Identification and mobilization of solar potentials via local strategies

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Work Package 3: Development of City Action Plans & Pilot Actions

Deliverable 6: OVERVIEW OF CURRENT CONDITIONS OF POLIS CITIES

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THE POLIS PROJECT

POLIS (*Identification and mobilization of solar potentials via local strategies*) is a European funded project under the Intelligent Energy – Europe Programme aiming at the implementation of strategic town planning and local policy measures to activate the solar ability of urban structures in European cities.

In recent years, diverse new technologies and legislative opportunities have been developed to undertake solar potential analyses and mobilize the solar potentials identified. The aim of POLIS project is to present and evaluate current developments and bring together key stakeholders of this process to improve planning and legislation practice towards a solar development, with the conviction that urban approaches are essential to enhance the integration of small-scale solar energy applications in the built environment.

With respect to the composition of buildings and urban structures the importance of solar energy is evident, since the shape of constructive structures and relevant surfaces are the basis for application of solar systems and also for receiving passive solar gains. Therefore, solar energy is more than other Renewable energy sources connected to the form, function and arrangement of buildings. To assure the ability of new structures fitting a solar energy supply, certain requirements need to be included in development planning and building legislation. In addition, also existing buildings need to be qualified for the application of solar systems: the knowledge of adequate building types and structures is therefore an essential requirement to improve strategic actions to mobilise the solar potential of existing built areas. In this respect several instruments are available to prescribe solar targets like municipal agreements, private law commitments or national building codes. The POLIS project focuses on local options regarding municipal commitments to elevated solar requirements to improve the solar qualification of new as well as of existing buildings and urban structures.

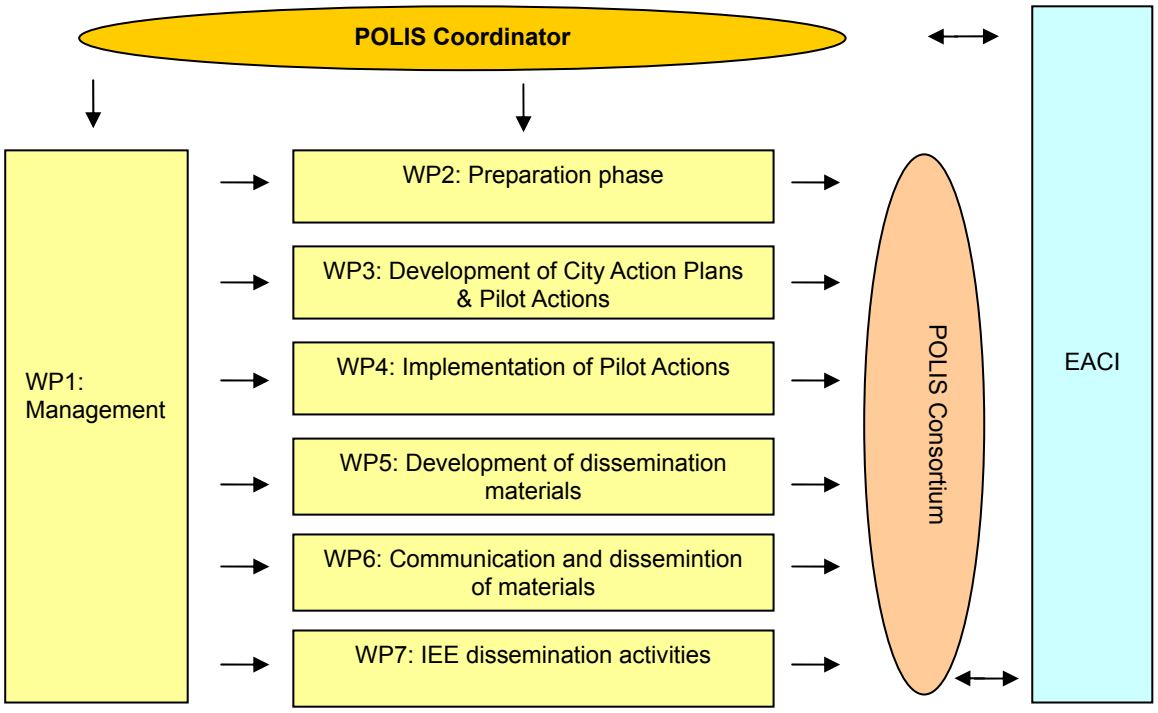
POLIS project brings together local authorities with different experiences and varying states of urban development from France, Germany, Portugal, Spain and Sweden, to share their knowledge on solar town planning and encourage further activities within the scope of an expert network for cities. Main results of the project will be:

- **Action Plans:** long-term strategic action plans to integrate solar energy at urban level embeded in overall planning strategies of POLIS participating cities: Lyon, Paris, Munich, Lisbon, Vitoria-Gasteiz and Malmö.
- **Pilot Actions:** short-term priorities to be developed in the participating cities within the project lifetime, such as identification of solar potentials, accomplishment of activities to mobilize identified potentials, development and implementation of town planning measures, financial and/or legislative measures.
- **Transfer of POLIS approach to other cities:** lessons learned and experiences from POLIS project will be described and evaluated as background for the development of planning references and legal guidelines. Together with the provision of a catalogue to promote urban planning instruments and best practices project the guidelines represent a major outcome of the project. The dissemination not only targets at the participating countries: workshops will address also other European cities, which will be supported through communication via a network for urban planners and municipal executives

The outcome of the POLIS project are expected to provide excellent circumstances for the implementation of small-scale RES in the participating cities with a roadmap for further

activities in the framework of solar developments. This will help to implement EU and national targets for renewable energies in 2020, as well as provide interested cities of all EU member states a pool of successful examples, strategies and instruments.

The structure of the project is summarised in the following diagram.



The composition of POLIS consortium guarantees an interdisciplinary approach to the work planned. Participation of local energy agencies, universities, consultancies, urban planning agencies and municipal planning departments provides a broad background of knowledge from the diverse fields of specialisation, as well as different perspectives and ways to approach the planned activities.

POLIS Consortium

Ecofys GmbH (Germany) – Project Coordinator
Climate Alliance – Klima-Bündnis (Germany) – Leader of WP5
Universidad Politécnica de Madrid (Spain) – Leader of WP3
Agence Locale de l'Energie de l'agglomération lyonnaise (France)
Agência Municipal de Energia e Ambiente de Lisboa (Portugal) – Leader of WP2
Lund University (Sweden) – Leader of WP4
City of Munich (Germany)
City of Vitoria-Gasteiz (Spain)
Atelier Parisien d'Urbanisme (France)
City of Paris (France)
Skåne Energy Agency - Solar City Malmö (Sweden)
Hespul (France)

POLIS project started in September 2009 and will run until August 2012. More information about the project can be found at: www.polis-solar.eu

EXECUTIVE SUMMARY

Within the framework of POLIS project, six European cities (Lyon and Paris in France, Munich in Germany, Lisbon in Portugal, Malmö in Sweden and Vitoria-Gasteiz in Spain) have committed on long-term strategies to integrate solar energy at urban level that are consistent with existing CO_2 mitigation targets in solar Action Plans embeded in local planning.

Although the cities are in different situations regarding solar energy so that their strategies are also different, a common objective is shared, namely, to steer the future development of solar energy with respect to urban planning by: the assessment of existing climate strategies and targets at city levels, the evaluation of solar potential in city areas, the development of solar targets and the definition of possible measures in diverse planning areas connected to general renewable energy targets.

In this report an overview of current conditions in POLIS cities is presented, in terms of urban and building structures, energy supply and consumption structure, existing solar actions and measures and urban planning practices regarding solar energy. In addition, an overview of the 19 Pilot Actions identified by the municipalities as priority measures for the long-term development of solar energy is provided. More information about the current conditions of POLIS cities and the selected Pilot Actions is available on the project web-site[1].

[1] www.polis-solar.eu (Sections: Solar urban planning in POLIS cities → Specific reports of each city; Publications → Deliverable 5: Fact sheets of Pilot Actions)

1 Introduction

Within the POLIS project, Work Package 3 deals with strategic measures of urban planning and local policies, with the aim of integrating solar energy at urban level in new and existing developments.

Particularly, each of the 6 participating cities of POLIS project (see Figure 1, Lyon and Paris in France, Munich in Germany, Lisbon in Portugal, Malmö in Sweden and Vitoria-Gasteiz in Spain) have committed on long-term strategies to integrate solar energy at urban level that are consistent with existing CO_2 mitigation targets (related to national/regional requirements or voluntary commitments, for example, the Covenant of Mayors, signed by all POLIS participating cities) in solar Action Plans embeded in local planning.

Figure 1. POLIS participating cities

In this report (section 2) an overview of current conditions in POLIS cities is described in terms of:

- Urban and building structures;
- Energy supply and consumption structure;
- Existing solar actions and measures; and
- Urban planning practices regarding solar energy.

In addition (section 3), the recommended Pilot Actions identified by the municipalities as priority measures for the long-term development of solar energy are presented.

More information about the current conditions of POLIS cities is available on the project web-site[2]. Concerning the Pilot Actions, these have been described in detail in the report "Deliverable 5: Fact sheets of Pilot Actions", also available on the project web-site[3].

[2] www.polis-solar.eu (Section: Solar urban planning in POLIS cities)
[3] (Section: Publications)

2 Overview of current conditions in POLIS cities

2.1 Lyon

Urban and building structure

In 2005, the Greater Lyon had 543,230 residential buildings: 81 % of these were collective housing, the rest is individual housing. In 2006, approximately 25% of roofs were on industrial or tertiary buildings in industrial zones (see Figures 1 and 2).

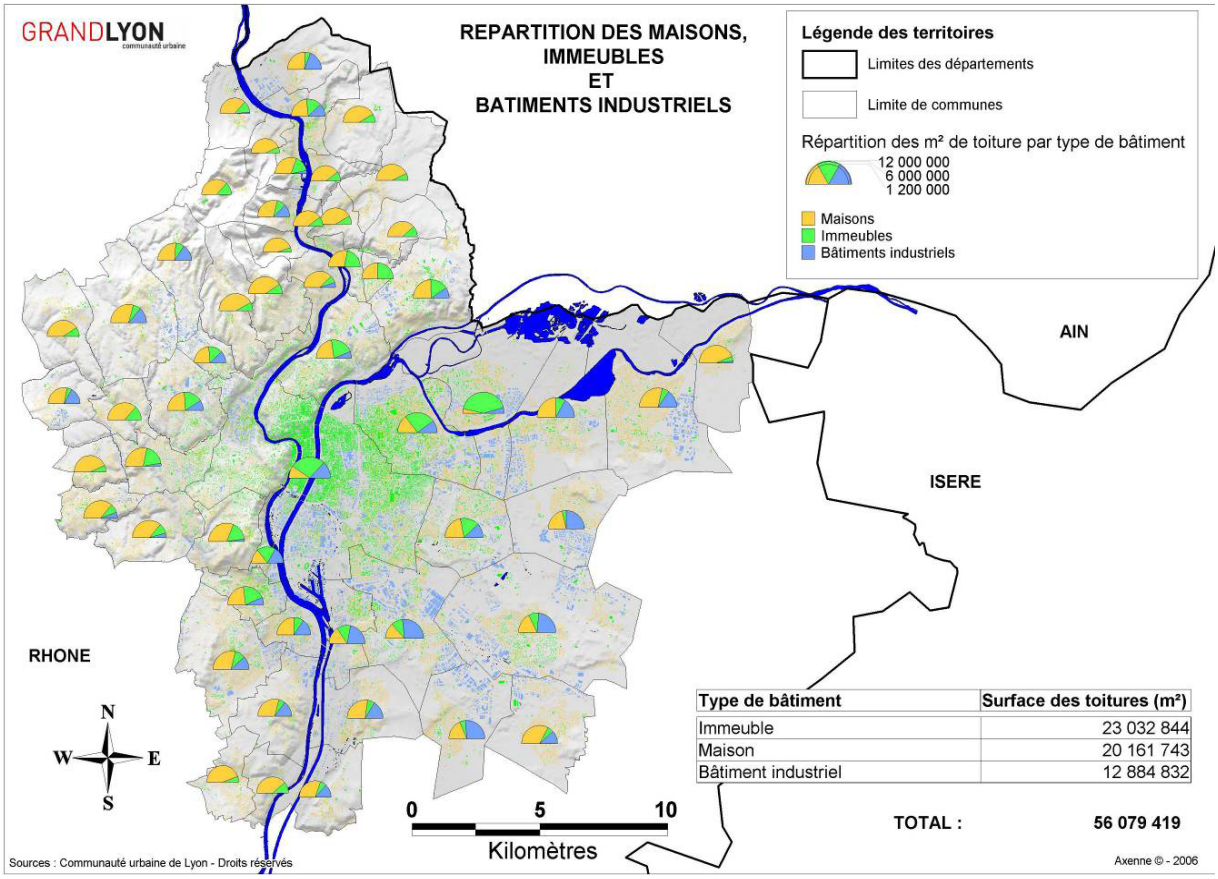


Figure 1. Distribution of buildings in the city of Lyon (source: "Diagnosis of renewable energies on Greater Lyon at the end of 2006, and study of the potential to the horizon 2020" – AXENNE)

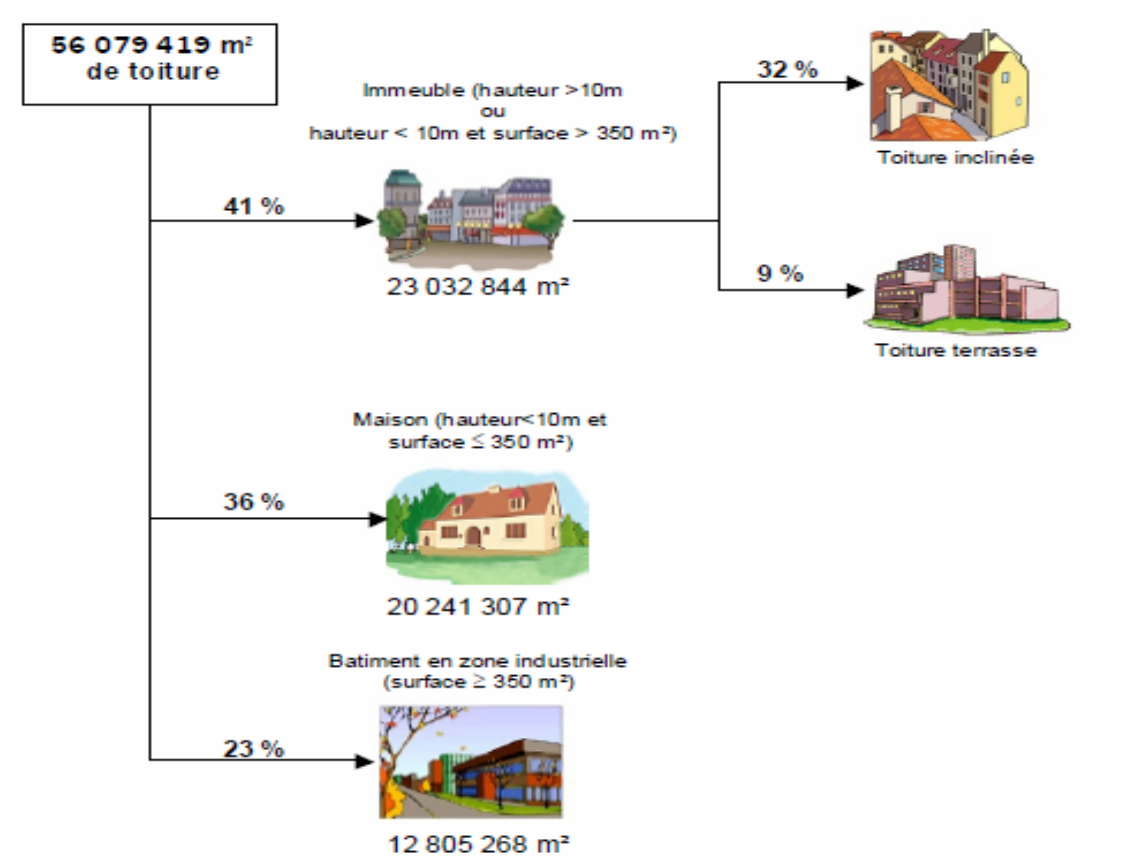


Figure 2. Roof types in the city of Lyon (source: "Diagnosis of renewable energies on Greater Lyon at the end of 2006, and study of the potential to the horizon 2020" – AXENNE)

There is a strong dynamics on the territory because about 40,000 collective housing and 8,616 houses were built in 7 years (between 1999 and 2005), which makes 7000 new housing per year. So, two aspects must be highlighted:

- The new housing represents a strong potential on which we can intervene systematically.
- The existing presents a large surface of roof to be exploited.

Energy consumption and supply structure

Electricity generation is extremely centralised in Lyon, with a well establish distribution grid in place. Five thermal energy distribution networks exist in some areas for district heating, with localised heat plants. Renewable energies correspond to 3.8 % out of Greater Lyon total energy consumption. Currently, the energy supplied by solar energy (thermal and photovoltaic) is not significant (approximately 0.01 % out of the total energy consumption).

Existing solar actions and measures and installed solar capacity

In December 2007, Grand Lyon councillors unanimously voted a Climate Action Plan through which Grand Lyon has adopted European Union goals on a local level, fixing targets for greenhouse gas reductions, reduction in energy consumption and an increase in the share of renewable energies. The Climate Action Plan specifies:

- A reduction in greenhouse gas emissions of 20% and an increase to 20% share of renewable energies within the Grand Lyon council area and own organisations by 2020 (compared to 2000).
- A reduction of 75% (= national French engagement of "Factor 4"[4]) in greenhouse gas emissions within the Grand Lyon council area and own organisations by 2050 (compared to 2000).

The Climate Action Plan is one of the main vectors for the Agenda 21. Local authorities have requested that the Action Plan be developed further to put the Grand Lyon on the track towards a "Factor 4" scenario in 2050. To reach these targets, Grand Lyon has created the Climate Action Plan Project Committee.

The specific target of 20% share of renewable energies by 2020 implies very concrete goals for solar technologies equivalent to: 560,000 m^2 of photovoltaics modules per year, and 67,000 m^2 of solar thermal collectors per year.

A series of guidelines have been put in place that must be met before the Grand Lyon will contribute financially to a specific project (subsidy or other financial assistance):

- New housing guidelines: Grand Lyon New Housing Guideline.
  Renewable and passive solar targets (mainly solar PV and thermal installations): 20% to 40% of the building consumption to be met by renewable energies and passive solar.
- New tertiary building guidelines: Grand Lyon New Tertiary Building Guideline.
  Solar targets: 0.03 m^2 of solar photovoltaic modules per m^2 SHON (Normative French unit used for the calculation of a building surface), with a minimum system size of 2kWp.

Programmes and studies have been undertaken to estimate opportunities and install solar energy facilities:

- Renewable Energy potential in the Grand Lyon area. A study has defined the development goals for different renewable energies so as to reach the 20% target in 2020. The Solar Potential study, done by the engineering office AXENNE has provided realistic knowledge about how much of the built environment is reasonably available for installing solar technologies. The surfaces available are:

Cultural and heritage constraints	Area (m2)	%
Solar energy impossible	144,038	0.3%
Solar energy difficult	11,463,221	21%
No cultural or heritage constraints	44,472,160	79%

- CONCERTO European Programme "Lyon Confluence": development of brownfield sites with ambitious targets for building energy consumption and high performance heating systems. Solar targets: 80% of energy needs to be met by renewable energies, including solar thermal and photovoltaics.

Other public and private organisations have created tools or programmes that are inline with

[4] French National scenario willing to divide by 4 the global energy consumption of the country by 2050.

the Climate Action Plan, including:

- SERL Energie: a public/private company that facilitates investments in renewable energies.
- SOLIRA: a private company developing citizen investments in photovoltaics (direct result of the European-funded project DeSolaSol).
- SOLPOOL: European programme working to provide solar energy to pools. 5% of the Grand Lyon pools now have some form of solar energy as a result of this programme.

The evolution of solar thermal and PV capacity between 2000 and 2008 is shown in the next Figures.

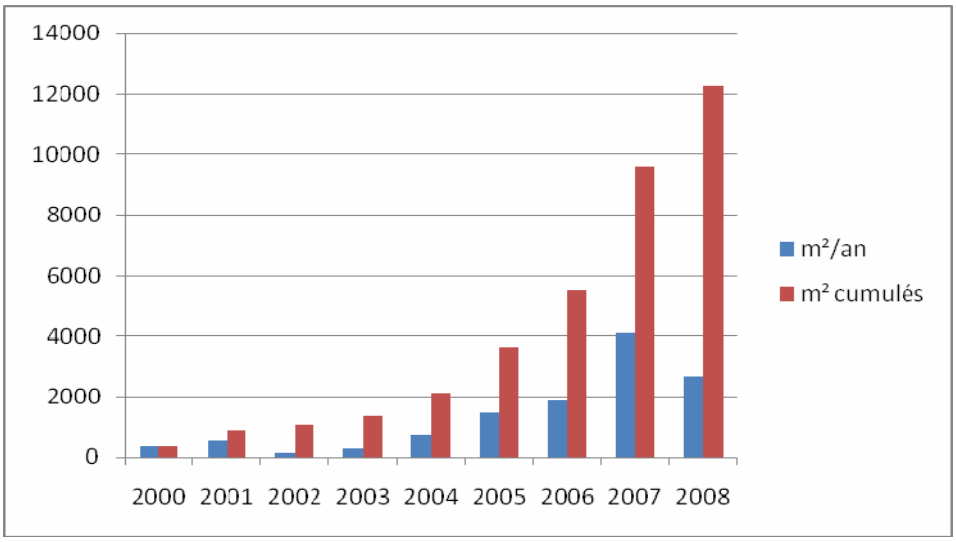


Figure 2. Solar thermal power installed in the Grand Lyon

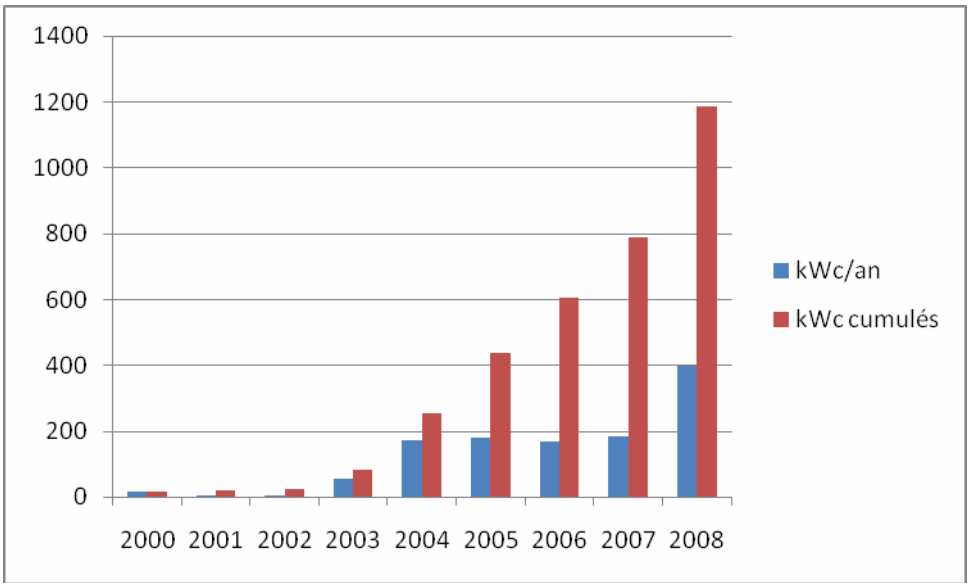


Figure 3. Solar PV power installed in the Grand Lyon

Urban planning practices regarding solar energy

It must be pointed out that local authorities in France are not empowered to make dispositions on their territory with legal binding ahead of national regulations. That's why in France, a mayor has no authority to impose a solar code or plan. Instead, he can impose urban rules for constructions (energy efficiency) applicable to projects in which the State is involved (buildings on the sessions of public land or on ZAC —urban development zones—, public housing); private operations are not required to apply those rules. It is expected that the new National Environment Law adopted in May 2010 will facilitate in the future that municipalities can incorporate solar requirements in local urban planning legal documents.

2.2 Paris

Urban and building structure

The City of Paris has around 100,000 buildings with a total surface of 120 million m^2. The building structure is summarised in the following figure.

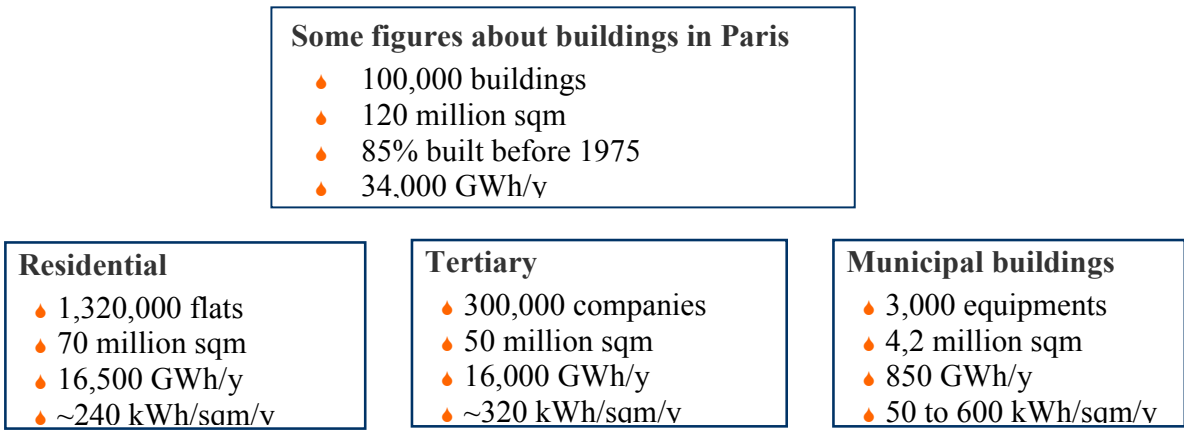


Figure 4. Information about building structure in the city of Paris

The EPICEA study (2008-2010) has developed a map of Paris using a Geographic Information System (GIS), where in each grid (250m x 250m) the height of buildings, the roof surface and roofing materials (zinc, tile, slate, flat roof) are represented, among other issues (see Figure 5). Current estimations indicate that there are around 10 million m^2 of flat roofs and more than 5 million m^2 roofs that would be available to receive solar systems (considering the obstructions). This analysis was made from flight picture of the city. A more accurate analysis about the opportunities for solar energy facilities is considered necessary, by considering additional parameters such as buildings orientation and roof tilt angle, shadows incidence, technical and architecture problems, etc.

Figure 5. Study "EPICEA" (APUR)

Energy consumption and supply structure

The energy supply structure in Paris is shown in Figure 6. The energy consumption of the City of Paris, all sectors considered, is 34,000 GWh / year.

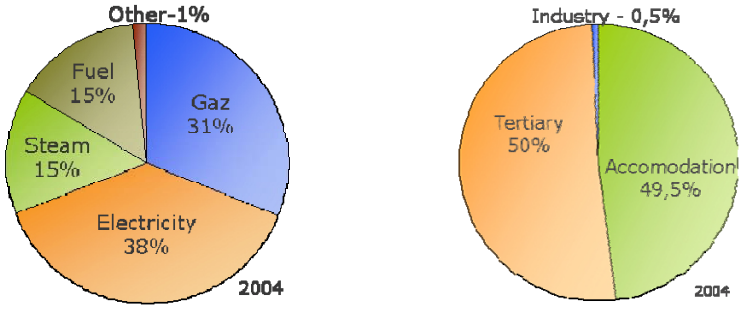


Figure 6. Paris energy mix (2004)

Two major features of Paris city are:

- Almost no industrial sector
- A large steam network (first network in Europe)

The residential and tertiary sectors divide the consumption to equal parts for 120 million sqm. The steam produced is consumed in Paris by the Compagnie Parisienne de Chauffage Urbain (CPCU) from the incineration of household waste (50%) and a complement of coal, oil or gas. The 3000 equipment of the Paris administration consume approximately 850 GWh / year. The street lighting (lights, security, streets, lights ...) consumes 150 GWh / year.

Current estimate of the share of renewable energy consumption in the Paris area is currently 6.1%. According to the current survey to establish the potential of RES for the City of Paris, solar thermal represents 0.7% of the RES production in Paris, and PV represents 0.1%.

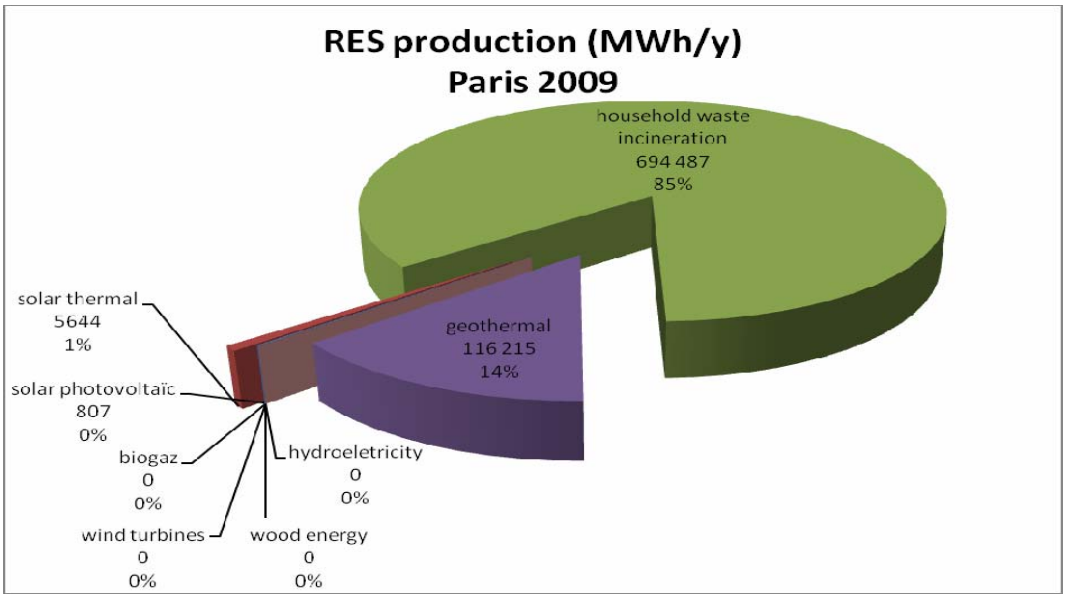


Figure 7. Renewable energies production in Paris in 2009 (sources: AXENNE)

The City of Paris is the licensing authority concerning the public distribution of energy (electricity, gas, district heating and district cooling) on its territory. The City of Paris involves energy distributors (EDF and GDF, CPCU) in the Climate Plan. Thus, all concessions contain dispositions to contribute to the objectives set by the Parisian municipality. For example, in the framework of the concession's renewal for distribution of electricity, ERDF will reduce delays in connecting electricity generators to 4 weeks, improve the overall efficiency of its network and work with the City to the development of a "smart-grid". CPCU, concessionary who handle the distribution of heat through the urban network, works to improve overall energy efficiency of its network and develops new sources of heat such as geothermal or biomass. Finally, in the areas of urban renewal, development of district heat and cold networks can offer a more energy-friendly environment.

Existing solar actions and measures and installed solar capacity

With the Climate Protection Plan the city of Paris has set ambitious goals against global warming and wants to be exemplary on it own skills. It plans to reduce global greenhouse gas emissions and energy consumption by 30% by 2020 compared to 2004. The plan also aims to reach 30% renewables in energy consumption of the municipal park.

The city has launched a major refurbishment plan of the municipal park to reach these objectives, including, the objective of 55,000 refurbished social dwellings, or 25% of the park by 2020. These renovated homes aim for a performance of 80 kWh per square metre of net floor area per year instead of 270 on current average. To achieve this goal the use of renewable energies will be essential and the sun will probably be the first option considered. The other major objective is the refurbishment of 600 schools by 2016 to reach a reduction of 30% of energy consumption for each building.

Currently, city of Paris finances a special survey to establish the installed solar capacity and the global potential of RES for the City by 2020. This survey will be available in June 2010. The first results of this study about assessment of RES in Paris in 2009 and precisely about solar energy give the following results:

Assessment of renewable energies in Paris in 2009			
solar thermal		**solar photovoltaic**	
equipments	113	equipments	33
surface (m²)	12359	surface (m²)	8113
annual production (MWh/y)	5644	annual production (MWh/y)	807
equivalent (toe/y)	485	equivalent (toe/y)	69
avoided CO2 emissions (tCO2/y)	32	avoided CO2 emissions (tCO2/y)	242
		installed power (kWp)	964

According to the same study, solar thermal installations represent 51% of the all RES equipments installed in Paris, and PV facilities 18% (see Figure 8). The city of Paris has initiated studies on the feasibility of solar installations on municipal public facilities and private domain.

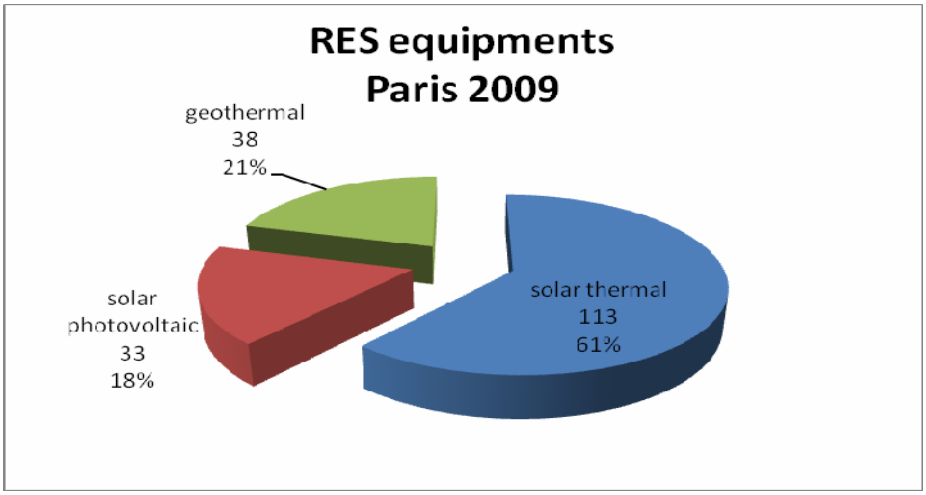


Figure 8. Renewable energy sources equipments in Paris (2009) (Sources: AXENNE)

Urban planning practices regarding solar energy

With the introduction of the Climate Plan in Paris the conception of urban planning involves taking into account the strategy "factor 4", including the 25% of energy consumption across Paris from renewables in 2020.This disposition is encouraged to private operators in terms of environmental recommendations annexed to the PLU (local urban planning plan). Thus this set of recommendations, aimed at players of the construction and management is a binding agreement for projects in which the town takes part, and is an encouragement for private operators.

Emphasis is placed on the fact that any new construction must tend towards an energy consumption of 50 kWh per square metre of net floor area per year, except technical impossibility justified by an independent engineering and design office, and any big rehabilitation must tend toward a consumption of 80 kWh per square metre of net floor area

per year, in conformity with the climate plan of Paris. In this way the set of recommendations promotes systems using renewable energy sources.

In addition to this set of recommendations, the city of Paris in collaboration with the Parisian Architecture Urbanism and Environment council (CAUE), realised several thematic sheets. One is specific to solar panels, it explains the influence of orientation and slope on performance, urban rules to respect, the principle of landscape integration, and it remains the administrative process and financial aids.

Concerning new social dwellings, new projects must use a solar production of hot water with a coverage rate of 30% minimum required, except in cases of major architectural constraints; in conformity with the climate plan of Paris.

It must be pointed out that local authorities in France are not empowered to make dispositions on their territory with legal binding ahead of national regulations. That's why in France, a mayor has no authority to impose a solar code or plan. Instead, he can impose urban rules for constructions (energy efficiency) applicable to projects in which the State is involved (buildings on the sessions of public land or on ZAC —urban development zones—, public housing); private operations are not required to apply those rules. Therefore, to achieve the energy performance levels required by the Climate Plan of Paris, building constructors can make use of renewable energies such as solar. It is expected that the new National Environment Law adopted in May 2010 will facilitate in the future that municipalities can incorporate solar requirements in local urban planning legal documents.

The texts of urban regulation are currently being amended to facilitate the accomplishment of the commitments of the Climate Plan. The modification of the PLU approved by the council in Paris on 29 and September 30, 2009 indicates that the installation of renewable energy is no more restrained by outlines of buildings, as well as insulating the exterior facades may intrude on the public domain up to 20 cm.

2.3 Munich

Urban and building structure

The urban planning department administers a database with all buildings in Munich. In general all building can be differentiated regarding age and kind of use in 62 urban types. The municipal utility also registers consumption data (gas, district heat and electricity) for each building. To generate a complete overview of the building stock, all existing data was put together. As a result 26% of all buildings are defined as before 1948, 35% in the timeframe of 1949-1968 and 39% after 1969 (see Figure 9).

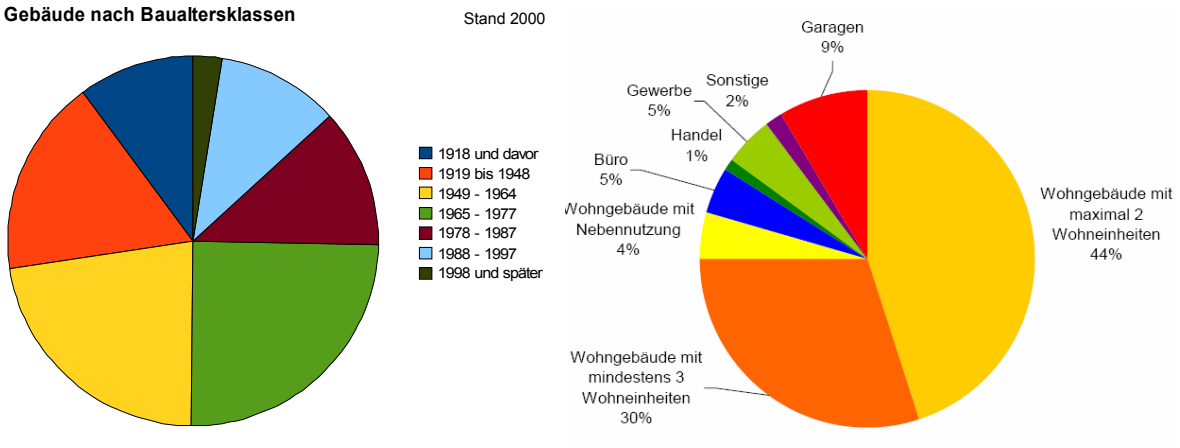


Figure 9. Building year of construction and building types

Concerning new building increase rate, Around 153,000 residential buildings are existing in Munich with an amount of 776,800 units and thereof 50% in multiple family houses; 6.2% of all units is social housing. In the last years (2005-2009) around 7000 units were newly constructed each year.

Energy consumption and supply structure

The City of Munich is to a 100% owner of the local utility (Stadtwerke München GmbH), which is the main stakeholder with regard to energy supply in Munich. The energy supply structure is as follows:

- Electricity. The power generation of the municipal utility was 7.73 TWh in 2008 with 290GWh of renewable energies. The Stadtwerke München offer their clients green electricity (M-Natur) with an extra charge of 1.82 c/kWh. The revenues are used to finance new renewable energy systems.
- District heating. The Stadtwerke München have continuously worked to build the local heat net. With 600 km length it is one of the largest in Europe. In 2008 4240 GWh of heat have been sold in areas like Freimann, Bogenhausen, Perlach, Sendling, Messestadt Riem and the inner city. Since 2009 district heat is also available in Pasing and Aubing-West.
- Geothermal energy. The Stadtwerke München have also invested in CHP plants and geothermal energy (available already in Messestadt Riem, Sauerlach and Freiham).
- Solar thermal energy. An overall amount of 4570 solar thermal systems are installed on buildings in Munich with an area of 52,300 m². The city of Munich supports the installation of solar thermal systems with a local subsidy scheme (FES).
- Solar local heating. In 1998 the pilot project „solar local heat at Ackermannbogen“ was developed. Since 2007 the area with 330 units is realized with heat generation through 3000m² of collectors and a seasonal storage of 5700m³.
- Photovoltaics. Following statements of the Stadtwerke München currently 1391 net integrated PV systems with an overall performance of 17322 kWp are installed in Munich. Of special interest are two projects in Munich:
  - Several large plants on the fair trade centre of Munich with 2.7 MWp
  - 40 PV systems of the Building Department of Munich with an overall performance of 370 kWp

Existing solar actions and measures and installed solar capacity

The following practices and measures are worth mentioning:

- Solar energy optimization of urban plans “SOLENOP”: instrument to optimize urban areas for the use of passive solar energy in areas with more than 500 dwellings.
- Catalogue of ecologic criteria: in case of land purchase the City of Munich provides recommendations concerning solar energy (Ökol. Kriterienkatalog).
- Solar potential online map: with the aid of a GIS based system all relevant roof and façade areas as well as the orientation of the buildings have been analyzed and visualized by the environmental department of Munich.
- Solar ordinance: the feasibility of a solar ordinance for existing buildings is still not assessed with respect to local and national legislation.
- Local subsidy scheme (FES): the local subsidy scheme for energy saving also provides grants for solar thermal systems with of 20% of the investment and a maximum amount of 50,000 Euros.
- Public participation for PV systems: The City of Munich supports public participation projects with free usage rights for roofs of public building.
- Munich’s quality standard for building and renovation: this standard provides specific requirements for residential buildings, which are connected to the allocation of local subsidy (FES)

Concerning solar potential, in average 1,800 hours of sunshine per annum with the energy of ca. 1,100 kWh per square meter is available in Munich. According to local conditions several potential studies have been carried out:

- Solar potential study “Local energy supply concept for Munich” (1999). The potential of the roofs in the Munich have been assessed by a team of scientist together with the City of Munich and the Stadtwerke Munich: as result an eligible area of 10 mio. m² was identified.
- Solar potential study „Building integrated photovoltaics“ (2004). The identified technical potential is 7.86 mio. m² on roofs and 3.77 mio. m² on facades, which means a total yield of 1.69 TWh per year. This would be 29% of the total power demand in Munich.
- Solar potential study of the City of Munich, environmental department (RGU, 2005). The identified technical-economic potential is around 9% of the total electric power demand in Munich. The area potential is 6,950,000 m² of eligible roof area, which means an amount of 695,000 kWh/a generated power. Steep roofs less than 125m² and flat roofs less than 200m² were excluded in this study. It is expected that small roofs have an additional potential of 5-10%.
- Solar potential within feasibility study for the “Solar initiative Munich” (2009). Assumption of the socio-economic potential on the basis of the technical potential of the RGU study. Limitation of technical potential through barriers regarding the respective ownership structure. Overall marketable potential until 2017 of 3.5% of the total power demand in Munich, mainly on commercial and public buildings.

Regarding installed capacity of solar technologies. as mentioned before, a total area of around 55,000 m² of solar thermal collectors and 17,322 kWp of PV modules have been installed in Munich.

Urban planning practices regarding solar energy

The following practices are worth mentioning:

- Solar energy optimization of urban plans “SOLENOP”: instrument to optimize urban

areas for the use of passive solar energy in areas with more than 500 dwellings

- Catalogue of ecologic criteria: in case of land purchase the City of Munich provides recommendations concerning solar energy (Ökol. Kriterienkatalog)
- Solar potential online map: with help of a GIS based system all relevant roof and façade areas as well as the orientation of the buildings have been analyzed and visualized by the environmental department of Munich.
- Solar ordinance: the feasibility of a solar ordinance for existing buildings is still not assessed with respect to local and national legislation.
- Local subsidy scheme (FES): the local subsidy scheme for energy saving also provides grants for solar thermal systems with of 20% of the investment and a maximum amount of 50,000 Euros.
- Public participation for PV systems: the City of Munich supports public participation projects with free usage rights for roofs of public buildings.
- Munich's quality standard for building and renovation: the standard provides specific requirements for residential buildings, which are connected to the allocation of local subsidy (FES).

2.4 Lisbon

Urban and building structure

According to the Lisbon's Local Plan for Housing, there are presently Lisbon 53,387 buildings, 41,295 of which purely residential.

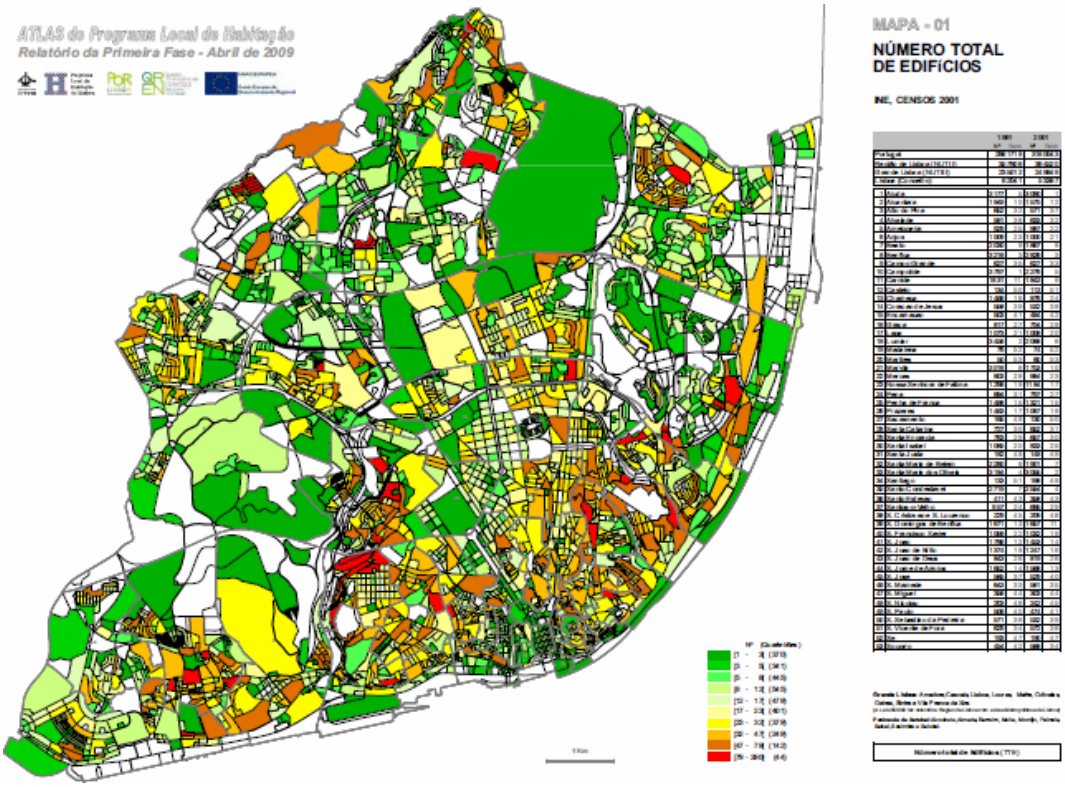


Figure 10. Distribution of the total number of buildings in Lisbon (http://habitacao.cm-lisboa.pt, 2009)

The medium age of buildings is 53,. years, what reflects a lower rate of new constructions over the years and an almost inexistent rate of refurbishment works, confirmed by the number of totally or partially abandoned buildings in Lisbon, .4,665. Apart from the number of total or partially abandoned buildings there are 4,568 buildings that need to be seriously refurbished, namely at the roof covers level and thermal insulation.

Existing solar actions and measures and installed solar capacity

In December 2008, the Lisbon Municipality approved the Energy-Environmental Strategy for the City of Lisbon, which aims to identify the path trough which Lisbon must develop in the upcoming years and sets targets for energy consumption reduction at the Municipality and the complete city level of 8.9% and 9.4% respectively, by the year 2013 (based on 2002 consumption levels). This document sets the main areas of intervention, as well as the targets to reach during the next four years. The main areas of intervention are:

- Reduce primary energy demand, increasing the efficiency and quality of the energy services;
- Promote the harmonization between supply and demand, through intelligent energy networks;
- Promote energy production decentralization and increase energy supply sources diversification (renewable energies, micro-generation e alternative fuels), increasing security of supply.

Regarding the targets established for 2013 there are objectives for the Lisbon Municipality and for the city of Lisbon. No specific targets are set towards the adoption of renewable energy sources in the city of Lisbon.

Regarding installed capacity of solar technologies in Lisbon:

- For solar thermal systems, the total installed capacity has not been still evaluated. Nevertheless, from the energy certification system it is possible to identify within the pool of certified dwellings how many have already installed solar thermal collectors and how many buildings still in construction are expected to install solar thermal systems. In Lisbon the number of certified dwellings with solar thermal systems totalizes 600 sqm. In buildings presently in construction the capacity being installed are 70 sqm. As for buildings under licensing the capacity to install are 5.800sqm (within the new STO at the national level).
- As for solar PV systems, considering only the systems installed within the micro-generation framework, Lisbon accounted in May 2009, for a total installed capacity of 200kWp.

Urban planning practices regarding solar energy

At the level of municipal regulations for building and urbanization the Lisbon Municipality has already narrowed more demanding requirements that, in compliance with current legislation in force (particularly with regard to the mandatory installation of solar thermal panels defined in Thermal Performance Building Regulation), promoting a more efficient adoption of renewables. Particularly, the Municipal Regulation of Urbanization and Construction of Lisbon (RMUEL), which entered in force in the beginning of 2009, establishes the following additional requirements on solar thermal obligations:

- The Municipality may consider to give incentives for the adoption of RES through adequate rates and taxes, including solar thermal systems;
- Buildings should have a User Manual that characterizes the building energy

performance and, among other functionalities, defines the adopted systems to provide sanitary hot water;
- The adoption of centralized solar thermal systems is compulsory in new buildings and should consider South Orientation, architectural integration and the hot water storage tank should be concealed.

In addition, at the national level, the framework that sets the rules for urban edification is RGEU – General Framework for Urban Edification. Within this framework, it is established that any construction or reconstruction work must consider the existence of natural light improving the building orientation and design towards receiving direct solar radiation. Article 59 defines the minimum distances between buildings, as well as the building maximum height depending on the surrounding constructions, in order to assure that every building receives a minimum solar radiation in the facades for a minimal period of the day, in what is know as the 45 degrees rule.

As fro Lisbon, the Lisbon Master Plan is presently under revision. Within this new Plan, intervention priority areas will be identified and defined the level of intervention, according to the different scales of intervention: urban plan, block plan and/or allotments. The current focus of public policies now aims at urban requalification and building refurbishment, bringing together the best practices and adoption of new technologies with the built heritage.

2.5 Malmö

Urban and building structure

The City of Malmö has developed from a garrison town in the late Middle Ages, into a shipping and transportation town, into an industrial city and today into an expansive big city with higher education. Some of the blocks are still characterized by the Middle Age appearance of the city.

The creation of the district of Western Harbour is based on a fundamental ecological approach to planning, building and construction. The aim is for the district to be an internationally leading example of environmental adaptation of a densely built urban environment. In the Western Harbour development, Flagghusen, two passive houses were built without heat energy. This trend continues to be interesting in both the WesternHarbour and Hyllie developments from the perspective of the municipality and building firms.

Sadelmakarbyn´s preschool in Southern Malmö is the municipality´s first low-energy preschool, an important pilot project for the construction of future municipal buildings. The preschool´s walls are a half meter thick, using dense materials whist energy consumption for water heating is limited to 70 kWh per square meter per year.

The City of Malmö is facing large investments in regeneration of the buildings from the post-war period. Regeneration will be made in a way that the buildings' efficiency is improved. Solar energy plants, for example fully integrated solar thermal roofs, will be one of the options in this work. Solar energy will also be integrated in new developments like for example Hyllie.

Energy consumption and supply structure

The energy types adding up to final energy use in Malmö within the period 1990-2006 show a quite stable or slightly increasing trend, except for fuel oils which was formerly a common source of heating but which have diminished rapidly in use (80%). The consumption of electricity, petrol and district heating energy has each increased by 4-6% during the period. The total energy use is distributed between some main sectors in accordance with FIG. As it can be seen, households (33%) and transports (29%) are the two largest consumers followed by other services (19%), which consists of the private service sector, for example offices, shops and other buildings. The industry sector adds up to a relatively small share (10%) and public services to 9% of total energy use.

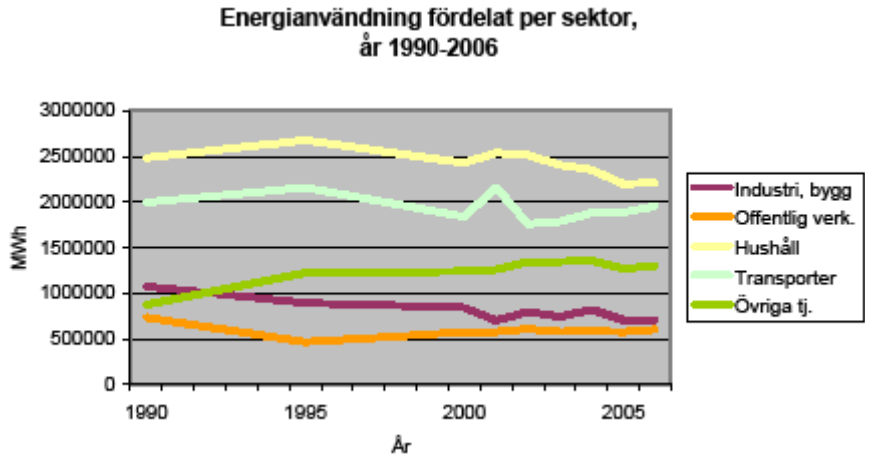


Figure 11. Final energy consumption in Malmö (1990-2006; source: Sabina Andrén, 2009)

Concerning electricity, in the last decade the Swedish electricity market has been deregulated and integrated with the Nordic countries (except Iceland) on a common market called Nord pool. The provision of electricity to Malmö thus belongs to a wider regional network and is the feature of a larger system, of which the control is only indirect and partial. Electricity is a product purchased by many different actors, from huge companies and public bodies to individuals and households. This creates different segments of the market, with different types of contracts and business conditions. For the average individual there is some degree of freedom, for example the right to choose power company and the possibility to earmark the contract demanding for example 'green' electricity. Even though the market is dominated by large suppliers, there is a formal possibility for local actors to produce electricity and to connect the producing units to the grid. Individuals as well as companies and public bodies may use this opportunity but the conditions are not advantageous for a small-scale producer. The municipality produced around 345 GWh of electricity from wind power, waste management and sewage treatment in 2006.

The recent renovation of the huge combined power and heating plant Öresundsverket is a good example of how electricity belongs to a larger regional context. This plant is situated in the Northern harbour area of Malmö. Opening in 2009 it is now one of the biggest and most modern plants in Northern Europe. It has a production capacity of 400 MW of electricity and also generates heat water with a production capacity of 250 MW. This facility makes Malmö as a geographical area a net-exporter of electricity and it is expected that the city's district heating system will be covered by 40% only from this plant.

Existing solar actions and measures and installed solar capacity

A new Energy Strategy in Malmö was approved by the city council in December 2009. According to the Energy strategy, switching to renewable energy sources is an important strategy for decreasing the environmental impact and securing a future energy provision. For electricity and heat production, bio-fuels, hydro-power, wind-power and solar-energy are the solutions being discussed. The potential within the area is great in the long term and the possibilities are good for more production. The City of Malmö should continue to act as a precursor when it comes to solar energy and wind power.
The long-term vision for Malmö (year 2030) is for the energy system to consist of only renewable energy sources and be characterized by an effective and safe energy use which contributes to the long-term sustainability of the city. In order to take important steps towards this vision, by the year 2020 the energy use should have decreased by at least 20 % per capita compared to the average annual use during the period of 2001 to 2005. The share of renewable energy should be at least 50 % of the total energy use. For Malmö municipality's own operation, more ambitious goals have been set as a part of the public sector's strive to serve as a role model and positive example to others. The energy use in the municipality's departments and companies should during the same period have decreased by 30 % and consist of 100 % renewable energy.

On the national level in Sweden, investment subsidies and grants are available, both for solar thermal and solar photovoltaic systems. The actual scheme for solar thermal collectors started in January 2009 and will continue to 2013. The subsidy can be applied for all glazed collectors with a liquid heat carrier and is based on the expected heat production. A new investment subsidy for solar PV installations, with a grant for 55-60% of the investment, started in June 2009, applicable to all buildings.

Regarding installed capacity of solar technologies, solar thermal in Malmö is 1.5 MW glazed collectors in the district heating network and 1 MW unglazed collectors for swimming pools. For PV technology installed capacity is around 450 kW_p for the City of Malmö and in addition there are also a few private installations with capacity below 50 kW_p. Contribution of solar energies to the local energy mix is so small that it is not measurable. At present, within the municipal Solar Energy initiatives in Malmö approximately 0.7 % of the heat and 0.3 % of the electricity used in the buildings within the Department of Internal Services comes from solar energy.

Urban planning practices regarding solar energy

The new Environmental program (2009-2020), approved by the council in December 2009, connects to the same renewable energy targets set in the Energy Strategy. In addition, the program has a target that by 2020, Malmö should be the world leader when it comes to sustainable urban development. Solar energy, wind power, hydropower and biogas will be phased in, and fossil fuels will be phased out.

In addition, in Malmö a more restrictive maximum energy demand than the in the actual Swedish building regulation BBR has been established, 85 kWh/sqm year within the definition of the new guideline "Environmental Building Program South". This document aims to be a guideline to support sustainable development and it is developed by cooperation between municipalities and construction companies. So far it is only mandatory for developers building on city-owned land within Malmö and Lund and is not mandatory

elsewhere. It is although stated that the goal for the city is to inform and encourage that the environmental building programme should be used also at non-city owned land. In this case voluntary agreements are needed.

2.6 Vitoria-Gasteiz

Urban and building structure

The City of Vitoria-Gasteiz has 100,272 buildings (2008 data). Several homogeneous areas can be found, as shown in Figure 12.

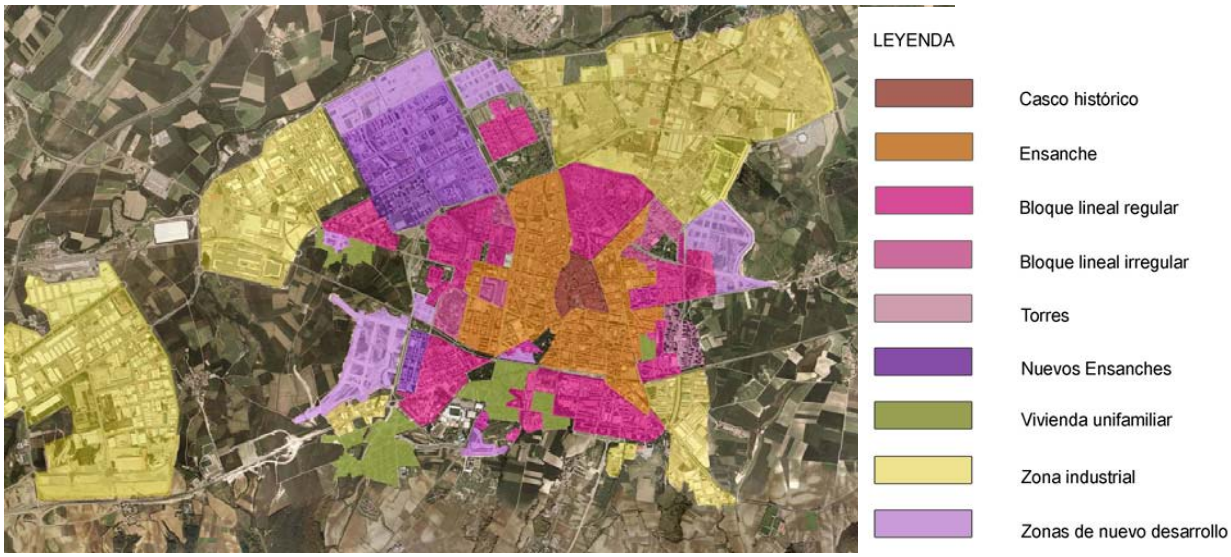


Figure 12. Areas of the City of Vitoria-Gasteiz

Refurbishment activities are increasing moderately in Vitoria-Gasteiz. There are some districts built on the sixties and seventies that need to be refurbished or demolished. Some of these refurbishments have been made to lower the energy demand of the old buildings, built with no thermal isolation and therefore have important energy consumptions.

Energy consumption and supply structure

Vitoria-Gasteiz has increased its size and population in the last years, with a current population of 239,361 citizens. Despite the energy efficiency measures taken, the energy demand has increased slightly during 2006 and 2008 due to this increase in population. The energy consumption by sectors is provided in the following table:

Energy consumption by sectors (2008)	
Sector	**[GWh]**
Residential sector	1079.41
Commercial sector	595.54

Mobility sector	1080.67
Primary sector	85.60
Water cycle	11.59
Municipal equipments and services	126.65
Waste management and urban cleaning service	16.74
Total (excluding industry consumption)	**2977.20**

The energy supply infrastructure consists of:

- Generation and cogeneration plants powered by gas, of private ownership;
- Cogeneration plants powered by biogas (methane coming from waste), owned by the municipality: the dumping site of Gardelegi, the sewage treatment plan of Crispijana and the urban waste treatment plan of Vitoria-Gasteiz.
- Distribution infrastructures of electricity and gas

Existing solar actions and measures and installed solar capacity

In December 1998, a Partial Plan was elaborated for the Sector 7 (Salburua District) where all the new buildings were southern orientated for the best solar potential. Also, as explained below, there are two instruments at local level that ask for requirements on solar energy beyond national requirements (National Building Code).

In addition, there are subsidies and fiscal benefits to promote solar energy (among other clean technologies):

- Subsidies: there are 2 different subsidies available in the Basque Country, managed by the Environmental Department of the Basque Government and EVE (Ente Vasco de la Energía-Basque Energy Agency). There are no subsidies given by the city of Vitoria-Gasteiz for the moment.
- Fiscal benefits for solar technologies (PV and solar thermal) include a 50% reduction on IBI tax (tax for owning a house) during the first 3 years after installations and 30% reduction on ICIO tax (tax for works on buildings); in both cases, only if the installations are not mandatory by the National Technical Building Code.

The current installed solar (thermal/photovoltaic) capacity in Vitoria-Gasteiz is 2.68 MWp solar PV and 11.75 MW (16,685m^2) of solar thermal, contributing in a 0.1% to the local energy mix.

Urban planning practices regarding solar energy

The main criterion for the integration of solar energy in urban planning is the national Technical Building Code (Código Técnico de la Edificación-CTE**),** mandatory since 2006**.** It has 12 Basic Documents, one of them, the DB HE establishes energy saving measures. It is divided in 5 parts (DB-HE1 to DB-HE 5), with 2 parts specifically related with active solar technologies:

- DB-HE4: Minimum solar contribution to Sanitary Hot Water. Depending on the location (5 climatic zones are defined), size and use of the building, a minimum solar contribution to the annual demand of sanitary hot water is defined, which varies

between 30 and 70% (different contributions are specified depending on the auxiliary energy used to complement the solar collectors performance: electricity and others).

- DB-HE5: Minimum photovoltaic contribution to electricity. Depending on the location, size and use of the building, a PV system shall be incorporated, the size of which depends on the building built area and the climatic zone where it is located. The buildings uses and minimum application limits are: Commercial, large supermarkets: 5000 m^2 built surface; Commercial, multi-stores: 3000 m^2 built surface; Storage warehouses: 10000 m^2 built surface; Showgrounds (for trade fairs): 10000 m^2 built; Office buildings: 4000 m^2 built surface; Hotels and guesthouses: 100 beds; Hospitals and clinics: 100 beds.

At local level, there are two instruments that ask for further requirements on solar energy:

- Passive solar: PGOU (Plan General de Ordenación Urbana, Master Plan) or Master Plan (Book III, Title V, Chapter 1, Section 1, Part 1, Article 5) : Solar irradiation. The façade must receive at least 1 hour of irradiation on its southern part, at 2 m height from lower ground, as to 22nd December date.
- Active solar: Administrative Statement by Ensanche 21 (Social building Agency linked to City Council): the roof surface area of the social buildings promoted by Ensanche 21 and not used for solar thermal will be conceded to the City Council of Vitoria-Gasteiz for 99 years for the eventual installation of solar PV modules.

The process of incorporating the solar urban planning to the legal framework needs the following steps:

- Law proposal by the Urbanism-Planification Department of the City Council of Vitoria-Gasteiz.
- Approval of the law proposal by the Political Groups of the city.

Depending on the law category, the timing for the incorporations of the solar urban planning differs: for modifications of the Master Plan the process takes typically between 9 and 12 months.

3 Priority measures for the long-term development of solar energy in POLIS cities

Within the POLIS project, after analysis of the local background of the participating cities, specific solar Action Plans have been defined by developed by Local Working Groups comprising municipalities and technical partners of POLIS. These Action Plans include long-term solar targets, main areas of interest (focus areas), relevant stakeholders for the implementation of solar energy in connection with urban approaches (target groups) and short-term measures to support the upgrade of solar energy and reach the proposed targets.

Of all short-term measures, some have been identified by the municipalities as priority “Pilot Actions” that will be implemented within POLIS project, between 2009 and 2012. Overall, 61 short-term measures have been defined, of which almost 1/3 (19 measures) are priority “Pilot Actions” that cover the following categories:

1. Large-scale identification of solar potential and definition of priorities (planning instruments);
2. Accomplishment of activities to mobilize solar potentials (campaigns, subsidy programs, local policies, information workshops, cooperations with existing programs, etc);
3. Development and realization of solar urban planning measures (in new developments or existing areas);
4. Development and realization of political or legislative measures (for example, introduction of a solar ordinance for new or existing buildings).

It must be pointed out that due to the fact that the cities are in different situations regarding solar energy, their strategies —i.e., the solar Action Plans— also differ. The following table presents an overview of the 19 Pilot Actions that have been identified as priorities, to be implemented within POLIS project. A more detailed description of the Pilot Actions can be found in the report “Deliverable 5: Fact sheets of Pilot Actions”, also available on the project web-site (section: Publications).

Country/ City	Local Working Group and priority measures for long-term development of solar energy	
France/ Lyon	Grand Lyon Urbanism agency, Grand Lyon technical services, Agence Locale de l'Energie de l'agglomération lyonnaise and HESPUL (technical partner)	
	Pilot Actions	**Category [1]**
	1. Interactive website with detailed real solar potential for Sainte Blandine district *Communication campaign to inform district inhabitants about the potential of PV technology on residential and local government buildings*	1
	2. Citizen jointly owned PV system at Lyon *Mobilization of local investments in PV systems by participating on the development and production of renewable electricity*	2
	3. Integrating solar into urban planning documents in Lyon *Development of urban planning methodologies with solar energy aspects as main criteria, by proposing 2 scenarios for a pilot area in Lyon to be restructured*	3
France/ Paris	City of Paris (Urban Ecology Department, Urban Planning Headquarter, Social Housing Headquarter, Public Works Headquarter) and Urban Planning Agency of the City of Paris (technical partner)	
	Pilot Actions	**Category**
	1. Precise identification of solar potential of Paris building stock and modelling tool *Modelling tool and detailed identification of the solar potential (PV or solar thermal) of the roofs of Paris complete building stock. Dissemination in an interactive internet-basedmap*	1
	2. Monitoring tool *Development of a monitoring tool of solar facilities to improve the existing knowledge, follow the implementation of new ones and adapt future actions oriented to promote solar developments*	2
	3. Setting of requirements in local plans *Survey to identify changes and adaptations needed on the Local Urban Planning Plan in order to incorporate solar requirements and therefore facilitate solar systems implementation*	3
Germany/ Munich	City of Munich (Urban Planning and Building Regulation Department) and Ecofys Germany (technical partner)	
	Pilot Actions	**Category**
	1. Development of a POLIS "Solar Guideline for Urban Planning" *Development of a solar guideline to facilitate a criteria-based assessment of urban planning documents and projects*	2
	2. Implementation of POLIS "Solar Guideline for Urban planning" findings within a new development area *Pilot project where the diverse instruments of the Guideline will be applied within the framework of the urban development project "Bayern Kaserne"*	3
	2 (alternative). Implementation of "POLIS Guideline for solar urban planning" into a pilot project within the building stock of an existing area *Pilot project where the diverse instruments of the Guideline will be*	3

Country/ City	Local Working Group and priority measures for long-term development of solar energy	
	applied within the framework of the urban refurbishment project of Neuaubing	
Portugal/ Lisbon	Lisbon municipality, Agência Municipal de Energia e Ambiente de Lisboa and Wee Solutions (technical partner)	
	Pilot Actions	**Category**
	1. Evaluation of solar potential in Lisbon at parish level *C Realistic assessment of the solar potential of Lisbon built environment using a top-down approach (from technical to market potential) for PV and solar thermal technologies*	1
	2. Definition of goals for solar technologies adoption (thermal & photovoltaic) *Based on the evaluation of solar potential in Lisbon at parish level (Pilot Action 1), the policy decision-making process will be assisted so to establish targets for the adoption of solar technologies in Lisbon, based on the policy scenario selected by the municipality, in accordance with national and local regulations*	2,3
	3. Evaluation of potential to integrate solar technologies in Boavista neighbourhood *Analysis of the existing urban rehabilitation regarding its solar integration potential; optimisation of the existing urban plan in order to maximise the potential for solar integration. Determination of preferential integration sites.*	1,2,3
	4**. Identification of the solar potential of Lisbon municipality built heritage – Service buildings with medium voltage electricity supply** *M Analysis of the solar economic potential of service buildings supplied with medium voltage, followwing a building-based approach based on an inventory of relevant buildings: identification of technical, technological and economic potentials*	1
	5. Training workshops for professionals on solar technologies and solar concepts of urban planning *D Realisation of 2 training workshops on solar technologies and its integration in the architectural and urban design processes targeted at Lisbon Municipality technicians dedicated to architecture, engineering and urban planning activities*	2
Sweden/ Malmö	City of Malmö (Environment Department, Real Estate Office, Urban Planning Department and Department of Internal Services), Skåne Energy Agency and Lund University (technical partner)	
	Pilot Actions	**Category**
	1. Urban planning in Sege Park *Introduction of solar energy requirements in the local Urban Plan of an existing area undergoing retrofitting measures*	3
	2. Solar energy requirements in exploitation and purchase agreements *Development and implementation of an exploitation or purchase agreement with solar energy requirements*	4
	3. Potential Study in Sege Park *Development of a methodology for assessing the detailed solar potential of buildings in Malmö that can be used by the public and possibly by other cities/countries with similar legislation*	1

Country/ City	Local Working Group and priority measures for long-term development of solar energy	
Spain/ Vitoria-Gasteiz	City of Vitoria-Gasteiz (Urban Planning Department, Environment and Sustainability Department and Energy Agency of Vitoria-Gasteiz) and Universidad Politécnica de Madrid (technical partner	
	Pilot Actions	**Category**
	1. Methodology and Assessment of the detailed Solar potential of Lakua district *Development of a methodology for assessing the solar potential of urban areas of Vitoria-Gasteiz that is compatible with local and national requirements. Application to the residential district of Lakua and general recommendations for strategic mobilisation of the potential identified*	1
	2. Assessment of the detailed Solar potential of Jundiz industrial area *Identification of the detailed solar potential of Jundiz industrial area and general recommendations for the strategic mobilisation of the potential identified*	1
	3. Assessment of the general Solar potential of the city of Vitoria-Gasteiz *Identification of the solar potential of the complete city of Vitoria-Gasteiz and general recommendations for the strategic mobilisation of the potential identified*	1
Note: (1) Pilot Actions categories: 1. Large-scale identification of solar potential and definition of priorities (planning instruments); 2. Accomplishment of activities to mobilize solar potentials (campaigns, subsidy programs, local policies, information workshops, cooperations with existing programs, etc); 3. Development and realization of solar urban planning measures (new developments or existing areas); 4. Development and realization of political or legislative measures.		

Table I. Overview of priorities (Pilot Actions) for the long-term development of solar energy in POLIS cities