Energy Certification of Berlaymont

Summary Report on project results

July 2005

The Berlaymont Building

The Berlaymont was built in the 1960s to house the headquarters of the European Commission. The building was originally designed by architect Lucien de Vestel, in cooperation with fellow architects Jean Gilson and André Polak. They created an imposing, cross-shaped building, with a central hub and four wings of different sizes radiating out from it. It is a large building, containing over 240 000 m2 of floor space on 16 levels. The structure was so technologically advanced for its time as to be considered revolutionary: the superstructure was suspended by steel braces from preflex prestressed beams resting on a reinforced concrete core.

The Berlaymont complex provided office space for 3 000 Commission staff and also contained rooms for meetings and conferences, a cafeteria, a restaurant, TV studios, shops, store-rooms and parking space for some 1 600 cars. A number of underground connections linked the building to nearby road tunnels, the metro and the railway station.

The first European civil servants moved in 1967 and the building was occupied until 1991. Over time, the building and its fittings came to show their age and no longer met the occupants' requirements. By 1991, it became clear that major works were needed to remove the large quantities of asbestos that were present in the building and the decision was made to go ahead with a full-scale renovation aiming at:

- *Creating a sober and functional building that projects an image corresponding to what is expected of such an institution*
- *Making the building as adaptable to changing needs as the existing structure would allow*
- *Integrating the building onto its urban environment more successfully, making it better accessible and more open to the public spaces around it, while allowing for security requirements*
- *Maintaining the existing capacity while increasing the work space and cellular office modulation*
- ***Creating a model building in terms of environmental protection and energy savings by applying, wherever possible, international and European directives that meets the highest environmental standards, is a model of energy efficiency and adheres to all international and European guidelines***
- *Creating a model of comfort for its occupants and visitors with high quality of space, direction, environment, vision, acoustics and operations.*
- *Preserving the symbolic value of the Berlaymont as the Commission's flagship building.*

The building reopened last year and, since November, it hosts the European Commission.

Table 1

Floor space above ground	130.309 m2	Capacity of self-service restaurant	760
Floor space below ground	111.206 m2	Meals served by day	2.000
Total floor space	241.515 m2	Rating of heating system	7.800 kW
Surface area of site	26.200 m2	Rating of cooling system	10.000 kW
No. parking spaces	1.156	Electrical power	13.000 kVA
Occupant capacity	2.250	Power of backup generators	2x1.250 kVA
No. of visitors per day	700	No. of lifts	47
No. of meeting rooms	33	No. of escalators	12
No. of interpreting booths	70	Cogeneration electrical capacity	2.500 kVA
Capacity of meeting rooms	933	Cogeneration heat output	2.000 kW

Source: "Berlaymont – Headquarters of the European Commission", OIB, 2004.

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1. The policy context

Under the Directive on the Energy Performance of Buildings[1]:

1. Member States will develop an integrated methodology for calculating the energy performance of a building (Article 3);
2. Member States will set minimum energy performance requirements on all new buildings and on large existing buildings undergoing major refurbishment (over 1000m2) (Article 4);
3. Energy certificates will be required when buildings are new, sold or rented (Article 7);
4. All large public buildings will be required to display this certificate (Article 7.3); and
5. Boilers and air-conditioning systems over a certain size will be inspected regularly (Article 8 and 9).

The Directive entered into force on 4th January 2003 (2002/91/EC). Member States must implement the measures set out in the Directive by 4th January 2006. They may apply for an additional 3 years because of a lack of qualified experts.

This Directive is a key element of the EU's strategy to meet its Kyoto Protocol commitments. Buildings account for 40% of the energy consumed in the EU and research shows that more than 1/5 of this energy could be saved by applying tougher standards on buildings.

A regulatory Committee has been established by the Directive – the Energy Demand Management Committee. The Committee is tasked with updating the annex of the Directive (which sets out the issues that should be covered by the methodology); and assisting the Commission in evaluating the impact of the Directive and in making proposals for additional energy efficiency measures in buildings. Before the implementation date, this Committee will discuss progress in implementation and share good practice.

2. Rationale and aims of the project to certify Berlaymont

At the meeting of the Energy Demand Management Committee on 19th March 2004, it was decided to set up two sub-groups; the first to monitor the work of the European Committee for Standardisation (CEN) to develop the methodology to calculate the energy performance of a building; and the second to undertake the energy certification of the Berlaymont building.

Although Member States have until January 2006 to implement this and the other measures in the Directive, the recent refurbishment of the Berlaymont building

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1 Directive 2002/91 of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, OJ L 1, of 4.1.2003, p. 65

offered an excellent and timely opportunity for the Commission to lead the way by undertaking an energy certification process for its newly refurbished headquarters, the Berlaymont Building.

Austria, France, Germany, Netherlands, Poland and Portugal agreed to participate in the Berlaymont Working Group and to issue their own certificates and/or analysis of the building, and have appointed experts. These Member State experts use their own calculation methods to determine the energy performance of the Berlaymont building.

The Commission considers that a prominent display of energy certificates from a number of European countries will highlight the European nature of this building and attract media attention. *Bruxelles-Capitale* will eventually be the responsible authority to ensure that the Berlaymont and other public buildings in its jurisdiction comply with the Directive. Representatives from *Bruxelles-Capitale* were involved in the project but will not be applying its own system for certification since it is under development.

This project offers a practical way to tackle the difficulties that may arise in certifying existing buildings more generally and to give Member States the opportunity to work together by piloting their methods for certification.

The **main goals of this project** were to:

- Make a public statement of commitment by the Commission on the importance of reducing energy consumption in buildings through the provision of an energy performance certificate.
- For Member States to pilot their method on a complex building and to learn from the other methods of certification.
- Raise the awareness of the Energy Performance of Buildings Directive and that Member States are required to introduce these new measures by January 2006.

This project is primarily an awareness raising, information-sharing and public relations exercise. It was not the intention to produce highly accurate and detailed energy performance certificates, or to compare the results from the different energy certificates. The overriding priority was that the energy certificates are available when the building is fully occupied and operational, since the key purpose of the project is to publicise the Buildings Directive.

The text of the Directive also calls for recommendations on the cost-effective improvement of the energy performance of the building (Article 7.2), but this is not within the scope of this project.

To support the Berlaymont Working Group, DG TREN has agreed to collect the information needed to calculate the energy performance of the Berlaymont building. In July 2004, the Commission contracted the assistance of a consultancy company, COMASE SA (Belgium), who is familiar with the Berlaymont building and has the knowledge and experience to collect and verify the necessary data.

3. The Energy Savings Features of the Berlaymont Building

The building complies with the legal requirements set in Belgium: a study of the building was undertaken in 1995 to show compliance with Belgium's K70 global insulation standard.

Façade
There is a double façade: the inner part has floor to ceiling glazing and the outer leaf has mobile glass louvers. It provides uniform lighting inside the building by the changing position of the louvers depending on the position of the sun. At the same time it prevents overheating of the building and works like a coat in cold winter. The louvers should reduce unwanted solar energy absorption by 89% on warm days. The glazing has very good insulation (U-value 1.5). There are black and white spots on the glass to make them as light-permeable as possible while reducing glare.

Lighting
There is an intelligent lighting system. The lighting of the offices is managed automatically. Thanks to probes, its light intensity changes according to the amount of daylight available. With full sunlight, only about 10% of artificial lighting will be used. Infrared sensors switch off the light automatically after 10-15 minutes if no one is in the room. The installed lighting capacity is 8w/m2 for offices.

Heating/Air-conditioning
A gas-fired cogeneration station on the top floor of the building generates electricity and heat at the same time. The electricity is used in the building and the heat produces hot water. The cogeneration station uses less fuel to produce electricity and heat together than if each were generated separately.

To minimise the amount of power consumed by the refrigeration units, an ice storage system has been installed. The ice is produced at night when energy prices are low and used during the day for the air-conditioning system.

A ceiling air-conditioning system for offices saves energy without generating noise or draughts or taking up floor space. There are insulated copper coils in the ceiling through which a fluid is pumped. In winter, hot water is pumped to prevent draughts and cold radiating from the windows. In summer, cold water is pumped to cool the air. Water temperature is controlled by the use of sensors to avoid condensation in the ceiling.

The air-conditioning in a room is automatically shut-off when the window is opened. This is a simple measure which can generate substantial savings.

Building Management System
Comfort levels are provided during working hours (between 8am and 9pm weekdays) and working hours can vary throughout the building. Ventilation and heating and cooling are stopped outside working hours. In the morning, the systems start running again and new air is provided. The start time is dependent on the time needed to attain comfort zone.

The ventilation system is specified to provide airflow of 35 m3/hour/air flow duct during the comfort period (between 8am and 9pm). The Belgium norm is 30m3/hour/person. There will be 2 air ducts for the smaller office space in the tower. Variable speed drives are installed on all floors.
No global estimation of energy to be consumed (kW/hr), but the University of Liege predicted the energy consumption of 2-3 offices, including internal gains.

Solar panels may be installed on the roof in the future but for hot water only.

Management of the lifts
The management of the calls of the lifts is completely computerized, resulting in a more rational and economic use of the lifts.

Toilets
Water collectors running underneath the building rainwater are used to flush toilets and urinals. Rainwater is also channeled to the watering plants system.

4. Methodology and Assumptions made

The project was broken down into the following 6 steps:

A. Assessment and agreement of data and confirmation that existing information is suitable for use
B. Compilation of the final data set and assumptions
C. Interpretation of the data set and assumptions by Member States experts; collection of supplementary data
D. Berlaymont building tour and inspection
E. Analysis and energy calculation by Member States' experts
F. Delivery of the energy certificates by the Member States' experts and reporting

During the project, the Commission organised three working meetings with the Berlaymont Working Group in Brussels (March, September and November 2004). COMASE SA took part in the September meeting to present the refurbishment of the Berlaymont Building and the available data.

The Berlaymont Working Group agreed that **one final set of data** should be used by all participants as well as **one set of assumptions** about how the building may perform during use. This is due to the fact that the overall quality of the data and process determines the accuracy of the final certificates issued. Also, the acquisition of data is time consuming for any complex building, especially for experts who are unfamiliar with the building. Finally, the data acquisition and inspection phases are considered to be the main sources of inaccuracy since the interpretation of experts can vary substantially.

This implies interpreting the building in terms of energy behaviour. A building has to be defined in physical terms in order to perform the calculations with a specific model. For instance: one has to decide how many zones are necessary to simulate the building; how the HVAC systems are related to the different zones and how they interact; what the expected nature is of the energy flows between zones. This is not just a matter of interpreting the building but also relates to the possibilities and constrains of the calculation model. There are models that only allow a one-zone interpretation of the building, while others might allow a multi-zone modelling. Thus the interpretation is model and building dependent. When the interpretation of the building is clear it is possible to define the necessary data for the calculation.

The Berlaymont Working Group agreed on the following **working assumptions**:

- Firstly, the Berlaymont building is located in their country, while using the climate and weather conditions for a reference location that is most similar to the Brussels weather data. Some countries, like Portugal, estimated a comparable Brussels weather data set, and this may mean establishing a fictional climate zone;
- Secondly, to examine the list of input data provided by, as well as the building interpretation assumptions made by the Netherlands (see Annex A) and to use it where appropriate. This will help reduce the variation of the final result between the Member States;
- Thirdly to include, at least, the first basement, this has the cafeteria and press rooms, in the energy calculation. Some countries, like Germany, also included the lower floors into the calculations.

In order to keep the project simple, the final data and assumptions were collected by COMASE SA experts who are familiar with the Berlaymont building and its archives. The COMASE experts were also called on to help Member State experts interpret the data and to give advice, for example suggestions on the number of appropriate zones that could be used. Where possible, data has been derived from the planned documents since the ‘as built’ documents were not ready in time. In fact, no running data would have been available until September/October 2004 at the earliest. Therefore, design data had to be used. It was assumed that the building had not been built and the data came from the design specification. COMASE SA was asked to find the most accurate and recent data.

The Member State experts verified and used the information provided by COMASE SA and the elements gathered during the building and classify the building according to their own National scale. There was a need to consider what benchmark to use. The data was transformed into input for the calculation models used by the experts. After execution of the calculation, the results of the energy consumption were determined, if possible together with primary energy use. Apart from the physical quality of the calculation model also other values affected the results, like climate data used in the model.

5. Summary of Member States’ results

Member States tested a number of different methods (e.g. simplified versus detailed; old versus revised method, etc.) to calculate the energy performance of the Berlaymont Building and delivered their energy certificates and reports to the Commission in November-December 2004. Austria had just appointed its expert in November and, therefore, was only able to produce its assessment and deliver the certificate in May 2005.

A short description of the Member States' methods is provided in Annex A of this report. Annex B includes the six certificates.

All certificates gave "Good" to "Very Good" energy efficiency ratings to the Berlaymont Building and concluded that it performs better than the average equivalent building in their country.

For instance, the Berlaymont Building is considered to be 45% better than the average energy demand of a group of analysed air conditioned office buildings in Germany, 41% better than minimum requirements in the Portuguese legislation, 24.2% better than a new building in the Netherlands and 7% better than a new reference building in France.

Table 2 summarises the results of Member States' assessments. There is no surprise that the **final results vary from country to country**: as the work was completed in advance of this legislation from being implemented, Member States used this opportunity to test national or new methods and to compare their results. These methods may emphasise different energy savings aspects of the building. As regards France, the only certified value is that of primary energy, so no further breakdown can be officially provided.

The **format and content of the certificates are not final or legally-binding**. Some Member States have not yet decided how their certificates will look, benchmarks or what information they will contain. In time, *Bruxelles-Capitale* will be responsible for ensuring that the Berlaymont and other public buildings in its jurisdiction comply with the Directive. Therefore, the comparison between certificates should be avoided (there is no right or wrong way) as the overall aim is to raise awareness of the legislation, to highlight the good cooperation between Member States and to emphasise the good energy saving aspects of the Berlaymont Building.

The Austrian and the Polish certificates gave a "C" as energy efficiency rating to the Berlaymont Building. Because of the fact, that this is the first rating for non residential building in Austria, the classification was defined as very conservative.

Table 2

	Austria	France	Germany	Netherlands	Poland	Portugal
No. of Zones ►	**19(144)**	**2**	**8**	**3**	**10**	**58**
Net Energy (specify units)►	**127,1 kWh/m²a**		**120,38 kWh/m²a**		**129,7 kWh/m²a**	**139,5 kWh/m²year**
Final Energy (specify units)►	**198,2 kWh/m²a**		**182,69 kWh/m²a**		**170,9 kWh/m²a**	**155,6 kWh/m²year**
Primary Energy (sp. units)►		**101 kWh/m²a**	**217,64 kWh/m²a**	**71.285.029 MJ/year**	**223,4 kWh/m²a**	**3.933.038 kgep/year**
Net Energy (specify units) Heating►	63,12 kWh/m²a		65,31 kWh/m²a		35,8 kWh/m²a	1,1 kWh/m²year
Cooling►	13,24 kWh/m²a		12,72 kWh/m²a		30,1 kWh/m²a	50,6 kWh/m²year
AC moisture/humidifying►	7,39 kWh/m²a		2,68 kWh/m²a		7,4 kWh/m²a	(included in cooling)
Ventilation (mechanical) ►	16,55 kWh/m²a		12,12 kWh/m²a		5,9 kWh/m²a	(included in heating and cooling)
Lighting►	18,19 kWh/m²a		18,69 kWh/m²a		13,4 kWh/m²a	14,5 kWh/m²year
Domestic Hot Water►	8,57 kWh/m²a		8,86 kWh/m²a		8,7 kWh/m²a	-
Solar Energy►			n.a.			-
Cogeneration►			Included in primary energy conversion		74,7 kWh_e/m^2a	Included in primary energy conversion
Equipment (if included) ►			n.a.		23,2 kWh/m²a	34,7 kWh/m²year
Pumps and Fans►			4,6 kWh/ m²a		3,3 kWh/m²a	27,2 kWh/m²year
Lifts and Parking►			5,57 kWh/ m²a (net parking energy)			11,4 kWh/m²year

6. Observations and lessons learned

The following observations and recommendations were made by the Member States experts:

- Assessing the energy performance of the Berlaymont Building was not an easy task, mainly due to the complexity of the building itself and its complex installations. In order to be able to compare the different European methods for the energy performance it is recommended to use a simple ‘shoe-box’ office;

- the complexity of the building has highly influenced the duration of the exercise and the effort spent by the experts, varying from approximately 2-3 days by the Dutch experts to 4 days by the German experts, excluding the time spent in the collection of the initial data, which was provided by COMASE. The collection of information usually represents the most expensive item in a building calculation.

- the hardest part in the exercise was to gather the information in order to make the assumptions;

- for the Dutch experts, it was not possible to compare the energy performance of the Berlaymont building with an existing building, since no benchmarks had been set; furthermore one key issue relates to striking the right balance between Reproducibility and Accuracy in this type of exercise;

- for the German experts, it was only possible to compare the results to a limited national survey, because the national requirement and benchmark system where not fixed at the time of the project;

- for the Portuguese experts, a major difficulty in the exercise relates to the building location as the climate in Brussels is totally different from anywhere in Portugal This has certainly an impact in the analysis and results, as the building designers chose solutions that are optimized for the Brussels climate and may not be optimized for the Lisbon (or elsewhere in Portugal) climate. For instance, cooling loads in Brussels are smaller than in Lisbon. Nevertheless, the solar protection is quite effective and the building still performs quite well, even in the Lisbon climate;

- for the Polish and Austrian experts, the exercise took longer than expected as there is no Polish method for this new type of building;

- Member States experts share the view that the quality of data acquisition is a key element influencing the overall performance of the certification process. In particular, deriving data through inspection and, in many cases, the level of completeness and realistic nature of the information extracted from the drawings and building description are the most dominant source of inaccuracy in this type of exercise. The acquisition of data, the actual calculation of the energy performance and the determination of an energy performance indicator explain the deviation that can be found between the experts’ calculations.

- Exact geometrical data are very important for a high quality of the calculation results. Floor spaces are defined in the COMASE documents. All other surfaces, like window areas and outside wall areas are not given. Specially, outside wall areas are very important for the calculation of the transmittance. To compare the results of the different countries in the future it will be necessary, that all countries use the same geometrical data and ambient data.

- The Buildings' Directive left a very high degree of subsidiarity in implementation, and there is a bottom up push for greater harmonisation. There is a clear desire to exchange information and experience between the various Member States so as to improve accuracy, as well as to increase harmonisation in order to be able to make comparisons between countries.

7. Conclusions and next steps

The Member States experts participating at this exercise concluded that the certification of large and complex buildings, such as the Berlaymont, can be a challenge and the co-ordination and cooperation between Member States has been very useful to benchmark and test the different systems of certification that exist or that are new.

As a follow up measure, the experts advanced that it may be interesting to repeat the certification in a few years using data on how the building actually performs so that a comparison can be made. The building could then be treated as "existing" rather than "new" or "major renovation", testing an operational rating against the initial asset rating, the only possibility at the opening of the building in November 2004.

In addition, replicating the Berlaymont exercise, but using other key European buildings, or a "normal" type of building in each country, would be an interesting follow up measure in order to set up a matrix of different buildings, and use it to compare and extract conclusions, notably towards greater harmonisation.

Finally, it results from the project that more work needs to be put on the accuracy, the methodologies as well as on technical issues related to the energy certification that are on the basis of its credibility.

To mark the completion of the Berlaymont energy certification project, on 22 June 2005, the Commission hosted a ceremony in the Berlaymont Building where the participating Member States presented their energy certificates to the Energy Commissioner, Mr. Andris Piebalgs and to the press. The permanent display of the six energy certificates in a prominent way in the Berlaymont building is foreseen, in order to highlight the European nature of this building as well as the energy savings aspects of the Berlaymont building, and to attract media attention and raise awareness of this forthcoming legislation.

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Annex A: Description of Member States methods used

Austria

In Austrian an official calculation method to appoint the energy performance of a non residential building is generated by experts at the moment. The existing OIB – guideline for residential buildings will be extended by the non residential parts. The Berlaymont building was calculated according the OIB – guideline from January 2005. This guideline allows the calculation of the heating and hot water system. The energy demands for lighting, ventilation, cooling and humidification were calculated by adequate European standards which were adjusted by national appointments.

The calculation method is a static monthly procedure. 19 main zones (offices, corridor, foyer, stairs, kitchen, sanitary, meeting rooms, and so on) were calculated. The different calculation zones (main zones) were determined by terms of use, like air changing rates, occupants and electrical devices in the zones. This 19 main zones were subdivided according external conditions like solar radiation into 144 calculation zones.

System data, U-values and other technical data were used according to the basic information received from the Commission and the consultant. Meteorological data were provided from the Austrian Central Institute for Meteorology and Geodynamics (ZAMG). The average values of the monthly average temperature and monthly average solar gains of the years 1961 to 1990 for the location Vienna – Hohe Warte were used.

There is no reference building for non residential building in Austria yet. The comparison with national standards is in the moment not possible.

Main criterion in Austria to classify a non residential building is the useful energy for heating. Second criterion is the sum of the final energy demand for heating, cooling, ventilation, hot water, lighting and humidification. Primary energy and CO_2 – standards are still under development.

Austria is divided into nine provinces. Each province presently has its own building law. There is an harmonisation process in progress. In Austrian currently no uniform energy pass exist. So representatively for all the nine provinces the Styrian energy pass was handed out to the commissioner. In Table 2 the composition of the net energy is declared. Table 3 shows the composition of the final energy of the Berlaymont Building.

Table 3

Heating and Domestic Hot Water	**131**	[kWh/(m².a)]
Cooling	**19**	[kWh/(m².a)]
Lighting	**18**	[kWh/(m².a)]
Air Distribution	**17**	[kWh/(m².a)]
Humidification	**10**	[kWh/(m².a)]
Air Distribution - Parking	**3**	[kWh/(m².a)]
Final Energy	**198**	[kWh/(m².a)]

France

No official method for existing buildings is in place. It is likely that the results could differ widely from reality. Tried out 4 different models and used areas provided by the Netherlands.
The different models used :

- “Th-C” for new buildings (RT2000)
- “Th-Clim” for future new buildings (RT2005)
- Pleiade-Comfie
- PAPTER

The one finally used for the presentation is “Th-C” for new buildings (RT2000). This method is based on the algorithms of the EN13190 for the heating needs. It is compulsory to use this method for all the new buildings since June 2001.

It was the first time in the French history that it was compulsory to calculate the energy needs in non residential buildings, so the method is now still in break-in period. An exemption asks can be made to take into account the CHP unit.

There are still a few calculation problems for heat losses + pumps + fans. Some consumption is not calculated by this model: cooling + hot water in the building area + CHP.

Main difficulties faced:

- CHP, absorption cooling are not common in France at the moment. That is the reason why no official model is yet able to consider those.
- The official methods are still in break-in period: pumps, fans + heat losses are not correctly taken into account at the moment for big non residential buildings.
- Those official methods have never been compared to real energy bills, but the results are said to be very far from other provisional consumptions calculations methods that exists in France.
- A few parameters have been taken as assumptions: permeability of ventilation ducts, products certification, efficiency of the heat exchanger for ventilation, part of gas & electricity cooling
- A difficulty was to enter the same inputs in the different models to compare the results.
- The CEN method is not enough advanced to place the energy consumptions of the building on a scale.

The estimated energy consumptions are: heating, cooling, general lighting in the heated/cooled area, hot water, fans and pumps. The following was not taken into account:

- parking + non heated rooms + heated rooms for process needs,
- the winter efficiency of the louvers as a “cover”
- the efficiency of the ice-storage (only to reduce the expenses)
- lifts and other electrical items that are not fans, pumps or lighting.

The indoor/outdoor temperature, the hours of occupancy, the indoor and solar heat gains are based on the “Th-C” model.

Germany

The German calculations are based on the new calculation standard DIN V 18599 which will be used as calculation code for the implementation of the EPBD. The code contains a holistic approach for the energy demand calculation and is divided into 12 different parts. The primary energy demand as the final result is calculated in the following steps: (1) calculation of net energy demands (heating, cooling, air-conditioning); (2) calculation of final energy demands (lighting, heating, ventilation, air-conditioning, DHW, multifunctional generators); (3) calculation of primary energy demands based on primary energy factors.

The first step of the calculation is the zoning of the building according to different usages and/or HVAC systems of rooms. In the case of the Berlaymont, the building was divided into 8 zones: press conferences; restaurants, kitchens, service areas, foyers, archives, etc; offices, media; meeting rooms; techniques; car park.

The geometric values for all zones were calculated from the architectural drawings. These values include the floor areas, the volume, the areas of the surfaces around the zones, etc. The U-values and other technical data were used according to the basic information received from the Commission and the consultant. The expenditure factors for the HVAC systems were calculated based on the description of systems by the consultant.

It was decided to use the national weather data for the calculations. In the German case this is the average national climate data (Würzburg).

The total primary energy of the Berlaymont is 37.156.325 kWh/a. In terms of floor area (i.e. net floor area including car park and techniques of 170.721 m^2), the total energy demand amount to 217,64 kWh/m^2a.

As the final certification is dividing the energy into heating, cooling, AC moisture, ventilation, lighting and domestic hot water, the energy constituents are: 120,38 kWh/m^2a of net energy; 182,69 kWh/m^2a of final energy; 217,64 kWh/m^2a of primary energy.

Comparing the calculated primary energy demand for the Berlaymont building (218 kWh/m^2a) with an energy-efficient air-conditioned office building (a bit less than 300 kWh/m^2a) and an average air-conditioned office building (approx. 400 kWh/m^2a), one concludes that the Berlaymont performs by far better than reference buildings in Germany.

Netherlands

In the Netherlands there are two methods to calculate the energy performance of non-residential buildings:

- NEN 2916: 2001: this is an official Dutch standard, which is implemented in the building regulations since December 1995. The method is mend to calculate the energy performance of new non-residential buildings;

- EPA-U: method to calculate the energy performance of existing non-residential buildings to perform energy saving advices

Both methods are based on static monthly calculations. The differences between the two methods are mainly caused by the differences between the two categories of buildings (e.g. for a new building, the behaviour of the occupants is not available and is fixed, while in an existing building it is variable).

For both methods, the calculation proceeds as follows:
- Divide the building into building types and one or more groups of general spaces
- Divide the building in heated zones
- Divide the heated zones in energy sectors
- Determine the characteristic energy consumption for: heating, comfort cooling, preparation of domestic hot water, humidifying, mechanical ventilation, lighting, gains of solar energy and cogeneration, energy-use of computers, elevators, etc (only in EPA-U)
- Determine the energy performance indicator (EPC = energy performances coefficient for new build non-residential buildings and EI = energy index for existing non-residential buildings).

For both methods the following assumptions have been made, in order to simplify the calculations.

1) The building can be divided in several regions:
  - Parking area (not included in the calculations)
  - Storage areas below level (not included in the calculations)
  - Technical rooms below level, and on top floor (not included in the calculations)
  - Climatized areas:
    - Offices, including all corridors: 99.111m^2 (section 1 in the calculations)
    - Restaurants: 6.121 m^2 (section 2 in the calculations)
    - Meeting rooms: 24.191 m^2 (section 3 in the calculations)

  So , the total area of the regions studied with both methods is 129.423 m^2.

2) Façade, floors, roof:
  - Windows: U_{window} = 2.2 W/m^{2}K
  - Façade, floors, roof: R_c = 3.0 m^{2}K/W

3) Installations:
  - Heating system: cogeneration and boilers
  - Cooling system: absorption on the cogeneration and chillers
  - Ventilation system: mechanical ventilation with heat recovery
  - Humidification: steam boilers
  - Lighting:11 W/m^2
  - Computers, elevators, etc: 2.864.50 kWh (assumption for EPA-U only).

Applying the NEN 2916 method, it can be seen that the energy performance of the Berlaymont meets the requirements of the Dutch regulation for new buildings and it is 24.2% better than necessary. Under the NEN 2916 method, the total primary energy of the Berlaymont amounts to 71.285.029 MJ/year.

As regards the EPA-U, it is possible to influence several parameters which re fixed in NEN 2916. It is also possible to fit the calculated energy-use, with the actual energy-use. As the Berlaymont has not been used for a very long period, this fit has not been made in this project. Compared to the NEN 2916 calculation, in the EPA-U calculation three parameters were changed: opening hours, number of occupants, internal load of computers etc. As the EPA-U method is not implemented in the building regulations, there are no maximum values for the energy-index. It is not possible to make the same comparison as for an existing building since no benchmarks have been set. In EPA-U the results are shown per section. The total primary energy of the 3 sections of the Berlaymont building amount to 98.309.776 MJ/year.

Poland

The analysis performed for Berlaymont building has been based on static hourly simulation for heating, cooling and electricity demands. For the sake of calculation the adequate simulation model of heat transfer has been created, around twenty temperature and humidity zones have been defined. Simulation has been performed using weather data conforming with WYEC2 standard.

Results of hourly calculations determined energy demand based on detailed analysis energy balance for heating, cooling and electricity for all zones, also the demand for hot water has been taken into account. The energy balance encompassed heat transfer by the envelope, internal and external heat gains, heat transfer between zones, heat transfer to ground by walls and floor, and amount of heat delivered to ventilation and air-conditioning systems.

Calculations of solar gains have been based on orientation of the walls, shading and controlling of shade done by the double skin façade. The standardised profiles of building use have been applied for estimation of temporary demands.

A decrease of approx. 20% of the building use has been taken into account due to the vacations. The results of calculations are sequences of data representing 8760 hours, for heating, cooling and electricity.

Hourly demand data have formed an input to tri-generation calculation module, elaborated at the National Energy Conservation Agency for one of the VIth Framework project dedicated to design sustainable office building (the SARA project).

Mathematical model of tri-generation assumes that the main sources of energy for the building are two gas engines producing electricity and heat, and system of three gas boilers. Electricity produced on site is used internally, in a case when the demand is higher then capacity of engines electricity is supplied from the grid, contrary it is sold to the grid.

When the heat demand is higher then the capacity of co-generation unit the gas boilers are switch on in the operation. Heat produced in transition periods is stored in special tanks, further used to cover temporary differences in heat demand.

During the summer the heat produced by engines is used for cold production in absorption chillers. The cooling unit is equipped with water cool storage. Overall efficiency of producing cold in such systems is about 65%.

Following these assumptions the hourly data about ingoing and outgoing energy to tri-generation system, amount of delivered gas and total working time of separate system elements have been estimated. These allows the preparation of certificate, where the range scale has been defined by the experience, and grades scope came from number of classes taken into consideration. Some very rough calculations using the ESPr program have been performed in order to verify the results.

Currently, no model exists to calculate the energy use for an office building. The experts divided the building into activity levels and needed information on the proposed use of each area, and an estimate of the hours of use. Calculation was made on a monthly basis and was checked against existing simulation programs.

Portugal

The Portuguese Certification Law is not yet officially approved but there is a complete draft currently undergoing the last steps before formal adoption by the Government.

Two methods were used for calculating the energy performance of the Berlaymont: 1) A simple calculation method that will use only one zone. 2) A more detailed simulation using several zones.

The data supplied by the EC through COMASE, as well as those interpreted by the Dutch experts in terms of surface areas for the envelope, have been used for both the simplified simulation methodology and a detailed simulation. The detailed simulation was carried out with Visual DOE 2.5. The detailed model has the following characteristics:

- 58 zones, distributed among technical floor (14th), presidency floor (13th), pairs of floors between floors 1-12, ground floor, basement (-1), and all the remaining underground spaces.
- Conditioned area: 107012 m^2 – area simulated: 133825 m^2.
- 25 individual HVAC systems, including at least 1/floor except technical floors.
- HVAC and Lighting simulated according to specs of the installed systems. As stated in the document “specification of services”, maximum light power is 8 W/m^2.
- The building was assumed to be located in Lisbon (as the building is dominated by internal loads, and outdoor climate does not represent an important effect, this was assumed to be an acceptable simplification).
- Central Plant includes cogeneration, absorption chillers and cool storage.

Parking consumption includes ventilation, lighting and other small electric consumption in these areas.

Light dimming in the office area as a result of day lighting leads to a reduction of 44% in electricity consumption, relative to a constant lighting strategy.

As sensibility analysis for the HVAC component, the Berlaymont building was simulated at other sites, i.e., Oporto (PT), Heathrow (UK) and Frankfurt (DE). HVAC represents between 45 and 49% of the total final energy consumption (gas and electricity) of the building, showing the small importance of the climate and the dominance by internal loads and consumption for equipment and lighting. A major importance in the HVAC consumption corresponds to pumps and fans power.

The Portuguese final IEE index takes into account three different types of areas: general office building, kitchen and parking. Each zone is characterized by an individual consumption level, and weighted on the basis of the respective areas.

The final IEE value resulting from the detailed simulation tool, based on the described assumptions, is 24.15 kgoe/m^2/year.

The simplified model (STE) produced for the general office area an IEE value of 22.6 kgoe/m^2/year and, therefore, an overall IEE of 20.2 kgoe/m^2/year.

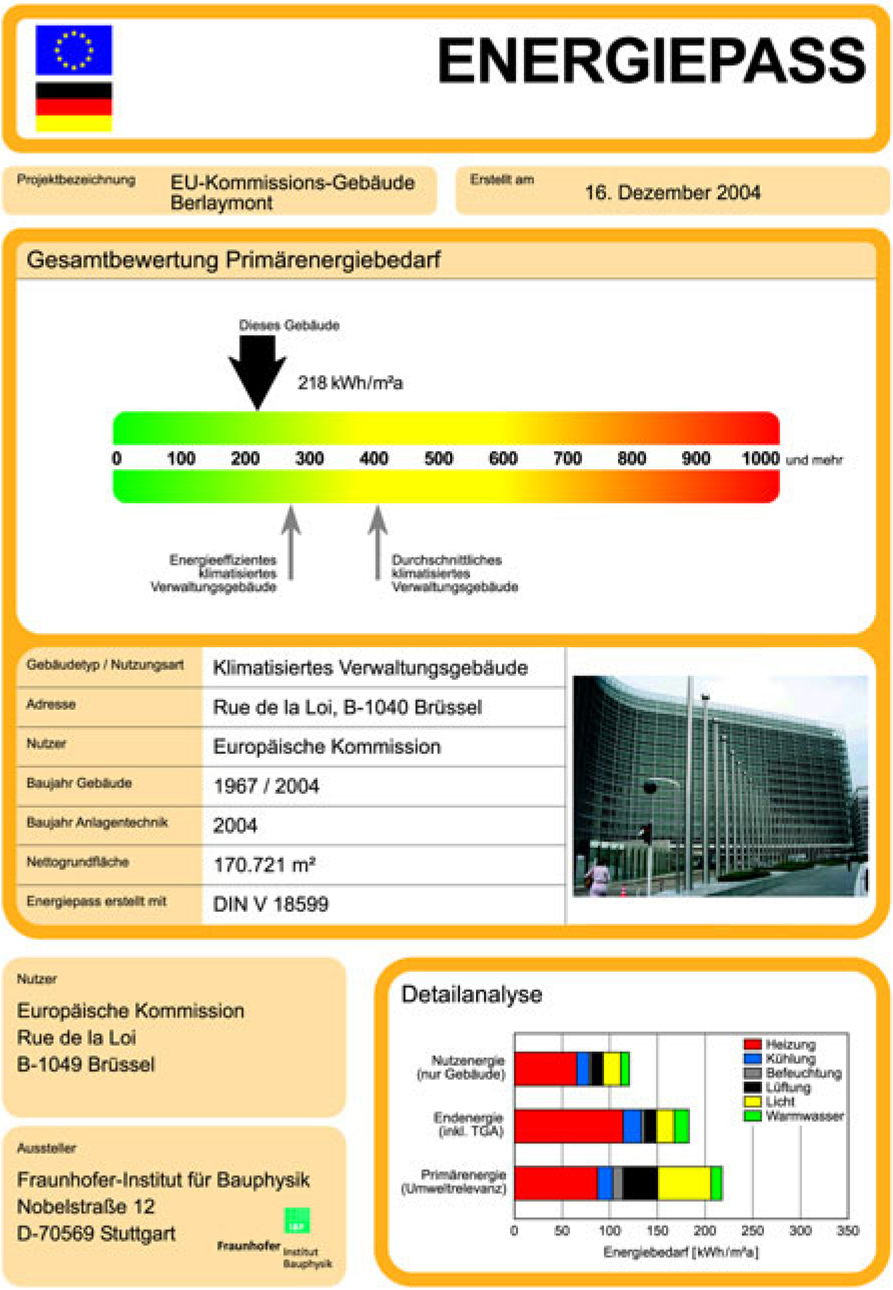
It should be noted that the simplified model is not able to account directly for cogeneration, so it was corrected taking in account the some values of heat and electricity produced by cogeneration in the detailed simulation.

The threshold values foreseen in the Portuguese Law are: 35 kgoe/m^2/year for an office in general, 118 kgoe/m^2/year for a kitchen and 12 kgoe/m^2/year for a parking.

On the basis of the areas of the three types of spaces in the Berlaymont building, the global reference IEE for this building is 30.44 kgoe/m^2/year. This value, according to the criteria set in the latest version of the applicable PrEN standard, is the lower limit of the B category (minimum required by the local regulations).

The threshold of the A category corresponds to a 25% improvement over the minimum requirement (equipment gains are excluded from the 25% improvement, meaning that the Berlaymont building with zero needs for lighting and HVAC would have an IEE of 15.27 kgoe/m^2/year). Thus, the threshold of the A category is 26.5 kgoe/m^2/year. The Berlaymont building, thus, is within the A category. It is 41% better than minimum requirements in the Portuguese legislation.

Annex B: Certificates


ENERGIEPASS

Projektbezeichnung	EU-Kommissions-Gebäude Berlaymont
Erstellt am	16. Dezember 2004

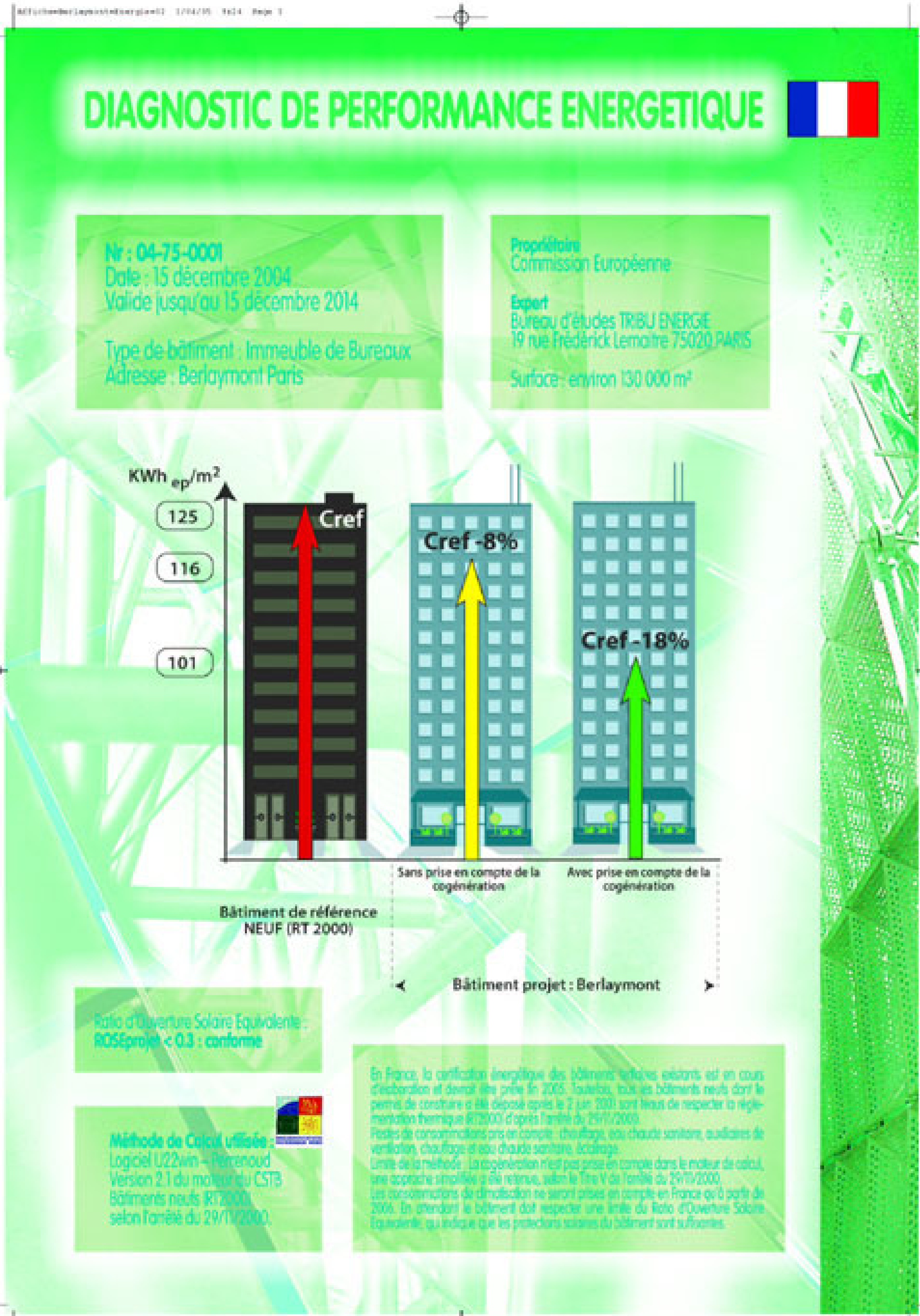
Gesamtbewertung Primärenergiebedarf

Gebäudetyp / Nutzungsart	Klimatisiertes Verwaltungsgebäude
Adresse	Rue de la Loi, B-1040 Brüssel
Nutzer	Europäische Kommission
Baujahr Gebäude	1967 / 2004
Baujahr Anlagentechnik	2004
Nettogrundfläche	170.721 m²
Energiepass erstellt mit	DIN V 18599

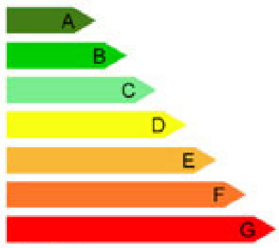
Nutzer
Europäische Kommission
Rue de la Loi
B-1049 Brüssel

Aussteller
Fraunhofer-Institut für Bauphysik
Nobelstraße 12
D-70569 Stuttgart

Detailanalyse


DIAGNOSTIC DE PERFORMANCE ENERGETIQUE
Nr : 04-75-0001
Date : 15 décembre 2004
Valide jusqu'au 15 décembre 2014
Type de bâtiment : Immeuble de Bureaux
Adresse : Berlaymont Paris
Propriétaire
Commission Européenne
Expert
Bureau d'études TRIBU ENERGIE
19 rue Frédérick Lemaître 75020 PARIS
Surface : environ 130 000 m²
KWh ep/m²
125
116
101
Cref
Cref -8%
Cref -18%
Bâtiment de référence NEUF (RT 2000)
Sans prise en compte de la cogénération
Avec prise en compte de la cogénération
Bâtiment projet : Berlaymont
Ratio d'Ouverture Solaire Equivalente :
ROSEprojet < 0.3 : conforme
Méthode de Calcul utilisée :
Logiciel U22win – Perrenoud
Version 2.1 du moteur du CSTB
Bâtiments neufs (RT2000)
selon l'arrêté du 29/11/2000.
En France, la certification énergétique des bâtiments tertiaires existants est en cours d'élaboration et devrait être prête fin 2005. Toutefois, tous les bâtiments neufs dont le permis de construire a été déposé après le 2 juin 2001 sont tenus de respecter la réglementation thermique (RT2000) d'après l'arrêté du 29/11/2000.
Postes de consommations pris en compte : chauffage, eau chaude sanitaire, auxiliaires de ventilation, chauffage et eau chaude sanitaire, éclairage.
Limite de la méthode : La cogénération n'est pas prise en compte dans le moteur de calcul, une approche simplifiée a été retenue, selon le Titre V de l'arrêté du 29/11/2000.
Les consommations de climatisation ne seront prises en compte en France qu'à partir de 2006. En attendant le bâtiment doit respecter une limite du Ratio d'Ouverture Solaire Equivalente, qui indique que les protections solaires du bâtiment sont suffisantes.

Energieprestatie certificaat

Energieprestatie utiliteitsbouw	energieprestatie van dit gebouw
Berekening conform NEN 2916:2001	klasse
zeer energiezuinig  niet energiezuinig	A
$Q_{pres,tot}/Q_{pres,toelaatbaar}$	0,758

resultaten energieprestatieberekening

verwarming	$Q_{prim,verwarming}$	41.142.822	MJ
ventilatoren	Q	20.721.331	MJ
warmtapwater	Q	1.884.723	MJ
pompen	Q	2.654.825	MJ
koeling	Q	7.773.572	MJ
bevochtiging	Q	1.345.211	MJ
verlichting	Q	28.943.949	MJ
comp. PV-cellen	Q	0	MJ
comp. WK	Q	-33.181.406	MJ
totaal	Q	71.285.029	MJ
toelaatbaar	Q	94.097.849	MJ

Gegevens van het gebouw:

Berlaymont gebouw te Brussel

Beschouwde gebruiksoppervlakten:
- Kantoorfunctie: 34.771,50 m^2
- Bijeenkomstfunctie met alcohol: 6.120,90 m^2
- Bijeenkomstfunctie overige: 24.191,10 m^2
- Gemeenschappelijke ruimten: 64.339,20 m^2

De parkeergarage, archiefruimten en het station zijn, in overeenstemming met NEN 2916:2001 en het Bouwbesluit, buiten beschouwing gelaten.

Gegevens certificerende instantie:

DGMR Bouw B.V.
ir. I.M. Kuijpers – van Gaalen
Postbus 153
6800 AD Arnhem
Nederland

in opdracht van:
ministerie van VROM
Den Haag, Nederland

datum afgifte: 2 november 2004
geldig tot: 2 november 2014

Aanbevelingen tot verbetering van de energieprestatie:
niet van toepassing

Energieausweis

Gebäudeart: Klimatisiertes Verwaltungsgebäude

Erbaut: 1967 / 2004

Standort:

PLZ: B-1040 Ort: Brüssel

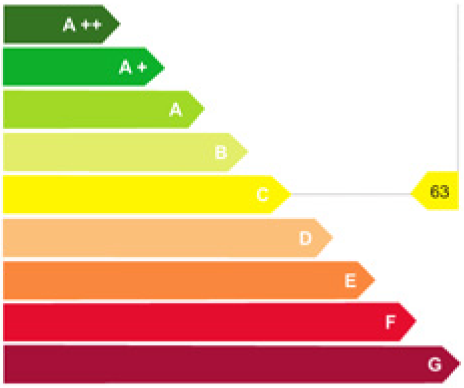
EZ: --- Grundst.Nr.: --- KG.: ---

Eigentümer/Errichter:

Name: Europäische Union

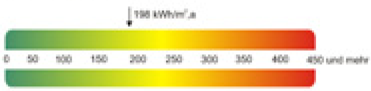
Adresse: Rue de da Loi
B-1040 Brüssel

Spezifischer Heizwärmebedarf:



Heizwärmebedarf:	63 kWh/m²,a	Kühlwärmebedarf:	13 kWh/m²,a	Endenergiebedarf:	198 kWh/m²,a
Heizenergiebedarf:	131 kWh/m²,a	Kühlenergiebedarf:	19 kWh/m²,a	CO_2-Emissionen:	--- t/a
Beleuchtung:	18 kWh/m²,a	Lüftung:	17 kWh/m²,a		

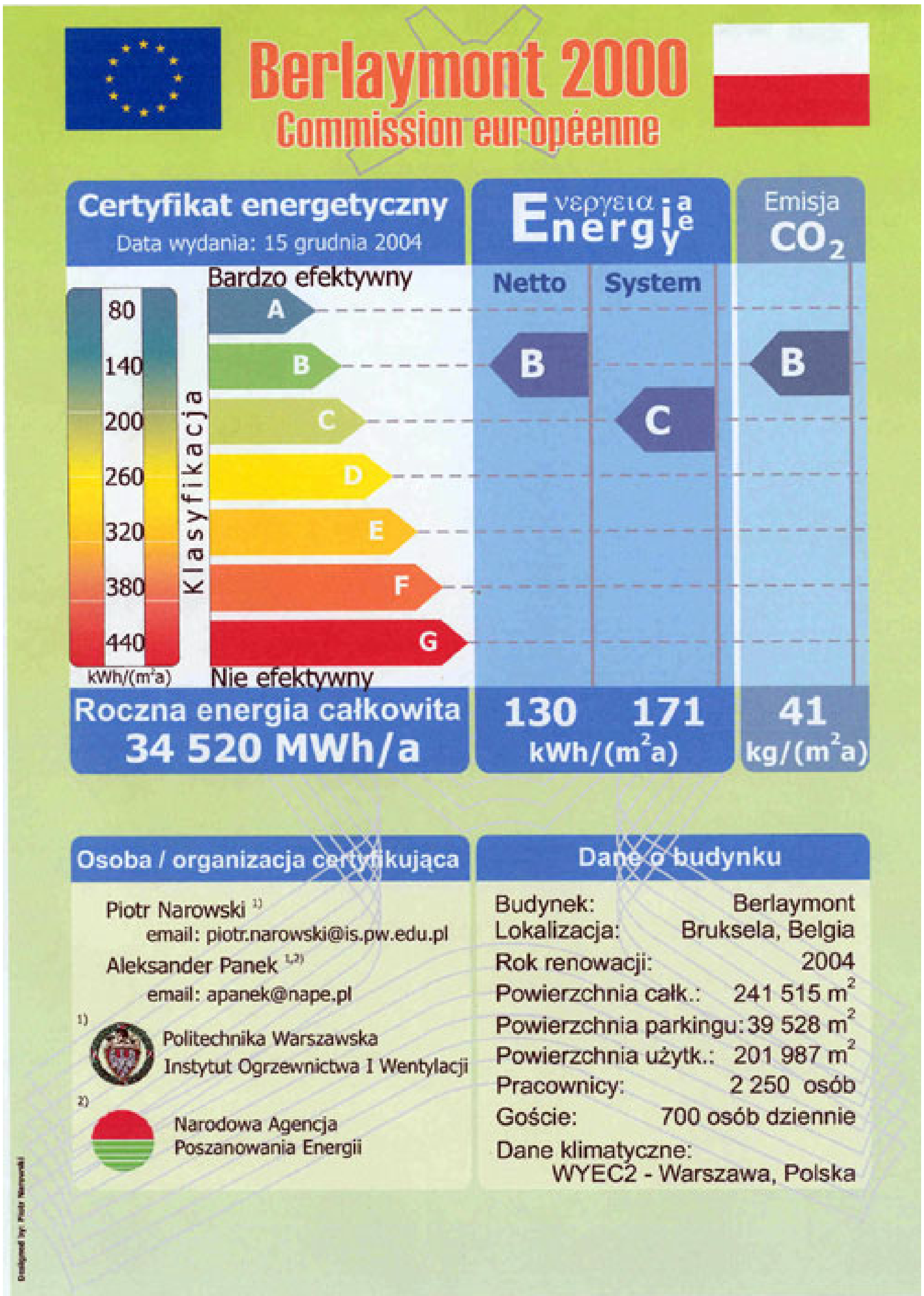
Endenergiebedarf:

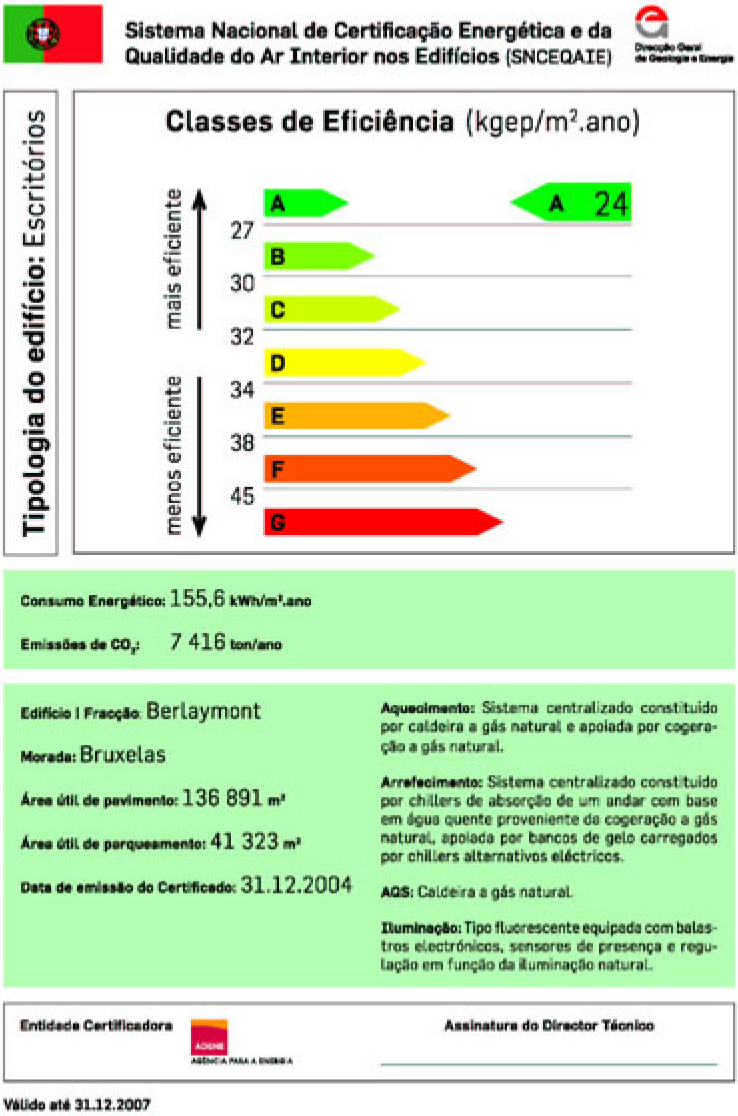


Aussteller:

Institut für Wärmetechnik (IWT)
Technische Universität Graz
Inffeldgasse 25/B
A-8010 Graz
www.iwt.tugraz.at

Ausweis Nr: 2005-1167 Gültigkeit: 2015 Datum: 02.05.2005 Unterschrift:


Berlaymont 2000
Commission européenne
Certyfikat energetyczny
Data wydania: 15 grudnia 2004
Bardzo efektywny
80
140
200
260
320
380
440
kWh/(m²a)
Klasyfikacja
A
B
C
D
E
F
G
Nie efektywny
νεργεια
Energia
Energie
Energy
Netto
System
B
C
Emisja
CO2
B
Roczna energia całkowita
34 520 MWh/a
130
171
kWh/(m²a)
41
kg/(m²a)
Osoba / organizacja certyfikująca
Piotr Narowski 1)
email: piotr.narowski@is.pw.edu.pl
Aleksander Panek 1,2)
email: apanek@nape.pl
1) Politechnika Warszawska
Instytut Ogrzewnictwa I Wentylacji
2) Narodowa Agencja
Poszanowania Energii
Dane o budynku
Budynek: Berlaymont
Lokalizacja: Bruksela, Belgia
Rok renowacji: 2004
Powierzchnia całk.: 241 515 m²
Powierzchnia parkingu: 39 528 m²
Powierzchnia użytk.: 201 987 m²
Pracownicy: 2 250 osób
Goście: 700 osób dziennie
Dane klimatyczne:
WYEC2 - Warszawa, Polska



Sistema Nacional de Certificação Energética e da Qualidade do Ar Interior nos Edifícios (SNCEQAIE)

Direcção Geral de Geologia e Energia

Tipologia do edifício: Escritórios

Classes de Eficiência (kgep/m².ano)

Consumo Energético: 155,6 kWh/m².ano

Emissões de CO_2: 7 416 ton/ano

Edifício I Fracção: Berlaymont

Morada: Bruxelas

Área útil de pavimento: 136 891 m²

Área útil de parqueamento: 41 323 m²

Data de emissão do Certificado: 31.12.2004

Aquecimento: Sistema centralizado constituído por caldeira a gás natural e apoiada por cogeração a gás natural.

Arrefecimento: Sistema centralizado constituído por chillers de absorção de um andar com base em água quente proveniente da cogeração a gás natural, apoiada por bancos de gelo carregados por chillers alternativos eléctricos.

AQS: Caldeira a gás natural.

Iluminação: Tipo fluorescente equipada com balastros electrónicos, sensores de presença e regulação em função da iluminação natural.

Entidade Certificadora — ADENE Agência para a Energia

Assinatura do Director Técnico

Válido até 31.12.2007

Annex C: Data collected

Drawings

- Architectural - drawings (floor plans, profiles and views of the building) and orientation of the building
- Mechanical systems – AHU/HVAC, schematics, plant-room
- General floor areas

General

- Total floor area and/or total usable floor area
- Description of the building, including the different functions and zones
- Assumptions the designers used for indoor air temperature during use and out of use, internal heat gain, etc.

Specifications

- Controls performance specification
- Full mechanical specification
- Plant component sizes/capacities (heating installation type - HR100, HR107, co-generation, heat-pump/heat source; and heating system type and ratings - low-temperature radiators, wall and/or floor heating, radiators)
- CHP plant
- Domestic hot water sources and ratings
- Humidifying system type (e.g not electrically fired, electrically fired, unknown/moisture recovery)
- Ventilation system type (e.g natural, mechanical or a combination of the two)
- Ventilation Fans (number and the real connected effective power (KW)
- Cold generator type (compression chiller, absorption chiller, cold storage, heat pump in summer operation) and absorption chiller (co-generation, at district heating); ratings and seasonal coefficients of performance

Profiles and loads

- Occupancy and when the building will be used (daytime, year)
- Lighting (including installed capacity and type of lighting control and luminaires – room switch, central on/off, daylight switch, sweeping switch)
- Small power (computers and plug-in appliances including kettles, vending machines, etc)
- Domestic hot water usage (energy used to heat the water that supplies the hot taps in the building)
- Ventilation (airflow at daytime/night-time and maximum airflow due to mechanical ventilation)
- Heat recovery type (none, heat-pipes, slowly rotating or intermitting heat exchangers)

Control strategies - Any documents that describe how the building systems will be run.

- Façade – tracking of the Sun by the louvers
- Natural ventilation

- Fans (type of flow control – throttle control, inlet blade adjustment, fan blade adjustment, speed control)

Fabric details

- Structure
- Cladding (material used to cover the outside of the building)
- Glazing – including thermal resistance of the glass and window frame (or the type of glass [HR, HR+, HR++] and the material of the window frame)
- Internal partitions
- Floors – including thermal transmittance
- Roofs – including thermal transmittance
- Walls – including insulation
- Double façade louver – leakage in particular, including thermal transmittance
- Sun visor type (none, inside/outside, manual/electric)

Room climate control systems

- Chilled ceilings

Climate data

- Test Reference Year (TRY) weather data set for Brussels. Should include hourly values, average monthly temperature and humidity. (One source of data is the Energy Research Group at University College Dublin).

Other

- Belgium's K70 Global insulation standard and other relevant standards covering energy use.

Annex D: List of participating Member States' experts and consultants

Austria

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streicher@tugraz.at

Mr. Jilek
Amt der Steiermärkischen Landesregierung
Fachabteilung 13A/Umweltrecht u. Energiewesen
Fachstelle Energie/Büro des Energiebeauftragten
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Mrs. Roger
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Direction Générale de l'Urbanisme, de l'Habitat et de la Construction
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Mr. Narowski
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Prof. Maldonado
Directorate General for Energy
Prof. Senior Adviser
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ebm@fe.up.pt

Mr. Fernandes
ADENE
National Energy Agency
Joao.francisco@netcabo.pt

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Mr. Nobels
Mr. Roger-France
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g.barchman@groupecomase.com