

Pilot Projects

D4.2 Intermediate Report

City: Ejby and Sønderborg

Region: Denmark

Organisation: CLEAN

Pilot Buildings:

- Ejby Sport Hall, Ejby
- Humlehøjhallen, Sønderborg

Executive Summary

Three pilot buildings were selected as pilot buildings for this project but one has already been excluded due to lack of interest and relevance. The two buildings left represent typical construction types and energy consumptions for Danish matters. The first audits have shown potentials for energy savings and this progress will be followed.

Ejbyhallen - Ejby Sports Hall is a private owned building managed by a board and the hall inspector. Money for investments can only be found from the revenues of the hall, local contributions or in very special occasions from funding by the municipality.

The building is compact in one level and consists of one big and two smaller halls, with a heated area of 1,770 m². The energy consumption is similar to comparable buildings in Denmark related to the age and construction type; the main building is built in 1975 with extensions in 2009 and 2013. Until now all refurbishments have been related to exchange of equipment due to failure or age with no focus on energy efficiency. For the last two years this has changed, the few exchanges done have been with an awareness of the importance to choose the right energy efficient product to gain energy savings and the focus in the management team has turned to a more energy vision but lack of money exposes the big decisions.

Humlehøjhallen - Humlehøj swimming stadium is owned by the Municipality of Sønderborg and managed by a hall inspector. The funding is by the City Council itself. The Municipality of Sønderborg is involved in implementation of energy efficiency due to investment, improvements and policy (a masterplan for the municipality and ProjectZero).

The hall is split in 2 halls and 3 items - 2 dry and one wet (the swimming hall), with a total heated area of around 5,000 m². The energy consumption is similar to comparable buildings in Denmark related to the age and construction type; Hall 1 is from 1979 as the swimming hall. Hall 2 is an extension from 2010. Until upstart of this project only a few things have been done and this more for replacement/maintenance than energy efficiency. The total investment for the improvements and photovoltaic is 830,000 € in 2014/2015. This investment includes refurbishment of the roof of hall 1 (new roof and increased insulation from 150 to 400 mm), photovoltaic on the roof of hall 1, new chloride dosage system, new LED, pool covers etc. in 2014-15. All improvements have been implemented in 2015 and are all almost running properly to day.

Pilot building no. 1 - Ejby Sports Hall

1. Pilot building description

Ejby Sports Hall is one big building with a gross floor of 1,770 m².

It consists of a sports hall (1,100 m²), a fitness room (250 m²), a multi hall (330 m²) and facilities as meeting rooms, cafeteria, storage rooms and bathing facilities.

The original building is built in 1975. Extensions are made in 1986, 2009 (multi hall) and 2013 (fitness room and storage – 500 m²).

The walls are brick walls with 50-100 mm insulation. The roof is made with 75 mm insulation and waved roof plates.

Activities is: football, handball, badminton, gymnastics, dance, table tennis, meetings, conferences and fitness. Football is also played outside.



The building is heated by district heating and only the fitness center and multi hall has ventilation system. The grid supplies electricity. The artificial lightning is in the big hall fluorescent tubes (3x7x7=147 pcs. X 36 W = 5,292 W). The light in the other halls are new tubes but not LED. Hot water is supplied by district heating and stored in a hot water tank. The circulation of hot water to the bathing rooms is running 24/7.

Period of measurement: [e.g. 1 January 2013 – 31 December 2013]

Electrical Consumption: 109,528 kWh/a (including lighting)

District heating Consumption: 237 MWh/a

Water Consumption: 1,008 m³/a

1.1 Previously energy efficiency measures

Till 2009 they never thought of energy efficiency and until upstart of this project there have been done very little due to energy efficiency.

The new building (fitness centre and multi hall) has ventilation system and the light here and in the other halls are new tubes but not LED.

1.2 Renewable resources

There are no renewable energy sources in the building

1.3 Reason for choice

Ejby Sports Hall is chosen to the project because they were curios to perform better in energy efficiency and they do not have the knowledge or manpower to investigate all the good and bad subjects in energy renovations.

There is a huge potential for energy savings in Ejby Sports Hall and they represent almost half of all halls in Denmark due to opportunities and daily problems.

2. Existing Monitoring System

Monitoring system is manually. Till this project started it was a monthly reading of the energy consumption of heat, electricity and water by the hall inspector; and collection of the energy bills. The results are mainly used for control of leakages. The exciting monitoring system (ECL) installed for steering the heating system in the big hall and the hot water has not worked and are never used as a monitoring system.

From 2013 the manual readings are split between the old hall (big hall) and the new halls (fitness and multi), electricity and water consumption are for the whole building and electricity also includes the outdoor lightning of the football area.

The energy bill is send directly from the energy supplier to the hall inspector.

The yearly energy consumption from the energy bills for 2013-16 is illustrated in the graph below.

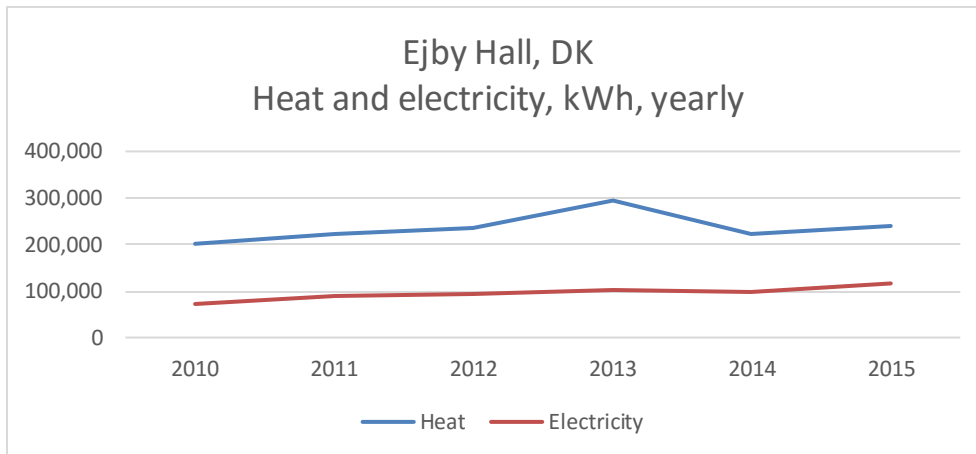


Figure 1 Heating and electricity consumption in kWh for 2013-15

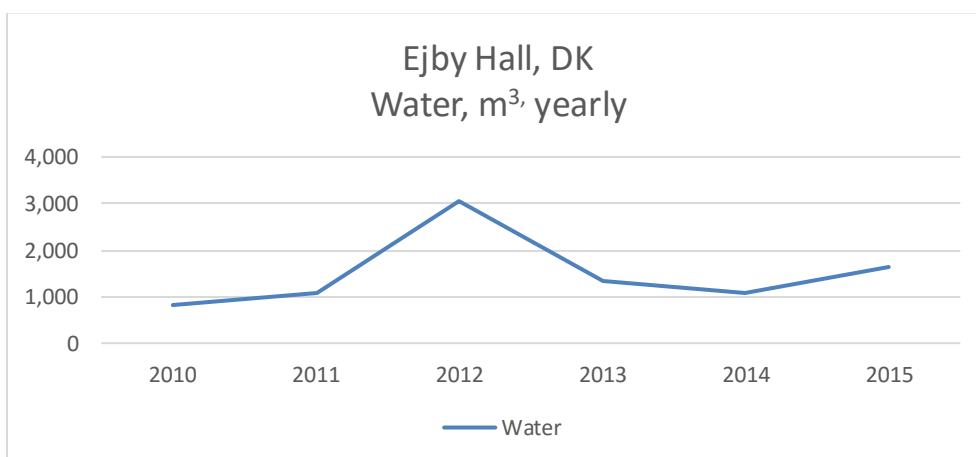


Figure 2 Water consumption in m³ for 2013-2015

The energy bill shows following prices:

Heat: 0.96 DKK/kWh in 2013 and 0.96 DKK/kWh in 2014

Electricity: 1.82 DKK/kWh in 2013 and 1.73 DKK/kWh in 2014
 Water: 11.82 DKK/m³ in 2013 and 11.03 DKK/m³ in 2014
 1 EURO = 7.6 DKK

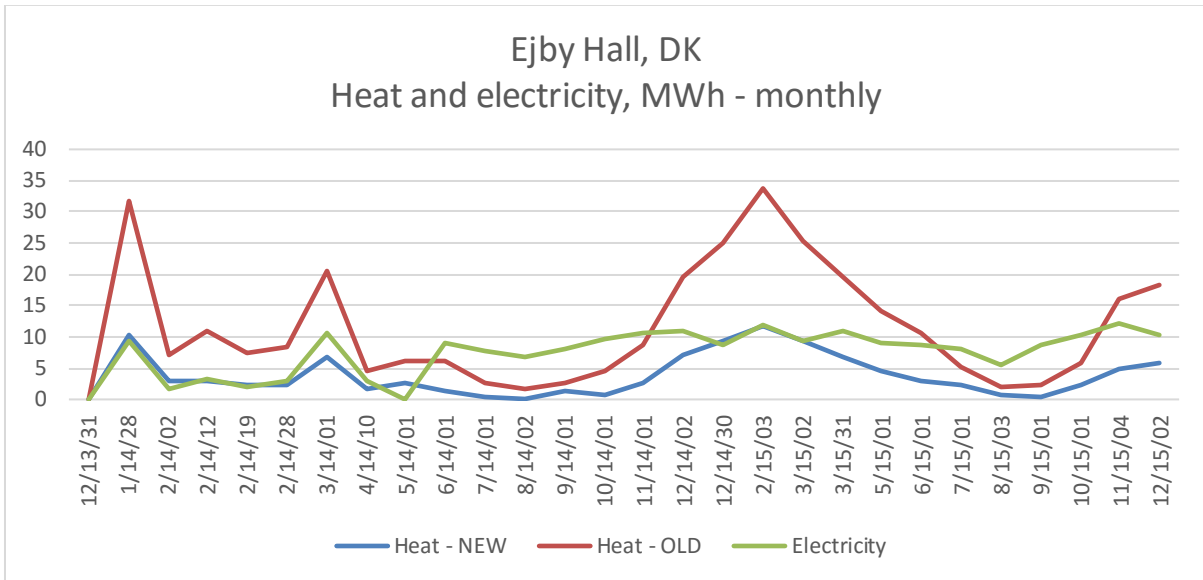


Figure 3 Heat and electricity consumption monthly measures for 2014-15

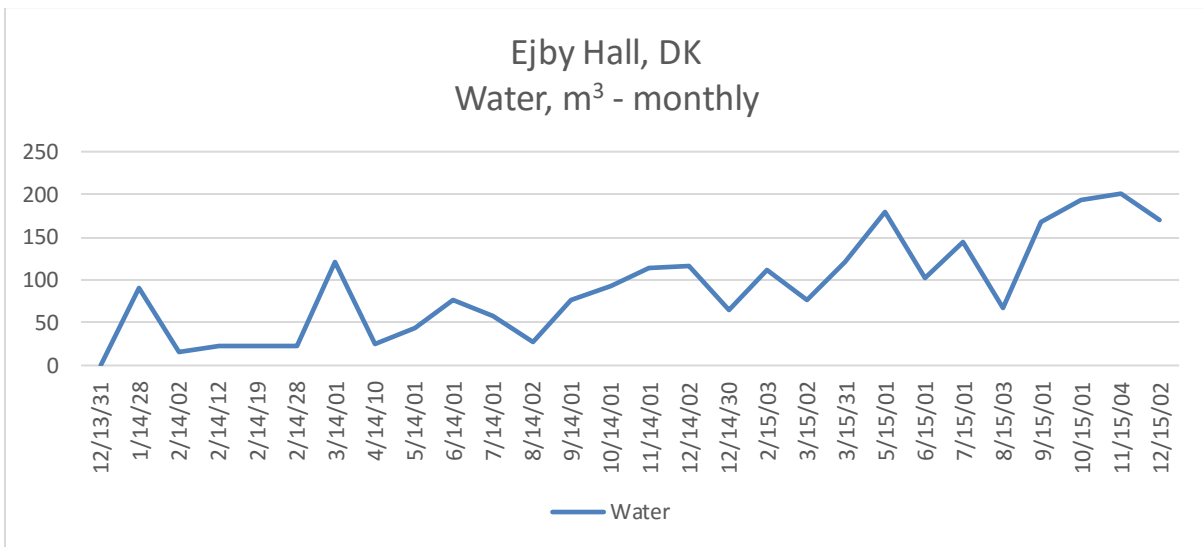


Figure 4 Water consumption monthly for 2014-15

Monthly automatic readings can be found in *Appendix A*.

3. Energy audit

The Ejby Sports Hall has not made the mandatory Energy Mark mainly because it is a private building and has not yet been through a sales process. They have not paid energy efficiency any attention until beginning of 2013.

In spring 2015 CLEAN performed an audit more or less to see and understand the situation and status of the building. Parallel to that Danfoss performed a real audit in terms of EnergyTrim where energy savings potentials was gone through. The audits show big potentials but without quantifying the potentials or taking care of the envelope of the building.

The main topics from the audits are listed below:

- Change of calorimeter (heating system)
- Change of ECL-steering
- Exchange of water hot tank
- Time management for hot water/heating

Main focus for Ejby Sports Hall is the change of the heating system in the big hall, an energy awareness campaign to start in 2016 and collecting arguments for the board to start more energy efficient refurbishments.

4. Proposed Measures

One simple solution for a start could be a **better overview of the monthly measures** compared to the outdoor temperature to give an awareness of the energy consumption over a year. Otherwise an extended solution on the ECL steering system could give a more detailed overview of where the energy is used.

For Ejby Sports Hall it seems that it has to be **small changes in the right direction** when items/systems have to be replaced/renewed; which can cause the best results – maybe an overall review of the energy consumption can give a priority list of where to start but the board and stakeholders are not there yet.

It seems to be **more arguments/results for the board** which is missing than lack of suitable measures.

Measures to be changes according to the hall inspector:

The **tank for hot water**, 1,000 litres is from 1975, the tank needs to be changed – a good solution could be a smaller tank with exchanger to secure a low return temperature.

The **ventilation** in the big hall is a static solution (naturally ventilation) with air coming directly from the outside through the end wall. When the heating system is changed the next will be to implement a ventilation system in the big hall.

The **envelope** is recognized by the time of the building year. The windows and doors to the outside cause cold areas and ventilation canals direct through the wall cause draft.

5. Stakeholders

Ejby Sports Hall is a private owned and an independent institution.

Ejby Sports Hall is daily managed by the hall inspector and the board is the highest authority. The board is represented by 9 persons – 2 from the municipality and 7 volunteers from the users of the hall (sport clubs, schools and associations). The representatives from the local area select the 7 volunteer members. As a remark it can be mentioned that sometimes it can be hard to find people for this volunteering work.

The board is responsible for the economic and thereby the investments and often it is depending on the board member's education, interest or focus how many and which kind of investments etc. it is possible to get through. For Ejby Sports Hall this means it is hard to find money for energy efficiency unless the return of investments can be calculated to below 2 years.

Money for investments can only be found from the revenues of the hall, local contributions or in very special occasions from funding by the municipality.

For Ejby Sports Hall this means that they (mainly the hall inspector) need a lot of knowledge to be able to convince the board to deal with energy efficient investments unless it is obviously needed exchanges of machinery etc. The board consists of two audits who looks at the numbers of today and therefore the hall inspector need well prepared arguments for energy saving issues to be able to argue against real numbers. On the other hand, the board has very little interest in measurement of the energy consumption – what and how to do it – unless the hall inspector manage this and tell about it.

Today the measurements are not used for this purpose. The hall inspector is not experienced in energy efficiency method, measures, products or solutions, he is depending on specialist in this subject and from this level it is hard to deal with business case analysis.

The board does know about the problems or that the energy consumption can be better (because they hear it from everywhere and because they can save money) and they do know that it can be cold inside the building, but they need money. Now the inspector hope that this project will give him knowledge, solutions, pros/cons but also arguments to deal with the board and politicians. He also participates in networks dealing with energy savings and systems where he learns about good and bad solutions and hear about results delivered.

6. Funding Methods

Ejby Sports Hall is a private company and will have to find the money for energy savings by themselves. Money for investments can only be found from the revenues of the hall, local contributions or in very special occasions from funding by the municipality. But they can get affordable loans by the municipality – to day up to 30 years and without paying interest.

Due to some discrepancies about the ownership of the ground, the municipality owns today - by a mistake - the ground where the hall is placed and it is not allowed for the municipality to give loan in buildings on their own ground. The ownership has to be transferred to the Ejby Sports Hall and this will not be possible before summer 2016, so until then they cannot get the affordable loans.

In Denmark it is also possible to get money from local investors or funding related to energy savings from national associations.

7. Business Case Analysis

Measure	Cost	Saving (yearly)	Unit (kwh/m ²)	Payback (years)	CO ₂	Sources of data
Calorifiers (Jan 2016)	€6,200,-	Appr. 50%	To be studied.	To be studied.	To be studied.	NOE Therm
	8 old calorifiers in the big hall are changed with 4 new. The heat supply for the big hall are separately measured. Figures are not yet available. NEO Therm air unit heater ATDA52-1.					
Insulation of pipes (Jan 2016)	€1,500,-	Appr. 50%	9,200 kWh	2	2,000	Mineral wool
Lightning LED + steering	€20,000,-	Appr. 50%	96,600 kWh 30,000 kWh	To be studied.	60,000	LED
	The artificial lightning in the big hall is fluorescent tube - 147 pcs. à 36 W = 5,292 W. Changing the fluorescent light in the big hall into LED light will reduce the electricity consumption remarkable. Steering will gain almost 30,000 kWh.					
Building Automation System – ECL (sept2014 +dec2015)	€1,500,-	Subject of research	To be studied	To be studied	To be studied	Danfoss
	ECL-system upgraded. The focus on the project is to research the effect on energy consumption after Building Automation System is upgraded.					
Mixing loops	€1,000,-	High	NA	To be studied.	To be studied.	
	Steering of 2 old mixing loops to be changed. Running to day 24/7.					
Circulation pump (Dec 2014)	Approximately €720,-	To be studied.	To be studied.	To be studied.	To be studied.	Grundfos
	One circulation pump for the heating system in the big hall was changed in December 2014 to a Grundfos Magna3 25-60 180 1x230VP N6/10 1.5					
Valves and circulation pumps – hot water (Sept 2014)	€2,000,-	Approximately 66-75%	Not relevant	NA	To be studied	Grundfos
	Grundfos Alpha2 20-60N 150mm A-mark – circulator pump is designed for the circulations of water in heating systems and reuse water where a high risk of corrosion is present. DanfossMSV-BD DN20 and Grundfos Alpha2 20-60 - savings min=35%					
Awareness Behaviour	€1,000,-	Point of research	Not relevant	NA	To be studied	Supplier
	Awareness of the use of energy placed in strategic places – where the energy is used – will be developed for the hall. An example could be: "If you shorten your showers we can afford new balls" etc.					
TOTAL	€34,000	11%	145,000 kWh	NA	62,000 kg	NA

Tabel 1 Electricity: 0.471 kg CO₂/kWh - Heating: 0.212 kg CO₂/kWh in Odense

8. Review of Energy Monitoring Systems

If a sport hall in Denmark has a steering system, it is a CTS steering – central state control and steering system – this include a lot of different systems (producers) to control heating and ventilation systems BUT most systems in sports halls consist only of a night-regulation or are steered by timer but all manual controlled.

PIR-sensor are used in many places to control the light BUT does not always give the best solution because the light often turns on for a longer period even if you just need to pick up a paper and there are plenty of daylight.

Example of newly used solutions in renovation of sport halls:

- LED HB Philips sports hall armature (715 lux and 4000 kelvin) with DALI steering. With activity control it gives 25 % reduction on on/off and 30% on dimming according to daylight.

9. Proposed Monitoring System

Ejby Sport Hall has a monitoring system installed for steering the heating system in the big hall and the hot water but this has never been set correct. Next step will be to change the program in the ECL-system when the new heating system will be installed in the big hall in December 2015 and connect another ECL-steering for the hot water to be able to control both systems. The communication between the ECL Comfort 310 controller and the ECL Portal uses the existing standard Internet connection (Ethernet) in the building.

One Danfoss ECL-steering control cost around 5,500 DKK (750€) for one string.

The Danfoss ECL Portal is an effective turnkey SCADA tool for service personnel of district energy stations to streamline service, commissioning, maintenance and control tasks.

The ECL Portal provide:

- Increase long-term system performance
- Gain a higher level of awareness and transparency of the energy consumption
- Improve service level and reduce response time to alarms
- Do troubleshooting without having to visit the heating system

The ECL Comfort 310 offers state-of-the-art options for communication interfaces. The range of options, available either built-in or with extension modules, includes Internet (Ethernet), Modbus, M-Bus, and USB for service purposes.

10. Implementation Plan

The new heating system in Hall 1 with change of 8 calorimeters will be implemented in November/December 2015.

Awareness/behaviour campaign will be developed by CLEAN and implemented late 2016 if it fit the management.

Change of ECL-steering and exchange of water hot tank and time management for hot water/heating will need to be explored deeper and arguments for the board to start more energy efficient refurbishments.

Pilot building no. 2 - Humlehøjhallen, Sønderborg

1. Pilot building description

Humlehøj stadium is two big buildings – Hall 1 including swimming hall and Hall 2. Total gross floor around 5,000 m².

Hall 1 is built in 1979 in 2-3 floors. Hall 1 (1.100 m²), swimming hall (1.100 m²) and the rest around 2,200 m². The swimming stadium consist of three pools: The main pool is 15x25m, 1,040 m³, the playing pool is 15x10m, 150 m³, and the hot water pool for babies is 5x5 m, 11 m³. Hall 2 from 2010 at 1,410 m².

The buildings are constructed of brick walls with insulation and with 150-200 mm insulation on the roof.

Activities are: handball, football, badminton, swimming, gymnastics, clamping wall, table tennis, archery, wrestling, shooting, meetings, cafeteria, bathing facilities etc. and outdoor activities.



The halls are heated by district heating with heat exchanger and a hot water tank. The ventilation system is supplied with cross flow heat exchanger. The grid supplies electricity. The artificial lightning is T8 58W x 90 = 5,220 W. A photovoltaic system is installed on the roof. The net supplies cold water; which is heated in a hot water tank.

Period of measurement: [e.g. 1 January 2013 – 31 December 2013]

Electrical Consumption: 360,000 kWh/a (including lighting)
 District heating Consumption: 1,257 MWh/a
 Water Consumption: 10,500 m³/a

1.2 Previously energy efficiency measures

Until upstart of this project only a few thing has been done and this more for replacement/maintenance than energy efficiency. From 2010-12 the focus became more on energy and energy efficiency

- Toilets have been changed to 4-liter flush
- Circulation pumps changes for hot water and heating
- Lights in hall 1 was changed to energy efficient types - T8

In 2013 the swimming hall was out of order for maintenance for 4 months.

1.3 Renewable resources

1.2 MW (800 m²) photovoltaic are installed on hall 1 in 2015.

1.4 Reason for choice

The building is chosen for the project because the building is part of a community (Sønderborg Kommune) with high ambitions of energy efficiency. The community has been frontrunners for refurbish and new building of low energy single-family houses and larger building.

In the budget 2014-15 there will be totally invested 830,000 € in refurbishment of the roof of hall 1 (new roof and increased insulation from 150 to 400 mm), photovoltaic on the roof of hall 1, new chloride dosage system, new LED, pool covers etc. All improvements will be implemented in 2015.

There are no recommendations or no plan for further investments.

2. Existing Monitoring System

Manual management is used. There is a BMS system for all the buildings at the location. The three stadiums have a sub meter for water, heat and electricity.

The awareness of the improvements and measurements seems to move the focus to a more energy efficient thinking. A lot of smart gears for collecting the energy numbers and using them for optimize the systems and be aware of unfortunate situations are still lacking.

In general, the management has lack of time/interest to collect knowledge of standards and updates. Today they are accurate enough employed to handle the work. The people are skilled and get the needed education internal and external. It is assumed that it takes 4 years to be familiar with all the systems. The environment has top priority.

It can be hard to find craftsmen for improving or changing systems or building components –at the right time and for the right job. They use normally three external energy consultants for advises.

The yearly energy consumption from the energy bills for 2013-16 is illustrated in the graph below.

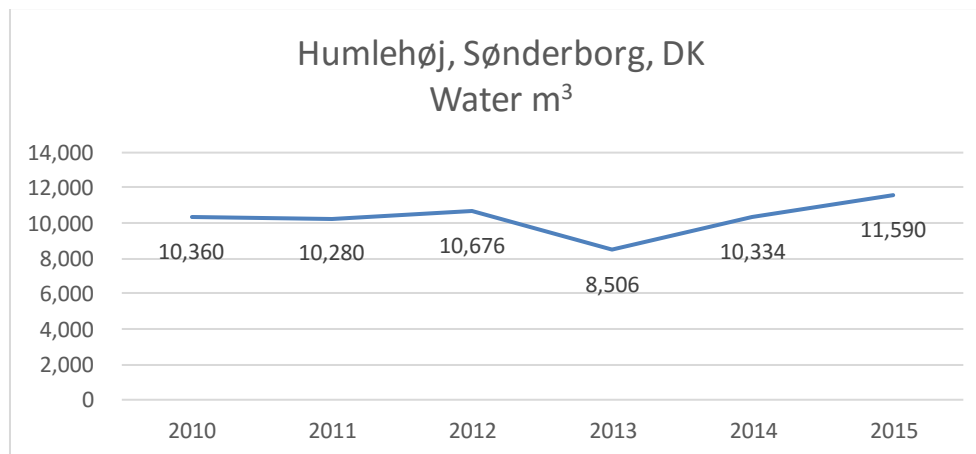


Figure 5 Water consumption in m³ for 2010-2015

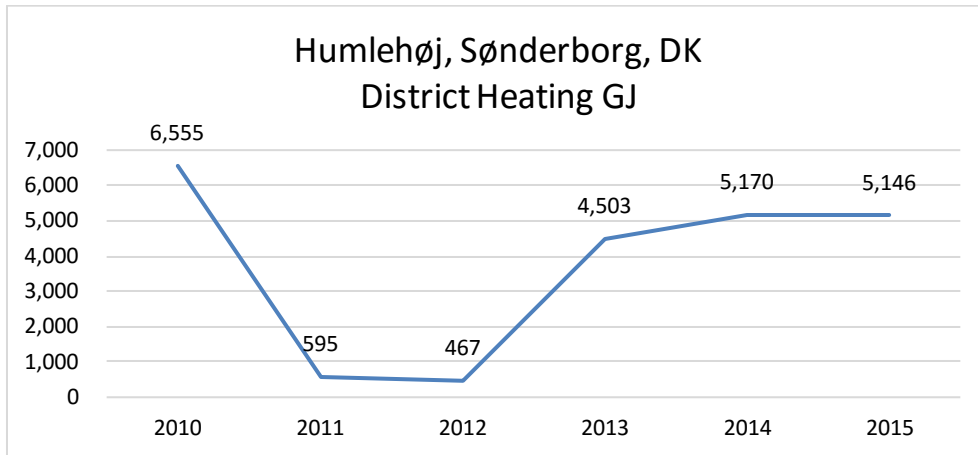


Figure 6 Heat consumption in GJ - numbers from 2011 and 2012 are not valid due to new measure

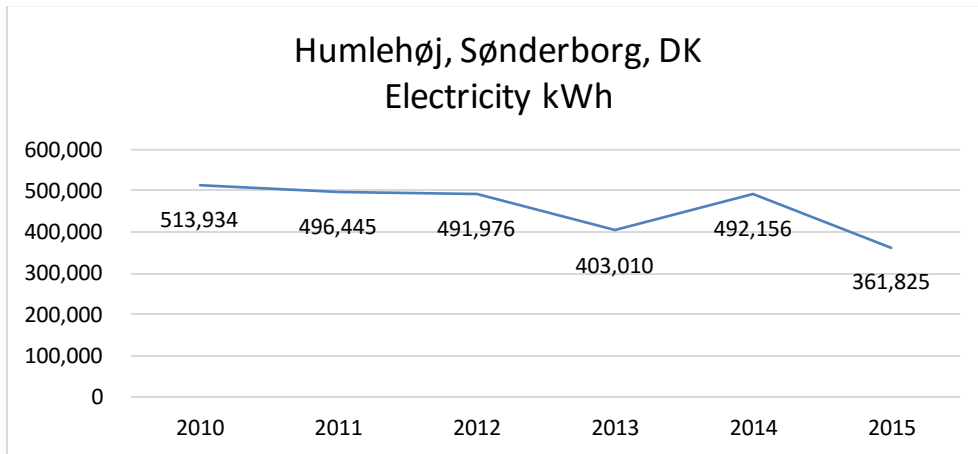


Figure 7 Electricity consumption in kWh for 2010-2015

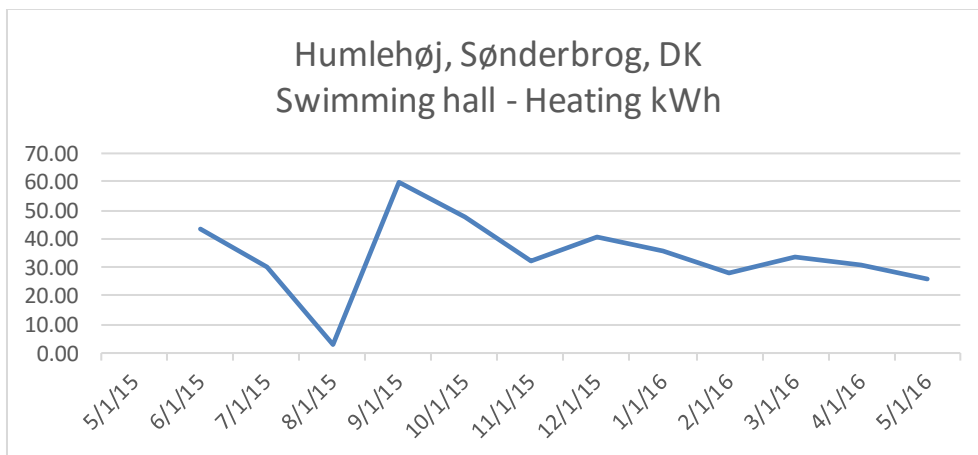


Figure 8 Heating consumption in the swimming hall after mounting of thermal carpets – numbers are not yet final verified

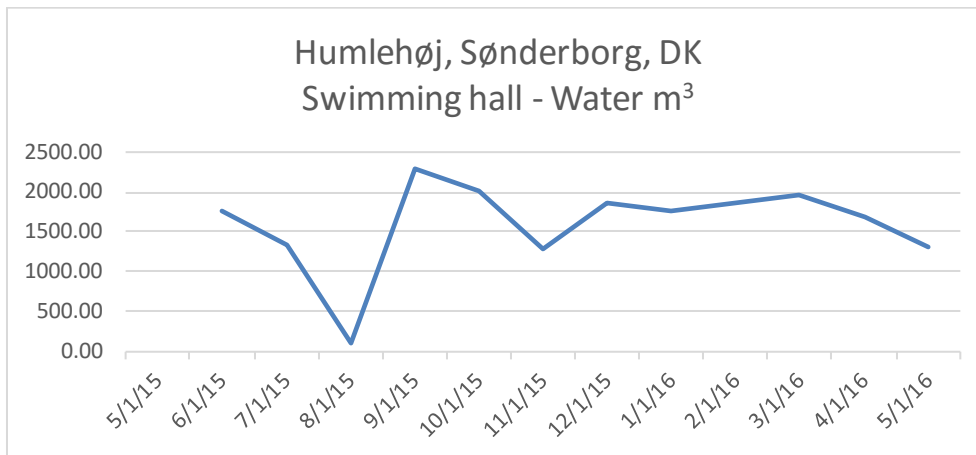


Figure 9 Water consumption in the swimming hall after thermal carpets - numbers are not yet final verified

3. Energy audit

The audit done in 2015 by CLEAN was a visual walk around on the stadium together with the responsible inspector. The trip is recorded as a sound file in Danish. In May 2016 a status for the progress was made.

The energy consumption in general is described as reasonable compared to similar buildings. The management are followers, they wait and see and hear what other have done and which results they reach, before they do changes. In daily life they trim and optimise the systems but there are room for more. They are not in front.

4. Proposed Measures

A lot of ideas and solutions are coming from the management and the interest about the energy topics are increased.

Improvements and awareness could **lower the return temperature of district heating** when it is send back to the district heating system. This gives a big potential for both consumption and saving money. In Denmark most district heating companies have a fee related to the ability to cool down the temperature of the returning district heating, this cooling is often a matter of awareness more than a system which do the progress.

Better waste management.

Water handling system. A new system could clean the exchanged water by 80% to clean drinking water which can be reused with a buffer tank – the investment is 100,000 € with a payback time at 5 years but this is not an option to day.

Change toilet and install touch free faucets (armatures).

LED everywhere.

Ventilation system with recovery will improve the energy consumption a lot.

5. Stakeholders

The stakeholder is the Municipality of Sønderborg, the owner of the Humlehøjhallen. The municipality of Sønderborg has 17 halls whereof 3 are owned by the municipality.

The daily management is handled by a Hall Inspector. There is a direct communication between both partners on organisation level.

The Municipality of Sønderborg are involved in implementation of energy efficiency due to investment, improvements and policy (a masterplan for the municipality and ProjectZero).

6. Funding Methods

The funding is by the Municipality of Sønderborg.


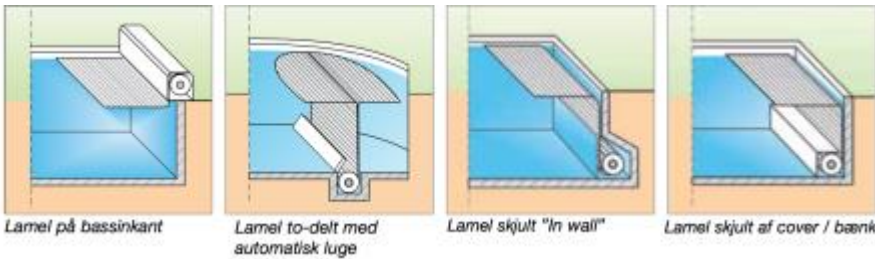
All investments have to be a part of the budget together with all other buildings in the community; this means that you have a long-term investment program and a supplementary appropriation when something need to be done or breaks down.

Till 2010 investment was totally for sports halls 85 mio. DKK. This has since 2012 been decreased to 25 mio. DKK. The payback-time has in same period changed from 20 to 10 years.

The energy companies might also help funding it by energy savings.

A lot of improvement has already been done or are to be done in Humlehøjhallen as part of an investment plan agreed by the Sønderborg Municipality – most of the agreed improvements have a pay-back time of 3-5 years and now it will be interesting to see if the improvements can be measured in the energy consumption over the next period.

7. Business Case Analysis

Measure	Cost	Saving (yearly)	Unit (kWh/m ²)	Payback (years)	CO ₂	Sources of data
Water handling system – anti-legionella (2015) (Trial 2013-4)	€12,500,-	Appr. 50%	NA	NA	NA	Danish Clean Water (DCW)
<p>Anti-legionella water handling system for all DHW. The process adds chloride (0,5ppm) which lower the amount of needed disinfection liquid but most important, makes it possible to decrease the temperature in the tanks and inlets as well. T_i -> T_o = 67 -> 55 is changed to 55 -> 48 degrees without legionella problems. The users are not informed about the chloride in the bathing water but non claims are received either.</p>						
Roof on Hall 1 (2014)	Included in €830,000	Appr. 40%	20,000 kWh/a	NA	3.800	
Insulation increased from 150 to 400 mm. Almost 10 kWh/m ² a.						
LED in walking area (2014)	Included in €830,000	Appr.	NA	NA	NA	
Thermal carpets (pool cover) (sum 2015)	€ 100,000,-	30% inside/ 60% outside	NA – depending on m ³ and m ² Calculated to appr. 220,000 kWh	3-5 years	To be studied	Processing Group
<p>Procover 6 mm with self-expelling flow forefront. Fixed in the ceiling. Automatic for the big pools from sum2015 – for the small pool from feb2016 until then it was not used.</p> <ul style="list-style-type: none"> - Main pool is 15x25m, 1,040 m³, saving 135,583 kWh/a - Playing pool: 15x10m, 150 m³ saving 63,190 kWh/a - Hot water pool for babies: 5x5 m, 11 m³, saving 19,080 kWh/a <p>Reduced also the use of disinfection.</p>						
						
Heating and hot water (20??)	€100,000,-	Subject of research	To be studied	5 years	To be studied	
Photovoltaic on Hall 1 (2015)	€170,000,-	Appr. %	Not relevant	NA	To be studied	Phønix
800 m ² = 1.2 MW						
LED lightning Swimming hall (sum 2015)	€30,000,-	Appr. 66-75%	32,000	10.2 years	0.429/kWh 13,690 kg	Natures LUX
<p>Hard to find lightning; which could handle the strong environment in a swimming area with chloride and hydrochloric acid in the air. Warranty 10 years. Changed from T8 58W x 90 = 5,220 W to IP67</p>						
Chloride production 13% -> 2%	Included in €830,000	NA	NA	NA	NA	
Tubes changed to LED panels (2015)	Included in €830,000	Appr.	20,000 kWh/a	NA	9,500	

New pump Swimming hall (sum 2016)	€12,000,-	Appr. 20%	NA	NA	To be studied	Grundfos
	Grundfos TP150-170-4-50Hz					
Steering of light (2016)	?	Appr.	NA	NA	To be studied	NA
	TURN ON is set manual and TURN OFF is automatically after 15. minutes					
TOTAL	€830,000	11%	292,000 kWh	NA	61,750 kg	NA

Tabel 2 Electricity: 0.471 kg CO₂/kWh - Heating: 0.190 kg CO₂/kWh in Sønderborg

The total investment for the improvements and photovoltaic is 830,000 € in 2014/2015. This investment includes refurbishment of the roof of hall 1 (new roof and increased insulation from 150 to 400 mm), photovoltaic on the roof of hall 1, new chloride dosage system, new LED, pool cover etc. in 2014-15. All improvements have been implemented in 2015 and are all almost running properly to day.

8. Review of Energy Monitoring Systems

The inspector has got additionally money (80,000€) for maintenance; this will be used for optimisation of the management system of the pools. This money and projects have not yet been planned.

9. Proposed Monitoring System

In general, the focus on energy efficiency has turned the inspector and his people in a more aware position of reading and following the consumptions BUT the systems are not talking together. This means that a lot of useful information is not used.

Today the management has to read and/or collect the numbers of energy consumption and type it into an excel sheet – what the numbers are used for depends on the persons sitting behind the computer.

An understanding of necessary reading can also be considered.

10. Implementation Plan

The inspector has got additionally money (80,000€) for maintenance; this will be used for optimisation of the management system of the pools. This money and projects have not yet been planned.

Touch free armature is considered.

Reuse of washing water is considered. Today the water is changed twice a week (2x30 m³) through a sand filter. Experiences from UFOX - 'Processing Group' shows it is possible to reuse 70% of the washing water. Investment: 100-120,000€.

CLEAN is offering control of the ventilation system by external consultancy.

11. Conclusion

The awareness of the improvements and measurements seems to move the focus to a more energy efficient thinking. A lot of ideas and solutions are coming from the management and the interest about the energy topics are increased. A lot of smart gears for collecting the energy numbers and using them for optimize the systems and be aware of unfortunate situations are still lacking.

A lot of improvement has been done –especially in Humlehøjhallen – and now it is interesting to see if the improvements can be measured in the energy consumption over the next period.