# RENEWABLES IN THE CITY ENVIRONMENT

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ABSTRACT: Renewables In The City Environment (RICE) is an EU ALTENER project, focussing on the problems and opportunities of exploiting renewable energies in urban areas. Its major output is a web based information resource. The RICE web site is centred around over 40 case studies, covering a range of renewable energies. The studies describe the issues (like town planning, site obstruction and pollution) which arose from their urban locations. The web site also contains general information about renewables and their role in cities, and links to other useful sites. Other project outputs include a set of brochures on the application of renewable energies in cities, and a Spanish translation of the design guide 'Environmental site layout planning: solar access, passive cooling and microclimate in urban areas.'

## 1. INTRODUCTION

Since most of Europe's population live in cities, renewable energies have to be widely adopted in urban areas if they are to achieve extensive market penetration. However there are special problems with adopting renewables in cities. The availability of the renewable energy resource itself may be modified or reduced by the surrounding urban environment.

For passive solar design in northern latitudes site layout is of particular importance. Because of low solar altitudes careful spacing of buildings is necessary to obtain solar gains throughout the winter but there are important benefits (typically around 10% of heating energy costs in housing) because of the long heating season and low external temperatures. Design studies in the UK [1] have shown that the benefits of passive solar design can be halved if the site layout is inappropriate.

Diffuse daylighting is a key strategy in the cloudy climate of northern Europe. The effective exploitation of daylight could lead to energy savings of 3-6 million tonnes of coal equivalent by 2020 [2]. To realise the benefits of daylighting, however, urban layout must minimise the problems of obstruction and overshadowing. Large obstructions both reduce the amount of daylight entering and worsen its distribution in the room. For example a 45 degree obstruction can halve the daylight coming in and reduce lighting energy savings by 20-25%.

In southern Europe, passive cooling becomes vitally important. Air conditioned buildings typically consume 50% more energy than naturally ventilated buildings, and in Southern Europe their maximum cooling demand coincides with times of peak general electricity consumption, resulting in utilities having to build extra power stations and increase the cost of electricity. However monitored results from the POLIS project [3] show that inappropriate urban design can result in a 5-15°C rise in temperature on the hottest days of the year, reducing the viability and effectiveness of passive cooling, and driving up air conditioning costs still further. Conversely climate sensitive urban layout techniques have been shown to cause a significant decrease in urban temperatures (4-8°C) in mid-summer.

Obstruction is a particularly important issue for photovoltaic facades. For example the obstructions to the Northumbria Building (Newcastle, UK), even though they are not particularly large, result in a 25% loss in output on average [4]. For selected PV arrays in Germany Jahn et al [5] report similar losses, averaging 20%. As the European White Paper envisages 500,000 1 kW building integrated PV systems being installed in Europe by 2010, this loss in output is overall extremely significant. Improved building layout strategies coupled with electrical design strategies can easily halve this output drop.

There is increasing interest in tapping wind energy in urban areas. The risk of noise from turbines has been an issue, but much quieter generators are now available. There are free standing harbour front installations in Copenhagen and in Blyth (UK). The possibility of building mounted wind turbines has been considered too. A key constraint, though, is the reduced wind energy availability due to the drag of the urban boundary layer caused by buildings.

Planners and developers are taking an interest in these issues, wanting to increase the uptake of renewable energies within an urban renewal context. Unfortunately current guidance and design tools do not give them the information they need. Building design guides concentrate on the interior environment with cursory, if any, treatment being given to the exterior layout. The city zoning guidance that is available tends to come from the United States, and is less appropriate to European conditions with less land available and less reliance on very tall buildings [6].

## 2. THE PROJECT

The Renewables In the City Environment (RICE) project tackles these issues. It aims to promote the use of renewable energies in cities. This involves :

- Gathering existing practical experiences of renewables in European cities and identifying the most effective and reproducible ones.

- Producing case studies of these examples in a common format
- Providing a comprehensive web based information resource including the case studies and a range of other material
- Further dissemination to those areas of the design and client communities without direct internet access. This includes the production of brochures, seminars and other design guidance.

## 3. THE RICE WEB SITE

### 3.1 Introduction

The web based information resource is now up and running at www.lema.ulg.ac.be/tools/rice. The core of the site is the case study material, although it includes a wide range of supporting information too.

### 3.2 The case studies

At the project planning stage it was decided that the case studies should be

- involving renewable energy
- on an urban or suburban site,
- where urban layout issues are important
- already built or at least under construction or at the planning stage.

Using these criteria the team selected 63 case studies spread throughout Europe. Case studies were taken from the partners' own experience and also the renewable energy literature, particularly Project Monitor [7]. An additional 8 studies were considered but rejected, either because they failed one of the criteria above, or because not enough information could be acquired about them. To date (October 2000), 47 of the studies have been installed on the site.

The selected case studies are listed below, together with the type of renewable energy and the urban pattern in which they are set.

**Austria**
Brunnerstrasse/Empergergasse, Vienna Multiple rows/ housing/ passive solar, protection from road noise
**Belgium**
Berlaymont, Brussels Open block/office/double façade, solar gain
CERA Bank, Leuven Bank/aquifer storage
Electrabel, Leuven Office/PV
Holiday Inn, Antwerp Hotel/cogeneration
Marchin, Liege Terraces/housing/solar gain RTBF, Mons, Belgium Detached/office (refurbishment)/cogeneration
Pierre Leclerq Terraced/house/passive solar
Pleiade, Louvain-la-Neuve Terraces/housing/solar gain, daylight
RTBF-Hainaut Industrial/cogeneration
**Denmark**
Baggesensgade, Copenhagen Closed border/housing (group) /sunspace, refurbishment
Smakkebo Semi detached/housing/passive solar
**France**
Bethercourt-sur-Mer Semi-detached/housing/solar
Jeux du Soleil, St Brieuc Open blocks/housing/roof mounted solar
Les Basses Fouassieres, Angers Terraces /housing /sunspace, Trombe wall
Les Garennes, nr Versailles Terraced/housing (group)/sunspaces, roof mounted solar
Le Lievre d'Or, Dreux Open block/housing (group) sunspace. Trombe wall
Les Pradettes, Toulouse Closed border/housing/passive solar
Les Tournesols, nr Lyon Semi detached/housing/passive solar, solar water heating
College, Modane, France Open block/school/daylight
Place du Millenaire, Montpelier, France Open space/vegetation
**Germany**
Hauser auf der Pick, Landstuhl Detached/housing/passive solar, solar water, earth shelter
Lindenwalde, Freiburg Multiple rows/houses/sunspace
Schools, Germany School, passive and active solar, natural ventilation
**Greece**
Abelokipi, Athens Housing/direct solar, trombe walls, greenhouse, natural ventilation
Alexandras Avenue, Athens Office/passive solar/ventilation/shading
Avax office, Athens city centre Office, daylighting, passive cooling
Filothei, Athens Housing/passive solar, vegetation, landscaping
Solar dwellings in Kalamata Housing/evaporative cooling, shading
Pedestrian streets, western Athens Outdoor spaces, solar gain, solar control, wind and landscaping
Poligono, Athens Houses/passive solar/vegetative cooling/landscaping
Polidroso, Athens Office, daylight, natural ventilation
Schools in Rethemnion Passive solar/solar panels
Solar village, Likovrisi, Athens Housing (group), passive and active solar, estate layout
Thermi, Thessaloniki Housing, direct solar, trombe walls, greenhouse, natural ventilation
**Ireland**
Carrigeen Park, Clonmel Terraced/housing/passive solar
**Italy**
Barbaricina, Pisa Open block/housing (group)/sunspace, solar water, wind shelter
Marostica Multiple rows/housing/passive solar, solar water heating
UPSE, Torino Open block/housing (group)/sunspaces, roof solar panels
**Netherlands**
Hoofdoorp, nr Amsterdam Multiple rows/housing/passive solar
**Norway**
University of Trondheim Block/university/courtyards, daylight
**Portugal**
EXPO site (ZIN), Lisbon Open space-restaurant/solar protection
**Spain**
UPC, Castelldefells, Catalonia University/outdoor microclimate
Ensanche de Vallecas, Madrid Housing/climatic urban design
Llavaneres, Catalonia Detached/housing/earth sheltering, passive solar

Los Molinos, Alicante Educational/urban design/courtyard/landscape
La Salut, Barcelona Terrace/housing/sunspaces
San Esteban, nr Valladolid Open block/housing/Trombe wall, sunspace, solar panel
Housing, Sevilla Multiple rows/housing/overshading, albedo
Santa Cruz, Sevilla various/shading
Expo Sevilla Outdoor spaces/cooling
Sevilla Green City Open spaces/vegetation, reforestation
Vores les Rondes, Barcelona Housing groups/climatic urban design

**United Kingdom**

Blyth Harbour Wind Farm Detached/ industrial area /wind energy
Bournville Solar Village Detached/housing/passive solar
Christopher Taylor Court Closed border, open block/housing group/Trombe wall
Doxford Office, Sunderland Detached/office/PV (tested for reflected glare)
Earth Centre, Conisbrough. Detached/exhibition/PV, daylight, solar heat
Giffard Park, Milton Keynes Multiple rows/housing/ passive solar with conservatories
Lowrie Park Road, London Multiple rows/housing/ sunspace, solar water heating
Pennyland, Milton Keynes Terraces/housing/passive solar
Willow Park, Chorley Detached (housing)/passive solar

An agreed dataset of information has been gathered about each case study. This includes location, climate, details of the building designer, plus detailed descriptive information on the urban setting, the technical challenge, the approach adopted and the degree to which the objectives were realised, with monitored data where available.

3.3 Other information on the site

The site includes a wealth of other information on the topic of renewables in urban areas. This includes:

- Introduction to the project.
- A comprehensive Questions and Answers section, giving detailed guidance on the range of renewable energies considered.
- Glossary of terms.
- A description of the TOWNSCOPE program [8], a software tool to evaluate urban environments
- A summary of the design guide ‘Environmental site layout planning: solar access, passive cooling and microclimate in urban areas’ [3] produced as paart of the earlier POLIS project
- Links to a range of relevant web sites including the ALTENER home page
- Details of the partners, including links to partner web pages.

## 4. SUPPLEMENTARY DISSEMINATION STRATEGIES

The following extra activities are being undertaken.

a) Brochures. A set of four brochures is being produced, to cover access to passive solar gain and daylighting in the city, the heat island effect and passive cooling, ventilation of street canyons and its impact on passive cooling design, and use of vegetation and water to promote passive cooling.

b) Translation into Spanish of the POLIS design guide on ‘Environmental site layout planning: Solar access, microclimate and passive cooling in urban areas’ [3].

c) A major seminar for urban designers and local authorities on planning for renewables and the urban environment, held at BRE on March 24th 2000.

d) articles in trade and other journals.

e) workshops on ‘Planning for daylight and sunlight’ for local authority planning officials

## 5. CONCLUSION

The RICE project provides comprehensive information on the key issue of exploiting renewable energies within the urban environment. This includes a set of detailed case studies. The project is due to be completed in December 2000.

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## REFERENCES

[1]