shown in figure 61, emissions from industrial activity in the year 2016 account for 37% of total emissions, followed by transportation and services, with emissions of 28% and 20%, respectively.

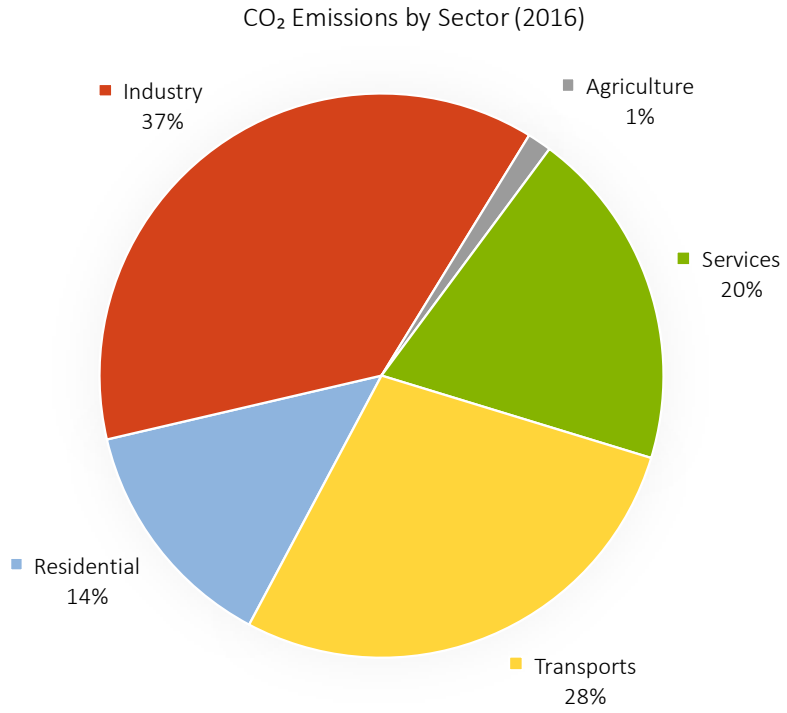


Figure 61: CO_2 emissions by sector of activity in 2016 [%]

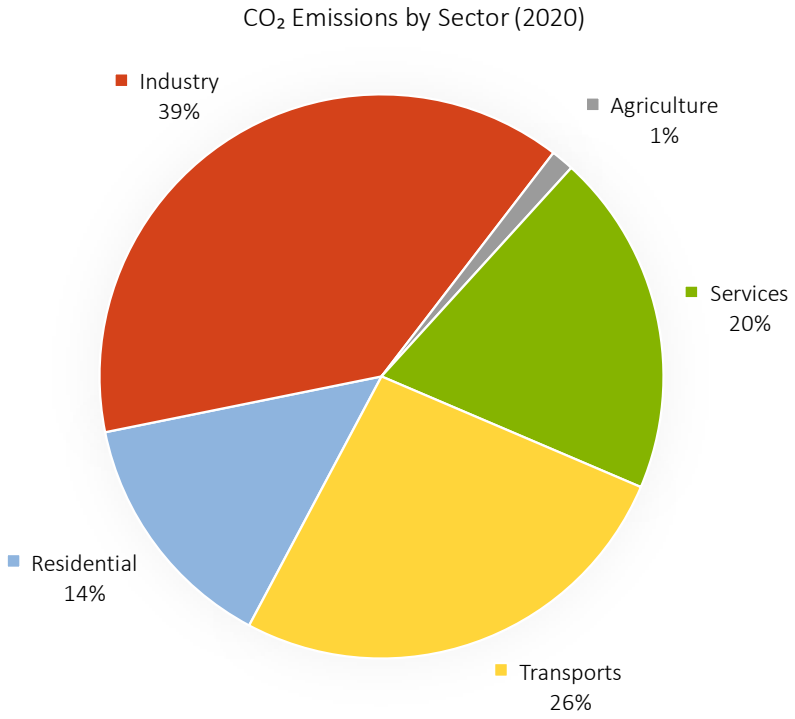


Figure 62: CO_2 emissions by sector of activity in 2020[%]

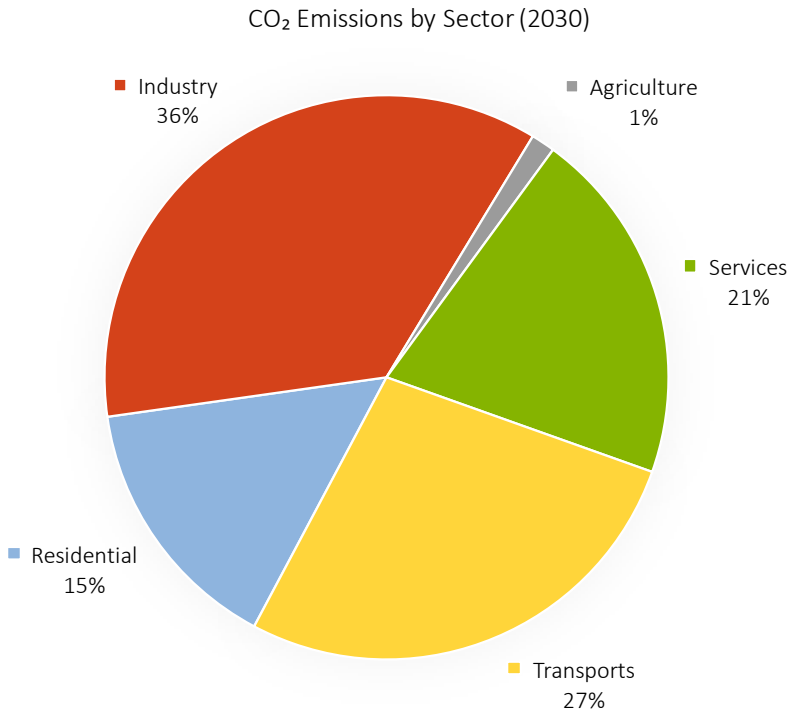


Figure 63: CO_2 emissions by sector of activity in2030 [%]

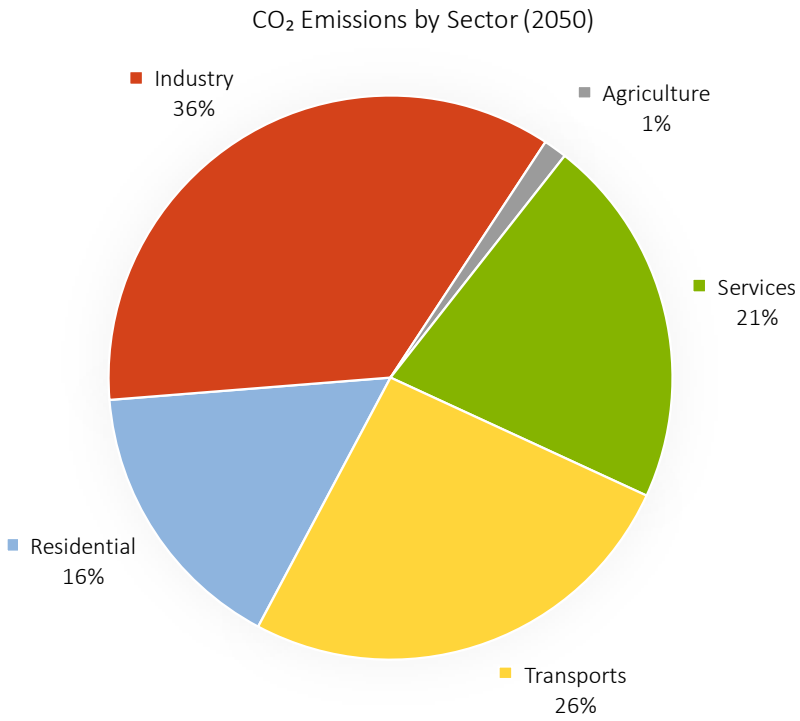


Figure 64: CO_2 emissions by sector of activity in 2050 [%]

In the municipality of Guimarães was identified 1 industry covered by the European Emission Trading Scheme (*EU* ETS), namely:

- TMG - Acabamentos Têxteis

It should be emphasized that the methodology proposed by the Covenant of Mayors for Climate and Energy doesn´t foresee the accounting CO_2 emissions from industries covered by the EU ETS, as these industries have a specific efficiency plan, namely the National Plan for the Allocation of Greenhouse Gas Emissions Licenses (PNALE).

Emissions by energy source

The following figures refer to the CO_2 emissions per energy vector consumed in the years 2016, 2020 and 2030 and 2050. The emission figures presented refer to the consumption of energy vectors: electric energy, natural gas, butane and propane gases, gasoline and auto gas, diesel fuel, dyed diesel and other fuels for industrial use. Thus, it is possible to observe the evolution of CO_2 emissions per energy vector over the projection period.

The analysis of figure 65 shows that about 45% of CO_2 emissions originate from electricity consumption and 22% from diesel fuel consumption. The use of natural gas also has a significant weight, corresponding to 19% of CO_2 emissions.

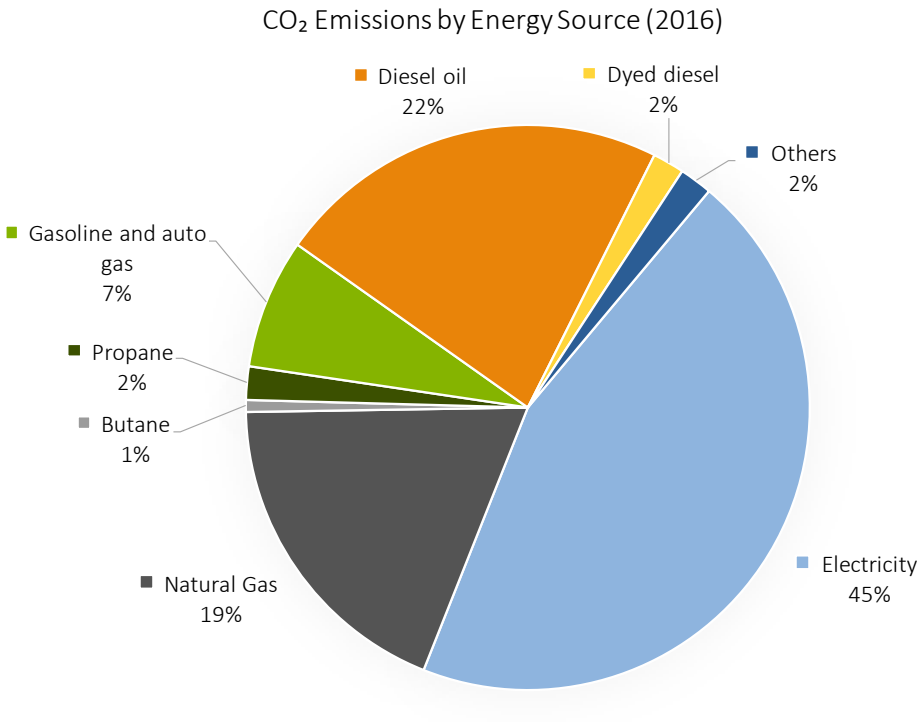


Figure 65: CO_2 emissions by energy source in 2016 [%]

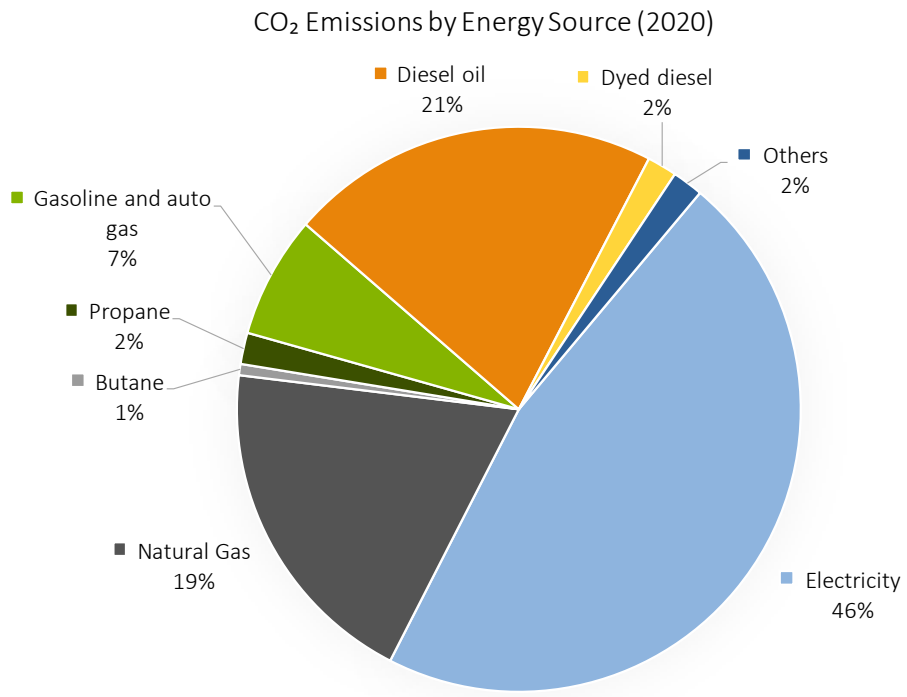


Figure 66: CO_2 emissions by energy source in 2020 [%]

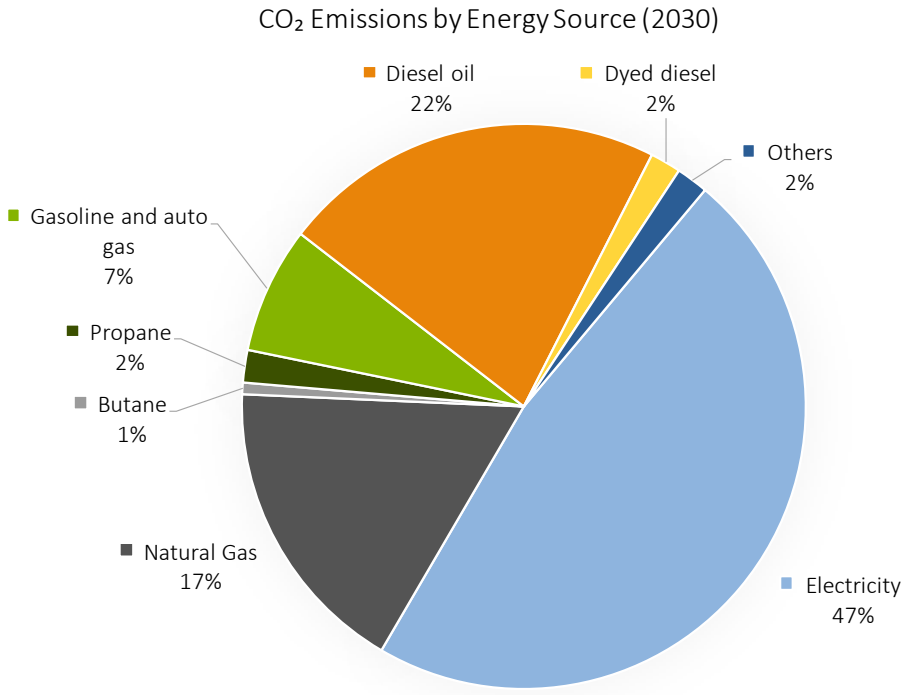


Figure 67: CO_2 emissions by energy source in 2030 [%]

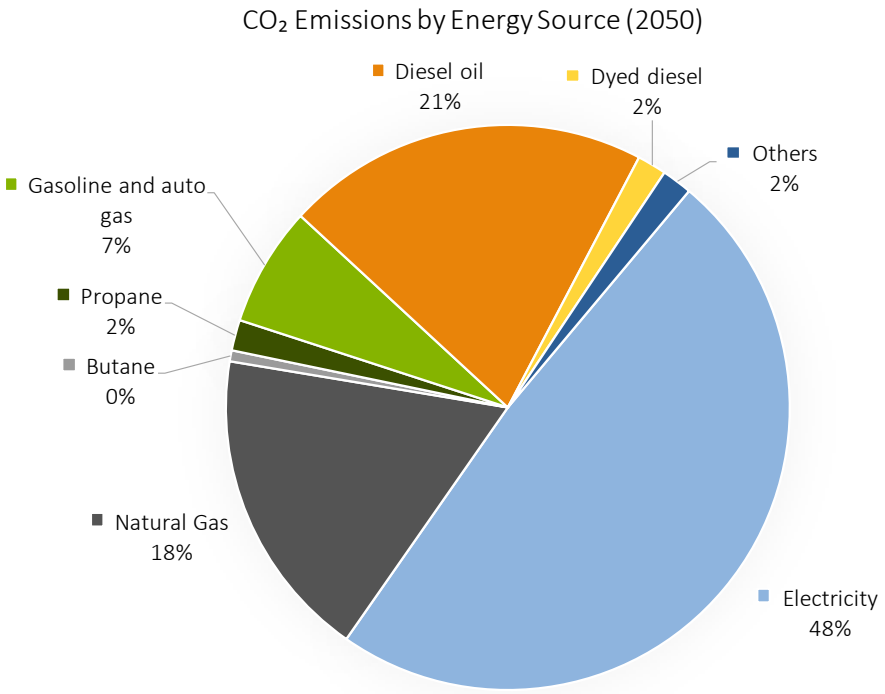


Figure 68: CO_2 emissions by energy source in 2050 [%]

6. OBJECTIVES AND STRATEGIES

Potential changes resulting from climate change may have significant impacts on the municipal territory as well as on the natural and human systems that constitute it. It is therefore essential to adopt an integrated climate change mitigation and adaptation strategy focused on promoting sustainable and resilient urban development.

6.1. Strategy for energy and climate

Using the Covenant of Mayors for Climate and Energy and the EU Strategy on Adaptation to Climate Change as starting point, new goals for 2030 were established in the Sustainable Energy and Climate Action Plan (SECAP), in line with the strategy followed by Guimarães for 2020.

The preparation and implementation of SECAP will allow the municipality to achieve a 39% reduction in energy consumption and 42% of the respective emissions in 2030, thereby exceeding the national targets for non-ETS sectors of a 30% reduction in CO_2 emissions by 2030, as defined in the 2020/2030 NPCC.

The implementation of measures to improve energy and climate sustainability is therefore essential to the renewal of the urban physical space, to economic development, social inclusion and protection of the environment. The development of partnerships between local authorities, citizens, civil society and the local economy is also indispensable for the successful implementation of a climate change mitigation and adaptation strategy.

In order to find the best solutions for future urban challenges that can contribute to the decarbonization of the economy, Guimarães intends to be a “Laboratory for the Future” – which includes twelve urban challenges in the fields of energy, mobility, data, circularity, green area, waste, equipment, culture, climate, knowledge, governance, economy – through the living lab approach – with the creation of a Living Lab for Decarbonization, which focuses on the areas of mobility, energy, circular economy and environment, and buildings –, by inviting citizens to co-create a smart-city through innovation and transformation.

Adaptation to climate change is also already underway in Guimarães. Strengthening the strategic approach based on timely and effective adaptation measures is important, thus ensuring the consistency of several sectors and focusing on the creation of synergies with other strategic objectives of the municipality.

6.2. Long-term goals and visions

Sustainable energy and climate measures have already been implemented by the municipality, not only through integrated policy options, but also with the involvement, awareness and behaviour change of the population towards greater environmental sustainability, thus reducing greenhouse gas emissions, in a win-win situation.

Bearing in mind the goal of becoming a low-carbon city by 2050, in line with the Low-Carbon National Roadmap, Guimarães will reinforce its strategy do reduce greenhouse gas emissions. The clean energy transition will be key and the municipality will focus on the investments in new low-carbon technologies, renewable energy, energy efficiency and grid infrastructure. Policies that promote a stable business climate which encourages low-carbon investments wil also be promoted.

Achieving the long-term climate objectives also requires contributions from every part of the economy and from us all as individual citizens. Community and corporate engagement is a critical part of energy and climate action and the municipality will promote the engagment of the comunity to take climate action.

7. SUSTAINABLE ENERGY AND CLIMATE ACTIONS

The Sustainable Energy and Climate Action Plan of the municipality of Guimarães represents the commitment of the Municipality with mitigation and climate change adaptation.

The Action Plan now presented follows the methodology proposed by the Covenant of Mayors with the appropriate adaptations to the reality of the municipality of Guimarães, using as a reference the results obtained in the energy matrix, both with regard to the reference situation and with regard to forecasts of its evolution.

In the implementation of PASEC, the municipality of Guimarães will develop several actions to mobilize local, business, social and institutional agents. In order to ensure the achievement of the desired results, measures to improve energy sustainability were defined after the survey of intervention options and energy needs, thus ensuring its applicability.

7.1. Sustainable mobility actions

Mobility is considered to be one of the most influential factors on quality of life of citizens. With transportation being the largest source of GHG emissions, significant changes must be made in both transport systems and vehicle fleets in order to reduce the climate impact of the transport sector. Due to more stringent European norms and national instruments, it is expected for CO_2 emissions from vehicles to decline in the years to come. Promoting rational articulation between different modes of transport will ensure adequate mobility, the promotion of social inclusion, competitiveness, the quality of urban life and the preservation of the historical heritage of the city.

Recent data released by the European Environment Agency places Portugal first in Europe for the efficiency of new cars, with the most efficient and less polluting fleet of new cars. Taxation structures encourage the purchase of more environmentally friendly vehicles (tax weighs CO_2 in 30%). Energy efficiency, electrical mobility and alternative mobility play a fundamental role in the decarbonisation of the transport sector. Despite all measures taken until now, the transport sector has still a significant weight in the final energy consumption in the Municipality of Guimarães and consequently in the CO_2 emissions occurring in the

territory. Energy demand in this sector represents 26% of total final energy consumed and 27% of total CO_2 emissions.

Optimization of the transport network

Optimize and create new solutions for the transport network, permanent and/or temporary, with more and better interconnections with each other. Study population movement flows, including commuting movements, events, among others, and adjusting the transportation network to their specific needs. Create an intelligent energy management platform for integrated urban mobility management and improved sustainability.

The existence of a responsible and population-friendly transport network is essential for greater sustainability in the mobility of people and goods. The development of new mobility concepts, the organization of public transport, logistics and planning solutions will improve efficiency and reduce air pollution and noise in urban areas, such as the development of intelligent and integrated transport systems, innovative search and alternative solutions for collective and non-motorized transport. Activities to support policy analysis and development, in particular on socio-economic aspects of transport and promotion of innovation to meet the challenges posed by transport, should also accompany the whole process of optimization of the transport network.

Integrating the various components of sustainability management into a single tool for shared sustainability management, including mobility, has been instrumental to the success of local strategies and agendas. This methodology should be supported by the use of an intelligent energy management platform with connection to peripheral elements (sensors, smartphones, etc.) that allow the availability and access to features of retrospective performance analysis and real-time information and monitoring. At the mobility level, the intelligent energy management platform should be linked to intelligent transport and management applications, including information, payment and other systems. This platform should also be characterized by the full integration of information flows, management systems, infrastructure networks and mobility services, using open technologies and new navigation and time-based applications based on satellite navigation systems.

The creation and implementation of a mobility plan that promotes synergies between different transport modes and respective users is of great importance. The proximity and accessibility of the population to public transport infrastructures and solutions should be maximized, just as the frequency and regularity of transport solutions must be optimized so that collective transportation - or other innovative solutions - an alternative to individual transport.

An integrated intermunicipal public transport network, with new circuits and supported by infrastructure support allows the adjustment of public transport supply to the population's needs.

The implementation of an intermodal transport system "door to door" for example, could lead to greater integration between transport modes, significantly reducing traffic congestion, and will facilitate the accessibility of elderly and vulnerable users.

The creation of synergies with companies and collectives, among others, for the implementation of alternative urban mobility solutions should also be promoted, with particular emphasis on tourist travel. Measures to encourage the use of public transport by employers or positive discrimination measures for sustainable transport users may also be implemented.

The public movement for major events involves several factors that are hardly controlled, such as traffic jams, parking problems and others, often compromising the sustainability of these initiatives. As such, the event planning should include the provision of parking areas associated with public transportation that make the connection between the parking areas and the venue.

Only the adoption of an intelligent planning methodology and integrated management can respond simultaneously to the issues of sustainable mobility, energy demand and supply, air quality and the urban environment and the management of assets and infrastructure. This methodology should be part of a regional framework that considers sustainability targets, including CO_2 emissions, and meets the needs of the population.

Efficient vehicles and fleets

Incorporate efficient vehicles, thus gradually renewing the fleet of land transport vehicles.

Road transport accounts for most of the mobility generated, and in the European Union the car accounted for 72% of total motorized mobility in 2008. The increasing dependence on private transport and the increase in the number of journeys per passenger has led to serious social, economic and environmental problems, including inefficient energy consumption in the transport sector. Currently, more than 20% of final energy consumed in the EU is the responsibility of the transport sector, and in 2008, in Portugal, this sector was responsible for 28% of total final energy consumption.

Efficiency and the need to reduce greenhouse gas emissions are increasingly present in the automotive sector: the automotive industry has made tremendous progress in reducing CO_2 emissions and technological development has been evident in meeting the objective.

At present, the replacement of old vehicles with new vehicles of the same range ensures in itself an increase in energy efficiency and consequently a reduction in fuel consumption per km.

However, it is not necessary to fully replace the vehicle in order to obtain energy and environmental benefits, that is, in many vehicles an effective maintenance can be significant in terms of its efficiency.

Optimization of fleet distribution

Design a plan for the introduction of improvements in the distribution network and support to urban services in order to allow better management of the fleets.

Many companies have fleets of vehicles assigned to their activity and/or assigned to company personnel, typically with management functions (board of directors, management).

Fleet management, especially at logistics level, plays a key role in improving the efficiency of companies, as it integrates supply chain management that plans, implements and controls the flow of goods, services and information between the point of origin and the point of consumption, so as to meet the needs of customers.

The typology of measures to be implemented in the field of fleet management includes optimization of routes (especially important in the case of distribution companies or whose activity involves regular visits to customers, the acquisition of fleets of less polluting vehicles (e.g. hybrid vehicles, electric vehicles, bicycles resource for local distribution, or others that enable the reduction of environmental externalities) and the review of the company's car allocation policy in order to promote the rationalization of allocation of vehicles.

A good fleet management leads to a competitive advantage and reducing costs, as well as the reduction of energy and corresponding CO_2 emissions and improving air quality and noise of urban consumption.

Optimization of professional mobility and commuting

Implement mobility plans for workers and users of business establishments in the municipality.

Mobility of workers, visitors and service providers constitutes a significant share of daily commuting in the municipality. Thus, attractive poles/travel generators play an important role in the field of mobility management and system sustainability.

As such, the adoption of good mobility practices should become a reality within the workplace, especially in large companies and at the hubs that generate travel.

In this context, the design and integrated implementation of mobility plans that increase the use of public transport, especially for commuting, becomes relevant and constitutes a very useful tool for the promotion of energy sustainability.

To the extent that there will always be a significant group of individuals who, for professional or personal reasons, will continue to use the car for their journeys, measures should also be recommended to optimize/rationalize the use of the car. In this context, it may be considered to carry out an analysis of the feasibility of implementing measures to promote Carpooling (sharing a car between employees who carry out the same course, sharing the cost of travel), Carsharing (use of vehicles made available/rented at certain points for specific journeys) or Vanpooling, for example, which would allow a reduction in the number of vehicles in circulation on a daily basis.

The creation of parking management models can also be used as an instrument for managing and controlling the demand for individual transportation. In the central areas of urban hubs, containing the use of long-term parking on the public road associated with commuting (employees of commerce and services) will ensure the existence of rotation parking for visitors, namely customers and suppliers.

Electric Mobility

Acquire electric vehicles and adopt strategic measures to promote the replacement of vehicles with fossil fuels by electric vehicles.

Increasing the use of alternative energy sources and of energy-efficient and clean vehicles, as well as their integration into the urban transport system, is a key strategy for improving urban sustainability and quality of life, as well as reducing dependence on fossil fuels. With the current technological advances, both in terms of batteries and cargo infrastructure, the use of electric vehicles has proved to be a viable solution.

Electric vehicles have incorporated different types of technologies, particularly in terms of structure, body, propulsion systems and energy sources, and can be distinguished electric vehicle batteries, electric vehicles and hybrid electric vehicles to fuel cells. The main limitations of electric vehicle batteries are related to the limited capacity of the batteries and their autonomy. In the case of hybrid electric vehicles, high costs and complexity are the main obstacles to their diffusion. Fuel-cell electric vehicles are still in the development stage, yet have a high potential. The costs of production and the lack of filling stations will be the main obstacles to the expansion of this technology.

The purchase of an electric vehicle on batteries allows a great energy saving, given that the electric motors are much more efficient than the internal combustion engines. A battery-

operated electric vehicle spends an average of 0.1 to 0.23 kWh per kilometre, while a vehicle with an internal combustion engine spends on average about 0.98 kWh per kilometre. With this performance electric vehicle batteries allows a large reduction in the cost per mission.

Hybrid electric vehicles combine more than one propulsion engine, with different types of power, most commonly the combination of a combustion engine and an electric motor. This system has been developed with the aim of improving the energy efficiency of cars, with more than one propulsion engine being involved, different types of power, use of kinetic energy generated by braking and start-stop system, which stops and starts automatically the internal combustion engine. The growing commercialization of hybrid electric vehicles allowed the increase in the performance and autonomy of electric propulsion vehicles. In order to reduce costs, efforts have been made to upgrade various electrical subsystems of hybrid vehicles, including electric motor, power electronics, power management units and batteries.

In order to favour an increasing use of the electric vehicle as an alternative to road transport using fossil fuels, exclusive infrastructure for electric vehicles such as loading points or parking spaces can be promoted. Possibility to make test drives and the creation of rental electric vehicle services, for example, are also actions to encourage electric mobility.

The provision of public electric bicycles and the creation of electric bicycle rental services are also relief projects for the democratization of these technologies and the feasibility of a new urban mobility profile.

The existence of a national platform for electric mobility could contribute to the structuring of two-wheel Electric Mobility Industries Clusters. This is a relatively new industry - boosted by the development of new batteries - so it is still an industry where new players can enter. For this to be possible, it is essential that there be concerted action between public policies and business strategies that create the conditions for the growth of local actors and the structuring of a competent supply chain in key technological areas.

The replacement of conventional vehicles by electric and hybrid vehicles in captive fleets of local, regional or national entities, as well as in passenger and freight transport fleets is recommended as a vector of dissemination of this typology of vehicles. This method makes it possible to identify and overcome possible technical and logistical difficulties in the supply of fleets, as well as to promote the increase of available infrastructures of supply. The promotion of the use of electric and hybrid vehicles could be reinforced by the development of policies and solutions that create an initial critical mass capable of accessing better prices for the acquisition of these vehicles. The favouring of users of these vehicles at the level of parking conditions or tax burden contributes significantly to boost the option for these technologies.

The association of renewable production of electricity to electric vehicle charging infrastructure systems allows accentuate the GHG emission reduction achieved with the use of electric vehicles. In this way it can also be a reduction in dependence on fossil fuels, with positive impacts on the local and national economy.

Increased pedestrian mobility and bicycle use

Create a network to make the city more pedestrian and cycling.

Nowadays, due to environmental and public health issues, it is increasingly recognized that soft modes of transport (individual travel and locomotion on wheels without the use of fuel energy) can be an alternative in short distance or in combination with other modes. The promotion of this type of travel reduces the number of vehicles in circulation and thus adds value to reducing energy dependence and greenhouse gas emissions and to human health as well.

The promotion of intermodality will allow an increase in the number of journeys by foot and bicycle over shorter distances. The creation of solutions that promote the realization of partial foot and/or bicycle routes, complemented by bus routes or other collective transport is suggested.

In order to promote mobility by foot and bicycle, it is considered essential to ensure the qualification of the pedestrian and cycling network, providing higher comfort and higher priority of the routes with higher flows or those in situation in need for improvement.

In this context, it can be argued, that the pedestrian and cycling networks should serve areas with greater intensity of trade and services, as well as the poles of greatest tourist concentration, surrounding areas of major travel generators and those with interfaces and transport stops serving and residential areas.

The quality of the network to be created/maintained must be ensured on a permanent basis, through an adequate monitoring of their conditions and appropriate maintenance actions, and should be promoted to increase the safety of their users, through an improvement in urban design and rectification of situations that lead to the risk of being hit.

As an incentive to the use of the bicycle, in addition to the promotion of the existence of equipment and support infrastructures that facilitate the use and parking of bicycles, cycling mobility should be promoted in recreational and leisure activities and as a sport practice. The use of the bicycle in regular activities will foster the taste for this means of transport and promote the improvement of the physical conditions of its users, leading to a greater use of this vehicle, including as an alternative mode of transportation in shorter distances. In order to increase the success of the pedestrian and cycling network, awareness and training of the

population should also be made for the use and coexistence with these modes of transport, aiming at their use also outside leisure activities.

Biofuels and alternative energy sources in transport

Promote the use of biofuels and alternative energy sources as the main fuel or blended with other fuels to power fleets.

Currently, the transport sector is almost exclusively dependent on petroleum products, making it one of the main responsible for the emission of greenhouse gases. The promotion of the production and use of biofuels will have a significant impact both in reducing the carbon footprint of the sector and in reducing the energy dependency of the municipality and the country.

Biodiesel produced from oils, used or new, of vegetable or animal origin is a sustainable energy source alternative to the use of diesel fuel, corresponding to the type of biofuel used most often in the country. The 100% use of this biofuel may require a small conversion to the engine and mechanical parts of the vehicle. However, there are already several brands of cars that allow the use of this type of fuel in a mixture with diesel.

Other biofuels also have a high potential. For example, biogas produced through biomass and/or the biodegradable fraction of waste (not in any way competing with food production). This biofuel can be purified to the quality of natural gas for transport use.

The use of biofuels is extremely positive at the environmental level, since their origin can be vegetable, causing the emissions balance associated with their use to be neutral or residual, minimizing landfill and valuing pollutant residues such as used oils or animal fats.

The European Commission has been supporting the development of hydrogen and fuel cells since the early 1990s. Fuel cells use hydrogen and oxygen to generate electricity through an electrochemical reaction, without emission of pollutants and without noise.

Hydrogen has a high potential as clean and efficient energy in stationary, portable and transport applications, being considered an important element in the future energy mix in transport. At European level, several projects are on the go to support the implementation of fleets of fuel cell vehicles, while developing hydrogen infrastructures and filling stations.

7.2. Sustainable buildings actions

A sustainable and efficient building stock is essential for minimizing environmental and climatic impacts and for maximizing the comfort and health of its occupants. In terms of energy efficiency, the buildings sector is responsible for the consumption of approximately

40% of final energy in Europe. More than 50% of this consumption can be reduced through energy efficiency measures. Increase energy sustainability in buildings, new and constructed, is essential to achieve the commitments assumed.

Efficient lighting in buildings

Elaborate an "Efficient Lighting Plan" that counts on the participation of professionals in service area, public equipment and/or private agents.

This plan should promote the replacement of inefficient lighting equipment with energy efficient ones, without compromising the needs of the population, and the quality of lighting, reflecting a reduction in consumption and consequently reducing CO_2 emissions and energy price.

Lighting is one of the end uses of energy in which the introduction of energy efficient solutions more compensates, both in terms of energy billing and comfort level. Typically in housing, it is possible to reduce the consumption of electricity used for lighting between 15 and 20%, without losing benefit of a good quality light. This potential of reduction can still reach 30 - 50% in the case of office buildings, commercial and leisure facilities.

In this context, several possibilities of increasing the efficiency of the interior lighting have been analysed, highlighting the substitution of lamps for more efficient lamps, being able to reach with this measure reductions that can reach economies of approximately 75%. the replacement of inefficient lamps with lamps with LED technology (Light Emitting Diode). LED technology gives lamps a high longevity, with a very long life span.

In addition to direct energy reduction, the replacement of inefficient lamps also contributes to the indirect reduction of consumption of ambient air, due to the greater energy conversion capacity in light, minimizing the waste of energy in the form of heat.

Optimization of lighting control systems, introducing presence detectors must be considered as well. They combine comfort and safety with greater energy efficiency. Illumination control allows unnecessary consumption to be avoided in spaces where the public's permanence and the time of use are high (open-spaces, waiting rooms, etc.) or in spaces where both the permanence and the time of use of the public are reduced (sanitary facilities, corridors, stairs).

Sustainable building, energy audits and building certification

To promote sustainable and efficient construction, as well as audits in existing buildings, public services and industries that allow the identification and evaluation of the degree of energy efficiency, resulting in energy certification and interventions to improve the sustainability and energy efficiency of the buildings.

Sustainable construction allows for better environmental and energy performance of the building. Through sustainable and efficient construction, it is intended to optimize resources, maintaining maximum comfort, giving priority to more efficient construction materials with lower environmental and social impacts, in addition to economic ones, in a life cycle perspective and considering bioclimatic architecture techniques. Acoustic comfort and adequate, preferably natural ventilation of the buildings, should also be ensured, ensuring the well-being and health of its users.

In practice, a sustainable building considers the internal characteristics of the sites, including sun exposure, climate and geography conditions, and considers the careful selection of materials that allow greater efficiency and sustainability. Energy audits are essential for a correct assessment and quantification of energy consumption. The audits allow to analyse and characterize in detail the state of equipment that consume energy, the inherent costs, identifying situations to be corrected or improved. In view of this analysis, viable solutions are defined that allow an increase in energy efficiency in the building.

The implementation of measures to minimize heat losses, such as thermal insulation, can contribute to this reduction. The suitability of the thermal insulation is critical for minimizing the thermal exchanges exist. In order to obtain an efficient insulation, it is necessary to adjust the temperature of the air, walls, floors and ceilings, which can be made in the basic building construction. The application changes at this level contributes to a better energy rating.

The promotion of the integration of green roofs contributes equally to an improvement in energy efficiency, increasing the insulation of roofs, reducing the incidence of solar radiation and cooling the roof through evapotranspiration process. Bioclimatic studies have shown that green roofs allow a reduction of up to 50% of the heat transferred through the roof to the interior of the buildings. In addition to the advantages of reducing energy requirements to maintain thermal comfort in buildings, the green roofs also have several advantages, namely: improved thermal and acoustic insulation of the building, increased carbon sequestration capacity and water retention rainfall - actively contributing to the prevention of smells, reduction of the "heat island" effect, reduction of maintenance costs of the building and improvement of the aesthetic quality of the building and the urban environment. The implementation of green roofs had to be based on species with reduced requirements of as

well as autochthonous, in the sense of contributing also to the maintenance of the local biodiversity.

The certification process involves the work of a qualified expert, which verifies, through audits, in addition to the above, the regulatory compliance of the building under the Regulation(s) applicable (Energy Performance Regulations for Residential Buildings and/or Energy Performance Regulation of Commercial Buildings and Services), to classify it according to its energy performance, based on an A + scale (best performance) to F (worst performance).

The energy certificate of a building describes its energy performance and includes the calculation of the expected energy consumption, resulting from their use, enabling prove the correct application of thermal regulation and indoor air quality in place for the building and its systems energy sources. In existing buildings, the energy certificate provides information on energy performance improvement measures, with economic viability, the owner can, without risk, implement to reduce their energy costs and enhance the comfort of the building. So, with this classification, it is known that the level assigned to the building and the next steps to achieve a better certified building efficiency.

In the legal context, energy certification is mandatory since the 1st of January 2009 for all buildings that are up for sale or rental. In particular, the buildings of large trade and services as well as public buildings should make a periodic assessment of their potential in the context of energy certification.

Efficient air conditioning and ventilation systems

Improve the energy efficiency of air conditioning and ventilation systems of tourist accommodation buildings, services, domestic, human health activities and sports and recreational activities, among others.

Air conditioning and ventilation systems play a key role in maintaining the thermal comfort and indoor air quality of buildings. These systems, on the other hand, account for a significant part of a building's energy bill and CO_2 emissions into the atmosphere, where its energy efficiency is critical.

The adjustment of air conditioning and ventilation to the specific use requirements, equipment selection favouring energy efficiency and proper installation of this equipment are essential.

Heat pumps come as a sustainable option in terms of climate control, as the main source of energy for the heat pump is outside air, regardless of the temperature it is in. When extracting and compressing the outside air through a compressor, this equipment allows, with

the help of a heat exchanger, to heat the interior air of the building. These systems allow the heating of both water and ambient air in an efficient way, as this technology consumes only 25% of electric energy in the air compression, obtaining the remaining 75% of the energy required for the ambient heating. Heat pumps can use a geothermal source. Due to the high energy requirements to reach, become a solution to consider when applying cooling/heating a room/building.

These systems, although supplied with electricity, use the stable temperature of the subsoil and/or groundwater to warm or cool a house or a building and its efficiency is determined by the type of soil and the existence or absence of water sheets. This type of system also ensures the heating of the sanitary water if necessary.

Whenever possible, natural ventilation systems should be implemented in detriment of mechanical ventilation equipment, in an optics of resource optimization, energy efficiency and cost reduction.

The installation of automatic control units for air conditioning and ventilation systems also contributes to an improvement in the energy efficiency of these equipment. Timers, presence sensors and thermostats are some examples of automatic control units are typically associated with efficient air conditioning and ventilation systems.

Efficient Boilers

Renew boilers using more efficient power supply systems or replace boilers with more efficient ones.

The renovation of old boilers for the latest technology can lead to a decrease in significant energy consumption. Latest, high-efficiency boilers can turn waste heat energy into combustion gases (11% of the energy produced by combustion) into useful energy for the boiler/system, reaching an efficiency of 91-93%.

There is a range of technological solutions on the market that allow the efficient control of the boiler system through automated systems, which enables a better management of the energy expended by the boiler, given the needs of the building.

In the case of domestic boilers, a star rating system is available, which is an indicator of the energy efficiency of this equipment, and those with the highest energy efficiency should be favoured.

Efficient household appliances

Promote a gradual renewal of consumer appliances that are not efficient, especially household appliances.

Household appliances are commonly used equipment in a building, regardless of its typology, so the use of more efficient equipment should be preferred.

Due to the increasing technological advances, consumers have more and more efficient equipment at their disposal. Therefore, a regular replacement of existing equipment with more efficient models should be promoted. As an illustration of the potential for consumption reduction of this measure, the scenario of renewal of all the domestic equipment of a housing unit is presented, which could translate into an annual reduction of the electric consumptions of the order of 30%. In buildings with different types of housing, the range of appliances we found is reduced, however, the repetition number of the same type apparatus and the number of uses to which they are subjected can be increased, which leads us to consider the possibility of reducing annual electrical consumption for these buildings, close to the same order of magnitude as seen in housing.

The energy label system identifies the energy efficiency of household appliances. Its scope of use is common throughout Europe and is presented as an information tool, at the service of the consumer. Under the current legislation, the seller is obliged to display the energy label of each model of appliance. Energy Star and GEA labels are used in office equipment and consumer electronics.

Efficient office equipment

Promote the gradual renewal of energy-efficient office equipment by more efficient ones.

The increasing introduction of electrical and electronic equipment in offices, verified in the last decades represents a considerable increase in the energy consumption of the buildings. On the other hand, there is also a high potential for energy savings associated with the use of this equipment.

The full utilization of the energy-saving potential of some electrical and electronic equipment can be achieved through the selection and acquisition of energy-efficient equipment.

As an example, energy saving of up to 80% could be achieved by replacing desktop computers with laptops. Similarly, replacing conventional CRTs for LCD monitors can lead to a reduction in fuel consumption by about 50%. The replacement of monofunctional devices with centralized multifunctional devices allows a maximum consumption reduction of around 50%.

In this context, it is also important to emphasize the energy efficiency criteria when selecting the office equipment for purchase, namely to choose equipment that has an Energy Star label (used in standby low consumption equipment) that has a correct design, that have inhibitors of energy consumption in the off mode, etc.

Efficient Industrial Equipment and Processes

Promote the gradual renewal of industrial equipment by more efficient ones and optimize industrial processes aiming at improving the sector's climatic sustainability.

In Portugal, the industry represents 34% of the final energy consumed. It is the second largest industry in terms of final energy consumption, surpassed only by the transport sector by two percentage points.

According to these data, the concern with the increase of the energy efficiency in this sector has been increasing, being one of the goals of the National Energy Strategy for 2020.

In order to accomplish this, there are some measures that help manufacturers to tailor their equipment and processes to new technologies and strategies. Improving energy efficiency of industries in Portugal is based on cross-cutting measures that provide an improvement in the Portuguese economy.

Some of the aspects to improve are of great impact in the industry and can be easily implemented. In this context, the systems driven by electric motors, the processes of production of heat and cold, the lighting and the efficiency of the industrial process stand out.

In relation to the systems driven by electric motors, it is important to highlight the optimization of the motors, the energy improvement of the pumping systems, the ventilation systems and the compression systems. The compressed air distribution network and the end-use devices also have improvements in their energy consumption.

Cold and heat production methods such as cogeneration, combustion systems, heat recovery and industrial cold are energy-intensive processes and it is important to improve their efficiency and sustainability.

The adoption of the Best Available Techniques contributes to an improvement in energy efficiency by avoiding and reducing emissions and the environmental impact of the industrial sector.

In order to make this measure of efficiency of equipment and industrial processes truly effective, it is necessary to control and monitor the measures implemented. It is also essential to integrate different processes, maintain equipment and ensure efficient thermal insulation, where applicable.

Efficient driving force equipment

Improvement of energy efficiency of power equipment through its gradual renewal, through the installation of complementary equipment and/or by improving the suitability of the operating conditions.

Efficient driving forces represent about half of the final uses of electricity in Portugal and its application is transversal to all sectors of activity, from simple domestic equipment to industrial machines.

With the use and the passing of the years this equipment lose efficiency, using more energy resources to perform the same function. In addition, the technology evolves very quickly and following directives of improvement of energy performance, reason why the equipment currently available in the market present superior energetic efficiencies. In this way, the renewal of power equipment by more efficient ones has a relevant impact in terms of reducing energy consumption and, consequently, reducing the emission of greenhouse gases.

The adjustment of the power adequacy of engines to the engines they drive is the priority measure to improve the energy efficiency of driving force equipment. Motors designed to operate above 75% of their nominal load have a higher efficiency. In electric motors the efficiency tends to increase with the increase of its nominal power. For example, motors of less than 1 kW have an efficiency in the order of 50-70%, motors between 1 kW and 10 kW have efficiencies of 75-85% and motors with higher powers can reach 90-95% efficiency.

In the case of induction motors whose operating regime is very variable, it may be opted for the installation of Electronic Speed Inverters (ESV). Several studies indicate that this solution has the greatest potential for savings. The ESV s allow the actuation of the amplitude and frequency of the motor supply voltage, controlling its angular velocity and its torque. In addition to speed control, the ESVs provide greater thermal protection to the motors and enable smooth starting and stopping, resulting in less mechanical and electrical wear of the equipment.

Alternatively, the use of high efficiency motors (HEM) may be considered. Through the use of better construction materials, better finishes and alteration of the dimensional characteristics of the engines, the HEM shows an improvement in performance compared to conventional motors, which is typically 3-4%, but may reach a maximum of 8%. Although they cost more, HEMs become profitable for longer uses.

7.3. Sustainable street lighting actions

Optimized lighting management

To adequately manage energy resources, namely through the selection of technologies and systems for the management, information, monitoring and control of the quality of public lighting, namely ballasts that allow a better management of energy/light flux in the public lightning.

Public lighting represents one of the most significant parcels in the energy bill of the municipalities, representing a high potential for energy savings. These savings could result from the use of more efficient ballasts and a greater spread of the use of flow reducers and light sensors, controlling their period of operation.

The luminous flow regulators allow an automatic reduction of the energy consumption, during a certain period, maintaining the quality and safety of the illumination of the place. It becomes possible to increase the useful life of each light spot and reduce the energy consumption in times of low traffic on public roads. This reduction could reach up to 40% of energy consumption in public lighting. This equipment also offers the possibility of integration into all lighting circuits equipped with discharge lamps such as fluorescents, mercury vapor, sodium vapor and metal iodides. The ballasts interconnect the power supply of an electrical circuit and one or more discharge lamps.

The replacement of conventional electromagnetic ballasts by electronic ballasts presents advantages such as better management of luminous flux and energy as a function of traffic density, atmospheric conditions, adaptability to the local parameters of the lighting project and the compensation of the factor of maintenance of the luminous flux of lamps, which tend to suffer depreciation over time. This replacement also allows a substantial reduction of energy losses and reactive energy, compared to electromagnetic ballasts.

This solution can be implemented in new equipment and equipment already operating.

The optimization of the network through a distribution and adequacy of the number of luminaires and integrated light intensity with the implementation of systems that allow remote or automatic control also allow a proper and efficient management in each situation.

The interconnection of this control with open energy management systems represents an additional benefit to the optimized management of public lighting, allowing measurements relevant to the management of consumption and of assets. The use of open systems through shareable integration protocols also allows continuous integration of technological innovation and a greater diversity of optimization and investment plans.

LEDs and efficient lamps in public lighting

Replace inefficient lamps with more efficient ones to improve the quality/cost ratio. LED technology is the most efficient solution for Public Lighting (IP) and traffic light signalling.

The high energy consumption of public lighting is often driven by a low efficiency of the lighting system, as a consequence of the predominance of inefficient equipment use, such as highly inefficient mercury vapor lamps, low efficiency lights and traffic lights, etc.

Currently there are solutions in the market that offer an efficient public lightning with the same quality. One possibility is to replace low-efficiency lamps, such as the ones that emit light in directions or areas that do not require lighting, such as light emitted into the sky (light pollution).

Another solution is the substitution of external factors for lamps. The use of mercury vapor lamps in public lighting is discouraged as these have a low luminous yield and as they age their flow is reduced considerably. On the other hand, the use of light bulbs with high luminous efficiency, such as sodium vapor lamps, for example, allows to reduce the consumption of electric energy and they present a suitable colour restitution for the street illumination of the urban and pedestrian zones.

Regarding the lamps for public lighting, the market solutions also pass through the LED`s, highlighting its use in traffic lights. The use of this technology in traffic lights allows a reduction of the consumption of around 80% to 90%, when compared to the consumption of incandescent lamps of the same luminous intensity. In addition, due to their low power consumption, LEDs can still be powered by photovoltaic panels.

Another of the advantages mentioned is related to the increase of road safety, since the index of reflection of sunlight is 50% lower in this system than in the traditional one, allowing a greater visibility and ending with the illusion that the lamps are connected, even when they are not.

7.4. Open Energy Management Systems

Use information and communication technologies as instruments to improve energy efficiency and reduce consumption in public and private buildings, public lighting and transport.

The integration of information and communication technologies in buildings and equipment, through the provision of an Open Energy Management System, which integrates an Intelligent

Energy Management System and a Collaborative Platform, presents a high potential in the identification, analysis, reduction and monitoring of consumption and CO_2 emissions.

The use of an Intelligent Energy Management System, able to receive electronic billing information, telemetry sensors and detailed characterization of use allows optimizing consumption, monitor in real time and minimize waste. This achieves greater efficiency in integrated energy and asset management, reducing expenses and improving performance. Access to this technology allows managers and users of public and private buildings and equipment, public lighting, car fleets, among others, to monitor energy demand in real time, control billing and analyse the adequacy of rationalization options for consumption, contracting of supply and improvement of efficiency. The integration of remote-control functions in a Smart Energy Management System also allows the automatic and/or specific energy control systems to eliminate unnecessary consumption without compromising its functionality.

The Smart Energy Management System should be perfectly integrated with other existing urban management systems, thus ensuring the ability to monitor, evaluate, monitor, alert and manage the entire urban system, as well as to efficiently emergency.

7.5. Awareness and education actions

Awareness and education for climate sustainability

Plan a set of actions to raise awareness and educate the population for good environmental, energy and resilience practices.

Promote and create technical structures for advice in the area of efficiency, climate sustainability and resilience, focusing on condominiums and/or residents' organizations.

Raising awareness of good practices among workers enables environmental awareness and behaviour change. Although there are numerous control applications that aim to reduce consumption associated with a given task, there are factors that are fully controlled by the worker.

The existence of open systems that identify possible measures to be implemented and the promotion of worker awareness through training associated with a specific energy efficiency measure can create a contagious effect since the trainee can teach colleagues, friends and family to more sustainable behaviour.

In this context, as an example, few drivers know how to best exploit the potential of vehicles with lower average fuel consumption and CO_2 emissions per kilometre. Implementing

training, awareness-raising and education measures allows for changes in driving habits that can translate into significant gains.

Voluntary reduction of carbon emissions

Promote and create a technical framework for energy efficiency advice for the industry and services sector.

The Voluntary Carbon Market arises in parallel with the Regulated Carbon Market and aims to offset emissions by individuals or companies that do not have a legal obligation under the GHG Emission Trading Scheme in order to mitigate its effects measures of CO_2 equivalent units.

The scientific principle is based on the fact that greenhouse gases mix rapidly in the air, dispersing all over the planet. As such, it is irrelevant where the GHG reductions occur, only mattering that less carbon is emitted to the atmosphere.

The Voluntary Carbon Market has grown strongly in recent years in the face of the growing concern of companies with their emissions, with more and more projects related to renewable energies or forest plantations.

The main advantage of this market is the possibility of accepting small projects, contrary to what is happening in the regulated carbon market.

Currently, there are still many sectors of activity without limitations of greenhouse gas emissions, which, through these markets, can contribute to their reduction. To this end, a technical structure should be created capable of disseminating the potential of the Voluntary Carbon Market and promoting the insertion of projects in this market. This team should also have the technical capacity to carry out emission inventories that are tailored to the specific needs of each client and can be adapted to a specific period of time, allowing the accounting of any specific production (of any product or service), event, or other not predicted, based on international calculation guidelines.

The application of this measure is based in part on the voluntary willingness of companies to change their energy history and increase their sustainability, which is why it is fundamental to raise awareness of the business sector.

7.6. Other transversal sustainability actions

Support urban investment and sustainable business

Providing technical support and discriminate positively new sustainable investments and green growth promoters.

Support for new investments is extremely important for the economic development of regions and municipalities. Support and information should therefore be made available to attract investment and foster entrepreneurship, which can be provided through local support structures. It is essential to ensure the necessary support for the promotion of green infrastructure, sustainable projects and the dissemination of companies with sustainable products and support for research, aiming at economic growth that contributes to the municipality's sustainability goals and does not compromise the quality of life of the environment where it is inserted. The development of a strategy to promote clustering and the development of initiatives based on eco-innovation promotes green growth, sustainable employment and green exports.

Sustainable investment can be promoted through the involvement of public and private stakeholders, for example in community sustainable development programs, in green business networks or through the provision of spaces with advanced technology solutions that provide environments conducive to eco-innovation. These initiatives, among others, foster green entrepreneurship and investment and the implementation of new management models that promote sustainable growth, create green jobs and protect the environment locally and globally.

With positive discrimination it becomes easier for companies that have not yet started a sustainable activity to opt for environmental issues when developing their business plan. Positive discrimination should focus on investments that consider sustainable growth as an incentive to the development of sustainable, energy-efficient projects, ideas and activities. Encouraging the publication of environmental reports, for example, contributes to the verification and monitoring of planned initiatives.

Favouring and supporting research and investment in a circular economy contributes to the optimization of the material life cycle, minimizing the environmental impact of the exploitation of raw materials and processing, processing and final product deposition activities.

Encouraging the economic sector, in particular forestry, for (re)afforestation with indigenous species allows for increased carbon sequestration, promoting and increasing forest biodiversity with species more adapted to local geoclimatic conditions - with less irrigation requirements with less fuel capacity in case of fire risk. Likewise, the promotion of new

agricultural species, preferably with reduced irrigation requirements, could be promoted, aiming at increasing biodiversity, reducing water consumption, energy and atmospheric emissions and, above all, the resilience of the sector to the impacts of the changes climate change.

Green public purchases

Design a tool that allows to ecologically measure all purchases of the municipality and provide quantitative information regarding the offer of products and services.

Public purchases account for more than 16% of the Gross Domestic Product of the European Union. In this way, the potential of green public purchase for sustainable development and the reduction of GHG is undeniable.

At the same time, green purchase of products or services by public entities conveys a positive image to the market, serving as an example to other identities, and encourages companies to seek to innovate their products in order to be truly sustainable products.

Recognizing the contribution that public purchases will have for sustainable development, the Council of Ministers Resolution No. 65/2007 of 7 May approving the National Strategy for Green Procurement 2008-2010 was presented. This strategy defines the priority products and services with which public entities must initiate their green purchasing policy. In relation to these products and services, ecological criteria were also developed, to be applied by the various agencies in their public procurement policy.

Thus, the need arises to devise a tool that considers the ecological criteria to be applied in the scope of the new public purchase policy and that allows to ecologically measure all products and services to be contracted seals municipal services.

Reinforcing climate resilience

Elaborate contingency and climate resilience plans, aiming at minimizing impacts and vulnerability to extreme events and emergencies resulting from climate change.

The adoption of local policies to adapt to climate change, through the creation of norms, regulations, plans and strategies adjusted to the local reality allows to frame the future response to all types of events, impacts and vulnerabilities to climate change identified for the municipality.

The elaboration of a specific contingency plan for the occurrence of heat waves allows a future response to this type of events, as well as impacts and vulnerabilities identified for the

municipality, avoiding damages to the health of the population, in particular children, the elderly and other risk groups. This plan should define a set of mitigation and adaptation measures against the eventual occurrence of heat waves and high solar radiation in the short and medium term, as well as actions to promote self-protection behaviours.

It is also essential to ensure the operationalization of the municipal plan for forest fire prevention and implement and maintain a network of defence against forest fires, aimed at preventing and efficiency in fighting forest fires. Likewise, the monitoring and conservation of defence and protection infrastructures should be ensured. They include not only defence and firefighting infrastructure, but also floods, among others, prioritizing the protection and defence of the most vulnerable areas and the preservation of natural resources associated with these areas.

The definition of methodologies for monitoring the main impacts of climate change identified for the municipality and the creation of monitoring indicators (qualitative and quantitative) allows the development of a monitoring/evaluation network and the involvement of key stakeholders, as well as the creation of an effective surveillance, alert and emergency management system.

It is also important to promote partnerships with insurance and banking institutions, among others, considering the role they play in financing possible interventions against climate events. Greater coverage of insurance against natural phenomena, increased accountability and response efficiency in the economic compensation of damage caused by extreme events and minimization of rehabilitation costs of the urban environment should also be promoted.

Sustainable water management

Improve the current model of water management, in terms of demand, consumption and water treatment. Optimize infrastructures for water supply and drainage of wastewater and rainwater.

The water sector is extremely important in the implementation of the local climate change mitigation and adaptation strategy. The process of water management must begin in the extraction until the end customer and the treatment of residual effluents.

The water sector is both a consumer of energy and a source of pollutant and GHG emissions, and a producer of renewable and clean energy through the biogas energy recovery. The forecast of hourly water consumption and the identification of peak hours allows management to better serve the customer and supplier, ensuring that supplies are maintained through lower energy consumption and consequently lower CO_2 emissions. The implementation of biogas production and energy recovery systems allows minimizing the

direct emission of greenhouse gases and pollutants as well as indirect emissions resulting from the production of electricity from fossil fuels. Increasing the coverage of wastewater drainage and treatment systems and the optimization of water and sludge treatment systems contribute to a greater availability of biogas and to the minimization of gas emissions into the atmosphere, as well as to the preservation of resources in particular downstream of the points of discharge of treated water.

The implementation of actions to promote the reduction of water consumption, the minimization of losses and the increase of energy efficiency of water supply, drainage and water treatment systems, associated with the optimization of the water management model, thus contributes to mitigation and adaptation climate change, as well as for more efficient use of resources.

The heating water for domestic use is also responsible for a significant energy consumption, as well as the capture and pumping for agricultural use, another area where energy consumption can be significant. Raising awareness and implementing measures to moderate water consumption in these sectors may reflect energy savings.

Promoting the implementation of innovative solutions for the recycling of rainwater, grey and treated water for uses with lower quality requirements (such as irrigation, street washing, etc.), contributes to reducing water consumption and consequently reducing activity of supply and treatment systems, reducing consumption, CO_2 emissions and costs. The use of rainwater and/or the creation and maintenance of rainwater retention basins in urban areas also contributes to flood control and increased availability of water for purposes other than human consumption.

Sustainable waste management

Design or improve the waste management model, minimizing the production of waste and its impact and achieving the maximum efficiency of energy use.

In Portugal, an average of 1.4 kg of domestic waste is produced daily per inhabitant, and awareness and education for the prevention of waste production are important.

The environmental and energy impacts resulting from the elaboration of a strategy and/or waste management plan adjusted to the local reality are enormous. Promoting a circular economy and preventing the production of waste are no longer consumed natural resources and energy, especially in extraction processes, transportation and processing of raw materials and later in the collection and treatment of waste.

Investment to awareness and education for the prevention of waste and for the separation and recycling of materials such as glass, plastic, paper and metal saves resources, to combat

the emission of pollutants and greenhouse gases and limit the occupation of soil deposition of waste, contributing to a model of sustainable development and a better environment.

Organic valorisation by anaerobic digestion or composting is also a strategic measure to reduce GHG emissions, as most of the methane emissions are due to the degradation of organic matter in Landfills. The routing of organic matter to a composting station allows the production of a "compound" of high quality for agriculture.

The implementation of a “pay-as-you-throw” (PAYT) system covering both the residential and commercial sectors is an incentive to source separation and selective collection rates. This system also allows for a more fair and equitable taxation, in favour of those who reduce and properly forwards waste sues.

Optimization of the energy and climate aspects of urban planning

Urban rehabilitation, promoting energy-efficient, climate-resilient rehabilitation and prioritizing the preservation of the natural environment and urban quality of life, in particular through the elaboration of adequate territorial management tools, an urban bioclimatic design manual and a plan for the improvement and optimization of the urban network. Revision of the Municipal Master Plan, maintaining sustainability as a determining factor. Ensure the preservation and management of natural spaces and water resources.

At the territorial planning and urban planning level, it is imperative to define territorial development strategies based on an integrated vision for the territory, with direct effects on the quality of life of the population, on sustainability and on the economic competitiveness of the territory.

In the sense of improving urban sustainability, the preparation of a manual or urban rehabilitation plan - integrated in a Sustainable Development Plan - becomes urgent, as well as the revision of the Municipal Master Plan, among others, based on the best solutions for energy sustainability, adaptation to climate change and the preservation of natural resources.

The intervention in urban rehabilitation, integrated in a sustainable development perspective, allows to achieve a greater qualification of the public space and to promote the economic and social development. This way, we work towards innovation in the solutions of urban qualification, preservation of natural spaces and increase of green infrastructures, strengthening the attractiveness of cities and the quality of life of the population. The simplification of procedures should also be ensured, promoting speed and transparency, both in terms of the elaboration and modification of territorial management instruments, and in the control of urban operations, penalizing non-compliance with land occupation regulations.

In a municipality with good urbanization and mobility policies, the quality of life of population increases as congestion and travel times are reduced and hence the energy required for traveling the emission of greenhouse gases and pollutants and noise are reduced.

Implementing measures capable of avoiding and reversing the abandonment of urban and forest areas, among others, and the degradation of the built-up park, can promote the requalification and revitalization of the municipality's territory, the protection of the natural and built heritage and cultural identity. At the same time, promoting rational land use, controlling urban sprawl and dispersion of built-up land, and strengthening cohesion, diluting asymmetries and ensuring equal access to infrastructure, equipment, services and functions.

Similarly, it is essential that future revisions of the Municipal Master Plan provide for these population displacement needs in order to shorten distances and maximize energy efficiency through a weighted planning of the territory.

In addition, a structure of the main urban road network should be fostered which facilitates the crossings of urban centres, as well as the entry and exit of these, so as to make it perfectly functional for different users. In this way it is also possible to release the secondary network and facilitate local access, favouring the pedestrian and cycle mode and the use of public transport. Thus, it contributes significantly to increase the quality of life of the citizens, and to promote the sustainability of the municipality.

The elaboration of a manual of urban bioclimatic design will contribute to the improvement of the comfort conditions of the park built through a better use of the natural resources. Thus, it is promoted the adoption of solutions, for example, improving the thermal comfort of buildings with lower power consumption and greater utilization of natural light.

The implementation of air quality and noise monitoring systems and the integration of data obtained in the analysis of land use planning options allow minimizing possible impacts on the quality of life and health of the population, as well as identifying key points of action for potential improvement needs.

The elaboration of a Landscape Plan capable of promoting the creation and preservation of urban green spaces, available and accessible to the community, makes a significant contribution to the mitigation and adaptation to climate change. In addition to its social function, providing spaces for leisure and interaction with nature, green spaces also play an important role in the mitigation of ambient temperature by intervening at the level of air infiltration, convection of heat and the transmission of radiation and contributing to increase the relative humidity of air. Vegetation also plays an important role in the regulation of the hydrological cycle, favouring the infiltration of water and its replacement in aquifers, or by inducing the evaporation of water through the evapotranspiration process. In this way, the promotion of green spaces is also an instrument to reduce the risks of urban floods. At the

level of the quality of the urban environment, these spaces also contribute to the reduction of the concentration of polluting gases and particles in the atmosphere and to the carbon sequestration, being solutions of control of the propagation of noise.

In this context, the importance of conserving and enhancing biodiversity, resources and natural and landscape heritage is also highlighted. Biological diversity is one of the pillars of sustainable development. The richness and variety of biodiversity is essential to ensure the provision of ecosystem services, namely drinking water, food, shelter, medicines and clothing. In addition, biodiversity-rich environments are more resistant to natural events. The control and reduction of invasive species is essential for the promotion of biodiversity and the preservation of indigenous species. At the forest level, the importance of planning that assures the active management of forest areas, increase, diversification and vitality of stands, as well as the reduction of fire risk, and that promotes the connectivity of the landscape is important.

At the level of the water systems, the importance of the ecological restoration of the water lines is emphasized, using techniques of natural engineering. The valorisation of rivers as living elements and the approximation of the population to water resources must also be favoured. Water resources must be experienced as scenic, playful, structuring and reference elements.

The optimization of urban planning should also seek to minimize the impacts of the occurrence of extreme rain phenomena. In this way, land planning and management instruments should seek to reduce waterproofing and soil erosion, promote the reduction of rainwater runoff and ensure the drainage and/or infiltration of rainwater. Equally important is the conditioning of construction in the vicinity of water lines, the creation of specific norms for flood zones and the requalification of riverine ecosystems. Provision should also be made for regular cleaning and clearing of water lines - without damaging the ecological system - and rainwater systems.

7.7. Renewable power actions

Integrated renewable generation

Promote and encourage investment in small power-projects and other energy production projects for self-consumption or sale of energy using renewable energy sources.

The increase in the use of energy from renewable sources is one of the main objectives of the European Union for the coming decades, highlighting the renewables targets in the EU energy

mix of 20% in 2020 and 27% in 2030. In this context, the implementation and incentive to invest in mini-energy projects and other projects of energy production for self-consumption or sale of energy using renewable energy sources, namely:

- Photovoltaic energy: Solar energy can be used to produce electricity through the installation of photovoltaic solar panels for self-consumption or injection into the grid. The legislative framework for self-consumption was made available in October 2014, presenting several advantages such as easy installation and maintenance.
- Wind energy: Wind energy represents the use of the kinetic energy contained in the wind to produce mechanical energy, which in turn is transformed into electrical energy by an electric generator. Wind energy is directly linked to solar energy as it originates in the heating of the atmosphere by the sun, which sets in motion masses of air.

  The micro-wind or small generators are able to generate a significant part of the electricity consumed in a family house or a small industry helping to reduce costs. It presents a good cost/benefit ratio and a relatively fast recovery period of investment.

  As long as there are appropriate climatic and physical conditions, the minicells allow to generate energy during many hours of the year. Combined with solar panels, batteries and other equipment, they can allow total energy autonomy.
- Biogas: Biogas is obtained through the anaerobic digestion of organic compounds, and can be used for energy production. The production and use of biogas have environmental and economic benefits as it promotes quality of life and contributes to economic and social development.
- Biomass: Biomass is the organic matter of vegetable or animal origin that can be used in solid, liquid or gaseous state. Biomass, when burned, is a source of energy that can be used in thermal power stations to produce electricity and heat. In addition, the use of forest residues for this purpose reduces the risk of fire if the cleaning is combined with a correct forest management.

  In a cogeneration process (Combined Heat and Power) biomass, the generator produces electric energy and thermal energy, which can be used for central heating, hot water production, heating of swimming pools, among others. Biomass cogeneration solutions are available for both residential and industrial sectors.
- Hydropower: Hydropower is one of the most efficient renewable energy sources. The mini-hydro and/or micro-hydro power plants, due to their size, low environmental impact and multiple use, are opportunities of high economic, environmental, strategic and social potential. In addition to the benefit of energy production from renewable sources, small hydroelectric dams allow the control and regularization of river flow, feed irrigation systems, support firefighting, capture water for human consumption and contribute to the development of agricultural activities -pastoris.

- **Geothermal energy:** Geothermal energy is an economical and efficient solution for environmental heating, water, fish farming or industrial processes.
- **Energy recovery of SUW**: Solid urban waste (SUW) can be subject to different treatment and recovery processes. The process of energy recovery consists of the combustion of solid waste in the combustion chamber. The steam produced in the process can be used to produce electricity that can be injected into the grid.

Despite the economic and environmental advantages of investing in energy projects for minigeneration and/or energy production, the lack of critical mass of these investments continues to be a barrier to attracting direct investment by conventional investors.

The availability of an integrated renewable generation platform could act as an investment mechanism. By integrating dispersed small-scale renewable generation projects, giving it a dimension, this platform represents a solution to overcome the lack of critical mass and attract investors. The dissemination of investment opportunities in renewable energies and energy efficiency in public and private buildings will constitute a tool for promoting, attracting and securing additional public and private investment in energy sustainability. This tool can boost the installation of photovoltaic, mini-hydro, mini-solar, biomass cogeneration equipment, among others, in public and private buildings, either for electricity production in a minigeneration regime or for private consumption or heat sales.

By exposing these investment opportunities, the company will also be involved in investing in projects for the minimization and/or production of energy for self-consumption, both as potential investors and as potential beneficiaries.

The implementation of this integrated renewable generation platform may also help overcome barriers to the internationalization of SMEs and facilitate access to finance by increasing the visibility and dissemination capacity of energy consumption and/actors.

Biomass and forest residues

Promote the use of forest biomass and forest residues as fuel for the sustainable production of various forms of final energy: electricity, heat and combined heat and power.

The use of biomass as an energy source is a sustainable way of producing energy and reducing the use of fossil fuels. Although biomass combustion processes lead to CO_2 emissions, the overall balance of the use of this energy source is zero, since the carbon dioxide absorbed during plant growth equals the CO_2 released during burning.

In combustion processes of forest biomass and plant waste for energy production a wide range of materials such as firewood, wood residues, forest residues, agricultural residues and

waste from the food and paper industries can be used. Although the use of traditional biomass, including firewood, continues to be an important source of energy, new compacted forms of high-quality biomass such as wood pellets and briquettes are increasingly being used despite their higher cost.

The use of biomass and forest residues for use in public and private buildings should be promoted through the creation of collection, storage and processing circuits, ensuring both the availability of biomass and the ease of access to this source of energy by part of the users, or a correct management of the forest areas, contributing simultaneously to the minimization of fire risks.

Thermal solar energy

Install solar thermal collectors in tourist accommodation, domestic buildings, human health activities, sports activities, among others.

The installation of solar thermal systems allows to reduce the consumption of fossil fuels and electricity used for hot water production and heating/cooling systems. At the same time, solar thermal technology can help reduce the problems associated with peak loads in the electrical system by offering non-electricity based heating/cooling.

Applications of solar thermal systems in residential buildings represent the majority of the facilities of this technology in Europe. The production of sanitary hot water (SHW) is the main use of these systems (90%). However, particularly in Central Europe, the rate of utilization of solar thermal systems to support environmental heating systems, including in district heating networks, has been increasing. There are also industrial plants that use this technology to supply low temperature heat.

The use of thermosyphon systems, which are more frequent in southern Europe, can suppress about 70-90% of the hot water needs in an average housing, generating 700-1,000 kWh of useful heat for each installed kW. For pumping systems, predominant in Central and Northern Europe, they allow the production of about 50-70% of the hot water needs in an average housing generating 500-650 kWh per installed kW.

The use of combined systems (hot water and ambient heating) also has a high potential for reducing energy consumption in buildings. In a well-insulated building, the solar fraction in energy use for the production of SHW and ambient heat can represent about 25-40%.

The cost of this technology is a major barrier to its expansion. Despite the low operating and maintenance costs compared to other alternative technologies, the initial investment is high. However, with rising fossil energy prices predicted over the next few decades, solar thermal

systems tend to become even more competitive and allow larger energy savings in the medium to long term.

8. IMPACT OF ENERGY SUSTAINABILITY ATIONS

This chapter presents the estimated quantification of the impact of the implementation of the energy sustainability measures recommended in this SECAP, considering the following energy consuming sectors:

- Municipal services;
- Service sector (non-municipal);
- Domestic sector;
- Industry, excluding EU ETS industries;
- Transportation;
- Agriculture, forestry and fisheries.

The following tables show energy consumption in 2008, considered as the reference year for the emissions inventory. These consumptions are broken down by sub-sector and energy vector. In addition, we present a forecast for 2030 with a breakdown by sector and similar energy vector, considering the implementation of measures of energy sustainability envisaged in the SECAP.

Also, in this chapter are the aggregate indicators of reduction of energy consumption, CO_2 emissions and energy invoice resulting from the application of these measures on emissions considered in the inventory.

Table 7: Energy consumption in 2008 - reference for the quantification of the impact of the implementation of energy sustainability measures

	Energy consumption [MWh/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Agriculture, animal production and related activities	4677	0	265	0	0	0	0	0	14984	0	0	0	0	0	0
Forestry and logging	23	0	0	0	0	0	0	0	0	0	0	25	0	0	0
Fishing and aquaculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of coal and lignite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of crude oil and natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of metal ores	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other extractive industries	6406	0	0	0	0	0	0	8085	0	0	0	0	0	13	0
Activities associated with the extractive industries	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food industry	10222	0	698	0	0	0	0	1415	0	0	0	0	0	0	2756
Beverages industry	2522	0	1323	176	0	0	0	0	0	0	0	0	0	0	1
Tobaco industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clothing industry	14617	0	1115	0	0	0	0	0	0	0	0	0	0	0	1267
Manufacture of leather and related products	11548	0	0	0	0	0	0	0	0	0	0	0	0	0	2627
Wood and cork industry	5503	0	339	0	0	0	0	4579	0	0	0	0	0	2	0
Manufacture of pulp, paper and paperboard	1869	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Printing and reproduction of recorded media	2721	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of coke and refined petroleum products	0	0	2540	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of chemical products	1162	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pharmaceutical products and preparations	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of rubber and plastic products	5138	0	0	0	0	0	0	0	0	0	0	0	0	0	23
Manufacture of other non-metallic mineral products	1954	0	109	0	0	0	0	4498	0	0	0	0	0	0	0
Manufacture of basic metals	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of fabricated metal products	23813	0	2603	0	0	0	0	792	0	0	0	0	0	0	25544
Manufacture of computer, electronic and optical products	126	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of electrical equipment	2956	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of machinery and equipment n.e.c.	2697	0	302	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of motor vehicles, trailers and semi-trailers	22	0	0	0	0	0	0	0	0	0	0	0	0	0	18527
Manufacture of other transport equipment	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of furniture and mattresses	69963	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other manufacturings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repair and installation of machinery and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	447
Waste collection, treatment and disposal activities	5906	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decontamination and similar activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Property development and construction	4674	0	23	0	0	0	0	219	0	0	0	0	0	171	0
Civil engineering	188	0	13	0	0	0	0	8326	0	199	7018	0	0	0	0
Specialized construction activities	1728	0	65	0	0	0	0	5842	0	0	0	0	0	39	0
Land transport and transport via pipelines	0	0	0	6027	0	232509	24674	658671	152	0	0	0	0	6283	0
Water transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection, purification and distribution of water	9099	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection and treatment of wastewater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accommodation	4783	0	3455	0	0	0	0	0	0	0	0	0	0	0	571

	Energy consumption [MWh/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Food and beverage service activities	21955	0	884	0	0	0	0	0	0	0	0	0	0	0	2056
Sale, maintenance and repair of motor vehicles and motorcycles	3997	0	0	0	0	0	0	0	0	100	0	0	0	0	0
Wholesale trade, except motor vehicles and motorcycles	17681	0	220	0	0	0	0	0	0	11311	0	0	0	0	0
Retail trade, except motor vehicles and motorcycles	38053	0	0	0	0	0	0	0	0	13481	0	0	0	199	218
Storage and auxiliary transport activities	4719	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Postal and courier services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Editing activities	20252	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Film and video activities	495	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Radio and television activities	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telecommunications	3460	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Computer programming, consultancy and related activities	270	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Information services activities	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services activities	2480	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insurance, pension fund, except compulsory social security	111	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services and insurance auxiliary activities	211	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activity	6252	0	105	0	0	0	0	0	0	0	0	0	0	0	0
Legal and accounting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Management consulting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Architecture, engineering and related technical consultancy activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scientific research and development activities	299	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Advertising and market research	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other scientific and technical activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veterinary Activities	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rental Activities	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Employment activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel agency, tour operator and related activities	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and security	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services to buildings and landscape activities	1241	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Office administrative and business support activities	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public administration and defence; compulsory social security	3721	0	2388	0	0	0	0	0	0	0	0	0	0	0	2348
Education	10361	0	1400	0	0	0	0	0	0	0	0	0	0	0	1630
Human health activities	8323	0	1487	0	0	0	0	0	0	0	7790	0	0	0	313
Social and housing support	3098	0	3079	0	0	0	0	0	0	0	0	0	0	0	1998
Social support without housing	0	0	822	0	0	0	0	0	0	0	0	0	0	7	335
Theatre, music and dance	242	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Libraries, archives, museums and other cultural activities	623	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambling and betting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sports activities,amusement and recreation activities	3744	0	551	0	0	0	0	0	0	0	0	0	0	0	1974
Activities of membership organisations	3668	0	545	0	0	0	0	0	0	0	0	0	0	0	1183
Repair of computers and personal and household goods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other personal service activities	1764	0	2000	0	0	0	0	0	0	0	0	0	0	0	49
International organizations activities	0	0	582	0	0	0	0	0	0	0	0	0	0	0	0
Public street lighting and traffic lights	17230	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Housing	178202	44063	34705	0	0	0	0	0	0	7	0	0	0	0	26098

Table 8: CO_2 emissions in 2008 - reference for the quantification of the impact of the implementation of energy sustainability measures.

	CO_2 emissions [tCO_2/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Agriculture, animal production and related activities	1824	0	60	0	0	0	0	0	4001	0	0	0	0	0	0
Forestry and logging	9	0	0	0	0	0	0	0	0	0	0	7	0	0	0
Fishing and aquaculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of coal and lignite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of crude oil and natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of metal ores	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other extractive industries	2498	0	0	0	0	0	0	2159	0	0	0	0	0	0	0
Activities associated with the extractive industries	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food industry	3987	0	159	0	0	0	0	378	0	0	0	0	0	0	557
Beverages industry	983	0	300	40	0	0	0	0	0	0	0	0	0	0	0
Tobaco industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clothing industry	5701	0	253	0	0	0	0	0	0	0	0	0	0	0	256
Manufacture of leather and related products	4504	0	0	0	0	0	0	0	0	0	0	0	0	0	531
Wood and cork industry	2146	0	77	0	0	0	0	1223	0	0	0	0	0	0	0
Manufacture of pulp, paper and paperboard	729	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Printing and reproduction of recorded media	1061	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of coke and refined petroleum products	0	0	577	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of chemical products	453	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pharmaceutical products and preparations	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of rubber and plastic products	2004	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Manufacture of other non-metallic mineral products	762	0	25	0	0	0	0	1201	0	0	0	0	0	0	0
Manufacture of basic metals	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of fabricated metal products	9287	0	591	0	0	0	0	211	0	0	0	0	0	0	5160
Manufacture of computer, electronic and optical products	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of electrical equipment	1153	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of machinery and equipment n.e.c.	1052	0	69	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of motor vehicles, trailers and semi-trailers	9	0	0	0	0	0	0	0	0	0	0	0	0	0	3742
Manufacture of other transport equipment	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of furniture and mattresses	27285	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other manufacturings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repair and installation of machinery and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	90
Waste collection, treatment and disposal activities	2303	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decontamination and similar activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Property development and construction	1823	0	5	0	0	0	0	59	0	0	0	0	0	0	0
Civil engineering	73	0	3	0	0	0	0	2223	0	53	1958	0	0	0	0
Specialized construction activities	674	0	15	0	0	0	0	1560	0	0	0	0	0	0	0
Land transport and transport via pipelines	0	0	0	1368	0	57895	6144	175865	41	0	0	0	0	0	0
Water transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection, purification and distribution of water	3549	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection and treatment of wastewater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accommodation	1865	0	784	0	0	0	0	0	0	0	0	0	0	0	115

	CO_2 emissions [tCO_2/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Food and beverage service activities	8562	0	201	0	0	0	0	0	0	0	0	0	0	0	415
Sale, maintenance and repair of motor vehicles and motorcycles	1559	0	0	0	0	0	0	0	0	27	0	0	0	0	0
Wholesale trade, except motor vehicles and motorcycles	6895	0	50	0	0	0	0	0	0	3020	0	0	0	0	0
Retail trade, except motor vehicles and motorcycles	14841	0	0	0	0	0	0	0	0	3600	0	0	0	0	44
Storage and auxiliary transport activities	1841	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Postal and courier services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Editing activities	7898	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Film and video activities	193	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Radio and television activities	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telecommunications	1349	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Computer programming, consultancy and related activities	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Information services activities	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services activities	967	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insurance, pension fund, except compulsory social security	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services and insurance auxiliary activities	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activity	2438	0	24	0	0	0	0	0	0	0	0	0	0	0	0
Legal and accounting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Management consulting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Architecture, engineering and related technical consultancy activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scientific research and development activities	117	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Advertising and market research	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other scientific and technical activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veterinary Activities	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rental Activities	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Employment activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel agency, tour operator and related activities	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and security	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services to buildings and landscape activities	484	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Office administrative and business support activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public administration and defence; compulsory social security	1451	0	542	0	0	0	0	0	0	0	0	0	0	0	474
Education	4041	0	318	0	0	0	0	0	0	0	0	0	0	0	329
Human health activities	3246	0	337	0	0	0	0	0	0	0	2173	0	0	0	63
Social and housing support	1208	0	699	0	0	0	0	0	0	0	0	0	0	0	404
Social support without housing	0	0	187	0	0	0	0	0	0	0	0	0	0	0	68
Theatre, music and dance	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Libraries, archives, museums and other cultural activities	243	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambling and betting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sports activities,amusement and recreation activities	1460	0	125	0	0	0	0	0	0	0	0	0	0	0	399
Activities of membership organisations	1430	0	124	0	0	0	0	0	0	0	0	0	0	0	239
Repair of computers and personal and household goods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other personal service activities	688	0	454	0	0	0	0	0	0	0	0	0	0	0	10
International organizations activities	0	0	132	0	0	0	0	0	0	0	0	0	0	0	0
Public street lighting and traffic lights	6720	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Housing	69499	10002	7878	0	0	0	0	0	0	2	0	0	0	0	5272

Table 9: Energy consumption estimated for 2030 assuming the implementation of energy sustainability measures.

	Energy consumption [MWh/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Agriculture, animal production and related activities	1566	0	24	0	0	0	0	0	9585	0	0	0	0	0	29
Forestry and logging	764	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing and aquaculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of coal and lignite	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of crude oil and natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of metal ores	3055	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other extractive industries	4402	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activities associated with the extractive industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food industry	18891	0	196	0	0	0	0	479	0	0	0	0	0	0	2605
Beverages industry	3057	0	892	0	0	0	0	0	0	0	0	0	0	0	0
Tobaco industry	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clothing industry	9833	446	1126	0	0	0	0	654	197	0	0	0	0	0	268
Manufacture of leather and related products	5291	0	21	0	0	0	0	731	0	0	0	0	0	0	1734
Wood and cork industry	2374	0	0	0	0	0	0	2786	9	0	0	0	0	0	9
Manufacture of pulp, paper and paperboard	3037	0	23	0	0	0	0	2340	0	0	1313	0	0	0	0
Printing and reproduction of recorded media	1004	0	198	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of coke and refined petroleum products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of chemical products	690	0	97	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pharmaceutical products and preparations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of rubber and plastic products	2880	0	0	0	0	0	0	0	0	0	0	0	0	0	110
Manufacture of other non-metallic mineral products	1539	0	48	0	0	0	0	4115	0	0	0	0	0	0	0
Manufacture of basic metals	277	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of fabricated metal products	23274	0	1183	0	0	0	0	967	0	0	0	5	0	0	20442
Manufacture of computer, electronic and optical products	258	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of electrical equipment	820	0	23	0	0	0	0	134	0	0	0	0	0	0	0
Manufacture of machinery and equipment n.e.c.	2405	0	517	0	0	0	0	0	0	0	0	0	0	0	296
Manufacture of motor vehicles, trailers and semi-trailers	88	0	28	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of other transport equipment	518	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of furniture and mattresses	8133	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other manufacturings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repair and installation of machinery and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste collection, treatment and disposal activities	6822	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decontamination and similar activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Property development and construction	1468	84	48	0	0	0	0	1079	0	0	0	0	0	0	75
Civil engineering	81	0	0	0	0	0	0	5931	0	1369	4573	0	0	0	0
Specialized construction activities	2759	0	0	0	0	0	0	1967	0	0	0	0	0	0	56
Land transport and transport via pipelines	0	0	0	3193	0	100546	8467	303854	0	0	0	0	0	33937	0
Water transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection, purification and distribution of water	12373	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection and treatment of wastewater	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accommodation	2837	0	660	0	0	0	0	0	0	0	0	0	0	0	2049

	Energy consumption [MWh/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Food and beverage service activities	10789	0	967	0	0	0	0	0	0	0	0	0	0	0	1584
Sale, maintenance and repair of motor vehicles and motorcycles	1626	0	0	0	0	0	0	0	0	826	0	0	0	0	9
Wholesale trade, except motor vehicles and motorcycles	6901	0	0	0	0	0	0	0	0	289	782	0	0	0	502
Retail trade, except motor vehicles and motorcycles	38283	0	0	0	0	0	0	0	0	2769	24280	0	0	0	431
Storage and auxiliary transport activities	287	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Postal and courier services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Editing activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Film and video activities	364	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Radio and television activities	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telecommunications	4416	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Computer programming, consultancy and related activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Information services activities	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services activities	1327	0	0	0	0	0	0	0	0	0	0	0	0	0	396
Insurance, pension fund, except compulsory social security	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services and insurance auxiliary activities	135	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activity	5919	0	0	0	0	0	0	0	0	0	0	0	0	0	11385
Legal and accounting activities	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Management consulting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Architecture, engineering and related technical consultancy activities	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0
Scientific research and development activities	273	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Advertising and market research	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other scientific and technical activities	10	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Veterinary Activities	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rental Activities	206	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Employment activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel agency, tour operator and related activities	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and security	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services to buildings and landscape activities	476	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Office administrative and business support activities	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public administration and defence; compulsory social security	15476	0	1156	0	0	0	0	0	0	0	0	0	0	0	1393
Education	2801	0	535	0	0	0	0	0	0	0	0	0	0	0	1130
Human health activities	1987	0	67	0	0	0	0	0	0	0	0	0	0	0	630
Social and housing support	3593	572	974	0	0	0	0	0	0	0	0	0	0	0	2820
Social support without housing	0	0	1568	0	0	0	0	0	0	0	0	0	0	0	576
Theatre, music and dance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Libraries, archives, museums and other cultural activities	1041	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambling and betting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sports activities,amusement and recreation activities	3205	0	1171	0	0	0	0	0	0	0	0	0	0	0	1802
Activities of membership organisations	5238	0	290	0	0	0	0	0	0	0	0	0	0	0	2072
Repair of computers and personal and household goods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other personal service activities	58981	0	3187	0	0	0	0	0	0	0	2912	0	0	0	6071
International organizations activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public street lighting and traffic lights	4609	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Housing	144420	18895	21853	0	0	0	0	0	0	7281	0	0	0	0	24953

Table 10: Estimated CO_2 emissions by 2030 assuming the implementation of energy sustainability measures.

	CO_2 emissions [tCO_2/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Agriculture, animal production and related activities	611	0	6	0	0	0	0	0	2559	0	0	0	0	0	6
Forestry and logging	298	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing and aquaculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of coal and lignite	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraction of crude oil and natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining of metal ores	1192	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other extractive industries	1717	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Activities associated with the extractive industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food industry	7367	0	45	0	0	0	0	128	0	0	0	0	0	0	526
Beverages industry	1192	0	202	0	0	0	0	0	0	0	0	0	0	0	0
Tobaco industry	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clothing industry	3835	101	256	0	0	0	0	175	53	0	0	0	0	0	54
Manufacture of leather and related products	2064	0	5	0	0	0	0	195	0	0	0	0	0	0	350
Wood and cork industry	926	0	0	0	0	0	0	744	2	0	0	0	0	0	2
Manufacture of pulp, paper and paperboard	1185	0	5	0	0	0	0	625	0	0	366	0	0	0	0
Printing and reproduction of recorded media	392	0	45	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of coke and refined petroleum products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of chemical products	269	0	22	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of pharmaceutical products and preparations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of rubber and plastic products	1123	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Manufacture of other non-metallic mineral products	600	0	11	0	0	0	0	1099	0	0	0	0	0	0	0
Manufacture of basic metals	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of fabricated metal products	9077	0	269	0	0	0	0	258	0	0	0	1	0	0	4129
Manufacture of computer, electronic and optical products	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of electrical equipment	320	0	5	0	0	0	0	36	0	0	0	0	0	0	0
Manufacture of machinery and equipment n.e.c.	938	0	117	0	0	0	0	0	0	0	0	0	0	0	60
Manufacture of motor vehicles, trailers and semi-trailers	34	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of other transport equipment	202	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of furniture and mattresses	3172	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other manufacturings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Repair and installation of machinery and equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste collection, treatment and disposal activities	2661	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decontamination and similar activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Property development and construction	572	19	11	0	0	0	0	288	0	0	0	0	0	0	15
Civil engineering	32	0	0	0	0	0	0	1584	0	365	1276	0	0	0	0
Specialized construction activities	1076	0	0	0	0	0	0	525	0	0	0	0	0	0	11
Land transport and transport via pipelines	0	0	0	725	0	25036	2108	81129	0	0	0	0	0	0	0
Water transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection, purification and distribution of water	4825	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Collection and treatment of wastewater	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accommodation	1106	0	150	0	0	0	0	0	0	0	0	0	0	0	414

	CO_2 emissions [tCO_2/year]														
	Electricity	Butane	Propane	Autogas (LPG)	Gasoline with additives	95 Unleaded gasoline	98 Unleaded gasoline	Transport diesel	Agricultural diesel	Heating oil	Fuel Oil	Oil	Petroleum Coke	Biodiesel	Natural Gas
Food and beverage service activities	4208	0	220	0	0	0	0	0	0	0	0	0	0	0	320
Sale, maintenance and repair of motor vehicles and motorcycles	634	0	0	0	0	0	0	0	0	220	0	0	0	0	2
Wholesale trade, except motor vehicles and motorcycles	2691	0	0	0	0	0	0	0	0	77	218	0	0	0	101
Retail trade, except motor vehicles and motorcycles	14930	0	0	0	0	0	0	0	0	739	6774	0	0	0	87
Storage and auxiliary transport activities	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Postal and courier services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Editing activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Film and video activities	142	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Radio and television activities	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telecommunications	1722	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Computer programming, consultancy and related activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Information services activities	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services activities	518	0	0	0	0	0	0	0	0	0	0	0	0	0	80
Insurance, pension fund, except compulsory social security	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial services and insurance auxiliary activities	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Real estate activity	2309	0	0	0	0	0	0	0	0	0	0	0	0	0	2300
Legal and accounting activities	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Management consulting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Architecture, engineering and related technical consultancy activities	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Scientific research and development activities	106	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Advertising and market research	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other scientific and technical activities	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Veterinary Activities	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rental Activities	81	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Employment activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Travel agency, tour operator and related activities	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research and security	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Services to buildings and landscape activities	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Office administrative and business support activities	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public administration and defence; compulsory social security	6036	0	262	0	0	0	0	0	0	0	0	0	0	0	281
Education	1093	0	122	0	0	0	0	0	0	0	0	0	0	0	228
Human health activities	775	0	15	0	0	0	0	0	0	0	0	0	0	0	127
Social and housing support	1401	130	221	0	0	0	0	0	0	0	0	0	0	0	570
Social support without housing	0	0	356	0	0	0	0	0	0	0	0	0	0	0	116
Theatre, music and dance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Libraries, archives, museums and other cultural activities	406	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambling and betting activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sports activities,amusement and recreation activities	1250	0	266	0	0	0	0	0	0	0	0	0	0	0	364
Activities of membership organisations	2043	0	66	0	0	0	0	0	0	0	0	0	0	0	419
Repair of computers and personal and household goods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other personal service activities	23003	0	723	0	0	0	0	0	0	0	812	0	0	0	1226
International organizations activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public street lighting and traffic lights	1797	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Housing	56324	4289	4961	0	0	0	0	0	0	1944	0	0	0	0	5041

Table 11: Estimate of the reduction of energy consumption achieved with the implementation of energy sustainability measures.

Sustainable energy measures	Energy consumption reduction [MWh/year]	Energy consumption reduction [%]
Efficient lighting in buildings	12.686	0,72
Street lighting optimized management	2.800	0,16
Energy-efficient construction and energy performance audits and certification	4.832	0,27
Energy-efficient vehicles and fleets	185.663	11
Electric vehicles	139.247	7,9
Transport network improvements	2.364	0,13
Equipment modernisation and plants retrofitting	2.200	0,12
Active monitoring (direct effect)	3.453	0,20
LED and innovative lighting systems	7.002	0,40
Solar energy	10.837	0,62
Energy-efficient acclimatization and ventilation systems	14.599	0,83
Efficient boilers	1.784	0,10
Biomass boilers	2.100	0,12
Biodiesel	27.849	1,6
Urban rehabilitation and accessibilities improvement	415	0,02
Water management	1.987	0,11
Waste management	699	0,04
Fleets supply management	221	0,01
Office equipment renewal and retrofitting	4.345	0,25
Domestic equipment renewal	29.863	1,7
Public awareness, education and awards for energetic efficiency	1.844	0,10
Efficient equipment and industrial processes	1.404	0,08
Voluntary carbon reduction programmes	1.235	0,07
Increase of cycling and walking	258	0,01
Commuting and professional mobility optimisation	2.233	0,13
Large events mobility optimisation	221.531	13
Green Public Procurement	483	0,03
Urban and business sustainable investment support	2.125	0,12
Professional performance improvement	281	0,02
Total	686.341	39

Table 12: Estimation of the reduction of CO_2 emissions achieved with the implementation of energy sustainability measures.

Sustainable energy measures	CO_2 emissions reduction [tCO_2/year]	CO_2 emissions reduction [%]
Efficient lighting in buildings	4.947	0,95
Street lighting optimized management	1.092	0,21
Energy-efficient construction and energy performance audits and certification	1.561	0,30
Energy-efficient vehicles and fleets	48.262	9,27
Electric vehicles	36.197	6,95
Transport network improvements	615	0,12
Equipment modernisation and plants retrofitting	858	0,16
Active monitoring (direct effect)	1.299	0,25
LED and innovative lighting systems	2.731	0,52
Solar energy	2.804	0,54
Energy-efficient acclimatization and ventilation systems	4.598	0,88
Efficient boilers	431	0,08
Biomass boilers	515	0,10
Biodiesel	7.239	1,39
Urban rehabilitation and accessibilities improvement	108	0,02
Water management	587	0,11
Waste management	260	0,05
Fleets supply management	58	0,01
Office equipment renewal and retrofitting	1.695	0,33
Domestic equipment renewal	11.646	2,24
Public awareness, education and awards for energetic efficiency	719	0,14
Efficient equipment and industrial processes	320	0,06
Voluntary carbon reduction programmes	448	0,09
Increase of cycling and walking	67	0,01
Commuting and professional mobility optimisation	580	0,11
Large events mobility optimisation	86.397	16,59
Green Public Procurement	188	0,04
Urban and business sustainable investment support	744	0,14
Professional performance improvement	95	0,02
Total	217.063	41,68

Table 13: Summary table of the aggregate values of the impact estimate of the implementation of the measures of energy sustainability

	Year	Energy consumption [MWh]	CO_2 emissions [tCO_2]	Energy invoice [€]
Baseline scenario Without applying of measures	2008	1.760.475	520.786	217.163.407
Baseline scenario with applying of measures	2008	1.074.134	303.723	122.818.181
Scenario designed without applying measures	2030	1.491.806	435.744	182.219.250
Scenario designed with applying measures	2030	879.304	242.358	98.027.917

Table 14: Summary table of reductions achieved with the implementation of energy sustainability measures, taking as reference the base year of 2008.

	Reductions (Baseline Scenario)	Reductions (Projected Scenario)
Energy consumption	39%	41%
CO_2 emissions	42%	44%
Energy invoice reduction	43%	46%

9. Investment

In the following tables, a summary of the estimated investment needed to implement the proposed measures, by sector of activity, and the main sources of funding expected to support this investment and its respective amounts are presented.

Table 15: Estimated net investment in energy sustainability for the implementation of PASEC in the municipal sector

Municipal sector	Reimbursable public investment
Municipal buildings and facilities	1.373.618
Municipal street lighting	3.366.234
Total	4.739.852

Table 16: Estimated net investment in energy sustainability for the implementation of PASEC in the private sector

Private sector	Private net investment
Buildings and equipment of services (non-municipal) and agriculture	9.706.604
Residential buildings	30.478.277
Industries	3.226.384
Transports	66.434.947
Renewable energy production	237.110.255
Total	346.956.467

Table 17: Potential sources of public funding for the implementation of PASEC and respective investment

Municipal sector	Reimbursable public investment
Municipal buildings and facilities	1.373.618
Municipal street lighting	3.366.234
Total	4.739.852

Table 18: Potential sources of private funding for the implementation of PASEC and respective investment

Sources of private financing	Net investment in energy efficiency and renewable energy integration
Private investment from energy service companies under energy performance contracting	179.113.798
Net investment in energy sustainability in services and agriculture sectors	4.413.341
Net investment in energy sustainability in industry sector	2.089.647
Net investment in energy sustainability in domestic sector	28.714.741
Net investment in energy sustainability in transports sector	27.035.658
Total	241.367.185

The access to support tools and funding sources of for the implementation of sustainability measures is essential for the successful implementation of the SECAP. The main financing opportunities identified for local actions in the fields of energy efficiency, sustainable mobility, renewable production and reduction of CO_2 emissions are listed below:

- European Structural and Investment Funds
- European Financing Programs
- Project Development Assistance
- Instruments of Financial Institutions
- Alternative financing schemes

10. PRESENT SITUATION

Guimarães has been committed to the implementation of the Action Plan for Energy Sustainability, with goals to 2020. In this context the municipality has promoted numerous initiatives, developing and accompanying the creation and implementation of projects and measures of energy efficiency and renewable endogenous production. The work carried out by the municipality on the involvement of local community for energy consumptions and greenhouse gas emission reductions should also be highlighted.

Overall, the evolution of energy sectoral energy needs in Guimarães showed a more moderate growth compared to the Business as Usual Scenario. The following tables show the evolution of energy consumption and CO_2 emissions from 2008 to 2016.

Table 19: Evolution of energy consumption from 2008 to 2016 in Guimarães.

		Energy consumption [MWh/year]		% of reduction	% of increase
		2008	2016		
Buildings, Equipment / Facilities and industries	Municipal buildings and facilities	47.271	13.786	71%	
	Terciary buildings and facilities (non-public)	188.196	299.390		59%
	Residential buildings	502.605	423.849	16%	
	Street lighting	17.230	14.876	14%	
	Industries (non EU ETS)	277.636	180.773	35%	
	Subtotal	1.032.938	932.674	10%	
Transports	Subtotal	928.316	782.156	16%	
Others	Agriculture	19.974	33.539		68%
Total	Total	1.981.228	1.748.370	12%	

Table 20: Evolution of CO_2 emissions from 2008 to 2016 in Guimarães.

		CO2 emissions [tCO2/year]		% of reduction	% of increase
		2008	2016		
Buildings, Equipment / Facilities and industries	Municipal buildings and facilities	15.893	3.107	80%	
	Terciary buildings and facilities (non-public)	66.214	70.873		7%
	Residential buildings	92.653	65.942	29%	
	Street lighting	6.720	3.538	47%	
	Industries (non EU ETS)	92.094	42.652	54%	
	Subtotal	273.573	186.112	32%	
Transports	Subtotal	241.312	189.544	21%	
Others	Agriculture	5.901	8.842		50%
Total	Total	520.786	384.497	26%	

11. IMPLEMENTATION AND GOVERNANCE

Governance has been defined to refer to structures and processes that are designed to ensure accountability, transparency, responsiveness, rule of law, stability, equity and inclusiveness, empowerment, and broad-based participation. Governance also represents the norms, values and rules of the game through which public affairs are managed in a manner that is transparent, participatory, inclusive and responsive. Governance therefore can be subtle and may not be easily observable. In a broad sense, governance is about the culture and institutional environment in which citizens and stakeholders interact among themselves and participate in public affairs. It is more than the organs of the government.

This chapter gives a basis for understanding the governace strategy of the municipaliy of Guimarães in order to of implement the policies needed to reach the city's climate goals. The implementation team should consist from experts of all field, involving as well students and the public community.

11.1. Governance and SECAP implementation

In order to find the best solutions for future urban challenges that can contribute to the decarbonzation of the economy, Guimarães intends to be a Laboratory for the Future, through the living lab approach, with the creation of a Living Lab for decarbonzation focused on the areas of mobility, energy, circular economy, environment and buildings, and by inviting citizens to co-create a smart-city through innovation and transformation. The City Lab will be associated with the Integrated and Strategic Management Office, to address all projects and structuring strategic decisions for the city and its population, in a transversal and multidisciplinary manner, either for a specific time and location, or with a general and timeless scope.

Furthermore, the operational implementation of the Municipal Strategy for Adaptation to Climate Change of Guimarães will continue, according to the vulnerabilities and climate risks assessment, together with the identification and evaluation of the identified adaptation options.

The municipality has also created “Brigadas Verdes”, formed by groups of volunteers aiming to develop projects for environmental conservation and incentivize private stakeholders to participate in good environmental practices.

Using knowledge acquired over the last years, Guimarães will adopt an integrated strategy for the mitigation of climate change, highlighting the following actions in the short and medium term that will simultaneously contribute to reduce emissions and increase resilience.

11.2. Mission Structure

The strategy established for Climate Change Adaptation was defined through a Mission Structure for Sustainable development of Guimarães (MS), created in 2015 under the development of Action Plan 2015-2017 (consisting of multidisciplinary green projects, implementation of which precedes and contributes for Guimarães SECAP implementation.

MS was established in a pro-active and cooperative manner by the City Hall, and it has also pioneered a strategic partnership with University of Minho. The structure includes an External Advisory Committee (EAC), composed of prominent individuals recognized internationally in different areas of sustainability; an Advisory Council, composed of 100 representatives of political parties and local associations, schools and Parish Councils; 12 operational units integrating the work of specialists in each ECG area with Municipal experts; and a Monitoring Committee, created to facilitate political management led by our Municipal Assembly. It´s main objective is ensure municipality’s greening policies implementation. This MS is organized at different levels, based on a matrix system, allowing for addressing each area transversally, reporting permanently to the Board for analysis and decision. Scientific validation is carried out by the EAC, and public syndication through quarterly Newsletters and the information platform “Guimarães mais verde”. This MS also monitors the city’s management tools.

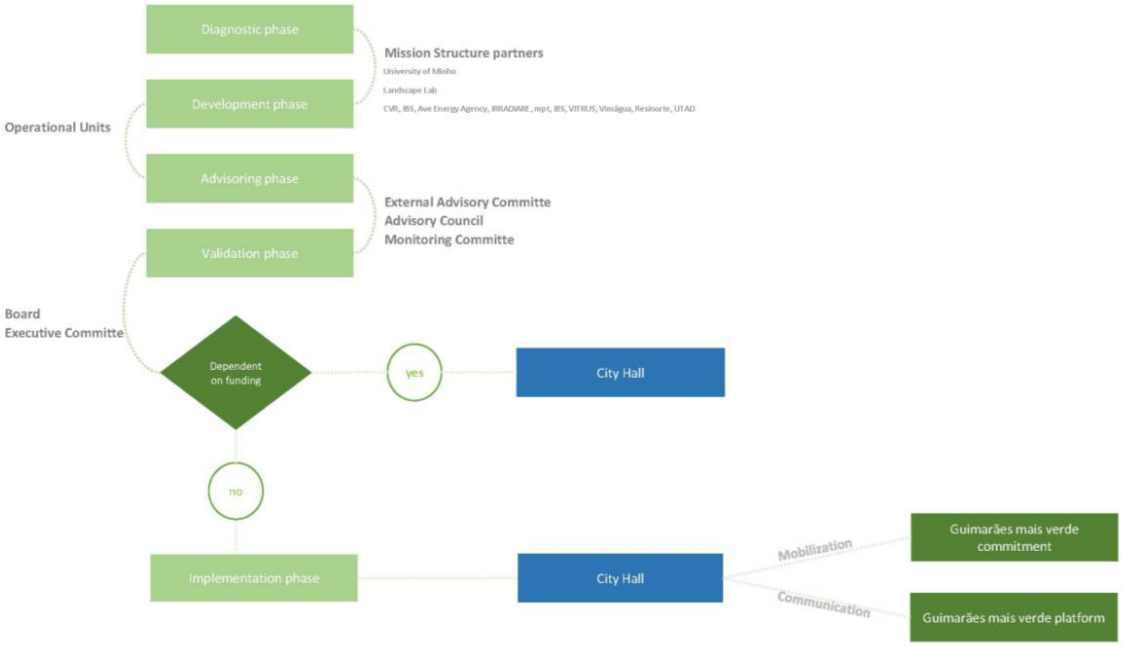


Figure 69: Mission Structure Flowchart (source: CM Guimarães)

Mission Structure is the hallmark of local political and governmental action - that institutions replicate and citizens interiorize on a daily basis – and its purpose is constructing a greener and more sustainable territory. This is a commitment that goes far beyond politics, since all political parties and parish councils have taken ownership by signing a declaration of political consensus that brings them all together in the construction of this exciting future.

11.3. Governance innovation

A general political consensus that climate protection measures should be implemented is much easier to find than an agreement on what this should actually mean in the concrete implementation of individual measures. In order to translate the political program into concrete action, it is therefore essential to reach a large number of relevant people, to gain an understanding of the respective issues and to gain constructive cooperation. Working in partnership with the persons responsible for the work areas concerned is therefore of particular importance.

For climate programmes, that cover, penetrate or involve almost all areas of the municipality and affect a large number of municipal services and institutions, a special implementation method should be constructed. For this reason, an Energy and Climate Program Coordinator should be appointed, which remit includes in particular the representation of the Mission Structure for Sustainable development of Guimarães, public relations, information and

awareness raising, activation, planning, coordination and support for the implementation of the measures, evaluation and success monitoring, and more.

Most importantly should be with setting up a Coordination Office, which can organize, coordinate and promote the implementation of the SECAP. The Coordination Office should compile in the view of the fact, that the targets may have a considerable range: quite clearly outlined concrete, easy-to-implement measures (e.g. producing an information brochure on the subject of energy saving), or offset by measures which are partly associated with high investment requirements (e.g. various infrastructure projects). Not just the amount of work or investments shape the structure of Coordination Office, but also the execution time, since decreasing emissions of huge amount of CO_2 equivalents contain very open tasks, which for their part only need to be concretised and require a process of several years.

In order to meet these requirements, the Coordination Office could set up as a "virtual organization" consisting of a very small section in the Municipal Department and a network of numerous experts from the work areas of the programme, e.g. from power generation to housing, from urban planning to traffic organization, from urban procurement to economic policy, etc. These experts remain organisationally in their respective departments (e.g. municipal departments, municipal enterprises and funds)

The frequency of meetings of the Coordination Office should be discussed, as well as their progress, evaluation of the results achieved, planning of further steps and the binding of these steps or decisions to the future. Chairman of these meetings should be the Climate Program Coordinator, responsible for determining further developments. The detailed work on the individual projects then can take place continuously as needed in smaller or sub-working groups, usually involving other relevant actors.

To make possible the voluntary investments in climate protection or sustainability for every company or legal person in the municipality, a Climate & Energy Fund could be committed, which offers loans for projects of different size, depending on the capacity of the fund. Management and administration of the fund could be managed by the Municipality, but also outsourced to private or public company, or consortium. The investments should be made under conditions in line with the prevailing market. This means that investments must have a minimum goal of return. The profile of the fund and the field of investments could range widely, from energy saving to waste management, or to the most innovative sustainable ideas.

12. MONITORING

In order to support SEAP monitoring process verification was defined set of monitoring indicators by energy sustainability actions and sector. These indicators allow monitoring of the implementation status of energy sustainability measures and are presented in the following figure.

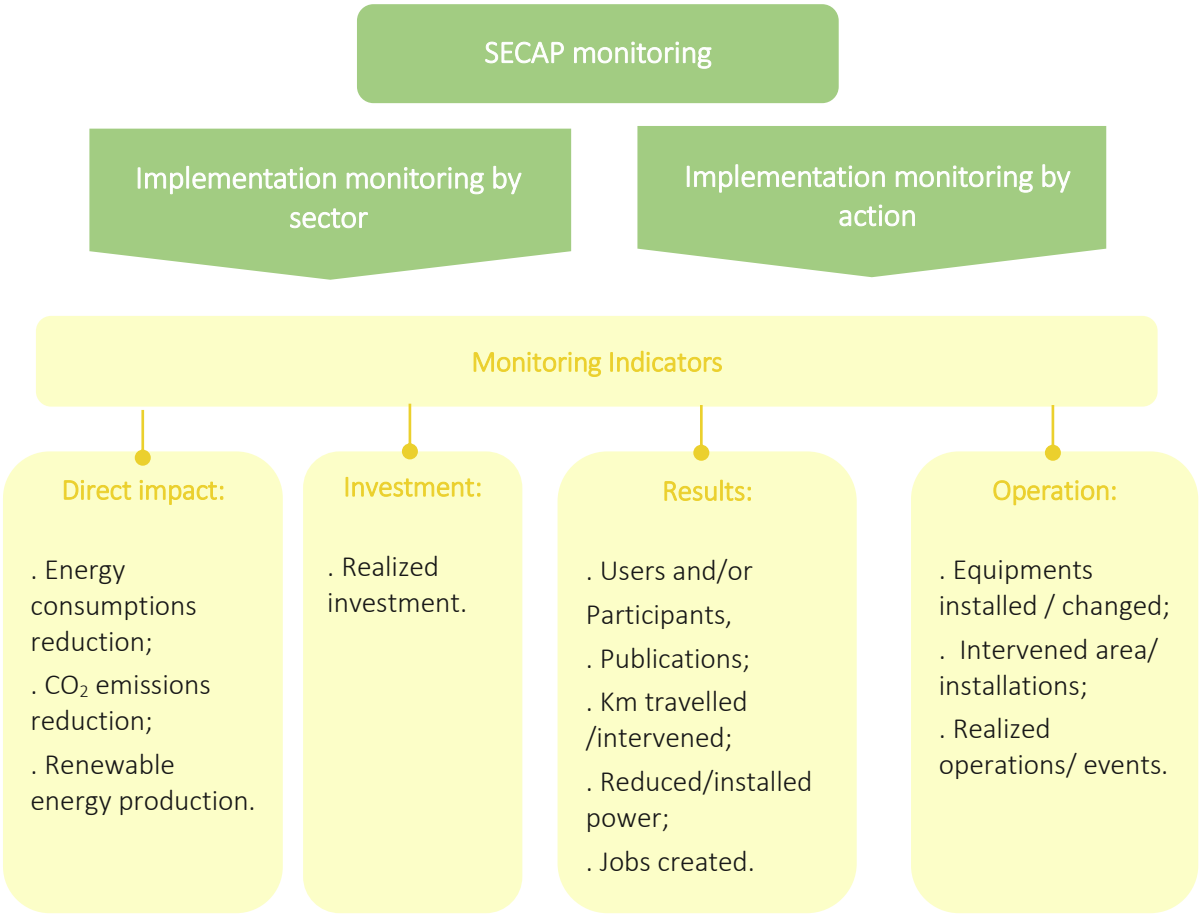


Figure 70: Illustration of SECAP monitoring indicators

The process of SECAP implementation and monitoring will be supported by the Intelligent Energy Management System (IEMSy), a tool to monitoring energy use, as well as energy invoice and to analyze the appropriateness of options for rationalizing consumption profiles, contracting for supply and improving efficiency. Therefore, the monitoring indicators will be obtained through IEMSy, project documents, local publications, reference statistical information and other data collected locally.

Digital Urban Platform

Guimarães Digital Urban Platform is a technical and management tool to obtain data in real–time, primarily, and aims at enabling a set of management instruments which converge to the improvement of the respective territorial sustainability and reduce the expenses on municipal budgets.

This system allows the energy management of public buildings, water supply systems and waste collection and treatment, street lighting network, municipal fleets and other municipal management consumptions, as well as invoices management and reporting tools for greater convenience of use. Guimarães Digital Urban Platform is already operating for a number of facilities and variables, as shown in figure 71

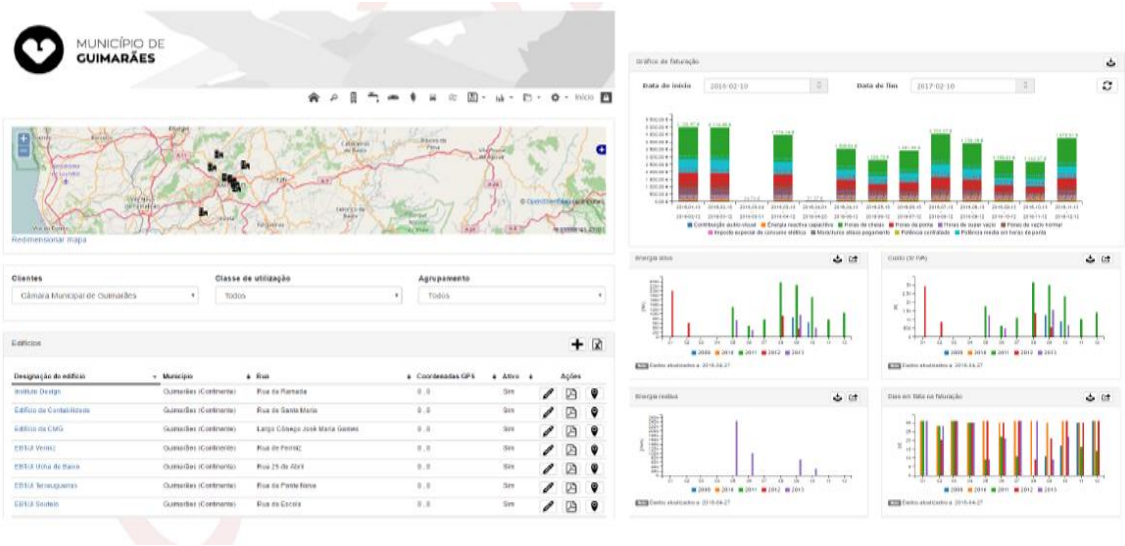


Figure 71: Performance Monitoring System in Guimarães Digital Urban Platform

In addition to cadastre, management, reporting and monitoring functions of IEMSy, this system can integrate a sensory network, teleconnection and alerts system. In order to continuously respond to user needs, IEMSy is updated regularly, often acquiring new features and continuously improving existing functionalities.

IEMSy light is the first application of the Guimarães Digital Urban Platform and aimed at the general public. It allows anyone to send illuminance measurement data in public lighting, in addition to the existing register (figure 72).

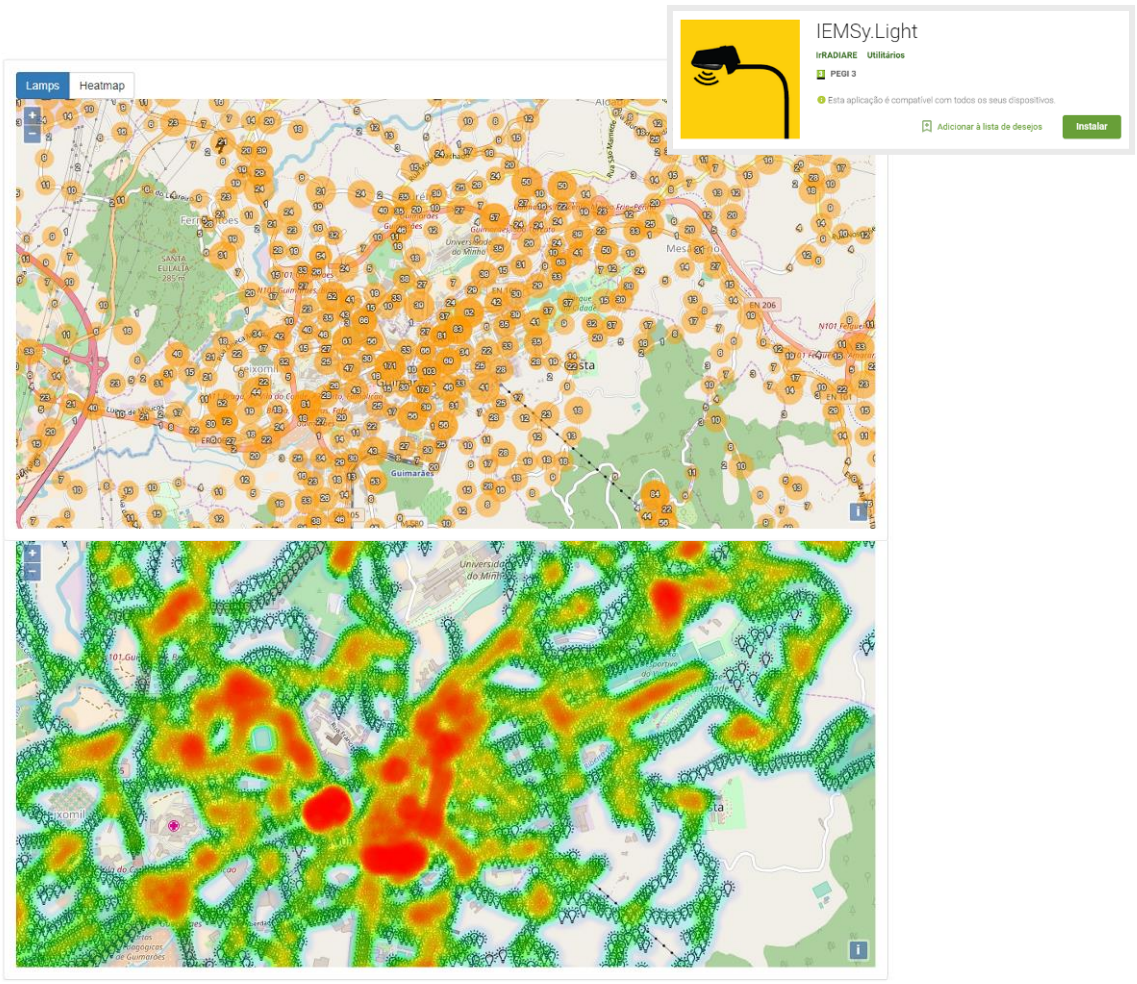


Figure 72: Aplication of data from IEMSy light in Guimarães

13. CONCLUSION

Guimarães could celebrate many successes in recent years. In 2017 became the most sustainable city in Portugal, with an innovative and bold urban development model combining the cultural heritage with the best environmental practices and public participation. Its citizens can't just be proud of the sustainable way they live, but also of past achievements of declining the Historic Centre as an UNESCO World Heritage, being the European Capital of Culture in 2012 or Best European City of Sport in 2013. A long-term plan of Guimarães is to design a successful city with permanent and unrivalled quality of life.

In the framework of the Sustainable Energy and Climate Action Plan, a number of sustainability measures have been defined, the implementation of which will allow compliance with the commitment made with the signature of the Covenant of Mayors for Climate and Energy, namely the reduction of, at least, 40% of the municipality's emissions by 2030 and the adoption of a joint approach on mitigation and adaptation to climate change.

Thus, the replication of the proposed solutions in SECAP must respond, through its components, functionalities and constituent instruments, to the requirements to support the following processes:

- Mitigation of the exposure of families, companies and the public sector to the high prices of energy goods and services;
- Reduction of energy and carbon intensity;
- Articulation of solutions aimed at reducing energy intensity and GHG emissions with those aimed at improving the quality of life, sustainability, competitiveness of the economy and equal opportunities, also between social, economic and regional sectors, between others.
- Mitigation of the exposure of families, companies and the public sector to the high prices of energy goods and services;
- Reduction of energy and carbon intensity;
- Articulation of solutions aimed at reducing energy intensity and GHG emissions with those aimed at improving the quality of life, sustainability, competitiveness of the economy and equal opportunities, also between social, economic and regional sectors, between others.

The key concept behind the proposed solution to maximize the energetic-environmental benefits is: to support the mobilization of the initiative, public and private, around the objectives of improving energy and climate sustainability, especially in relation to the strengthening the competitiveness and innovation of energy services markets and with the participation of the population and social, institutional and economic organizations in

meeting energy intensity reduction and greenhouse gas emission targets in territory of Guimarães.

Municipality of Guimarães has the courage to dream, the will to mobilize resources, and to nurture aspirations among people and organizations to build an increasingly inclusive and sustainable territory. The municipality wants to focus on support of public and private initiatives, improvement of energy sustainability, particularly as it relates to enhancing competitiveness and innovation in energy services markets and increase population and social agent participation in meeting targets for reducing municipal energy and carbon intensity.