Designing heat pump systems: Users' experience with software, guides and handbooks

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The IEA Heat Pump Centre

The IEA Heat Pump Centre (HPC) is the focal point of the Implementing Agreement on Heat Pumping Technologies of the International Energy Agency (IEA), also called the IEA Heat Pump Programme.

The IEA was founded in 1974 as an autonomous body within the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. Activities are directed towards the IEA Member countries' collective energy policy objectives of energy security, economic and social development, and environmental protection.

One important activity undertaken in pursuit of these goals is a programme to facilitate co-operation to develop new and improved energy technologies and introduce them into the market. Activities are set up under Implementing Agreements which provide the legal mechanism for establishing the commitments of Participants and the management structure to guide the activity. There are 40 currently active Implementing Agreements, encompassing activities relating to fossil fuels, renewable energy, efficient energy end-use, fusion power and information dissemination. This publication concerns the Implementing Agreement on Heat Pumping Technologies.

The member countries of the HPC form a network for exchanging information on heat pump technology. By increasing awareness and understanding worldwide, the HPC aims to accelerate the implementation of heat pump technology as a means to reduce energy consumption and thereby to limit harmful environmental effects. HPC tasks include:

- Collecting, analysing and disseminating heat-pump-related technical, market, regulatory, and environmental information;
- Fostering international co-operation in research and development; and
- Facilitating contacts and information exchange among those involved in the research, development, design, manufacture, regulation, marketing, and application of heat pumps.

Summary

The IEA Heat Pump Centre wants to extend its Internet site with an assessment of users' experience with design tools (software, design guides and handbooks) for residential, commercial and industrial heat pump applications to facilitate the choice for these design tools.

During the project 67 design tools, including handbooks, have been identified; 29 suppliers of design tools have returned our questionnaire. Most of these design tools originate from the USA. About two-thirds of the design tools is suitable for residential buildings and commercial/institutional buildings, half of them is suitable for industrial processes. Many design tools are meant for three or more target groups (consulting engineers, equipment suppliers, researchers and education). The suppliers said that to be 'familiar with the basic principles of heat pumps' is enough to use most design tools.

The number of useful questionnaires completed by users of design tools is 10. Most users who completed the users' questionnaire originate from Europe and are consulting engineer (40%) or originate from research institutes and education (30%). The design tools 'on the whole' are assessed at good by 50% of the users (excellent: 20% and moderate: 20%). Residential buildings are the main application of the design tools (60%), 40% of the users uses the design tool for commercial/institutional buildings. The main tasks the software design tools are being used for are system performance prediction and detailed system design (both 78%), followed by cycle design (56%).

A database plus interface has been developed for the processing of the results of the project. The database brings together information about heat pump design tools and the related users' experience. It also generates documents with descriptions of design tools and users' experience with an individual or all design tools. Finally, it allows to select design tools by one or several keywords.

The number of completed questionnaires was lower than expected. The National Team contacts and Executive Committee delegates of the Heat Pump Programme, heat pump associations world-wide and other individuals involved in heat pump (system) design have been informed about the project and asked for their co-operation. They were asked (by email and phone) to complete the questionnaires composed for suppliers and users of heat pump design tools on-line at the Internet site of the HPC. Despite the efforts of the project team and the HPC the response was quite low.

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Appendices

1 Introduction

The IEA Heat Pump Centre (HPC) is the International Energy Agency's information centre for heat pumping technologies, applications and markets. The HPC's role is to accelerate the implementation of heat pump technology through information exchange and knowledge transfer, and thereby optimise the use of energy resources for the benefit of the environment. This is achieved by offering a world-wide information service to support all those who can play a part in the implementation of heat pump technology including researchers, engineers, manufacturers, installers, equipment users, and energy policy makers in utilities, governments and other organisations.

The Internet site of the HPC (www.heatpumpcentre.org) consists of information about heat pumps, the IEA, news and contacts. To facilitate the choice for design tools (software, design guides and handbooks) for residential, commercial and industrial heat pump applications, the Internet-site is to be extended with an assessment of users' experience with these tools.

The scope of the project includes design programs and guides for heating and cooling system design (incorporation of heat pumps in a residential or commercial building or an industrial process), but also design tools that allow sizing of heat pump components. Publicly available programs and guides in the following languages are included in the scope: Danish, Dutch, English, French, German, Italian, Japanese, Norwegian, Spanish and Swedish.

The study focuses on the following countries: USA, Sweden, Switzerland, UK and Japan, being major heat pump markets, but the project has a world-wide coverage. The results of the project are especially interesting for designers, heat pump manufacturers and suppliers, contractors and installers.

Apart from this final report a database/interface combination is developed for storing and representing the results to facilitate easy updating on the Internet.

2 Methods for data collection

Information about the project was posted on the HPC Internet site. An email message was composed and sent by the HPC to its National Team contacts, Executive Committee delegates and heat pump associations world-wide to inform them about the project and ask for their co-operation and input in identifying:

- design tools relevant for inclusion in this survey;
- names and addresses of suppliers of design tools;
- names and addresses of users of design tools (e.g. companies, organisations, individuals, groups of users).

A search on the Internet and a literature search were conducted. The members of the Dutch organisations CAPE-NL (Computer-aided process engineering) and Exergy.NL (platform for process integration) were addressed. A news item was published in the Dutch heat pump newsletter (WP Impuls). All information, received and gathered, was used to compose a list of known design tools and suppliers, which was placed on the Internet-site.

A questionnaire for suppliers of design tools was composed and placed on the Internet-site. The suppliers were requested to complete the suppliers' form. On the basis of that information the design tools were evaluated for their relevance to the project.

The information about design tools increased slowly but surely. To stimulate visitors of the Internet-site to complete the on-line questionnaire, preliminary data of relevant design tools was placed on the Internet-site. Also the questionnaire for users of design tools was placed on the Internet-site. Several email messages were sent by the HPC to inform the heat pump community about the progress of the project and to ask for their co-operation.

As very little users' forms were received, the project team contacted heat pump organisations and other relevant HPC contacts by phone to identify users and to request them to complete the questionnaire. Also the users named by suppliers of design tools were contacted, of course without mentioning the name of the design tool, nor of its supplier to prevent biased information.

To facilitate future maintenance of the results (after completion of this project), a database plus interface for the processing of the results was developed. The database was filled with the answers to the questionnaires, after the completed users' forms were assessed for their consistency. The interface is able to generate documents (MS Word) with descriptions of design tools and documents with users' experience about a single or all design tools in the database. The database also facilitates the selection of design tools by one or several keywords, e.g.: application category, target group, language.

Visitors of the Internet-site who wanted to be kept informed (subscribers) were informed about the project several times.

3 Design tools

The information in this chapter is based on the questionnaires completed by the suppliers of the design tools. The characteristics of all relevant design tools provided by suppliers are discussed in this chapter. A list of the other design tools that has been identified, is presented in appendix A. Characteristics of the relevant design tools are presented in appendix B. The questionnaire for the suppliers of design tools is available from www.heatpumpcentre.org/tools/q_suppl.htm.

3.1 List of relevant design tools

Tables 1a and 1b present the 29 relevant design tools that have been selected for inclusion in the survey. A completed suppliers' form was a necessary condition. Complete descriptions, including full references, can be found in Appendix B.

Table 1a: List of relevant handbooks with their suppliers. Abbreviation in italics.

Relevant handbooks	**Name of supplier**	**Country**
Air-Conditioning and Sanitary Engineering Handbook *(SHASE AC & San.)*	The Society of Heating, Air-conditioning and Sanitary Engineers of Japan (SHASE)	Japan
Ground Source Heat Pumps: Design of Geothermal Systems for Commercial and Institutional Buildings *(ASHRAE GSHP)*	ASHRAE	USA
Handbook heat pumps (*ISSO HP*)	Stichting ISSO	The Netherlands
Handbook Industrial heat pumps (*Industrial HPs)*	TNO MEP	The Netherlands
Refrigeration and Air-Conditioning Handbook *(REITO AC&R)*	Japan Society of Refrigeration and Air-conditioning Engineers (REITO)	Japan

Table 1b: List of relevant software tools with their suppliers. Abbreviation in italics.

Relevant software	**Name of supplier**	**Country**
ART	Universidad Politecnica de Valencia	Spain
Coolpack	Technical University of Denmark	Denmark
CoolTool	Dehon service Netherlands	The Netherlands
Cycle-Tempo	TNO MEP	The Netherlands
DOE/ORNL HP Design model (*DOE/ORNL HP Model*)	Oak Ridge National Laboratory	USA
EES, Engineering Equation Solver (*EES)*	F-Chart Software	USA
Frigosim	Thorbergsen Frigosoft	Norway
GchpCalc 4.0	Energy Information Services	USA
GLHEPRO	IGSHPA / Oklahoma State University	USA
HPSEL	EA Technology Ltd	UK
HVAC1 Toolkit: A Toolkit for Primary HVAC System Energy Calculation (*HVAC1 Toolkit)*	ASHRAE	USA
HVAC2 Toolkit: Algorithms and Subroutines for Secondary HVAC Systems Energy Calculations (*HVAC2 Toolkit)*	ASHRAE	USA
KM.Kreis	FKW GmbH	Germany
MOMO (Modualr Modeling) (*MOMO)*	CETIAT	France
Odessy	TNO MEP	The Netherlands
Refprex	Re/genT bv	The Netherlands
RETScreen International (*RETScreen*)	CANMET Energy Diversification Research Lab.	Canada
Svepet	Swedish Royal Institute of Technology	Sweden
SwEWS	Nova Energie GmbH	Switzerland
TRNSYS	Thermal Energy Systems Specialists	USA
Vitocalc	Nowab	Sweden
Wdim	König Wärmepumpenservice	Germany
WP-Calc	Nova Energie GmbH	Switzerland
WP-OPT	WPsoft GbR – Dr. Weinmeister & Partner	Germany

3.2 Brief description and applications

Table 2a gives a brief description of the selected software tools. Descriptions of the handbooks are in Table 2b.

Table 2a: Brief description of the relevant handbooks.

Handbook	**Brief description**
SHASE AC & San.	Handbook in three volumes: Fundamentals, Air-conditioning systems and Sanitary systems
ASHRAE GSHP	Book to assist HVAC design engineers in efforts to create high-quality GSHP systems for commercial and institutional buildings at reasonable costs.
ISSO HP	This ISSO handbook helps engineers design heat pump systems for (commercial/institutional) buildings.
Industrial HPs	Handbook, from basic principles through feasibility study, design and implementation of industrial heat pumps.
REITO AC&R	Handbook in six volumes: Fundamentals; Equipment; Air-conditioning; Refrigeration systems; Food, Biology and Medical Sciences; and Plant engineering & safety control.

Table 2b: Brief description of the relevant software tools.

Software tool	Brief description
ART	ART (Advanced Refrigeration Technologies) is a simulation tool for refrigeration equipment of the vapour compression type.
CoolPack	CoolPack is a (freeware) collection of simulation programs.It includes refrigerant properties, cycle analysis, dimensioning and evaluation of systems.
Cooltool	Design software for air-conditioning and refrigeration plants. Up to 27 evaporators and coolers can be included in the systems.
Cycle-Tempo	Cycle-Tempo is a tool for simulating stationary energy systems. The program has many possibilities.
DOE/ORNL HP Model	Research tool for use in the steady-state simulation and design analysis of air-to-air heat pumps and air conditioners.
EES	EES solves up to 10,000 simultaneous nonlinear equations.
FrigoSim	Process simulation program for thermal energy plants, such as heat pump and air conditioning systems, and refrigerating plants.
GchpCalc 4.0	GchpCalc is a program for sizing vertical loop ground source heat pump systems.
GLHEPRO	GLHEPRO is a tool for designing vertical ground loop heat exchangers for commercial and institutional buildings.
HPSEL	Calculates heating requirements of a specified house (Europe). Then selects best heat pump from a database (at present only fictioned).
HVAC1 Toolkit	A collection of subroutines and corresponding documentation that describes algorithms for predicting the performance of HVAC components.
HVAC2 Toolkit	Only available source of consolidated information for documenting mathematical models and calculation algorithms required to analyze HVAC systems.
KM.Kreis	Calculation of nearly every refrigerant as single points, tables, 6 cycles.
MOMO	The user selects components, and the programme calculates temperatures, system efficiencies, etc. for refrigeration and heat pump systems.
Odessy	Odessy will scan for application possibilities for industrial heat pumps.
Refprex	Refprex is an interface tool between the Refprop program and MS Excel. Refprop is the Refrigerant Property program supplied by NIST, USA.
RETScreen	Renewable energy project analysis software consisting of easy to use Microsoft Excel spreadsheets. Freeware.
Svepet	A quasi-static simulation model calculates energy demand, energy saving potential as well as economic outcome for a given heat pump installation.
SwEWS	SwEWS allows the analysis of a specific depth profile (for boreholes) defined by the user. Database Swiss Plateau Molasse.
TRNSYS	Analyses dynamic energy systems. Contains mathematical models for a large number of system components and a method for adding new components
Vitocalc	Vitocalc enables you to dimension a Viessmann heat pump so that it suits its purpose.
Wdim	Allows calculation of all components of a heat pump heating system e.g. buffer size, number of boreholes etc.
WP-Calc	User friendly tool for the design of heat pump systems including economical aspects as well as technical optimiziation. Based on Excel spreadsheets.
WP-OPT	WP-OPT is intended for dimensioning and simulating heat pump heating systems, starting from the building and the heat source.

Tables 3a and 3b show a breakdown of the application of the design tools. The Tables use the abbreviations of the software and handbook titles that have been introduced in Table 1a and 1b.

Table 3a: Application of handbooks

Handbook	**Residences**	**Commercial/ institutional**	**Industry**	**Other**
SHASE AC & San.	x	x		air heating and cooling
ASHRAE GSHP		x		
ISSO HP	x	x		
Industrial HPs			X	Interaction with CHP
REITO AC&R	x	x	X	Refrigeration and air conditioning

Table 3b: Application of software tools.

Software tool	Residences	Commercial/ institutional	Industry	Other
ART	x	x	x	
CoolPack				refrigeration, heat pumps
Cooltool		x	x	x
Cycle-Tempo	x	x	x	
DOE/ORNL HP Model				x (1)
EES	x	x	x	
FrigoSim	x	x		pavement heating
GchpCalc 4.0		x		
GLHEPRO		x	x	
HPSEL	x			
HVAC1 Toolkit	x	x	x	
HVAC2 Toolkit	x	x	x	x
KM.Kreis				
MOMO	x	x	x	
Odessy			x	
Refprex				refrigerant properties
RETScreen	x	x		
Svepet	x			
SwEWS	x	x	x	
TRNSYS	x	x	x	
Vitocalc	x	x	x	
Wdim	x			
WP-Calc	x	x		
WP-OPT	x	x		

(1) residential and light commercial air-to-air air conditioning and heat pumps

Many software tools and handbooks can be used for more than one application. The table shows the following distribution:

- Residential applications: 66%
- Applications in commercial/institutional buildings: 66%
- Applications in industry: 48%

3.3 Tasks

The design tools can be used for the following tasks:

Table 4a: Contents of the various handbooks

Handbook	Preliminary design	Outline technical design	Detailed design	Cycle design	System design	Properties of working media	Economics	Application fields for heat pumps	Selection of heat pump type	Safety aspects, maintenance and legislation
SHASE AC & San.	x	x		x	x	x		x	x	x
ASHRAE GSHP	x	x	x						x	
ISSO HP		x							x	
Industrial HPs	x	x		x	x	x	x	x	x	
REITO AC&R	x	x		x	x	x		x		x

Table 4b: Tasks performed by the various software tools

Software tool	Preliminary design	Outline technical design	Detailed design	System performance prediction	Detailed system design	Cycle design	Properties of working media	Economics
ART	x	x	x	x		x	x	
CoolPack	x	x	x	x	x		x	x
Cooltool	x	x	x	x	x	x	x	
Cycle-Tempo	x	x				x	x	
DOE/ORNL HP Model			x	x		x	x	
EES	x	x	x			x	x	x
FrigoSim	x	x	x	x	x	x	x	
GchpCalc 4.0	x	x	x	x	x			
GLHEPRO			x	x	x			
HPSEL	x	x	x		x	x		x
HVAC1 Toolkit								
HVAC2 Toolkit								
KM.Kreis	x			x	x		x	
MOMO			x	x	x	x	x	
Odessy	x			x				x
Refprex	x	x	x		x	x	x	
RETScreen	x			x	x			x
Svepet	x			x			x	x
SwEWS	x				x		x	
TRNSYS	x	x	x	x	x	x	x	x
Vitocalc	x	x		x	x			x
Wdim	x	x		x	x		x	x
WP-Calc		x	x	x	x	x	x	x
WP-OPT		x	x	x	x		x	x

Most suppliers report that their tool should be applied for outline technical design, slightly more than detailed system design and also more than preliminary design. The most-performed task of software tools is system performance prediction. Most of the handbooks reviewed in this study provide assistance for the selection of heat pump type.

3.4 Target groups

The suppliers answered that the design tools can be used by the following target groups, see Table 5a and 5b:

Table 5a: Handbook users, according to suppliers

Handbooks	Consulting engineers	Contractors	Equipment suppliers	Researchers	Education	Process Industry	Other
SHASE AC & San.	x	x	x	x		x	
ASHRAE GSHP	x	x	x	x	x		
ISSO HP	x						
Industrial HPs	x		x	x	x	x	
REITO AC&R	x	x	x	x		x	

Table 5b: Software tool users, according to suppliers

Software tools	Consulting engineers	Contractors	Equipment suppliers	Researchers	Education	Process Industry	Other
ART	x	x	x	x	x	x	
CoolPack	x	x	x	x	x	x	
Cooltool	x		x		x	x	
Cycle-Tempo	x	x	x	x	x	x	
DOE/ORNL HP Model	x		x	x	x		
EES				x	x	x	
FrigoSim	x	x	x	x	x	x	
GchpCalc 4.0	x	x	x				
GLHEPRO	x	x	x	x	x	x	
HPSEL	x			x			
HVAC1 Toolkit	x		x				
HVAC2 Toolkit	x		x				
KM.Kreis	x			x	x	x	
MOMO	x	x	x	x	x	x	
Odessy	x			x	x	x	
Refprex	x	x	x	x	x	x	
RETScreen	x	x	x	x	x	x	x (1)
Svepet	x	x	x	x			
SwEWS	x	x		x	x		
TRNSYS	x		x	x	x	x	
Vitocalc	x	x					x (2)
Wdim	x	x	x		x	x	
WP-Calc	x	x			x	x	
WP-OPT	x		x		x		

(1) professional services, association/NGO, project developer, financial institution, government
(2) initiated house-owners

The table shows that nearly 100% of the design tools is intended for consulting engineers. Furthermore, the data show that two-thirds of these tools are targeted towards equipment suppliers, researchers or education as well. Most of the tools are intended for 3 or more target groups.

3.5 Language

Table 6a and 6b show the languages of the software tools and handbooks respectively. The large majority of the software tools is in English. German is the second most popular language for these design tools. For the handbooks, the international relevance is worse, with two of the handbooks in Japanese and a further two in Dutch.

Table 6a: Language of the handbooks.

Handbooks	**Danish**	**Dutch**	**English**	**French**	**German**	**Italian**	**Japanese**	**Norwegian**	**Spanish**	**Swedish**
SHASE AC & San.							x			
ASHRAE GSHP			x							
ISSO HP		x								
Industrial HPs		x								
REITO AC&R							x			

Table 6b: Language of the software tools.

Software tool	Danish	Dutch	English	French	German	Italian	Japanese	Norwegian	Spanish	Swedish
ART			x							
CoolPack	x		x							
Cooltool		x	x	x	x	x			x	x
Cycle-Tempo			x							
DOE/ORNL HP Model			x							
EES			x							
FrigoSim			x							
GchpCalc 4.0			x							
GLHEPRO			x							
HPSEL			x							
HVAC1 Toolkit			x							
HVAC2 Toolkit			x							
KM.Kreis			x	x	x				x	
MOMO			x	x						
Odessy			x							
Refprex			x							
RETScreen			x	x						
Svepet										x
SwEWS					x					
TRNSYS			x							
Vitocalc					(1)					x
Wdim					x					
WP-Calc				x	x					
WP-OPT			x		x					

(1) possibly a German translation later

3.6 Breakdown of users

3.6.1 Number of users world-wide

The suppliers of the design tools indicated that the following numbers are using their tools (For those tools that are not mentioned below, the supplier said that the number is unknown):

0 to 10
- Odessy

11 to 50
- Cycle-Tempo
- MOMO
- SwEWS

51 to 100
- Refprex

101 to 500
- DOE/ORNL HP Model
- FrigoSim
- GLHEPRO
- TRNSYS
- WP-Calc

more than 500
- CoolPack
- CoolTool
- GchpCalc 4.0
- RETScreen
- WDim

The data show that most tools considered in this project are used by more than 100 users. The minority is being used by a smaller number. Two tools in this group are special-purpose: the SwEWS programme has a Swiss database, and Odessy is for industrial heat pump applications.

3.6.2 Number of tools sold

Similar to the data in section 3.5.1., this section shows how many design tools have been sold (Likewise, when numbers were unknown, the tools have not been mentioned):

0 to 10
- HPSEL
- Odessy

11 to 50
- Cycle-Tempo
- FrigoSim
- MOMO
- Refprex
- SwEWS

51 to 100
- WDim

101 to 500
- GLHEPRO
- KM.Kreis
- TRNSYS
- WP-Calc

more than 500
- CoolPack
- CoolTool
- EES
- GchpCalc 4.0
- ASHRAE GSHP (handbook)

The comparison with the data in 3.6.1 shows that the average number of sold copies is lower than the average number of users. More than one user can use one copy. Furthermore, the number of sold copies is not applicable to popular freeware tools, such as RETScreen and CoolPack (though the CoolPack supplier answered “more than 500”).

3.6.3 Origin of users by continent

Table 7 shows the origin of the users by continent, along with the data concerning number of users and number of copies sold, as indicated by the suppliers:

Table 7a: Number of users (by continent) and number of copies sold (handbooks).

			Number of users by continent					
Handbook	**Number of users**	**Number sold**	**Europe**	**North-America**	**Central/ South America**	**Asia**	**Africa**	**Australia**
SHASE AC & San.	n.a.	n.a.				100		
ASHRAE GSHP	n.a.	> 500	2	95		3		
ISSO HP	n.a.	n.a.	100					
Industrial HPs	n.a.	n.a.						
REITO AC&R	n.a.	n.a.				100		

Table 7b: Number of users (by continent) and number of copies sold (software tools).

			Number of users by continent					
Software tool	**Number of users**	**Number sold**	**Europe**	**North-America**	**Central/ South America**	**Asia**	**Africa**	**Australia**
ART	n.a.	n.a.			No data			
CoolPack	> 500	> 500	95	1.5	1	1	1	0.5
Cooltool	> 500	> 500	98					
Cycle-Tempo	11-50	11-50	75		15	5		5
DOE/ORNL HP Model	101-500	n.a.	3	80	2	10		5
EES	n.a.	> 500	40	50		10		
FrigoSim	101-500	11-50	94	1		5		
GchpCalc 4.0	> 500	> 500		100				
GLHEPRO	101-500	101-500	x	x		x		
HPSEL	n.a.	< 11			No data			
HVAC1 Toolkit	n.a.	n.a.	x	x				
HVAC2 Toolkit	n.a.	n.a.	x	x				
KM.Kreis	n.a.	101-500	95	3		2		
MOMO	11-50	11-50	100					
Odessy	< 11	< 11	x			x		
Refprex	51-100	11-50	40	30	5	25		
RETScreen	> 500	n.a.	x	x		x	x	
Svepet	n.a.	n.a.			No data			
SwEWS	11-50	11-50	x	x				
TRNSYS	101-500	101-500	70	20	3	5		2
Vitocalc	n.a.	n.a.	x					
Wdim	> 500	51-100	99	1				
WP-Calc	101-500	101-500	100					
WP-OPT	n.a.	n.a.	100					

The data show that most tools are used in either Europe or North-America. There are few tools (EES, Refprex and TRNSYS) that are used in a significant share on both of these continents. This survey has hardly identified tools that are used in Asia, Central/ South America, Africa and Australia.

3.6.4 Origin of users by profession according to suppliers

Table 8a and 8b show the profession of users as indicated by the suppliers:

Table 8a: Users of handbooks by profession

Handbook	Consulting engineers	Contractors	Equipment suppliers	Researchers	Education	Industry
SHASE AC & San.	30	10	40	5	5	10
ASHRAE GSHP	70	10	10	5	5	
ISSO HP	90					
Industrial HPs						
REITO AC&R	20	10	60	5	5	10

Table 8b: Users of software tools by profession

Software tool	Consulting engineers	Contractors	Equipment suppliers	Researchers	Education	Industry
ART						
CoolPack	4	25	25	1	25	20
Cooltool						
Cycle-Tempo	10		15	10	50	15
DOE/ORNL HP Model	5		50	20	25	
EES	20		10	20	30	20
FrigoSim	10		10	30	40	10
GchpCalc 4.0	50	30	15	5		
GLHEPRO	x	x	x	x	x	x
HPSEL						
HVAC1 Toolkit	x	x				
HVAC2 Toolkit	x	x				
KM.Kreis	30			15	5	50
MOMO	10		45			45
Odessy	x			x	x	x
Refprex	x	x	x	x	x	x
RETScreen	x	x	x	x	x	x
Svepet						
SwEWS	x	x		x	x	
TRNSYS	60			15	15	10
Vitocalc	x	x				
Wdim	x	x	x	x	x	x
WP-Calc	40	30	5	5	10	10
WP-OPT	75		20		5	

x = percentages not mentioned by supplier

Table 8a and 8b show that most tools are predominantly used by consulting engineers. Equipment supplier is the second most popular profession among users of the tools. According to their suppliers, the tools EES and FrigoSim are mostly used in education, but their use is broad.

3.7 Knowledge necessary to use the design tool

The overview below indicates what knowledge is required to work successfully with the tool. It shows that most tools require some previous knowledge of the basic principles of heat pumps. Some tools, such as EES, are not specifically intended for heat pump design and therefore require much input by the user.

no specific knowledge of heat pumps

- Industrial HPs (handbook)
- HPSEL
- Refprex

familiar with the basic principles of heat pumps

- SHASE AC & San. (handbook)
- ART
- CoolPack
- CoolTool
- Cycle-Tempo
- FrigoSim
- GLHEPRO
- ASHRAE GSHP (handbook)
- ISSO HP (handbook)
- HVAC1 Toolkit
- HVAC2 Toolkit
- KM.Kreis
- MOMO
- Odessy
- RETScreen
- Svepet
- TRNSYS
- Vitocalc
- WDim
- WP-Calc
- WP-OPT

expert in the field of heat pumps

- DOE/ORNL HP Model
- EES
- REITO AC&R (handbook)
- SwEWS

3.8 Training time required

The overview below shows the opinion of the suppliers concerning the required training time for their tools. The encouraging result is, that most tools can be used after 0-2 days of training. The tools that require most training time have the broadest scope and are typically suitable for anything from preliminary design to detailed system design.

0 to 2 days

- ART
- CoolPack
- Cycle-Tempo
- DOE/ORNL HP Model
- EES
- GchpCalc 4.0
- GLHEPRO
- ASHRAE GSHP (handbook)
- ISSO HP (handbook)
- HPSEL
- KM.Kreis
- MOMO
- Odessy
- Refprex
- RETScreen
- Vitocalc
- WDim
- WP-Calc
- WP-OPT

3 to 5 days

- CoolTool
- SwEWS
- TRNSYS

6 or more days

- FrigoSim

3.9 Price of a basic package

The prices of a basic package vary widely, by more than a factor of 100. The lowest cost is for CoolPack and RETScreen, which are freeware. Also here, the more expensive are typically the more flexible, more-duty tools.

less than 50 USD
- CoolPack
- DOE/ORNL Heat Pump Design Model
- Industrial HPs (handbook)
- RETScreen International

50 to 249 USD
- ASHRAE GSHPs (handbook)
- ISSO HP (handbook)
- HVAC1 Toolkit
- HVAC2 Toolkit
- SwEWS

250 to 499 USD
- SHASE AC & San. (handbook)
- EES
- GchpCalc 4.0
- Refprex
- REITO AC&R (handbook)
- WDim
- WP-OPT

500 to 2499 USD
- CoolTool
- FrigoSim
- GLHEPRO
- KM.Kreis
- Odessy
- WP-Calc

2500 to 4999 USD
- ART
- TRNSYS

5000 USD or more
- MOMO

4 Users' experience with design tools

The number of users' questionnaires received is eleven, plus two useless (incomplete) questionnaires. One supplier of design tools completed the questionnaire for users of design tools about his own design tool. This answer has not been considered in the further analysis. See www.heatpumpcentre.org/tools/q_users.htm for the questionnaire for users of design tools.

The information in this chapter is based upon the ten questionnaires completed by users of design tools. The users' experience is presented as percentage of the number of evaluations of each design tool. If several answers to a question are possible, the sum of the percentages can exceed 100%. Also the overall users' experience is given, i.e. the answers as percentage of the total number of evaluations of all design tools.

This chapter includes brief discussions of the results and comparisons of the opinions of users and suppliers. However, the possibilities for firm conclusions are extremely limited due to the small number of users that took part.

4.1 List of evaluated design tools

Users' experience with the following design tools is available:

Name of tool	**Country user**
Cycle-Tempo	The Netherlands
DOE/ORNL Heat Pump Design Model	Switzerland
FrigoSim	Korea
FrigoSim	Spain
GLHEPRO	United Kingdom
GLHEPRO	USA
Handbook Heat Pumps (ISSO 38)	The Netherlands
TRNSYS	Switzerland
WP-OPT	Germany
WP-OPT	Sweden

Most users that took part in this survey originate from Europe.

4.2 Users' specification

Answers to the question 'In what field(s) does your organisation operate?'. For instance: GLHEPRO has been evaluated by two users, 50% (one of them) answered 'contractors'. Overall, 10% of the ten users answered 'contractors'. The sum of the percentages for some of the tools exceeds 100%, because some users have given two or more answers.

Within this limited group, most users worked for consulting engineering firms. This coincides with the target groups mentioned in 3.4.

Table 9: Origin of users by kind

Origin of users by kind	consulting engineers	contractors	equipment suppliers	research institutes	education	industry	other	evaluations
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo							100	1
DOE/ORNL Heat Pump Design Model	100			100	100			1
FrigoSim				50	50			2
GLHEPRO	50	50					50	2
Handbook Heat Pumps (ISSO 38)								1
TRNSYS				100				1
WP-OPT	100		50		50			2
Overall	40	10	10	30	30	0	20	10

4.3 Applications

Answers to the question 'Which application(s) do you use the design tool for? (several answers possible)'. See section 4.2 for an explanation about the interpretation of the percentages.

Overall, most tools are used for residential installations. The value of this conclusion is limited, because of the low number of participating users.

Table 10: Applications of the design tools.

Applications	residential buildings	commercial/institutional buildings	industrial processes	other	evaluations
	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo			100		1
DOE/ORNL Heat Pump Design Model	100	100			1
FrigoSim	50		50		2
GLHEPRO		100			2
Handbook Heat Pumps (ISSO 38)	100				1
TRNSYS	100				1
WP-OPT	100	50			2
Overall	60	40	20	0	10

4.4 Stage of the design process

Table 11 presents the answers to the question 'For what stage of the design process do you use the design tool? (several answers possible)'. See section 4.2 for an explanation about the interpretation of the percentages.

Table 11: Stage of the design process

Stage of the design process	preliminary design	outline technical design	detailed design	evaluations
	[%]	[%]	[%]	[#]
Cycle-Tempo	100	100		1
DOE/ORNL Heat Pump Design Model	100	100	100	1
FrigoSim	50	50		2
GLHEPRO	100	50	50	2
Handbook Heat Pumps (ISSO 38)	100		100	1
TRNSYS			100	1
WP-OPT	100	50	50	2
Overall	80	50	50	10

The assessed tools are mostly used for preliminary design, even though suppliers have intended the majority of these tools for outline technical design.

4.5 Tasks

Answers to the question 'What task do you use the design tool for? (several answers possible)'. As software tools and handbooks can be used for different tasks, the possible answers to this question for users of software tools differed from the answers for users of handbooks. In this paragraph the software tools are discussed first, followed by the handbooks. See section 4.2 for an explanation about the interpretation of the percentages.

Table 12a: System performance prediction related tasks, used by respondents.

		System performance prediction							
			Simulation of applications				Analysis of applications		
	Respondents (#)	General	General	Buildings	Industrial processes	Other	General	Process integration	Other
Cycle-Tempo	1	100	100		100		100	100	
DOE/ORNL HP Model	1	100	100	100					
Frigosim	2	100	100	50	50				
GLHEPRO	2	50	50	50					
TRNSYS	1								
WP-OPT	2	100	50	100			50		50
Overall	9	75	67	56	22	0	22	11	11

Table 12b: Detailed system design related tasks, used by respondents.

		Detailed system design										
	Respondents (#)	General	Heating load	Cooling load	Hot water	Selection heat source and sink	Ground loop sizing	Bivalent system design	Zoning	Thermal storage	Distribution systems	Other
Cycle-Tempo	1	100	100	100								
DOE/ORNL HP Model	1	100	100	100					100	100	100	100
Frigosim	2	50			50	50				50		
GLHEPRO	2	100	50				50					
TRNSYS	1											
WP-OPT	2	100			50	50	50	50				
Overall	9	78	22	22	22	22	22	11	11	22	11	11

Table 12c: Cycle design related tasks, used by respondents.

	Respondents (#)	Cycle design							
		General	Evaporator	Condenser	Compressor	Selection of standard equipment	Controls	Choice of refrigerant	Other
Cycle-Tempo	1	100							100
DOE/ORNL HPDM	1								
Frigosim	2	100				100			
GLHEPRO	2								
TRNSYS	1	100				100	100		100
WP-OPT	2	50			50			50	
Overall	9	56	0	0	0	33	11	11	22

Table 12d: Thermo-physical properties and economics-related tasks, used by the respondents.

	Respondents (#)	Thermo-physical properties of working media					Economics		
		General	Refrigerants	Humid air	Ground water	Soil charact-eristics	General	Payback time	Comparison with conventional
Cycle-Tempo	1						100		100
DOE/ORNL HPDM	1								
Frigosim	2	50	50						
GLHEPRO	2						50		50
TRNSYS	1								
WP-OPT	2	50	50				50		50
Overall	9	22	22	0	0	0	33	0	33

System performance prediction and detailed system design are the tasks that the majority of users undertake with this design software. When considering system performance prediction, system simulation in building applications was the most popular among the current group of users.

Comparing these data to the suppliers' information listed in table 4b, a few programs appear to be used for tasks that were not specified by the supplier. This may be due to a different understanding of the terminology between supplier and user(s) (in many cases, just one person) or to user defined subroutines:

- Cycle tempo is used for all main tasks, though the supplier says the tool is suitable for cycle design and thermo-physical properties only.

- GLHEPRO is used for economic analyses, which is not a main task of the programme according to the supplier
- WP-OPT is used for cycle design, which is not a main task according to the supplier.

The reverse situation occurs as well: that a tool is not used for all the tasks it offers. This is not an unusual situation. Many people use spreadsheet programs without realising their full possibilities.

The data presented in Tables 12a-d are presented in the Figures below as well as overall figures.

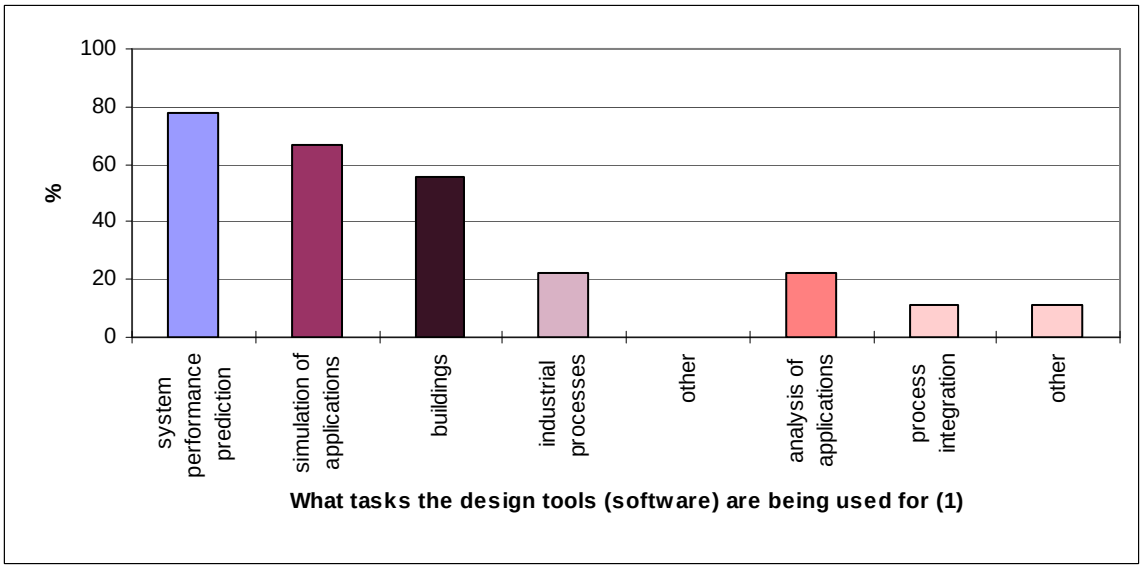

Figure 1: Percentage of users to apply the software tools for system performance prediction (left) and related subtasks.

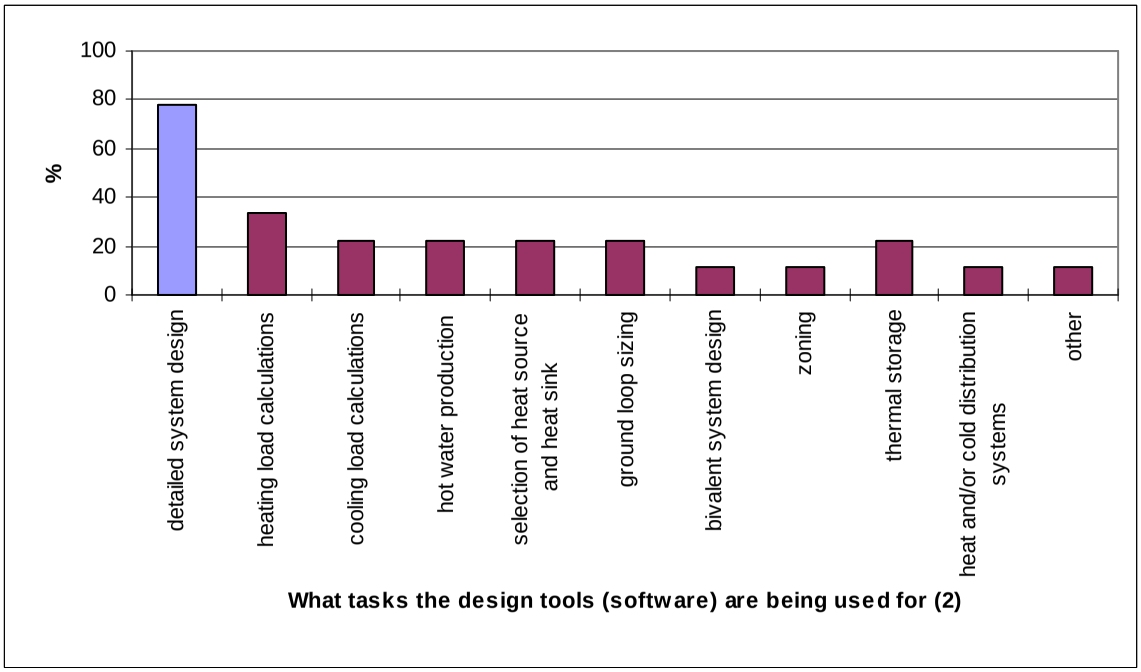

Figure 2: Percentage of users to apply the software tools for detailed system design (left) and related subtasks.

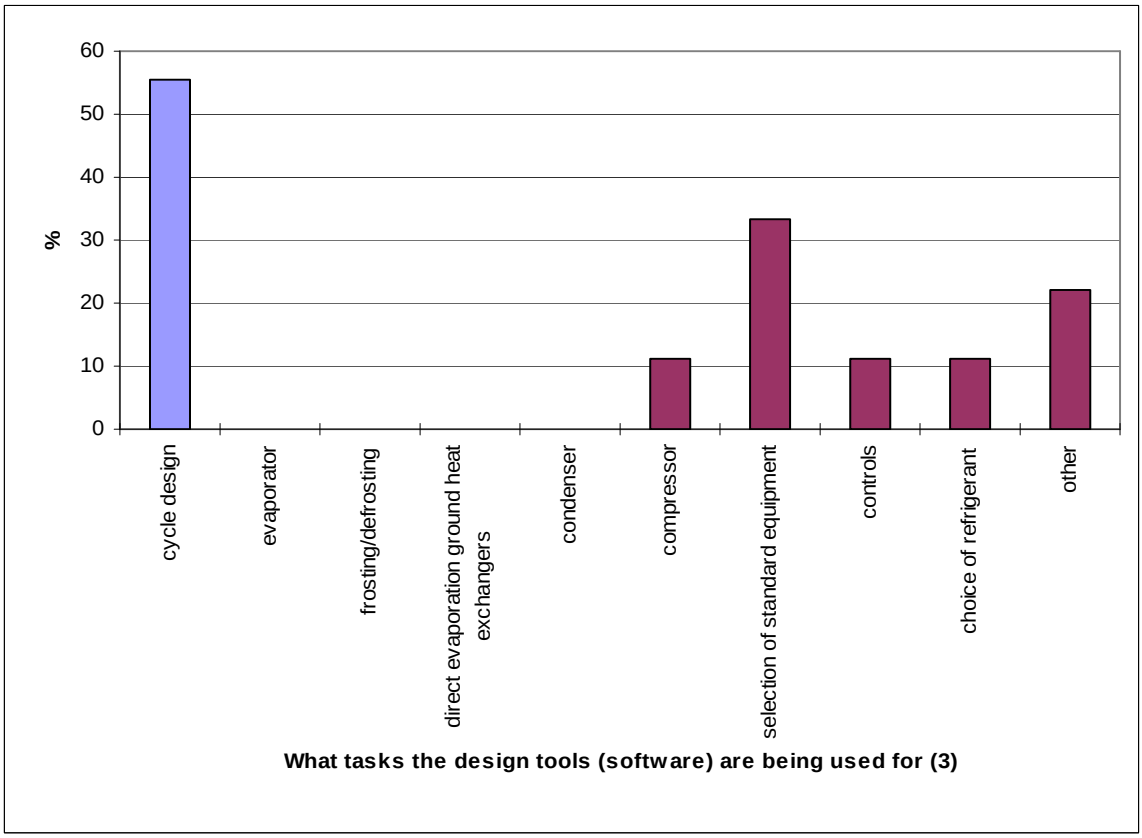

Figure 3: Percentage of users to apply the software tools for cycle design (left) and related subtasks.

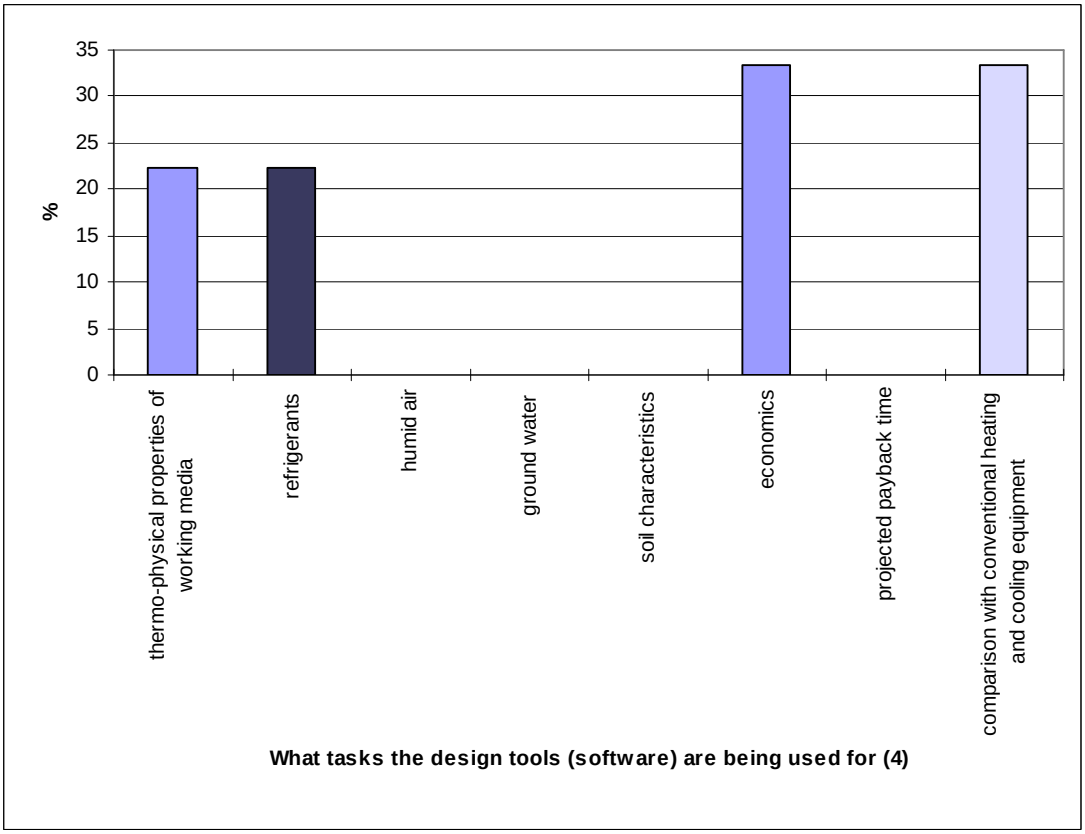

Figure 4: Percentage of users that apply the software tools for thermo-physical properties of working fluids and economics (solid bars) and related subtasks (hatched bars)

The question 'What task do you use the design tool for? (several answers possible)' answered by the one user that evaluated a handbook. In this case, only the answers of this user are reported. This person clearly utilises the handbook for system design and some system design subtasks.

Table 13: Tasks used by the respondent evaluating the ISSO handbook.

	ISSO HP	**Overall**
Number of evaluations	1	1
System design	100	100
- Bivalent system design	100	100
- Heat/cold distribution systems	100	100

4.6 Time-span and frequency of use

Table 14 presents the answers to the question 'How often do you use this design tool, in days per year?' for both software tools and the handbook. Overall, 10% of the ten users uses the design tools 100 or more days per year. Most respondents use the design tool only 6 to 19 days per year.

Table 15: Frequency of use.

Number of days per year	less 5 [%]	6 to 19 [%]	20 to 49 [%]	50 to 99 [%]	100 or more [%]	evaluations [#]
Cycle-Tempo				100		1
DOE/ORNL Heat Pump Design Model					100	1
FrigoSim		100				2
GLHEPRO		100				2
Handbook Heat Pumps (ISSO 38)	100					1
TRNSYS		100				1
WP-OPT			50	50		2
Overall	10	50	10	10	10	10

Figure 5 below presents the answers to the questions 'How long did you use the design tool, in months?' (left bar) and 'How often do you use this design tool, in days per year?'(right bar) as percentages of the total number of evaluations (= 10). Concerning time-span, the majority of the users has used the design tool for more than a year, and 40% even longer than 3 years.

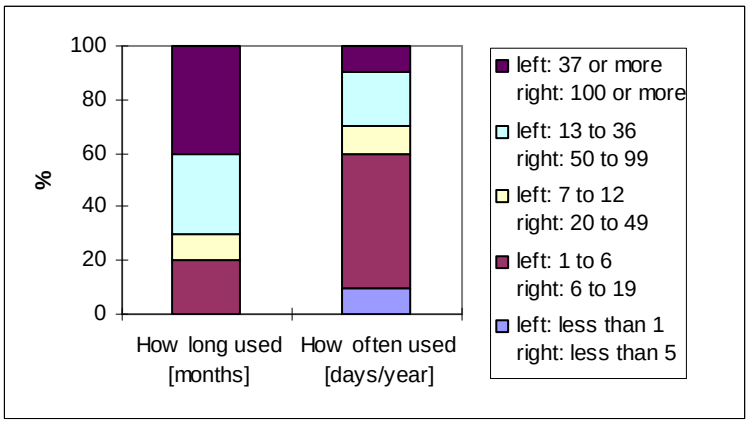

Figure 5: Time-span and frequency of use in months and days/year respectively.

4.7 Assessment of output

Results
Answers to the question 'How do you assess the results of the design tool?'. Table 16 presents the overall figures. The users are in general satisfied with the results obtained from the design tools: 50% assesses them as good and 30% as excellent.

Table 16: Assessment of the results obtained with software tools and handbooks.

Assessment of results	excellent	good	moderate	bad	not applicable	evaluations
	[%]	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo	100					1
DOE/ORNL Heat Pump Design Model		100				1
FrigoSim		100				2
GLHEPRO		50	50			2
Handbook Heat Pumps (ISSO 38)			100			1
TRNSYS		100				1
WP-OPT	100					2
Overall	30	50	20	0	0	10

Output presentation (software only)
Table 17 shows the answers to the question ‘How do you assess the output/presentation of the results?’ (only applicable to software tools). Also here, most users are satisfied: 67% rates the presentation as good, and 11% as excellent.

Table 17: Assessment of output presentation (software tools only).

Assessment of output presentation	excellent	good	moderate	bad	evaluations
	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo	100				1
DOE/ORNL Heat Pump Design Model		100			1
FrigoSim		50	50		2
GLHEPRO		50	50		2
TRNSYS		100			1
WP-OPT		100			2
Overall	11	67	22	0	9

4.8 User-friendliness and support by the supplier

Table 18 shows answers to the question 'How do you assess the user-friendliness of the design tool?'. In general, the respondents answered ‘good’ or ‘moderate’. See also Figure 6.

Table 18: Assessment of user-friendliness

Assessment of user-friendliness	excellent	good	moderate	bad	evaluations
	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo		100			1
DOE/ORNL Heat Pump Design Model		100			1
FrigoSim	50		50		2
GLHEPRO		50	50		2
Handbook Heat Pumps (ISSO 38)			100		1
TRNSYS			100		1
WP-OPT		100			2
Overall	10	50	40	0	10

Table 19 shows answers to the question 'How do you assess the support offered by the supplier of the design tool?'. The most frequent answer was ‘excellent’ followed by ‘unknown’.

Table 19: Assessment of support offered by the supplier (software tools only)

Assessment of support supplier	excellent	good	moderate	bad	unknown	not applicable	evaluations
	[%]	[%]	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo	100						1
DOE/ORNL Heat Pump Design Model					100		1
FrigoSim					50		2
GLHEPRO		50	50				2
TRNSYS	100						1
WP-OPT	50						2
Overall	33	11	11	0	22	0	9

Figure 6 presents the answers to the questions 'How do you assess the way in which user-defined subroutines can be added? and 'What is your opinion on the procedure for installing the design tool?' and the Table 18 and 19 above, presented as percentages of the total number of evaluations (user-friendliness: 10 evaluations, other questions: 9 evaluations (software tools only). The figure shows that not all of the users have answered all questions.

The figure shows in general a favourable picture. The only thing is that a number of users are dissatisfied with the possibilities of adding user-defined subroutines, since 20% characterises this as bad.

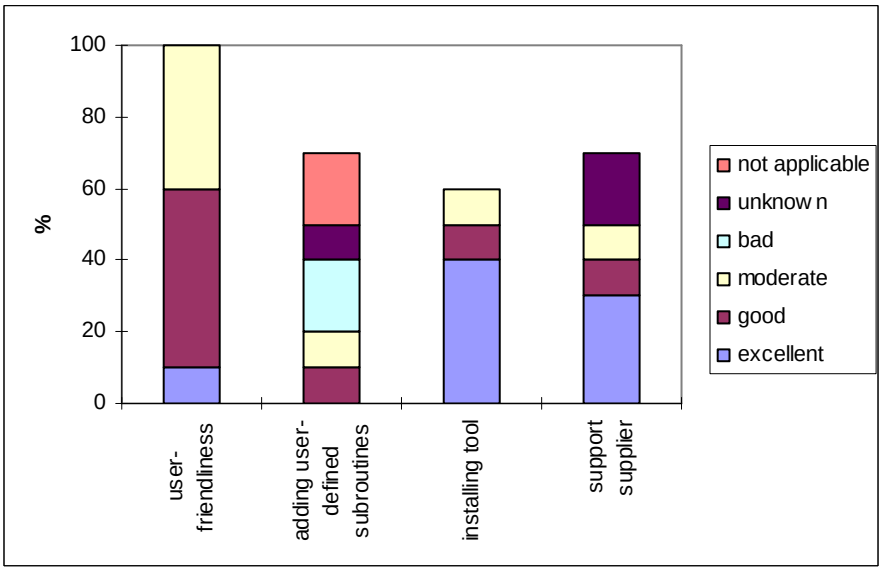

Figure 6: User-friendliness, user-defined subroutines, installation and support.

4.9 Databases

Figure 7 shows the overall assessment of the databases available for calculations. The questionnaire distinguished databases with standard equipment, with thermo-physical properties and with climatic data, and asked to assess the accuracy of the data, amount of data and maintainability and adjustability. Maintainability of the databases is applicable to software tools only; therefore these percentages are based upon the 9 evaluations of software tools. 'Accuracy' and 'amount' are based upon the 10 evaluations of all design tools.

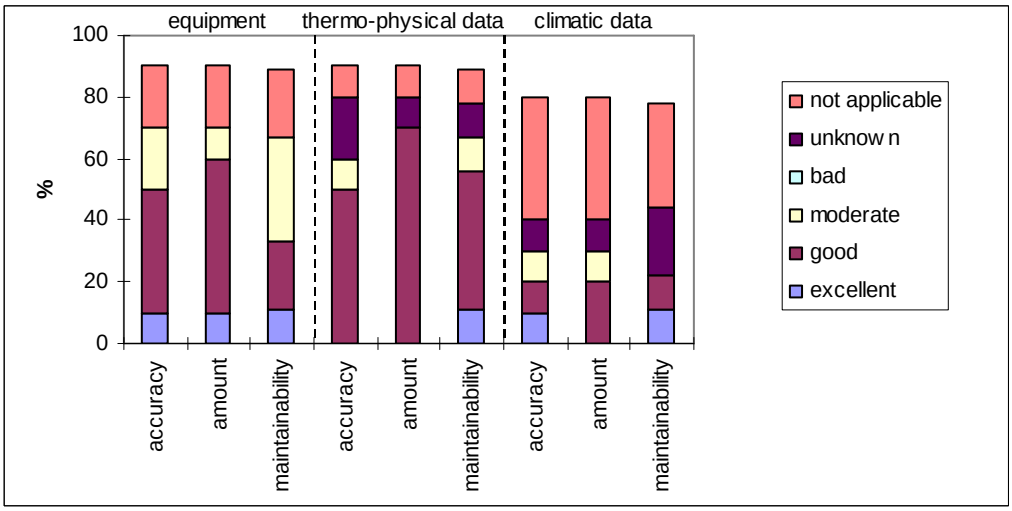

Figure 7: Assessment of databases with standard equipment, thermo-physical properties and climatic data, which are part of the design tool.

Figure 7 shows the following:

- Databases of standard equipment are available in about 70% of the assessed programs. The accuracy and the amount are mostly rated as good, but the maintainability is moderate.
- Databases of thermo-physical properties of working media are available in 60-70% of the cases. They are mostly rated as good on accuracy, amount of data and maintainability.
- Databases of climatic data are not present in most of the assessed programs. The general opinion is favourable: 2 out of 3 rate as excellent or good.

4.10 Readability and index of handbooks

For handbooks, users were asked to assess the readability and the index. The user that evaluated a handbook assessed the readability as good and the index as moderate.

4.11 On the whole

The design tools 'on the whole' are considered good, according to 50% of the completed users' forms. The scores for the individual tools are presented below. Since only one user has been reviewing the tool in most cases, absolute scores for individual design tools have a limited significance.

Table 20: Assessment of design tools "on the whole".

Assessment 'On the whole'	excellent	good	moderate	bad	evaluations
	[%]	[%]	[%]	[%]	[#]
Cycle-Tempo		100			1
DOE/ORNL Heat Pump Design Model		100			1
FrigoSim		50			2
GLHEPRO		100			2
Handbook Heat Pumps (ISSO 38)			100		1
TRNSYS			100		1
WP-OPT	100				2
Overall	20	50	20	0	10

5 Discussion

Twenty-four software tools and five handbooks have been entered in the project. Together, they form a broad selection of tools suitable for various heat pump design tasks.

- A significant share is used in Europe, another major share in North America. Asia is underrepresented as yet.
- The majority of the software tools is in English. For handbooks, the international relevance is worse (two Japanese and two Dutch).
- Most tools reviewed in this project are used by more than 100 users.
- Most software tools and handbooks can be used for more than one application.

Despite the efforts of the project team and the HPC, the number of returned questionnaires both from suppliers and users is lower than expected. The total number of users' assessments stands at ten. It is obvious that the ten user assessments of the seven different design tools are insufficient for conclusions about the individual tools, and that the value of general conclusions based on these ten assessments is extremely limited.

Reasons for the low number of users' questionnaires were:

- too busy/no time;
- we don't use heat pump design tools (in our country);
- I am a supplier of design tools myself, so I am biased;
- we only use the design tools developed by ourselves, which are not generally available.

The factors below have had an important impact on the number of completed questionnaires:

- Users could only give their experience about design tools that had been entered by their suppliers. The reason for this was our desire to have information about the design tools in a standardised way, and commitment from the suppliers.
- Initially, the project focused on English-language design tools. Later on, the scope was extended to include the languages of all IEA Heat Pump Programme member countries: Danish, Dutch, English, French, German, Italian, Japanese, Norwegian, Spanish and Swedish.

The responses of the users are a valuable additional source of information on the applicability of the tools:

- Most users work for consulting engineering firms and use the tools for residential installations. This coincides with the main target groups and the main application area of the 29 entered tools.
- Users seem to use the tools for simpler tasks than intended by their suppliers. Most users say they use the tools for preliminary design. Suppliers had indicated that they had been intended for outline technical design.

Obviously, users are the best source for assessments of user-friendliness and related aspects. The user-friendliness of the reviewed tools was rated as good by 50% of the users, but as moderate by 40%. The general opinion of the users ranged from excellent (20%), good (50%) to moderate (20%).

Experience with a similar project on software tools for process integration has shown that more and more suppliers and users take the time to contribute. This would give the present project much more impact and should be promoted by all means.

Within this project, a database to maintain the data has been developed. This database plus interface developed for the processing of the results enables:

- input and maintenance of general information about heat pump design tools based upon the suppliers' questionnaire developed;
- input and maintenance of users' experience with these design tools based upon the users' questionnaire developed;
- generating documents (MS Word) with descriptions of design tools based upon the information in the database;
- generating documents with users' experience with an individual or all design tools in the database;
- selecting design tools by one or several keywords, e.g. application category, target group, language.

6 Conclusions

Conclusions from the assessment of design software and handbooks

Twenty-four software tools and five handbooks have been entered in the project. The total number of identified heat pump design tools is 67. The entered design tools form a broad selection of tools suitable for various heat pump design tasks:

- A significant share is used in Europe, another major share in North America. Asia is underrepresented as yet.
- The majority of the software tools is in English. For handbooks, the international relevance is worse (two Japanese and two Dutch).
- Most tools reviewed in this project are used by more than 100 users.
- Most software tools and handbooks can be used for more than one application. About two-third of the design tools is suitable for residential buildings and commercial/institutional buildings, half of them is suitable for industrial processes.
- Almost every design tool is meant for consulting engineers. Many design tools are meant for 3 or more target groups (consulting engineers, equipment suppliers, research institutes and education).
- To be 'familiar with the basic principles of heat pumps' is enough to use most design tools. Less than 3 days is the required training time for most design tools.

Conclusions from the users' assessments

The number of returned questionnaires both from suppliers and users is lower than expected. The total number of users' assessments stands at ten, mostly from European users. It is obvious that the ten user assessments of the seven different design tools are insufficient for conclusions about the individual tools, and that the value of general conclusions based on these ten assessments is extremely limited.

Application

- 40% of the participating users is consulting engineer.
- Residential buildings are the main application of the design tools (60%), 40% of the users uses the design tool for commercial/institutional buildings.
- The assessed tools are mostly used for preliminary design (80%), even though suppliers have intended the majority for outline technical design.
- System performance prediction and detailed system design are the main tasks for the software design tools (both 78%), followed by cycle design (56%).
- 50% of the users uses the design tool 6 to 19 days per year. The majority has been using the design tool for more than a year, and 40% even longer than 3 years.

Results and user-friendliness

- The design tools 'on the whole' are assessed as good by 50% of the users (20% excellent and 20% moderate).
- The users are in general satisfied with the results obtained from the design tools. 50% assesses them as good and 30% as excellent. Most users are satisfied with the output presentation as well.
- User-friendliness and support shows in general a favourable picture. The two most problematic areas are user-friendliness – rated as moderate by 4 out of 10 – and the possibility to add user-defined subroutines – rated as bad by 2 out of 7.
- The questions about the databases showed a mixed picture:

- Databases of standard equipment are available in about 70% of the assessed programs. The accuracy and the amount are mostly rated as good, but the maintainability is moderate.
- Databases of thermo-physical properties of working media are available in 60-70% of the cases. They are mostly rated as good on accuracy, amount of data and maintainability.
- Databases of climatic data are not present in most of the assessed programs. The general opinion is favourable: 2 out of 3 rate as excellent or good.

7 Recommendations

- Extend the Internet site of the IEA Heat Pump Centre with the results of this project and inform the heat pump community about it.

- Continue the gathering of information about heat pump design tools and users' experience with these tools

- Take care of maintenance of the Internet site

- Think of other ways to convince users of design tools of the value of completing the questionnaire, e.g. a little present, a symposium, publication of results of case-studies with design tools, ...

- Offer visitors of the Internet site the possibility to select design tools by one or several keywords (like http://www.interduct.tudelft.nl/PItools/search/search.html).

Appendix A. List of design tools identified

In this appendix all design tools identified are listed except the relevant design tools discussed in chapter 3. Several of the design tools in this appendix are of relevance too, but the suppliers of these design tools haven't completed our questionnaire for suppliers or could not be contacted.

Name of tool	Name of supplier	Country	Relevance	Comments
ABSIM	ORNL	USA	unknown	
ARTI Refrigerant Database	ARTI	USA	unknown	
Aspen Plus	AspenTech	USA	yes	
BAMALOAD	Energy Information Services	USA	yes	
CYCLE_D	NIST USA	USA	yes	
CaSIS	EDF	France	unknown	
Carnot	Solar-Institut-Jülich, FH Aachen	Germany	unknown	
Cycle-11	NIST	USA	unknown	outdated?
Cyrano	CETIAT	France	unknown	
DSD	Ruess und Hausherr	Switzerland	unknown	
EVAC			unknown	
EVAP5	NIST	USA	unknown	
EWS	Novaenergie	Switzerland	unknown	
Earth Energy Designer	Justus Liebig Univ.	Germany	unknown	
Ecofys - Dynamic simulation program	Ecofys	The Netherlands	no	internal use only
Evap coil	Conde Engineering	Switzerland	unknown	
GHLEWIN	Oklahoma State University	USA	unknown	
GHP Piping Design	Energy Information Services	USA	yes	
HPCEL			unknown	
HPDesign	Conde Engineering	Switzerland	unknown	
HTFS	Hyprotech	Canada	yes	
HVAC Systems and Equipment	ASHRAE	USA	yes	
IDA/IDA ICE	EQUA Simulation technology group	Sweden	unknown	
IHP Screening Program	IEA HPC	The Netherlands	unknown	
Moist	NIST	USA	no	limited relevance
NetLoopCost	Energy Information Services	USA	yes	
PRODIM	Thorbergsen Frigosoft		no	outdated, now Frigosim
PROSIM	Thorbergsen Frigosoft		no	outdated, now Frigosim
Psychrometrics	Energy Information Services	USA	yes	
Purez	ORNL	USA	unknown	
RADS	Cold-Wave	The Netherlands	yes	
REFLEAK	NIST	USA	no	limited relevance
REFPROP	NIST USA	USA	unknown	
Spreadsheet comp. system KW/ton & EER (1)	Energy Information Services	USA	yes	
Swimming pool HP heating est. program (2)	Arieh (?)		unknown	
Technical documents EDF/France	EDF	France	unknown	
TideLoad4Z	Energy Information Services	USA	yes	
WPSIM	Deerns (?)	The Netherlands	unknown	

(1) Simple spreadsheet to compare the system KW/ton and EER
(2) Swimming pool heat pump heating estimating program

Appendix B. Information about the design tools

Air-Conditioning and Sanitary Engineering Handbook

12th edition (1995), first publication: 1934

Application(s)
residential buildings, commercial buildings, air heating and cooling

Target group(s)
Consulting engineers, contractors, equipment suppliers, research institutes, industry

Brief description
This handbook consists of three volumes.
1. Fundamentals: Fundamentals, System planning, Structural strength, Material
2. Air-conditioning systems: Heating and cooling load calculations, System design,
3. Sanitary systems: Application systems design, case studies.

Language(s)
Japanese

Author
(Not yet available)

Organisation
The Society of Heating, Air-conditioning and Sanitary Engineers of Japan,
1-8-1 Kita-shinjuku Shinnjukuku, 169-0074, Tokyo, Japan,
Tel.: +81 3 3363 8261, Fax. +81 3 3363 8266,
URL of home page: http://wwwsoc.nacsis.ac.jp/shase/

Users according to organisation/publisher
Consulting engineers (30%), contractors (10%), equipment suppliers (40%), research institutes (5%), education (5%), industry (10%)
Asia (100%)

Use
Knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
Training time required [days]: unknown

Tasks
Intended use: preliminary design, outline technical design
Application fields for heat pumps, selection of heat pump type
System design: heating load calculations, cooling load calculations, hot water production, heat and/or cold distribution systems
Cycle design: evaporator, condenser, compressor, and controls
Thermo-physical properties of working media: humid air
Safety aspects, maintenance and legislation: legislation/code of practice

ART

Version: 2.11, last updated: 15/10/2001 (first release: 2001)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
ART (Advanced Refrigeration Technologies) is a simulation tool for refrigeration equipment of vapour compression type. It is completely devoted to assist the design and selection of refrigeration equipment and components, especially, but not restricted, for HVAC applications.

It allows the calculation of:
- Fluid properties of pure fluids and any mixture. A software tool called GENMAP is provided to be able to generate a file with the thermodynamics and transport properties of any refrigerant under the specified range of operation. Calculations are performed with REFPROP from NIST and conveniently transformed in a table containing all the required information. ART calculates the required properties by interpolation from the table. Additionally, built-in tables allow the calculation of the properties of any usual secondary fluid, i.e. water, air and common brines.
- Theoretical cycle. The software allows for the evaluation of the theoretical cycle for the prescribed evaporation and condensation temperatures and cooling or heating duties. The compressor characteristics can be specified in a number of ways including usual data from catalogues and built-in default efficiencies.
- Real cycle. The software allows for the evaluation of the working cycle for the prescribed components: evaporator, condenser, piping and compressor, at the given temperature and flow rate of the heat sources (secondary fluids). Heat exchangers can be prescribed just as an effective area and a given function of the overall heat transfer coefficient, or through a detailed 1D modelling which is able to take into account the HE type, flow arrangement and other factors. The compressor characteristics can be specified in a simple manner or by user-defined correlations for the isentropic and volumetric efficiencies. Pressure drop through every component is considered in the calculations.

Parametric studies with single or combined input variables can be easily performed. The user interface has been designed in order to make data input as comfortable as possible and to allow a fast visual analysis of the obtained results.

Language(s)
English

Supplier
Universidad Politecnica de Valencia, IMST, Instituto de Ingenieria Energetica,
Camino de Vera 14, E 46022, Valencia, Spain,
Tel.: +34 963877323, Fax. +34 963877329,
E-mail: corberan@ter.upv.es
URL of home page: http://www.imst.upv.es
URL of demo version: http://www.imst.upv.es/software_propio.htm

Contact
Jose M. Corberan
Tel.: +34 963877323
E-mail: corberan@ter.upv.es

Price
2500 - 4999 USD
Other possibilities: Educational version (DEMO) is free

Users according to supplier
unknown

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated, is maintained by supplier), database with thermo-physical properties (is available, can be manipulated), correlation methods for physical properties are available
data exchange with other software: export of data is possible (word processor, spreadsheet)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications (refrigeration unit)
cycle design: evaporator, condenser, compressor, selection of standard equipment, choice of refrigerant
Thermo-physical properties of working media: refrigerants, humid air

System requirements
Operating system: Windows 95/98/2000/NT, Linux
40 MB hard disk space, 32 MB RAM, Pentium 100 MHz

Documentation
Installation guide, user manual, reference manual, technical manual, tutorials

Services
Hot-line phone, hot-line email, free updates, training facilities

Literature
- Corberan, J.M., Gonzalvez, J., The matching problem on the modelling of vapor compression systems. A tool to analyze the system behavior., Proc. Int Refrigeration Conf. at Purdue, USA, pp 233, 1998
- Corberan, J.M. et al., Simulation of an air-to-water reversible heat pump, Int. Refrigeration Conf. at Purdue, pp. 8, 2000

CoolPack

Version: 1.45, last updated: 7/3/2001 (first release: 1999)

Application(s)
Refrigeration, Heat Pumps

Target group(s)
Consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
CoolPack is a collection of simulation programs each with a specific calculation purpose.

The programs can be used for obtaining refrigerant properties, refrigeration cycle analysis, dimensioning of systems, selection of components, and evaluation of system and component operation.

CoolPack is freeware.

Language(s)
Danish, English

Supplier
Tech. Univ. of Denmark, Department of Mechanical Engineering,
Building 402, DK-2800, Kgs. Lyngby, Denmark,
Tel.: +45 4 525 4129, Fax. +45 4 593 5215,
URL of design tool: http://www.et.dtu.dk/coolpack

Contact
Arne Jakobsen
E-mail: aj@et.dtu.dk or coolpack@et.dtu.dk

Price
Less than 50 USD (lease: 0 USD/year)
other possibilities: CoolPack is freeware!

Users according to supplier
5000 users (2000 tools sold)
consulting engineers (4%), contractors (25%), equipment suppliers (25%), research institutes (1%), education (25%), industry (20%)
Europe (95%), USA and Canada (1.5%), Central and South America (1%), Asia (1%), Africa (1%), Australia and New Zealand (0.5%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: possibility to store new cases, database with thermo-physical properties (is maintained by supplier)
Data exchange with other software: output of other software can be used as input (RefProp 6.01), export of data is possible (spreadsheet)

Tasks
Intended use: preliminary design, outline technical design, detailed design
System performance prediction: analysis of applications (Refrigeration process design)
Detailed system design: cooling load calculations
Cycle design: evaporator, condenser, compressor, choice of refrigerant
Thermo-physical properties of working media: refrigerants, humid air
Economics

System requirements
Operating system: Windows 95/98/2000/NT
38 MB hard disk space, 64 MB RAM, PC 200 MHz

Documentation
Installation guide, tutorial, tutorials

Services
On-line help, hot-line phone, hot-line email, free updates

CoolTool

last updated: 4/1/2001 (first release: 1992)

Application(s)
commercial buildings, industrial processes

Target group(s)
consulting engineers, equipment suppliers, education, industry

Brief description
CoolTool design software for air conditioning and refrigeration

Complete pipe-sizing, component design for 18 different parts, 33 refrigerants, cooling load, h,x - chart, cold storage, cooling load calculation, system flow diagram
- one stage cycles
- two stage cycles
- compound plants with direct evaporation up to 27 evaporators
- compound plants for secondary refrigerants up to 27 coolers
- compound plants with overflooded evaporation up to 27 evaporators

Language(s)
Dutch, English, French, German, Italian, Spanish, Swedish

Supplier
Dehon service Netherlands,
Ekkersrijt 1411, 5692 AL, Son, The Netherlands,
Tel.: +31 499 474 705, Fax. +31 499 474 705,

Contact
Hans van Assouw
E-mail: h.v.assouw@dehon.nl

Price
500 - 2499 USD

Users according to supplier
1000 users (800 tools sold)
Europe (98%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 3 - 5
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated), database with thermo-physical properties (is available), database with climatic data (is available, can be manipulated)
data exchange with other software: output of other software can be used as input (spreadsheet, Tubenet)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications (buildings, industrial processes, plant design refrigeration), analysis of applications (process integration)
detailed system design: heating load calculations, cooling load calculations
cycle design: evaporator, condenser, compressor, selection of standard equipment, choice of refrigerant
thermo-physical properties of working media: refrigerants, humid air

System requirements
Operating system: Windows 95/98/2000/NT, Linux
30 MB hard disk space, 16 MB RAM, PC 166 MHz

Documentation
installation guide, user manual

Services
on-line help, hot-line email

Cycle-Tempo

Version: 5.0, last updated: 6/1/2001 (first release: 1980)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
Cycle-Tempo is a tool for simulating stationary energy systems based on the philosophy to give the user as much freedom as possible to define the system. This definition regards to the configuration (apparatus types and the way they are connected), but also to which information is input and which information should be calculated. The program is suited to model all kinds of systems where energy (power and/or heat) is generated or transferred. For modeling heat pumps the REFPROP database from NIST has been integrated in the program. A module for calculating ammonia/water properties, useful for modeling sorption systems, is also available.

Language(s)
English

Supplier
TNO MEP,
PO Box 342, 7300 AH, Apeldoorn, The Netherlands,
Tel.: +31 (0)55 5493493,
URL of demo version: on request

Contact
Marcel J.E. Verschoor
Tel.: +31 (0)55 5493 800
E-mail: m.j.e.verschoor@mep.tno.nl

Users according to supplier
30 users (30 tools sold)
consulting engineers (10%), equipment suppliers (15%), research institutes (10%), education (50%), industry (15%)
Europe (75%), Central and South America (15%), Asia (5%), Australia and New Zealand (5%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with thermo-physical properties (is available, is maintained by supplier)
data exchange with other software: export of data is possible (word processor, spreadsheet)

Tasks
intended use: preliminary design, outline technical design
cycle design: evaporator, condenser, compressor, choice of refrigerant
thermo-physical properties of working media: refrigerants, humid air, ground water

System requirements
Operating system: Windows 95/98/2000/NT
25 MB hard disk space, 16 MB RAM, 8 MB video chart

Documentation
installation guide, user manual, reference manual, technical manual, tutorials

Services
on-line help, hot-line phone, hot-line email, free updates, training facilities, add-on packages, maintenance service, field engineer

Literature
- Verschoor, M.J.E., Adapting CHP Software to Suit the Modelling of Heat Pump and Refrigeration Systems, 59th EUROTHERM Seminar, 6-7 July 1998, Nancy, France
- Verschoor, M.J.E., Analysis of software tools for designing heat pumps, TNO-MEP report R98/353 (1998)
- Verschoor, M.J.E., Modeling Refrigeration and Heat Pump Systems with Software for power Cycles, 20th International Congress of Refrigeration, IIR/IIF, 19-24 September 1999, Sydney, Australia

DOE/ORNL Heat Pump Design Model

Version: Mark V, version 95d, last updated: 1/1/1995 (first release: 1978)

Application(s)
residential and light commercial air-to-air ACs and HPs

Target group(s)
consulting engineers, equipment suppliers, research institutes, education

Brief description
The DOE/ORNL Heat Pump Design Model is a research tool for use in the steady-state simulation and design analysis of air-to-air heat pumps and air conditioners. The program can be used with most of the newer HFC refrigerants as well as with CFCs and HCFCs. The standard vapor-compression cycle is modeled with empirical representations for compressor performance and first-principle region-by-region modeling of the heat exchangers.

An online Web version is available that can be used with default configurations or with user-specified component and operating parameters for analyzing the performance of single-speed, air-to-air equipment. Users can conduct 1- or 2-variable analysis of design and operating parameters.

Strengths: Predicts EER, capacity, air- and refrigerant-side conditions for cooling or heating operation with first-principles heat exchanger modeling; handles a variety of refrigerants; will size flow control devices given heat exchanger (HX) design exit conditions; useful in studying the general performance trends when varying HX design parameters (with or without a fixed design capacity) and operating conditions (with or without a fixed refrigerant charge and flow control); moderate accuracy with fast execution; user-tuneable.

Language(s)
English, English Units

Supplier
Oak Ridge National Lab,
PO Box 2008, Mail Stop 6070, Oak Ridge, TN 37716-6070, USA,
Tel.: +1 865 574 2016, Fax. +1 865 574 9338,
URL of demo version: http://www.ornl.gov/~wlj/hpdm/

Contact
Keith Rice
E-mail: ckr@ornl.gov

Price
less than 50 USD
other possibilities: operational Web version freely available.

Users according to supplier
300 users
consulting engineers (5%), equipment suppliers (50%), research institutes (20%), education (25%), Europe (3%), USA and Canada (80%), Central and South America (2%), Asia (10%), Australia and New Zealand (5%)

Use
knowledge necessary to use the design tool: expert in the field of heat pumps
training time required [days]: 0 - 2
kind of user interface: Web browser with HTML forms, PC/DOS command line
data management: standard examples exist, possibility to store new cases
data exchange with other software: output of other software can be used as input (input text files), export of data is possible (spreadsheet, output text files)

Tasks
intended use: detailed design
system performance prediction: simulation of applications (air-to-air AC and HP equipment)
cycle design: evaporator, condenser, compressor, controls, choice of refrigerant, refrigerant charge and cycle balance
thermo-physical properties of working media: refrigerants, humid air

System requirements
Operating system: Current Web browser or PC/DOS
0.5 MB hard disk space, 0.505 MB RAM, PC 386, math. coprocessor 25 MHz

Documentation
user manual, technical manual, installation text files

Services
free updates, limited e-mail support

Literature
- C. K. Rice, 1997. "DOE/ORNL Heat Pump Design Model, Overview and Application to R-22, 3rd Int. Conf. on Heat Pumps in Cold Climates, Caneta Research Inc.
- ORNL/TM-10192, 1988. S. K. Fischer, C. K. Rice, and W. L. Jackson, The Oak Ridge Heat Pump Model: Mark III Version Program Documentation, March 1988.
- ORNL/CON-80/R1, 1983. S. K. Fischer and C. K. Rice, The Oak Ridge Heat Pump Models: I. A Steady-State Computer Design Model for Air-to-Air Heat Pumps, August 1983,

EES, Engineering Equation Solver

Version: 6.199, last updated: 4/11/2001 (first release: 1995)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
research institutes, education, industry

Brief description
EES solves up to 10,000 simultaneous nonlinear equations. It is not specifically a heat pump program. The user must supply the equations. There are examples given for heat pump analysis. Thermophysical and transport properties for almost all refrigerants (and other substances) are built into EES.

Language(s)
English

Supplier
F-Chart Software,
4406 Fox Bluff Road, 53562, Middleton, WI, USA,
Tel.: +1 608 836 8361, Fax. +1 608 836 8536,
E-mail: info@fchart.com
URL of home page: http://fchart.com
URL of demo version: http://fchart.com

Contact
William A. Beckman
E-mail: beckman@engr.wisc.edu

Price
250 - 499 USD (lease: NA USD/year)

Users according to supplier
2000 tools soldconsulting engineers (20%), equipment suppliers (10%), research institutes (20%), education (30%), industry (20%)
Europe (40%), USA and Canada (50%), Asia (10%)

Use
knowledge necessary to use the design tool: expert in the field of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (can be manipulated), database with thermo-physical properties (is available), database with climatic data (can be manipulated)
data exchange with other software: output of other software can be used as input (word processor, spreadsheet, User must supply equations - can do "anything"), export of data is possible (word processor, spreadsheet)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications (buildings, industrial processes), analysis of applications
cycle design
thermo-physical properties of working media: refrigerants, humid air, soil characteristics
economics

System requirements
Operating system: Windows 95/98/2000/NT
5 MB hard disk space

Documentation
user manual

Services
hot-line phone, hot-line email, add-on packages, maintenance service

FrigoSim

Version: 2.3, last updated: 2/19/2001 (first release: 1983)

Application(s)
residential buildings, commercial buildings, Pavement heating

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
FrigoSim is a process simulation program for thermal energy plants. It is particularly suitable for design of refrigerating plants, including heat pumps and air conditioning systems. FrigoSim assists the user in making an optimal design of a plant with respect to capacity and economy. The accuracy of the calculation is mainly based on the component data quality and the user effort to set up a detailed plant description.

Features:
- Fluid thermal and transport properties data based on built-in function libraries for 34 refrigerants and 13 pure fluids and 12 aqueous fluids over a range of concentrations.
- 84 component models using these fluid libraries.
- Arbitrary complexity in connecting a maximum of 200 components. Duplication of entire plants or plant details for set-up of multiple aggregates.
- Any number of concurrent multiple-layered, transient heat conduction calculations with non-linear/phase-change materials, connected directly or through other components.

- Working directly with plant layout, with component symbols selected to your preference. Calculation results also presented in layout. Alternative display of results in enthalpy-pressure, entropy-temperature and psychrometric charts.
- Construction of plants from scratch or from a number of plant templates. Support for user or company specific component libraries.
- Scaling of single components, groups of components or entire plants to meet capacity requirements. Component optimization mechanism for best plant performance.

- 9 versatile control mechanisms applied to single components or component aggregates.
- Output of user-selected component quantities. Calculation of user-specified quantities, e.g. for economy analysis. Output for spreadsheet processing.
- Flexible description of component properties. Mechanism for input of practically available data, including data from industry.
- On-screen tools for instant check of effect caused by component size change or modified boundary conditions or control-type conditions.

- The unit system can be selected from several alternatives (SI, UK and US) plus individual unit selections.
- Microsoft Windows user interface, with logically organized menu commands, a toolbar and help texts.

Language(s)
English

Supplier
Thorbergsen Frigosoft,
Lundasen 54, N-7089, Trondheim, Norway,
Tel.: +47 7 389 5808,
URL of demo version: http://ed.interconsult.com/frigosoft/frigosim

Contact
Even Thorbergsen
E-mail: even.thorbergsen@frigosoft.no

Price
500 - 2499 USD

Users according to supplier
200 users (50 tools sold)
consulting engineers (10%), equipment suppliers (10%), research institutes (30%), education (40%), industry (10%)
Europe (94%), USA and Canada (1%), Asia (5%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 6 or more
kind of user interface: menu driven
data management: standard examples exist, database with standard equipment (can be manipulated), database with thermo-physical properties (is available, is maintained by supplier)
data exchange with other software: export of data is possible (word processor, spreadsheet)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications: analysis of applications (process integration)
detailed system design: hot water production, selection of heat source and heat sink, ground loop sizing, thermal storage, heat and/or cold distribution systems
cycle design: evaporator, condenser, compressor, selection of standard equipment, choice of refrigerant
thermo-physical properties of working media: refrigerants, humid air, ground water, soil characteristics

System requirements
Operating system: Windows 95/98/2000/NT
10 MB hard disk space, 4 MB RAM

Documentation
installation guide, user manual, tutorials

Services
on-line help, hot-line email, maintenance service

GchpCalc 4.0

Version: 4.0, last updated: 15/05/01 (first release: 1993)

Application(s)
commercial buildings

Target group(s)
consulting engineers, contractors, equipment suppliers

Brief description
GchpCalc is a program for sizing vertical loop ground source heat pump systems. Input includes zone-by-zone (or total) building heating & cooling loads, maximum and minimum desired loop temperature, ground thermal properties, bore diameter/ grid patterns/ separation, tube dimensions, grout type, and desired equipment manufacturer. Help screens available for thermal properties of soils, rocks and grouts. Optional subroutines embedded in program to compute average thermal conductivity, diffusivity, and perform pump requirement estimates. Program will also size supplemental cooler and consider integrated water heating.

Output includes required ground loop size, system demand and efficiencies (heating and cooling) required flow rate, fluid cooler size, model numbers of equipment to meet zone-by-zone HVAC requirements, long term ground temperature change, water flow rates, pump size and demand, and anti-freeze requirements (if any). Alternative designs can be easily evaluated.

Language(s)
English

Supplier
Energy Information Services,
708 Vicksburg Drive, 35486-0013, Tuscaloosa, AL, USA,
Tel.: +1 205-343-9049, Fax. +1 205-348-6419,
E-mail: geokiss@home.com
URL of home page: http://www.geokiss.com

Contact
Penny Kavanaugh

Price
250 - 499 USD

Users according to supplier
600 users (600 tools sold)
consulting engineers (50%), contractors (30%), equipment suppliers (15%), research institutes (5%), USA and Canada (100%)

Use
knowledge necessary to use the design tool: unknown
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated), database with thermo-physical properties (is available, can be manipulated)
data exchange with other software: output of other software can be used as input (Companion Load & Energy Calculator (BamaLoad))

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications (At full load)
detailed system design: heating load calculations, cooling load calculations, hot water production, ground loop sizing, zoning, Note: supplemental program (BamaLoad) required.

System requirements
Operating system: Windows 95/98/2000/NT
10 MB hard disk space, 64 MB RAM, Pentium I 200 MHz

Documentation
installation guide, user manual, reference manual, technical manual, tutorials

Services
One and two-day seminars

Literature
- Ground Source Heat Pumps, Kavanaugh and Rafferty, ASHRAE

GLHEPRO

Version: 3.0.3, last updated: 8/4/2000 (first release: 1995)

Application(s)
commercial buildings, industrial processes

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
GLHEPRO is a tool for designing vertical ground loop heat exchangers for commercial and institutional buildings. It is based on the University of Lund methodology.

Users are expected to provide information on monthly total heating and cooling loads, monthly peak heating and cooling loads, ground thermal properties, circulating fluid properties and flow rate, borehole geometry and grout properties, borehole configuration, and heat pump data.

Standard libraries are provided for ground and fluid thermal properties and heat pumps; users may add their own entries to all libraries.

Since the program relies on pre-computed g-functions to describe the temperature response, a library of over 300 borehole configurations is also provided. GLHEPRO has two primary functions: 1) given the above data, it can predict monthly average and peak entering fluid temperatures to the heat pump, and 2) given the above data and user-desired minimum and maximum heat pump entering fluid temperatures, find the minimum borehole depth that meets the user design criteria.

Language(s)
English

Supplier
IGSHPA / Oklahoma State University,
490 Cordell South, 74078, Stillwater, OK, USA,
Tel.: +1 405 744 5175, Fax. +1 405 744 5283,
URL of design tool: http://www.mae.okstate.edu/glhepro

Contact
prof. Jeffrey D. Spitler
E-mail: spitler@okstate.edu or glhepro@okstate.edu

Price
500 - 2499 USD

Users according to supplier
175 users (175 tools sold)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry
Europe, USA and Canada, Central and South America (%), Asia, Australia and New Zealand (%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated, is maintained by supplier), database with thermo-physical properties (is available, can be manipulated, is maintained by supplier)
data exchange with other software: output of other software can be used as input (spreadsheet, BLAST, Trane Trace), export of data is possible (spreadsheet)

Tasks
intended use: detailed design
system performance prediction: simulation of applications (ground heat transfer)
detailed system design: ground loop sizing
economics: comparison with conventional heating and cooling equipment

System requirements
Operating system: Windows 95/98/2000/NT
10 MB hard disk space, 64 MB RAM, CD Rom speed: 1

Documentation
user manual, tutorials

Services
hot-line phone, hot-line email, training facilities

Literature
- Spitler, J.D. 2000. GLHEPRO -- A Design Tool For Commercial Building Ground Loop Heat Exchangers. Proceedings of the Fourth International Heat Pumps in Cold Climates Conference, Aylmer, Québec. Augus

Ground Source Heat Pumps: Design of Geothermal Systems for Commercial and Institutional Buildings

1st edition (1997), first publication: 1997
ISBN: 1-883413-52-4

Application(s)
commercial buildings

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education

Brief description
Book to assist HVAC design engineers in efforts to create high-quality GSHP systems for commercial and institutional buildings at reasonable costs. Starts with concepts familiar to traditional HVAC designer and integrates geological and ground heat exchanger principles and design concepts. Topics include introduction and overview, heat pump equipment, fundamentals of ground heat exchange, design of closed loops, pump and piping sub-system design, ground water (open loop design), surface water systems (open and closed), and economics.

Language(s)
English

Author(s)
Steve Kavanaugh & Kevin Rafferty
Tel.: 205-348-1649 & 541-885-1750,
E-mail: skavanaugh@coe.eng.ua.edu and raffertk@oit.edu

Organisation
ASHRAE,
1791 Tullie Circle NE, 30329-2305, Atlanta GA, USA,
Tel.: +1 404 636 8400, Fax. +1 404 321 5478,
E-mail: orders@ashrae.org
URL of home page: www.ashrae.org

Publisher
ASHRAE Atlanta, GA USA

Users according to organisation/publisher
900 tools soldconsulting engineers (70%), contractors (10%), equipment suppliers (10%), research institutes (5%), education (5%),
Europe (2%), USA and Canada (95%), Asia (3%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2

Tasks
intended use: preliminary design, outline technical design, detailed design
selection of heat pump type
system design: selection of heat source and heat sink, ground loop sizing
thermo-physical properties of working media: ground water, soil characteristics

Handbook Heat Pumps (ISSO 38)

1 edition (1996), first publication: 1996
ISBN: 90-5044-052-5

Application(s)
residential buildings, commercial buildings

Target group(s)
consulting engineers

Brief description
The ISSO handbook combines knowledge and experience with regard to applications of heat pumps in buildings, especially in the Netherlands. The handbook takes into account the whole life-cycle of heat pumps.

Language(s)
Dutch

Author
(not yet available)

Organisation
Stichting ISSO,
Postbus 1819, 3000 BV, Rotterdam, The Netherlands,
Tel.: +31 (0)10 2065969, Fax. +31 (0)10 2130384,
E-mail: isso@isso.nl

Publisher
Stichting ISSO Rotterdam The Netherlands

Users according to organisation/publisher
consulting engineers (90%),
Europe (100%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2

Tasks
intended use: outline technical design
selection of heat pump type
system design: heating load calculations, cooling load calculations, heat and/or cold distribution systems

Handbook Industrial Heat Pumps

1 edition (1998), first publication: 1998
ISBN: 90-5576-139-7

Application(s)
industrial processes, Interaction with CHP

Target group(s)
consulting engineers, equipment suppliers, research institutes, education, industry

Brief description
Contents of Dutch Handbook Industrial Heat Pumps:
- introduction: basic principles, diffrences industrial and residential heating appliances
- The heat pump in detail: detailed principles, definitions, detailed description different types, components, specific properties
- Implementation in industrial processes: heat pump and other saving options, exergy analysis, Pinch analysis, combination with CHP
- Feasibility phase
- Design phase
- Implementation phase
- Examples of industrial appliances

Language(s)
Dutch

Author(s)
H. Boot, J. Nies, M.J.E. Verschoor, J.B. de Wit

Organisation
TNO MEP,
PO Box 342, 7300 AH, Apeldoorn, The Netherlands,
Tel.: +31 (0)55 5493493,

Publisher
Kluwer Bedrijfsinformatie Deventer Netherlands

Users according to organisation/publisher
unknown

Use
knowledge necessary to use the design tool: none
training time required [days]: unknown

Tasks
intended use: preliminary design, outline technical design
application fields for heat pumps, selection of heat pump type
system design: heating load calculations, selection of heat source and heat sink, process integration
cycle design: evaporator (frosting/defrosting), condenser, compressor, controls, choice of refrigerant
thermo-physical properties of working media: refrigerants, humid air
safety aspects, maintenance and legislation: maintenance topics, safety aspects, legislation/code of practice, trouble shooting
economics: comparison with conventional heating and cooling equipment

HPSEL

Version: 1.81, last updated: 7/1/1997

Application(s)
residential buildings

Target group(s)
consulting engineers, research institutes

Brief description
Uses in built climate data for various European regions to calculate heating requirements of a specified house. Then selects, from a database of heat pumps (at present only fictioned), the top 10 for the particular application on the basis of either cost, energy consumption, or CO2 emission. Database of heat pumps never properly populated so tool never made commercially available.

Language(s)
English

Supplier
EA Technology Ltd.,
Capenhurst Technology Park, CH22EN, Capenhurst, Chester, United Kingdom,
Tel.: +44 151 347 2391,
E-mail: mark.betnet@eatechnology.com

Users according to supplier
0 tools sold

Use
knowledge necessary to use the design tool: none
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, database with standard equipment (is available), database with climatic data (is available)
data exchange with other software: output of other software can be used as input (spreadsheet)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications (buildings)
detailed system design: heating load calculations, hot water production, selection of heat source and heat sink, bivalent system design
cycle design
economics

System requirements
Operating system: Windows 3.1
640 MB hard disk space, 500 MB RAM

HVAC1 Toolkit: A Toolkit for Primary HVAC System Energy Calculation

Version: 1.0, last updated: 6/1/1999 (first release: 1999)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, equipment suppliers

Brief description
A collection of subroutines and corresponding documentation that describes algorithms for predicting the performance of HVAC components. The Toolkit documentation includes thorough descriptions of the component models and solution algorithms, detailed information on the structure of the individual FORTRAN routines, as well as illustrative examples of system simulation with the Toolkit routines.

The Toolkit serves two purposes: modules for large-scale simulation and stand-alone component performance prediction. The Toolkit components can also be used to calculate the performance of a component with a dedicated driver program to provide the necessary information flow to the Toolkit routines.

Language(s)
English

Supplier
ASHRAE,
1791 Tullie Circle NE, 30329-2305, Atlanta GA, USA,
Tel.: +1 404 636 8400, Fax. +1 404 321 5478,
E-mail: orders@ashrae.org
URL of home page: www.ashrae.org

Contact
Marc Wilson
E-mail: mwilson@ashrae.org

Price
50 - 249 USD

Users according to supplier
consulting engineers, equipment suppliers,
Europe, USA and Canada

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: unknown

System requirements
Operating system: Windows 95/98/2000/NT
5 MB hard disk space, 8 MB RAM, 386 33 MHz, 8 MB video chart, CD Rom speed: 2

HVAC2 Toolkit: Algorithms and Subroutines for Secondary HVAC Systems Energy Calculations

Version: 1.0, last updated: 6/1/1993 (first release: 1993)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, equipment suppliers

Brief description
Only available source of consolidated information for documenting mathematical models and calculation algorithms required to analyze HVAC systems. This collection of subroutines on a 3.5" disk enables engineers to create ad hoc programs that investigate project-specific problems or analyze novel designs not in packaged programs.

Language(s)
English

Supplier
ASHRAE,
1791 Tullie Circle NE, 30329-2305, Atlanta GA, USA,
Tel.: +1 404 636 8400, Fax. +1 404 321 5478,
E-mail: orders@ashrae.org
URL of home page: www.ashrae.org

Contact
Marc Wilson
E-mail: mwilson@ashrae.org

Price
50 - 249 USD

Users according to supplier
consulting engineers, equipment suppliers,
Europe, USA and Canada

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: unknown

System requirements
Operating system: Windows 95/98/2000/NT, DOS
5 MB hard disk space, 8 MB RAM, 386 33 MHz, 8 MB video chart, CD Rom speed: 2

KM.Kreis

Version: 4.0, last updated: 1/1/2000 (first release: 1993)

Target group(s)
consulting engineers, research institutes, education, industry

Brief description
Calculation of nearly every refrigerant as single points, tables, 6 cycles.
Demo version found on the web site (www.fkw-hannover.de).
Data referring ASHRAE standards.
Refrigerant module for own applications also available as Pascal-Module. Implementation in Excel avialable.
Upgrade with CO_2 supercritical in process at IKK Hanover.

Language(s)
English, French, German, Spanish

Supplier
FKW GmbH,
Weidendamm 14, 30419, Hannover, Germany,
Tel.: +49 511 167 4750, Fax. +49 511 167 4752,
E-mail: e-mail@fkw-hannover.de
URL of home page: http://www.fkw-hannover.de

Contact
Mr. Gebhardt

Price
500 - 2499 USD
other possibilities: request for special price

Users according to supplier
350 tools soldconsulting engineers (30%), research institutes (15%), education (5%), industry (50%)
Europe (95%), USA and Canada (3%), Asia (2%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: Mask with input output
data management: possibility to store new cases
data exchange with other software: export of data is possible (tables, points, 6 cycles, 6 basic cycles)

Tasks
intended use: preliminary design
system performance prediction
detailed system design: heating load calculations, cooling load calculations
thermo-physical properties of working media: refrigerants

System requirements
Operating system: Windows 95/98
1 MB hard disk space

Documentation
install file

Services
direct contact

MOMO (Modular Modeling)

Version: 2.16, last updated: 21/2/2000 (first release: 1997)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
The software MOMO works in the following way :

1) database you select the components you're interested in:
- compressor (scroll, rotary, reciprocating...)
- evaporator (fin coil, shell and tubes, tube in tube, plate HX...)
- condenser (the same)
- expansion valve (thermostatic, capillary tube, electronic...)
- 4 ways valve
using the software database
2) then MOMO assembles all components together
3) you specify connections length, diameter...
4) you specify the fluid charge and superheating
5) you specify air temperatures and velocities, or water temperature and flow rate
6) then MOMO tells :
- cooling, heating and electric capacities
- EER or COP
- pressure drops
- outlet temperatures
- ...

MOMO can be used with a lot of fluids (R22, R410A, R134a, R407C, R404A, hydrocarbons...)
MOMO can run in both cooling and heating mode
MOMO can be used to design chillers, split systems, heat pumps...

Language(s)
English, French

Supplier
CETIAT, Air Conditioning and Heat Exchangers,
25 avenue des Arts BP 2042, 69603, Villeubanne cedex, France,
Tel.: +33 4 72 44 49 00, Fax. +33 4 72 44 49 99,
URL of home page: www.cetiat.fr

Contact
Philippe Pra
Tel.: +33 4 72 44 49 67
E-mail: philippe.pra@cetiat.fr

Price
5000 or more USD
other possibilities: Free demo version available.

Users according to supplier
50 users (25 tools sold)
consulting engineers (10%), equipment suppliers (45%), industry (45%)
Europe (100%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated, is maintained by supplier), database with thermo-physical properties (is available, is maintained by supplier)
data exchange with other software: export of data is possible (Microsoft Excel)

Tasks
intended use: detailed design
system performance prediction: simulation of applications (buildings, industrial processes, commercial)
detailed system design: hot water production
cycle design: evaporator, condenser, compressor, choice of refrigerant, expansion valve, 4 ways valve
thermo-physical properties of working media: refrigerants, humid air, ground water

System requirements
Operating system: Windows 98/NT
25 MB hard disk space, 64 MB RAM, Pentium 400 MHz, 8 MB video chart

Documentation
installation guide, user manual, tutorials

Services
on-line help, hot-line phone, hot-line email, free updates, add-on packages, maintenance service

Odessy

Version: 1.3, last updated: 4/30/2000 (first release: 1999)

Application(s)
industrial processes

Target group(s)
consulting engineers, research institutes, education, industry

Brief description
Odessy will scan for application possibilities for industrial heat pumps.
Basically it is a pinch oriented tool which explicitely incorporates possible implementation of different heat pump systems and/or combined heat and power. The tool optimises toward minimum primary energy consumption and gives detailed information on energy cost savings and requiered investments for heat exchangers, heat pumps and combined heat and power.

Language(s)
English

Supplier
TNO MEP,
PO Box 342, 7300 AH, Apeldoorn, The Netherlands,
Tel.: +31 (0)55 5493493,
URL of demo version: ftp://neptunus.tno.nl/TNO/MEP/demos/Odessydemo Setup.exe

Contact
H. Boot
E-mail: h.boot@mep.tno.nl

Price
500 - 2499 USD
other possibilities: Educational version

Users according to supplier
10 users (10 tools sold)
consulting engineers, research institutes, education, industry
Europe, Asia (1%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated)
data exchange with other software: output of other software can be used as input (word processor, spreadsheet), export of data is possible (word processor, spreadsheet, Graphics exported (WMF, BMP))

Tasks
intended use: preliminary design
system performance prediction: analysis of applications (process integration)
economics

System requirements
Operating system: Windows 95/98/2000/NT
15 MB hard disk space, 16 MB RAM, PC 100 MHz, CD Rom speed: 4

Documentation
user manual, Course manual, tutorials

Services
on-line help, hot-line email, free updates, training facilities, maintenance service

Refprex

Version: 6.01, last updated: 30/05/2000 (first release: 1994)

Application(s)
Refrigerant Properties

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
Refprex is an interface tool between the Refprop program and MS Excel. Refprop is the Refrigerant Property program supplied by the National Institute of Standards and Technology, USA. Refprex is basically a library of property functions which make it possible to obtain refrigerant property data directly in Excel. Just by inserting a function in a cell in a worksheet any desired refrigerant property can be obtained (pressures, temperatures, enthalpies, entropies, viscosity etc.). Refprex can also be linked to other environments next to Excel, e.g. to C++, Delphi, Labview etc.

Language(s)
English

Supplier
Re/genT bv,
Lagedijk 22, 5605 BZ, Helmond, Netherlands,
Tel.: +31 492 476365, Fax. +31 492 476369,
E-mail: info@re-gent.nl
URL of home page: http://www.re-gent.nl
URL of demo version: http://www.re-gent.nl

Contact
Martien Janssen
Tel.: +31 492 476365
E-mail: martien.janssen@re-gent.nl

Price
250 - 499 USD

Users according to supplier
100 users (40 tools sold)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry
Europe (40%), USA and Canada (30%), Central and South America (5%), Asia (25%)

Use
knowledge necessary to use the design tool: none
training time required [days]: 0 - 2
kind of user interface: integration in Excel
data management: database with standard equipment (can be manipulated, database with standard equipment, is maintained by supplier), correlation methods for physical properties are available
data exchange with other software: output of other software can be used as input (spreadsheet), export of data is possible (spreadsheet)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: analysis of applications (process integration)
detailed system design: refrigerant properties
cycle design, choice of refrigerant
thermo-physical properties of working media: refrigerants

System requirements
Operating system: Windows 95/98/2000/NT
3 MB hard disk space

Documentation
installation guide, worksheets, tutorials

Services
on-line help, hot-line phone, free updates, maintenance service

Refrigeration and Air-Conditioning Handbook

5th edition (1999), first publication: 1963

Application(s)
residential buildings, commercial buildings, industrial processes, refrigeration and air conditioning

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, industry

Brief description
This handbook consists of 6 volumes,
1. Fundamental
2. Equipments
3. Air-conditioning
4. Refrigeration systems
5. Food, Biology and Medical Sciences
6. Plant engineering & safety control

Language(s)
Japanese

Author
(not yet available)

Organisation
Japan Society of Refrigeration and Air-conditioning Engineers,
8 Saneichou Shinjukuku, 160-0008, Tokyo, Japan,
Tel.: +81 3 3359 5231, Fax. +81 3 3359 5233,
URL of home page: http://village.infoweb.ne.jp/~reito

Publisher
Japan Society of REfrigeration and Air-conditioning Engineers Tokyo Japan

Users according to organisation/publisher
consulting engineers (20%), contractors (10%), equipment suppliers (60%), research institutes (5%), education (5%), industry (10%)
Asia (100%)

Use
knowledge necessary to use the design tool: expert in the field of heat pumps
training time required [days]: unknown

Tasks
intended use: preliminary design, outline technical design
application fields for heat pumps
system design: heating load calculations, cooling load calculations
cycle design: evaporator (frosting/defrosting, direct evaporation ground heat exchangers), condenser, compressor, controls, choice of refrigerant
thermo-physical properties of working media: refrigerants, humid air
safety aspects, maintenance and legislation: maintenance topics, safety aspects

RETScreen International

Version: 98, 99 and 2000, last updated: 3/25/2001 (first release: 1998)

Application(s)
residential buildings, commercial buildings

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry

Brief description
RETScreen Renewable Energy Project Analysis Software

Download free-of-charge at : http://retscreen.gc.ca

RETScreen is a standardised and integrated renewable energy project analysis software consisting of easy to use Microsoft Excel spreadsheets. The software can be used to evaluate the annual energy production, costs and financial viability of the following renewable energy technologies (RETs) anywhere in the world :
Wind energy; Small hydro; Photovoltaics; Solar air heating; Biomass heating; Solar water heating; Passive solar heating; and Ground-source heat pumps.

RETScreen is useful for both decision-support and capacity-building purposes. In terms of decision-support, RETScreen provides a common platform for evaluating project proposals while significantly reducing the costs (down to one tenth the cost of conventional studies), time and errors associated with preparing preliminary feasibility studies. Regarding its capacity-building benefits, the software, together with the On-line product, cost and weather database and On-line User Manual, serves as an ideal educational and industry/market development tool.

RETScreen was developed by Natural Resources Canada's (NRCan) CANMET Energy Diversification Research Laboratory (CEDRL) with the contribution of over seventy experts from industry and government.
RETScreen is funded in part by NRCan's Renewable and Electrical Energy Division (REED) through the Renewbale Energy Deployment Initiative (REDI). RETScreen is being further developed with the following collaborating organisations: UNEP, NASA.

Language(s)
English, French

Supplier
CANMET Energy Diversification Research Laboratory,, Natural Rescources Canada,
1615 Lionel-Boulet, J3X 1S6, Varennes, Quebec, Canada,
Tel.: +1 452 652 4621, Fax. +1 450 652 5177,
URL of design tool: http://retscreen.gc.ca
E-mail: rets@nrcan.gc.ca

Price
less than 50 USD (lease: free USD/year)

Users according to supplier
14000 users
consulting engineers, contractors, equipment suppliers, research institutes, education, industry
Europe, USA and Canada, Central and South America (%), Asia, Africa, Australia and New Zealand (%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated, is maintained by supplier), database with climatic data (is available, can be manipulated, is maintained by supplier), correlation methods for physical properties are available
data exchange with other software: output of other software can be used as input (spreadsheet), export of data is possible (spreadsheet)

Tasks
intended use: preliminary design
system performance prediction: simulation of applications (buildings)
detailed system design: heating load calculations, cooling load calculations, ground loop sizing
economics: comparison with conventional heating and cooling equipment

System requirements
Operating system: Windows 95, Windows 3.1 for version 98
177 MB hard disk space

Documentation
installation guide, user manual, reference manual, technical manual, worksheets

Services
on-line help, hot-line email, free updates, training facilities, add-on packages

Svepet

Application(s)
residential buildings

Target group(s)
consulting engineers, contractors, equipment suppliers, research institutes

Brief description
A general design tool developed by the Royal Institute of Technology in cooperation with the major actors on the swedish heat pump market. A quasi-static simulation model calculates energy demand, energy saving potential as well as economic outcome for a given heat pump installation. Design of vertical boreholes and horizontal ground coils are included. To be launched in the beginning of 2002.

Language(s)
Swedish

Supplier
SVEP,
Box 17537, 118 91, Stockholm, Sweden,
Tel.: +46 8 762 75 00, Fax. +46 8 762 74 73,
E-mail: info@svepinfo.se
URL of home page: http://svepinfo.se

Contact
Anders Paulsson, VD

Users according to supplier
unknown

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: unknown
kind of user interface: menu driven
data management: database with standard equipment (is available, database with standard equipment, is maintained by supplier), database with thermo-physical properties (is maintained by supplier), database with climatic data (is available)

Tasks
intended use: preliminary design
system performance prediction: simulation of applications (buildings)
detailed system design: heating load calculations, hot water production, selection of heat source and heat sink, ground loop sizing, bivalent system design, heat and/or cold distribution systems
thermo-physical properties of working media
economics: comparison with conventional heating and cooling equipment

System requirements
Operating system: Windows 95
20 MB hard disk space, 16 MB RAM, PC 233 MHz

Documentation
installation guide, user manual, reference manual, technical manual

Services
on-line help, hot-line email, maintenance service

SwEWS

Version: 1.0, (first release: 1999)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, contractors, research institutes, education

Brief description
The software tool SwEWS allows the analysis of a specific depth profile defined by the user. Based on the input for the stratal model the programme calculates the geothermal parameters for each horizon together with a temp. profile. The result can be analyzed in various tables and graphic displays. For further use the data can also be exported as a ASCII file.
The database characterizes in detail the main lithological rock types in the three Molasse groups OSM, OMM and USM within the Swiss Plateau Molasse.

Language(s)
German

Supplier
Nova Energie GmbH,
Schachenallee 29, 5000, Aarau, Switzerland,
Tel.: +41 62 834 0300, Fax. +41 62 834 0323,
E-mail: office.aarau@novaenergie.ch
URL of home page: http://www.infoenergie.ch

Contact
Pius Hüsser
Tel.: +41 62 834 03 00

Price
50 - 249 USD

Users according to supplier
20 users (20 tools sold)
consulting engineers, contractors, research institutes, education,
Europe, USA and Canada

Use
knowledge necessary to use the design tool: expert in the field of heat pumps
training time required [days]: 3 - 5
kind of user interface: menu driven
data exchange with other software: export of data is possible (word processor)

Tasks
intended use: preliminary design
detailed system design: selection of heat source and heat sink, ground loop sizing, zoning
thermo-physical properties of working media: ground water, soil characteristics

System requirements
Operating system: Windows 95/98/2000/NT
50 MB hard disk space

Documentation
installation guide, user manual, tutorials

Services
hot-line phone

TRNSYS

Version: 15.0, last updated: 4/1/2001 (first release: 1975)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, equipment suppliers, research institutes, education, industry

Brief description
TRNSYS is a program that analyses dynamic energy systems. It contains mathematical models for a large number of system components and a method for adding new components if the ones needed aren't included. The user forms a system by connecting components (represented by icons) together in a graphical interface. Although, since the TRNSYS input file is text based, tools are provided for direct manipulation. Output is user defined and can be in the form of text based output files or online plots. In both cases, any system variable can be examined. TRNSYS was first written in 1975 to study a building with passive solar heating. It is currently developed by a joint US-European team of engineers and computer scientists.

Language(s)
English

Supplier
Thermal Energy Systems Specialists,
5610 Medical Circle - Suite 31, 53719, Madison, Wisconsin, USA,
Tel.: +1 608 274 2577, Fax. +1 608 278 1475,
E-mail: information@tess-inc.com
URL of home page: http://www.tess-inc.com

Contact
Jeff Thornton

Price
2500 - 4999 USD (lease: n/a USD/year)
other possibilities: a 50% discount is given to academic institutions

Users according to supplier
300 users (300 tools sold)
consulting engineers (60%), research institutes (15%), education (15%), industry (10%)
Europe (70%), USA and Canada (20%), Central and South America (3%), Asia (5%), Australia and New Zealand (2%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 3 - 5
kind of user interface: graphical interface and command line are both possible
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated), database with thermo-physical properties (is available, can be manipulated), database with climatic data (is available, can be manipulated), correlation methods for physical properties are available
data exchange with other software: output of other software can be used as input (word processor, spreadsheet, all output is text based)

Tasks
intended use: preliminary design, outline technical design, detailed design
system performance prediction: simulation of applications (buildings, industrial processes), analysis of applications
detailed system design: heating load calculations, cooling load calculations, hot water production, selection of heat source and heat sink, ground loop sizing, bivalent system design, zoning, thermal storage, heat and/or cold distribution systems
cycle design, choice of refrigerant
thermo-physical properties of working media: refrigerants, humid air, ground water, soil characteristics
economics: comparison with conventional heating and cooling equipment

System requirements
Operating system: Windows 95/98/2000/NT
70 MB hard disk space, 32 MB RAM, PC 133 MHz, 4 MB video chart, CD Rom speed: 4

Documentation
installation guide, user manual, reference manual, tutorials

Services
on-line help, hot-line phone, hot-line email, free updates, training facilities, add-on packages, maintenance service

Literature
- "Low-Risk and Cost-Effective Prior Savings Estimates for Large- Scale Energy Conservation Projects in Housing: Learning from the Fort Polk GHP Project"; Nat. Energy Prg. Evaluation Conference, 1997
- "Comparison of Practical Vertical Ground Heat Exchanger Sizing Methods to a Fort Polk Data/Model Benchmark"; ASHRAE Summer Meeting Boston, MA USA; 1997

- "Assessment of Anti-Freeze Solutions for Ground-Source Heat Pump Systems" (ASHRAE Research Project 908).
- McLinden, M. O. and S. A. Klein (1983). "Simulation of an Absorption Heat Pump Solar Heating and Cooling System." Solar Energy 31, 5: 473.
- Giardina, J., (M.S., 1994), "Evaluation of Ground Coupled Heat Pumps for the State of Wisconsin."

Vitocalc

Version: 2.0, last updated: 10/8/2001 (first release: 2000)

Application(s)
residential buildings, commercial buildings, industrial processes

Target group(s)
consulting engineers, contractors

Brief description
Vitocalc enables you to dimension a Viessmann heat pump so that it suits its purpose.
The source is bedrock, ground soil, lake and sea bottom, outdoor air and outgoing ventilation air.
One or several heat pumps with the same source may be combined together with a suitable peak power unit.

Language(s)
Swedish, possibly a German translation later

Supplier
Nowab,
S Kungsv 269, 181 63, Lidingö, Sweden,
Tel.: +46 8 7663885, Fax. +46 8 7665437,

Contact
Jan-Erik Nowacki
E-mail: nowacki@algonet.se

Users according to supplier
consulting engineers, contractors,
Europe

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available), database with thermo-physical properties (is available, can be manipulated), database with climatic data (is available, can be manipulated)

Tasks
intended use: preliminary design, outline technical design
system performance prediction (buildings, industrial processes)
detailed system design: heating load calculations, cooling load calculations, hot water production, selection of heat source and heat sink, ground loop sizing, bivalent system design, heat and/or cold distribution systems
thermo-physical properties of working media: humid air, ground water, soil characteristics
economics

System requirements
Operating system: Windows 95/98/2000/NT, 32 bit Windows
5 MB hard disk space

Documentation
installation guide, user manual, possibility to call designer

WDim

Version: 1.2.8, last updated: 3/30/2001 (first release: 1997)

Application(s)
residential buildings

Target group(s)
consulting engineers, contractors, equipment suppliers, education, industry

Brief description
The tool is mainly useful for designers, plumbers and suppliers of heat pumps. You can calculate all components of a heat pump heating system in a really short time. For example the dimension of heat source, buffer size, probe-count, -width and many more.

In addition you can determine heating and cooling requirements. An economic efficiency check makes the feature list complete. For more information take a look at our German website: www.dim.de (sorry no English pages online).

Language(s)
German

Supplier
Koenig-Waermepumpenservice,
Siedlung 34, 04934, Hohenleipisch, Germany,
Tel.: +49 03533 / 161204,
URL of design tool: http://www.wdim.de

Contact
Harald Koenig
E-mail: h.koenig@waermepumpen.org or info@wdim.de

Price
250 - 499 USD
other possibilities: buying a number of program starts

Users according to supplier
1000 users (100 tools sold)
consulting engineers, contractors, equipment suppliers, research institutes, education, industry
Europe (99%), USA and Canada (1%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, database with standard equipment (is available, can be manipulated), database with thermo-physical properties (is available, can be manipulated), database with climatic data (is available, can be manipulated)

Tasks
intended use: preliminary design, outline technical design
system performance prediction: simulation of applications (buildings)
detailed system design: heating load calculations, cooling load calculations, hot water production, selection of heat source and heat sink, ground loop sizing, bivalent system design, zoning, thermal storage, heat and/or cold distribution systems
thermo-physical properties of working media: refrigerants, humid air, ground water, soil characteristics
economics: comparison with conventional heating and cooling equipment

System requirements
Operating system: Windows 95/98/2000/NT
10 MB hard disk space, 32 MB RAM, PC 166 MHz

Documentation
installation guide, user manual, technical manual

Services
on-line help, hot-line email, free updates, training facilities

WP-Calc

Version: Ver 1.1, last updated: 1/1/1998 (first release: 1995)

Application(s)
residential buildings, commercial buildings

Target group(s)
consulting engineers, contractors, education, industry

Brief description
User friendly tool for the design of heat pump systems including economical aspects as well as technical optimiziation. Based on Excel spreadsheets.

Language(s)
French, German

Supplier
Nova Energie GmbH,
Schachenallee 29, 5000, Aarau, Switzerland,
Tel.: +41 62 834 0300, Fax. +41 62 834 0323,
E-mail: office.aarau@novaenergie.ch
URL of home page: http://www.infoenergie.ch

Contact
Pius Hüsser

Price
500 - 2499 USD
other possibilities: Demo-Version available

Users according to supplier
200 users (200 tools sold)
consulting engineers (40%), contractors (30%), equipment suppliers (5%), research institutes (5%), education (10%), industry (10%)
Europe (100%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: possibility to store new cases, database with standard equipment (is available), database with thermo-physical properties (is available), database with climatic data (is available)

Tasks
intended use: outline technical design, detailed design
system performance prediction: simulation of applications (buildings)
detailed system design: heating load calculations, hot water production, selection of heat source and heat sink, bivalent system design, thermal storage
cycle design
thermo-physical properties of working media
economics

System requirements
Operating system: Windows 95/98/2000/NT
2 MB hard disk space, 16 MB RAM, 486 50 MHz

Documentation
installation guide, user manual, tutorials

Services
hot-line phone, free updates

WP-OPT

Version: 2.7, last updated: 10/10/2001 (first release: 2000)

Application(s)
residential buildings, commercial buildings

Target group(s)
consulting engineers, equipment suppliers, education

Brief description
WP-OPT kann Wärmepumpen-Heizanlagen ausgehend vom Gebäude und der Wärmequelle dimensionieren und simulieren (monovalent/monoenergetisch, mit/ohne Direktverdampfung, Luft-, Wasser- und Soleanlagen, Einsatz mehrerer Wärmepumpen). Unter anderem berechnet das Programm auch die jährlichen Betriebskosten und die Jahresarbeitszahl. Bei Sole/Wasser-Wärmepumpen wird ausserdem die Auskühlung des Erdreichs berechnet. Der Eingabeaufwand ist durch zahlreiche Voreinstellungen sehr gering. Ein Wirtschaftlichkeitsvergleich mit anderen Heizungen is auch vorhanden.
WP-OPT is able to dimension and simulate heat pump heating systems, starting from the building and the heat source (monovalent/monoenergetic; with/without direct evaporation; air, ground-water and soil heat pumps; more than one heat pump). The program calculates amongst others yearly energy costs and the efficiency of the heat pump. For ground-coupled heat pumps the ground temperature is also calculated. The program user has little work because of many standard settings. There is also a comparison to conventional heating.

Language(s)
English, German

Supplier
WPsoft GbR - Dr. Weinmeister & Partner,
Pirnaer Strasse 16, D-01454, Radeberg, Germany,
Tel.: +49 3528 452922, Fax. +49 3528 411926,
E-mail: info@wpsoft-gbr.de
URL of home page: http://www.wpsoft-gbr.de
URL of demo version: http://www.wp-opt.de

Contact
Herr Stephan Weinmeister
Tel.: +49 3528 452922

Price
250 - 499 USD
other possibilities: 30 Euro/Year (>100 licenses)

Users according to supplier
consulting engineers (75%), equipment suppliers (20%), education (5%),
Europe (100%)

Use
knowledge necessary to use the design tool: familiar with the basic principles of heat pumps
training time required [days]: 0 - 2
kind of user interface: menu driven
data management: standard examples exist, possibility to store new cases, database with standard equipment (is available, can be manipulated, is maintained by supplier), database with thermo-physical properties (is available, can be manipulated, is maintained by supplier), database with climatic data (is available, can be manipulated, is maintained by supplier)
data exchange with other software: export of data is possible (HTML-Format)

Tasks
intended use: outline technical design, detailed design
system performance prediction: simulation of applications (buildings)
detailed system design: hot water production, selection of heat source and heat sink, ground loop sizing, heat and/or cold distribution systems, temperature of ground and soil for ground loops
thermo-physical properties of working media: humid air, ground water, soil characteristics
economics: comparison with conventional heating and cooling equipment

System requirements
Operating system: Windows 95/98/2000/NT
10 MB hard disk space, 64 MB RAM, Pentium 100 MHz, CD Rom speed: 4

Documentation
installation guide, user manual, tutorials

Services
on-line help, hot-line email, training facilities, maintenance service

Literature
- sbz, Genter Verlag Stuttgart, 2. Juni-Heft 2001

- Strompraxis, VWEW-Verlag Frankfurt, Heft 5/2001
- Tagungsband "Innovationen bei der Energieeinsparung", Finsterwalde 2000
- Tagungsband "Energie und Gebäudetechnik 2000", HTWK Leipzig
- Wärmetechnik, Genter Verlag Stuttgart, Januar 2000