PLEEC
PLANNING FOR ENERGY EFFICIENT CITIES

Deliverable 4.1

Urban and energy planning in Santiago de Compostela

FINAL Report
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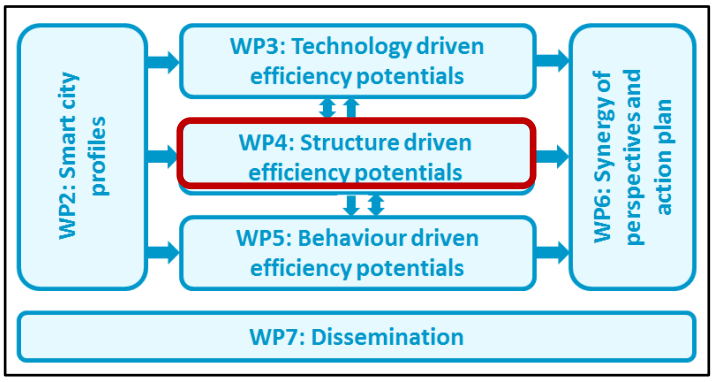
SEVENTH FRAMEWORK PROGRAMME

This project is financed by the European Union

Abstract

Main aim of report

The purpose of Deliverable 4.2 is to give an overview of urban energy planning in the six PLEEC partner cities. The six reports illustrate how cities deal with different challenges of the urban energy transformation from a structural perspective including issues of urban governance and spatial planning. They will provide input for the following cross-thematic report (D4.3).



WP4 location in PLEEC project

Target group

The main addressee is the WP4-teams (universities and cities) who will work on the cross-thematic report (D4.3). The reports will also support a learning process between the cities. Further, they are relevant for a wider group of PLEEC partners to discuss the relationship between the three pillars (technology, structure, behaviour) in each of the cities.

Main findings/conclusions

Santiago de Compostela has several urban and climatic features that can be considered positive for energy efficiency. Consequently, the topic has not been a high priority issue for both the society and the municipal authorities, and is not yet an explicit component of local urban plans.

Santiago's role in energy efficiency is basically following the regional policies of the Galicia Autonomous Community, which in turn follow the state level policies. The largest amount of energy consumption in Galicia is in the industry sector, followed by transport, and finally domestic and public services. The Galician industrial sector has a larger proportion of final energy consumption than that at Spanish level, while the domestic has much less. The regional policies address these four consuming sectors.

As the seat of the Galician government, and final destination of the Way of Saint James, Santiago has widely profited from state and regional funds, agencies, policies and urban interventions, mainly focused in its historic centre. The link conservation-energy efficiency is therefore very important in Santiago, but until now mainly a matter of studies than significant interventions.

The most direct sustainability related planning initiatives have been sustainable transport plans elaborated at both municipality and autonomous community with the purpose to increase public transport and diminish private car use, which have delivered meagre results. An important issue constraining Santiago council to deliver joined up energy efficiency measures relates to the features of its planning system and planning tradition, based on building codes and rigid plans, with slow procedures.

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Activities carried out including methodology used

The six reports are based on workshops (Stoke-on-Trent, Turku, Copenhagen), interviews with stakeholders in the cities, the analysis of local reports, planning documents and news in the press, as well as close contact with our city partners (see methodology chapter).

The PLEEC Project

Energy efficiency is high on the European agenda. One of the goals of the European Union's 20-20-20 plan is to improve energy efficiency by 20% in 2020. However, holistic knowledge about energy efficiency potentials in cities is far from complete. Currently, a variety of individual strategies and approaches by different stakeholders tackling separate key aspects hinders strategic energy efficiency planning.

For this reason, the PLEEC project – "Planning for Energy Efficient Cities" – funded by the EU Seventh Framework Programme uses an integrative approach to achieve the sustainable, energy–efficient, smart city. By coordinating strategies and combining best practices, PLEEC will develop a general model for energy efficiency and sustainable city planning. By connecting scientific excellence and innovative enterprises in the energy sector with ambitious and well-organized cities, the project aims to reduce energy use in Europe in the near future and will therefore be an important tool contributing to the EU's 20-20-20 targets.

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1. Introduction

This is one of six case studies in the PLEEC project, carried out with the purpose to describe how cities deal with climate change-related planning, strategies and interventions. Although not explicitly, the focus has been the relationship between urban issues – the structure of the city, its density and the cohesion between the built environment and the infrastructure – energy, and climate change-related initiatives.

The structure of the study follows the format decided in the discussions held prior to the visit to the site. Significant part of this report concerns the regional context, the autonomous community of Galicia, where Santiago de Compostela is located. This was considered necessary to understand Santiago's situation, both in terms of urban development as well as in terms of energy policies.

This case study was elaborated by Ana Maria Fernandez Maldonado, from the TU Delft team, and reviewed with the comments of the Santiago de Compostela PLEEC team, and with successive exchanges, especially with Dr. Arq. Patricia Liñares.

2. Methods

The case-study was elaborated in three phases, following the path designed by the PLEEC project. First, a template on content was discussed between the researchers at the backdrop of the first data collected about the six cities. Second, discussions between researchers and city representatives took place at the joint meeting in Stoke-on-Trent. A short workshop involving all PLEEC participants helped determine what were general attitudes towards energy efficiency in different partner municipalities. The workshop allowed some discussion of key issues prior to the field trip. Additional discussions were held with local partners through telephone and Skype interviews. Finally, the field trip was organized, and data obtained through interviews, reports, and planning documents collected from the local partners (see Table 2.1). With that information, complemented with Internet research and WP2 reports, a draft was elaborated. This was submitted to local partners for comments and corrections to improve the text.

Table 2.1: Field study agenda in Santiago de Compostela, 2-3 June 2014

Monday, 2 June 2014			**Hosts / interviewee**
9:00	12:00	Council of Santiago	**Fernando Suárez Lorenzo**, Coordinator of the project in Santiago; head of the Innovation Section of the Council of Santiago **Arq. Inaki Soto**, from the Section of Urbanism of the Council of Santiago
12:00	14:00	Consorcio	**Arq. Angel Panero Pardo**, from the Consorcio (institutional cooperation between the Government of Spain, the Xunta de Galicia (regional gov.) and the city of Santiago) involved in the EFFESUS EU project **Arq. Idoia Camiruaga**, from the Consorcio, involved in the FASUDIR EU project
16:00	19:00	Council of Santiago	**Jose Julio Ares Suarez**, from EMETEL, company which provides a smart city platform for the city **Dr. Arq. Patricia Liñares**, researcher from the

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			University of Vigo.
Tuesday, 3 June 2014			
10:00	11:30	Council of Santiago	**Andoni Manso Pajarron,** from FERROVIAL servicios Espana, company which provides services to the city
12:00	15:00	University of Santiago de Compostela	**Juan Arias**, researcher from the University of Santiago **Esteban Vieites,** researcher from the University of Santiago

3. Santiago de Compostela and its regional setting

Santiago de Compostela is the capital of Galicia, one of the 17 autonomous communities of Spain. Galicia has a total area of 29,574 km^2 and a population of 2.747.207 inhabitants in January 2014 (INE, 2014). It is divided in four provinces: A Coruña, Lugo, Ourense and Pontevedra. Santiago is located in the province of A Coruña, with 1.133.471 inhabitants, which is the most populated province of Galicia, located at its North Western extreme. A Coruña has most of the long Galician coastline, including 8 ports, and as such, it has important fishing and maritime-related industries. Santiago de Compostela is one of the 93 municipalities of A Coruña, which is governed by Xunta de Goberno of the Deputacion da Coruña.

3.1 Galicia autonomous community

Galicia is located at its North Western extreme of Spain (see figure 3.1). With the Basque Country and Catalonia, Galicia is one of the historic nations of Spain, with a rich history and an own identity and language, Gallego. It has a long coastline (1,660 km) to the west and north, and is bordered by Portugal to the south, and the autonomous communities of Castile and León, and Asturias to the east.

Figure 3.1. Location of Galicia in Spain (Source: HansenBCN, 2009)

Galicia is governed by the Xunta de Galicia, and has its own Parliament with 75 elected deputies, with legislative power. The Xunta has both executive and administrative powers and coordinates the activities of the four provincial councils. Since the 1978 constitution, autonomous communities are in charge of planning functions, but should follow the national spatial policies, whose regulations are mainly restrictive in order to avoid undesirable development (European Commission, 1999). Energy-efficiency issues

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at this level are linked to the *Consellería de Medio Ambiente, Territorio e Infraestructuras* (Secretary of Environment, Land and Infrastructures).

Galicia's eccentric location in relation to Spain and Europe has been a great disadvantage to the region, which has determined its difficult economic prospects in modern times. Galician industrial development has been slow, and the region has remained as a predominantly rural society during a long period. Its dependence on first sector activities, related to agriculture, livestock, forestry and fishing did not change much during the Franco's regime, when other Spanish regions industrialised. The exceptions were the cities of Vigo and A Coruña, designated in the 1960s as free economic zones in the frame of the national development policy, what promoted industrialization and made these two cities grow. During that time, hydro-electric dams were built in the Galician south east by Fenosa, the monopolistic electricity supplier, which served as important sources of energy for the Spanish industrialization process (Keating, 2001).

Partly due to the historic domination of the Catholic Church, in which Santiago traditionally has an important role, Galicia used to be a stronghold of the monarchists during the Spanish Civil War (1936-1939) and supported Franco's dictatorship (1939-1975), as Franco himself was a native Galician. After that period, Galicia remained a politically conservative region "The autonomous government has been dominated since it was set up, by the Spanish Conservative Alianza/Partido Popular (PP) under the leadership, since 1989, of Manuel Fraga, former Franco minister and unsuccessful leader of the national opposition." (Keating, 2002:228).

Galicia, with Andalusia and Extremadura, are the regions with the lowest GDP per capita in Spain, in which the levels of capital spending per capita is well below the European average (Guisan, 2006). Galicia has been affected by a late urbanisation process, reaching its urban majority only during the 1970s (Máiz and Lozada, 2000). However, it is still perceived as a predominantly rural territory, whose urban system is dominated by the cities of Vigo and A Coruña, with Santiago linking both of them (Gómez et al., 1995).

During the 19th and 20th centuries, the region's high rates of poverty promoted a huge emigration to Latin America and other European regions, which, combined with the low birth rates, decreased Galicia's population weight in Spain from 11% into 5.97% in 2011. "The late industrialization process, the decline in the relative prices of agriculture, and the low participation of Galicia in many important chapters of Spanish public spending have been some of the main factors behind its weight loss relative to the national population" (Guisan et al., 2002:i). "Galicia never produced a vibrant commercial and industrial bourgeoisie. The middle classes found employment in the state bureaucracy, the military or, if they entered the private sector, in the banks" (Keating, 2001:227). During the 1990s, the Galician population increased, as in many other regions of Spain, but after 2008, it has begun to decrease again.

Galicia greatly profited from European structural funds, and money for infrastructural projects which have greatly improved roads, telecommunication networks and airports since the 1980s. There has been "a massive and largely indiscriminate programme of investment subsidies, up to the high limits laid down by the EU for the most needy

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regions" (Keating, 2001:230). Since the 1990s, Galicia has made great progress in terms of industrialization, tourism and education (Guisan et al., 2002). Traditional industries, fishing industries and agriculture have suffered due to the competition from other European states and the imposition of quotas (Keating, 2001), but other modern industries have thrived such as ICT and fashion manufacturing, in which the Inditex group – one of the largest in the world – is one of the more salient examples.

3.2 The Consorcio of Santiago de Compostela

One of the most important agencies in the city is the Consorcio of Santiago de Compostela (www.consorcio-santiago.org/es), the executive agency of the Royal Board of Santiago (Real Patronato de Santiago). Created in 1993, it is an institutional cooperation between the three levels of government: the Government of Spain, the Xunta de Galicia, and the city of Santiago. The work of the Consorcio is focused on carrying out urban renewal interventions, infrastructure upgrading and public space recovery, because the preservation and enhancement of Santiago de Compostela's historical heritage is considered the engine of the local and regional economy.

The Consorcio works on the basis of eight-year plans. The last one was the 2006-2014 plan. The next plan was in the making during the June 2014 visit, in which energy efficiency would be an important issue (Panero, 2014). The Consorcio is partner of other 7th framework programme European projects that are related to energy efficiency, such as EFFESUS (Energy efficiency in historic centres) (www.effesus.eu) and FASUDIR (Friendly and Affordable Sustainable Urban Districts Retrofitting) (fasudir.eu), in which Santiago de Compostela is a case-study. The difference with PLEEC is that EFFESUS is not involved in energy efficiency at urban level, but at building (construction) level. The goal of FASUDIR is to help select and prioritise energy efficiency retrofitting interventions at district level.

3.3 Brief overview of Santiago de Compostela

Location

The municipality of Santiago de Compostela is located at the western part of Galicia, along a corridor that connects the more populated and dynamic cities of Vigo, at the south and A Coruña, at the north (see Figure 3.2). It has an area of 222 km^2, which contains the city of Santiago, with its historic core and successive expansions and 29 rural parishes. Santiago de Compostela is a picturesque and historic city with a great religious and cultural significance in Spain, whose historic centre has been appointed by UNESCO as a World Heritage Site.

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Figure 3.2 Galician borders and urban system (from Google maps)

History

Although Santiago has a relatively small population for both Spanish and Galician standards, the city has a rich and long-standing cultural and religious significance. In the 9th century, Santiago de Compostela became an important destination of Christian pilgrimage throughout all Europe, due to the shrine of Saint James the Great, who gave the city its name. Figure 3.4 shows the road network that led to Santiago in Europe, known as the Way of St. James. Although the popularity of the Way was almost extinct outside Spain in the 14th century due to the effects of the plague, and later to the rise of Protestantism, the pilgrimage surged again after Santiago de Compostela became World Heritage Site in 1985, and especially during the 1990s due to a regional strategy, the Xacobeo, launched with the purpose to recover, diversify and internationalize the Way of Saint James (Precedo et al., 2007).

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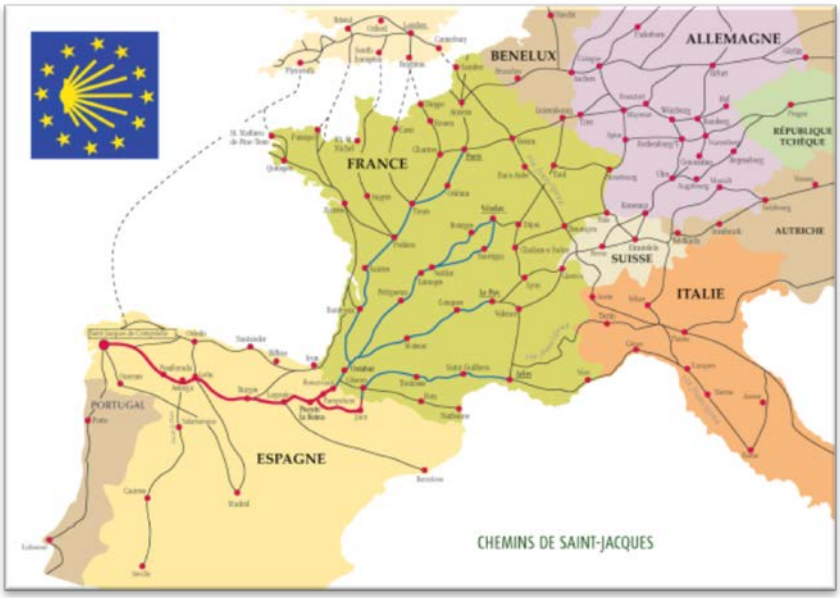

Figure 3.3 The Way of Saint James in Europe (Source: Manfred Zentgraf, Volkach, Germany)

Population

Table 3.1: Important indicators of Santiago de Compostela (Giffinger et al., 2014; INE 2014)

Indicator		Year
Inhabitants Santiago Municipality	96.041	2013
Number of dwellings	45.194	2001
Number of residential buildings	14.658	2001
Administrative area in km^2	220	2014
Settled area in km^2	14,7	2013
GDP per capita in Euros	€ ~21.000,-	2011
Average annual household net income in Euros	€ ~39.000,-	2013

The population of Santiago de Compostela municipality was 96.041 inhabitants in January 2013. Figure 3.4 shows the evolution of Santiago's population since 1900, showing a great jump during the 1970s and a relative stability since then. However, it is considered that de facto population is much more, due to the commuters from neighbouring municipalities and university students (approximately 30,000) that are not counted in the statistics. The population of its metropolitan area reached 184.022 inhabitants in 2013. Table 3.2 shows the population in all municipalities that conform Santiago de Compostela metropolitan area, their area in m^2, and the population of their capital in January 2013 (IGN, 2014).

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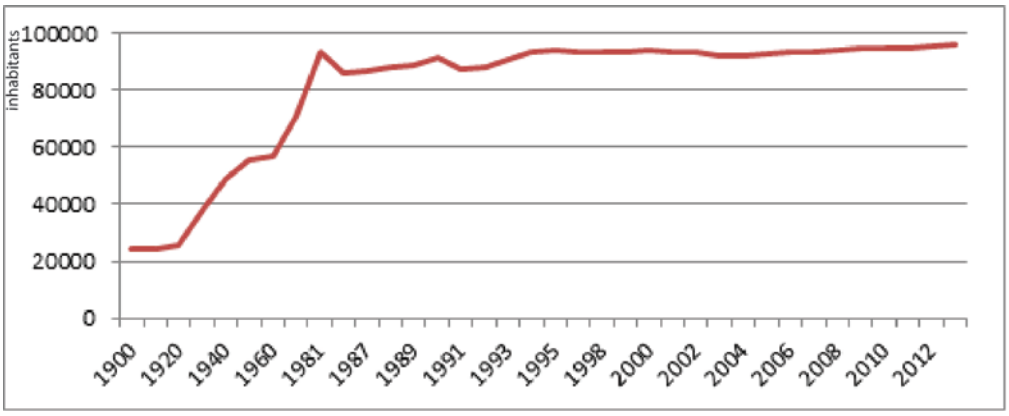

Figure 3.4 Evolution of Santiago de Compostela's population since 1900 (Data from INE, 2014)

Table 3.2 Population and area of municipalities that conform Santiago de Compostela metropolitan area (Data from INE, 2014)

Municipality	Population	Area in km²	Capital	population
Ames	29689	80.04	Bertamiráns	7960
Arzúa	6276	155.47	Arzúa	2728
Boqueixón	4370	73.17	O Forte	117
O Pino	4708	132.14	O Pedrouzo	745
Oroso	7431	72.59	Sigüeiro	3734
Padrón	8707	48.37	Padrón	2992
Santiago de Compostela	**96041**	**220.00**	**Santiago de Compostela**	**80076**
Teo	17942	79.29	A Ramallosa	591
Touro	3919	115.34	Fonte Díaz	429
Trazo	3343	101.30	Viaño Pequeno	126
Val do Dubra	4136	108.63	Bembibre	1003
Vedra	5008	52.77	Avenida do Mestre Manuel Gómez Lorenzo	109

Economic base

Santiago stands on three main pillars: educational, cultural/religious and administrative. Through the Way of Saint James, Santiago is a very popular religious and touristic destination – with an estimated 240,000 pilgrims for 2014. The increasing popularity of the Way of Saint James has invigorated the local and regional economies, being one of the few sectors that has not suffered from the Spanish economic crisis in the latest years (Minder, 2014). Besides its important religious and cultural significance, Santiago has historically been a university city, the seat of the University of Santiago de Compostela, established in the early 16th century. Consequently, Santiago has more than thousand years as a religious destination and more than 500 years as an educational destination. The main sites of these two historic functions, the Saint James Cathedral and pilgrims accommodations, and the university campus, are still the most dominant features of Santiago's urban structure.

Due to its role as former capital, Santiago de Compostela became the capital city of Galicia in 1978, and the seat of its government, the Xunta de Galicia, the parliament and other institutions of the autonomous community. Being the seat of Galicia's government has also attracted firms to settle in Santiago. Important industries established in its

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territory are timber transformation (FINSA), the automotive industry (UROVESA), and telecommunications and electronics (Blusens and Televés), as well as financial institutions such as Banco Gallego. Thanks to this, Santiago enjoys a high quality of life, and a lower rate of unemployment than the average in Spain and in Galicia.

Climate

Santiago is 260 metres above sea level and looks eastwards towards the fertile hills of inland Galicia and the Way of St. James, which connects it to the north of Spain and Europe. At its west side, it is only 30 kilometres away from the Atlantic coast, what brings a humid oceanic climate, with mild temperatures. The average annual temperature is around 15º C. The winter average is 8º C, with few days of frost and rarely snow. Santiago enjoys a pleasant summer with temperatures ranging from 20º to 27º C. However, Santiago's sky is generally cloudy, due to high rainfall (see Figure 3.5). Winds from the Atlantic coast clashing with the surrounding mountains make Galicia the region with the highest rainfall in Spain, producing a beautiful green landscape. "Santiago de Compostela is usually considered the rainiest city in Spain. Grey skies, endless rain and wet stone make up the typical picture of the city." (Liñares, 2012:63).

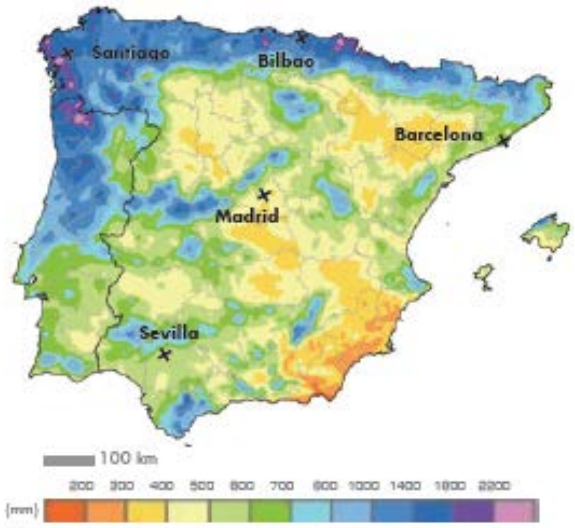

Figure 3.5 Total Annual Precipitation in Spain and Portugal (Source: Liñares, 2012: 65)

However, solar radiation is not very low compared to other Spanish cities (Liñares, 2012). Moreover, comparing to the other five PLEEC cities, Santiago has the highest average of hours of sunshine per day (see Table 3.3).

Table 3.3 Average hours of sunshine per day (Source: Urban Audit)

City	average hours of sunshine/ day
Ekilstuna	4,6
Jyväskylä	4,5
Santiago	5,3
Stoke-on-trent	3,4
Tartu	4,4
Turku	1,9

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Urban structure

According to Santiago's last General Plan (PXOM), three zones can be distinguished in the city (Concello de Santiago de Compostela, 2008):

- The historic city, object of many regionally, nationally and internationally funded projects for its protection, valorisation and rehabilitation, following the regulations of the Special Plan for the Rehabilitation and Protection.
- The consolidated city, surrounding the historic city along defined boundaries, generally known as el Ensanche (the extension). It has reached its full urban development, so only specific actions to reform and improve public space are suitable for intervention.
- The city in transformation, the areas next to the consolidated city, which are gradually being affected by processes of land development.

The first two areas have a high-density (compact) urban pattern, while the latter has a more diffuse urban pattern towards important access roads, following a radial type of urban expansion, which is typical of the Galician territory, a process which can also be seen in the historic maps (see next section). The most important exception to this radial pattern of development is the industrial area located at the northeast of the city.

There is also a proportion of population living outside the city, in dispersed rural villages. From the 96,041 inhabitants of Santiago municipality in January 2013, 80,076 were living in the city and the rest dispersed in the rural villages (16.6% of the total population) (IGN, 2014).

Currently, Santiago functions as a metropolitan area which includes the surrounding municipalities of O Pino, Ames, Arzua, Touro, Trazo, Brión, Oroso, Padrón, Teo, Boqueixón, Vedra, and Val do Dubra, most of which have their own Plan General de Ordenación Municipal (PXOM) (Municipal General Plan of Urban Development) (Xunta de Galicia, 2012). Figure 3.6 shows the location of the surrounding municipalities.

Figure 3.6. Municipalities conforming Santiago metropolitan area (Adapted from Oreiro, 2014)

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4. Historical urban development

At the beginning of the 20th century Santiago de Compostela was a relatively unimportant Galician city, only remarkable as national religious site, as venue of the regional livestock market and a place of agricultural transactions. The extension of its urban fabric coincided with what is today its historic centre, accommodating its main institutions, the university and the Catholic Church, as well as most the dwellings of its population, approximately 24,120 inhabitants.

The process of transformation of historic centres occurring in many European cities along the 19th century were not so noticeable in Santiago, due to low demographic growth trends and small industrial sector growth. At the end of the 19th the historic centre gradually received more and more households and inhabitants, which led to a significant densification of its built environment (Liñares, 2012). The changes that eventually led to the creation of the ensanches or urban expansions occurred in Santiago considerably later than in other Galician cities, especially Ferrol, A Coruña and Vigo. Due to its religious and cultural role, Santiago remained focused on the renovation of the old urban layout, adapting it to the needs of a modern city without losing its condition of historic and monumental town. The delay in the construction of the Ensanche led to the intense use of the space in the historic area. The interventions included the suppression of existing arcades, the alignment of some streets and squares; and improvements of the pavement with granite or cobblestones, suppressing vegetation. A very common practice was also the increment in building height, with the construction of galleries in the upper levels. In 1930 more than one third of the buildings had three floors and less than one sixth had only one floor. Patricia Liñares (2012) has made an in-depth analysis of these transformations and of the evolution of the dwellings of the historic centre of Santiago, in relation with their environmental performance.

Figure 4.1 shows a scheme of the typical section of an urban block in the inner-city of Santiago, which usually correspond to a long block in the North-South orientation, and the corresponding dwellings in the East-West orientation. This figure illustrates its evolution from two-floor single family buildings with a large backyard in medieval times, into several-floor buildings in modern ages, and again into building structures with increased height and depth occupied by several families, with very little open space in-between.

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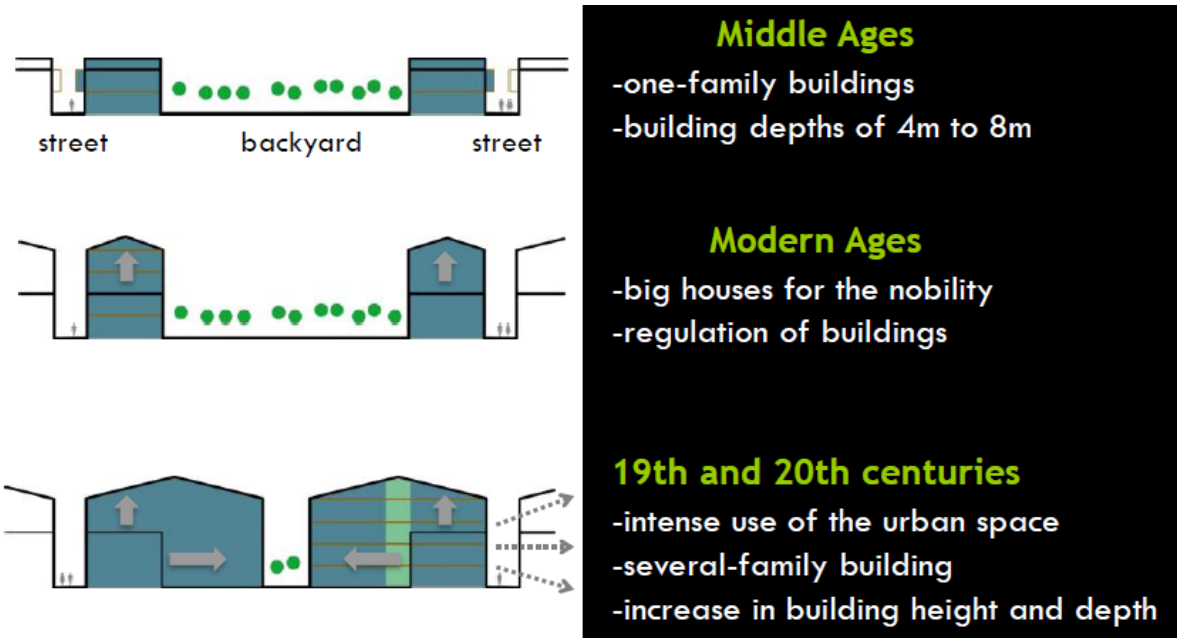

Figure 4.1 Historic evolution of inner-city dwellings in Santiago de Compostela (Source: Liñares, 2012).

Liñares (2012) concludes that this intense densification of the building structures in the inner city during the 19th and 20th centuries has severely damaged the bioclimatic qualities of the involved buildings and surrounding urban space. This remarkable process of densification has also produced a negative impact on the energy efficiency of the urban fabric of both the historic centre and the extensions that followed its development, as el Ensanche.

Figure 4.2 shows a map of Santiago in 1908, depicting the historic city with its monuments (in black and white) and its residences (in orange). The map also illustrates the radial pattern of urban growth typical of the Galician territory along the most important roads, which, in the case of Santiago, used to be the medieval paths belonging to the Way of Saint James.

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Figure 4.2 Map of Santiago in 1908 (Source: Oreiro, 2014)

In the 1920s, Santiago' population began to grow more rapidly. In 1940, Santiago had almost doubled its population, to 49,191 inhabitants, but had not expanded much more than what it was in 1907, besides from the university campus area, which later would become the south campus, and some blocks towards the south of the historic centre, which would be later developed as *El Ensanche*. The Ministry of Education elaborated a Special Plan for the Protection of Santiago de Compostela, which would be the first of a series of plans to preserve its historic centre. This plan proposed to surround the historic core by a buffer zone, which went much further than the existing urban fabric. This plan was approved by law in 1940 (Oreiro, 2014). Figure 4.3 shows this plan, illustrating the Old Town area as a historic-artistic zone (bordered in dark brown), the buffer zone (bordered in blue), a Special Use Zone which included the campus (bordered in orange) and green zones (in green).

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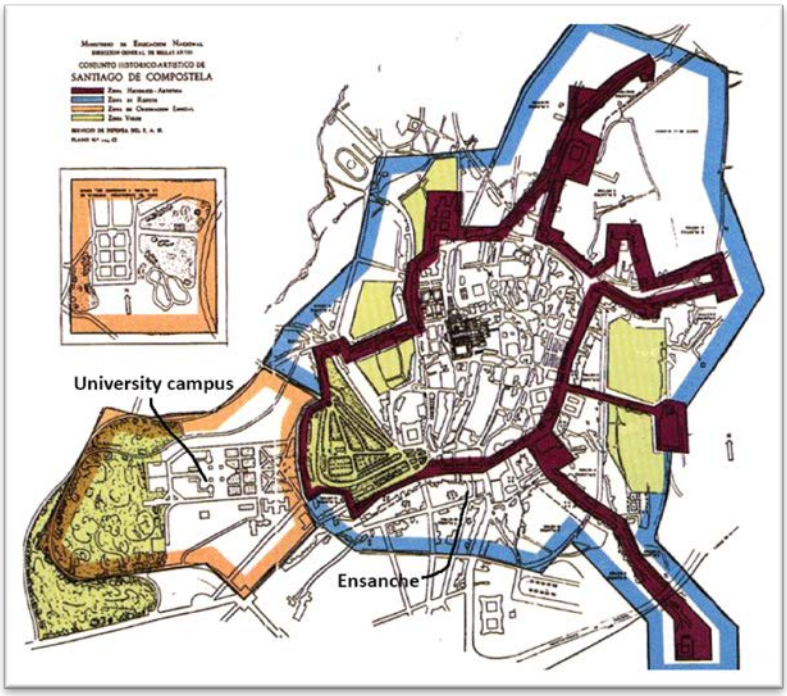

Figure 4.3 Special Plan for the Protection of Santiago de Compostela in 1940, showing the Old Town and the Buffer Zone (Source: Oreiro, 2014)

During the 1950s, a process of modern economic development was initiated in Spain, which included a strong focus in tertiary education, which hugely increased the access to the university, until then a privilege for the very few. In this new context, Santiago University created new faculties and studies, increasing the number of students, teachers and administrative staff tenfold during the 1960-1985 period. The educative function became the engine of growth of Santiago during that period (Lois, 1999) in which Santiago grew from 57,165 inhabitants (in 1960) to 86,250 in 1986.

In 1966, a new plan was made, which divided the city in different zones. Figure 4.4 shows the plan and in black, the built areas of the city, which did not differ much from the 1940 plan. Population growth had led to a slow expansion of the residential areas adjacent to the centre. The main difference between the urban area in 1940 and in 1966, was the incipient development of the south part of the centre, el Ensanche, and the south campus, which can be better appreciated in Figure 4.5, an aerial photo of Santiago in 1968. The urban extension of Santiago in 1966 was 375 Ha., while the old town extension was the original 29,5 Ha.

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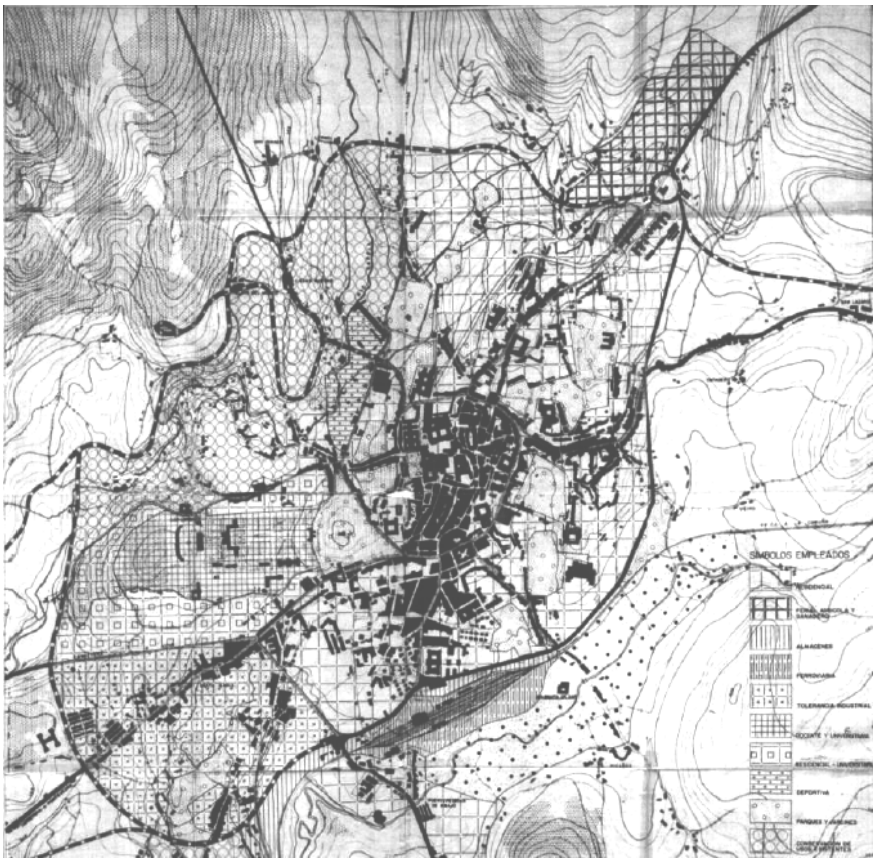

Figure 4.4 Structural plan of Santiago in 1966 (Source: Oreiro, 2014)


Figure 4.5 Aerial photograph of Santiago in 1968 (Source: http://www.santiagodecompsotela.org)

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Eight years later, in 1974, the extension of the city's urban area was 540 Ha. The general urban plan approved that same year was an expansion plan which foresaw the demand for large residential areas to house new residents (Oreiro, 2014). In 1975, the political situation of Spain changed after the end of the dictatorship and the beginning of democracy. A series of new laws and regulations completely modified the political scene, and some of these transformations had a very positive effect in Santiago. With the 1978 constitution and the establishment of Autonomous Communities in Spain, Santiago was established as the capital of Galicia and the seat of its Parliament and its government, the Xunta. This significant appointment brought about many new jobs and new residents, what led to a demand for new housing, and resulted in a clear spatial expansion. As the seat of the Galician government, Santiago has widely profited from special funds, agencies, policies and urban interventions.

Another important landmark occurred in 1985, when Santiago's historic centre was designated an UNESCO World Heritage Site. Not long after, some unwanted urban trends began to be evident in the city and especially in its historic centre. Santiago was expanding horizontally during the 1980s: its urban fabric more than doubled during the 1974-1988 period, from 540 Ha. into 1.360 Ha. Private car mobility also increased hugely during this period, what was leading to growing traffic congestion. In 1989 almost every household had a car (Oreiro, 2014). More importantly, the centre was losing population, housing rents were very high, it concentrated an aging population, while 40% of dwellings required rehabilitation, and 16% of them were empty (UN-Habitat, 1996).

As mentioned before, Santiago de Compostela's process of urban expansion initiated in the 1970s, relatively late comparing to other Spanish cities (Panero, 2010). Its urban fabric more than doubled during the 1974-1988 period, from 540 Ha. into 1.360 Ha (Oreiro, 2014). The main expansion area was el Ensanche, the zone located at the south-west of the historic centre, while the city centre began to depopulate and lose vitality. In order to avoid the later, the General Plan of Urban Development of 1989 promoted compact urban growth and the continuity of the urban fabric for new urban developments. It proposed high-density housing development in two types of areas: infill in existing areas, and a large new area for development at the eastern part of the periphery, the As Fontiñas neighbourhood. The same plan also proposed the Industrial Park at the north east periphery.

In recent years, two main processes of expansion have characterised Santiago's spatial evolution. On the one hand, there has been a process of spatial expansion within Santiago municipality, but hardly accompanied by population growth. An examination of both the population evolution and urban expansion in Santiago since 1960 (see Figure 4.6) shows that it had a rapid population increase in the 1960-1980 period. However, since the 1990s there is a minimal population growth, while its urban area has tripled in the 1989-2008 period, with an average annual increase of 205,26 Ha. The timeline of the spatial extension coincided with a construction boom and economic growth at national level, and a process of economic revitalization at local level.

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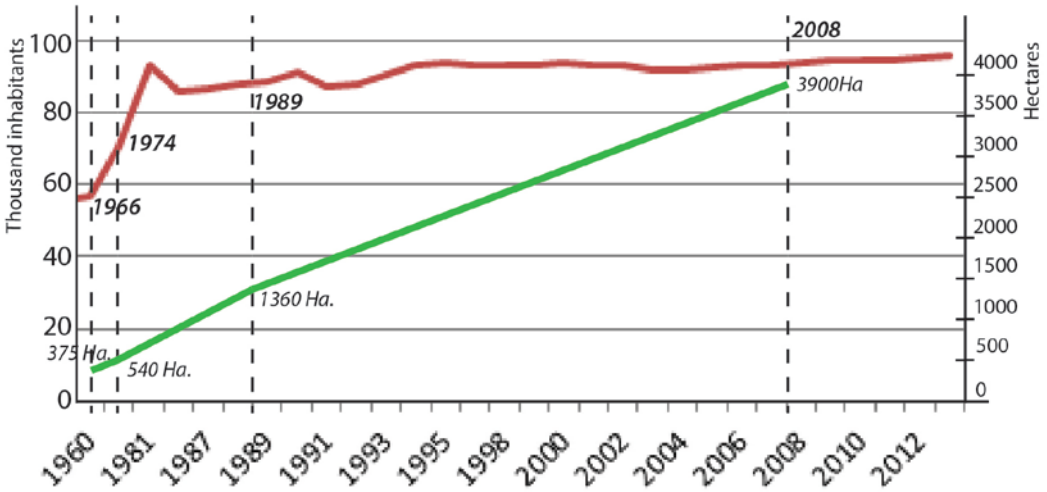

Figure 4.6 Evolution of population (left axis) and urban area (right axis) in the municipality of Santiago de Compostela. (INE, 2014 and Oreiro, 2014)

One of the most important urban expansions is the residential area of As Fontiñas, which was developed in the late 1990s until 2006, with a very orthogonal street pattern, which greatly contrasts with the urban pattern of the rest of the city. Another significant urban intervention in Santiago was a large urban project designed by architect Peter Eisenman, the so-called City of Culture. Commissioned by the Xunta – more specifically by its president Manuel Fraga during his administration from 1990 until 2005 – on a €400 million budget in an attempt to emulate the success of the Guggenheim Museum in Bilbao, the City of Culture is located on the hilltop of Mount Gaiás, overlooking Santiago de Compostela

Figure 4.7 shows the city of Santiago in 2007, in which the area of the historic centre is highlighted. The figure shows the location of El Ensanche, the then recently finished neighbourhood of Fontiñas at the right side, and the City of Culture. The two residential areas were developed according the typical features of the Spanish urbanism of high residential density, mixed with commercial functions. However, the City of Culture has been considered a great urban fiasco. Due to the out-of-proportion ambitions of the project, it was featured in national newspapers as a 'monument to incoherence' (Peregil, 2011), and it is mentioned – with the airports of Ciudad Real and Castellón, and the Valencia's City of Arts and Sciences – as one of Spain's white elephants that dragged Spain into the crisis (Harter, 2012).

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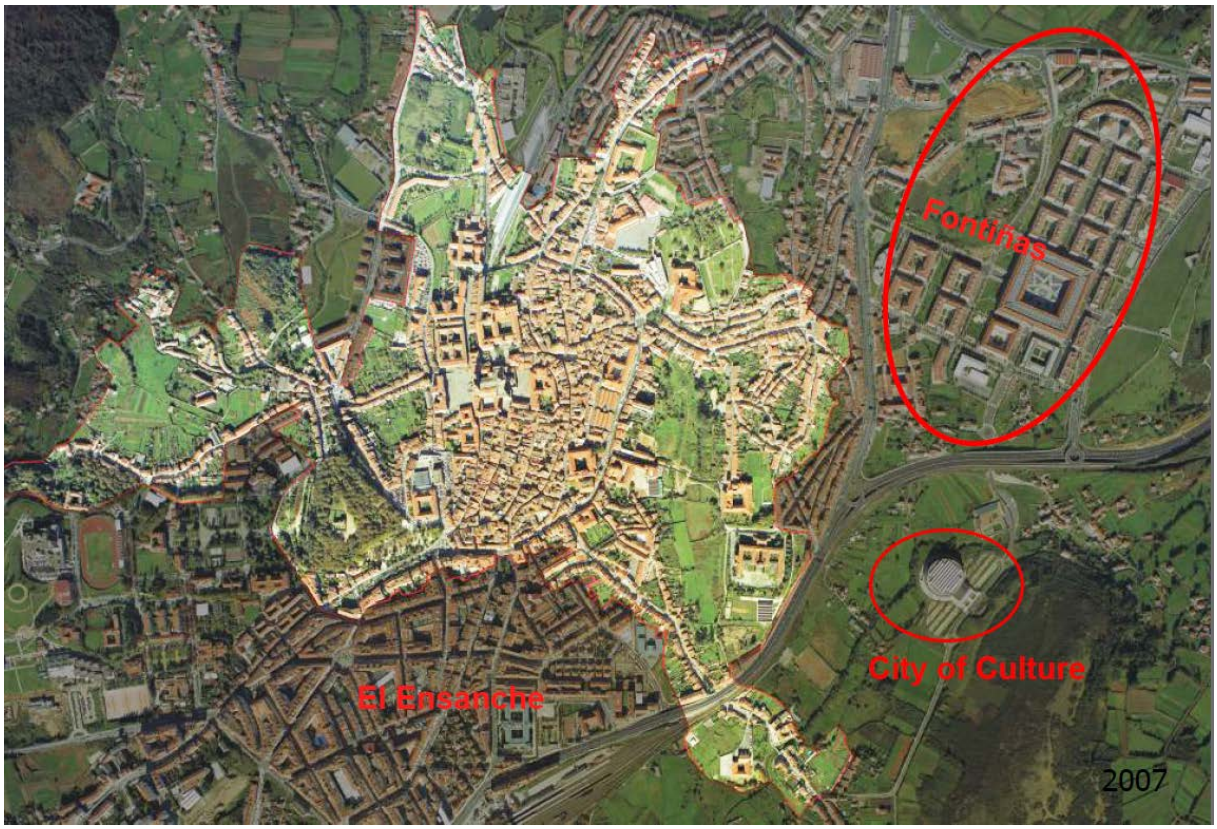

Figure 4.7 Santiago de Compostela in 2007 (Adapted from Panero, 2010)

The first buildings of the City of Culture, a library and a newspaper archive were inaugurated in 2011 (see Figure 4.8). Designed for a huge amount of visitors, the project is largely underused and it has received huge criticism as a massive architectural extravagance in a country with high unemployment and high budget deficit. "But others see the complex of six buildings in Galicia as a monument to the vanity of the region's former rightwing premier, Manuel Fraga, and an anachronism at a time of austerity. The project, still only half-built, has already cost four times more than originally planned."(Tremlet, 2011:1). Only a year after the inauguration, the construction of the rest of the buildings was cancelled, a decision for which the Xunta had to negotiate 18 million euros of compensations. In March 2013, the Xunta decided to definitively terminate the project. In 2014, the existing building have received new functions.

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Figure 4.8 The City of Culture in Santiago de Compostela (Source: El País, 2011)

On the other hand, there is a process of spatial expansion of the metropolitan area, due to population growth. In the 1990s, profiting from the high housing demand in Santiago, and in the context of its compact city policy, its bordering municipalities began to offer land for new residential developments. These areas were attractive to develop due to their good road connections to Santiago. Once built, low middle-income households and young people moved to these new developments, to commute every day with the car. In such way, Santiago began to function as a metropolitan area. The most rapidly growing new areas are located at the east and south east of Santiago (see Figure 4.9), along important highways such as the Autoestrada do Atlántico AP-9 (E-1) connecting Santiago with Vigo, the Autoestrada Central Gallega AP-53 and the AG-56.

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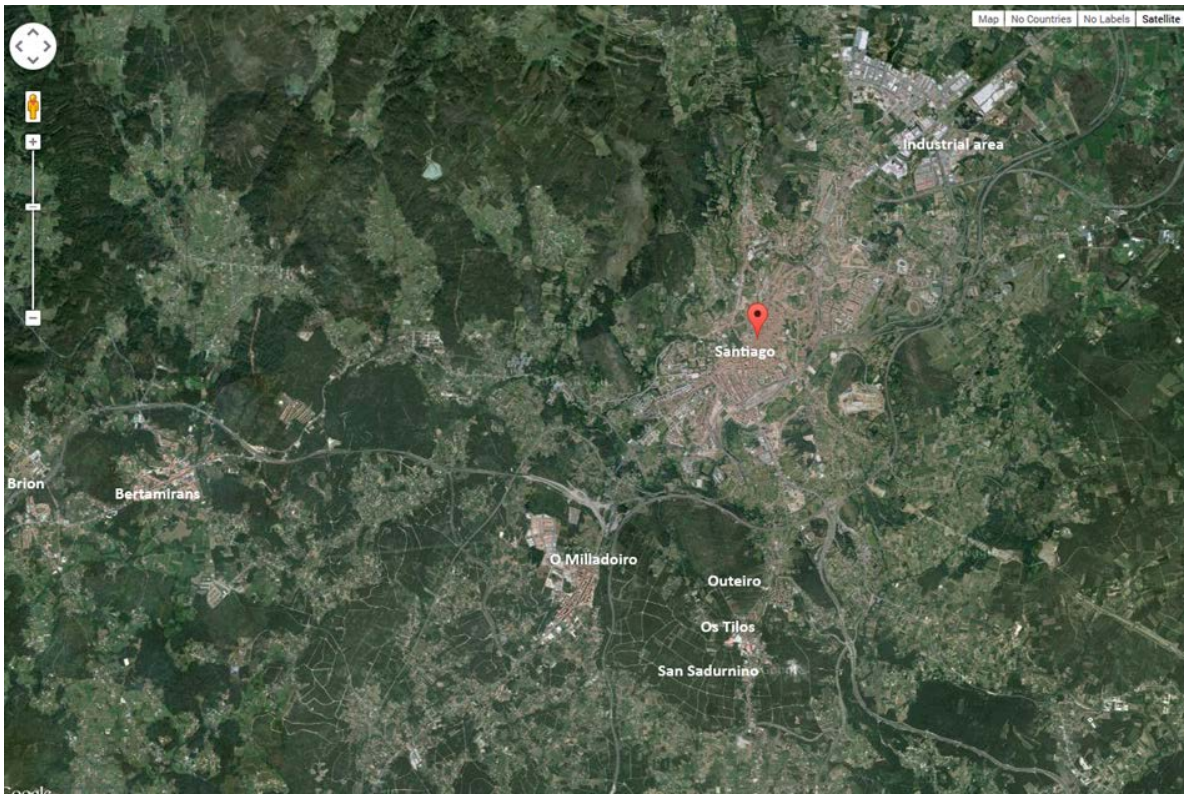

Figure 4.9 Main dormitory areas in Santiago de Compostela metropolitan area from the air (From Google maps)

The population growth in these areas is remarkable. While Santiago de Compostela's population increased by 1508 inhabitants in the 1998-2009 period, the population of the metropolitan area outside Santiago increased by 24013 inhabitants in the same period. Figure 4.10 compares Santiago and Galician population growth (in percentage) with the growth of the Santiago agglomeration outside its central city. Within the municipalities that conform the metropolitan area of Santiago, the one which grew the fastest was Ames, followed by Oroso, Teo and Brión, while Val de Dubra, Vedra and O Pino lost population (see Figure 4.11). The fastest growing dormitory area is O Milladoiro, in Ames, whose growth represents 70% of the total growth of the metropolitan area.

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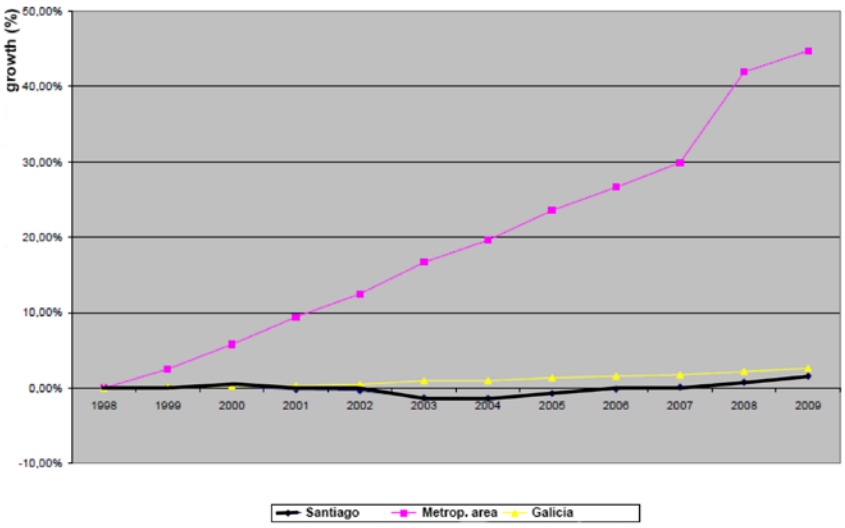

Figure 4.10 Evolution of population in Santiago, its metropolitan area and Galicia (Source: Xunta de Galicia, 2012).

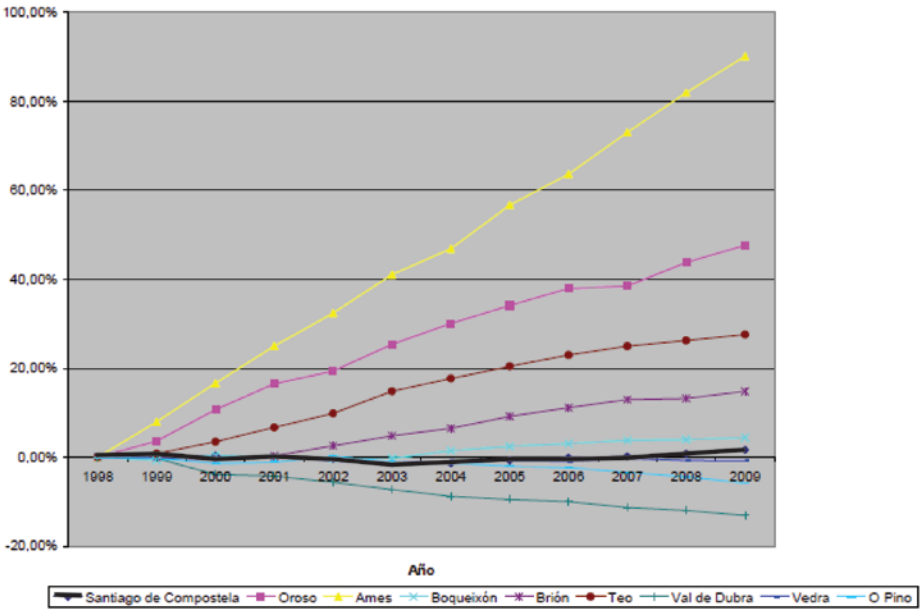

Figure 4.11 Evolution of population of the municipalities conforming Santiago's metropolitan area (Source: Xunta de Galicia, 2012).

5. State, regional and local energy planning

European Union's energy policies (objectives, legislation and programmes) have been a key driving force in the production of national policy on energy efficiency Spain (Moreno, 2013; Martínez de Alegría et al., 2009). The European Union adopted the Energy & Climate Package, setting ambitious energy and climate targets, the so-called 20-20-20 objectives by 2020: reducing greenhouse emissions by 20%, increasing to 20% the share of renewable energy, and achieving a 20% saving through energy efficiency. The basic pillars of Spain's energy policy are: promotion of renewable energy, diversification of energy sources and energy efficiency (Freire, 2012). From these three, the development of renewable energies had had a high priority, and made Spain become

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a world leader in renewable energy. “More than 27 percent of Spain’s power supply in 2012 came from renewable sources, excluding big hydroelectric generators, compared with around 13 percent in 2007 — one of the highest shares in the European Union” (Cala, 2013:2). However, the highly subsidised renewable energy sector has been the most affected from a major restructuring of the energy sector in 2013, designed to tackle the huge tariff deficit in Spain, the difference between the real cost of electricity generation and what is paid by consumers (Cala, 2013).

There are important reasons for energy savings and diversification in Spain: it has high energy consumption; high dependency of oil related products; and a relatively low energy price that does not encourage savings (Freire, 2012), although the latter does not concern the residential electricity price, which has been steadily increasing during the latest years and is now above the European average (see Figure 5.1).

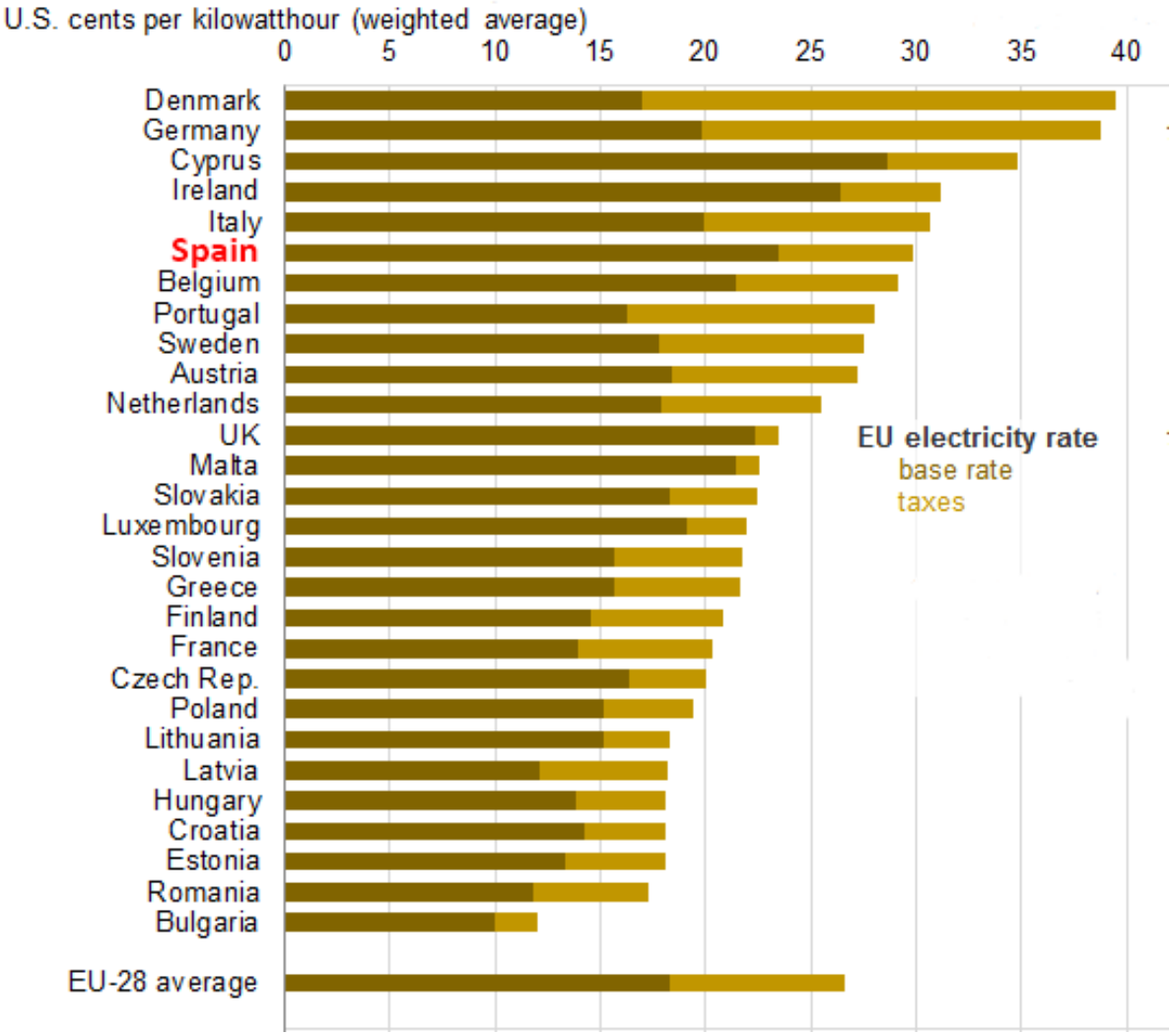

Figure 5.1 Residential electricity prices in Europe in 2013 (Source: EIA, 2014)

But energy efficiency policies have been a relatively new concern (Moreno, 2013), which has only grown in front of the alarming increase of energy consumption. Figure 5.2 show the energy consumption evolution in Spain since 1990, which coincided with a cycle of economic bonanza. On the other hand, it has decreased since 2007 due to the financial crisis and economic recession of the country.

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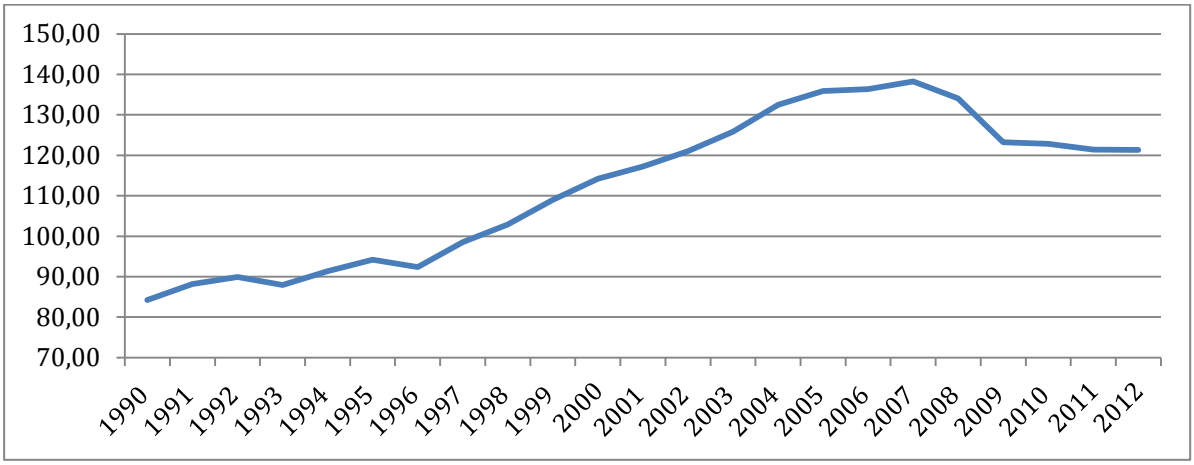

Figure 5.2 Energy consumption evolution in Spain 1990-2012 (Source: Eurostat, 2014)

Estimates for full energy-saving potential in end-use sectors are illustrated in Table 5.1, which is why energy efficiency policies are very much focused on building regulations.

Table 5.1 Potential energy saving in end use sectors in Europe (Martínez de Alegría et al., 2009)

Sector	Full energy saving potential 2020 (%)
Residential buildings (households)	27
Commercial buildings (service sector)	30
Transport	26
Manufacturing Industry	35

According to the legal framework set by the 1978 Spanish Constitution, not only the state government but mostly the Autonomous Communities have an important role in the energy sector. Municipalities have a lesser role, however, and mostly only follow the regional policies and programmes. On the other hand, both Autonomous Communities and municipalities are responsible of areas with a big energy saving potential such as the provision of public transportation and urban planning-related issues (Martínez de Alegría et al., 2009).

5.1 State level energy efficiency policies in Spain

Energy policy in Spain has evolved towards the European Union guidelines such as the liberalisation of energy markets, the security of supply, the development of interconnection infrastructures and the reduction of polluting emissions. Spain has specific challenges which have also demanded a response. The most important are: (1) a high energy consumption per unit of gross domestic product; (2) a high degree of energy dependency; and (3) high levels of greenhouse gas emissions, mostly due to a high growth of electricity generation and the demand for transport over the last decades.

Spain is indeed a high energy consumer. During the 1973-2008 period, the consumption of electric energy multiplied fivefold in Spain (Freire, 2012), and the country now consumes more energy per unit of gross domestic product than the average of European countries. This happens even in comparison with those which have a similar industrial and productive structure and level of economic development. This is mostly an effect of the accumulation of energy-intensive economic growth patterns. The sectors that most

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energy consume were in 2008 transport (38,8%) followed by industry (33,3%). Other uses consumed the rest 28% (Freire, 2012).

Spain is also highly energy dependent, as it imports more than 75% of the primary energy it consumes. In terms of oil – which represents almost half of the energy demand – and gas, the imports reach 100% and 99%, respectively, what makes the country highly vulnerable to the impact of oil and gas prices (Uría, 2012). To illustrate the demand Table 5.2 shows the primary energy consumption in Spain in 2009, and the percentage of each type of energy. Likewise, Table 5.3 shows the final energy consumption in the same year, and the percentage of each type of energy.

Table 5.2 Primary energy consumption in Spain in 2009, and proportion of each type (Freire, 2012)

	Ktep	%	% self-sufficiency
Carbon	10353	7,9	36,5
Oil	63673	48,8	0,2
Natural gas	31104	23,8	0
Hidraulic	2258	1,7	100
Nuclear	13750	10,5	100
Eolic, biomass, other	10067	7,7	100
Power balance (imp-exp)	-697	-0,5	
TOTAL	130508	100	23

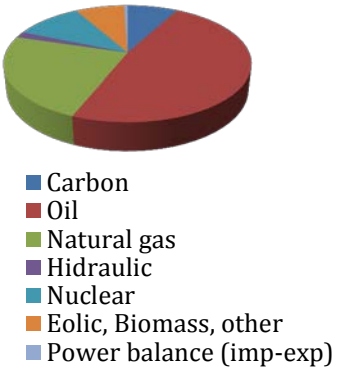
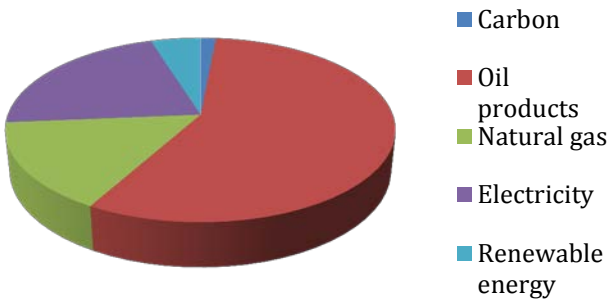


Table 5.3 Primary energy consumption in Spain in 2009, and type of proportion of each type (Freire, 2012)

	Ktep	%
Carbon	1453	1,5
Oil products	55387	56,6
Natural gas	15183	15,5
Electricity	21008	21,5
Renewable energy	4746	4,9
TOTAL	97776	100



Concerted efforts have been made in the area of energy efficiency over the last years to correct these trends, following European regulations, and especially the objectives in terms of savings and energy efficiency set by Directive 2006/32/EC on energy end-use of energy and energy services. Accordingly, the Spanish national government has produced a series of plans, regulations and strategies:

- Spanish Strategy for Climate Change and Clean Energy (EECCEL)
  - Nacional Plan for Adaptation to Climate Change
  - Strategic Lines against Climate Change
  - Nacional Allocation Plan
  - Biodigestion Plan for Animal Waste
  - Biodigestion Plan for Animal Waste (BOE nº 151)
  - National Integrated Plan for Waste
- Spanish Strategy for Sustainable Mobility

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- Housing State Plan for the promotion of rental housing, rehabilitation, regeneration and urban renewal 2013-2016.
- Basic Document for Energy Savings in the Technical Code of Buildings
  - Energy Certification in new buildings
  - Energy Certification in new buildings (BOE nº 27)
  - Regulation for Thermal Installations of buildings
- Spanish Strategy for Energy Savings and Efficiency (E4) (2003)
  - E4 Action Plan of Energy Efficiency 2005-2007 (2004)
  - E4 Action Plan of Energy Efficiency 2008-2012 (2007)
  - E4 Action Plan of Energy Efficiency 2011-2020 (2011)

The fist on the list, the Strategy of Climate Change and Clean Energy (EECCEL) attempts to provide coherence to the several climate change-related policies. It defines the basic guidelines for medium and long term approaches (2001-2012-2020). The more specific energy efficiency policy document is the E4 Strategy for Energy Savings and Efficiency, approved in 2003, which "identifies the strategic objectives of energy efficiency, as well as the route that energy policy should take to achieve the objectives of same: security of supply in terms of quantity and price with some basic levels of self-sufficiency, taking into consideration the environmental impact that its use entails and the importance of the competitiveness of our Economy." (Ministerio de Industria, 2007:1)

Most energy efficiency policies have focused on energy savings in buildings (both residential and industrial) and public lighting, as it is considered that they account for much of the energy consumed. Important legislation regarding these issues are:

- Royal Decree 314/2006 establishing the new Technical Building Code, which provides concrete measures for energy efficiency and integration of renewable energy;
- Royal Decree 1027/2007 amending the Regulation of Thermal Installations (Boilers) in Buildings approved (RITE); and
- Royal Decree 1890/2008 concerning the Regulation of Energy Efficiency Exterior lighting installations.

In 2009, a Basic Document on Energy Efficiency was produced with the purpose to establish rules and procedures for compliance with the basic requirements of energy saving in new buildings, which were set as the following:

1. Limitation of energy demand
2. Efficiency of thermal facilities
3. Energy efficiency of lighting installations
4. Minimum solar contribution to sanitary hot water
5. Minimum photovoltaic contribution of electricity

Regarding existing buildings, the Housing State Plan 2013-2016 (Tinsa research, 2013) for the promotion of rental housing, rehabilitation, regeneration and urban renewal helps finance the interventions in collective residential buildings (built before 1981), for the improvement of building quality, up to the current technical standards. To be subsidized, the works should lower the overall annual energy demand in at least 30% over the previous situation. The works may include, among others:

- Improving the thermal envelope of the building aimed at reducing energy demand, including the installation of bioclimatic devices.

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- Installation of heating, cooling, domestic hot water and ventilation for thermal conditioning or increasing energy efficiency.
- The installation of generators for the use of renewable energy such as solar, biomass and geothermal energy, reduce consumption of conventional thermal or electrical energy the building.
- Improving the energy efficiency of public facilities lifts and lighting.

In July 2011, the National Action Plan of Energy Efficiency (NEEAP) 2011-2020 was approved by the Spanish Council of Ministers, fulfilling the requirements of Directive 2006/32/EC of the European Union, and continuing the E4 Strategy. NEEAP is the main instrument for funding local actions in the frame of the national aid programmes managed by the Instituto para la Diversificacion y Ahorro de Energia (IDAE) (Institute for Energy Efficiency and Diversification). NEEAP set new requirements of energy efficiency for five consuming sectors plus the Energy Transformation sector (IDAE, 2011). The consuming sectors are the following:
1) Industry;
2)Transport;
3) Buildings & Equipment;
4) Public Services; and
5) Agriculture & Fisheries

Table 5.4 shows the energy efficiency measures in the sectors Transport, Buildings & Equipment and Public Services.

Table 5.4 Main energy efficiency measures in the E4 Action Plan (Source: NEEAP 2011-2020)

Transport
Urban mobility plans
Company transport plans
Larger participation of collective means in road transport
Larger participation in train transport
Larger participation in sea transport
Transport infrastructures management
Road transport fleet management
Aircraft transport fleet management
Eco-driving for cars and vans
Eco-driving for trucks and buses
Eco-driving for Aircrafts
Renewal of road transport fleets
Renewal of air transport fleets
Renewal of sea transport fleets
Renewal of car stock
Building & equipment
Energy rehabilitation of the thermal envelop in existing buildings
Improvement of energy efficiency of the thermal installations in existing buildings
Improvement of energy efficiency of the indoor lighting installations in existing buildings
New buildings and rehabilitation of the existing ones with high energy qualification
Improvement of energy efficiency in refrigeration commercial installations
Construction or rehabilitation of nearly-zero energy buildings
Improvement of the energy efficiency of the electric appliances stock
Public services
Renewal of the existing outdoor lighting installations

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Surveys, feasibility analyses and audits in the existing street lighting installations
Training of the local council energy managers
Improvement of energy efficiency of the current water purification plants, supply, treatment of sewage waters and desalination

In accordance with the methodology proposed by the European Commission, the energy efficiency goals of this Action Plan involve 17,842 Ktoe savings of final energy for 2020 and 35,585 Ktoe of primary energy, calculated with reference to year 2007. Figure 5.3 illustrate the percentage that these savings represent for both primary (left) and final (right) energy consumption, in relation to total consumption. The achievement of these objectives in the sectors covered by this Action Plan (the five consuming sectors plus the Energy Transformation Sector) will be possible with the application of funds amounting to €4,995 million during 2011-2020 which will mobilise an associated investment of €45,985 million.

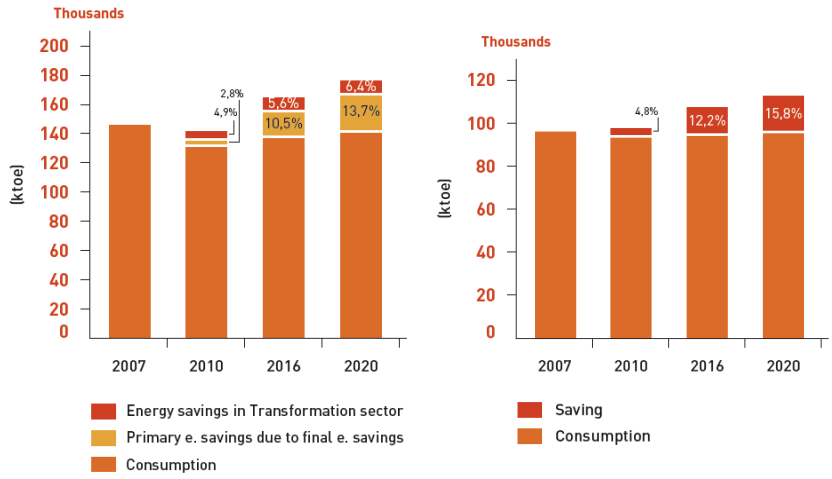

Figure 5.3 Objectives of primary energy efficiency (left illustration) and final energy efficiency (right illustration) for 2020 in Spain (Source: NEEAP 2011-2020)

The priorities of the NEEAP objectives are the following:

1. More participation in the railway mode (Transport).
2. Energy renovation of the thermal envelop in existing buildings (Building & Equipment).
3. Improvement of energy efficiency in the thermal installations in existing buildings (Building & Equipment).
4. Mobility plans for companies and activity centres (PTT) (Transport).
5. Sustainable Urban Mobility Plans (SUMP) (Transport).
1. Improvement of energy efficiency in indoor lighting installations in existing buildings (Building & Equipment).
6. Improvement of equipment and processes technology (BAT) (Industry)
7. Renovation of existing street lighting installations (Public Services).
8. Promotion of co-generation plants for non-industrial activities (Energy Transformation).
9. Energy audits and action plans to improve agriculture estates (Agriculture & Fisheries)

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5.2 Regional energy planning in Galicia

The energy context in Galicia is similar to the one of Spain: a high energy consumption; a high degree of energy dependency; and high levels of greenhouse gas emissions. Galicia transforms 9% of the primary energy of Spain, and imports 86% of the primary energy resources used. The level of self-sufficiency in Galicia is 39,5%. If oil products are considered, the level decreases up to 23,6% (Uría, 2012). Table 5.5 shows the types and proportion of final energy consumption in Galicia, in 2009, in which oil products energy consumption constitute more than half of the total. Figure 5.4 shows the evolution of the total final energy consumption in the 1997-2009 period, in which it increased by 38,2%.

Table 5.5 Final energy consumption in Galicia, in 2009 (Freire, 2012).

	Ktep	%
Carbon	0	0
Oil products	3431	53,6
Natural gas	475	7,4
Electricity	1768	27,6
Renewable energy	724	11,3
TOTAL	6399	100

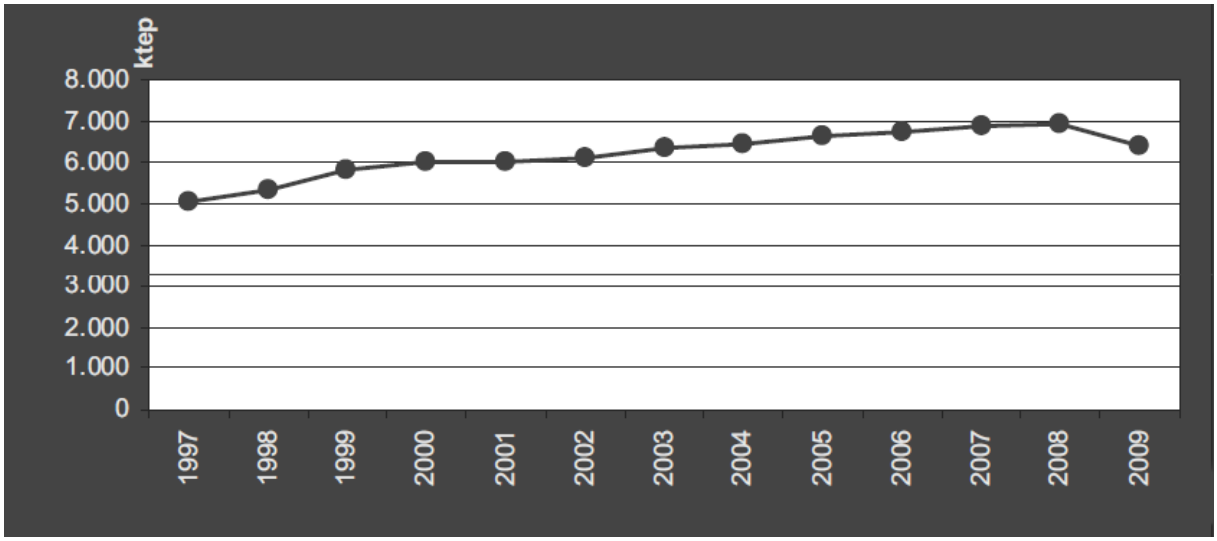

Figure 5.4 Evolution of final energy consumption in Galicia 1997-2009 (Freire, 2012).

Figure 5.5 illustrates the evolution of the structure of electricity generation in Galicia, showing the great variation on the level of energy coming from renewable sources through the years. This variation is related to climatic factors which make the hydro-electric and wind energy sources vary, among others.

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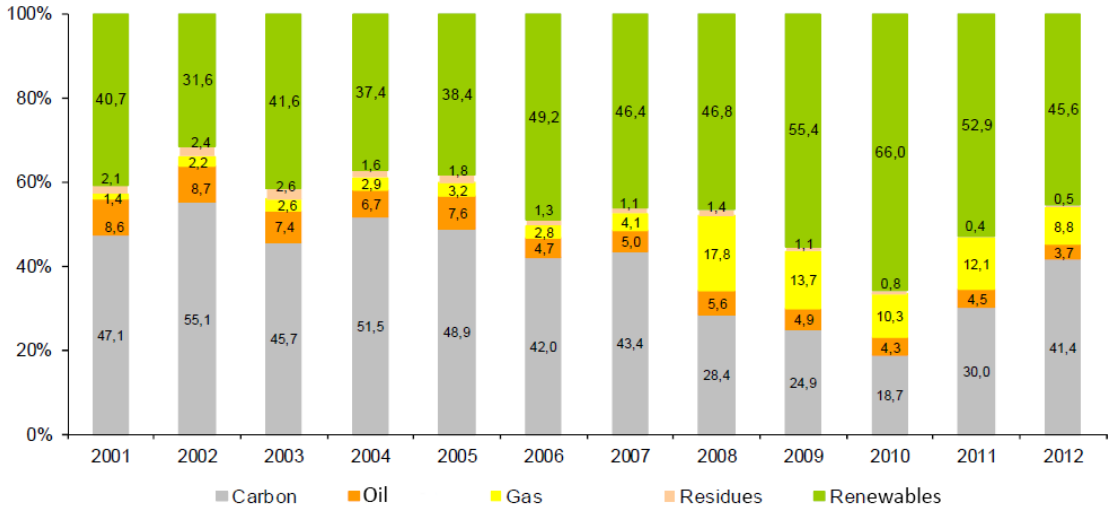

Figure 5.5 Structure of electricity generation in Galicia, in percentage. (INEGA, 2012).

Finally, Table 5.6 compares the energy consumption per sector in Galicia (in 2009) and in Spain (in 2008) showing the very large proportion of energy consumed by the industrial sector in Galicia, and much less in the domestic and public services.

Table 5.6 Energy consumption per sector in Galicia and in Spain (Freire, 2012, with data from INEGA)

	Galicia (2009)	Spain (2008)
Industry	47,4%	33,3%
Transport	33,1%	38,8%
Domestic and public services	19,5%	28%

The Spanish E4 Action Plans on Energy Efficiency are essentially carried out through joint management and finance among the state administration and the Autonomous Communities. Almost all Autonomous Communities have developed their own strategies to promote the rational use of energy, focusing on saving measures at industrial, commercial and residential level. In most cases, these policies focus on assigning subsidies for the implementation of energy efficiency measures in those sectors.

In Galicia, the objectives in terms of energy efficiency are described in the Savings and Energy Efficiency Plan 2010-2015, which follow almost entirely the state plans. The specific actions of this plan are specified in three areas (INEGA, 2014): (1) the Action Plan for Energy Saving and Efficiency in the Galician Public Administration; (2) measures of sectoral scope in the five consuming sectors considered the E4 strategy; and (3) measures of global scope reaching all sectors of society.

The Energy Institute of Galicia (INEGA) is the general coordinator of the first plan, which includes three main goals:

- To set an energy efficiency strategy in Galicia to coordinate the activities of the Regional and Local Administrations to establish common policies for energy efficiency to benefit from existing synergies.
- To perform activities of energy saving and efficiency in public buildings (including health centres, schools, and administrative buildings).

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- To encourage a programme of activities in the field of energy efficiency in the local Galician administration.

1. The sectoral measures include:
   - **In the Industrial Sector:** Energy management programmes including energy assessment of firms; sectoral studies for productivity improvements and promotion of energy efficient equipment; introduction of innovative technologies; development of pilot projects; measures aimed at efficient use of energy in industrial processes; Diversification of energy sources; and training of energy technicians, and appointment of an "Energy Coordinator" in industries.
   - **In the Residential sector:** Campaigns on good energy use practices at home; improvement of thermal installations in buildings; improvement of internal lighting; implementation of energy efficiency criteria in the rehabilitation of thermal building envelops; Appliance Renewal Plan for replacement of energy inefficient appliances, and the implementation of building energy qualification in compliance with Directive 2006/32/EC.
   - **In the Public Services Sector:** Energy management programmes including energy assessment of public services institutions; development of pilot projects; informative campaigns on good energy use practices; reduction of energy demand of existing buildings; and promoting energy micro- and tri-generation.
   - **In the Transport Sector:** Movega Plan for the promotion of electric vehicles; modal shift to more efficient modes, from road to rail and maritime transport; promotion of local urban mobility plans, transportation plans for home-workplace daily trips, promotion of urban and intercity public transport; energy labeling of vehicles; renewal of the transport fleet; workshops on efficient driving; and energy diversification

2. The measures of global scope comprise informative and educational campaigns for promoting energy efficiency; educational campaigns for the rational use of energy; assessment on rational use of energy issues at different public and private institutions; and technical and economic assistance for projects aimed at rational use of energy.

5.3 Local energy planning in Santiago de Compostela

Santiago is present in several European initiatives for climate change and energy efficiency such as the 2020 Plan, and the Spanish Network of Cities for Climate (Red Española de Ciudades por el Clima). However, in the interviews with local municipal functionaries in Santiago they stated the absence of local municipal policies that attempt to control energy use or promote efficiency outside the council. This is because Spanish municipalities do not have the capacity to dictate norms. Local governments cannot oblige home owners or firms to get a certificate of energy efficiency, for example. Normative capacity is a legal attribute of the state and the autonomous communities, which have to be approved by the national or regional Parliament or the Council of Ministers. City officials state that, for example, an important leverage for savings on household energy would be the increase of the residential energy price, but that is out of the hands of the council. What Santiago can do in terms of energy efficiency promotion is to produce ordinances for good-practice guides. In consequence, there are no key documents or measures on energy efficiency at local level.

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The main issues constraining Santiago council to deliver energy efficiency measures are the features of its planning system and planning tradition. This includes the council's limited legal competence as a body able to deliver measures outside the ones contemplated in the local General Plan (Plan Xeral de Ordenacion Municipal, PXOM). The city may pass ordinances, but these do not have the power of law as the General Plans, which have to be approved by the regional government (Xunta) in order to be implemented.

In Galicia, as in the rest of Spain, planning procedures are extremely slow. A plan takes minimally 10 years to be approved by the Xunta. In the meanwhile, the situation in the city has greatly evolved. As the plans are not flexible, they are unable to adapt to the changing urban reality. This is the main reason why there are no locally-designed energy efficiency measures in the current planning context of Santiago de Compostela, whose last PXOM was elaborated during the years of the Spanish economic boom of the 2000s and approved at the beginning of the economic crisis in 2008 (see next section).

To pay attention to the energy-efficiency demands of today, the Council of Santiago began in 2012 a process to contract the preparation of a Master Plan for Energy Efficiency and Sustainability. From the four energy-consuming sectors: housing, business/industry, municipal and transport, the plan focuses on the last two. Its main actions refer to the optimization of the electric monthly bill; efficiency in heat production systems; using efficient lighting technologies; modification of the uses of energy; increasing efficiency in electrical machinery; savings on water consumption; use of renewable energy; energy management; and exterior lighting. The sustainability plan, dated December 2014, is still in its draft phase, to be approved by the council and the Xunta.

A significant way in which the council promotes energy efficiency is through the implementation of the national and regional measures to reduce energy consumption in their own buildings. There is also support to interventions in terms of energy efficiency carried out in important buildings of the historic area. Finally, the city attempts to reduce energy in some of the services it provides to citizens through concessions with private firms. This can only be done once the old contract with the firms has come to an end, and a new concession has to be initiated. For example, when the more recent contract for the maintenance and conservation of green areas was negotiated, measures for water conservation and modification of planted species were included. When a new contract for public lighting will have to be negotiated, aspects of energy efficiency in the design and type of lamps, etc. will be considered. But apart from these small-scale initiatives, city officials state that they cannot significantly and directly intervene on energy efficiency.

An issue of utmost importance in Santiago is the sometimes difficult relationship between energy efficiency and conservation of the local heritage, especially in the historic area, strictly regulated by the Special Plan (see next section). At architectural level, this relationship is one the main topics of the actions of the Consorcio, especially in the frame of the EFFESUS (Energy efficiency in historic centres) European programme which deals with that topic. The study of Liñares (2012) about the refurbishment of Santiago's historic housing also deals with this topic, describing how the dwellings' evolution and architectural transformation led to the densification of the building block.

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This has produced a negative impact on the energy efficiency of the urban fabric of the historic centre. "Due to the poor solar access of the houses in Santiago, solar gains are minimal compared to heat losses, and so the balance of the building relies upon thermal resistance and airtightness. In spite of the cloudy climate, bigger solar gains may effectively contribute to raise the energy efficiency of the building." (Liñares, 2012:23). However, the execution of the necessary renewal to improve the dwellings' technical standards, is many times complicated by the regulations of the Special Plan, what increases the costs of the works. There are, however, examples of energy efficiency interventions carried out in important buildings of the historic core, realised by private institutions, with support of the Consorcio and the council.

Summarizing, the aspects in which local policy most directly contributes to the 2020 objectives are the following:

- Contribution to diminishing of CO_2 emissions through traffic plans;
- Improvement of energy efficiency of municipal buildings; and
- Efforts towards sustainable management of municipal services such as energy (public lightning) and water services.

6. Management of urban planning and energy today

To answer how is the current situation of energy planning in Santiago de Compostela, this section presents the important urban planning documents that have a strong relation with the structural aspects of energy efficiency. However, it should be remarked that energy planning is mostly done at the state and autonomous community level, so there are no specific projects for the promotion of energy efficiency at the local level. From these documents, the one which has a more direct relationship with energy efficiency issues is the Plan de Movilidad Urbana Sostenible (PMUS) (Sustainable Urban Mobility Plan) of Santiago de Compostela.

6.1 Previous Plan Xeral de Ordenacion Municipal (PXOM)(1989)

Considering the depopulation of the historic centre as one of the most significant problems of Santiago de Compostela, the city formulated a new General Plan of Urban Development in 1989. This important plan promoted a compact urban growth and continuity of the urban fabric, and had a strict and orderly policy for new urban developments (Soto, 2014). The structural plan (see Figure 6.1) proposed infill housing in existing areas at the south west of the city (in red), and a large development, As Fontiñas, at the north east of the city, which would be developed between 1995 and 2006. For the first time, ring roads and mobility studies according to the modes of transportation were included in a General Plan (Oreiro, 2014). The plan also proposed a large area at the north east periphery of the city, reserved for the Industrial Park. This structural plan has strongly shaped Santiago's current urban structure.

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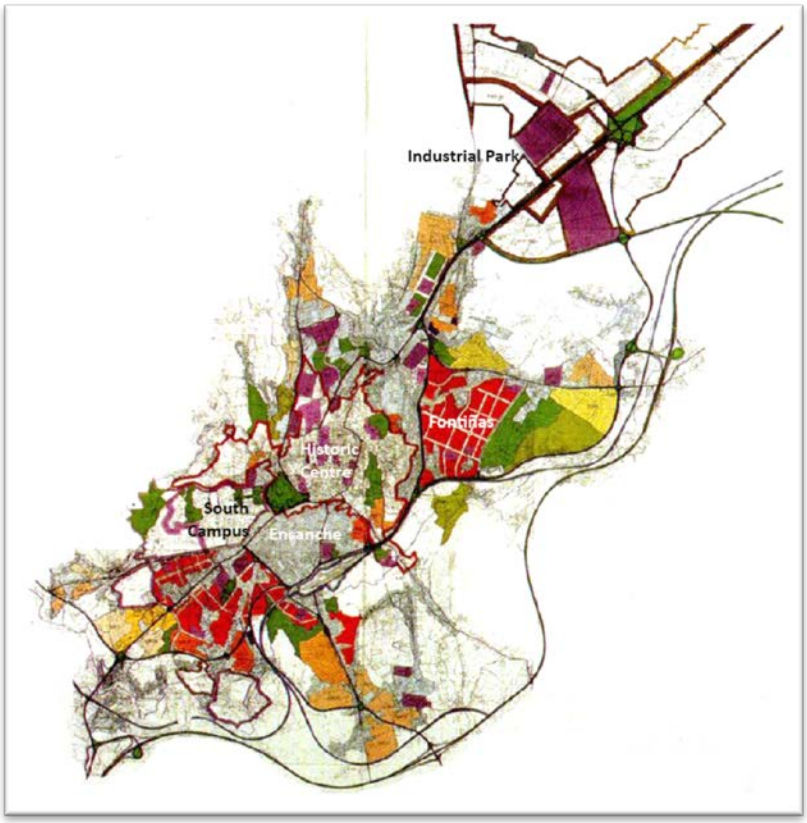

Figure 6.1 General Plan of Urban Development of 1989 (Source: Oreiro, 2014)

The 1989 general plan also extended Santiago's historic area from the 29,5 Ha. into 175,56 Ha. to include the Buffer Zone defined in the 1940 Plan (the extended historic area limits are shown in Figure 6.1 in a red line). For this area, the same team of planners formulated and initiated the 'Special Plan for the protection and rehabilitation of the historical city of Santiago de Compostela' (only approved in 1997), whose main provisions are illustrated in Figure 6.2. The Special Plan's specific regulations specifies materials, volumes, colours and general preservation of old buildings. Its main priority was to promote the renewal of the buildings of the extended historic area (Oreiro, 2014).

The regulations of this Special Plan still apply today. However, the council of Santiago initiated in September 2013 the process to contract the preparation of the revision of this Special Plan. In November 2014, the Xunta adjudicated the project to the firm THUBAN ESTUDIO, SL. Among the issues that the revision should address are a Management Plan, a list of urban regeneration projects, and the preparation of ordinances and guidelines for the urbanisation and re-urbanisation of the historic city (Concello de Santiago, 2013)

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Figure 6.2 Special Plan for the Protection and Rehabilitation of the (extended) historic area of Santiago, approved in 1997 (Source: Liñares, 2012).

Both the General and the Special Plan had as objectives: (1) to promote the residential use of the historic centre; (2) to improve the pedestrian infrastructure, meeting places, and links between different parts of the city, eliminating vehicular traffic; and (3) to create green corridors in the historical city linking parks with rural landscape (UN-Habitat, 1996). The implementation of the measures of the Special Plan had such an important role in improving the urban quality of the historic centre, that the European Commission and the European Council of Town Planners awarded the 1997-98 European Town Planning Prize to the Special Plan in the category Local planning.

At national level, important economic transformations were happening in the 1990s. Spain was beginning a long cycle of economic growth in the context of economic liberalisation and privatisation processes. During the 1996-2007 period, economic growth was mainly based on the expansion of the financial and construction sectors, which led to unprecedented levels of new residential developments. To make this possible, local governments received great freedom to allow the expansion of new developments, for which they got vast cash flows from developers in return. To profit from these financial opportunities, Santiago's bordering municipalities began to offer land for new residential developments. This process especially occurred at the south west of Santiago – in the neighbouring municipalities Teo, Ames and Brion – which thanks to their good road connections to Santiago, released low-cost land at the bordering areas (Soto, 2014). Due to the lower prices, these new developments were convenient to middle-income households and young people, who moved out of Santiago to commute every day with the car. In such way, Santiago began to function as a metropolitan area.

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6.2 Current Plan Xeral de Ordenacion Municipal (PXOM)(2008)

The current PXOM of Santiago was formulated during the 2000 decade, the years of Spanish economic bonanza and the construction boom. However, there were long planning delays for its approval by the regional parliament, a typical feature of the Galician planning context (Soto, 2014). The PXOM was finally approved in 2007, and its revision was approved in October 2008. By that time, the area of Santiago's urban fabric had extended almost threefold, from 1360 Ha. in 1989 up to 3900 Ha. in 2008.

The objectives of the PXOM of Santiago de Compostela (Concello de Santiago de Compostela, 2008), currently valid, are:

- To consolidate an established housing policy
- To anticipate a wide supply of land for businesses and activities
- To integrate and complement the planned road infrastructures, connecting them with European networks and of access to the city
- to consolidate the continuous urban growth of the city
- to establish land reserves for implementing major urban functions
- to achieve the full recovery of the World Heritage-historic centre and to increase the value of the heritage buildings of the municipality
- to consolidate the environmental systems surrounding the city
- to boost the system of territorial villages. To consolidate the planned and emergent development corridors. To reinforce the rural villages with residential settlements and provide urban services.
- to deepen the sustainability criteria in the municipal spatial planning. To promote the implementation of Agenda 21 issues
- to insert local urban planning into the relationships with the urban centre, the Region and the Metropolitan Region of Santiago

Despite the mentioned objective of consolidating a continuous urban growth of the city, city officials claim that this plan has embraced a completely different concept than the previous compact urban tissue concept (Soto, 2014). By the time the plan was approved, however, the construction bubble had already exploded in Spain, so most of the plan's specific proposals were not realistic in the new context. In terms of environmental sustainability the PXOM is very weak, and it does not mention concepts of climate change, renewable energy or energy efficiency.

Figure 6.3 shows the structural scheme of Santiago in the General Plan, illustrating the compact consolidated city, the radial expansions, and the many small villages (núcleos rurales) spread over the rest of the territory.

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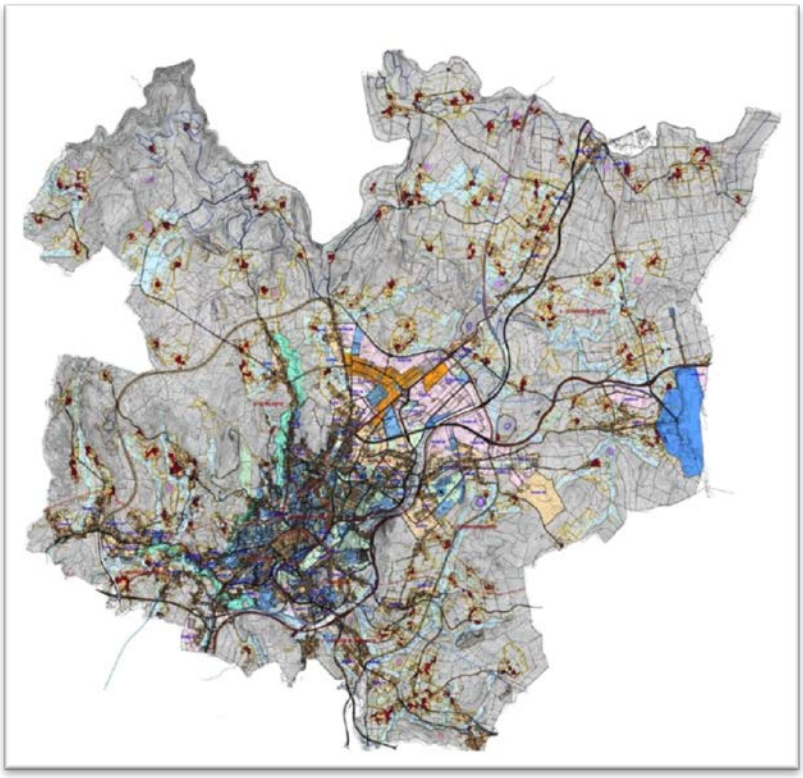

Figure 6.3 General Plan of Urban Development (PXOM) of Santiago de Compostela in 2008 (Source: Oreiro, 2014)

As previously mentioned energy efficiency was not such a significant consideration during the period of elaboration of the PXOM. Consequently, it does not contemplate the promotion of energy efficiency in terms of building orientation; proportion of green areas; densities; dispersion; concentration; proportion of people living close to high-quality transit; position in regional urban system; and many other urban features related to energy efficiency. On the contrary, the last PXOM incorporated an expansionist type of urban growth, overturning previous compact city considerations. Expansionists notions are not any more popular among planners at present, but there are no immediate plans to produce a new PXOM. The energy-related limitations of the PXOM will be overcome by the new Master Plan for Energy Efficiency and Sustainability that is in the preparations phase (see previous section).

There have been, however, indirect initiatives to promote energy efficiency at local level. The most important is SmartIAGO, which profiles itself as the first integral SmartCity project for a World Heritage city at European level. This project, still looking for funding, will have sustainability as principle of the interventions to be implemented. SmartIAGO has four main objectives, from which the first one is the most related to energy efficiency:

1. Sustainable and intelligent mobility, which implies ensuring that the transport systems meet the economic, social and environmental needs, while minimizing adverse impacts. The actions in this objective include:
   - Intelligent Distribution Centre, for the distribution of goods in the historic center
   - Intelligent Traffic Management Systems, with dynamic traffic light network, automatic access and monitoring within the Historic Area

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- Intelligent Parking Management

2. SmartIAGO Citizenship, which implies connecting citizens through intelligent devices and sensors deployed to generate and consume information and innovative services to improve quality of life. The main actions include:
   - Management of Citizenship in Historic Downtown, Public Safety and Emergency, Emergency Coordination and Mobility Center.
   - Intelligent Urban Waste Management and Awareness in Intelligent Urban Waste Management.

3. SmartIAGO environment, which involves the development/improvement of infrastructure. The actions for this include:
   - (ICT) Infrastructure connection and mapping of the underground urban networks in the historic centre.
   - Heritage Conservation historical centre.
   - Revitalization of Historic Centre - SMART District, including new lifestyles in the Historic Centre (Historic Center SMART_District).

4. SmartIAGO Government, which refers to efficient public services with a continuous improvement of services and interactions with citizens through continuous innovation and a democratic community leadership. This would include:
   - Comprehensive Information Management and Services in the Historic Centre
   - Integrated Services with citizens and the business sector, in the form of a platform to offer services to citizens and businesses.

6.3 The mobility situation and plans in Santiago

These two types of expansion have evidently increased mobility and the number of trips to and from Santiago. Both Santiago and Galician population have a very high rate of private car ownership, that has been gradually growing, up to the situation in which almost one in two persons own a car. Car ownership has grown much faster than population growth, especially in Galicia and Santiago. Figure 6.4 shows the evolution of this rate since 1998 in Santiago, its metropolitan area and Galicia. Car ownership is, however, somewhat lower in the metropolitan area. Ames, the fastest growing municipality has the lower car ownership rate: 396 cars per 1000 inhabitants. This apparent contradiction is explained by the lower income of households living there.

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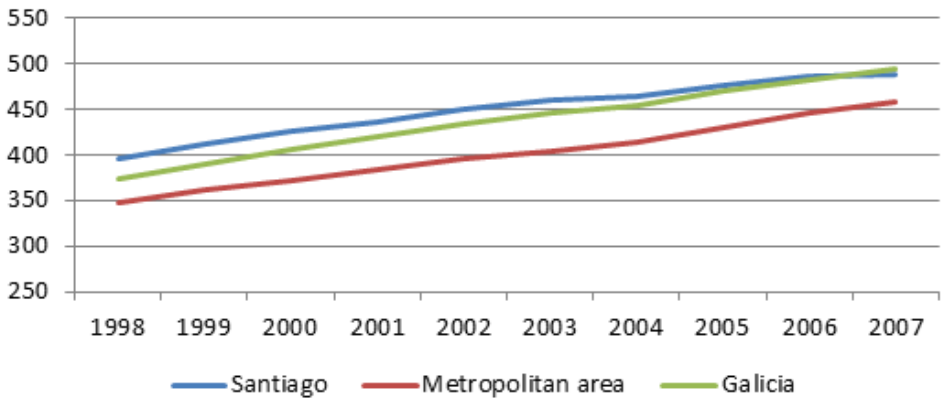

Figure 6.4 Evolution of motorization rate in Santiago, its metropolitan area and Galicia, in number of cars per 1000 inhabitants (Data from Xunta de Galicia, 2012).

Metropolitan expansion and the high rate of car ownership have led to a high number of commuting trips to Santiago de Compostela, where the job market is located. But only a small fraction of the daily trips from other municipalities to and from Santiago are done by public transportation, as Figure 6.5 shows.

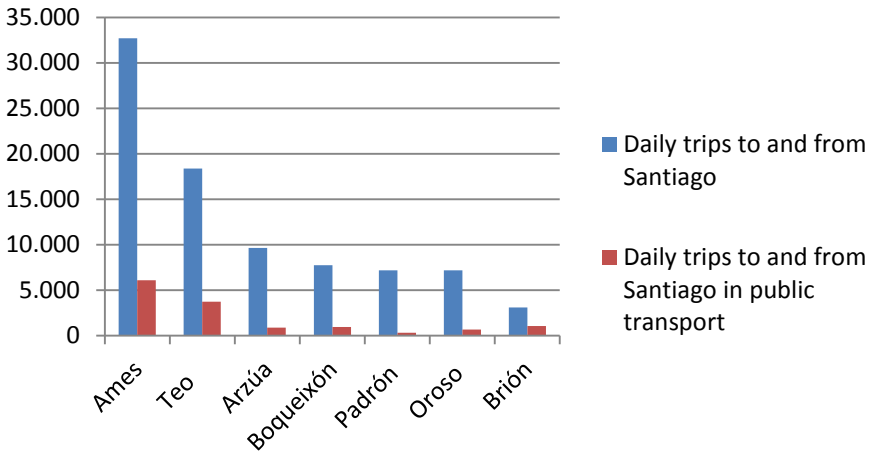

Figure 6.5 Daily commuting to and from Santiago, in total and in public transportation (Data from Xunta de Galicia, 2012).

Figure 6.6 shows the strong direction of daily commuting towards the municipalities located at the southwest of Santiago, but also the presence of longer commuting trips coming and going to municipalities not in the immediate surroundings of Santiago. This is because Santiago's role as the capital of Galicia produces a high flow of commuters not only coming from its metropolitan surroundings but also from the rest of Galicia. The AP-9 road is the main corridor by which faraway commuters access to capital, with about 87,000 daily trips (see figure 6.7).

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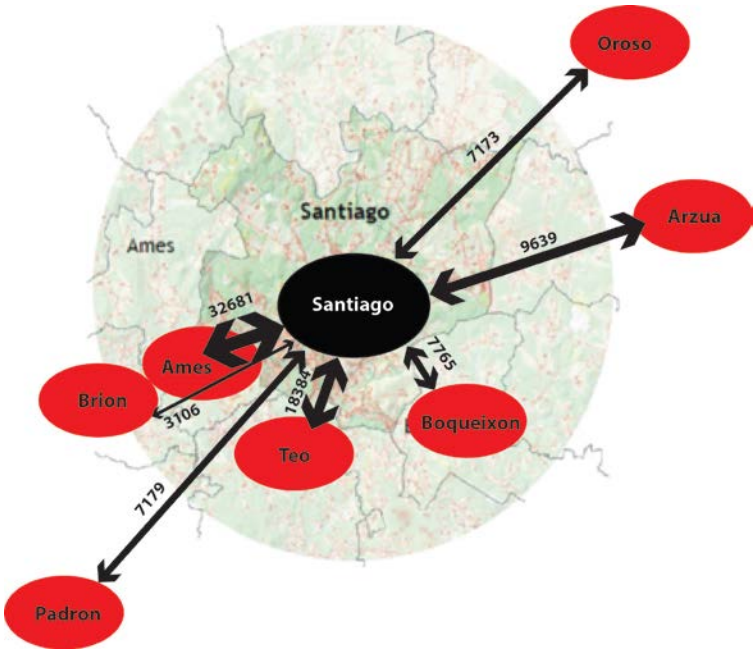

Figure 6.6 Daily commuting to and from Santiago (Own elaboration with data from Xunta de Galicia, 2012).

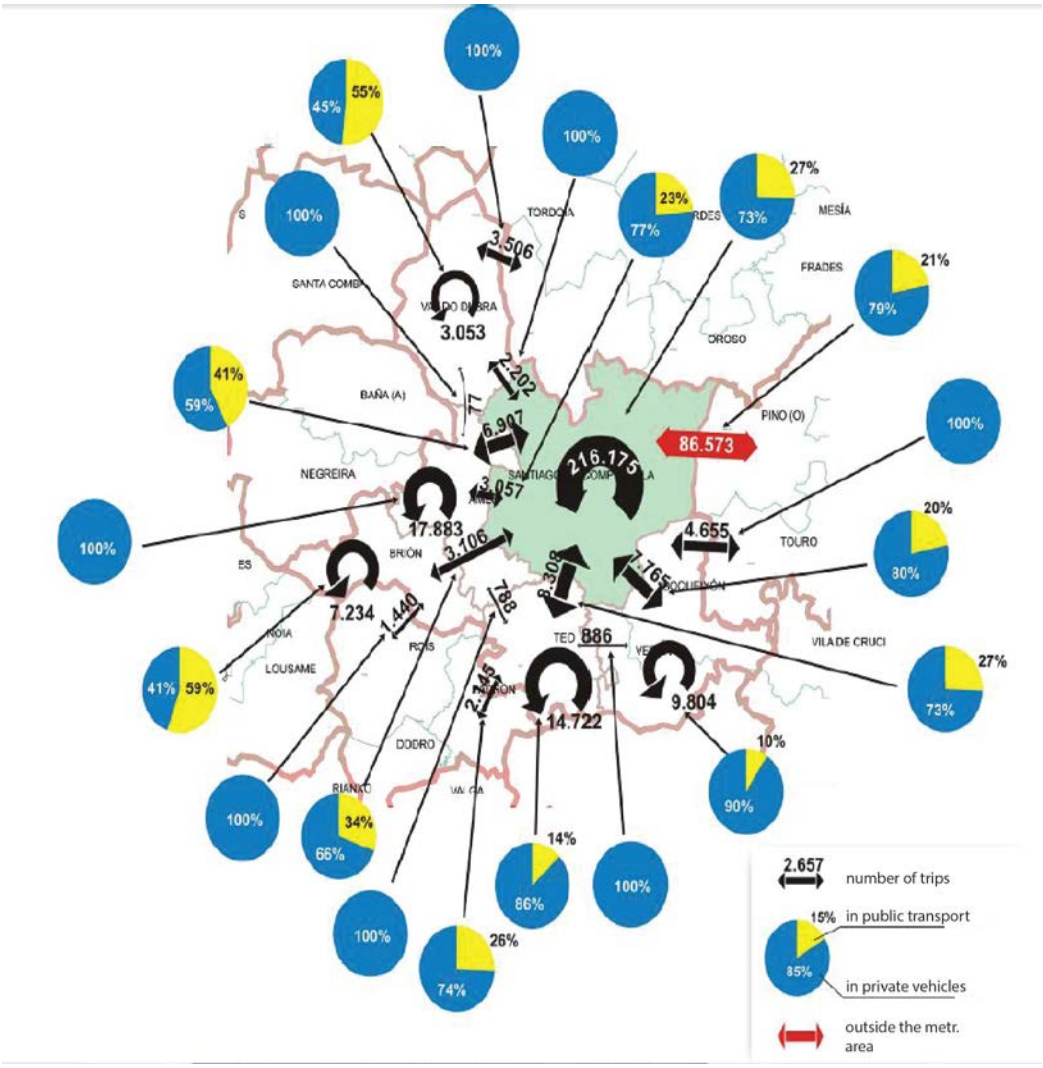

Figure 6.7 Number of trips on weekdays to and from Santiago (Xunta de Galicia, 2012)

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All this has evidently increased traffic congestion, especially at peak hours. Figure 6.8 illustrates traffic intensity during an average day, when in some parts of the city, an average of more than 25,000 vehicles pass per day (in purple). Table 6.1 shows the daily number of trips in Santiago de Compostela and in its metropolitan area, revealing the great proportion of trips in private vehicles.

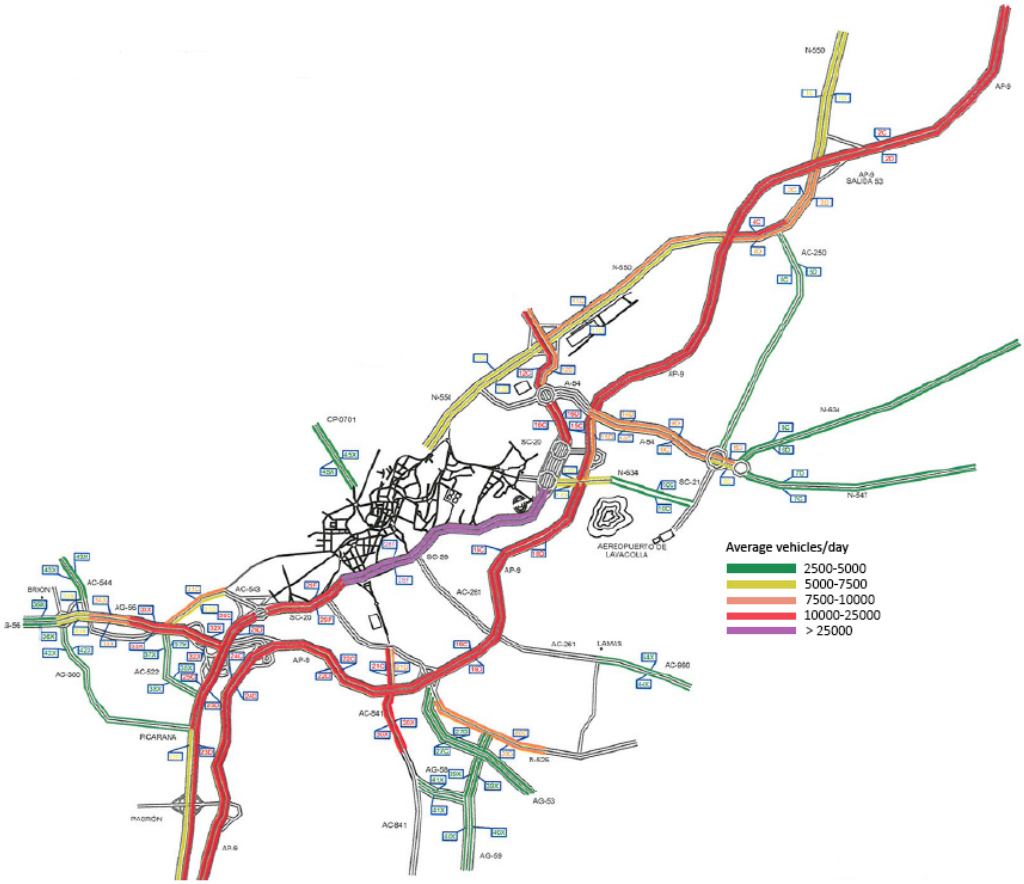

Figure 6.8 Traffic intensity in a week day in Santiago (Xunta de Galicia, 2012)

Table 6.1 Total number of trips in Santiago and its metropolitan area (Concello de Santiago, 2011)

	Metropolitan area			Santiago de Compostela		
Indicator	**Trips/day**	**%**	**Mobility ratio/inh.**	**Trips/day**	**%**	**Mobility ratio/inh.**
Total trips	385.184		2,50	253.909		2,67
Trips in motorized vehicles	248.137	64,42%	1,61	138.346	54,49%	1,45
Trips without motorized vehicles	137.047	35,58%	0,89	115.562	45,51%	1,22
Trips in private vehicles	206.088	53,50%	1,34	107.812	42,46%	1,13
Trips in public transport	42.049	10,92%	0,27	30.534	12,03%	0,32
Trips on foot	135.515	35,18%	0,88	114.414	45,06%	1,20
Trips on bicycle	1.532	0,40%	0,01	1.148	0,45%	0,01

Railroad network

The railroad connects the main Galician cities and connects Galicia with the rest of Spain and Portugal, but due to the eccentric location of Galicia, there are no direct connections

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to Madrid or Lisbon. There is an investment plan to connect Galician cities with the high-speed rail network to get to Madrid in a maximum time of 3 hours.

There are no train services to destinations close to the city of Santiago de Compostela. But there are two regional lines linking the city of Santiago: (a) A Coruña - Santiago - Vigo, with a frequency of 16 trains per day; and (b) Santiago - Ourense - Puebla de Sanabria, with one train per day. The mobility of medium and short-haul rail is practically nonexistent, due to both the short supply as the low potential demand due to the dispersion of the population and the absence of high density corridors. Figure 6.9 shows RENFE rail network deployment in Galicia, and the location of Santiago within the network.

Figure 6.9 Renfe network in Galicia (Xunta de Galicia, 2012)

Bus transport network

Santiago counts with a municipal enterprise (TUSSA) which maintains an urban transportation system, whose trajectories are shown in Figure 6.10 is the municipal company responsible of public transport within Santiago. It has 22 lines, with frequencies between 20 and 60 minutes, including some special lines at lower frequencies (2-3 and even 1 bus/day). The bus network is organised around the ring of the historic centre, which they border but not enter, and in particular its south-east stretch, where most lines separate following the main roads with a southwest and northeast direction. The lines with the higher frequency pass through El Ensanche, the most dense and lively area of the city. There are also lines that take to the campus north and south, to the most distant points such as the provincial and academic hospitals, to Fontiñas and to the City of Culture. By contrast, in the peripheral areas, public transport supply is weak.

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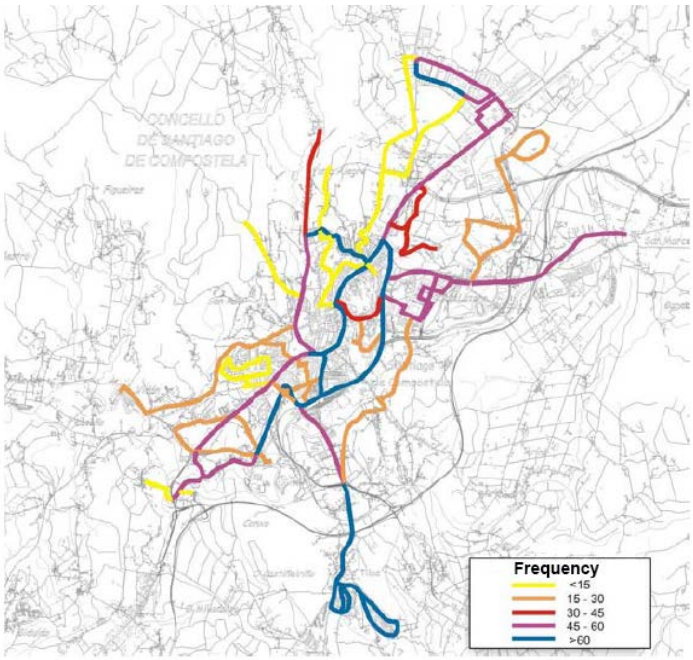

Figure 6.10 Urban transport lines in Santiago de Compostela and their frequency (Xunta de Galicia, 2012)

Demand for public transport at metropolitan level

Santiago area concentrates a large amount of metropolitan population, especially in its south and west area, as their corridors concentrate most commuters routes numbers per year: just over a million in the corridor of the AC-543, and 1.8 million in the N-550 South corridor that leads to O Milladoiro (Ames). The south and southeast corridors linking Santiago with Vigo and Ourense have more than 400,000 commuters per year. The north corridor has fewer environmental demands, under to 100,000 passengers per year. Figure 6.11 shows the public transport demands in the different corridors.

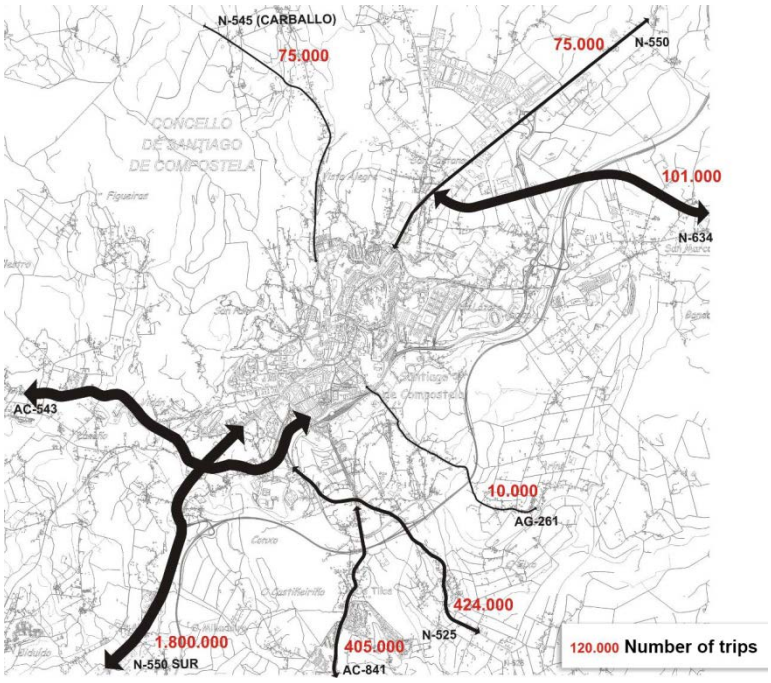

Figure 6.11 Public transport demands in the main highway corridors (Xunta de Galicia, 2012)

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The Galician and local governments have joined forces to improve Santiago's mobility situation at local and regional level. The plans prepared for that are described in the following subsections.

Plan de Movilidad Urbana Sostenible (PMUS)

The PMUS of Santiago de Compostela is a project for Sustainable Urban Mobility elaborated by the Council of Santiago in collaboration with the Xunta de Galicia and INEGA. PMUS was done after a long process of surveys and consultation to the population. The final proposal was presented in 2011. It is intended as a tool to improve the quality of life of citizens through the improvement in transportation and metropolitan mobility. The PMUS envisages "hard" and "soft" measures. The hard measures are infrastructural projects, while the soft measures refer to the management of mobility, such as the promotion of sustainable transport, changing commuters' attitudes, information, communication, services coordination, regulations, etc. which are often key to enhance the effectiveness of hard infrastructure measures.

PMUS' main objective is to achieve a change in the patterns of mobility of citizens towards a more sustainable mobility, in order to get a more balanced system, with a lower participation of private vehicles and an increased role of public transport and soft mobility modes (walking and cycling). PMUS involves the following sustainability aspects:

- Environmental Sustainability: Reducing energy consumption; reducing CO_2 emissions; reducing noise pollution; reducing land consumption; etc.
- Social Sustainability: Equal opportunities for all citizens and all modes of transport; creating a liveable, walkable and friendly city; universal accessibility; ensuring road safety in the city; etc.
- Economic sustainability: A system that minimizes the costs for administration and citizens; improving citizens' travel times; and reducing the associated administration costs.
- Technical Sustainability: A system adapted to the real mobility needs of the different social groups in Santiago de Compostela. For example, captive users of public transport, cyclists, residents, students, seniors, young people, etc.

PMUS has established six intervention programmes for the achievement of its goals:

- Planning for sustainable mobility
- Improvement of the use of public transport
- Ordering of traffic and circulation
- Programme of urbanistic integration
- Programme of parking improvement (Plan Sectorial de Aparcamientos)
- Improvement of pedestrian and bicycle circulation

Within the framework of the intervention programmes, the Plan Sectorial de Aparcamientos (Xunta de Galicia, 2012) and the bicycle plans are salient. The former complemented the urban transport system with two border parking garages, Santa Marta, at the south of the city centre and Salgueiriños, at the south, close to the main transport lines and access roads to the city and with a service of buses to transport people to the centre (see Figure 6.12). Tussa, the municipal transport agency claims that they offer comfortable parking spaces at reduced tariffs and good connections with public transport. However, city officials have remarked despite the small fee (initially

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one euro per day and later free) this initiative did not succeed, because people prefer to use their cars up to their immediate destination. Instead of using the border parking garages, people park their cars in the street (two hours for one euro), or use the more expensive private parking garages (Suárez, 2014).

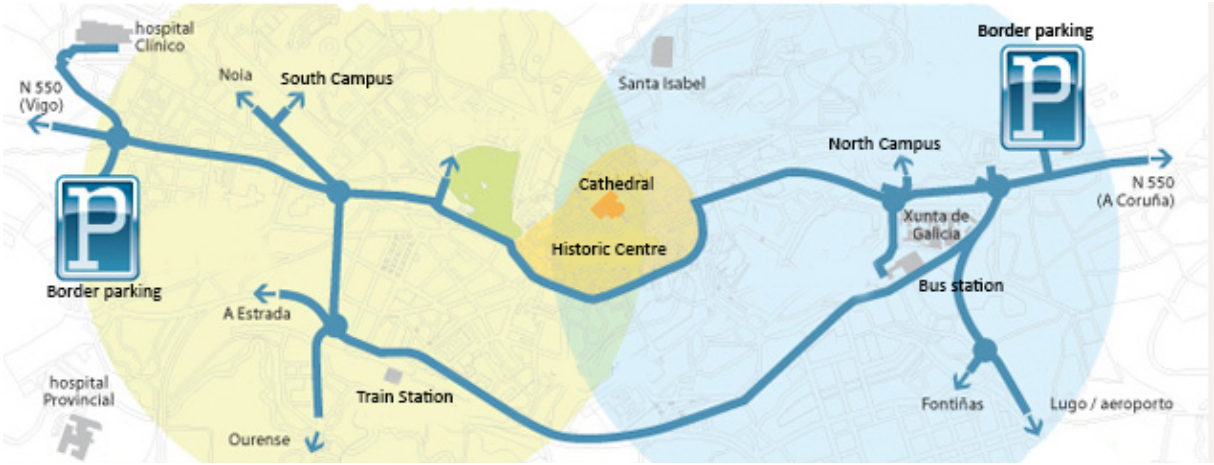

Figure 6.12 Border parking garages in Santiago (www.tussa.org)

The other important initiative is "Combici", for public bicycles. TUSSA, the municipal company responsible for public transport organised a bicycle service with 100 bicycles. Registered users could make use of the service, which had nine stations covering mainly the historic centre, the university campuses, and the east area of the city (see Figure 6.13). However, the initiative did not prosper. Several arguments have been mentioned as probable cause: the lack of bicycle lanes make it dangerous to use the bicycles; it rains so frequently in Galicia that it is not comfortable to ride a bike; the city is not flat; car drivers do not respect cyclists, so it becomes dangerous; and probably most of all, people are used to use their own car even for short trajectories (Suárez, 2014).

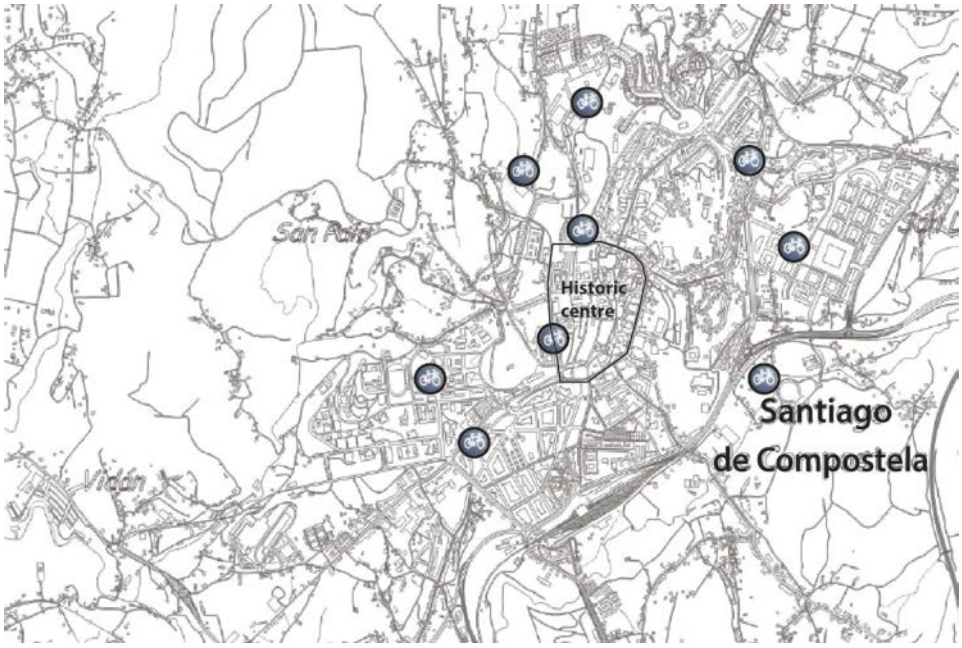

Figure 6.13 Location of the nine bicycle stations in Santiago (Xunta de Galicia, 2012)

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Plan de Transporte Metropolitano de Santiago de Compostela

The Metropolitan Transport Plan of Santiago de Compostela was elaborated by the Metropolitan Transportation Commission of the Xunta de Galicia and approved in 2010. The Transport Plan includes the municipalities of Ames, Boqueixón, Brion, Santiago, Oros, Teo, Valle del Dubra and Vedra, and the recently added Pendiente, Taurus and Dash. The population served by this plan is 178,000 inhabitants.

The plan contemplates 16 new lines in Santiago metropolitan area, an increase of 10% of the previous, to achieve a total of 177 lines. This was the result of negotiations between the Department of Environment, Planning and Infrastructure of Galicia with the involved municipalities. One of the challenges of the Metropolitan Transportation Commission was to integrate the metropolitan transport network with the public transport services in the city of Santiago. The opening of these 16 new bus routes is precisely an attempt to improve the connection with the neighbouring municipalities with the city of Santiago.

The Santiago Metropolitan transport Plan expects to get 14.4 million annual passenger trips using the public transport system in 2015. Without the interventions, the number of estimated trips in the public transport system would be about 8.3 million trips. The expectation is a very high increase of the use of public transport -- reducing car use up to 2000 vehicles per day -- which, in the context of the car use preference of the population of Santiago, seems little realistic. The plan also contemplates the introduction of an integrated metropolitan card (TMG) that would give the right to freely connect with other vehicles of public transport. The implementation of the Plan would cost 1.2 million euros, for which 70% is funded by the Xunta de Galicia and the rest by state level funds.

7. A good-practice of sustainable urban intervention

The previous section have shown that the interventions in terms of energy efficiency mostly concern interventions carried out in important buildings of the historic area and in municipal buildings. There are few concrete cases in which energy efficiency concepts have been implemented at the scale of the urban structure. The most interesting case is the Plan de Optimización Energética (POE) (Energy-Efficiency Plan) prepared at the end of the 1990s by the Santiago de Compostela University (USC) (FuturEnergy, 2014). The POE is carried out by the Sustainable Development Office of the University, created in 2011 for this specific goal. Although the POE is elaborated by the university administration, it is conceived to be driven by the participation of the whole university community.

Its main motivation is energy and economic savings with emphasis in respect to the environment, and focusing on the use of own resources and knowledge; the development of a centralized monitoring system; and the use of cogeneration engines (Vidal and Vieites, 2014). POE works through three axis: Knowledge Generation and Environmental Education; Planning, Management and Environmental Assessment; and Dissemination, Participation and Awareness.

Since July 2013, the POE has been working under the frame of the OPERE project, joint initiative between the USC and the EnergyLab (http://www.life-opere.org). OPERE aims at introducing efficient management systems, (in thermal and electrical energy networks) in existing complexes with large energy consumption. To prove its viability, OPERE has begun the implementation of an energy management project in some of the large facilities of the USC Campus (see Figure 7.1). It is a pilot project on energy management, to provide quantitative results of reducing consumption and reducing greenhouse gas emissions associated with the implemented measures. These results may be used as a model for application in other buildings of similar characteristics at the university or other public or private institutions (FuturEnergy, 2014).

Figure 7.1 Pilot interventions of the OPERE project (Source: Vidal and Vieites, 2014:5).

The ambitions in the education field are to increase the academic curriculum and content with sustainable development issues and climate change awareness. In the field of research, to encourage alternatives to address the relationship between human activity and the environment. The expected results include 30% reduction in energy consumption; 35% reduction of the environmental impact; energy-efficient and replicable management of the system networks; and the return on investment on tested strategies and measures for energy saving and efficiency.

POE's main instruments are: selective interventions; measurements for control of emissions and energy consumption; studies and reports; and information and awareness campaigns. One of the most relevant interventions has been the implementation of district heating for the university campus. The equipment consists of cogeneration facilities for the production of electricity and heat (heating and sanitary hot water) campus in the North (0.9 MW) and South Campus (2.1 MW) (see Figure 7.2).

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Figure 7.2 District heating facility (Barral w/d:3)

Other important selective interventions of the Plan have included:

- Photovoltaic installation and shading of the Faculty of Physics building
- Photovoltaic installation for self-energy consumption of the CIQUS building
- Facility with geothermal heat pump in the new CITIUS building
- Intelligent lighting in students' residence halls
- Rationalization of schedules in buildings
- Change of fuel of university boilers
- Renewal of damaged facade of the Faculty of Law and Public Policies
- Installation of thermal solar energy in the CIQUS CIMUS building
- Shading of facade to decrease in solar radiation incident in the E.T.S.E. building
- Energy certification of all university buildings (in realization)

In terms of measurements, the USC has created a tele-control centre, which centrally manages most of the heating, air conditioning and lighting of the USC faculty buildings. This allows to monitor the evolution and to plan selective interventions in case needed. Figure 7.3 shows the evolution of energy consumption of gasoil, natural gas and electricity in the campus since 2005, while Figure 7.4 shows the evolution of heating energy efficiency.

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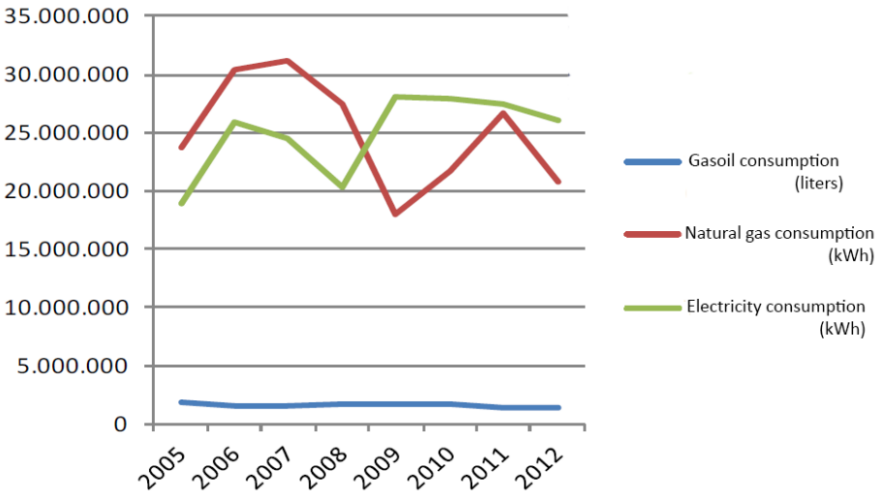

Figure 7.3 Evolution of energy consumption of gasoil, natural gas and electricity in the USC campus (Barral w/d:12)

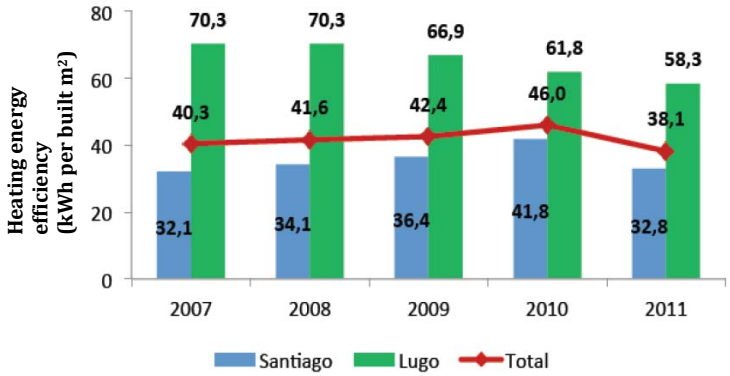

Figure 7.4 Evolution of heating energy efficiency in USC campus (Barral w/d:13)

POE has also carried out relevant studies related to energy efficiency, such as the Energy evaluation in the education centres, and a Study of light pollution at USC. There are also reports dealing with Social Responsibility and Indicators of sustainability. The USC pays great attention to the ecological footprint, an indicator of the environmental impact caused by human demand on existing resources in the planet's ecosystems, relating it to the Earth's ecological capacity to regenerate resources. It represents the area of ecologically productive land and water required to generate resources and to assimilate the wastes produced by each given population, according to their way of life, in an indefinitely way (ha/person/year). It is calculated that the ecological footprint of the USC is 0.22 ha / year / person in 2012, which represents an area of 5,170 ha / year. This is 55 times the size of the campus of Santiago plus the campus of Lugo. In this indicator, energy consumption represents the 62%. Figure 7.5 shows the proportion of the different sectors to the energy consumption in the campuses.

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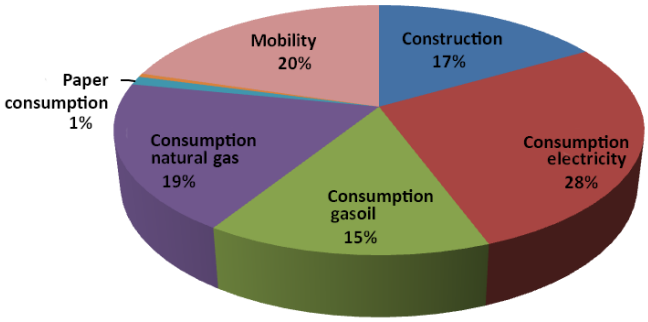

Figure 7.5 Energy consumption in the campuses of USC (Barral w/d: 17).

Regarding awareness campaigns, there are continuous activities, widely publicised in university forums and social networks, that pay attention to issues such as energy saving solutions, light pollution, site visits to technical facilities for renewable energy, training and awareness in university residences, encouraging cycling mobility, encouraging walking mobility, proximity food, and the USC in Transition Project, a participatory project for the strengthening of the university's environmental sustainability.

The milestones in 2012 have been:

- 5.1% of reduction of electric consumption (from 2010)
- 21.9 % reduction of natural gas consumption
- 8.3% reduction of CO_2 emissions associated to energy consumption
- 31.5% reduction of water consumption
- 5.2% increase of selective waste collection
- 1.4% reduction of production of dangerous waste
- Assignment of 259 bicycles to students and staff

The ambition of the USC in Transition Project is to reduce the USC ecological footprint and to mobilise the university community to be part of the transition processes. To implement it, members of the USC community self-organize into "groups in transition" to work in the implementation of activities aimed at reducing the ecological footprint of the university on various issues related to environmental sustainability. Through the implementation of participatory initiatives and environmental education, USC aims to reduce its ecological footprint, reduce its energy dependence and develop greater resilience in the context of the environmental crisis and climate change. Figure 7.6 shows the scheme of organisation of the USC in Transition project, illustrating its four work areas: food, mobility, energy consumption and social cohesion.

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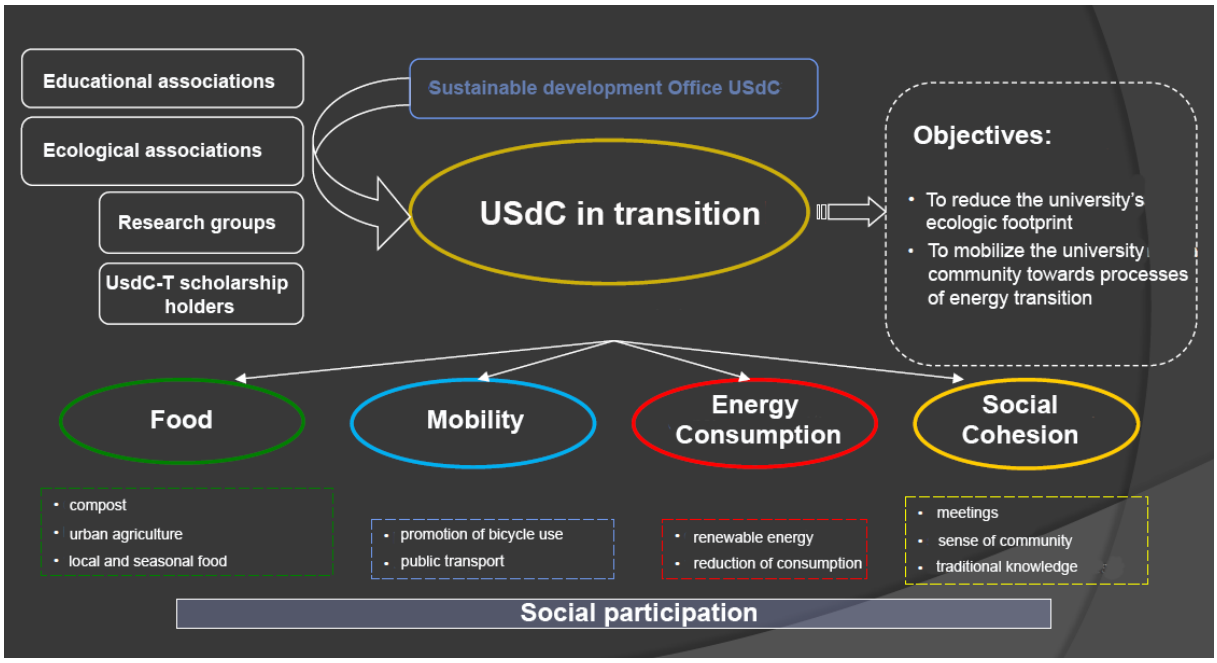

Figure 7.6 Organisation of the USC in Transition project (Barral w/d:27)

An important part of the above mentioned project is dedicated to sustainable mobility. To improve the level of sustainable mobility and encourage slow and public transport, the actions have included: a bicycle loan programme; building cycling routes around the campus of Santiago, car parking for carpool at USC; online information on urban transport in Santiago and Lugo; an annual survey of mobility behaviour at the USC; and a pedestrian map of Santiago and Lugo. The results of the last survey are shown in Figure 7.7, illustrating the high use of car mobility, especially by faculty staff.

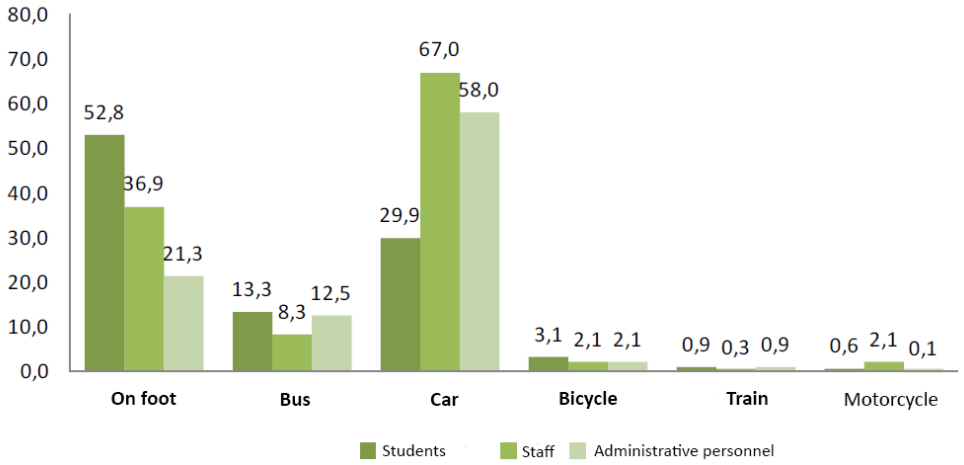

Figure 7.7 Mobility survey of USC community (Barral w/d:24)

The project envisages some possible areas for improvement such as better communication to the university community regarding the infrastructure interventions, measures for system optimization (installation of meters), improvement of energy inefficient facilities, delimitation of USC own facilities, continuation of raising awareness campaigns, and providing the university community with a set of environmental indicators including energy sustainability indicators.

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8. Summary of urban and energy planning in Santiago de Compostela

European Union's energy policies (objectives, legislation and programmes) have been a key driving force in the production of national policy on energy efficiency Spain. The main policy documents taking into account climate change issues at this level are the Spanish Strategy for Climate Change and Clean Energy (EECCEL); the Strategy for Sustainable Mobility; and the Strategy for Energy Savings and Efficiency (E4).

These documents clearly embrace the European 20-20-20 objectives by 2020: increasing to 20% the share of renewable energy, achieving a 20% saving through energy efficiency, and reducing greenhouse emissions by 20%. The development of renewable energies has been a priority for the Spanish energy policy, and made Spain become a world leader in renewable energy, but this sector has decayed since 2013. On the other hand, energy efficiency policies have been a less important concern, that has only increased in the context of an alarming increase of energy consumption and energy prices. Most of these policies have focused on energy savings in buildings (both residential and industrial) and public lighting, which account for much of the energy consumed.

The guidelines of the E4 Action Plan on Energy Efficiency essentially is carried out in Galicia through a joint management among the state administration and the Galicia Autonomous Community. The finance of projects and programmes is also shared by the Spanish state and the Galician region. The main document at regional level is the Savings and Energy Efficiency Plan 2010-2015, where the objectives in terms of energy efficiency are described, which follow almost entirely the state level plans. Its main instruments are the Action Plan for Energy Saving and Efficiency in the Galician Public Administration; and sectoral measures in the consuming sectors considered the E4 strategy: industrial, residential, public services and transport. The largest amount of energy consumption in Galicia is in the industry sector, followed by transport, and finally domestic and public services. The Galician industrial sector has a larger proportion of final energy consumption than that at Spanish level, while the domestic has much less.

Due to its planning competences, the council of Santiago de Compostela is weak in terms of energy efficiency measures. There are no key documents or specific policies on energy efficiency at local level, while the ongoing programmes and projects are decided and funded by the Xunta de Galicia and the Spanish state. The municipal actions for energy efficiency consist in the contribution to diminishing of CO_2 emissions through traffic plans; the improvement of energy efficiency of municipal buildings; and the management of municipal energy and water services with sustainable principles. The council is also trying to find funding for SmartIAGO, an Intelligent City project for Santiago, in which the interventions to be implemented will have sustainability as a principle of action. One of the objectives is to embrace sustainable and intelligent mobility, ensuring that the transport systems meet the economic, social and environmental needs, while minimizing adverse impacts.

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Santiago de Compostela's rich history and culture – and its ancient role as a destination of an important medieval pilgrimage – has clearly dominated its urban planning and development. As capital of Galicia, Santiago has profited from numerous state and regional funded projects and programmes to improve its urban features. Most of these projects and plans have as main motive the conservation and transformation of its historic centre. Santiago de Compostela has some positive characteristics that contribute to a poor awareness of energy efficiency and climate change issues among its population: a large extension of green areas, even in its historic centre, and a very compact urban fabric, while the climatic conditions are not so severe to demand great energy consumption.

The main strategic and planning documents for Santiago de Compostela are the Plan Xeral de Ordenacion Municipal (PXOM) (2008) (General Plan of Urban Development at municipal level); and the Plan de Transporte Metropolitano de Santiago de Compostela (PMUS)(Santiago de Compostela Metropolitan Transport Plan) (Concello de Santiago, 2012).

Due to cultural and historic reasons, Galician and in general Spanish urban development strives for compact and mixed-functions type of growth. This has also been the case in Santiago de Compostela, whose 1989 PXOM's structure plan strongly promoted compact and continuous urban growth, not because of energy efficiency reasons, but due to the need to revitalize the city centre. Santiago's current PXOM (2008) mentions the intention to continue with the planning guidelines introduced in the previous plan, and claims a focus on continuous, dense and compact growth. (Concello de Santiago de Compostela, 2008). However, since the plan was elaborated before the crisis, some of its previsions have become obsolete in the new economic context. The plan is also very weak in terms of environmental sustainability, and it does not even mention concepts of climate change, renewable energy or energy efficiency. These limitations of the PXOM will be overcome by the new Master Plan for Energy Efficiency and Sustainability that is in the preparations phase.

PXOM distinguishes three areas In the urban structure of Santiago: the historic city; the consolidated city, surrounding the historic city along defined boundaries; and the city in transformation, the areas next to the consolidated city, which are gradually being affected by processes of land development. The first two areas have a high-density pattern, and the historic centre is completely assigned for pedestrian use. The city in transformation has a more diffuse pattern, following important access roads. Additionally, there is an important proportion of population living in dispersed rural villages in the periphery. Figure 8.1, shows the built-up area of Santiago, in which the different zones can be distinguished. The map also illustrates the radial type of urban growth typical of the Galician territory, in which its urban fabric prolongs itself along the main roads, which can also be seen in the historic maps.

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Figure 8.1 Built up area of Santiago de Compostela (Source: Consorcio, 2014).

Santiago's recent spatial evolution can be characterised by two processes of expansion: one within Santiago municipality, not accompanied by population growth; and another of the metropolitan area, due to population growth, mainly of young middle-low income households. Most of these households commute daily to Santiago, where the jobs are located, using their own private cars, because public transport is not good enough. There is a very high rate of private car ownership in Santiago and in Galicia, which has been growing up to the situation in which almost one in two persons own a car. Metropolitan expansion and high private car ownership have evidently increased mobility and the number of trips to and from Santiago, which reaches 120,000 vehicles per day, a very high rate for a population of less than 100,000 inhabitants. This has led to traffic congestion at peak hours in three of the road accesses to the city.

Two plans related to mobility have been elaborated to improve the mobility conditions, improving public transportation. The Plan de Movilidad Urbana Sostenible (PMUS) and the Plan de Transporte Metropolitano de Santiago de Compostela have very good intentions in terms of sustainable mobility but have to begin with changing the preference of Santiago's inhabitants for the use of the car even for very short trips.

9. Perspectives for thematic report (D4.3)

Santiago de Compostela's singularity is mostly based on its location in a South European country, with very different cultural, planning and climatic circumstances than in the other five cases in PLEEC. Therefore, **Santiago has several features that can be considered as positive for energy efficiency**. It is a high-density city, with a large proportion of green areas and mixed-functions. Due to its mild climate, it has relatively high average hours of sunshine, while the domestic heating consumption is low, what translates itself into a low energy demand in the residential sector. More importantly, local planning has focused in the regeneration of its pedestrian historic core and, unlike

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most other municipalities in Spain, it has resisted the Spanish construction boom. This has led to the conservation of a compact and almost walkable city, but on the other hand, it has favoured the emergence of new dormitory areas at the municipal borders.

As Santiago has these relative advantages, **energy efficiency has not been a priority for both the society and the municipal authorities**, and is not an explicit component of local plans. The existing policies and measures for energy efficiency are mainly decided and executed at the level of the Galicia Autonomus Community. As the seat of the Galician government, and the final destination of the Way of Saint James, Santiago has widely profited from state and regional funds, agencies, policies and urban interventions. The combination and complementarity of the local special plan for the conservation and regeneration of the historic centre, and the Xacobeo regional strategy for the recovery, diversification and internationalization of the Way of Saint James, have succeeded in improving the urban quality of the historic centre, increasing the tourism towards the city and improving quality of life in the whole city.

The link conservation-energy efficiency is therefore important in Santiago. The Consorcio, a cooperation agency between the Government of Spain, the Xunta de Galicia, and the city of Santiago is partner in two European-funded projects which deal with the topic: EFFESUS (Energy efficiency in historic centres)—involved in energy efficiency mostly at building level – and FASUDIR (Friendly and Affordable Sustainable Urban Districts Retrofitting), to improve energy efficiency retrofitting interventions at district level.

Santiago de Compostela's role in energy efficiency is basically strictly following the regional policies. The council has limited power to force individual households or firms to embrace energy efficient behaviour. The city's current performance in energy efficiency issues are mainly limited to try to perform an exemplary role by making its own buildings energy efficient and, in as much as possible, to gradually make sustainable adaptations in the contracts of the public services it has to deliver to citizens (public lightning, waste collection, etc.). There have been regional and local plans to reduce energy consumption in public transport, which is still inefficient despite several interventions to try to increase its use and make mobility more sustainable. The failure of these plans and measures suggest that behaviour plays an important role.

The main issues constraining Santiago council to deliver joined up energy efficiency measures are the features of its planning system and planning tradition, based on building codes and rigid plans, with slow procedures**.** This includes the council's weakness and limited legal competence as a body able to deliver measures outside the ones contemplated in the local General Plan (Plan Xeral de Ordenacion Municipal, PXOM). The city may pass ordinances, but these do not have the power of law as the General Plans, which have to be approved by the regional government (Xunta) in order to be implemented.

In Galicia, and in general in Spain, planning procedures are extremely slow. A plan takes as much as ten years to be approved by the Xunta. In the meanwhile, the situation in the city has greatly evolved and the plans are unable to adapt to the changing urban reality. This is the main reason why there are no locally designed energy efficiency measures in the current planning context of Santiago de Compostela, whose last General Plan was

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elaborated during the years of the Spanish economic boom of the 2000s and approved at the beginning of the economic crisis in 2008. Energy efficiency was then not a significant consideration in the future of the city.

Summarizing, Santiago de Compostela's performance in terms of energy efficiency is not exceptional, due to little societal awareness of the energy transition challenges. Santiago is favoured by an alliance between the three levels of government, the Consorcio, to protect its main urban asset, its historic centre. The link conservation-energy efficiency becomes then the most relevant topic. In the context of the local climatic and urbanistic features, energy planning has not been a priority. Energy planning and policies are elaborated and implemented at State and Autonomous Community level. The planning system gives Santiago Council little legal competence to regulate energy consumption in the residential and industrial sectors, while the latter is the highest consumer. Santiago has to concentrate in the municipal consumption (buildings and services), and urban mobility, where the plan and policies have been so far, not especially successful.

10. Lessons and links to other PLEEC work packages

The most direct link to other PLEEC work packages is with WP6, regarding the development of an Action Plan for the city. In that respect, Santiago planning system has some limitations described in previous sections, which make the implementation of such an Action Plan a difficult issue.

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