Contract N°: EIE/04/107/SO7.38635

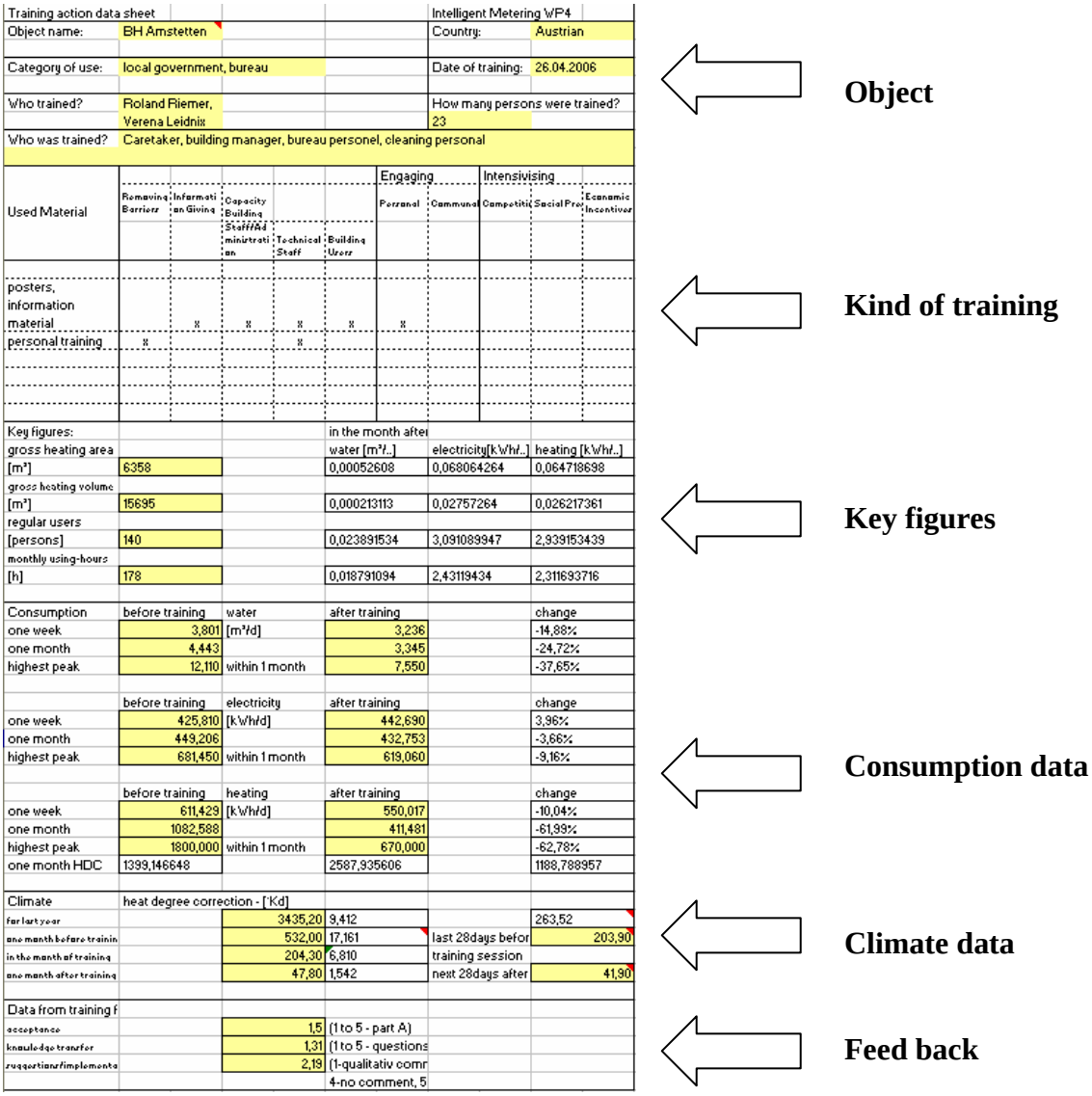
Report on analysis of the results of training (work-package 4)

Date: 11th December 2006

Co-ordinator:
Leicester City Council/Leicester Energy Agency (LEA) (UK)
Partners:
County of South Jutland (Denmark), Energieagentur Waldviertel (EAW4) (Austria), ENERGIE 2000 e.V. (Germany), Esbensen (Denmark), IT Power Ltd (UK), Sonnenplatz Großschönau GmbH (Austria).

In work-package 4 we had to analyze the results of training to find out what the things are, which make training effective. We also reflected about the best way of evaluation and the results of training at different partners.

To get the data for evaluation, we used the training-action-data-sheet (TADS). Every partner who carried out training had to fill in a TADS for it.



Training action data sheet				Intelligent Metering WP4	
Object name:	BH Amstetten			Country:	Austrian
Category of use:	local government, bureau			Date of training:	26.04.2006
Who trained?	Roland Riemer, Verena Leidnix			How many persons were trained?	23
Who was trained?	Caretaker, building manager, bureau personel, cleaning personal				

Used Material	Removing Barriers	Information Giving	Capacity Building: Staff/Administration	Capacity Building: Technical Staff	Capacity Building: Building Users	Engaging: Personal	Engaging: Communal	Intensivising: Competition	Intensivising: Social Pressure	Economic Incentives
posters, information material		x	x	x	x	x				
personal training	x			x						

Key figures:			in the month after		
gross heating area [m²]	6358		water [m³/..] 0,00052608	electricity[kWh/..] 0,068064264	heating [kWh/..] 0,064718698
gross heating volume [m³]	15695		0,000213113	0,02757264	0,026217361
regular users [persons]	140		0,023891534	3,091089947	2,939153439
monthly using-hours [h]	178		0,018791094	2,43119434	2,311693716

Consumption	before training	water	after training		change
one week	3,801	[m³/d]	3,236		-14,88%
one month	4,443		3,345		-24,72%
highest peak	12,110	within 1 month	7,550		-37,65%
	before training	**electricity**	**after training**		**change**
one week	425,810	[kWh/d]	442,690		3,96%
one month	449,206		432,753		-3,66%
highest peak	681,450	within 1 month	619,060		-9,16%
	before training	**heating**	**after training**		**change**
one week	611,429	[kWh/d]	550,017		-10,04%
one month	1082,588		411,481		-61,99%
highest peak	1800,000	within 1 month	670,000		-62,78%
one month HDC	1399,146648		2587,935606		1188,788957

Climate	heat degree correction - [Kd]			
for last year	3435,20	9,412		283,52
one month before training	532,00	17,161	last 28days befor	203,90
in the month of training	204,30	6,810	training session	
one month after training	47,80	1,542	next 28days after	41,90

Data from training f		
acceptance	1,5	(1 to 5 - part A)
knowledge transfer	1,31	(1 to 5 - questions
suggestions/implementa	2,19	(1-qualitativ comn
		4-no comment, 5

Object

Kind of training

Key figures

Consumption data

Climate data

Feed back

In the "**Object**" part we collected data from the object and the training. Very important for the analyses was the date of training and the number of the trained persons. Also important was the category of use of the building and which persons were trained.

"**Kind of training**" gives information about the activities. The activities are cut in three main-groups and are divided into different actions. The main groups are:

enabling
engaging
incentivising

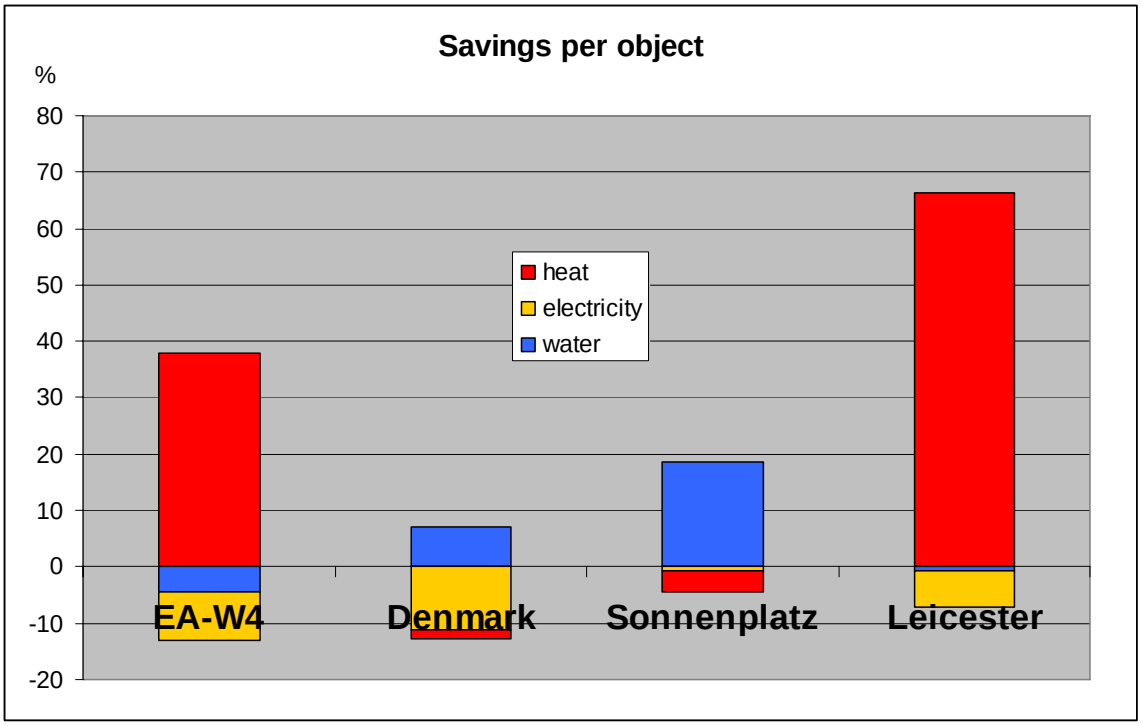
"**Key figures**" contains the consumption divided by area, volume, persons and using hours. Key figures make objects with the same category of use comparable. Different partners start their savings on different levels. Key figures can help to identify those levels. Be aware that some consumptions and therefore key figures too are depending on climate.

"**Consumption data**" is the block with the most important data. In this block are the consumption data weekly (7 days), monthly (28 days) and the highest peak value listed up.
A week is the shortest time unit to look at, because normally the consumption is different every weekday. To look on short term effects you have to sum up the consumption values from Monday to Sunday. For the monthly consumption we took 28 days because of the different weekday-consumption and the different month-length. The highest peak is an indicator for unusual consumption (special events).

"**Climate data**" gives information about the temperature and the heating days (in Kelvin days [Kd]). Therefore we collected the data of the last year, and especially the data 28 days before and after the training-session. The data were taken from the nearest meteorological station.

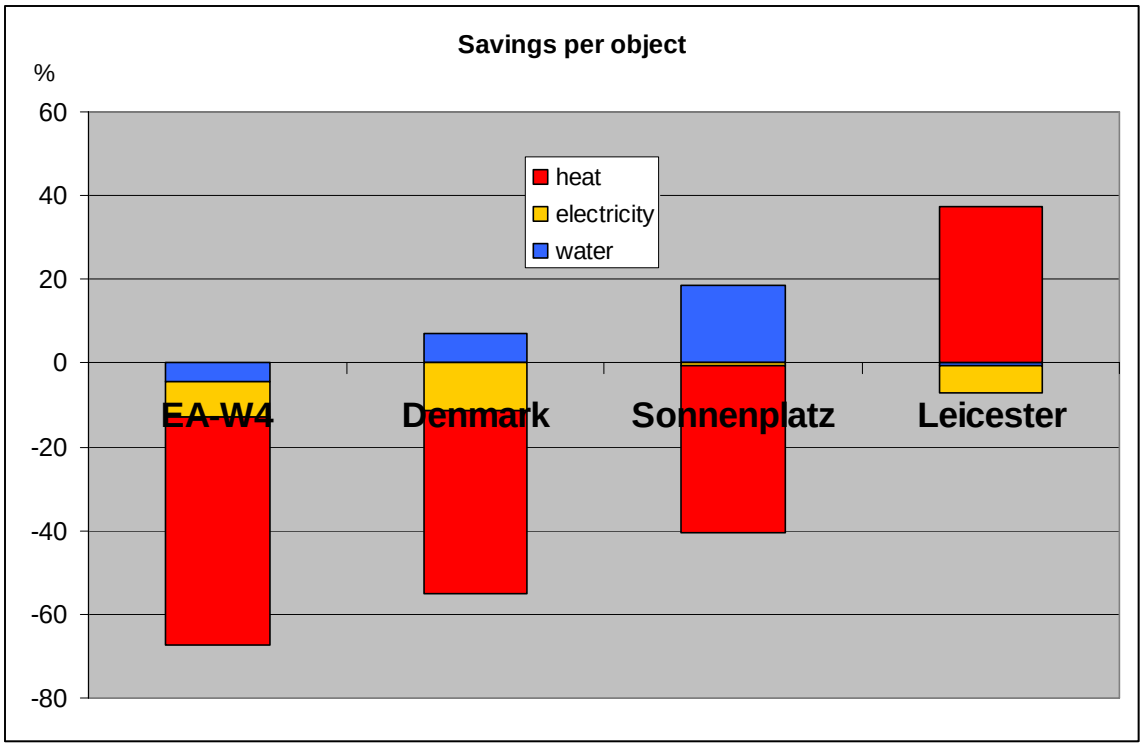
"Feed back" was planned to find out the acceptance and implementation of our training. We divided into 3 categories with school note system (1 very good to 5 poor). The categories were acceptance of the training, knowledge transfer and suggestions from the trainees. Most trainees gave a school note of 1 or 2.

With the savings in % we watched the results of training for the different partners. We did sum up the savings of the single trainings, and divided by the number of trainings to get an average for different partners.



with heat-degree-correction

At the first look it seems like the heat consumption was rising because of the trainings. During the analyses we considered a lot of possibilities to evaluate the heating savings, but with the collected data from the TADS there is no possibility to get the data into a comparable form.
Without heat-degree-correction the data look extremely different. Both versions can't be used to make a clear, meaningful statement. Without the heat-degree-correction (HDC) the temperature changes are not included.
Especially during heating times with only few consumption the heat degree correction may be too strong, e.g. training sessions in May of the EAW4 could have brought reductions as well as rises.
2006 was a warmer year than 2005, therefore without HDC there should be a reduction in heat consumption be done easy. On the other hand with HDC it is more difficult to reach a reduction in the heat sector. The heat plant works with less efficiency at warmer temperatures.
Also the water consumption was difficult to reduce because of the warmer year 2006. Training, which was really effective was in the sector of electricity.



without heat-degree-correction

The heat-degree-correction we used for the evaluation of the TADS:

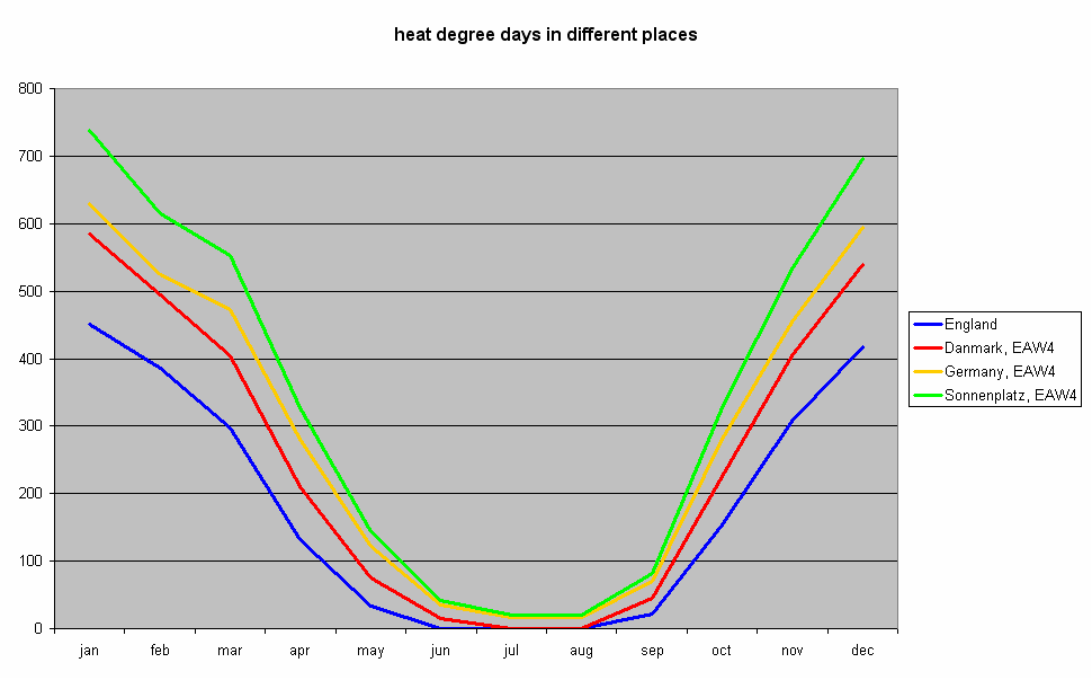
Corrected consumption before training

$$\text{actual consumption before training (28 days)} \times \frac{(\text{HDD month before training} + \text{HDD month of training} + \text{HDD month after training})/3}{\text{HDD 28 days before training}}$$

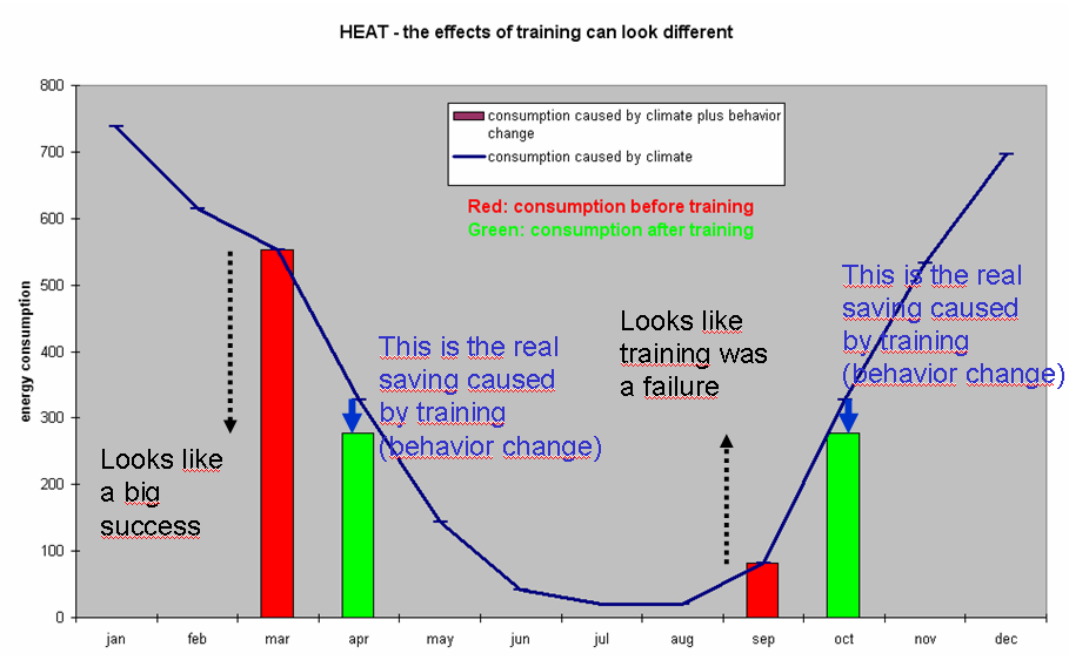
Corrected consumption after training

$$\text{actual consumption after training (28 days)} \times \frac{(\text{HDD month before training} + \text{HDD month of training} + \text{HDD month after training})/3}{\text{HDD 28 days after training}}$$

As we see on the following diagram the heat-degree-days are different for nearly every place. “EAW4” had objects in different climate-zones. The climate in England is rather temperately. The climate in Groß-Schönau (“Sonnenplatz”) in turn is rather rough.



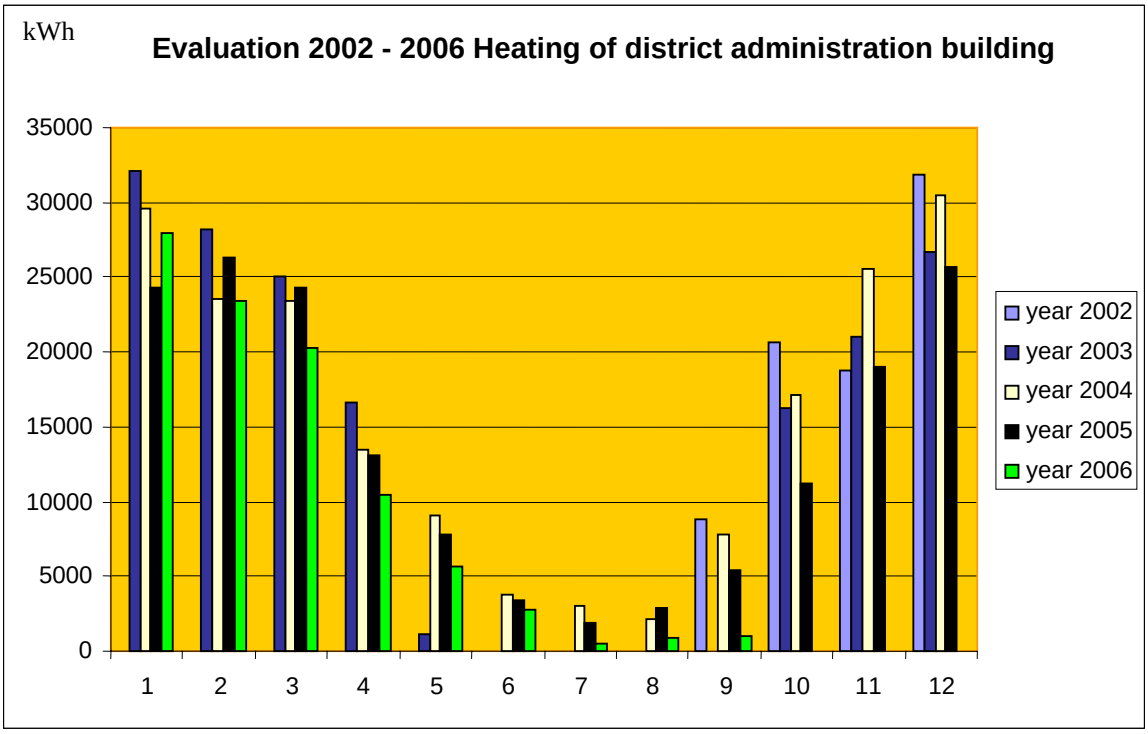
If the training took place in spring or autumn, in a climate with huge temperature changes, it may looks like a huge saving but there's no saving at all or it looks the other way round.



Heat-degree-correction makes the data from one object comparable to the data from the year before, but it's not possible to compare the month before training with the month

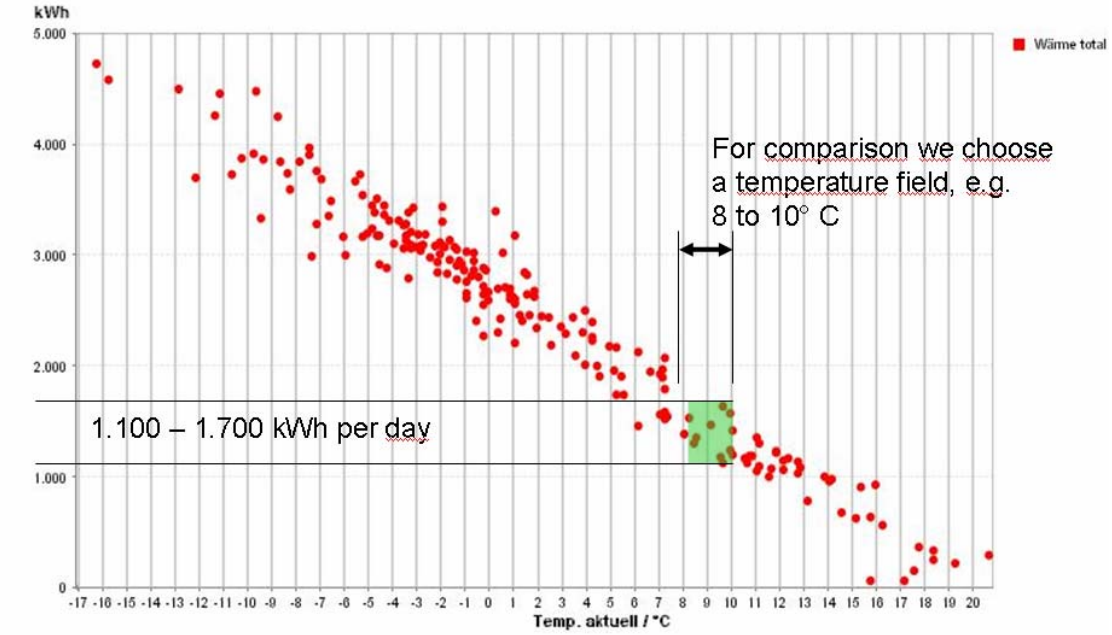
after training. If the climate and the temperature would be the same, before and after, it would be possible, but this case didn't happen and can't happen for all objects. The HDC is a smoothing function for comparison reasons. As we see on the diagram, comparing the consumption of July with August or December with January works well but March with April will be worse. There are many other things which have influence on the energy-consumption, like building-insulation, warm-water-production, user behavior and many more.

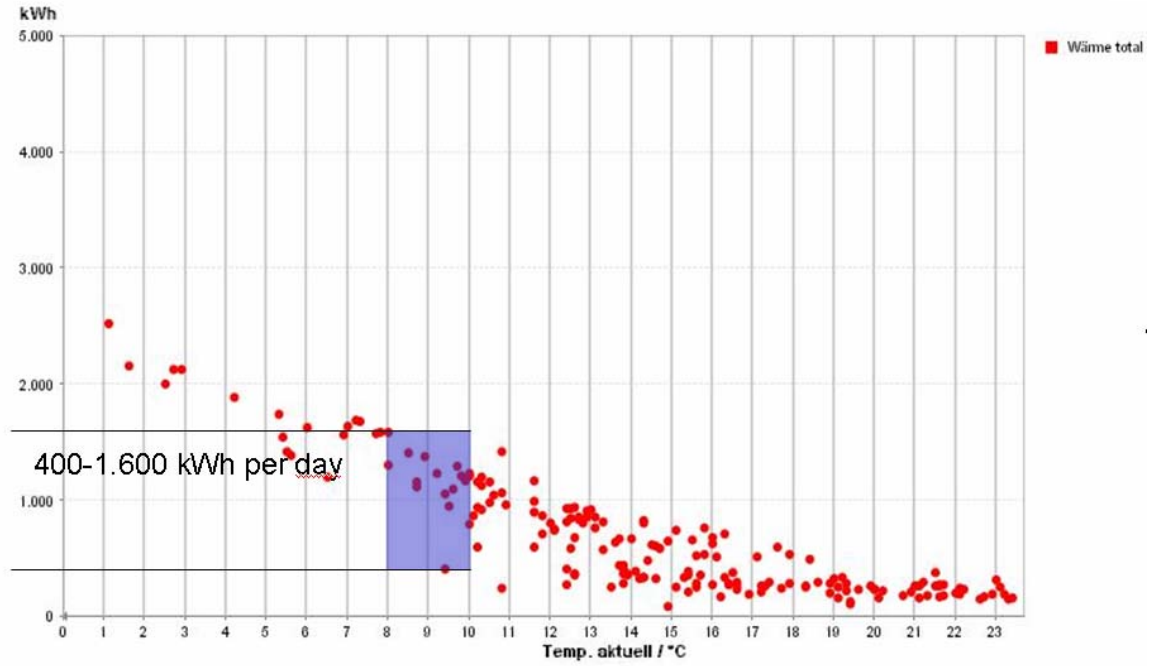
To make heating-analysis useful, we would need the consumption data from the year before. With heat-degree-correction the two years would be a little bit more comparable.



Longer time periods of consumption for comparison are important. The best way to evaluate the heat-consumption-savings would be to set the consumption in dependency with the local outside temperature. The EAW4 used proxy meter from Siemens which recorded and analyzed in their energy accounting program emc the temperature too for temperature signatures. As well as climate data from the nearest meteorological stations can be used.
First a time period of at least half a year should be evaluated before we start training. During this half year there should be summer and winter months included, so we suggest January till June or July till December to get a base line of data showing the different daily outside temperature linked to the daily consumption. So at a different temperature field you have a range of typical daily consumption in kWh.
After training this range should be shifted downwards to less daily consumption to show success. To sum up the days delivers the savings of a longer time period.

The energy signature also gives information about the building quality or the right dimension of the plant.





First we take a closer look at the number of persons trained. We divided the number of persons in three different groups. The three groups are “technical staff”, “users” and “administration”.
Technical staff: Technical staff is the group which takes care of the heating system and the electrical and water equipment.

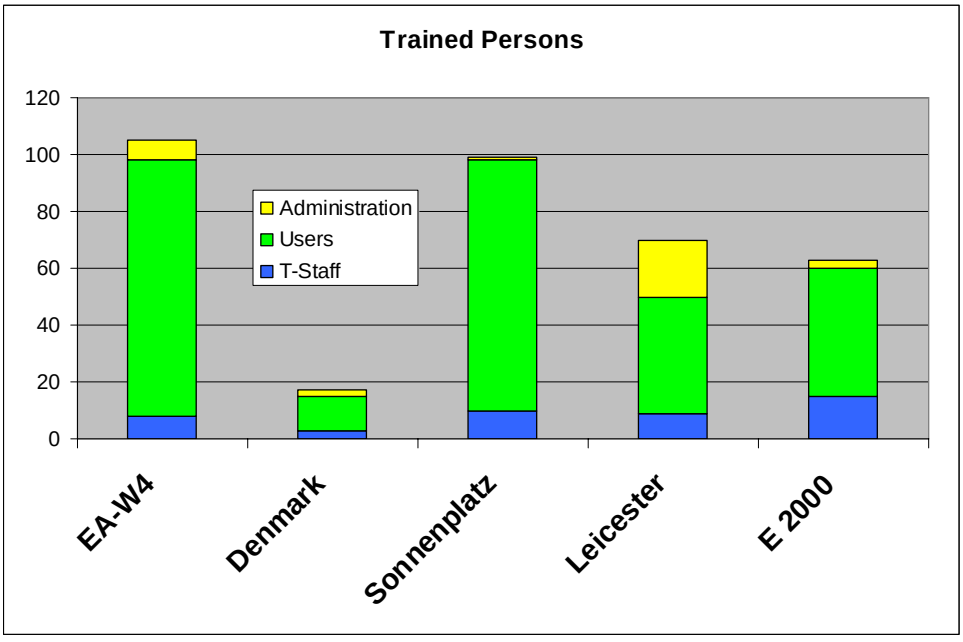
Users: Users are the people who live, work or at least spend some time in the object of training. They can’t change the adjustment of the heating plant but may influence with their need of warmth in the rooms the system. They consume water and electricity. Turning the lights on and off, or standby times are things they can influence in a high way.

Administration: The administrators are the people who make decisions. They are the legislature of the buildings, and so they guide and direct the user behavior.

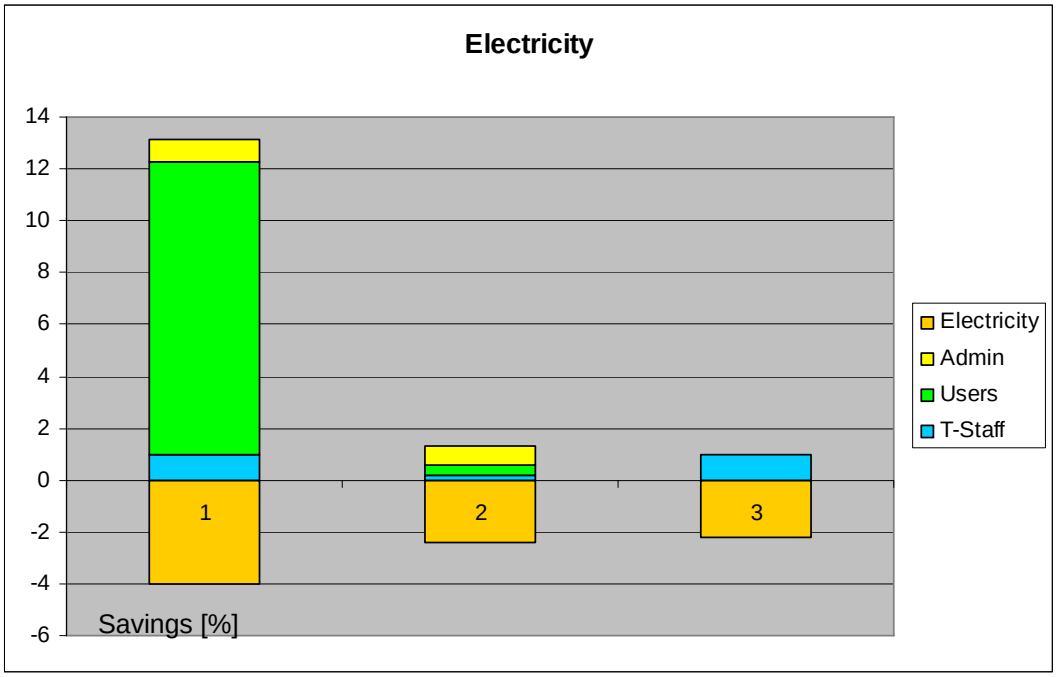
The different partners trained different numbers of persons and especially different numbers of persons of a certain group of persons.

In this chart, the numbers of persons of each group are listed for each partner

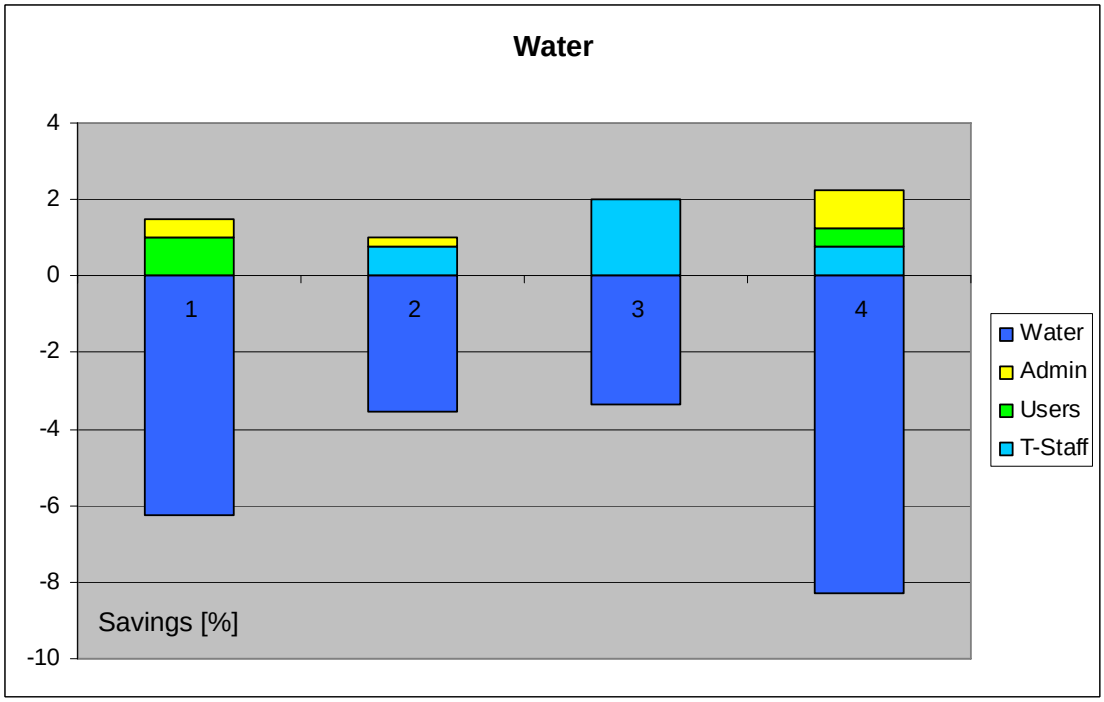
	EA-W4	Denmark	Sonnenplatz	Leicester	E 2000
T-Staff	8	3	10	9	15
Users	90	12	88	41	45
Administration	7	2	1	20	3



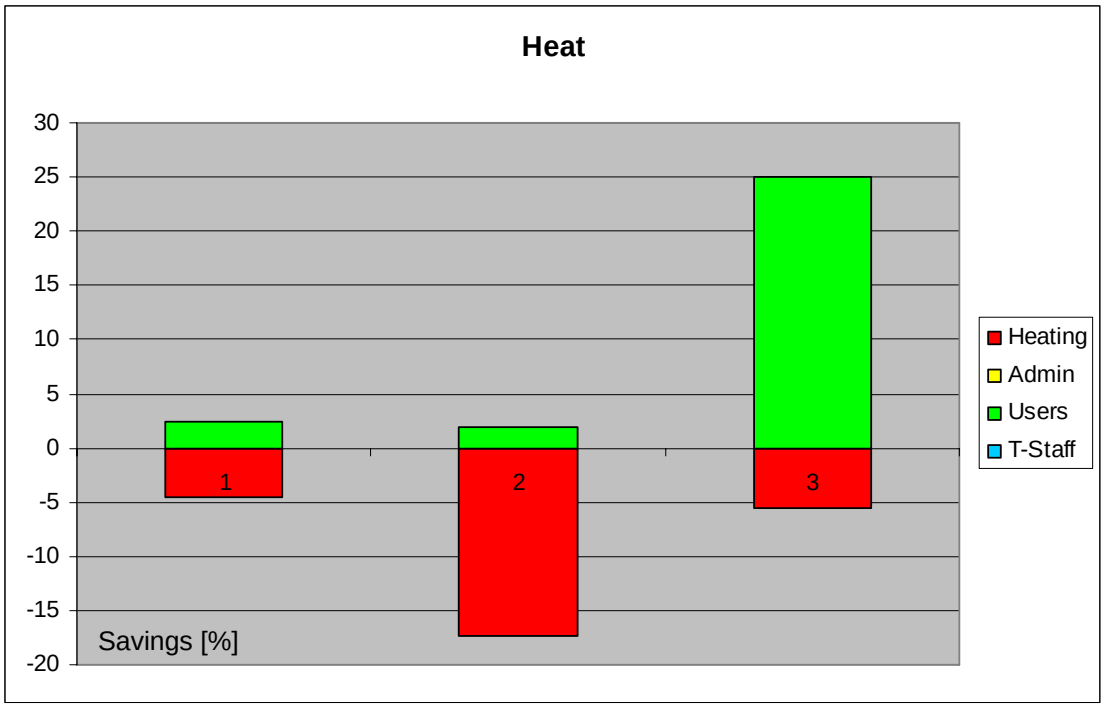
The Number of trained persons mustn't have an impact on the quality of training, and on the amount of savings. Denmark is a good example for that. Denmark has trained less people then the others, but they had the highest electricity-saving.
In the following graphs you see the three best training-models of each category (electricity, water, heat). In the negative y-axis you see the effect of this single training in saving electricity consumption. Above the savings (on the positive y-axis) you see the number and which kind of persons took part in these trainings.



For the savings in electricity, it is very important to train the administration staff. If the boss says: "turn off the lights", the lights will be turned off. If somebody who has the technical know-how and a lot of experience would say the same thing, it mustn't have the same effect.

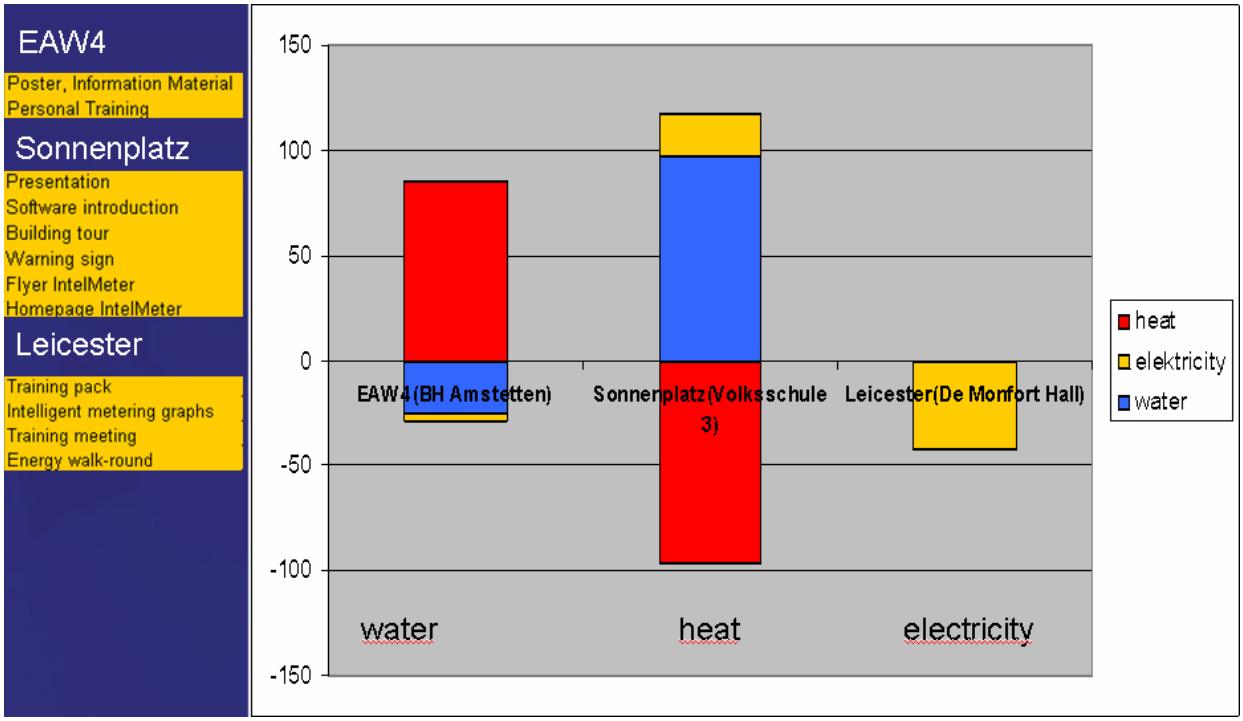


In saving water the technical staff has a big influence. They keep an eye on running water, and can repair leaky pipes.



For the heat savings the training of building users was best. They influence by their need for warmth and by their way of ventilation (open windows, how long).

Here we see three examples of huge savings. Interesting in these examples is that the saving in one category is very high, but the effect on the saving in other categories is not high. Maybe the training was focused on one category or the persons were interested in one special category.

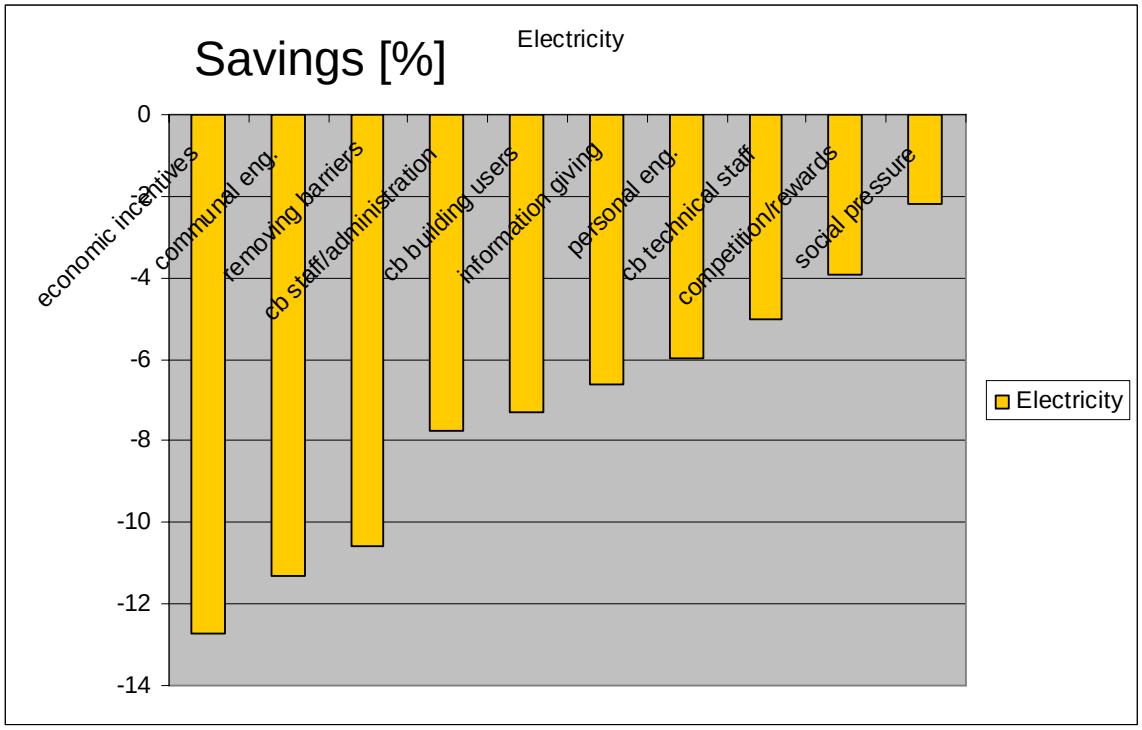


Most effective trainings in different sectors in percent [- %].

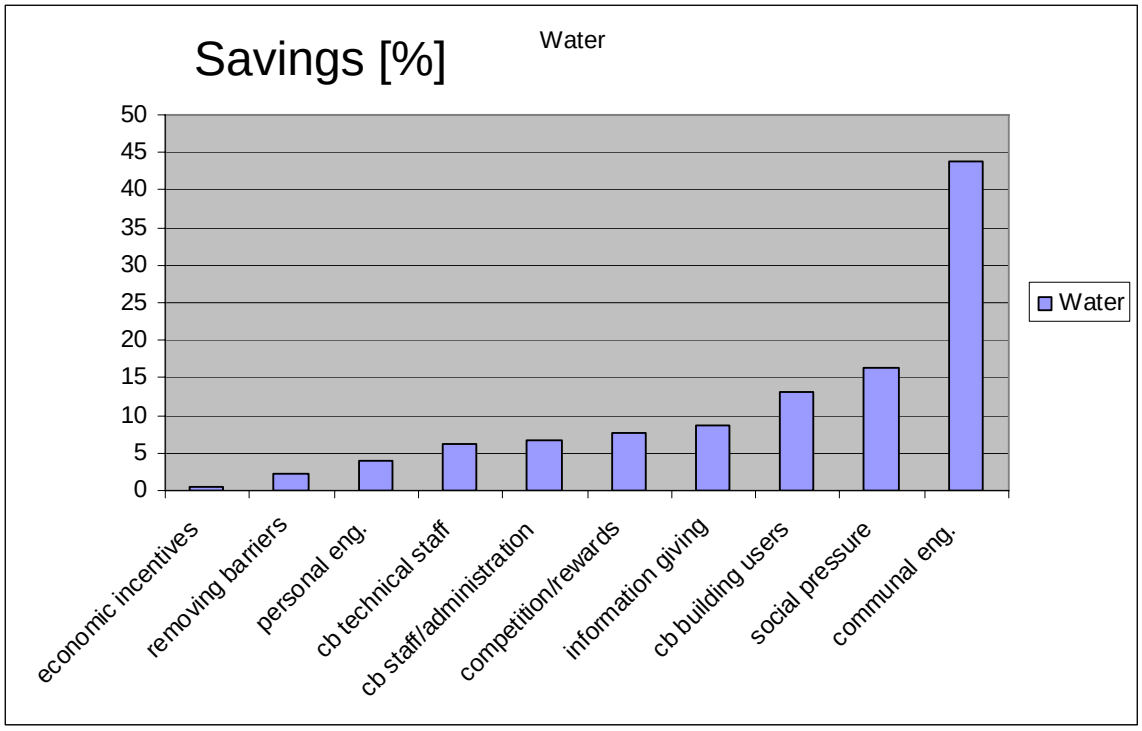
The training methods were separated in three units:

Enabling	Removing barriers
	Information giving
	Capacity building of
	-staff/administration
	-technical staff
	-building users
Engaging	Personal engaging
	Communal engaging
Incentivising	Competition/rewards
	Social pressure
	Economic incentives

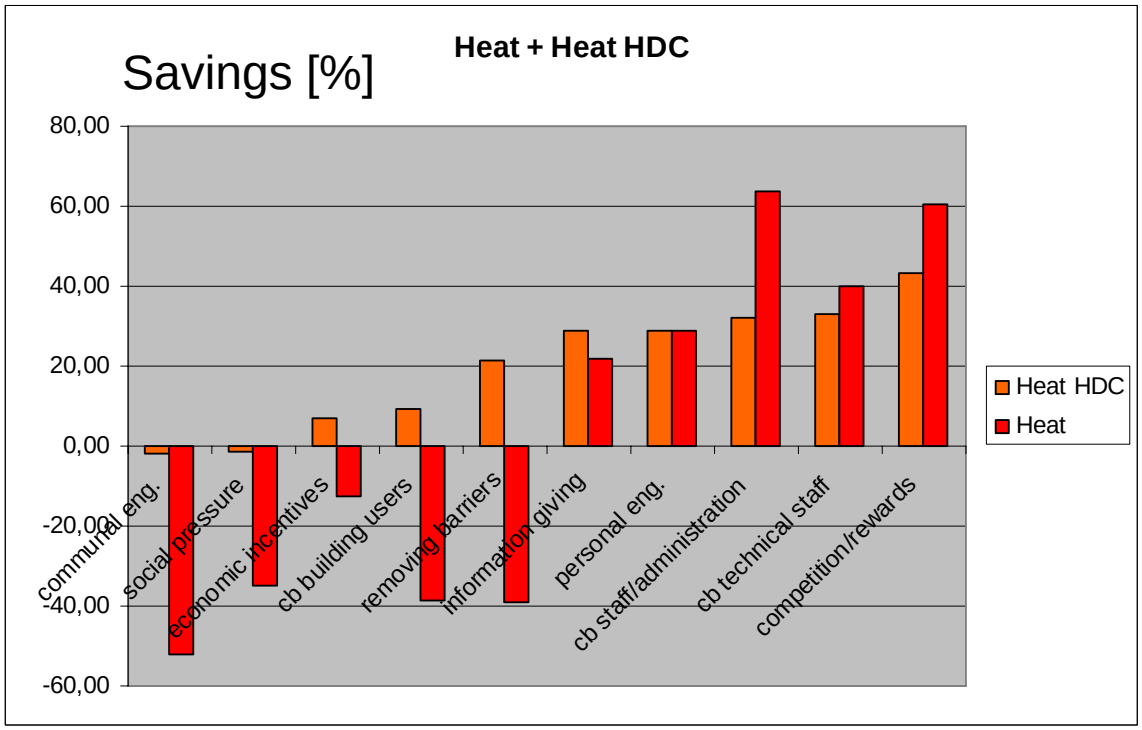
Every training session contains a certain number of actions. To analyze the effect of the different actions, we took the savings of all the trainings which worked with the action we want to analyze (based on the type of training shown on the training action data sheet).



For electricity economic incentives appear to have had the most positive influence on the results of training. Second and third best were Communal engaging and removing barriers. Every action of the three most effective belongs to another method-group. The least effective actions were social pressure and competition/rewards.



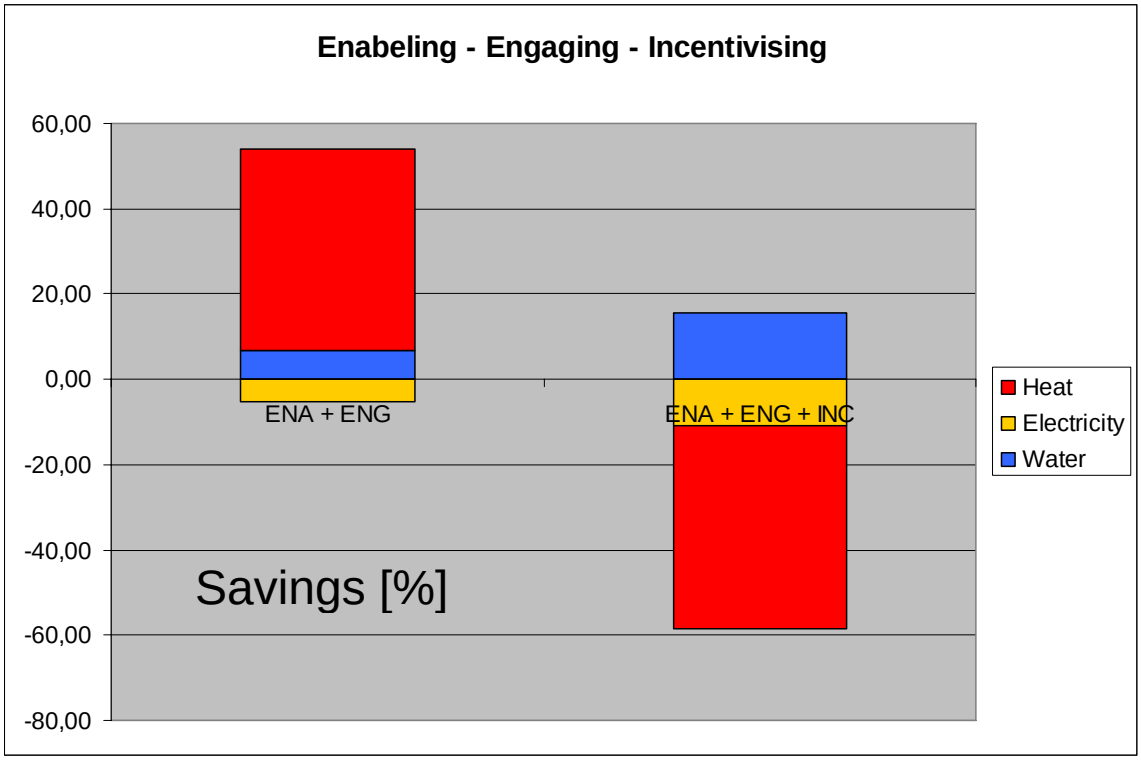
By water in general the consumption was rising. The most effective action appears to have been economic incentives, like before. Also quite effective were removing barriers and personal engagement. The least effective actions were communal engaging and social pressure.



Heat actions are not rateable exactly. In the graph above you see the measured heat savings and the heat-degree-corrected savings. The most effective action in both categories (Heat and Heat HDC) was communal engaging. Not really effective in both categories were competition/rewards, capacity building technical staff and capacity building staff/administration.

If we accumulate the effects of the different actions we see that all categories have similar effects by the same actions. Heat is not comparable because of the reasons mentioned above.

In both categories economic incentives appear to have had the largest effect on savings. Removing barriers also was important for each category. So these two actions appear to have been the most effective, which should be contained in every training session. Competition/rewards and social pressure do not appear to have been so effective. In both categories these two actions are allocated on the less effective end.



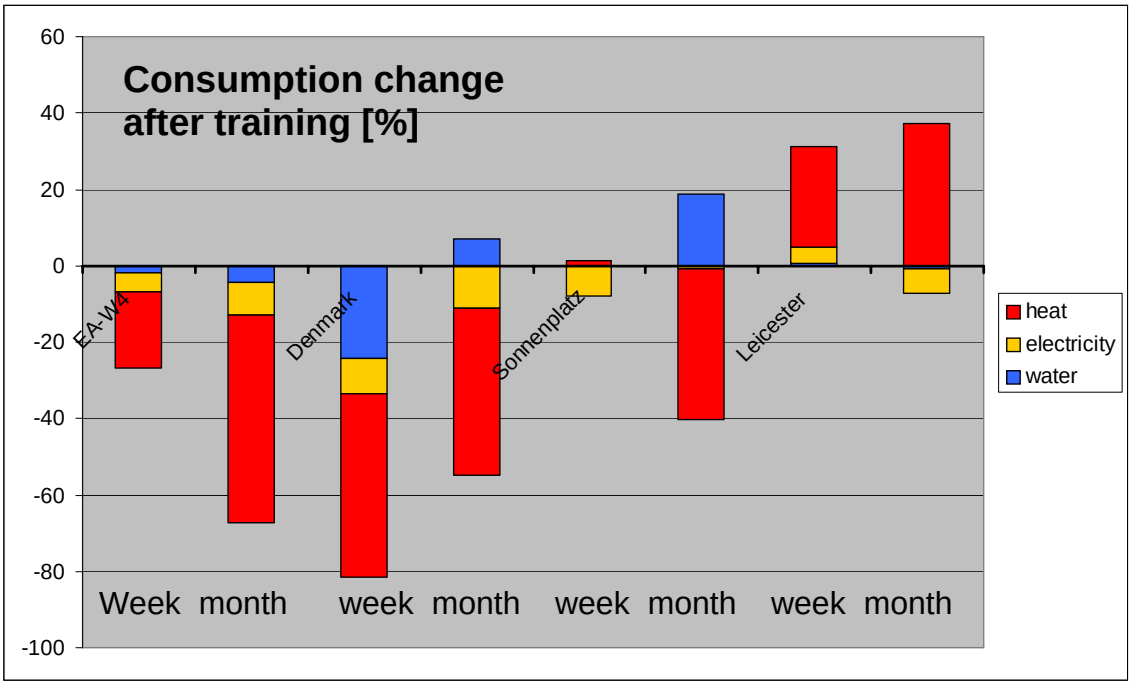
If we take a look at the methods (enabling, engaging and incentivising), we see that all our trainings in the whole project had actions out of all three methods, or out of enabling and engaging. In the graph above we see that incentivising (in an economic way) appears to have a huge impact on the results of training. The saving in electricity is five times higher then without incentivising. The savings in heat-sector are higher too, but as mentioned before that can't be taken seriously.

In electricity saving training the technical staff has not the same effect as training the others (users and administrators). The water consumption is more influenced by the technical staff.

In Denmark the relation between technical staff and the others is slightly different.

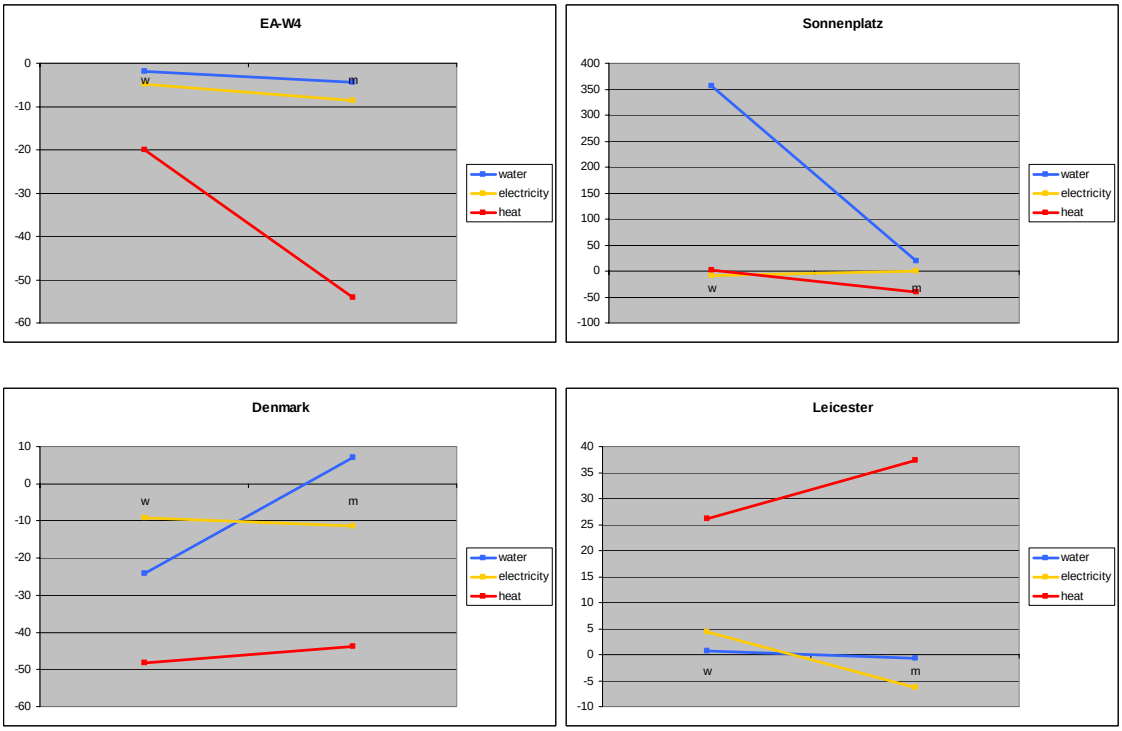
In Denmark training the technical staff is more effective in every category. Even electricity and heat consumption are declining.

In the following graph the weekly and monthly consumption changes are opposed.

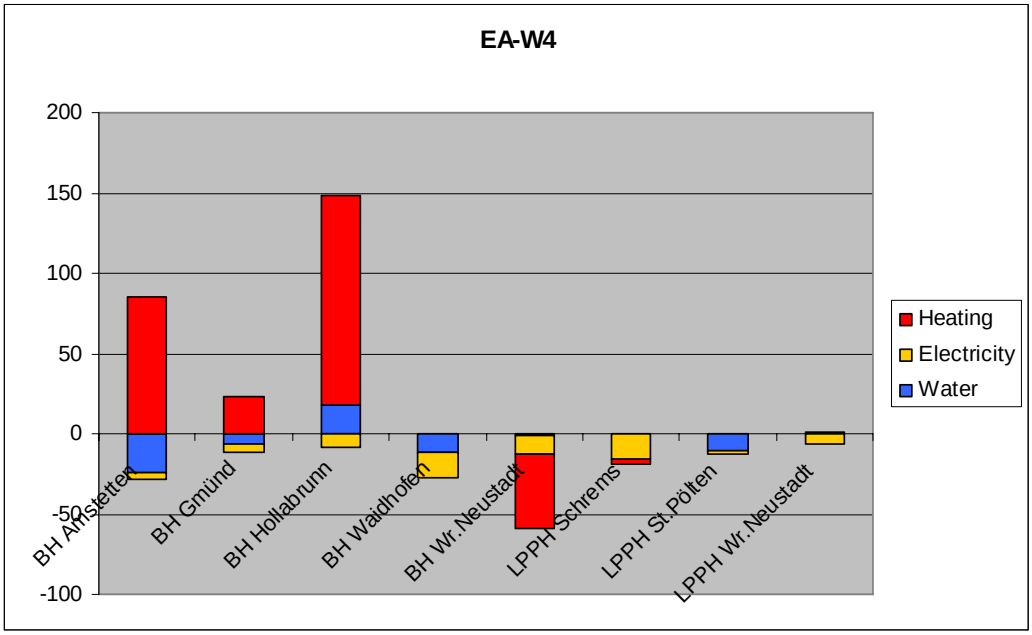


To oppose the long term effects and the short term effects (monthly, weekly), gives information about the training that can't be detected out of one value. If the weekly saving (in %) is higher than the monthly saving the potential of saving is not exploited. If it is possible to save a certain amount of energy in one week, it must be possible to save the same amount in the next week too. If the saving in the month after training is higher than the saving in the week after training the training, the measures need more than a week to show their effect.
The electricity savings of Sonnenplatz are an example for the potential that's not exploited. The water savings of Energieagentur Waldviertel (EA-W4) are a good example for the other case.

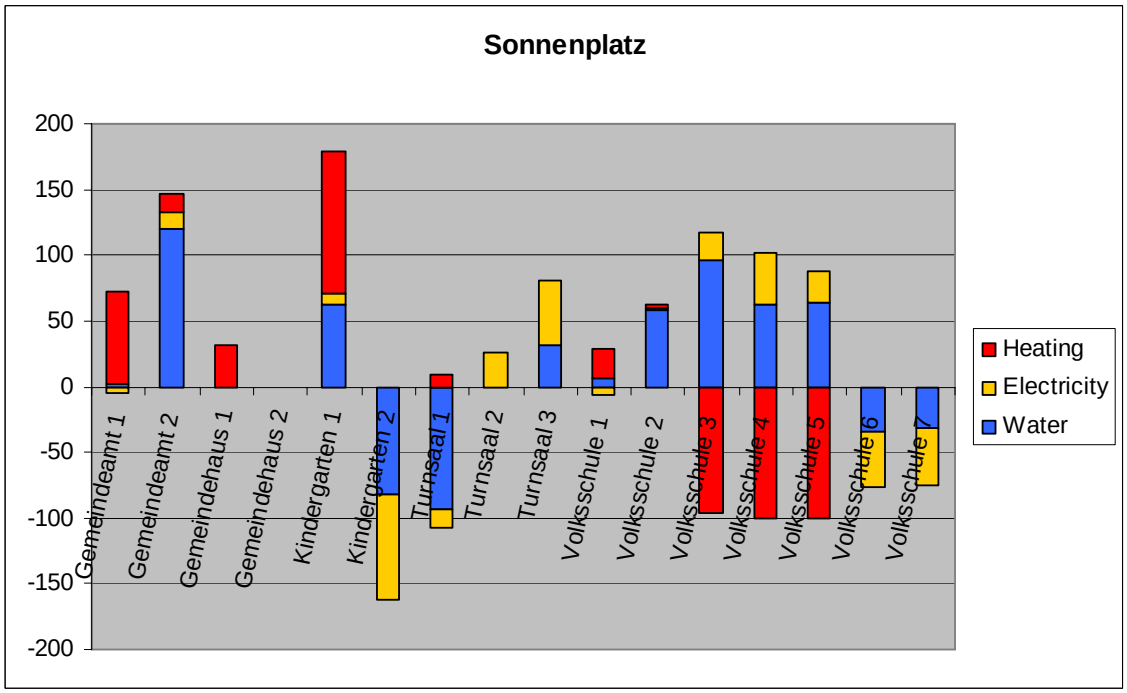
We made the following graphs to see more easily if the savings are rising or declining after the trainings of the different partners.



To show the data we worked with, we want to show the following graphs. These graphs show the savings (in %) in the different categories (electricity, water and heat) of the different objects/trainings. The values in the first graphs (Savings per object) are the average of the values we listed up here. Under the graphs are a few words about the allocation of the values, if there are many extreme variations, or if the success of training was quite constant. We never mentioned the change in energy for heating because of many reasons we noted before.

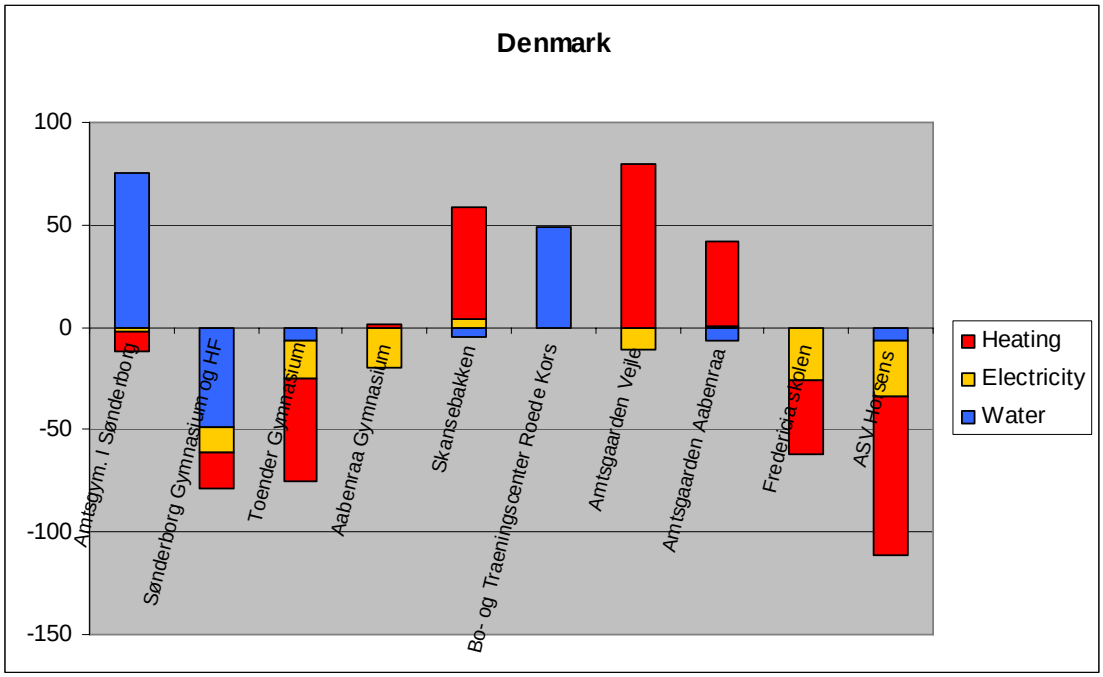


The objects/trainings of Energieagentur Waldviertel (EAW4) were very continuous. Electricity saving took place in every object. The water consumption was only rising in one object, in the other objects the water consumption was declining.

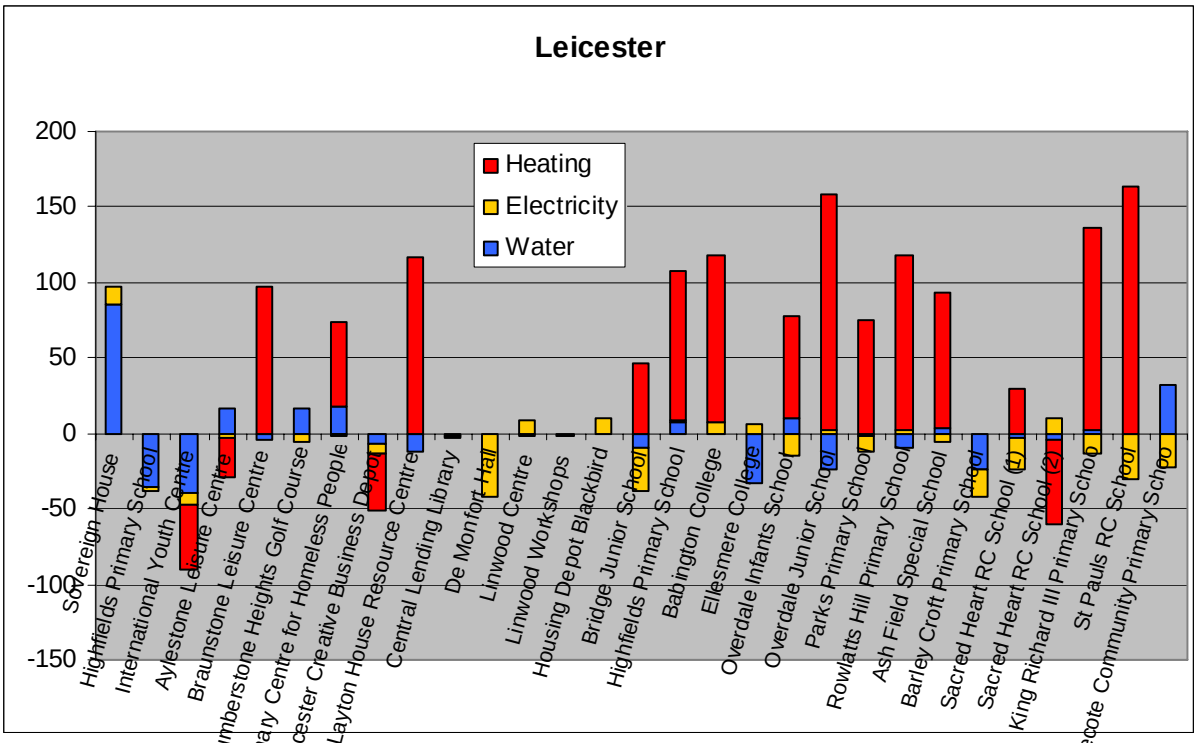


The Sonnenplatz trainings on electricity and water caused changes in both directions. Some trainings of Sonnenplatz caused huge savings, others caused big declining. Nearly at every training electricity and water consumption changes went in the same direction. Some of the trainings took place in moments of use changes, for example the beginning

or end of holidays in schools, or an event in the council building before or after the training. Such events can affect the evaluations. The time gaps between different training actions were sometimes quite short which can affect distinguishing between the actions.



Nearly every object/training needed less electricity in the month after training in Denmark. Most of the objects had a declining water-consumption either. But there are two buildings with a huge rise of water consumption which leads to an average consumption rising.



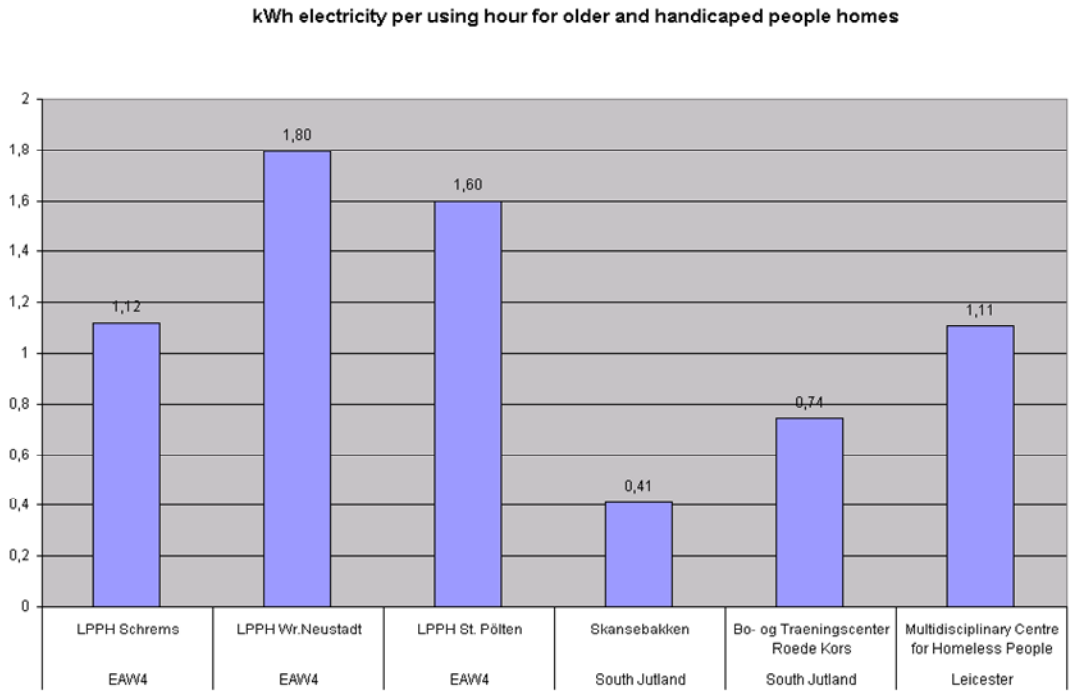
Leicester had a few huge savings in electricity, but there were more reductions than increases in consumption. The water consumption in average made no big steps but more buildings had savings in water consumption than increases, but if there wouldn't be the extreme rising of water consumption in the object "Sovereign House" the average saving would be larger.

(The heating figures in the graph are heat degree day corrected. For the 14 buildings which show an increase in heating consumption after the training 11 of these show a decrease without a heat degree correction. Several training visits were carried out around the end of the heating season or when little heating was needed in the summer and it appears that the use of a heat degree correction here has given unusual results. (For certain buildings the gas for heating was not connected to the intelligent metering system.) Comments on monitoring savings from heating are given on page 4.)

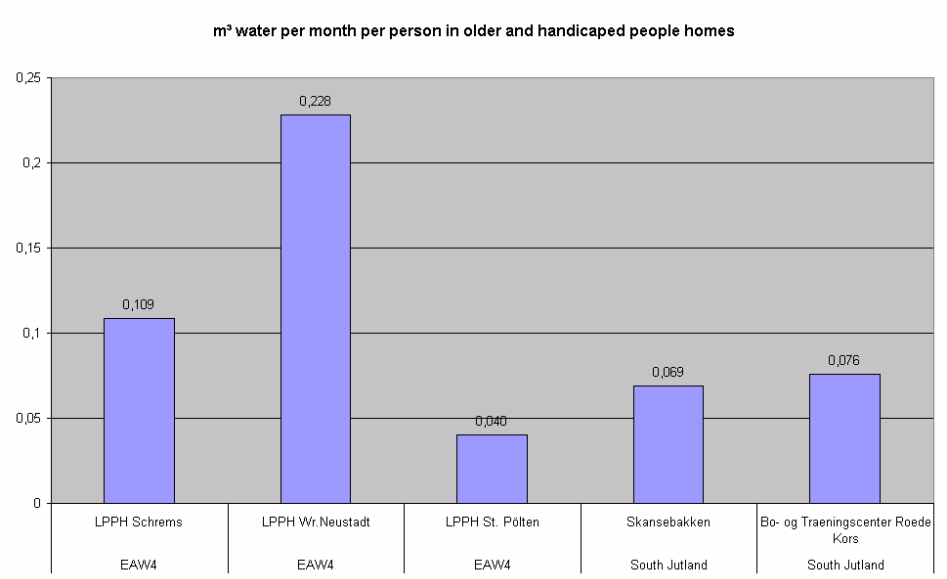
To make the objects comparable we took a look on some key-figures. For objects with the same category of use the key figures can be compared, and it's possible to take a look on the differences

We took a look at the electricity per using hour [kWh/h] and the water consumption per month, per person [m³/month/person]. For heat sector we could not use monthly key figures, because in different months the climate is not comparable.

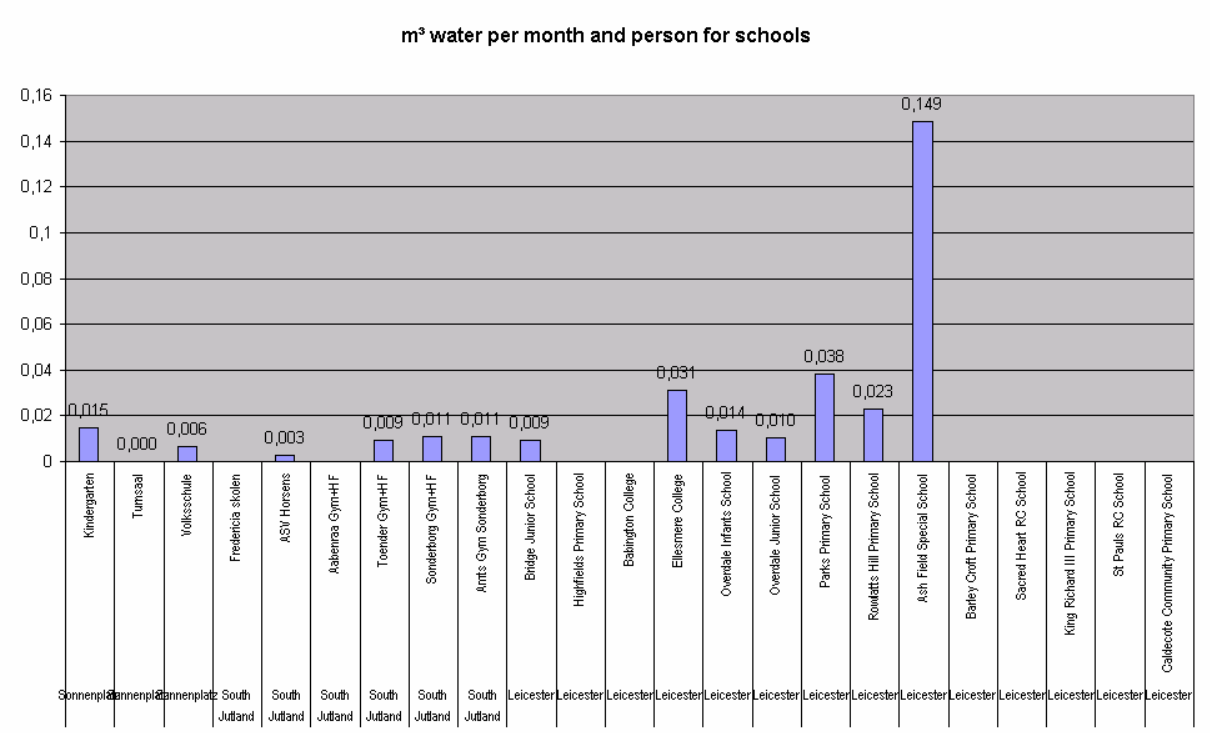
One of the categories was "homes for older and handicapped people". In this category we had six objects, three in Austria (EA-W4), two in Denmark (South Jutland) and one in England (Leicester). The other category were the schools. Here we had more objects.



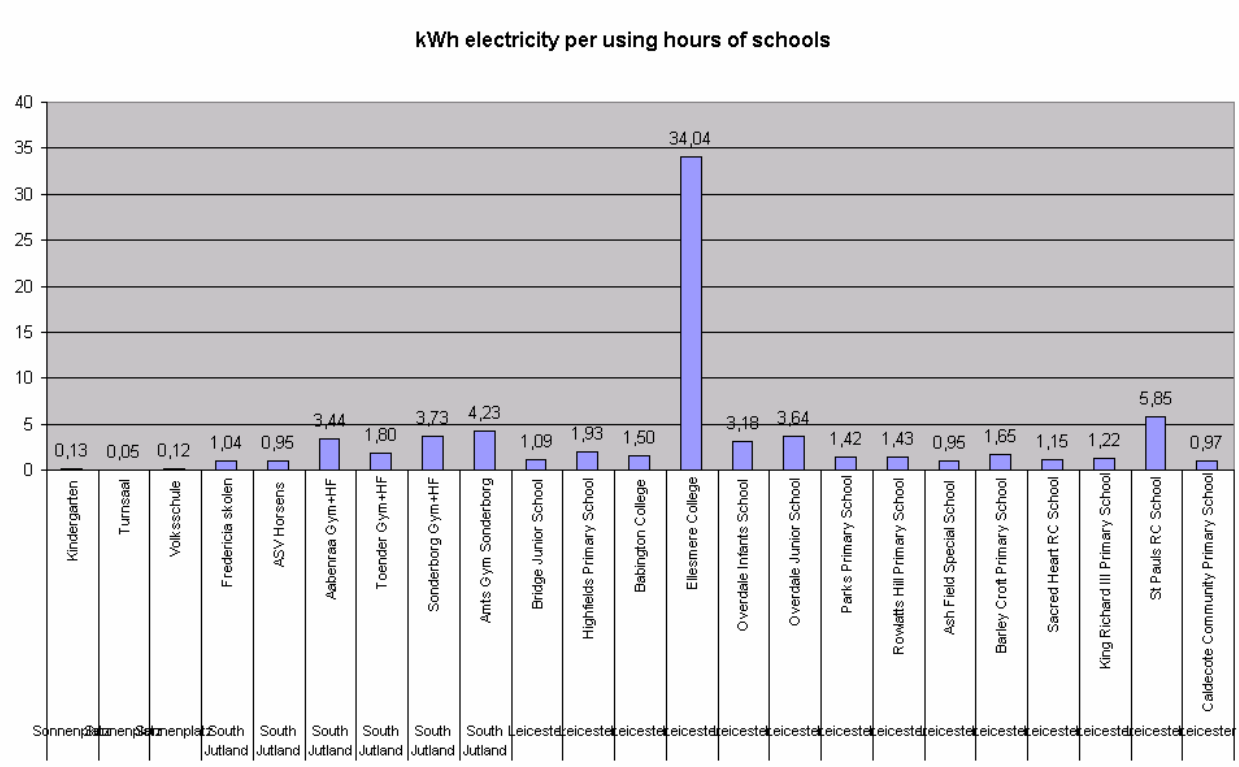
The values go from 0,41 [kWh/h] up to 1,80 [kWh/h]. The values of the Danish objects are lower (=better) then the values of the other partners.



The water consumption of “LPPH Wr. Neustadt” is five times higher than the water consumption of “LPPH St. Pölten. This shows that it would be good to take a closer look at this object.



Here by the water consumption key figures “Ash fields Special School” has a ten times higher value then the other objects. Leicester City Council’s Energy Management Team has identified a water leak from intelligent metering data and has been in contact with the school to stop the leak.



We had a lot of different school types (primary, secondary, special schools), and so it's no wonder at all that the key figures are not as close together.
In "Ellesmere College" the electricity value is extremely high. May there an error occurred in data transfer.

Reductions may be shown in their amount of energy or water, it can also be shown as a saving of money or greenhouse gases.

with inteligent metering	Electricity	Heating
savings [MWh]	56	175,8
savings [€]	7840	8790
savings [t CO2Eq]	20,4	47,6

Example of a boarding home for older people in Austria (LPPH Schrems) with savings estimated for a whole year. The savings in the heat sector were estimated with the use of Heat degree days.

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