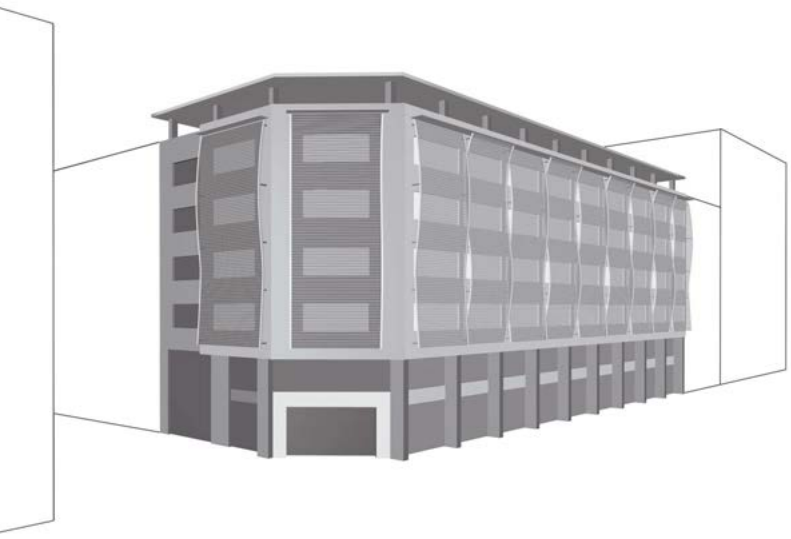
ZUMTOBEL



# Building efficiency study

How lighting control and solar protection systems can reduce an office building's energy consumption

**January 2012**

aj enginyeria

CREVER

Universitat Rovira i Virgili

## Real-time measurements confirm energy savings of up to 30 percent

Experts from design and research joined forces to determine the impact of a control system for lighting and anti-glare protection on an office building‘s energy consumption. The building examined, which is situated in Barcelona, was refurbished in 2009 and fitted with a Zumtobel control system. This system controls the lighting and adjusts the slats of the blinds dependant on daylight and the position of the sun. The scenarios simulated on the basis of a model building and the energy savings thus calculated were verified using real-time measurements. The impressive result: Zumtobel‘s control system is able to reduce the building‘s total energy consumption by up to 30 percent.


UNIVERSITAT ROVIRA I VIRGILI
DEPARTAMENT D'ENGINYERIA MECÀNICA

Alberto Coronas, catedrático del area de Máquinas y Motores Térmicos del Departamento de Ingeniería Mecánica de la Universidad Rovira i Virgili

Hace Constar

Que el Estudio " Análisis del impacto energético de las medidas de control solar y lumínico aplicadas en el edificio SCDT de la Generalitat de Catalunya" ha sido realizado por Arturo Ordoñez Garcia bajo mi supervisión y con la colaboración de Jose Luis Hernandez de la empresa AJ Enginyeria

Y para que así conste, firmo este documento en Tarragona a 30d e Noviembre de 2011

Certification of the authors' independent study.

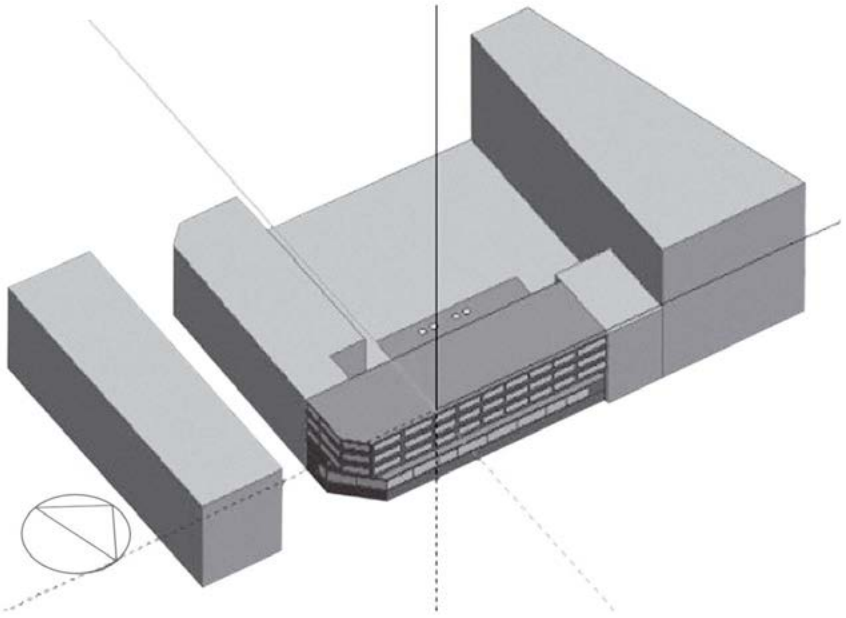
Authors of the study: AJ INGENIERÍA José Luis Hernández, industrial engineer, in collaboration with CREVER research group for applied thermal engineering and URV Universitat Rovira i Virgili in Tarragona.

The architecturally sophisticated façade fitted with movable slats (left picture) has a positive impact on the building's energy balance. The picture to the right shows the building before refurbishment.

**Serveis Territorials del Department de Treball de la Generalitat de Catalunya, Barcelona | ES**
Architect: Joan Francesc Serra Andreu, Barcelona | ES
Electrical consultant: Dr. Ing. Ind. Juan Hernandez Mayor, Barcelona | ES
Lighting solution: LUXMATE lighting management with external daylight sensor, PANOS Q LM downlights

# Key data on building and method of work

**The building under examination accommodates public and private offices. The total floor space of around 6,800 m² is distributed over six floors. The size of the building did not change during refurbishment. Only the room layouts were changed and the control systems for lighting and blinds control were implemented.**



3D model created using the “DesignBuilder” software

## System components

**Control bus**
The Zumtobel control system is based on a field bus supporting free topology wiring, which ensures that future expansions or adjustments of the system can be made in an easy and cost-effective manner. Addressing requires neither complex programming consoles nor specific computer software.

**Communication system**
All luminaires are individually controlled using a digital DALI signal, the scope ranging from a minimum level of 1-3 % to 100 %. All control modules feature the service of monitored outputs for localising malfunctions.

**Lighting**
In offices and foyers, 600 x 600 mm wide-area luminaires including double parabolic reflectors made of frosted aluminium, each fitted with three 24 W T16 fluorescent tubes, were installed. The toilet facilities are illuminated by 2 x 26 W and 2 x 18 W PANOS Q LM downlights. All luminaires, both of the Zumtobel brand and of the Lledó brand, are controlled via DALI.

**Blinds**
The motor-driven slats are controlled by the Zumtobel system. They protect the façade from direct sunlight and the people working in the building from glare.

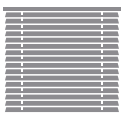
**Method of work**
An analysis was carried out based on dynamic energy simulations. Models and calculations were created using the DesignBuilder and EnergyPlus programs.

designbuilder.co.uk | sol-arq.com | apps1.eere.energy.gov/buildings/energyplus

**Measuring daylight**
The system obtains data via a central light sensor mounted at the top of the building. The external daylight sensor collects data regarding direct light incidence from every geographic direction as well as the diffuse light provided by the current state of the sky.

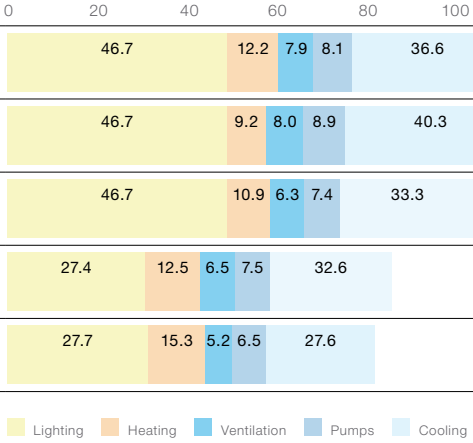
**Daylight-based control of luminaires**
The luminaires in rooms fully or partially illuminated by sunlight are adjusted depending on the daylight available, which increases user convenience and at the same time results in considerable energy savings.

**Automated slat positioning**
As soon as direct rays of light pass through the window, the position of the slats combined in groups are adjusted to the actual position of the sun. Thus, direct solar radiation is avoided, although diffuse incidence of light is allowed. In order to achieve a perfect result, both the building's geometrical structures and the shadows cast by adjacent buildings are considered by the control system.



# Scenarios and their results

| Scenario | | Energy consumption in kWh/m² | Total | Saved |
|---|---|---|---|---|
| 01 | Building before refurbishment | 46.7 / 12.2 / 7.9 / 8.1 / 36.6 | 111.2 | -1.7 % |
| 02 | Refurbished building without slats and without lighting control | 46.7 / 9.2 / 8.0 / 8.9 / 40.3 | 113.1 | Reference value |
| 03 | Refurbished building, with slat control | 46.7 / 10.9 / 6.3 / 7.4 / 33.3 | 104.6 | -8.1 % |
| 04 | Refurbished building, with lighting control | 27.4 / 12.5 / 6.5 / 7.5 / 32.6 | 86.5 | -23.5 % |
| 05 | Refurbished building, with slat and lighting control | 27.7 / 15.3 / 5.2 / 6.5 / 27.6 | 82.3 | -27.3 % |




After refurbishment of the building, four possible scenarios for lighting control were designed: no control at all, control of the solar protection system alone, lighting control alone and a combination of both. Each scenario was simulated over the course of an entire year in order to obtain relevant and far-reaching data on energy consumption with respect to lighting and air conditioning.

**Energy consumption**
Consumption data for lighting and air conditioning were analysed individually for each scenario. For the scenarios without slat control, a solution with transparent curtains inside was simulated.

**Lighting systems**
All scenarios were calculated with the installed load (W/m²) of the lighting system actually installed in the building. This also applies to scenario 01, so that the increased energy efficiency of the newly installed luminaires and electronic devices does not have any impact on the evaluation.

**Air-conditioning system**
Simulation of the heating and cooling systems was dimensioned for optimum convenience at all times of occupation over the entire year. Differences relevant for comparison of energy efficiency levels emerged mainly with respect to air-conditioning. The same system was chosen for all scenarios, so that improvements due to more efficient devices do not have any impact on the evaluation of the lighting control system.

**-1.7 %**

**01 Before refurbishment**
The total energy consumption is 1.7 percent below that of the refurbished building. The insulation of the new external walls of the main façade has been improved, their heat storage capacity is lower.

**Reference value**

**02 Refurbished building**
The refurbished building without control systems serves as a reference for comparing energy efficiency levels so that the improvement achieved by the slat and lighting control systems can be clearly identified.

**-8.1 %**

**03 Refurbished building with slat control**
Thanks to the installation of movable solar protection slats, energy consumption for cooling is significantly reduced from 40.3 kWh/$m^2$ to 33.3 kW/$m^2$. Energy consumption for heating, however, slightly increases from 9.2 kWh/$m^2$ to 10.9 kWh/$m^2$, since the improved anti-glare protection results in somewhat increased heating demands in winter.

**-23.5 %**

**04 Refurbished building with lighting control**
Energy consumption for lighting is nearly cut in half, from 46.7 kWh/$m^2$ to 27,4 kWh/$m^2$. Energy consumption for cooling is reduced from 40.3 kWh/$m^2$ to 32.6 kWh/$m^2$, since the luminaires emit less heat thanks to reduced switch-on times and lower lighting levels.

**-27.3 %**

**05 Refurbished building with slat and lighting control**
Scenario 05 comprises all steps taken during refurbishment and achieves the best overall result. A comparison with scenario 04 without slat control shows that energy consumption for cooling is further reduced from 32.6 kWh/$m^2$ to 27.6 kW h/$m^2$, since the slats mounted on the façade provide solar protection, whereas energy consumption for lighting and heating is only slightly increased. Extrapolated to the total floor space of 6,800 $m^2$ and taking into account the local energy price of EUR 0.15*, the overall result is impressive: 196,520 kWh of energy and EUR 29,487 of energy costs are saved each year.

* according to www.endesaonline.com, as at November 2011

Thanks to combined slat and lighting control, a total of 30.8 kWh/$m^2$ are saved each year, in comparison with the building without any control system. Thus, total energy consumption was reduced by 27.3 percent, amounting to annual savings of EUR 29,487. For lighting, even savings of more than 40 percent are possible.

**Study details**
Scan this QR code to see the full details of the study at
**zumtobel.com/barcelonastudy**

# ZUMTOBEL


**United Kingdom**
Zumtobel Lighting Ltd.
Chiltern Park
Chiltern Hill, Chalfont St. Peter
Buckinghamshire SL9 9FG
T +44/(0)1753 482 650
F +44/(0)1753 480 350
uksales@zumtobel.com
zumtobel.co.uk

**USA and Canada**
Zumtobel Lighting Inc.
17-09 Zink Place, Unit 7
Fair Lawn, NJ 07410
3300 Route 9W
Highland, NY 12528
T +1/(0)845/691 6262
F +1/(0)845/691 6289
zli.us@zumtobel.com
zumtobel.us

**Australia and New Zealand**
Zumtobel Lighting Pty Ltd
333 Pacific Highway
North Sydney, NSW 2060
T +61/(2)8913 5000
F +61/(2)8913 5001
info@zumtobel.com.au
zumtobel.com.au

**China**
Zumtobel Lighting China
Shanghai office
Room 101,
No 192 YIHONG Technology Park
Tianlin Road, Xuhui District
Shanghai City, 200233, P.R. China
T +86/(21) 6375 6262
F +86/(21) 6375 6285
sales.cn@zumtobel.com
zumtobel.cn

**Hong Kong**
Zumtobel Lighting Hong Kong
Unit 4319-20, Level 43,
Tower 1, Metroplaza,
223 Hing Fong Road,
Kwai Fong, N.T.
T +852/(0)2503 0466
F +852/(0)2503 0177
info.hk@zumtobel.com

**India**
Zumtobel Lighting GmbH
A 274, 1st Floor,
Defence Colony,
110024 New Delhi
T +91/98 102 19 531
enquiries.india@zumtobel.com

**Singapore**
Zumtobel Lighting Southeast Asia
5 Kaki Bukit Crescent,
#04-02 Koyotech Building
416238 Singapore
T +65 6844 5800
F +65 6745 7707
info.sg@zumtobel.com

**United Arab Emirates**
Zumtobel Lighting GmbH (Branch)
Dubai Airport Free Zone,
Building 6W, B Block, 233
PO Box 54302
Dubai
T +971/(0)4 299 3530
F +971/(0)4 299 3531
info@zumtobeluae.ae

**Romania**
Zumtobel Lighting Romania SRL
Tipografilor 11–15,
S-Park Office, Wing A1-A2
013714 Bucharest
T +40 312253801
F +40 312253804
welcome.ro@zumtobel.com
zumtobel.com

**Hungary**
Zumtobel Lighting Kft
Váci út 49
1134 Budapest
T +36/(1) 35 00 828
F +36/(1) 35 00 829
welcome@zumtobel.hu
zumtobel.hu

**Croatia, Bosnia and Herzegovina**
Zumtobel Licht d.o.o.
Radnička cesta 80 – Zagrebtower
10000 Zagreb
T +385/(1) 64 04 080
F +385/(1) 64 04 090
welcome@zumtobel.hr
welcome.ba@zumtobel.com

**Serbia**
Zumtobel Licht d.o.o.
Karadjordjeva 2-4
Beton Hala
11000 Belgrade
T +381/(0)11 65 57 657
F +381/(0)11 65 57 658
welcome@zumtobel.rs

**Czech Republic and Slovak Republic**
Zumtobel Lighting s.r.o.
Jankovcova 2
Praha 7
170 00 Praha
T +420/(2) 66 782 200
F +420/(2) 66 782 201
welcome@zumtobel.cz
zumtobel.cz

**Poland**
Zumtobel Licht GmbH Sp.z.o.o.
Platinium III
ul. Wołoska 9a
02-583 Warszawa
T +48/(22) 856 74 31
F +48/(22) 856 74 32
welcome@zumtobel.pl
zumtobel.pl

**Slovenia**
Zumtobel Licht d.o.o.
Štukljeva cesta 46
1000 Ljubljana
T +386/(1) 5609 820
F +386/(1) 5609 866
welcome@zumtobel.si
zumtobel.si

**Russia**
Zumtobel Lighting GmbH
Official Representative Office
Skakovaya Str. 17
Bld. No 1, Office 1104
125040 Moscow

T +7/(495) 945 36 33
F +7/(495) 945 16 94
info-russia@zumtobel.com
zumtobel.ru

**Norway**
Zumtobel Belysning
Hoffsveien 4
Postboks 1025 Hoff
0218 Oslo
T +47 22 06 50 50
F +47 22 06 50 52
firmapost@zumtobel.com
zumtobel.no

**Sweden**
Zumtobel Belysning
Birger Jarlsgatan 57
113 56 Stockholm
T +46 8 26 26 50
F +46 8 26 56 05
info.se@zumtobel.com
zumtobel.se

**Denmark**
Zumtobel Belysning
Indiavej 1
2100 København
T +45 35 43 70 00
F +45 35 43 54 54
info.dk@zumtobel.com
zumtobel.com

**Headquarters**
Zumtobel Lighting GmbH
Schweizer Strasse 30
Postfach 72
6851 Dornbirn, AUSTRIA
T +43/(0)5572/390-0
F +43/(0)5572/22 826
info@zumtobel.info

Zumtobel Licht GmbH
Grevenmarschstrasse 74-78
32657 Lemgo, GERMANY
T +49/(0)5261 212-0
F +49/(0)5261 212-7777
info@zumtobel.de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