# **EED version 4**

Earth Energy Designer

## Update manual

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See Appendix A for update news.

The latest version of this document is available at <a href="https://www.buildingphysics.com/manuals/EED4.pdf">https://www.buildingphysics.com/manuals/EED4.pdf</a>

#### **BLOCON**

www.buildingphysics.com

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# 1. Introduction

Blocon is proud to present a new version of EED. Many new important features have been added. Up-to-date information is given on <u>www.buildingphysics.com</u>.

This update manual covers new features that have been added since version 3. New users should also read the full manual for version 3 at

https://www.buildingphysics.com/manuals/EED3.pdf

Please see this pdf for tutorial: https://buildingphysics.com/download/exampleseed.pdf

Please see this pdf for some questions/answers: https://buildingphysics.com/download/eedfaq.pdf

This manual covers the *desktop version* of EED v4. There is also an optional *web version*: "**EED on the web**" that runs on a dedicated server with extreme calculation performance. It can be started from any operating system and/or device with an HTML5-compliant web browser, such as IE10/11, Chrome, Safari, Firefox, Opera, etc. It supports PC, Mac, iPad, iPhone, Chromebook, Android and many other popular devices. For more info, see: https://www.buildingphysics.com/manuals/EEDONTHEWEB.pdf

#### 1.1 What's new in EED v4

The most important new feature is the following:

- Simulations with hourly values for load are possible. See Chapters 2 and 3.
- Approximation for irregular configurations. See Chapter 4.

### 1.2 Demo version

The demo version has the following restrictions:



#### 1.3 Installation and requirements

EED v4 requires only about 0.2 GB RAM (a pc with 2 GB is recommended), and less than 30 MB hard disk space. EED runs on both 32-bit and 64-bit Windows 10, 8, and 7.

Use the setup program to install EED. The installation will automatically create correct folders. Administrators rights are needed for the setup since the setup-program writes in the registry and program folders.

This will install the EED exe-file and some other files to folder "C:\Program Files (x86)\BLOCON\EED\_v4.3".

2024-03-27 08:20	Program	26 149 kB
2016-09-12 15:25	DAT-fil	4 kB
2021-05-11 16:03	Programtillägg	1 098 kB
2021-05-11 16:06	Program	287 kB
2024-03-27 08:23	DAT-fil	65 kB
2024-03-27 08:23	Program	3 149 kB
	2024-03-27 08:20 2016-09-12 15:25 2021-05-11 16:03 2021-05-11 16:06 2024-03-27 08:23 2024-03-27 08:23	2024-03-27 08:20       Program         2016-09-12 15:25       DAT-fil         2021-05-11 16:03       Programtillägg         2021-05-11 16:06       Program         2024-03-27 08:23       DAT-fil         2024-03-27 08:23       Program

Files installed to C:\Program Files (x86)\BLOCON\EED\_v4.3

Note: From version 4.3 the setup file will install material files (and some other files) to the shared folder "C:\Users\Public\Documents\BLOCON\EED 4" by default. This is also the folder where the user stores project data files.

Languages	2024-03-27 08:23	Filmapp	
output	2024-03-27 08:23	Filmapp	
Projects	2024-03-27 08:23	Filmapp	
BH_coordinates_SBM.txt	2015-12-09 23:27	Textdokument	1 kB
BH_coordinates_xy.txt	2015-12-10 16:34	Textdokument	1 kB
Borediam.txt	2012-01-12 23:08	Textdokument	1 kB
cond.txt	2012-01-12 23:06	Textdokument	5 kB
EED.DES	2017-05-23 09:24	DES-fil	1 kB
Fillcond.txt	2012-01-12 23:07	Textdokument	2 kB
gfunc4.eed	2012-01-12 23:05	EED-fil	1 419 kB
GFUNC4.TXT	2012-01-12 23:07	Textdokument	28 kB
Hcdat.txt	2016-12-08 14:46	Textdokument	7 kB
Heatcap.txt	2012-01-12 23:07	Textdokument	4 kB
Heatflux.txt	2012-01-12 23:07	Textdokument	7 kB
Hourly_example_1.DAT	2016-11-28 08:58	DAT-fil	7 kB
Hourly_example_1_load.txt	2016-11-28 09:18	Textdokument	1 kB
Hourly_example_1_peakload_A1.txt	2016-10-28 12:20	Textdokument	1 kB
Hourly_example_1_peakload_A2.txt	2016-11-28 09:17	Textdokument	1 kB
Hourly_example_1_peakload_B1.txt	2016-10-28 12:20	Textdokument	1 kB
Hourly_example_1_peakload_B2.txt	2016-11-30 08:51	Textdokument	1 kB
Hourly_example_1_peakload_B3.txt	2016-11-30 08:52	Textdokument	1 kB
Hourly_example_1_peakload_B4.txt	2016-11-30 09:00	Textdokument	1 kB
Hourly_example_1_peakload_B5.txt	2016-11-30 09:00	Textdokument	1 kB
Hourly_example_1_peakload_C.txt	2016-11-28 15:01	Textdokument	1 kB
pipe.txt	2017-02-20 17:35	Textdokument	5 kB
qtest.txt	2016-09-27 14:55	Textdokument	1 kB
Surftemp.txt	2012-01-12 23:06	Textdokument	7 kB
fluid.out	2017-02-23 15:18	OUT-fil	7 kB
ffmin.out	2017-02-23 15:18	OUT-fil	1 kB
Theme.txt	2017-05-23 09:24	Textdokument	1 kB
UNTITLED.OUT	2017-02-23 15:18	OUT-fil	9 kB

Files and folders installed to C:\Users\Public\Documents\BLOCON\EED 4

Before v4.3, the setup file installed these files to the local user documents folder "My documents\Blocon\EED 4" (e.g. "C:\Users\[user name]\Documents\Blocon\EED 4").

This could be a problem when an admin account was used for installation and another local user account was running the program and had no access to the (admin) document folder (where gfunc4.eed and other necessary files were present). With v4.3 different users on the same machine can now access the shared files.

This means that when you update your old version to v4.3 there may be two document folders (the old local document folder and the new shared document folder). If EED detects both folders upon start (it will actually search for the file "gfunc4.eed") it will ask what folder you want to start in, see picture below. Simply erase (or rename) the folder you don't want to use and EED will use the other one upon start. Remember to move your input files first if applicable.



The used folder name is shown in the EED main window. It is also shown by the menu item Info/System info in EED (see row "Start up directory").

It is also possible to change to another start up folder (e.g. to a Dropbox folder). To do this open the shortcut for EED that is located in "C:\ProgramData\Microsoft\Windows\Start Menu\Programs\BLOCON". Right-click on the shortcut for "EED 4.3" and choose Properties and set folder name in the "Start in" field. See picture below. Make sure you copy all the files (with sub-directories) to the new folder. However, if EED finds the default shared or local user folders it will try to use them first so make sure you delete (or rename) these folders first.

Säkerhet	Information	Tidigare versioner				
Allmänt	Genväg	Kompatibilitet				
EE	D 4.3					
Гур:	Program					
Plats: EED_v4.3						
M <u>å</u> l:	Files (x86)\BLOCON\EED_v4.3\EED_v4_3.exe"					
<u>S</u> tarta i:	"C:\Dropbox\EED"					
<u>K</u> ortkommando:	Inget					
K <u>ö</u> ri:	Normalt fönster	N				
K <u>o</u> mmentar:						
Ö <u>p</u> pna filsöl	kväg Bytikor	n Avan <u>c</u> erat				

#### 1.4 Activation and deactivation of EED

The first time EED is started it requires to be activated. Administrators rights are needed for this.

In order to move the license to a new PC, you need to deactivate the old PC first:

The license will be deactivated when the software is uninstalled via the Windows control panel (make sure you have Internet access during this point). This will release the activation so that it can be used on a new machine by the same or by another user. EED will not work on the deactivated PC.

So, uninstall EED first on the old computer. After that download the latest version and install/activate it on the new computer. Then copy your data files from the old machine to the new machine.

Please note that it is not possible to swap the license back and forth between two PC:s. There is a built in limit for this and too many deactivations on the same machine will block it for further activations. A single user license should be used permanently on one PC, but can be deactivated in order to be moved to a new PC of course.

#### 1.5 Floating network license option added in EED v4.20

An annual subscription for multiple users with floating licenses are now offered, see <a href="https://www.buildingphysics.com/download/floatinglicenses.pdf">https://www.buildingphysics.com/download/floatinglicenses.pdf</a>

# 2. Some changes compare to EED v3

### 2.1 Simulations F9 and F10

Solving a case for required borehole length (F10) will show a chart "T(D)" (fluid temperatures – depth) for the chosen simulation time. The figure below shows results after 25 years.

In the following case a depth D=76,78 m is found (marked in green):



The min/max fluid temperatures are here given by:



If a depth D is found, the value will be used in the "Borehole and heat exchanger" menu:

Borehole and heat exchanger		×
-Borehole		
Type Config.	Single-U 🗧	
0 ("1 : single") Depth	76,78	m
Spacing Diameter	110,000	m ) mm
Contact resistance pipe/filling Filling thermal conductivity	0,0000	(m·K)/W W/(m·K)
Vol. flow rate Q: for all boreholes epr borehole Series factor (1=parallel):	Qbh=Q=2 l/s	l/s
U-pipe		
Outer diameter Wall thickness Thermal conductivity	32,000 3,000 0,420	mm mm W/(m·K)
Shank spacing	70,000	mm
	Shank sj	bacing 78
		32
Copy to clipboard	<u>i</u> <u>c</u> o	se

(In EED v3 this value was not automatically changed).

To get the fluid variation for the whole simulation time, press F9 (Solve mean fluid temperatures):



Any area can be zoomed. The heat extraction rate is also plotted here:



For the following case, a depth is not found:





#### 2.2 Quicker and better optimization

EED v4 will find more solutions (especially for cases with cooling loads) compared to v3 for the optimization. EED v4 is more than 50 times faster than EED v3. As an example, assume we have an annual base load value of 1000 MWh:

Base load				×			
-Base load	(without DH	IW):					
Annual	energy and	monthly pro	file				
Monthly	energy va	lues					
[MWh]	Heat	Cool	Ground				
Annual	1000	0,000	Update				
SPF	3,00	3,00					
	Direct	Direct					
January February March April May June July August September October November	0.155 0,148 0,125 0,099 0,064 0,000 0,000 0,000 0,000 0,061 0,087 0,117	0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000	103,611 98,944 83,611 66,278 42,944 0,278 0,278 0,278 0,278 40,944 58,278 78,278 78,278 96,270				
December	0,144	0,000	96,278				
Sum:	1	0	670				
-Domestic I Ani	nual 5,	000 SPF	3,00				
[MWh] Heat Heat: 1000 (333)	pump G  x1/3 + 1  33) (f	Ground 000x2/3 666,67)	Building = 1000				
DHW: 5x1/ (1,66	3 + 5 i67) (i	ix2/3 3,3333)	= 5				
Cool: 0x1/ (0)	3 + C (1	1×4/3 D)	= 0				
Heat:	Heat pump 335 == Grour	Building > _ ==> 100 nd 670	) 5				
Cool:	Cool: Heat pump Building 0 ==> <== 0						
	Grour	nd 0					
Heat extracte	ed from grour	nd: 666,67+3,3	3333-0=670				
3	Graph		Close				

Optimization for "Max land area" of 500x500 m<sup>2</sup> takes 2,5 minutes using EED v3, and only 8 seconds using EED v4 (on an Intel i7 3770K @3.5Ghz CPU), see below.

🖲 Opti	mization	UNTITLED.DAT										_	×
<u>F</u> ile													
Config		0	- 797	Optir	nize	🗹 Automatic	: grid step		Step: 2	m Sort Total	length	O Cost	
Max land	l area	500	x 500 m²		Config	69/69 "3 x	6, L2-configurat	ion''					
Borehole	spacing	5	. 100 m		Spacing	100 m							
Borehole	denth	50	. 300 m	4396 cases trie	d	Round of	f values	E	Best configs:	06 123 56 140	53 115 132 -	177 189 69	
	- dopan	2000		Solutions found	: 2343	🗌 Also list c	ases with warnir	ngs					
Max no b	orenoles	2000		Analys started 1	4:00:58, stopped 1	4:03:28 time: 2m3	Os Double clia	ck on row for	details				
Config	No bh	Туре	Spacing [m]	Depth [m]	Total length [m]	Land area [m <sup>2</sup> ]	Length [m]	Width [m]	Comments	Cost [EUR]			^
123	13	5 x 5 U-configu	100	284	3689	1,6E005	400	400	Chosen f	0			
106	13	3 x 6 U-configu	99	284	3689	98010	495	198	Detailed	0			
106	13	3 x 6 U-configu	100	284	3689	1E005	500	200	Detailed	0			
123	13	5 x 5 U-configu	98	284	3689	1,54E005	392	392	Detailed	0			
123	13	5 x 5 U-configu	99	284	3689	1,57E005	396	396	Detailed	0			
123	13	5 x 5 U-configu	100	284	3689	1,6E005	400	400	Detailed	0			
123	13	5 x 5 U-configu	95	284	3690	1,44E005	380	380	Chosen f	0			
106	13	3 x 6 U-configu	96	284	3690	92160	480	192	Detailed	0			
106	13	3 x 6 U-configu	97	284	3690	94090	485	194	Detailed	0			
106	13	3 x 6 U-configu	98	284	3690	96040	490	196	Detailed	0			
123	13	5 x 5 U-configu	95	284	3690	1,44E005	380	380	Detailed	0			
123	13	5 x 5 U-configu	96	284	3690	1,47E005	384	384	Detailed	0			
123	13	5 x 5 U-configu	97	284	3690	1,51E005	388	388	Detailed	0			
106	13	3 x 6 U-configu	95	284	3691	90250	475	190	Chosen f	0			
106	13	3 x 6 U-configu	93	284	3691	86490	465	186	Detailed	0			
106	13	3 x 6 U-configu	94	284	3691	88360	470	188	Detailed	0			
106	13	3 x 6 U-configu	95	284	3691	90250	475	190	Detailed	0			
123	13	5 x 5 U-configu	92	284	3691	1,35E005	368	368	Detailed	0			~

🗿 Opti	mization	UNTITLED.DAT EE	D v4.20	0								- 0	×
<u>F</u> ile													
Config		0	•	797	Optim	ize	🗹 Automati	c grid step		Step: 2	m Sort: m Total	length	
Max land	area	500	×	500 m²		Config	69/69 "3 x	6, L2-configurat	tion''		🔿 Cost		
Borehole	spacing	5	· [	100 m		Spacing	100 m						
Derehala	danth	50	, È	300 m	4097 cases tried	1	🗹 Round ol	f values	E	Best configs: 1	06 123 56 140 9	53 115 132 177	189 69
Duteriole	uepm	1		2000	Solutions found:	28	130 📃 Also list c	ases with warni	ngs				
Number o	f borehole	is <u> </u>	14	2000	Analysis started	10:34:24, stop	oed 10:34:32 time: 8s	Double click (	on row for det	ails			
Config	No bh	Туре	S	pacing [m]	Depth [m]	Total length [r	n] Land area [m <sup>2</sup> ]	Length [m]	Width [m]	Comments	Cost [EUR]		^
123	13	5 x 5 U-configu		100	284	368	9 160000	400	400	Chosen f	0		
106	13	3 x 6 U-configu		98	284	368	9 96040	490	196	Detailed	0		
106	13	3 x 6 U-configu		99	284	368	9 98010	495	198	Detailed	0		
106	13	3 x 6 U-configu		100	284	368	9 100000	500	200	Detailed	0		
123	13	5 x 5 U-configu		98	284	368	9 153664	392	392	Detailed	0		
123	13	5 x 5 U-configu		99	284	368	9 156816	396	396	Detailed	0		
123	13	5 x 5 U-configu		100	284	368	9 160000	400	400	Detailed	0		
106	13	3 x 6 U-configu		95	284	369	0 90250	475	190	Chosen f	0		
123	13	5 x 5 U-configu		95	284	369	0 144400	380	380	Chosen f	0		
106	13	3 x 6 U-configu		95	284	369	0 90250	475	190	Detailed	0		
106	13	3 x 6 U-configu		96	284	369	0 92160	480	192	Detailed	0		
106	13	3 x 6 U-configu		97	284	369	0 94090	485	194	Detailed	0		
123	13	5 x 5 U-configu		95	284	369	0 144400	380	380	Detailed	0		
123	13	5 x 5 U-configu		96	284	369	0 147456	384	384	Detailed	0		
123	13	5 x 5 U-configu		97	284	369	0 150544	388	388	Detailed	0		
106	13	3 x 6 U-configu		92	284	369	1 84640	460	184	Detailed	0		
106	13	3 x 6 U-configu		93	284	369	1 86490	465	186	Detailed	0		
106	13	3 x 6 U-configu		94	284	369	1 88360	470	188	Detailed	0		~

(The optimization using hourly values will take about 2 minutes only in v4, see section 3.6).

Double-click any row to get the fluid temperature variation. Note that the values for spacing and depth in the "Borehole and heat exchanger" menu will be set to new values (just as in v3).

# 3. Simulations with hourly values

### 3.1 Introduction

EED v4 can calculate the response due to any hourly load variation. This means that it handles any loads for cooling, heating, and DHW (District Heat Water), with a resolution of one hour.

To use hourly simulation, go to menu item "Input/Hourly Calculations" and check "**Solve for hours**". All calculations will then use hourly values. This affects items "*Solve mean fluid temperatures F9*", "*Solve required borehole length F10*", and "*Solve required borehole length – Optimization F11*".

S Hourly calculation (load profile)			– 🗆 X		
Solve for hours					
Make hourly loads from monthly	Show chart with resulted load profile				
Make hourly loads from monthly	y peak loads				
Read file(s) with hourly values	(exchanging any values giver	by monthly base and	d peak loads)		
Use same annual variation	(values for the first year will	be used for all years	)		
File load options:					
Directory path: C:\Users\The	omas \Documents \Blocon \EED	4\			
··· Path found			File types possible:		
A. Read file with net heat in	njection:		(Click for help)		
qtest.txt	Ope	n OK	1 2		
OB. Read files with loads:					
Heat: qtest.txt	Ope	n OK	1 2		
Cool: qtest.txt	Ope	n OK	1 2		
DHW: qtest.txt	Ope	n OK	1 2		
○ C. Read file with loads in xl	s-style:				
qxls.txt	Ope	n OK	3		
You can enable/disable sepa	rate loads for options B and C	2			
Heat: 🗸		Default date for	mat: vvvv-MM-dd		
Cool:		Help op date f	formate		
DHV:		neip on date i	ormats		

### 3.2 Note on calculation times

A simulation using hourly values for the load takes longer time than a simulation using monthly values, but is still very quick with the new parallel SIMD or GPU methods, see chapter 6. As an example, solving for fluid temperatures for the first 25 years may take only a few seconds on a CPU such as an Intel i3, i5, or i7. A calculation based on monthly values normally takes less than a second.

#### *Tip to decrease the calculation time when using hourly values:*

It is normally sufficient to only look at a specific year (e.g. the 25:th year if the loads are the same every year). Use "Show results after x years" in menu item "Simulation period". The CPU time in this case will just be a fraction of a second since output only will be calculated and showed for year 25 (no output will be shown for years 1-24). See examples below.

Simulation period	×				
Simulation period First month of operation	25 years 9				
Show results after	0 years				



Simulation period						
Simulation period First month of operation	25 years					
Show results after	years					

CPU-time about 0.2 seconds on a i7

### 3.3 Specifying data for hourly values

The given monthly base and/or peak loads for heating, cooling and DHW can be used as default hourly values (repeated for all years). Any hourly value can be changed by data given in files. It is possible to exchange any number of values (from one specified hour up to all values for 100 years which is 876000 hours). In this way, it is quite simple to use the base loads together with new hourly values for e.g. peak heat and cools loads taken from the files. *It is of course also possible to specify the complete load profile by using files only*.

**Make hourly loads from monthly base loads:** The monthly base loads for heating, cooling and DHW as given in menu "**Input/base loads**" can be used to create default hourly values (repeated for all years). The calculated hourly results for the mean fluid temperature will be the same as in the case with a monthly calculation for each month.

**Make hourly loads from monthly peak loads:** If monthly peak loads are given, the last hours of each month will be used to fill hourly values. E.g. if the power is 5kW with the duration of 5 hours in January, the 5 last hours (t=726..730) will use 5kW. *Note that if the peak load value is less than the base load value, the base load value will be used*.

The two options above make it possible to open a EED v3 project and directly run an hourly simulation based on the monthly loads. It is then quite easy to see the effect of a peak load just by defining some new values in text file(s).

Values for hourly heat injection/extraction rates to/from the borehole, or loads, can be given by three methods using files:

A. **Read file with net heat injection**: Direct hourly values [W] for net heat injection to the boreholes are given in one file. Positive values means heat injection, negative values means heat extraction.

File type 1 and 2 can be used, see description below.

- B. Read files with loads: Values for hourly loads [W] are given in three separate files for heating, cooling, and DHW, respectively.
   *File type 1 and 2 can be used, see description below.*
- C. **Read files with loads in XLS-style:** Values for hourly loads [W] are given in one file for heating, cooling, and DHW, respectively. *File type 3 should be used, see description below.*

The matrix below shows available combinations:

File Type:	1	2	3
Input method			
А	х	х	
В	х	х	
С			х

The heat injected to the boreholes for each hour for method B and C is calculated as  $q_{injected} = q_{heat} * (spf_h - 1.0) / spf_h + q_{cool} * (spf_c + 1.0) / spf_c + q_{dhw} * (spf_{dhw} - 1.0) / spf_{dhw}$ 

Note that all heat flows are here defined as positive from the ground to the borehole which means that the values in the files for heating and DHW loads should be negative (heat is extracted from boreholes), while the cooling load values should be positive (heat is injected).

Also note that the SPF values for heat, cooling, and DHW are the same as the ones given in menu "Input/base loads".

It is possible to enable/disable to use any of the loads by checking Use.

The heat injection rates, and loads, are given for the whole system (i.e. for all boreholes) in [W]. EED will divide the values with the number of boreholes and the depth for the current configuration and present results in W/m (i.e. per meter borehole).

If Use same annual variation (using data for year 1) is checked, the load profile for the first year will be used for all years (even though the file(s) have values for t>1 year).

Any text file can be opened in the Notepad editor by pressing **Open** (if it already is open press Alt-Tab to toggle between EED and Notepad). The files will be re-read whenever a simulation is started (F9, F10, or F11). Remember to save the file before starting any analysis.

**Tip:** Since there are many ways to give input for loads it is a good idea to check that resulting data are correct. The chart "Show chart with resulted load profile" will show the final heat injected/extracted to/from boreholes that is used for the simulation.

#### Format for files

There are three ways how to specify data in files, see **type 1**, **2**, and **3** below. The first row in a file should contain the type number followed by an optional **factor** that is multiplied with the values read. Values are assumed to be in [W]. If values are given in kW, the factor should be 1000. The factor may also be negative, e.g. "-1" will change values taken from a heating load file (with negative values since heat is extracted) to positive values which means heat injection (cooling load), and vice versa. It is also quite easy to use this factor in order to see the effect if loads are raised by e.g. 10% (factor 1.1), lowered by 20% (factor 0.8), or doubled (factor 2). Comments can be added after the data, or on a separate line that starts with "%". Blocks can be commented out by "{" and "}".

Default load values are given in SI units as [W], but can also be given in Imperial units as [BTU/h].

The decimal mark for load values can be both a dot (".") or a comma (","). EED will automatically recognize e.g. "45.2" and "45,2" as the same value.

**File type 1**. Hourly values (q0, q1, q2...) given as a list. Maximum number is 876000 (100 years). Normally 8760 values are given in order to specify data for a year.

row 1:	[type] [factor] (optional)	example: "1 1000"
following rows:		-
(optional)	[dateformat] [string]	example: "dateformat ymd"
(optional)	[dateseparator] [string]	example: "dateseparator -"
(optional)	[BTU] Input given in BTU/h	instead of in W (1W=3.41214 btu/hour)
(optional)	[date] example: "2006-03-2."	l" or "2006-03-21 10:00"
	[value]	example: "45.2"

The parameters [dateformat] and [dateseparator] are described in a separate section below.

The optional [date] row specifies when hourly data is started for a specific year. The date can be given as:

"2006-03-21 00:00", or "2006-03-21 00:00", or just "2006-03-21", will give start index t=1896h (it has passed 79 days, i.e. 79\*24=1896h, to this date and time for year 2006) which means that the first value read (on third row) will have index q1896, the second value q1897, and so on. Since data is not given for q0..q1895, values from base loads will be used if that option is checked, otherwise zeros.

"2006-03-21 05:00:00", or just "2006-03-21 5" will give start index t=1901h which means that the first value read will have index q1901, the second value q1902, and so on.

If no row is given, the start time is assumed to be t=0, and the first value read will have index 0 ("q0"). The start time can be different in e.g. the load files for heating, cooling, and DHW.

Example A:	
1	% type 1, comments can be written after "%"
-45818.6	% q0=-45818.6  W (a negative value means heat is extracted from boreholes)
-46807.9	% q1=-46807.9 W
-47203.6	% etc
Example B:	
1 1000	% type 1, values are given in kW so we specify a factor 1000
-45.8	% q0=-45.8 kW=-45800 W
-46.8	% etc
-47.2	

Example B in BTU/h

1 1000 BTU	% type 1, values are given in kBTU/h so we specify a factor 1000
-156 -160 -161	% q0=-156 kBTU/h=156000 BTU/h % etc
<i>Example C</i> : 1 -1000 2006-03-21 -45.8 -46.8 -47.2	% type 1, factor is negative and file values will change sign % start time for index % q1896=45.8 kW (heat is now injected since the factor is negative) % q1897=46.8 kW % q1898=47.2 kW
Example D: 1 1100 -45.8 { -46.8 } -47.2	% type 1, values are given in kW and raised by 10% which gives factor 1100 % q0=-45.8*1100=-50380 W will be used % many rows can be commented with a block comment % q1 now becomes -47.2*1100=-51920 W

File type 2. Time, value and optional duration time given on each row:

row 1:	[type] [factor] (optional)	example: "2 1000"
following rows:		
(optional)	[BTU] Input given in BTU/h i	instead of in W (1W=3.41214 btu/hour)
	[time] [value] [duration] (optio	mal) example: "2m -2.774 1m"

The time (and duration time) can be given in hours, or by using a *time-string* which is a sequence of pairs with a number and one of the following letters:

v	year (365 days, 8760 hours)
m	month $(365/12=30,417 \text{ days}, 8760/12=730 \text{ hours})$
m	1000012 - 30.417  days,  8700712 - 750  hours

- d
- day (24 hours) hour (can be omitted) h

Here are some examples of time-strings:

"1y14h"	1 year and 14 hours (can also be given as e.g. "1y14" or "8774h" or "8774")
"14m3d15"	1 year, 2 months, 3 days and 15 hours (same as "1y2m3d15")
"1m"	1 month
" <del>1h2d</del> "	Not valid. The expression must be in descending order, see next row.
"2d1h"	This string is OK, meaning 2 days and 1 hour

Examp	le E:	The time does not have to be given in any specific order:
2		% type 2
1	-45818.6	5 % q1=-45818.6 W
4	-46807.9	9 % q4=-46807.9 W
55	-47203.6	5 % q55=-47203.6W
6	-46807.9	9 % q6=-46807.9W

Example E in BTU/h

2	% type 2
BTU	
1 -156340	% q1=-156340 BTU/h
4 -159715	% q4=-15971 BTU/h
55 -161065	% q55=-161065 BTU/h
6 -159715	% q4=-15971 BTU/h

<i>Example F</i> : 2 1000 0 -3.439 1m 1m -3.284 1m 1m721 -10 10l 2m -2.774 1m 3m -2.197 1m 4m -1.420 1m % no load for s	Some r	<ul> <li>nonthly loads:</li> <li>% type 2, factor is 1000 since we give data in kW</li> <li>% -3439 W is used for q0q729 (i.e. for Jan)</li> <li>% -3284 W is used for q730q1459 (i.e. for Feb)</li> <li>% e.g. a peak load that now replaces q1450q1459 with -10 kW</li> <li>nonths (comments can be added after "%)</li> </ul>			
%9m -1.931 1n 10m -2.596 1n	%9m -1.931 1m % this row is ignored since it is commented out 10m -2.596 1m				
11m -3.196 In	1				
Example G 2	A peak	heat load is put at the last 10 hours in Jan:			
720 -3333	10	% q720q729 put to -3333 W			
Example H 2	A peak	cool load is put the first two days in July after the 5 <sup>th</sup> year:			
5y6m 6000	2d	% q48180q48227 put to -6000 W (1st index calculated as 5*8760+6*730=48180) (last index calculated as 5*8760+6*730+2*24-1=48227)			

(Note that option Use same annual variation (using data for year 1) should not be checked in example H case since data are given for t>1 year in this case.)

File type 3. Hourly values for date and time, heat load, cool load, and DHW load, are given in four columns in a text file. Data can be copied from e.g. Excel into the text file.

	Α	В	С	D	E 🔺
	Date and time	Heat from the ground	Heat to the ground	DHW	
		while heating (kW	while cooling (kW)		
1					
2	2006-03-21 00:00	-82,65	0		
3	2006-03-21 01:00	-79,51	0		_
4	2006-03-21 02:00	-76,97	0		
5	2006-03-21 03:00	-92,35	0		
6	2006-03-21 04:00	-155,43	0		
7	2006-03-21 05:00	-134,94	0		
8	2006-03-21 06:00	-111,7	0		
9	2006-03-21 07:00	-66,75	0		
10	2006-03-21 08:00	-87,72	0		
11	2006-03-21 09:00	-65,02	0		
12	2006-03-21 10:00	-54,69	0		
13	2006-03-21 11:00	-42,35	0		
14	2006-03-21 12:00	-29,78	4,32		
15	2006-03-21 13:00	-0,75	8,37		
16	2006-03-21 14:00	-0,21	15,9		
17	2006-03-21 15:00	0	22,32		
18	2006-03-21 16:00	0	23,91		
19	2006-03-21 17:00	0	23,13		
20	2006-03-21 18:00	-43,98	0		
21	2006-03-21 19:00	-56,85	0		
22	2006-03-21 20:00	-61.42	0		
23	2006-03-21 21:00	-57.66	0		

row 1:	[type] [factor] (optional)	example: "1 1000"
following rows:		
(optional)	[dateformat] [string]	example: "dateformat ymd"
(optional)	[dateseparator] [string]	example: "dateseparator -"
(optional)	[BTU] Input given in BTU/h instea	ad of in W (1W=3.41214 btu/hour)
(optional)	[date] [q_heat] [q_cool] [q_dhw]	

The date and time can be given as "yyyy-mm-dd hh:ss" or "yyyy-mm-dd hh", e.g:

"2006-03-21 00:00", or "2006-03-21 00"

*Example A*:

3 1000		% type 3 factor 1000
2006-03-21 00:00	-82,60	% qh=-82,6 kW at t=1896, qc=0
2006-03-21 01:00	-79,5 0 -1	% qh=-79,5 kW at t=1897, qc=0 kW, qdhw=-1 kW
2006-03-21 02	-33 2 -0.1	% qh=-33 kW at t=1898, qc=2 kW, qdhw=-0.1 kW

In this case, the date 2006-03-21 00:00 gives t=31+28+20=79 days (t=24\*79=1896).

Note that leap years (e.g. year 2016) have 366 days, and 29 days is February. The date 2016-03-21 00:00 gives t=31+29+20=80 days which is 1920h (t=24\*80).

Note that these lines are ok:

"2006-03-21 00:00 -82,65"
Value defined for heating. No values defined for cooling and DHW.
"2006-03-21 00:00 -82,65 5,5"
Values defined for heating and cooling. No value defined for DHW.
"2006-03-21 00:00 -82,65 5,5 0"
Values defined for heating, cooling, and DHW (=0)

What does *defined* value means? Assume that "Make hourly loads from monthly base loads" and/or "Make hourly loads from monthly peak loads" is checked. Defined values in files will always override

(exchange) the default values from monthly base and peak loads. If you do not want to define a value use "x", such as

"2006-03-21 00:00 x 5,5 x" or just "2006-03-21 00:00 x 5,5"

Base load/peak load value will be used for heating and DHW, and 5,5 will be used for cooling

"2006-03-21 00:00 82,65 x 0"

82,65 will be used for heating, base load/peak load value will be used for cooling, but value will be zero for DHW

#### 3.4 Date formats

Different date formats can be used in file type 1 and 3. The default date format is taken from the OS settings. It is possible to force the format by using "dateformat" and "dateseparator", see examples below.

It is sufficient to give "dateformat" and "dateseparator" once (before the first date is given).

Adding "dateformat" and "dateseparator" in a load file is recommended since the file will work on all PC:s regardless of date formats in OS.

\_\_\_\_\_

#### **Examples file type 1:**

dateformat ymd % Sweden, Germany, etc dateseparator date 2006-03-21 11:00

dateformat dmy % Germany, etc dateseparator . date 21.03.2006 11:00

dateformat mdy % USA, etc dateseparator / date 3/21/2006 11:00

#### **Example file type 3:**

(Same input specified in three different date formats)

\_\_\_\_\_

3 1000		
dateformat ymd		% Sweden, Germany, etc
dateseparator -		
2006-03-21 00:00	-82,65 0	% (t=24*79=1896)
2006-03-21 01:00	-79,51 0 -1	
2006-03-21 02	-33 2 -0.1	
dateformat dmy % G	ermany, etc	
dateseparator.		
21.03.2006 00:00	-82,65 0	% (t=24*79=1896)
21.03.2006 01:00	-79,51 0 -1	
21.03.2006 02	-33 2 -0.1	
latafa muat na la		0/ 110 4
dateformat mdy		% USA, etc
dateseparator /		
03/21/2006 00:00	-82,65 0	% (t=24*79=1896)
03/21/2006 01:00	-79,51 0 -1	
03/21/2006 02	-33 2 -0.1	

#### 3.5 Example (Hourly\_example\_1.dat)

Consider the base loads given below. The ground load (that depends on the SPF) will here be used as default values for all hours (repeated for every year). E.g., the ground load for January is calculated as 16,200\*0,155\*(3-1)/3+5\*(3-1)/3/12=1.952 MWh (contribution from heat load and DHW load). The heat extraction from the ground will be 1,952e6/730=2674 W per hour during January. Since we have one borehole of 110 m depth, the heat extraction is 2674/110=24,31 W/m.

Base loa	d				×		
-Base I	oad (witho	ut DHW)	:				
Anr	Annual energy and monthly profile						
	ntniy energ	ly values	5				
[MWh]	Heat	C	ool	Ground			
Annua	16,	.200	0,000	Update			
SPF		3,00	2,00				
	Dire	ect 🗌	Direct				
Janua Febru March April May June July Augus Septer Octob Noven Decen	ry 0, ary 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0	155 148 125 099 064 000 000 000 000 001 087 117 144	0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000 0,000	1,952 1,876 1,628 1,347 0,969 0,278 0,278 0,278 0,278 0,337 1,217 1,541 1,833			
S	ium:	1	0	14,133			
-Dome	stic hot wa	ter (DHV	v):	0.00			
	Annual	5	SPF	3,00			
[MWh] Heat:	Heat pump 16,2x1/3 (5,4)	Grou + 16,2> (10,8	<b>nd</b> (2/3 )	Building = 16,2			
DHW:	5x173 (1,6667)	+ 5x2/3 (3,33	3 33)	= 5			
Cool:	0x172 (0)	+ 0x3/2 (0)	2	= 0			
Heat:	Heat pt 7,0667	ump 7 ==> _ Ground	Building ==> 21,2 14,133	1			
Cool:	Heat pu (	ump ) ==>	Building <== 0	l			
		Ground	0				
Heat ex	tracted from	ground: 1	10,8+3,333	33-0=14, 1 Load	•		
	C Graph			Close			

For this demonstration case we only simulate three years:

Simulation period	x
Simulation period First month of operation	3 years
Show results after	0 years
	se

Let us first make an ordinary monthly simulation:



Press F9. The output from a monthly simulation will give Tmin=-0,076 after three years:

The heat extraction is 2674/110=24,31 W/m for January, just as we calculated before.

Now let us do an hourly simulation using the base load values:

S Hourly calculation (load profile)		- 🗆 ×					
Solve for hours							
Make hourly loads from monthly base loads	Show chart with re	esulted load profile					
Make hourly loads from monthly peak loads							
Read file(s) with hourly values (exchanging any values	given by monthly base and	d peak loads)					
Use same annual variation (values for the first yea	ar will be used for all years	)					
File load options:							
Directory path: C:\Users\Thomas\Documents\Blocon	EED 4\						
··· Path found		File types possible:					
A. Read file with net heat injection:		(Click for help)					
Hourly_example_1_load.txt	Open OK	1 2					
O B. Read files with loads:							
Heat:txt	Open File not found	1 2					
Cool:txt	Open File not found	1 2					
DHW:txt	Open File not found	1 2					
○ C. Read file with loads in xls-style:							
txt	Open File not found	3					
You can enable/disable separate loads for options B and C:							
Heat:	Default date for	mat: yyyy-MM-dd					
Cool: DHW:	Help on date f	formats					
	ricp of date i						

Since we do not have peak loads it does not matter whether "Make hourly loads from monthly peak loads" is checked or not.

Press button "Show chart with resulted load profile":



As shown above, the heat extraction from the ground is 1,952e6/730=2674 W during January.

Press F9 to start a simulation. The output from a hourly simulation will give the same minimum mean fluid temperature as the monthly simulation: Tmin=-0,076 (at t=3 years):



We now use the file "Hourly\_example\_1\_load.txt" that have the following data instead (here opened in "Notepad"):

Hourly_example_1_load.txt - Anteckningar	—	×
<u>A</u> rkiv <u>R</u> edigera Forma <u>t</u> Vi <u>s</u> a <u>H</u> jälp		
<pre>h % type 1 dateformat ymd % Sweden, Germany, etc dateseparator3000 %q0=-3 kW -4000 %q1=-4 kW -6000 -6000 -2000 -3000 -1000 -2000</pre>		^
		$\sim$

S Hourly calculation (load profile)	– 🗆 ×
Solve for hours	
Make hourly loads from monthly base loads Show chart with	resulted load profile
Make hourly loads from monthly peak loads	
Read file(s) with hourly values (exchanging any values given by monthly base a	nd peak loads)
Use same annual variation (values for the first year will be used for all year	rs)
File load options:	
Directory path: C:\Users\Thomas\Documents\Blocon\EED 4\	
··· Path found	File types possible:
A. Read file with net heat injection:	(Click for help)
Hourly_example_1_load.txt Open OK	1 2
O B. Read files with loads:	
Heat:txt Open File not found	1 2
Cool:bxt Open File not found	1 2
DHW: ,txt Open File not found	1 2
C. Read file with loads in xls-style:      .txt     Open File not found	3
You can enable/disable separate loads for options B and C:	
Heat: Default date for Default date for DHW: Help on date	ormat: yyyy-MM-dd e formats

Since Use same annual variation (using data for year 1) is checked, the profile will be repeated year after year.

Open the hourly chart load profile. Zoom up the area for hours between e.g. 0 and 12 (click and hold down left mouse button and move cursor left/down):





The output from the hourly simulation now gives Tmin=-5,854:



Zoom the area around t=1 year (here we have first changed the time label to hours in menu item "Options"). The ground heat injection value at e.g. t=3h (and t=8763h and so on) has the value -6000 W which gives 54,54 W/m for one borehole with depth 110m.



Let us see the effect from a peak load, here 5 kW during 10 hours at the end of January:

Peak heat a	Peak heat and cool power					
	Peak hea	ţ		Peak coo	<u>əl</u>	
	Power	Duration		Power	Duration	
	[kW]	[h]		[kW]	[h]	
January	5,000	10,000		0,000	0,000	
February	0,000	0,000		0,000	0,000	
March	0,000	0,000		0,000	0,000	
April Mau	0,000	0,000		0,000	0,000	
June	0,000	0,000		0,000	0,000	
July	0.000	0,000		0,000	0.000	
August	0,000	0,000		0,000	0,000	
September	0,000	0,000		0,000	0,000	
October	0,000	0,000		0,000	0,000	
November	0,000	0,000		0,000	0,000	
December	0,000	J 0,000		0,000	0,000	
🔁 Graph						

The output from a monthly simulation (uncheck "Solve for hours") will give Tmin=-1,47 after three years:



We can make an hourly simulation as follows:

O Hourly calculation (load profile)		-	- 0	×		
Solve for hours			1	- <b>6</b> 1-		
Make hourly loads from monthly base loads		show chart with resu	inted load pr	one		
Make hourly loads from monthly peak loads						
Read file(s) with hourly values (exchanging any values	given by	monthly base and p	eak loads)			
Use same annual variation (values for the first yea	ar will be	used for all years)				
File load options:						
Directory path: C:\Users\Thomas\Documents\Blocon	EED 4					
··· Path found		F	ile types p	ossible:		
A. Read file with net heat injection:			(Click f	or help)		
Hourly_example_1_load.txt	Open	ок	1 2	2		
O B. Read files with loads:						
Heat:bxt	Open	File not found	1 2	2		
Cool:txt	Open	File not found	1 2	2		
DHW:bxt	Open	File not found	1 2	2		
C. Read file with loads in xls-style:						
txt	Open	File not found		3		
You can enable/disable separate loads for options B and C:						
Heat:		Default date forma	it: vvvv-M	M-dd		
Cool:			. ,,,,,			
DHW:		Help on date for	mats			



#### Resulted load profile



Zoomed area for end of January

Since the SPF is 3, the ground load will be 5000\*2/3=3333 W for the peak. The output from an hourly simulation will also give Tmin=-1,47 after three years:



For illustration, we now define the same peak loads by using files instead. The data defined for load option A, B, and C below will all give the same load profile (see chart above) and the same calculated results for the mean temperature.

#### File load option A

O Hourly calculation (load profile)			-		$\times$		
Solve for hours							
Make hourly loads from monthly base loads		Show chart with re	sulted lo	ad profile			
Make hourly loads from monthly peak loads							
Read file(s) with hourly values (exchanging any values)	ues giver	n by monthly base and	d peak loa	ads)			
Use same annual variation (values for the first	year wil	be used for all years	)				
File load options:							
Directory path: C:\Users\Thomas\Documents\Bloc	con\EED	4\					
··· Path found			File typ	es possib	le:		
A. Read file with net heat injection:			(0	lick for h	elp)		
Hourly_example_1_peakload_A1.tx	Ope	n OK	1	1 2			
O B. Read files with loads:							
Heat:txt	Ope	n File not found	1	1 2			
Cool:txt	Ope	n File not found	1	1 2			
DHW:txt	Ope	n File not found	1	1 2			
○ C. Read file with loads in xls-style:							
txt	Ope	n File not found		3	3		
You can enable/disable separate loads for options B and C:							
Heat:		Default date for	mat: wa	w-MM-dd			
Cool:		Hele en date for	formate				
DHW:		Help on date 1	ormats				

See load file "Hourly\_example\_1\_peakload\_A1.txt":

🥘 Ηοι	urly_examp	ole_1_peak	load_A	1.txt	_		×
<u>A</u> rkiv	<u>R</u> edigera	Forma <u>t</u>	Vi <u>s</u> a	<u>H</u> jälp			
1 dateform date 204 -3333,3: -3333,3: -3333,3: -3333,3: -3333,3: -3333,3: -3333,3: -3333,3: -3333,3: -3333,3: -3333,3:	<pre>% type 1 mat ymd arator - 06-01-31 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3</pre>	% Sweder %it has p	n, Gerr	many, etc 30 days,	30*24=7	720h	~
							$\sim$

Pressing F9 gives Tmin=-1,47.

We can also use file type 2, see "Hourly\_example\_1\_peakload\_A2.txt".



Pressing F9 gives Tmin=-1,47.

In this case we have replaced the same hourly loads from the monthly peak load with data from file, so it does not matter whether "Make hourly loads from monthly peak loads" is checked or not,

#### File load option B

Make sure to disable the import of "Cool" and "DHW" values at the bottom:

🎸 Hourly calculation (load profile)	– 🗆 X						
Solve for hours Make hourly loads from monthly base loads Make hourly loads from monthly peak loads Read Black bit heuriculates (accherging peruvakas pipe)	Show chart with resulted load profile						
Use same annual variation (values for the first year will	l be used for all years)						
File load options:							
Directory path: C:\Users\Thomas\Documents\Blocon\EED	4\						
Path found           A. Read file with net heat injection:           Image: Hourly_example_1_peakload_A2.txt	File types possible: (Click for help) en OK 1 2						
B. Read files with loads:							
Heat: Hourly_example_1_peakload_B1.txt Ope	en OK 1 2						
Cool:txt Ope	en File not found 1 2						
DHW:txt Ope	en File not found 1 2						
C. Read file with loads in xls-style:	en File not found 3						
You can enable/disable separate loads for options B and C:							
Heat: Cool: DHW:	Default date format: yyyy-MM-dd Help on date formats						

See file "Hourly\_example\_1\_peakload\_B1.txt". In this case we have the peak load 5 kW. However, since the value in menu item "Peak load" replaces the base load value (heating + DHW) we need to subtract the DHW (5e6/8760=0,5708 kW) since it is included in the base load from "Make hourly loads from monthly base loads). (This is ok since the SPF-value is the same for the heat load and the DHW load in this case.)

See file "Hourly\_example\_1\_peakload\_B1.txt":

Hourly_example_1_peakload_B1.txt - Antec	×
<u>A</u> rkiv <u>R</u> edigera Forma <u>t</u> Vi <u>s</u> a <u>H</u> jälp	
1 1000 % type 1 factor 1000 since kW is used dateformat ymd % Sweden, Germany, etc dateseparator -	^
date 2006-01-31 %it has passed 30 days, 30*24=720h -4,4292 % 5-0,5708 kW	
-4,4292 -4,4292	
-4,4292 -4,4292 -4,4992	
-4,4292 -4,4292	
-4,4292 -4,4292	
	$\sim$

Pressing F9 gives Tmin=-1,47.

Another, perhaps simpler way, would be to use 5 kW for the heat load and just put zero for the DHW load (with use DHW enabled):



🗐 Hourly_example_1_peakload_B3.txt 🗕 🗆	×
<u>Arkiv R</u> edigera Forma <u>t</u> Vi <u>s</u> a <u>H</u> jälp	
1 1000 % type 1 factor 1000 since kW is used dateformat ymd % Sweden, Germany, etc dateseparator -	^
date 2006-01-31 %it has passed 30 days, 30*24=720h -0 % 5-0,5708 kW	
-0	
-0	
-0	
-0	
-0	
-0	
-0	
-0	
	$\sim$

Or by using file type 2:

Hourly_example_1_peakload_B4.txt	×	
<u>A</u> rkiv <u>R</u> edigera Forma <u>t</u> Vi <u>s</u> a <u>H</u> jälp		
2 1000 % type 2 factor 1000 since kW is used	~	
		61
		for neating
Hourly_example_1_peakload_B5.txt	$\times$	
<u>A</u> rkiv <u>R</u> edigera Forma <u>t</u> Vi <u>s</u> a <u>H</u> jälp		
2 1000 % type 2 factor 1000 since kW is used	^	]
	×	for DHW

### File load option C

S Hourly calculation (load profile)	- 🗆 X					
<ul> <li>✓ Solve for hours</li> <li>✓ Make hourly loads from monthly base loads</li> <li>Make hourly loads from monthly peak loads</li> </ul>	Show chart with resulted load profile					
Read file(s) with hourly values (exchanging any values given by monthly base and peak loads)						
File load options:						
Directory path: C:\Users\Thomas\Documents\Blocon\EED 4\						
··· Path found	File types possible:					
A. Read file with net heat injection:	(Click for help)					
Hourly_example_1_peakload_A2.txt Ope	en OK 1 2					
O B. Read files with loads:						
Heat: Hourly_example_1_peakload_B1.txt Ope	en OK 1 2					
Cool:txt Ope	n File not found 1 2					
DHW:bxt Ope	n File not found 1 2					
C. Read file with loads in xls-style:						
Hourly_example_1_peakload_C.txt Ope	en OK 3					
You can enable/disable separate loads for options B and C:						
Heat: Cool:	Default date format: yyyy-MM-dd					
DHW:	Help on date formats					

Hourly_example_1_peakload_C.txt						×
<u>A</u> rkiv <u>R</u> ed	ligera	Forma <u>t</u> Vi <u>s</u> a	<u>H</u> jälp			
3 1000 % type and factor						$\sim$
dateformat ymd % Sweden, Germany, etc						
2006-01-31	00:00	-5	0	0		
2006-01-31	01:00	-5	0	0		
2006-01-31	02:00	-5	0	0		
2006-01-31	03:00	-5	0	0		
2006-01-31	04:00	-5	0	0		
2006-01-31	05:00	-5	0	0		
2006-01-31	06:00	-5	0	0		
2006-01-31	07:00	-5	0	0		
2006-01-31	08:00	-5	0	0		
2006-01-31	09:00	-5	0	0		
						$\sim$

Here we have just copied the following rows from an Excel sheet:

	А	В	С	D	E
1					
2	2006-01-31 00:00	-5	0	0	
3	2006-01-31 01:00	-5	0	0	
4	2006-01-31 02:00	-5	0	0	
5	2006-01-31 03:00	-5	0	0	
6	2006-01-31 04:00	-5	0	0	
7	2006-01-31 05:00	-5	0	0	
8	2006-01-31 06:00	-5	0	0	
9	2006-01-31 07:00	-5	0	0	
10	2006-01-31 08:00	-5	0	0	
11	2006-01-31 09:00	-5	0	0	
12					

See file "Hourly\_example\_1\_peakload\_C.txt". Pressing F9 gives Tmin=-1,47.
# 3.6 Optimization for hourly values

The optimization will take longer time using hourly values compared to monthly ones but is still quite quick. Consider the example in section 2.2 where the optimization with monthly values during 25 years took 2 seconds to complete (on an Intel i7 3770K @3.5Ghz CPU). The same optimization takes about 2 minutes [updated value for v4.20] using hourly values, see below. The analysis involves 4097 different configurations which means that about 30 configurations are analyzed every second.

🗳 Opti	mization	UNTITLED.DAT EE	ED v4.20								— C	x c	
<u>F</u> ile													
Config 0 - 797			Optir	Optimize Automatic grid step				Step: 2 m Sort:					
Max land	larea	500	x 500 m²		Config	69/69 "3 x	6, L2-configura	ation''		O Cost			
Borebole	spacing	5	. 100 m	Spacing		100 m			[Hourly calculation]				
	opeoing	50	300 m	4097 cases trie	d	🗹 Round of	f values	E	lest configs: 1	06 123 56 140	53 115 132	2 177 189 69	Э
Borehole	depth	1	. 300 m	Solutions found	1: 2831	🗌 Also list c	ases with warn	ings					
Number o	of borehole	s L	. 2000	Analysis started	10:36:55, stopped	10:39:20 time: 2m	25s Double o	click on row for	details				
Config	No bh	Туре	Spacing [m]	Depth [m]	Total length [m]	Land area [m <sup>2</sup> ]	Length [m]	Width [m]	Comments	Cost [EUR]		(	^
123	13	5 x 5 U-configu	100	284	3689	160000	400	400	Chosen f	0			
106	13	3 x 6 U-configu	98	284	3689	96040	490	196	Detailed	0			
106	13	3 x 6 U-configu	99	284	3689	98010	495	198	Detailed	0			
106	13	3 x 6 U-configu	100	284	3689	100000	500	200	Detailed	0			
123	13	5 x 5 U-configu	98	284	3689	153664	392	392	Detailed	0			
123	13	5 x 5 U-configu	99	284	3689	156816	396	396	Detailed	0			
123	13	5 x 5 U-configu	100	284	3689	160000	400	400	Detailed	0			
106	13	3 x 6 U-configu	95	284	3690	90250	475	190	Chosen f	0			
123	13	5 x 5 U-configu	95	284	3690	144400	380	380	Chosen f	0			
106	13	3 x 6 U-configu	95	284	3690	90250	475	190	Detailed	0			
106	13	3 x 6 U-configu	96	284	3690	92160	480	192	Detailed	0			
106	13	3 x 6 U-configu	97	284	3690	94090	485	194	Detailed	0			
123	13	5 x 5 U-configu	95	284	3690	144400	380	380	Detailed	0			
123	13	5 x 5 U-configu	96	284	3690	147456	384	384	Detailed	0			
123	13	5 x 5 U-configu	97	284	3690	150544	388	388	Detailed	0			
106	13	3 x 6 U-configu	92	284	3691	84640	460	184	Detailed	0			
106	13	3 x 6 U-configu	93	284	3691	86490	465	186	Detailed	0			
106	13	3 x 6 U-configu	94	284	3691	88360	470	188	Detailed	0			~

Note that the optimization is made for the last year that is assumed to be the worst one. However, since it is possible to define (peak) hourly values for any year, the worst year might be another than the last one. It is up to the user to run a case to see what year is worst if this is the case, and then use that year as "Simulation period" for the optimization, see below.

Simulation period	×			
Simulation period First month of operation	25 9			
Show results after	1 years			

# 3.7 Exporting data

Hourly data (such as mean fluid temperatures, heat extraction rate, inlet/outlet fluid temperatures) can be previewed and exported to e.g. Excel.

As an example, all data shown in the chart window below can be exported. Choose "Options/Use hours" to label the x-axis in hours:



Press Options/Edit chart to get to the editing menu. Choose "Data" for preview:

Chart Series Dat # Text Y Y 0 1 2 3	ta Tools 	Animations I —Tf_in Y	Export Print —Tf_out	Themes Peak max	—Peak min					
# Text Y Y 0 1 2 3		—Tf_in Y	Tf_out	-Peak max	—Peak min					
# Text Y Y 0 1 2 3	Y 0,634 0,612	Y	Y			-Heat extr				
0 1 2 3	0,634 0,612	0.901		Y	Y	Y				
1 2 3	0,612	0,001	0,467			24,306				
2 3		0,78	0,445			24,306				
3	0,599	0,767	0,432			24,306				
	0,59	0,757	0,422			24,306				
4	0,582	0,749	0,415			24,306				
5	0,576	0,743	0,408			24,306				
6	0,57	0,738	0,403			24,306				
7	0,566	0,733	0,398			24,306				
8	0,561	0,729	0,394			24,306				
9	0,558	0,725	0,39			24,306				
10	0,554	0,722	0,387			24,306				
11	0,551	0,718	0,384			24,306				
12	0,548	0,716	0,381			24,306				
13	0,545	0,713	0,378			24,306				
14	0,543	0,71	0,375			24,306				
15	0,54	0,708	0,373			24,306				
16	0,538	0,705	0,371			24,306				
17	0,536	0,703	0,368			24,306				
					•		M	A	3D 🕽	< 🗋 v
									Cly	Se

Press the copy icon (at the lower left). Paste data into excel or other editor.

Another option is to use the "Export" tab, and "Data" to export values. You can choose to export all series, or just one. The example below shows Tf (mean fluid temperatures).

📀 Editing Chart1	□ x					
Chart Series Data Tools Animations	Export Print Themes					
Picture Native Data						
Se <u>r</u> ies:	Include Options Format					
Tf 🗘	Use Series Format					
- Eormat:	Value Format:					
Text Excel	÷					
🔿 XML 💿 JSON						
Preview						
X Tf 8 750 0 634						
8 761 0,612						
8 763 0,59						
8 764 0,582 8 765 0,576						
8 766 0,57						
<u> </u>	Þ					
Copy Save	Send Preview					
	Close					

Use the copy button to copy the text. Below it is pasted into Excel.

D1	.6 🔻	: ×	$\sqrt{-f_x}$		
	А	В	с	D	E
1	х	Tf			
2	8 760	0,634			
3	8 761	0,612			
4	8 762	0,599			
5	8 763	0,59			
6	8 764	0,582			
7	8 765	0,576			
8	8 766	0,57			
9	8 767	0,566			
10	8 768	0,561			
11	8 769	0,558			
12	8 770	0,554			
13	8 771	0,551			
14	8 772	0,548			
15	8 773	0 545			

Tip: If you only want to export data for the last year, e.g. the 25<sup>th</sup> year, change "Show results after 24 years:

Simulation period	×			
Simulation period First month of operation	25 years 9			
Show results after	24 years			
Close				



## 3.8 EWT and LWT

The calculated resulting temperatures are the mean fluid temperatures (Tf) inside the pipe, at half of the depth of the borehole. Typically in heating mode the Entering Water Temperature (EWT) (which is the temperature out of the borehole into the heat pump) is about 1.5-2.0 °C higher, the return temperature Leaving Water Temperature (LWT) the same value lower than the mean temperature.

In cooling mode, EWT is about 2 °C lower than the mean, return higher. This values depend upon flow rate, but also borehole depth, pipe diameter, filling, shank spacing, etc.

For hourly calculations, EED presents a simplified calculation of Tf\_in (EWT) and Tf\_out (LWT) as

Tf\_in=Tf-0.5\*Q/(Cf\*Vf) Tf\_out=Tf+0.5\*Q/(Cf\*Vf)

where

Q: total effect [W] Cf: Volumetric heat capacity [J/(m<sup>3</sup>,K)] Vf: Flow [m<sup>3</sup>/s]

# 4. Approximation for irregular configurations

[Updated in v4.14]

# 4.1 Introduction

EED v4 can approximate an irregular configuration with a regular one in order to calculate corresponding fluid temperatures. A file with borehole configuration can be read and a list of best matching regular configuration and borehole spacing B is presented ("Find all regular solutions"). See example below for which an explanation will follow.

Irregular configuration			_		×
Calculate F for file	File: BH_coordinates_xy.txt		Format:	с, у	~
Find all regular solutions Plus/Minus num bh: 0 Confor 176	Finding all regular solutions with 12 boreh Trying to match F-value for irregular confi- Choose solution with closest match for K: 0 [TC=3,5 W/( $m \cdot K$ ) VHC=2,16 MJ/( $m^3 \cdot K$ )]	oles g: 0,722 ,5333			^
Coning: 1	Config B F	iter dx	dy	K	
Spacing B: 7,651	11 12 : 1 x 12, line 5,13 0,722	8 56,43	0	0	
Export to E2	37 12 : 3 x 10, L-config 5,4188 0,722	7 48,77	10,838	0,2222	
Export to 12	43 12 : 4 x 9, L-configu 5,5533 0,722	7 44,427	16,66	0,375	
	48 12 : 5 x 8, L-configu 5,6491 0,722	7 39,544	22,596	0,5714	
	52 12 : 6 x 7, L-configu 5,6983 0,722	7 34,19	28,491	0,8333	
Calculate F for config and B	68 12 : 3 x 5, L2-config 8,8386 0,722	5 35,355	17,677	0,5	
	74 12 : 4 x 4, L2-config 9,0088 0,722	5 27,027	27,027	1	
Find spacing B for config	114 12 : 4 x 5, U-configu 6,6836 0,722	6 20,051	26,734	0,75	
	131 12 : 6 x 4, U-configu 6,0872 0,722	7 30,436	18,261	0,6	
Clear text	148 12 : 8 x 3, U-configu 5,7264 0,722	7 40,085	11,453	0,2857	
	165 12 : 10 x 2, U-config 5,4004 0,722	7 48,604	5,4004	0,1111	
	176 12 : 3 x 5, open rect 7,6515 0,722	6 30,606	15,303	0,5	
	188 12 : 4 x 4, open rect 7,4613 0,722	6 22,384	22,384	1	
	237 12 : 2 x 6, rectangle 8,409 0,722	5 42,045	8,409	0,2	
	283 12 : 3 x 4, rectangle 9,5381 0,722	4 28,614	19,076	0,6667	
	Best matching config: #176: "12 : 3 x 5, op (Press button "Export to F2" to export valu	en rectangle es for confi	" B= 7,6 g and B)	515 	~

In the above example, the following configuration is read (example file "BH coordinates xy.txt"):

🥘 В	H_coordin	ates_xy.txt -	Antec	kningar	_	×
<u>A</u> rkiv	<u>R</u> edigera	a Forma <u>t</u>	Vi <u>s</u> a	<u>H</u> jälp		
7.5	9	25.00				$\sim$
2.5	9	17.50				
2.5	9	10.00				
7.5	9	5.00				
10.	90	40.00				
17.	50	37.50				
15.	90	25.00				
15.	90	10.00				
22.	50	30.00				
22.	50	21.25				
20.	90	16.25				
22.	50	2.50				
						$\sim$

The file shows data (x,y) for 8 boreholes.

Important: Please note that EED reads the values in the format of a "single" data type that normally has 7-8 significant digits and some data might be lost here (decimals).

Assume coordinates are

393606.08	5827825.6
393611.96	5827824.21
etc	

Then remove "3936" (or deduct 393600) from the first column, and "5827" (or deduct 5827000) in the second one, you will get

606.08	825.6
611.96	824.21
etc.	

The file can also be read in another format (used by SBM software, example file "BH\_coordinates\_SBM.txt"):

/III BI	H_coordinates.txt - Ar	iteckningar	- 🗆	×
<u>A</u> rkiv	<u>R</u> edigera Forma <u>t</u>	Vi <u>s</u> a <u>H</u> jälp		
	190.00	10.00	0.00	^
	7.50	25.00	0.00	
	190.00	10.00	0.00	
	2.50	17.50	0.00	
	190.00	10.00	0.00	
	2.50	10.00	0.00	
	190.00	10.00	0.00	
	7.50	5.00	0.00	
	190.00	10.00	0.00	
	10.00	40.00	0.00	
	190.00	10.00	0.00	
	17.50	37.50	0.00	
	190.00	10.00	0.00	
	15.00	25.00	0.00	
	190.00	10.00	0.00	
	15.00	10.00	0.00	
	190.00	10.00	0.00	
	22.50	30.00	0.00	
	190.00	10.00	0.00	
	22.50	21.25	0.00	
	190.00	10.00	0.00	
	20.00	16.25	0.00	
	190.00	10.00	0.00	
	22.50	2.50	0.00	
				~

Pressing "Calculate F for file" shows data for the irregular configuration:

Irregular configuration		-	×
Calculate F for file	File: BH_coordinates_xy.txt	Format: x,y	 ~
Find all regular solutions Plus/Minus num bh: 0	Number of BH read: 12. dx:20 dy:37,5 K:0,5333 F: 0,722		 ^
Config: 176 Spacing B: 7,658			
Export to F2 Show iterations Calculate E for config and R			
Find spacing B for config			
Clear text			
<u>I</u> <u>C</u> lose			~

**K** is the smallest value of dx/dy or dy/dx, e.g.

"Number of BH read: 12. dx:20 dy:37,5 K:0,5333 F: 0,722"

gives K=20/37,5= 0,5333.

**F** is a conservation value that should be the same for the original irregular config and the matching regular config. Note that the F-value depends on the thermal conductivity and volumetric heat capacity of the ground. These values are taken from the "Ground properties" window:

Ground properties			×
Thermal conductivity	3,500	?	W/(m•K)
Volumetric heat capacity	2,160	?	MJ/(m³∙K)
Ground surface temperature	8,000	?	°C
Geothermal heat flux	0,06000	?	W/m²
	👖 Close		

A matching regular configuration with the same number of boreholes with spacing B is found when the F-value matches the F-value for the irregular configuration.

The best matching configuration is then choosen looking at the nearest K-value (we want the land area shape to match as good as possible). For the above example. The K-value for the irregular configuration was 0,5333. The best matching regular configuration is "#176: "12 : 3 x 5, open rectangle" with B=7,6582 since K is 0.5 (15,316/30,633=0,5), see first window in this section:

Config	В	F	iter	dx	dy	Κ
176 12 : 3 x 5, open rect	7,6515	0,722	6	30,606	15,303	0,5

Here, the difference of K is 0,5333-0,5=0,0333. The second best match (with difference 0,5714-0,5=0,0381) would be #48:

48 12 : 5 x 8, L-configu 5,6491 0,722 7 39,544 22,596 0,5714



**Approximation**: config #176: "12 : 3 x 5, open rectangle", B=7,66 dx=30,6 m dy=15,3 m

The number of boreholes in the matching configuration should normally be the same as in the irregular configuration. However, it is possible to allow (+/-) number of boreholes:

🚺 Irregular configuration		-	
Calculate F for file	File: BH_coordinates_xy.txt	Format:	х,у ~
Find all regular solutions			
Plus Minus num bh:	Trying to match E-value for irregular config: 0.722		<u>^</u>
	Choose solution with closest match for K: 0,5333		
175	[TC=3,5 W/(m·K) VHC=2,16 MJ/(m <sup>3</sup> ·K)]		
Config:   170	Config B F iter dx	dy	K
Spacing B: 7,651			
Spacing 5. )	10 11 : 1 x 11, line 5,13 0,722 8 56,43	0	0
Export to F2	11 12 : 1 x 12, line 5,13 0,722 8 56,43	0	0
	12 13 : 1 x 13, line 5,13 0,722 8 56,43		0
	29 11 : 2 x 10, L-config 5,6494 0,722 7 50,844	5,6494	0,1111
Calculate E for config and P	36 11 : 3 x 9, L-configu 5,8304 0,722 7 46,643	11,661	0,25
Calculate P for cornig and B	37 12 : 3 x 10, L-config 5,4188 0,722 7 48,77	10,838	0,2222
	42 11 : 4 x 8, L-configu 5,9793 0,722 7 41,855	17,938	0,4286
Find spacing B for config	43 12 : 4 x 9, L-configu 5,5533 0,722 7 44,427	16,66	0,375
	44 13 : 4 x 10, L-config 5,184 0,722 8 46,656	15,552	0,3333
Clear text	47 11 : 5 x 7, L-configu 6,0741 0,722 7 36,445	24,297	0,6667
	48 12 : 5 x 8, L-configu 5,6491 0,722 7 39,544	22,596	0,5714
	49 13 : 5 x 9, L-configu 5,2774 0,7219 7 42,219	21,11	0,5
	51 11 : 6 x 6, L-configu 6,1064 0,722 7 30,532	30,532	1
	52 12 : 6 x 7, L-configu 5,6983 0,722 7 34,19	28,491	0,8333
	53 13:6x8, L-configu 5,3346 0,722 7 37,342	26,673	0,7143
	56 13 : 7 x 7, L-configu 5,354 0,722 7 32,124	32,124	1
	68 12 : 3 x 5, L2-config 8,8386 0,722 5 35,355	17,677	0,5
	74 12 : 4 x 4, L2-config 9,0088 0,722 5 27,027	27,027	1
	105 11 : 3 x 5, U-configu 7,6619 0,722 6 15,324	30,648	0,5
	106 13 : 3 x 6, U-configu 6,94 0,722 6 13,88	34,7	0,4
	114 12 : 4 x 5, U-configu 6,6836 0,722 6 20,051	26,734	0,75
	122 11 : 5 x 4, U-configu 6,6719 0,7221 6 26,688	20,016	0,75
	123 13 : 5 x 5, U-configu 6,0224 0,722 7 24,09	24,09	1
	131 12 : 6 x 4, U-configu 6,0872 0,722 7 30,436	18,261	0,6
	139 11 : 7 x 3, U-configu 6,2054 0,722 7 37,232	12,411	0,3333
	140 13 : 7 x 4, U-configu 5,6152 0,722 7 33,691	16,846	0,5
	148 12 : 8 x 3, U-configu 5,7264 0,722 7 40,085	11,453	0,2857
	156 11 : 9 x 2, U-configu 5,8149 0,722 7 46,519	5,8149	0,125
	157 13 : 9 x 3, U-configu 5,3212 0,722 7 42,569	10,642	0,25
	165 12 : 10 x 2, U-config 5,4004 0,722 7 48,604	5,4004	0,1111
	176 12 : 3 x 5, open rect 7,6515 0,722 6 30,606	15,303	0,5
	188 12 : 4 x 4, open rect 7,4613 0,722 6 22,384	22,384	1
	237 12 : 2 x 6, rectangle 8,409 0,722 5 42,045	8,409	0,2
	283 12 : 3 x 4, rectangle 9,5381 0,722 4 28,614	19,076	0,6667
	Best matching config: #176: "12 : 3 x 5, open rectangl (Press button "Export to F2" to export values for conf	e" B= 7,6 ig and B)	5515

"Export to F2" will copy the values for configuration number and spacing B to window "Borehole and heat exchanger" (F2).

It is possible to calculate F for any configuration and B, see below:

Irregular configuration					—		×
Calculate F for file	File: BH_coordinates_xy.txt				Format:	ç, y	~
Find all regular solutions							
Plus/Minus num bh: 0	Config	в	F	dx	dy	ĸ	
Config: 114	114 12 : 4 ж 5, U-configu	6	0,8048	18	24	0,75	
Spacing B: 6,000							
Export to F2							
Calculate F for config and B							
Find spacing B for config							
Clear text							~

It is also possible to find spacing B for any configuration that will match the F-value taken from the current file, see below:

Irregular configuration					_		×
Calculate F for file	File: BH_coordinates_xy.txt				Format:	x,y	~
Find all regular solutions							
Plus/Minus num bh: 0	Config	в	F it	er dx	dy	K	
Config: 114	114 12 : 4 x 5, U-configu	6,6836	0,722 6	20,051	26,734	0,75	
Export to F2							
Calculate F for config and B							
Find spacing B for config							
Clear text							~

## 4.2 Test of approximation, example 1

Consider the above example with an original irregular configuration of 12 boreholes that has been analyzed using SBM ("Superposition borehole model") described by "*Eskilson, P, 1987. Thermal analysis of heat extraction boreholes. Department of Mathematical Physics, PhD Thesis, (Lund University.) Sweden*". We use depth=190 m for all boreholes and the following load for the example:



The results below shows that all approximations gives an error of less than about 0.1  $^{\circ}$ C compared with the results for the original configuration.



Irregular configuration and calculation (25 years) in SBM.

		SBN	1	E	ED
	В	Tf_min	Tf_max	Tf_min	Tf_max
Original irregular configuration (SBM)	-	1,39	5,62	-	-
Regular approximation with "176 12 : 3 x 5, open rect"	7,65	1,33	5,55	1,35	5,57
Regular approximation with "11 12 : 1 x 12, line"	5,13	1,34	5,76	1,40	5,75
Regular approximation with "37 12 : 3 x 10, L-config"	5,42	1,33	5,71	1,38	5,70
Regular approximation with "48 12 : 5 x 8, L-configu"	5,65	1,38	5,69	1,39	5,68
Regular approximation with "68 12 : 3 x 5, L2-config"	8,84	1,34	5,59	1,42	5,60
Regular approximation with "114 12 : 4 x 5, U-configu"	6,68	1,30	5,58	1,35	5,60
Regular approximation with "237 12 : 2 x 6, rectangle"	8,41	1,35	5,60	1,42	5,63

Fluid temperatures after 25 years.

# 4.3 Test of approximation, example 2

For this example we use the following load, ground thermal conductivity and volumetric heat capacity:



Ground properties			×		
Thermal conductivity	1,300	?	W/(m·K)		
Volumetric heat capacity	1,600	?	MJ/(m³·K)		
Ground surface temperature	6,700	?	°C		
Geothermal heat flux	0,04000	?	W/m²		
	-		1		



### The configuration with 78 boreholes (D=100 m) is as follows:





Irregular configuration and calculation (50 years) in SBM.

The matching regular configurations with 78 boreholes are:

💽 Irregular configuration	-	
Calculate F for file	File: BH_coordinates_2_xy.txt Format: x,	у ~
Find all regular solutions Plus/Minus num bh: 0	Finding all regular solutions with 78 boreholes Trying to match F-value for irregular config: 0,1133 Choose solution with closest match for K: 0,469 [TC=1.3 W(m.K) VHC=1.6 MJ(m <sup>3</sup> .K)]	^
Config: 430	Config B F iter dx dy	ĸ
Spacing B: 16,076 Export to F2	270 78 : 2 x 39, rectangl 13,327 0,1133 6 506,42 13,327 305 78 : 3 x 26, rectangl 14,938 0,1134 6 373,45 29,876 430 78 : 6 x 13, rectangl 16,076 0,1133 7 192,92 80,382	0,0263 0,08 0,4167
Calculate F for config and B	(Press button "Export to F2" to export values for config and B)	
Find spacing B for config		
Clear text		~

The best matching configuration 430 gives an error of about 0.4 °C compared with the results for the original configuration using SBM. This case is a bit more difficult to approximate due to that the configuration has two "groups".

		SBN	1	E	ED
	В	Tf_min	Tf_max	Tf_min	Tf_max
Original irregular configuration (SBM)	-	-1,70	2,79	-	-
Regular approximation with "270 78 : 2 x 39, rectangl"	13,3	-0,93	3,57	-0,82	3,74
Regular approximation with "305 78 : 3 x 26, rectangl"	14,94	-1,39	3,10	-1,22	3,35
Regular approximation with "430 78 : 6 x 13, rectangl"	5,42	-2,11	2,38	-1,82	2,73

Fluid temperatures after 50 years.

# 5. Changeable user interface of EED

# 5.1 Introduction

The user interface of EED can now be "personalized" using different windows style themes. A style is a collection of painting rules you can dynamically apply to an entire Windows application, changing the size and appearance of various elements, the fonts, and the color scheme. One example of the available styles is the so-called Modern UI (originally known as "Metro").

Goto menu item Options/Themes to change current appearance:



The default theme is "Windows":



Below are examples of a couple of other themes.



The theme is saved to file "Theme.txt" in folder "C:\Users\\*username\*\Documents\Blocon\EED v4 every time EED is closed.

# 6. Faster hourly simulations

[Available in v4.14]

# 6.1 Introduction

Hourly simulations of borehole fluid temperatures are time consuming. There are several methods reported in literature that decreases the calculation time by using so-called load aggregation schemes that lump the hourly loads on a borehole heat exchanger into larger blocks of time in order to reduce the number of operations needed. One example is shown in "A load-aggregation method to calculate extraction temperatures of borehole heat exchangers" [1], see <a href="http://publications.lib.chalmers.se/records/fulltext/163661/local\_163661.pdf">http://publications.lib.chalmers.se/records/fulltext/163661/local\_163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661/local\_163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661/local\_163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661/local\_163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661/local\_163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.lib.chalmers.se/records/fulltext/163661.pdf</a> or <a href="https://publications.lib.chalmers.se/records/fulltext/163661.pdf">https://publications.se/records/fulltext/163661.pdf</a> or <a href="https://publications.se/records/fulltext/163661.pdf">https://publications.se/records/fulltext/163661.pdf</a>

EED v4.14 uses a different approach that is very fast (and does not introduce an error as in the load aggregation case). Solving 25 years of hourly fluid temperatures takes less than a second on a hi-end CPU, and only a few seconds when solving for 100 years.

This impressive speed is due to the capabilities of modern CPU:s. The calculation of fluid temperatures using the g-function is well suited for multiple CPU processing that performs the same operation on multiple data points simultaneously. This method is sometimes called "single instruction, multiple data" (SIMD), see e.g.

https://en.wikipedia.org/wiki/SIMD

Instead of using traditional ("serial") programming where floating point operations are performed on an element in a vector one by one, modern CPU:s can make these calculations for the whole vector at the same time. In addition to this, most modern computers have multiple cores that will accelerate the calculation speed even further (roughly speaking; if we e.g. have a PC with 4 cores we can do calculations for 4 different hours at the same time). The total speed gain is typically 10-150 times higher compared to using conventional serial implementation. The higher number of cores, the faster speed increase.

As described above, EED can use the CPU ("central processing unit") for fast SIMD calculations. As an alternative, EED can also use the GPU ("graphics processing unit") to speed up calculations. Architecturally, a CPU is composed of just a few cores that can handle a few software threads at a time. In contrast, a GPU is composed of hundreds, or thousands, of cores that can handle thousands of threads simultaneously. Also, the GPU achieves this acceleration while often being more power- and cost-efficient than a CPU. The gain using a hi-end graphics card (GPU) might be 200-300 times. In the benchmarks below, one example shows that it is possible to solve for 100 years in just 4 seconds on a \$300 graphics card (Radeon RX 480).

EED can uses GPU:s (and other devices) that are conformant with OpenCL, see <a href="https://en.wikipedia.org/wiki/OpenCL">https://en.wikipedia.org/wiki/OpenCL</a>

For OpenCL compliant devices (such as graphics cards), see <a href="https://www.khronos.org/conformance/adopters/conformant-products#opencl">https://www.khronos.org/conformance/adopters/conformant-products#opencl</a>

*EED uses the CPU as the default choice since some graphics cards (GPU:s) are not compatible. It is up to the user to test the GPU method.* 

### References:

[1] Claesson, J, Javed, S, 2012. A load-aggregation method to calculate extraction temperatures of borehole heat exchangers. ASHRAE Transactions, vol. 118(1), pp. 530-539.

# 6.2 Options for calculations

Several options for hourly calculations can be chosen in EED (menu item Settings/Numerical options for hourly calculations), see below. All options will give the same results, it is only the calculation times that will differ.

Numerical options for hourly computation	×			
Method:				
◯ Serial CPU				
Threaded parallell CPU (SIMD) [around 15-150 times faster]				
O GPU/CPU (OpenCL) [up to 200-300 times faster]				
CPU detected:				
Intel(R) Core(TM) i7-3770K CPU @ 3.50GHz Number of cores: 4 Number of logical cores: 8				
GPU and OpenCL devices detected;				
NVIDIA CUDA GeForce GTX 680				

The default (and recommended) method is "**Threaded parallel CPU SIMD**" which is 15-150 times faster than "Serial CPU" (as used in previous versions EED v1.0-v4.13).

The "GPU/CPU (OpenCL)" method might be even faster but requires a modern graphics card with sufficient memory, and OpenCL compliance. Calculations may work for e.g. 25 years, but not for e.g. 50 years or more due to too little memory and compatibility problems. This warning below is displayed when this method is chosen.

EED	×
OpenCL will work on most newer g If you get an error (such as memory (The longer simulation period, the l	raphics card but might not been compatible with all cards. / out of resources), change to another method. larger memory requirement.)
	ОК

This error will be displayed if the calculation does not work on a specific graphics device:



# 6.3 Benchmarks for F9 ("Solve mean fluid temperatures")

The tables below show calculation times (in seconds) for different PC:s for hourly analysis.

As an example, the calculation of hourly fluid temperatures for 100 years (Tf<sub>0</sub>..Tf<sub>876000</sub>) only takes 5 seconds on a "High-end PC" from 2021 using "Threaded CPU SIMD", and 2 seconds using the "GPU OpenCL". With the standard "serial" method it would take 733 seconds.

Below are descriptions for used PC:s.

#### Hi-end PC 2021 (price Dec-2021: 1500 USD)

CPU: 11th Gen Intel(R) Core(TM) i7-11700F @ 2.50GHz, 8 cores, 16 threads, released Q1-21 GPU: GeForce RTX 3070@ 1.50GHz, 8 GB RAM, 5888 cores, FP32: 20 TFLOPS

#### Hi-end PC 2016 (price Nov-2016: 3300 USD)

CPU: Intel i7-6900K@3.2GHz Broadwell-E, 8 cores, 16 threads GPU: Radeon RX 480, 8 GB ram, 2304 cores, FP32: 5.8 TFLOPS This is the PC used as a server for "EED on the WEB", see https://www.buildingphysics.com/manuals/EEDONTHEWEB.pdf

#### Hi-end PC 2012

CPU: Intel i7-3770K, 4 cores, 8 threads, @3.5GHz Ivy Bridge GPU: GeForce GTX 680, 2 GB ram, 1536 cores, FP32: 3.2 TFLOPS

#### Hi-end PC 2009

CPU: Intel Core 2 Duo P7450, 2 cores, @2.13GHz Penryn GPU: Graphics card not compliant with OpenCL

Below are benchmarks for hourly calculations for EED v4.20. To repeat the cases just open EED and use the default data. Open menu "Input/Hourly calculation" and check "Solve for hours". Change the simulation time in menu "Simulation period".

#### Hi-end PC 2021:

Simulation time	Serial CPU	Threaded CPU SIMD	GPU OpenCL
10 years	6 sec.	<1 sec.	<1 sec.
25	44	<1	<1
50	180	2	1
100	733	5	2

#### Hi-end PC 2016:

Simulation time	Serial CPU	Threaded CPU SIMD	GPU OpenCL
10 years	9 sec.	<1 sec.	<1 sec.
25	61	<1	<1
50	244	3	3
100	966	6	4

#### Hi-end PC 2012:

Simulation time	Serial CPU	Threaded CPU SIMD	GPU OpenCL
10 years	10 sec.	<1 sec.	<1 sec.
25	64	2	<1
50	251	5	4
100	983	20	Not enough RAM

#### Hi-end PC 2009:

Simulation time	Serial CPU	Threaded CPU SIMD	GPU OpenCL
10 years	15 sec.	2 sec.	Not compatible
25	99	9	Not compatible
50	410	35	Not compatible
100	1681	278	Not compatible

In reference [1] above, the simulation time on an "Intel dual core 2.10 GHz processor" was 25 seconds for a simulation time of 20 years using a load aggregation method. Using "Threaded CPU SIMD" on an Intel Core 2 Duo P7450 as comparison takes 6 seconds with EED v4.14. The "Serial CPU" method takes 63 seconds.

It should be noted that the speed increase between e.g. "Threaded CPU SIMD" and "Serial CPU" is higher for newer PC:s (due to newer SIMD options and higher number of cores), such as on i3/i5/i7/i9 etc. CPU:s.

## 6.4 Benchmarks for F10 ("Solve required borehole length")

For this calculation, the "Threaded CPU SIMD" will always be used unless "Serial CPU" is chosen.

### Hi-end PC 2021:

Simulation time	Serial CPU v4.20	Threaded CPU SIMD v4.20	GPU OpenCL
10 years	2 sec.	1 sec.	
25	6	1	"Threaded CPU SIMD" will be used for all calculations
50	11	2	will be used for all calculations
100	22	6	

### Hi-end PC 2012:

Simulation time	Serial CPU v4.20	Threaded CPU SIMD v4.20	GPU OpenCL
10 years	4 sec.	2 sec.	
25	8	3	"Threaded CPU SIMD"
50	15	7	will be used for all calculations
100	29	19	

There will also be a speed increase by using parallel methods for "*Solve required borehole length – Optimization F11*". The example in section 3.6 now takes 147s on "Hi-end PC 2012" and 76s on "Hi-end PC 2012".

🗳 Opti	imization	FINA_B1.D	AT EE	D v4	.20										_		×
<u>F</u> ile																	
Config		[	0	-	797		Opti	nize		🗹 Automatic	grid step		Step:	2 m	Sort: Tota	l length	
Max land	d area		500	×	500	mŕ		Config		69/69 "3×6	6, L2-configura	tion''			O Lost		
Borehole	spacing		5		100	m		Spacing		100 m			Hourly calcul	lationj			
Borehole	denth	Г	50		300	m	4097 cases trie	d		Round off	values		Best configs:	10612	3 56 140	53 115	132177
		i i	1		2000		Solutions found	: 2	831	🗌 Also list ca	ises with warn	ings					
Number	of borehole	s I			2000		Analysis started	110:44:18, stop	pped 10	):46:45 time: 2m2	?7s Double o	lick on row fo	or details				
Config	No bh	Туре			Spacin	g [m]	Depth [m]	Total length [	[m] l	Land area [m²]	Length [m]	Width [m]	Comments	Cos	st [EUR]		^
123	13	5 x 5 U-cor	nfigu			100	283,74	3688	,6	160000	400	400	Chosen f	. 0			
106	13	3 x 6 U-co	nfigu			100	283,75	3688	8,8	100000	500	200	Detailed	0			
123	13	5 x 5 U-co	nfigu			99	283,76	3688	,9	156816	396	396	Detailed	0			
123	13	5 x 5 U-cor	nfigu			100	283,74	3688	,6	160000	400	400	Detailed	0			
106	13	3 x 6 U-cor	nfigu			97	283,83	3689	,7	94090	485	194	Detailed	0			
106	13	3 x 6 U-cor	nfigu			98	283,8	3689	,4	96040	490	196	Detailed	0			
106	13	3 x 6 U-cor	nfigu			99	283,78	3689	,1	98010	495	198	Detailed	0			
123	13	5 x 5 U-cor	nfigu			96	283,84	3689	,9	147456	384	384	Detailed	0			
123	13	5 x 5 U-cor	nfigu			97	283,82	3689	,6	150544	388	388	Detailed	0			
123	13	5 x 5 U-cor	nfigu			98	283,79	3689	,3	153664	392	392	Detailed	0			
106	13	3 x 6 U-cor	nfigu			95	283,88	3690	,4	90250	475	190	Chosen f	. 0			
123	13	5 x 5 U-cor	nfigu			95	283,87	3690	,3	144400	380	380	Chosen f	. 0			
106	13	3 x 6 U-co	nfigu			94	283,91	3690	,8	88360	470	188	Detailed	0			~

#### Hi-end PC 2021:

Simulation time	Serial CPU v4.20	Threaded CPU SIMD v4.20	GPU OpenCL
25 years	208 sec.	76 sec.	"Threaded CPU SIMD" will be used for all calculations

#### Hi-end PC 2012:

Simulation time	Serial CPU v4.20	Threaded CPU SIMD v4.20	GPU OpenCL
25 years	400 sec.	147 sec.	"Threaded CPU SIMD" will be used for all calculations

# 7. Appendix A. List of new update features

For update info, see also section "Version update info" at <u>ahttps://buildingphysics.com/eed-2/</u>

# Update 4.14 (Jan 4, 2017)

Faster hourly simulations. See Chapter 6.

Approximation for irregular configurations. Updated solver. See Chapter 4.

### Copy images to clipboard

The old option "File/Copy to clipboard" in the charts for fluid temperatures and load profile copied the chart image with data as an enhanced metafile (EMF). Using hourly values would result in a very large image which could be hard (slow) to handle in e.g. Word.

Chart images can now be copied in bitmap format to clipboard via menu item "File/Copy to clipboard...(Bitmap)".

The old metafile option is still available as "File/Copy to clipboard...(EMF)" but there will be a warning if there are many data values:

Confirm	X
?	There are 420480 values and the amount of data copied will be large. If you copy this image into e.g. Word there might be a problem with slow handling. Consider instead to copy to BMP format. Do you really want to continue to copy image in EMF format?
	<u>Y</u> es <u>N</u> o



Use copy to clipboard in bitmap format for smaller image size.

### Date format

Dates can now be written in short format in the xls-style option, e.g. as for a German date type:

"1.9.2015 4	-18,6	0,0	0"	(short format "m.d.yyyy h is now ok)
"01.09.2015 04	-18,6	0,0	0"	(the standard long format "mm.dd.yyyy hh")

#### Debug check box for hourly values

There is now a debug option (see below) that can be used if there is an error message when a load file is used. A message window will show rows that are read from the load file. The last row will indicate the error, see example below, when e.g. "Show chart with resulted load profile" is pressed, or when a simulation is started.

S Hourly calculation (load profile)		– 🗆 X							
Solve for hours									
Make hourly loads from monthly base loads	Show chart wit	th resulted load profile							
Make hourly loads from monthly peak loads									
Read file(s) with hourly values (exchanging any values given by monthly base and peak loads)									
Use same annual variation (values for the first ye	ar will be used for all ye	ears)							
File load options:									
Directory path: C:\Users\Thomas\Documents\Blocom	VEED 4\								
··· Path found		File types possible:							
A. Read file with net heat injection:		(Click for help)							
qtest.txt	Open OK	1 2							
O B. Read files with loads:									
Heat: qtest.txt	Open OK	1 2							
Cool: qtest.txt	Open OK	1 2							
DHW: qtest.txt	Open OK	1 2							
• C. Read file with loads in xls-style:									
MQ41_Hourly_load.txt	Open OK	3							
You can enable/disable separate loads for options B and C:									
Heat: 🔽 Cool: 🗹 DHW: 🗹	Default date Help on da	e format: yyyy-MM-dd							
Debug. Check this box if you get error in load file.									

		🚫 Message wind	low			_	×
		<u>C</u> lear					
		13.8.2016 19	0,0	344,5	0		~
		13.8.2016 20	0,0	279,0	0		
		13.8.2016 21	0,0	203,8	0		
EED	×	13.8.2016 22	0,0	165,5	0		
		13.8.2016 23	0,0	167,6	0		
		14.8.2016 0	0,0	167,0	0		
'5x' is not a valid floating point value.		14.8.2016 1	0,0	121,6	0		
<b>V</b>		14.8.2016 2	0,0	90,2	0		
		14.8.2016 3	0,0	74,4	0		
		14.8.2016 4	0,0	73,8	0		
ОК	1	14.8.2016 5x	0,0	88,6	0		
							<b>~</b>

#### Miscellaneous

- Fixed error "List index out of bounds" that sometimes occurred when clicking in the configuration list.
- Values for heat extraction are now shown as zeros before first month of operation.

### Update 4.15 (Jan 4, 2017)

Fix: Graph for fluid temperatures was sometimes not updated when hidden.

### Update 4.16 (Feb 22, 2017)

- · Fix: EED showed an error message when started on systems with decimal separator "."
- · Fix: Last hourly value for temperature was sometimes zero using GPU-calculation
- New "pipe.txt" file: names such as "PE DN25 PN6" changed to "PE DN25 SDR-17"

PE DN45 SDR-17 added

### Update 4.17 (March 1, 2017)

 $\cdot$  EED v4 now always shows results from first year (0) for monthly simulations (same as in v3). The option "Show results after x years" is now only valid for hourly simulations (in order to make these calculations quicker). The default value has also been changed from "1" to "0".

Simulation period	×
Simulation period First month of operation	25 years 9
For hourly simulations: Show results after	0 years
<u>C</u> lose	

 $\cdot$  EED v4 now shows output temperatures and heat extraction rates with a precision of three digits. More digits can be chosen by checking "Show results with more digits" in the Settings menu.

## Update 4.18 (April 13, 2017)

· Compatibility with Windows 10 "Creators update" added.

Earlier versions of EED will not start if your OS is updated to Windows 10 "Creators update". There is however a quick fix that will make old versions of EED run under this OS: Go to folder C:Program Files (x86)BLOCONEED\_v4.17, right-click "EED\_v4\_17.exe" and choose Properties. In the Compatibility tab, change "Compatibility mode" to "Windows 7".

<sup>•</sup> New version of TurboActivate (4.0.9.6).

# Update 4.18b (April 21, 2017)

• For admins/superusers: It is now possible to silently install, uninstall, activate, and deactivate EED using a command line in a batch-file, see <a href="https://www.buildingphysics.com/download/silent\_eed.pdf">https://www.buildingphysics.com/download/silent\_eed.pdf</a>

# Update 4.19 (May 23, 2017)

 $\cdot$  Pipe thermal conductivity can now be larger than 100 W/(m·K), see menu "Borehole and heat exchanger".

# Update 4.20 (April 11, 2019)

### - Improved accuracy for optimizations

The convergence for required fluid temperatures is now enhanced.

Example with monthly heat loads

As a typical way of using the optimization consider example in section 2.2 with an annual base load value of 1000 MWh. The optimization for "Max land area" of 500x500 m<sup>2</sup> takes 8 seconds (on an Intel i7 3770K @3.5Ghz CPU), see below.

🗳 Opti	mization	UNTITLE	D.DAT	EED	v4.20								_		×
<u>F</u> ile															
Config			0	-	797		Optir	nize	Automatic grid step			Step: 2	m 💿 Total	length	
Max land	larea		500	×	500	m²		Config	69/69 "3 x	6, L2-configura	tion''		🔘 Cost		
Borehole	spacing		5		100	m		Spacing	100 m						
Borebole	denth		50		300	m	4097 cases trie	d	Round of	ff values	E	Best configs: 1	06 123 56 140	53 115 1	32 177
N N			1		2000		Solutions found	1: 2830	🗌 Also list c	ases with warn:	ings				
Number o	of borehole	s			1 2000		Analysis started	12:18:31, stopped	12:18:39 time: 8s	Double click	on row for det	ails			
Config	No bh	Туре			Spacing	) [m]	Depth [m]	Total length [m]	Land area [m <sup>2</sup> ]	Length [m]	Width [m]	Comments	Cost [EUR]		^
123	13	5 x 5 U-c	onfigu			100	283,74	3688,6	160000	400	400	Chosen f	0		
106	13	3 x 6 U-c	onfigu			100	283,75	3688,8	100000	500	200	Detailed	0		
123	13	5 x 5 U-c	onfigu			99	283,76	3688,9	156816	396	396	Detailed	0		_
123	13	5 x 5 U-c	onfigu			100	283,74	3688,6	160000	400	400	Detailed	0		_
106	13	3 x 6 U-c	onfigu			97	283,83	3689,8	94090	485	194	Detailed	0		_
106	13	3 x 6 U-c	onfigu			98	283,8	3689,4	96040	490	196	Detailed	0		_
106	13	3 x 6 U-c	onfigu			99	283,78	3689,1	98010	495	198	Detailed	0		_
123	13	5 x 5 U-c	onfigu			96	283,84	3689,9	147456	384	384	Detailed	0		_
123	13	5 x 5 U-c	onfigu			97	283,81	3689,6	150544	388	388	Detailed	0		_
123	13	5 x 5 U-c	onfigu			98	283,79	3689,3	153664	392	392	Detailed	0		~

Now double-click the first row. This will show the fluid temperatures.





Press F10. This will again confirm the required borehole length:

The calculated length 284 m (or more exact 283,74 m which is the same value from the optimization list) will be inserted in the menu below.



### Example with hourly heat loads

Go to menu item Input/Hourly calculation and check "Solve for hours". The optimization now takes 2m30s, see below.

🗳 Opti	imization	UNTITLED.	.DAT E	ED	v4.20			- 🗆 X							
<u>F</u> ile															
Config			0		797		Optimize		Automatic grid step			Step: 2	m 💿 Tota	l length	
Max land	l area		500	х	500	m²		Config	69/69 ''3 x	6, L2-configur	ation''		O Cost		
Borehole	spacing	Г	5	-	100	m		Spacing	100 m		]	Hourly calcula	tion]		
Developede		Ē	50		300	m	4097 cases trie	d	🗌 Round o	off values	E	Best configs: 1	06 123 56 140	53 115	132 177
Dorenoie	ellepin				2000		Solutions found	: 2831	🔄 Also list (	cases with war	nings				
Number o	of borehole	s I	-	•	2000		Analysis started	12:31:31, stoppe	d 12:34:01 time: 2r	n30s Double	click on row fo	r details			
Config	No bh	Туре			Spacin	g [m]	Depth [m]	Total length [m]	Land area [m <sup>2</sup> ]	Length [m]	Width [m]	Comments	Cost [EUR]		^
123	13	5 x 5 U-con	nfigu			100	283,74	3688,6	160000	400	400	Chosen f	0		
106	13	3 x 6 U-con	nfigu			100	283,75	3688,8	100000	500	200	Detailed	0		
123	13	5 x 5 U-con	nfigu			99	283,76	3688,9	156816	396	396	Detailed	0		
123	13	5 x 5 U-con	nfigu			100	283,74	3688,6	160000	400	400	Detailed	0		
106	13	3 x 6 U-con	nfigu			97	283,83	3689,7	94090	485	194	Detailed	0		
106	13	3 x 6 U-con	nfigu			98	283,8	3689,4	96040	490	196	Detailed	0		
106	13	3 x 6 U-con	nfigu			99	283,78	3689,1	98010	495	198	Detailed	0		
123	13	5 x 5 U-con	nfigu			96	283,84	3689,9	147456	384	384	Detailed	0		
123	13	5 x 5 U-con	nfigu			97	283,82	3689,6	150544	388	388	Detailed	0		
123	13	5 x 5 U-con	nfigu			98	283,79	3689,3	153664	392	392	Detailed	0		~

### - Improvements for graphs for monthly calculations

Graphs similar to those presented in EED v3 has now been added to v4. There are also a few more options/changes:

New legends added (base min/max, peak min/max) Legend "peak max" changed to "peak cool load" Legend "peak min" changed to "peak heat load"

See example below (input file at <u>https://buildingphysics.com/download/input\_for\_graphs.dat</u>):









There are new menu options: Line thickness (1,2,3) Text labels for months (for Tf monthly calculations)



To get the picture below for file "input for graphs.dat" (similar as in EED v3) do as follows:

Open the dat-file and solve (F9) Press menu item "Last year" Uncheck Options/Line mode stairs Check Options/Show grid Check Options/Line thickness 3 Check Options/Use months

Text labels for months is according to Options/Text labels for months...



Here is the EED v3 graph:



Note. The labels for months are for some languages currently set to 1,2,3... The labels for months is defined in file "Lang\_out\_\*\*\*.txt" where \*\*\* is the language (e.g. "Lang\_out\_ger.txt" for German). This file is located in folder "...\Documents\Blocon\EED 4\Languages". Below is an example how to change the labels in German.

You can edit the labels in this file using Notepad directly:

🧾 La	ang_out_ger.txt -	Anteckning	jar —	×
<u>A</u> rkiv	<u>R</u> edigera For	ma <u>t</u> Vi <u>s</u> a	<u>H</u> jälp	
þ				~
2				
3				
4				
6				
7				
8				
9				
10				
12				
Einga	bedatei			
Diese	Ausgabedatei	Ĺ		
Datum				
Uhrze	it			
Anmer	kungen zum Pr	rojekt		~

It is also possible to edit the file in EED. Go to menu item "EED Settings/Language":

Set Language	Х
English Arabic Basque Catalan ChineseSimp Czech Danish Dutch Estonian Farsi	
Finnish French	
Greek Hebrew Hungarian Italian Japanese Korean Latvian Lithuanian Polish Portuguese Romanian Russian Serbian (Serbian Latin) Cyrillic (Serbian Latin) Cyrillic (Serbian Cyrillic) Slovene Syk Slovak Spanish Swedish Turkish Vietnamese	
Edit/add languages	

### Press button "Edit/add language":

Press button Edit/add language :	7				
Sprache/Language X					
Hilfe					
Language setting:					
O Use default initial language (English)					
Use language files below					
Menu text:					
File: LANG_MENU_GER.TXT					
Change Edit Clear Create					
Input text:					
File: LANG_IN_GER.TXT					
Change Edit Clear Create					
Output text:					
File: LANG_OUT_GER.TXT					
Change Edit Clear Create					
Chart editor:					
German					
Farsi					
French (German)					
Galician					
Greek					
Get latest language files [Buildingphysics.com]					
👖 Übernehmen					
	Press	bu	tton "Edit" for Lang out ge	er.txt.	
					 ~
Edit left hand side: LANG_OUT_GER.TXT (see	reference	e at r	ight hand side: LANG_OUT_ENG.TXT)	_	~
<u>File Font <update></update></u>			TAN		
2			FEB		
März			MAR		
4 5			MAY		
e			JUN		
7			JUL		
° 9			SEP		
10			OCT		
11			NOV		
Eingabedatei			Input file		
Diese Ausgabedatei			This output file		
Datum			Date		
Anmerkungen zum Projekt			MEMORY NOTES FOR PROJECT		
EINGABEDATEN (PLANU	JNG)		DESIGN DATA		
UNTERGRUND Wärmeleitfähigkeit des Erdreichs			GROUND Ground thermal conductivity		
Spez. Wärmekapazität des Erdreichs			Ground heat capacity		
Mittl. Temperatur d. Erdoberfläche			Ground surface temperature		
Geothermischer warmefluss BOHRUNG UND ERDWÄRMESONDE		5	BOREHOLE		
	>		<		>
<			-		-

This will give the following picture:



### - Directory path for load files set to current working directory by default

If the *directory path* for file load options is empty the current working directory will now be used. In the example below the working directory is "C:\Users\Thomas\Documents\Blocon\EED 4\".

O Hourly calculation (load profile)			– 🗆 X
Solve for hours  Make hourly loads from monthly base loads Make hourly loads from monthly peak loads		Show chart with re	esulted load profile
Read file(s) with hourly values (exchanging any v	alues giver	n by monthly base and	d peak loads)
Use same annual variation (values for the first File load options:	st year will	be used for all years	)
Directory path:			
Path:C:\Users\Thomas\Documents\Blocon\E	ED 4\		File types possible:
○ A. Read file with net heat injection:			(Click for help)
EED_4_OFFICE-L-hourly-loads.txt	Open	ОК	1 2
B. Read files with loads:			
Heat: EED_4_OFFICE-L-hourly-loads.txt	Open	ОК	1 2
Cool:txt	Open	File not found	1 2
DHW:txt	Open	File not found	1 2
○ C. Read file with loads in xls-style:			
qxls.txt	Open	ОК	3
You can enable/disable separate loads for options	B and C:		
Heat: 🔽 Cool:		Default date forma	at: yyyy-MM-dd
DHW:		Help on date for	mats
Debug. Check this box if you get error in load fi	le.		

In version 4.19 (and earlier) the absolute path had to be given. If the input file was used on another system with a different working directory it would be a problem to find the load file(s) and a new path had to be given.

It is also possible to use a relative path. All load files could e.g. be in the same folder "\Documents\Blocon\EED 4\TestLoadFolder" se below.

S Hourly calculation (load profile)	- 🗆 X
Solve for hours	
Make hourly loads from monthly base loads	Show chart with resulted load profile
Make hourly loads from monthly peak loads	
Read file(s) with hourly values (exchanging any values give	n by monthly base and peak loads)
Use same annual variation (values for the first year wil	l be used for all years)
File load options:	
Directory path: TestLoadFolder	
Path:C:\Users\Thomas\Documents\Blocon\EED 4\Test	LoadFolder
	File types possible:
○ A. Read file with net heat injection:	(Click for help)
EED_4_OFFICE-L-hourly-loads.bxt Open	OK 1 2

The working folder is given in "properties" (right-click start menu item of EED), see below.

🖒 Egenskaper fö	r EED 4.19	×
Säkerhet Allmänt	Information Genväg	Tidigare versioner Kompatibilitet
	0 4.19	
Typ: I	Program	
Plats:	EED_v4.19	
M <u>å</u> l:	es (x86)\BLOCON\EEI	D_v4.19\EED_v4_19.exe"
<u>S</u> tarta i: <u>K</u> ortkommando:	C:\Users\Thomas\Doo	cuments\BLOCON\EED 4"
K <u>o</u> ri: K <u>o</u> mmentar:	Normalt fönster	~
Öppna filsök	väg Bytikon	Avan <u>c</u> erat
	ОК	Avbryt <u>V</u> erkställ

Ps. If you change the working directory ("Start in") make sure you copy all essential files (such as gfunc4.eed and .txt-files) and folder "Languages" to the new directory.

### - Unicode format for load files added

Older versions of EED could sometimes not read load files saved in Unicode or UTF-8 format (these files had to be saved in ANSI to be read). Unicode and UTF-8 format are now also supported.

### - Floating network license option added

An annual subscription for multiple users with floating licenses is now offered, see <u>https://www.buildingphysics.com/download/floatinglicenses.pdf</u>

# Update 4.3 (March 27, 2024)

- The license manager has been updated with many performance improvements.
- EED now install gfunc4.eed (and some other files) to the common folder C:\Users\Public\Documents\BLOCON\EED 4 by default so that the files can be shared by different users. See also Section 1.3 "Installation".
- Modern design for the open/save file dialog.
- New version for setup program.
- Data for flow rate, and for values given in mm, are now saved with three decimals (e.g. 0,234), earlier it was saved with two decimals (0,23).