Second International Conference Buildings and the Environment, June 1997, Paris

SOFTWARE FOR ENERGETIC RETROFIT AND FOR THE PRESENTATION OF LOW ENERGY SOLAR ARCHITECTURE

St. Benkert, J. Schnieders, F.D. Heidt[1]
Department of Physics, University of Siegen, D-57068 Siegen
Phone: +49-271-740-4181, Fax: +49-271-740-2379

ABSTRACT: **The research project "Software Laboratory for Low Energy and Solar Architecture" is dedicated to the reduction of environmental impact of buildings caused by heating energy consumption. For this purpose software is developed to advise architects and civil engineers on energy and building related issues. Two of these programs are presented here.**

The database *NESA* describes in a multimedia way low energy and solar architecture in Germany. *NESA* aims at improving the dissemination of knowledge related to passive solar and energy conscious design. The amount of presented information and its easy handling make *NESA* equally useful for both consulting and education. Several calculation tools are provided with the program. *NESA* also includes a small glossary of technical terms for passive solar and low energy architecture.

***RESA* simplifies the planning of energetic retrofit for existing buildings. Building components such as walls, windows, floors, etc. are input from a database that contains the most widely used building constructions. The program then determines a ranking of suitable renovation measures depending on user-defined optimization criteria. To be able to do so, the heating energy demand before and after the renovation and the costs of all proposed measures are calculated.**

Key words: energetic retrofit, low energy architecture, multimedia presentation, passive solar architecture

1 MULTIMEDIA DATABASE *NESA*

1.1 Introduction and purpose of *NESA*

The effective use of solar energy and energy saving measures can drastically reduce the demand of heating, cooling and lighting energy required for conditioning buildings. Experiences on passive solar and energy conscious design are well-known but not at all widespread. In almost every country, however, there are many examples of diverse buildings - residential, commercial or institutional - where energy saving and solar concepts have successfully been realized. It is the purpose of this work to improve the dissemination of related knowledge by means of modern multimedia software.

[1] Author to whom correspondence should be addressed

In this context indication of the building´s energy performance is a sectoral aspect only. It must be put in relation to essential further information about the building such as visual aesthetics, integration into surroundings and landscape, architectural concept, functions of rooms, constructional details, material selection, techniques of building services and many others. The multimedia program *NESA* compiles information related to these different aspects of a building under the development environment *Toolbook.*

Preliminarily ten houses are included in the database. Much more examples - residential, commercial and institutional buildings - shall be added so that finally a representative electronic picture-book of passive solar and low energy architecture in Germany will exist. Additionally the example buildings can be modified within the program. Hereby it is possible to generate own projects, compare them to given ones and perform several related analysis tasks such as energy analysis and shading calculation.

The goal of *NESA* is to assist architects, engineers and energy consultants, specialized workmen and potential building clients to get a comprehensive survey and better understanding of concepts and practice of passive solar and low energy buildings.

NESA was developed within the research project "Software Laboratory for Low Energy and Solar Architecture" of the AG Solar of the German State of Nordrhein-Westfalen (North-Rhine-Westphalia) at the University of Siegen. Idea and software are based on the program *DIAS*, developed at CUEPE, University of Geneva, by Prof. W. Weber and his team [1], adaptation of the program to German conditions was carried out at the University of Siegen [2, 3, 4].

1.2 Description of *NESA*

The program *NESA* uses state-of-the-art multimedia techniques for the presentation of building examples, for documentation of results, information and dissemination to the public as well as for education and training of students and professionals. Photos, drawings, computer animated sequences and hotword-clickable text show multiple aspects of all the topics included in the database. *NESA* consists of the following elementary components:

- **Maps**

A survey map shows the sites of the included buildings. Climatic maps show the geographic distribution of solar radiation and ambient temperature in Germany.

- **Objects**

NESA visualizes ten German low energy and solar houses with detailed explanations by means of photos, plans, elevations, conceptual and detail drawings. These examples show passive solar energy use, solar heating systems and systems for heat recovery. Also buildings with photovoltaic equipment for electricity supply and complete solar energy supply of an undivided family house are demonstrated.

• **Calculation Tools**
The program *NESA* calculates for the described buildings and for user-defined projects e.g. heat transfer coefficients, detailed monthly energy analysis, heating demand according to the German *Wärmeschutzverordnung*, fuel demand and shading.

• **Encyclopedia**
The encyclopedia contains keywords and terms related to solar architecture, low energy houses, heating demand and technical equipment for buildings. It includes definitions, equations, units, drawings, descriptions and references.

The following figures present typical screenshots for the different program elements mentioned above.

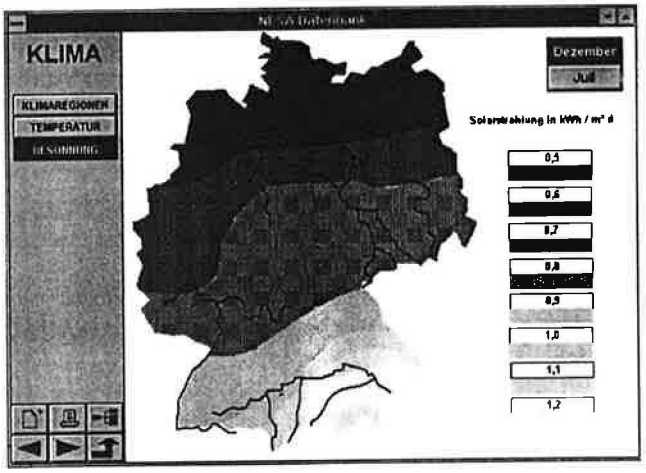


Figure 1: Maps

Solar potential of distinct regions of Germany is highlighted on a climatic map. A survey map shows the sites of all buildings included in the database.

Figure 2: Objects

Photos give a first impression of the distinct houses.

Figure 3: Plans

The embedded plans give ideas for own projects and serve as guides to activate further photos of a building by simply clicking with the mouse.

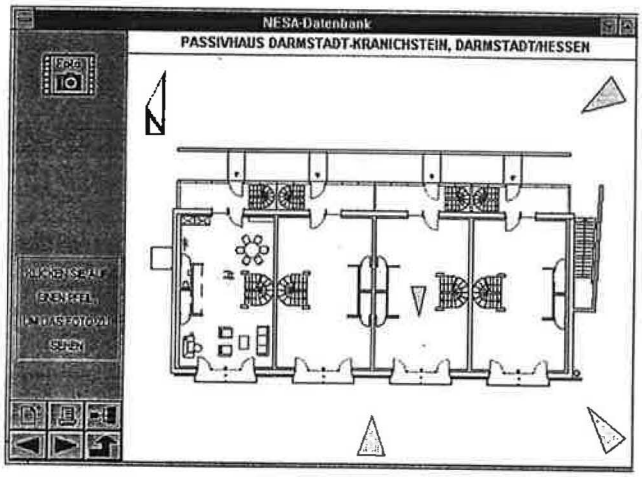


Figure 4:
Calculation Tools

Own projects may be calculated with the tool for monthly energy analysis. Data from buildings included in the database may be loaded and edited.

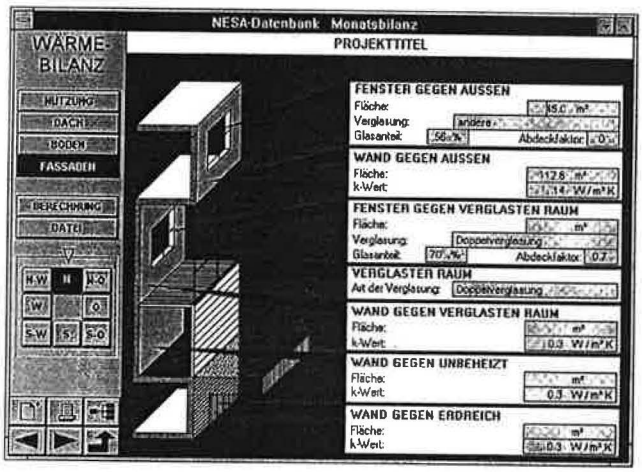
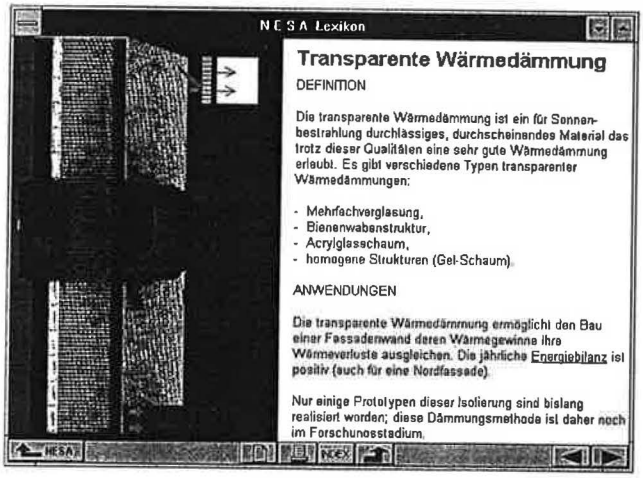


Figure 5:
Encyclopedia

The encyclopedia contains text, figures and photos related to solar architecture, low energy houses, heating demand and technical equipment for buildings. Links to underlined words are easily accessed by clicking on them.



2 *RESA*

2.1 Introduction

For a long time to come, the major part of the total energy requirements for space heating will be consumed in buildings that already exist today, not in those to be erected in the future: For existing buildings in Germany, the mean specific heating energy demand is something more than about 200 kWh/m²a, and most of them will still be occupied for many years. New buildings constructed according to the German "Wärmeschutzverordnung" from the year 1995 are supposed to require less than half of this heating energy. Progress in energy efficient buildings is going strong, so newly constructed buildings are about to use only a small share of the country's total heating energy demand. Energetic retrotrofit is therefore an important issue.

The potential of energy saving measures in existing buildings is considerable. Insulating walls and replacing leaky windows does not only save energy, it improves the occupants' comfort, too. Many retrofit measures are even economically reasonable.

For home owners, private as well as public, it is difficult to assess the possibilities for energetically renovating their buildings. Usually, they will need professional help, e.g. from specialized engineers. Working out a set of appropriate retrofit measures for a specific object takes some time and thus may quickly become expensive.

The aim of *RESA* is to offer support in respect to this matter. With *RESA*, it will be possible to determine an overview of sensible retrofit measures for a particular building whithin less than two hours. The program output includes a set of retrofit measures, a determination of the related costs and the energy savings to be expected (Fig. 6).

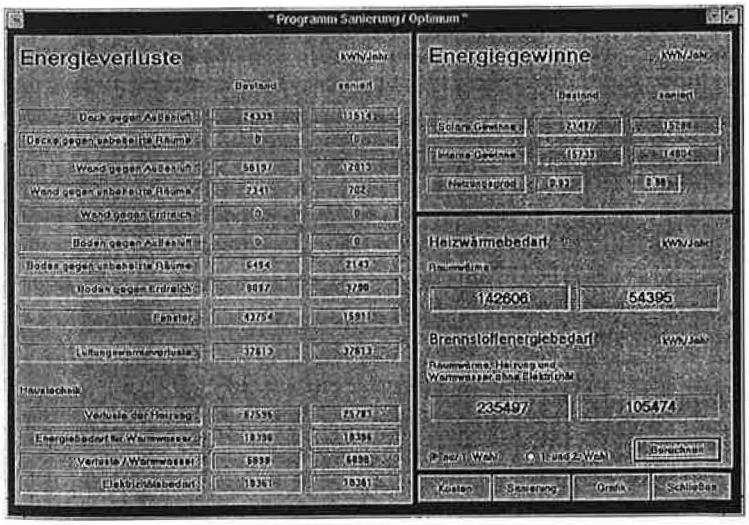


Figure 6: This table of *RESA* displays the energy flows in the building before and after the renovation.

RESA has the ability to calculate the heating energy demand of a given building according to the Swiss SIA 380/1 or, optionally, to the 1995 German "Wärmeschutzverordnung". It knows the heat transfer properties and the costs of renovation measures from an attached da-

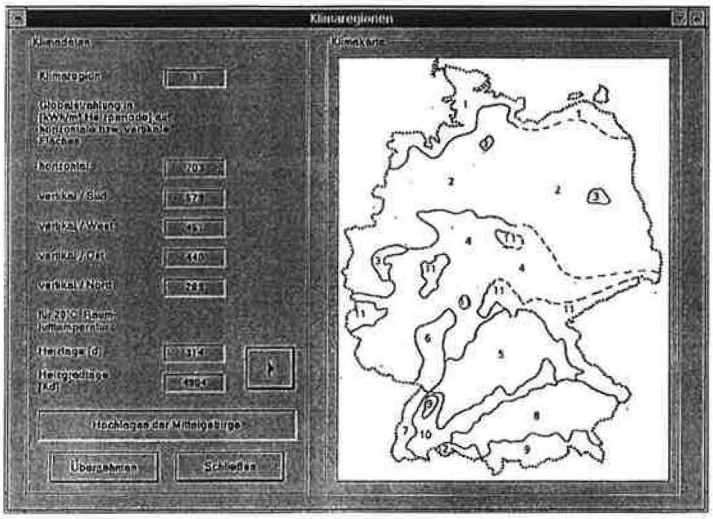


Figure 7: Determining the building site's climate in *RESA*.

tabase and is able to determine a ranking of these measures. The program is easy-to-use; no special training is required except for a basic knowledge about energetic retrofit.

2.2 Building input

The first step of the retrofit process is to enter the building in its current state, i.e. walls, windows, roofs, floors and heating system together with their relevant properties. The dimensions of the building must still be taken from a drawing or from direct measurement, but *RESA* offers considerable support in determining the other data required. In Germany, the climate of the building site can be derived from the post-code or a map (Fig. 7). The building components are chosen from a database with common constructions (Fig. 8). The relevant properties are transferred to the input forms by means of a mouse-click. A graphical representation of every component illustrates the selected materials and constructions.

2.3 Retrofit suggestions

Once the input process is finished, *RESA* figures out the best set of renovation measures depending on several optimization criteria such as maximum energy saving with a given amount of money, minimal cost at a given energy saving, maximum cost efficiency after a given number of years, maximum energy saving, etc. For every building

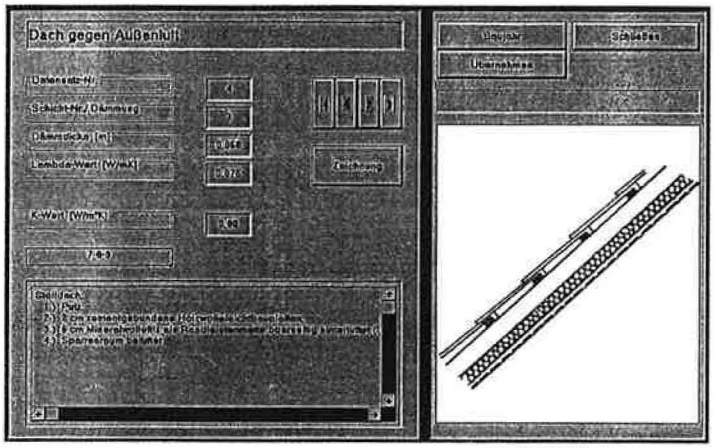


Figure 8: Choosing a roof construction in *RESA*.

component, *RESA* searches another database for appropriate renovation measures, calculates the respective cost and the amount of saved energy and determines the best of the variants. As in the input process, every renovation measure is presented together with a drawing, which makes it easier to judge the suggested measures.

To a large extent, the determination of retrofit suggestions can be influenced by the user: If, e.g. for reasons of protection of monuments, the façade of a building must not be changed, a corresponding option can be activated. Building components that one wishes to preserve may totally be excluded from the process. Renovation suggestions can be worked out manually as well, starting either from the original building or from the automatically generated renovation suggestions. To this aim, *RESA* places its retrofit database at the user's disposal.

2.4 Other aspects

The relatively complex process of energetic retrofit may lead to multiple solutions. In order to facilitate the choice of the right solution in each individual case, a means to store and compare several different retrofit variants for the same building is integrated.

A report containing a description of the existing building, the retrofit suggestions, the energy savings, etc. can be printed out as well.

3 CONCLUSIONS

The multimedia database on passive solar and low energy architecture in Germany *NESA* is well suited to give a comprehensive survey and better conceptual understanding of this field of architecture, building physics and engineering. *NESA* includes illustrative examples of buildings, contains a broad range of related information and allows the user to perform many types of calculations for built-in examples and own projects. The integration of further building examples is planned and under preparation. *NESA* is easy to use and therefore adapted to broad-range application as information and instruction tool.

The adviser for energetic retrofit *RESA* is intended to support people concerned with the renovation of existing buildings. Help is offered in the survey of the existing building, the determination of the heating energy demand and the choice of appropriate renovation measures. User-defined optimization criteria for the automatic determination of a ranking of retrofit measures and the possibility to manually adapt the results to the circumstances of the individual case give the program enough flexibility for practical use; nonetheless the user needs only a basic knowledge about energetic retrofit in order to handle the program.

ACKNOWLEDGEMENTS

The authors wish to thank the Ministry of Science and Technology of North-Rhine-Westfalia, Germany, for the support of this project under Contract No. 253-011-91 (AG-Solar NRW). They are further indebted to Prof. W. Weber and P. Haefeli at CUEPE, University of Geneva, and to all the builders and architects who readily let their buildings be presented in the *NESA* program. They also thank Dipl.-Phys.-Ing. Joachim Groß for his great work in programming the *RESA* code.

REFERENCES

[1] W. Weber, H. Drexler, P. Gallinelli, P. Haefeli, B. Lachal, D. Gonzalez: *DIAS Interactive Database on Solar Architecture - PEM Pascool Electronic Metahandbook*, Conference Proceedings, Solar Energy in Architecture and Urban Planning, 4th European Conference (1996), Berlin, pp. 201...204

[2] F.D. Heidt, T. Braeske, H. Drexler: *NESA - an innovative multimedia software presenting examples of passive and low energy architecture in Germany*, Conference Proceedings, Solar Energy in Architecture and Urban Planning, 4th European Conference (1996), Berlin, pp. 193...196

[3] T. Braeske, F.D. Heidt: *Innovative software for education and visualization of passive solar and low energy concepts*, Proceedings PLEA 96, 13th International Conference on Passive and Low Energy Architecture, July 16th...18th 1996, Louvain-la-Neuve, Belgium, pp. 51...56.

[4] Benkert, St., Braeske, T. and Heidt, F.D.: Presentation of passive solar and low energy architecture in Germany by multimedia software. Proceedings EuroSun '96, 16. - 19. Sept. 1996, Freiburg.

[5] Braeske, T., Heidt, F.D. and Schnieders, J.: Software to assess energy performance and energy savings economy in buildings. Proceedings EuroSun '96, 16. - 19. Sept. 1996, Freiburg.

[6] Groß, Joachim: Bilanzierung und Optimierung der Wärmeflüsse in einem Gebäude mit einem Computermodell. Diploma thesis, Fachbereich Physik, Universität-GH Duisburg and Fachgebiet Bauphysik und Solarenergie, Universität-GH Siegen, 1995.