

## Using solar energy - supporting community energy self sufficiency

Barcelona was the first European city to implement a Solar Thermal Ordinance, integrated in a long-term framework for climate change, with a mitigation and adaptation impact. The local government closely monitored the implementation of the Ordinance, and now shares valuable insights regarding the challenges faced and the benefits of this strategy.

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### Summary

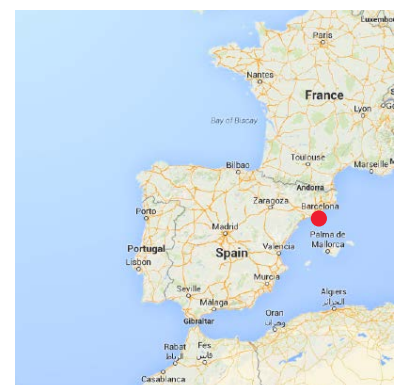
In 2000, Barcelona was the first European city to develop and implement a Solar Thermal Ordinance (STO), making it compulsory to use solar energy to supply 60 percent of running hot water in all new buildings, renovated buildings, or buildings changing their use. The STO has been integrated into the overarching political and planning framework for climate change mitigation. Within this framework, Barcelona aims to achieve energy self-sufficiency in the long term through the promotion of energy efficiency and the use of renewable energy resources.

As a result of the STO, the surface area of installed solar panels in Barcelona increased from 1,650 square meters (m<sup>2</sup>) in 2000 to 87,600 m<sup>2</sup> in 2010. At the time of installation, this carried a projected energy savings potential of over 70,000 megawatt hours (MWh) per year, and a projected avoided emission potential of 4,300 tons of carbon dioxide (CO<sub>2</sub>) per year.<sup>1</sup> However, the acceptance of solar thermal technology by stakeholders has not developed as expected, and in 2011 this led Barcelona to revise the projected achievements to 11,222 MWh and 1973 tons of CO<sub>2</sub> per year.<sup>2</sup> To consolidate acceptance of the Ordinance, and as part of its integrated approach towards energy self sufficiency, the City Council has strengthened its governance framework and stakeholder engagement efforts.

### The important potential of solar thermal energy

In 2009 water heating represented 13 percent of households' energy consumption in the European Union,<sup>3</sup> 18 percent in the USA,<sup>4</sup> and 27 percent in Spain.<sup>3</sup> In Barcelona, it is estimated that hot water represents 28 percent of the energy needs of households,<sup>5</sup> which would have corresponded to 1,329,815 MWh during 2008. In addition, many other facilities in the community, such as swimming pools, laundries, canteens, hospitals, and food industry buildings, consume a significant amount of hot water; all of which has a noticeable impact on their energy bill.

Typically, water is heated using natural gas or electricity. Changing this presents an opportunity for solar energy use (using readily available technologies), which would reduce both dependency on fossil fuels and the emissions of greenhouse gases (GHG). However, despite the high potential for solar energy use in Barcelona, before the Local Government intervened and took a leading role, the solar thermal market remained underdeveloped.



### Facts & Figures

**Population / Land area**  
1,612,000/ 102 km<sup>2</sup> (2014)

**Municipal budget**  
€2,295,881,000 (2012)

**Greenhouse gas inventory**  
Yes (1998 and 2008)

**GDP per capita**  
38,500 Euro (2010)

Barcelona has been a member of ICLEI since 1995



## The Urban-LEDS Project

An Urban Low Emissions Development Strategy (Urban LEDS) defines a pathway to transition a city to a low emission, green and inclusive urban economy, through its integration into existing city development plans and processes.

The Urban-LEDS project (March 2012 - March 2016), funded by the European Union, was jointly implemented by UN-Habitat and ICLEI. It supported local governments in emerging economy countries (Brazil, India, Indonesia, South Africa) and in Europe to transition to urban low emission development using ICLEI's GreenClimateCities methodology, comprehensive process guidance, to integrate low emission strategies into all sectors of urban planning and development.

For more information, please visit: <http://urbanleds.iclei.org/>

## Barcelona's longstanding commitment to sustainability

Barcelona has a long standing commitment to integrating sustainability principles and values into municipal policy and action. In 1993, Barcelona joined ICLEI's **Cities for Climate Protection Campaign**. After signing the Charter of European Cities & Towns Towards Sustainability – **Aalborg Charter** (1994), Barcelona then initiated an extensive participatory process which culminated with the approval of the **Citizens Commitment to Sustainability 2002-2012** – Agenda 21 in Barcelona (2002).

In 2008, Barcelona signed the **Covenant of Mayors**, voluntarily supporting the implementation, at local level, of a package of measures adopted by the European Union. With a target date of 2020, these measures looked to reduce CO<sub>2</sub> emissions by 20 percent, increase energy efficiency by 20 percent, and ensure that 20 percent of energy comes from renewable sources.

Since 2010, Barcelona is also a signatory to the **Mexico City Pact**, the Global Cities Covenant on Climate, a voluntary initiative of mayors and local authority representatives around the globe committing to advance local climate action (both mitigation and adaptation) and foster city-to-city cooperation. Furthermore, the Agenda 21 process is ongoing: in 2012, Barcelona renewed its **Citizens Commitment to Sustainability** for the period 2012-2022. This is a critical aspect for achieving success in the community.

## Integrated action to deliver large-scale solar thermal energy in the community

The Barcelona City Council has taken decisive actions to enhance the use of renewable energy in its community, including the use of solar thermal energy for water heating. The local government has set the example, installing systems in its own buildings and facilities, but also using its regulatory powers to require the use of solar energy in privately owned buildings. The Council took an integrated approach to overcome existing barriers. A range of complementary actions were taken, including stakeholder engagement, capacity building, information campaigns, and fiscal incentives.



Local government leading the way: a solar energy installation at the Public Health Agency Laboratory

## Ordinance leverages the solar thermal market

Barcelona is the first European city to enact a Solar Thermal Ordinance (STO), making it compulsory to use solar energy to supply 60 percent of running hot water in all new buildings, renovated buildings, or buildings undergoing a change of use, independently of whether they are privately or publicly owned. This ordinance applies to buildings that are intended for residential purposes, health and wellness, sport, commercial, industrial, and any other purpose that entails the presence of dining rooms, kitchens or collective laundries. The STO was approved by the Barcelona City Council in July 1999, and came into effect one year later, in August 2000.

Benefiting from the experience gained during the initial years of implementation, the Local government amended the ordinance in 2006 to expand the scope of buildings to which it applies, and to safeguard the good performance of the solar thermal systems installed: the use of certified solar collectors and technical requirements for the maintenance and use of solar thermal systems were introduced, harmonizing the policy with other ordinances at the regional and national level.

With the approval of the Barcelona Environmental Ordinance (May 2011), the STO was expanded to include solar photovoltaics (PV), requiring the use of solar energy for electricity generation in the design of new and renovated buildings.

| Sectorial Indicators  |   |
|---|---|
| Residential water consumption per inhabitant (l/hab/day)  | 112.9 (2008), 109.5 (2011)                                    |
| Annual hot water energy requirement for Barcelona households                                    | 1,329,815 MWh (2008)  |
| Contribution of Sanitary Water Heating to the Residential Final Energy Consumption in Barcelona | 28%   |
| Sunshine received in Barcelona annually (hours/year)  | 2,351   |
| Barcelona's annual solar radiation  | 14.5 MJ/m <sup>2</sup> /day<br>1,470 kWh/m <sup>2</sup> /year |

## Creating an enabling political and strategic framework

In alignment with Barcelona's Local Agenda 21 objectives, in 2002, the City Council approved the **Barcelona Energy Improvement Plan 2002-2010 (PMEB)**. This strategic municipal level document encompasses energy, air pollution, and greenhouse gases, and contains an action plan with 55 measures to promote energy efficiency and renewable energy. The monitoring and assessment of the Solar Thermal Ordinance implementation is one of the projects in the PEMB.

In 2011, the City Council approved the **Barcelona Energy, Climate Change and Air Quality Plan 2011-2020**. The plan contains 108 projects that focus on improving technology, raising awareness, and energy demand management.

## Governance and technical capacity for delivery

The technical expertise necessary for monitoring and assessing the Solar Thermal Ordinance implementation has been ensured through the **Barcelona Energy Agency**, a municipal organization. The Agency tracks the number of solar thermal systems and total surface installed, as well as the condition and performance of the existing systems, and the reactions of stakeholder groups to the technology.

### Solar thermal market barriers and risks

#### Barriers

- Lack of awareness of the benefits
- Insipient solar thermal systems market
- Negative perception of stakeholder groups and users towards the technology
- Absence of participants to test and certify new solar thermal collectors
- Lack of technical experts to project, install and maintain the systems
- Absence of a performance-guarantee provided by suppliers and/or installers

#### Risks

- Improper maintenance of solar thermal systems, leading to poor performance and weakening their reputation



Stakeholder engagement was a fundamental aspect for the successful implementation of the STO. Because of the engagement efforts of city staff and officials, solar infrastructure can be seen at a variety of public and private buildings throughout the city.

Recognizing the importance of internal **stakeholder engagement, coordination, and capacity building** to enable STO implementation, the Barcelona City Council trained staff on solar energy; over a series of ten meetings, training was provided for the 72 municipal technicians that manage Work licenses in the City's Urbanism Department. Moreover, 67 external technicians from ten different companies were provided with solar thermal audit training.

### Engaging key stakeholders and the citizens

**Stakeholder engagement** is essential, both as an enabler and as a multiplier of the impact of the STO. Soon after its implementation, a working group was formed to discuss the objectives and scope of the STO. It included professional associations for architecture and engineering, promoters, residential building administrators, a consumers association, municipal representatives concerned with heritage and public housing, as well as solar industry associations. The Stakeholder Forum, named "**Taula Solar**" (which cleverly translates to "Solar Panel"), played an instrumental role in supporting debate and reaching a consensus on the original STO text (1998-1999), and during its revision process (2004-2005).

In 1999, an agreement was reached with stakeholder groups for the STO to enter the ordinance into force once year after it was published, thus enabling the construction industry to prepare for the new regulation.

Some professional groups involved in building design initially showed some indifference or negativity towards solar thermal systems. Many developers considered it to be just another licensing requirement and cost, while architects had aesthetic concerns. The **Environmental Department of the Barcelona City Council** led a positive campaign outlining the benefits of solar energy, and held meetings and workshops to build the capacity necessary to generate the enthusiasm needed to overcome this reluctance. This shows that a potentially negative first impression amongst officials and other stakeholders is not necessarily a barrier to success, if appropriate steps are taken to address the situation.

Targeted educational and information campaigns promoted by the Barcelona City Council were also conducted in various media to **raise awareness** among key stakeholder groups and the population in general. To ensure the good performance of the solar thermal systems, end users were informed on how to use these systems and about their maintenance requirements. The Environmental Department of the Barcelona City Council, through its **Environmental information desk** (open six days a week), gave advice to the population on solar thermal use and maintenance.

Despite these efforts, the perception of different stakeholder groups towards solar thermal systems has not shifted as significantly as expected. To address persisting negative perceptions, a hearing process called "**Solar Reflection Days**" took place in 2013 to showcase the state-of-the-art solar thermal systems in Barcelona and debate priority action lines to contribute to the energy self-sufficiency municipal strategy. Within the hearing process, 70 people took part in five technical workshops classified by activity sectors (hotels, sport centers and hospitals) and phases in a solar thermal system life-cycle (design & execution and operation & maintenance). Stakeholder groups involved included the solar thermal industry, facility companies, installation and maintenance staff, and managers of buildings with high hot water consumption. Educational institutions and multiplier organizations, such as professional associations, were also invited to participate in the hearing process.

## Actions and initiatives related to the Solar Thermal Ordinance

|                               |  |
|-------------------------------|--|
| <b>Policy</b>                 | <ul style="list-style-type: none"><li>• Barcelona Energy Improvement Plan 2000-2010 (2002): for lowering emissions and increasing energy efficiency.</li><li>• Barcelona Energy, Climate Change and Air Quality Plan 2011-2020 (2011): focusing on energy efficiency, improving technology and raising awareness.</li><li>• Barcelona Self-sufficient Energy Plan 2014-2024: focusing on becoming a self-sufficient city in the future (currently being drafted)</li></ul> |
| <b>Regulation</b>             | <ul style="list-style-type: none"><li>• Solar Thermal Ordinance is approved (published in 1999, enters into force in 2000): compulsory solar thermal hot water in private and public buildings</li><li>• STO amended to expand the scope of buildings to which it applies and add technical requirements (2006)</li><li>• Barcelona Environmental Ordinance (2011): requires photovoltaic in new and renovated buildings</li></ul>   |
| <b>Fiscal</b>                 | <ul style="list-style-type: none"><li>• Municipal Fiscal Ordinance sets discount in housing taxes for voluntary solar (thermal or photovoltaic).</li></ul>   |
| <b>Governance</b>             | <ul style="list-style-type: none"><li>• Barcelona Energy Agency is responsible for STO implementation, monitoring, and dissemination (2003)</li></ul>  |
| <b>Capacity Building</b>      | <ul style="list-style-type: none"><li>• Training of municipal and external technical staff on solar energy</li><li>• Environmental information desk gives advice to the population on solar thermal use and maintenance</li></ul>  |
| <b>Stakeholder Engagement</b> | <ul style="list-style-type: none"><li>• Creation of a Stakeholder Forum “Taula Solar”</li><li>• Meetings with key professional groups (municipal and external)</li><li>• Solar discussion forum (2013) to identify opportunities and barriers and promote renewable energies</li></ul>   |
| <b>Raising Awareness</b>      | <ul style="list-style-type: none"><li>• Targeted campaigns</li></ul>   |
| <b>Technology</b>             | <ul style="list-style-type: none"><li>• Solar thermal and photovoltaic energy systems in public buildings, facilities, and spaces</li><li>• Solar thermal and photovoltaic energy systems in privately owned buildings covered by the ordinances</li></ul>   |

### Setting an example – solar thermal energy in municipal facilities

In regard to solar thermal energy, the Barcelona City Council actively engages as a role model for the entire community. The total solar thermal surface installed at the time the STO came into effect (1,650m<sup>2</sup>) was largely due to the local government’s initiatives in its own facilities. Since then, it has continued to have a leading role: in 2008, a total of 110 systems were installed in municipal facilities (including social housing, sport facilities, and schools) corresponding to 8,233.54m<sup>2</sup> (over 10 percent of the city’s installation total) and a production of 6,642.032 MWh/year.<sup>5</sup>

### Budget and finances

The costs of mandatory installation of solar thermal heaters in buildings covered by the STO are carried by the private sector. To limit these costs for private actors, Barcelona offers a housing tax incentive for voluntary solar (thermal or photovoltaic) installations, regulated by the Municipal Fiscal Ordinance: The incentive provides a 50 percent tax reduction for the four years after the installation.

Financing of the municipal solar thermal installations has been assumed by the Barcelona City Council. Municipal photovoltaic installations have also been financed through the municipal budget and, in some cases, other public administrations have acted as co-financers,<sup>1</sup> including departments that promote work in public buildings and public spaces, such as the Municipal Institute for Urban Landscape (IMPU in Catalan).



Photo: © Ajuntament de Barcelona

Tax incentives are provided for voluntary solar installations on private housing.

## Results

The approval of the STO has created **new market opportunities**. Requests for the installation of solar thermal systems has increased, and so has the total surface area of solar thermal systems in the city from 1,650m<sup>2</sup> in 2000 to 87,600m<sup>2</sup> in 2010, increasing the licensed surface by a factor of more than 50 times.

This has created projected **energy savings** of over 11,200 MWh per year, and resulted in a **reduction of greenhouse gas emissions** of approximately 1,970 tons of CO<sub>2</sub> per year; further contributing to Barcelona's **energy independence**.

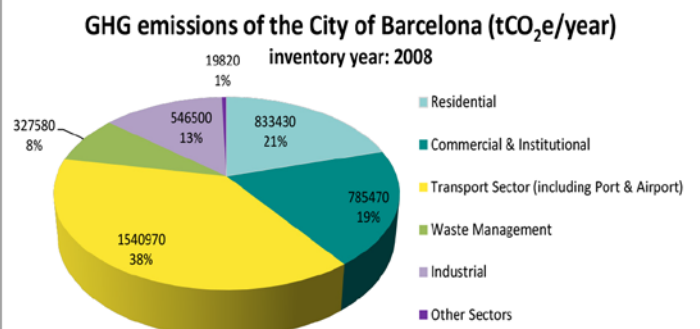
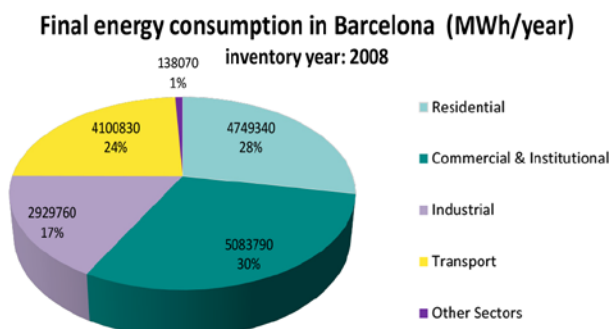
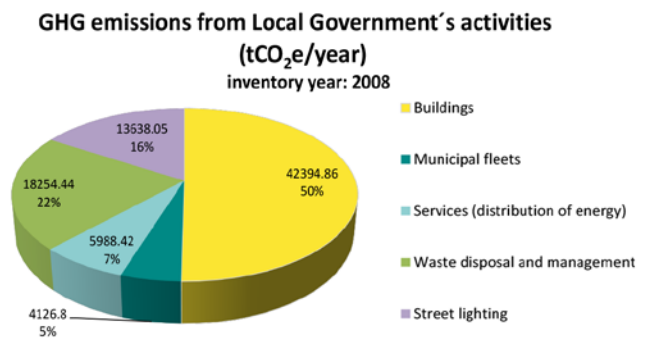
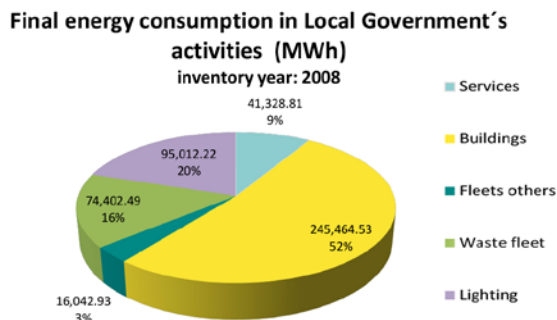
Nevertheless, challenges remain. In 2010, only 46 percent of the total area approved for solar thermal infrastructure had been provided with systems, and only 20 percent of the total number of systems were operational.<sup>7</sup> This is attributed to the negative perception of different stakeholder groups towards solar thermal systems. These observations led to the **"Solar Reflection Days"**, which were held to showcase the quality of solar thermal systems in Barcelona, and to communicate the municipal strategy for energy self-sufficiency.

The use of solar energy has **created new jobs** within the Barcelona City. According to the Association of Solar Thermal Industry (ASIT) [2012], the installation of 275,590 m<sup>2</sup> of solar thermal collectors in Spain generated 5000 direct jobs. Although there is no specific study for Barcelona, assuming a directly proportional relation, the estimated value for Barcelona corresponds to the creation of approximately 1500 to 1600 jobs.

The STO **created a domino effect throughout Spain (and the world)** with more than 70 Spanish municipalities subsequently adopting solar ordinances. This process culminated in 2006, with the inclusion of a requirement to install solar thermal systems in the national Technical Building Code.<sup>5</sup>

The STO and complementary actions adopted have enhanced Barcelona's **international sustainability profile**, and delivered economic, environmental, social, and institutional benefits to the city and region, all whilst establishing a path towards a sustainable energy infrastructure.

| Solar Thermal in municipal facilities                                    |                            |
|--|----------------------------|
| Solar thermal energy generated (2012)                                    | <b>7,128.080 MWh</b>       |
| Solar thermal installations (2012)                                       | <b>129</b>                 |
| Solar thermal collection area (2012)                                     | <b>8,841 m<sup>2</sup></b> |
| Spanish cities replicating Barcelona's model for Solar Thermal Ordinance | <b>&gt;70</b>              |



## Lessons learned

- **Ensuring the performance of the installed systems is essential to promote the acceptance of the technology by different stakeholder groups**, especially end users. Solar panels require regular maintenance in order to ensure their continued performance. To address this, the STO was revised in 2006 to include technical requirements for the verification and maintenance of the solar thermal systems installed. In addition, the Environmental Information Desk of the City Council, open 6 days per week, provides advice to the population on solar systems use and maintenance.
- **Monitoring and complementary measures are needed to ensure the enforcement of the Ordinance.** The negative perceptions of different stakeholder groups towards solar thermal systems need to be addressed. This can be achieved through meetings, workshops and reflection panels. However, these need reiteration until the benefits of the measure become evident and are widely recognized by the different professional groups involved (developers, architects). An information desk can also be used to support end-users, providing advice on energy systems to the population.
- **A simplified Ordinance can help ensure compliance;** in particular, making the administrative processes more accessible will augment the success of the STO.
- **Establish partnerships with other public institutions.** This particularly applies to those with interests in the energy field. Universities and professional associations can help to share roles, costs, and assist in both the dissemination of information and the raising of awareness.
- **Obtain citizen support, including from key stakeholder groups**, in order to ensure the successful implementation of the measures set out in the legislation. To do so, the administration must ensure that citizens see the co-benefits both for themselves and their wider community. For this purpose, the City Council has implemented a set of measures that ranges from stakeholder engagement to raising awareness: a participatory discussion forum was used to reach a consensus regarding the amendment of the ordinance. Moreover, the city ran educational and information campaigns, held meetings with key technical professional groups (including City officials and architects), and led a solar discussion forum to identify the opportunities and barriers of this technology. By taking these measures, the City has engaged with developers, designers, the construction sector, and the solar thermal industry to promote the use of renewable energy through the decreasing a buildings' primary energy consumption.
- **Synergies can be found with solar electricity.** The installation of solar systems in public areas can help to raise the visibility of solar energy and its acceptance by the population. In 2009, the Barcelona Transport Authority introduced 2000 solar powered bus stops in 18 communities throughout the Barcelona metropolitan area. These bus stops have an electronic panel that updates the bus schedules every 30 seconds. As these stops are entirely self-sufficient, they can be installed with much greater ease and speed than if they had to be connected to the local electricity grid. The stops are also remarkably energy efficient (they can run for up to five days without solar radiation) and have been praised for their modern design.

### Solar water heaters in Belem, Brazil

Although there is no data available on the cost savings achieved by the private sector in Barcelona, the installation of solar water heaters in Betim, Brazil, resulted in 20 percent savings of electricity consumption for the average three-to-four member family. This was confirmed through a survey on households where the equipment had already been in place since between two and five years earlier.<sup>6</sup>

#### Main benefits of solar thermal systems delivery at large scale

##### Community

- Economic growth associated with the solar thermal market
- Job creation
- Reduced fossil fuel consumption and dependency
- Improved air quality where fossil fuels are replaced
- Potential to reduce the end-consumer's energy bill

## Key Contacts

**Barcelona City Council**  
Barcelona Energy Agency  
Barcelona, Spain  
Tel: +34-932/564 430  
Email: [agenciaenergia@bcn.cat](mailto:agenciaenergia@bcn.cat)  
<http://www.barcelonaenergia.cat/>

**ICLEI World Secretariat (WS)**  
*Capacity Center*  
Kaiser-Friedrich-Str. 7  
53113 Bonn, Germany  
Tel. +49-228 / 97 62 99-00  
Fax +49-228 / 97 62 99-01  
Email: [capacity.center@iclei.org](mailto:capacity.center@iclei.org)  
[www.iclei.org](http://www.iclei.org)

## Acknowledgements

Authors: Ana Marques (ICLEI World Secretariat; Toni Pujol (Barcelona City Council)

Contributors: Fermín Jimenez, in charge of the Solar Ordinance (Barcelona Energy Agency); Manel Torrent i Aixà, Technical Director (Barcelona Energy Agency); Michael Woodbridge (ICLEI World Secretariat)

Editors: Siegfried Zöllner (ICLEI Europe); Kathrine Brekke & Maryke van Staden (ICLEI World Secretariat)

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## Replication

One of the most noteworthy elements of the STO is the extent to which it has already been replicated; over 70 Spanish municipalities have implemented similar ordinances,<sup>8</sup> and the Barcelona model is internationally recognized as a best practice initiative.

The factors required to make the implementation of a solar thermal ordinance a success are strong political will, combined with the support of key professional groups and the general public. The Barcelona City Council has encouraged the development of its STO through periods of resistance, and this reflects their long standing commitment to the integration of sustainability principles and values into municipal policies and actions, which includes the promotion of the rational use of energy and of the use of renewable energies.

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Agenda 21 indicators, Barcelona statistical department



**Ajuntament  
de Barcelona**

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ICLEI World Secretariat. Kaiser-Friedrich-Straße 7, 53113 Bonn, Germany  
Email: [urban.research@iclei.org](mailto:urban.research@iclei.org)

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