Property name: Tampere Hall
Property owner: The City of Tampere
Consultants: Bionova Ltd

Total Concept method

Step 1. Creating the action package

Building and its use

Year built: 1990
Area: 28 357 m² Heated area
Type of building: Congress and concert centre

Tampere Hall is a congress and concert entre located in the city centre of Tampere, Finland. A venue for congresses, fairs and concerts, it hosts a restaurant, a café and cultural facilities for theatre, exhibitions… It was built in 1990 and is since then the largest congress centre in northern Europe with over 28.000 m2. Virtually all of the building's surface is considered to be heated, apart from ventilation engine rooms. Shortly after the building's completion, an adjacent hall was built, the Sorsapuisto hall (areas 10 and 11). In 2005, the Sorsapuisto hall was connected to the main building with a glass tunnel (area 9).

An extension between Sorsapuisto hall and the main building will be built in 2015. During the renovation a museum (Muumilaakso) will move to the building. The facilities currently used by Rondo and Studio in the basement and first floor totaling 1020 m2 will be renovated for the museum. According to the demands related to galleries the museum requires special facilities with an extensive automated, mechanical ventilation in order to control humidity and temperature. Additional facilities are also created by adding a 800 m2 multi-purpose area and by constructing an intermediate floor to restaurant Soolo in order to increase the restaurant area in the second floor. Dressing and backstage areas will also be realized in the small hall during the changes in the building use. Additional office spaces are also to be constructed..

The building is currently used as congress and fair centre and as a music concert and rehearsal hall. Lectures and theatre plays also happen there. There is also a restaurant and a café open to the public during the working hours of the centre. In the future, a permanent museum and a new restaurant will open in the ground floor. All these different activities imply that the use of the premises varies a lot and the schedule of the lighting and ventilation are very difficult to model for an average use without very precise monitoring.

Indoor climate

For the moment, the indoor climate is satisfying in the building. In the winter, warm masses of air escape the ground level towards the higher levels of the main lobby, and this causes draft as well as important energy losses to replace the warm air downstairs. In the summer, the indoor air in the southern wing gets hot, while the basement has to be heated. Inside the conference and concert halls, working environment standard conditions and comfort requirements are guaranteed for the workers and the visitors. The building's cooling system has been improved by switching to district cooling in 2014.

The status of the building and its technical systems before measures

Building envelope

The building envelope is original from the respective building year (1990, 1992, 2005). The walls are concrete sandwich walls with mineral wool (125 to 175 mm) thermal insulation in the core. The facade is ceramic brick, glass and Kuru granite. The roof structure is mainly made of hollow core slabs with expanded polystyrene thermal

insulation and bitumen finish. Windows display a wide scope of variations (glass walls, fixed/open windows, aluminium/wood framed windows).

The building envelope is protected by the Finnish National Board of Antiquities, so changes to the structure and to the outside appearance are impossible. The envelope is also of good condition. Due to this reason the main focus was on the windows for which the improvements would be possible without interfering with the protected appearance.

Ventilation

The ventilation devices are mostly original ones. 119 devices are distributed along 10 ventilation circuits leading to different areas of the centre. The system works with variable air flows. Only 5 devices are fitted with a heat recovery unit. The ventilation system fulfils the current requirements but is nearing the end of its service time. Concepts for renewing the system have been drafted but not implemented yet.

The ventilation is manually controlled by timing it to operate according to planned use/events in the building. Due to this reason there is no regularity in the use times as they depend on the events and use of the facilities each year.

Heating

The building uses the district heating network to heat the premises. All areas are heated by hydronic radiators and warm supply air. The heating system is original from the construction. In the large building the heating/cooling requirements can differ between spaces and thus the building might be heated and cooled at the same time.

Cooling

Until the summer of 2014, the centre was cooled by two electrical cooling units. They were shut down when the building was connected to the district cooling system. When switching to district cooling no changes were made to the cooling radiators but the system was created by lowering the temperature of the district heating with a booster pump when necessary. The kitchen, the café and the restaurant have their own electrical cooling equipment (fridges, freezers …).

Lighting

The lighting system is the one that has changed the most since the construction of the building. About 70 % of the 5700 lamps have been changed to LED-lights in the past years and this change is still ongoing. In the concert halls, precise lighting requirement and design conditions have made the switch to LED impossible until recently. A suitable model was found and changed is now planned in both concert halls.

For the moment, there is no automatic control of the lights in the building. Many lights stay on all day in storage rooms, toilets, hallways etc. The installation of motion detector lighting is complicated by the lights switching off when people are in the facility.

Equipment

The electrical equipment is very varied, ranging from coffee machines to sound amplification installations. It is difficult to assess the exact consumption of each device or even of groups of devices because there is no submetering in place. The kitchen holds a list of all its devices, be their usage is complicated to model since the activity varies greatly according to the number of workers, musicians and visitors in the centre.

Water supply and warm water

The building is connected to the city's water supply network and water consumption is documented by the maintenance crew. Metering was included for hot water use during summer 2014. Based on the estimates of the building users approximately 35 % of the water is heated. The water is heated using district heating.

20 % of the faucets in the building have been replaced with electonic ones. Flow limiters have been installed to the remaining 80 % during spring 2013.

Control and monitoring system(s)

The ventilation, heating and electric systems are monitored in real time using a computer software of Schneider Electric. The HVAC is manually driven and rescheduled daily on the grounds of the upcoming activities in the centre. There are no automatic controls of the ventilation and heating system. Technicians have to operate the

system to cool down or warm up the premises. Monthly statistics and maintenance schedule are stored on the facility maintenance web portal of the centre. Only the total electricity and district heating consumption of the entire building are metered. There is no submetering at the moment.

Energy and resource use before measures

Consumption measured in 2013:

The total district heat consumption in 2013 was 3050 MWh (heating 2930 MWh and warm water 130 MWh). Measuring related erros have been corrected by Tampere hall Ltd. The information related to district heating has been weather-corrected.

The measured results for 2013 and 2014 do not represent the current consumption as technical changes have been ongoing. District cooling was installed into the building in the summer of 2014 and was implemented in October. During the implementation the settings of the booster pump did not work as planned which caused increased electricity consumption in the subsequent months (September-October). This has been fixed, however the electricity consumption measured for 2014 could not be utilized in estimating the post-implementation consumption. In addition, TK62 was replaced in August. There has also been other changes in 2014; flow limiters have been installed in faucets and showers, few waterless urinals have been installed and the number of LED lighst have been increased.

The change in the building's use also affected the evaluation of the energy and resource use. During the renovation the purpose of use will partly be changed into museum which causes tightened demands for the ventilation. Because the equipment need to be replaced due to the changed purpose of use, their replacement with minimum requirement ventilation equipment has been included in the new energy consumption baseline. The equipment would be installed with coil heat exchangers fulfilling the yearly efficiency of 45 % required by legislation and a system with an SFP-value of at least 2 kW/m3/s.

Calculated baseline of energy consumption (including the changes of 2014 as well as the change in use) before presented measures:

Specific energy use before measures	176 kWh/m²,Vuosi
From which	
Heat energy	108 kWh/m²,Vuosi
Electricity	72 kWh/m²,Vuosi
District cooling	10 kWh/m²,Vuosi
Water consumption	6230 m3

The electricity use for ventilation purposes was extrapolated from the nominal consumption of the 50 biggest ventilation devices. This gives a total electricity consumption of 950 MWh or 33 kWh/m2 in 2013.

The electricity consumption of the lighting was computed based on estimated utilization profiles and energy profiles of each lamp type. The result is 630 MWh, or 22 kWh/m2.

The electrical consumption of the restaurant is based on the average electrical consumption of a restaurant per square meter according to RakMK 2013. The electrical consumption of the restaurant is 140 MWh or 5 kWh/m2.

Because of the amount of the user equipment and the changing use profiles, the electricity consumption of the equipment could not be calculated reliably. Therefore it was roughly estimated based on other known electricity consumptions and average consumption of commercial buildings. The electricity consumption of the equipment was calculated to be 340 MWh per year or 12 kWh/m2.

District cooling was estimated based on realized values of August, September and October of 2014. The impact of the booster pump on the total electricity consumption of the cooling system was not separated. This is due to

the fact that the electricity consumption of the booster pump will depend on the control method and its impact on the total consumption was estimated to be minor. Total district cooling was 290 MWh.

Information concerning water consumption was delivered by Tampere hall Ltd based on their own follow-up. Total water consumption in 2013 was 6306 m3 and 29 litres per visitor or 35 litres per userday. On the other hand, the consumption is affected by the flow limiters installed during spring 2014. This was estimated to affect the consumption by approximately 15 %. Metered data for the warm water was not yet available, but based on information from the building's maintenance and few metering results from spring 2014, the warm water consumption was estimated to be 35 % of the total water consumption. Based on this, the calculated baseline waterconsumption is 6230 m3 per year.

Identified energy saving measures

Structural renovations are restricted by the protection of the building as well as its architecture. On the other hand the building's structures are in good condition due to which related renovations are not necessary. From the structural changes mainly the ones in the vicinity of the extension were included in the package as the ongoing renovation can reduce their cost and on the other hand enable the implementation considering the use of the building.

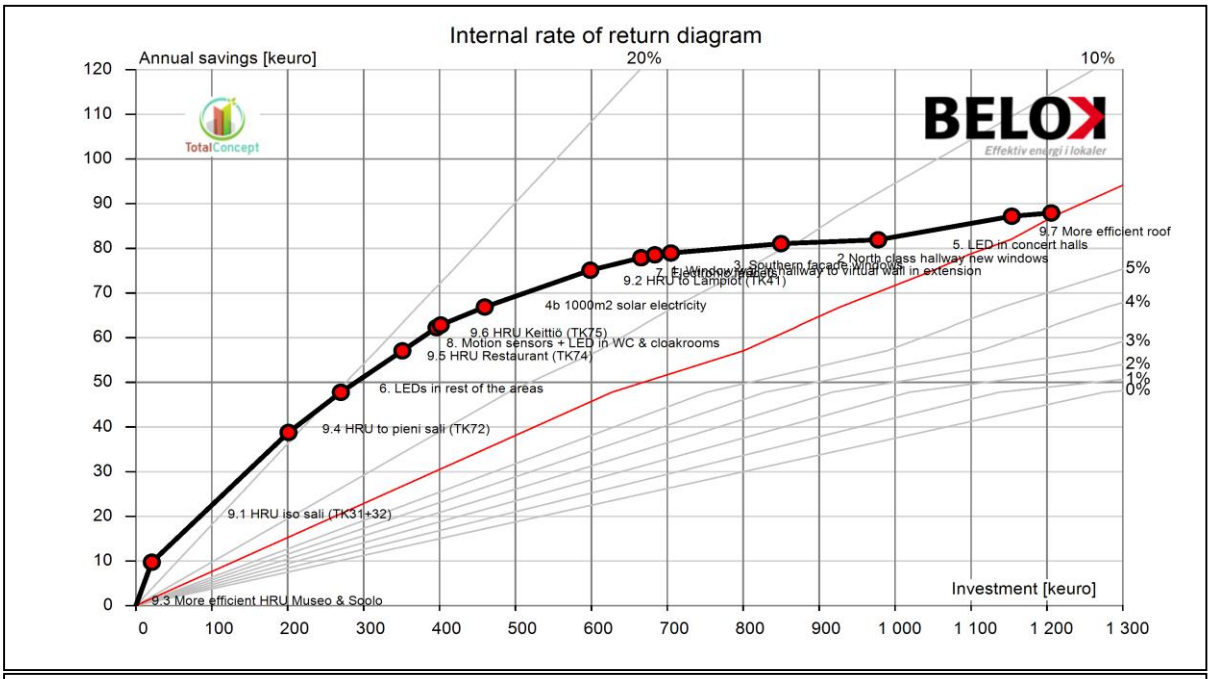
The Tampere Hall has invested in improving the lighting and the measures related to lighting play a major part also in this package. The package considers the benefits from both replacing the lights with more energy efficient ones and changing the control method. Implementing such measures is also possible during the renovation even when the building is being used.

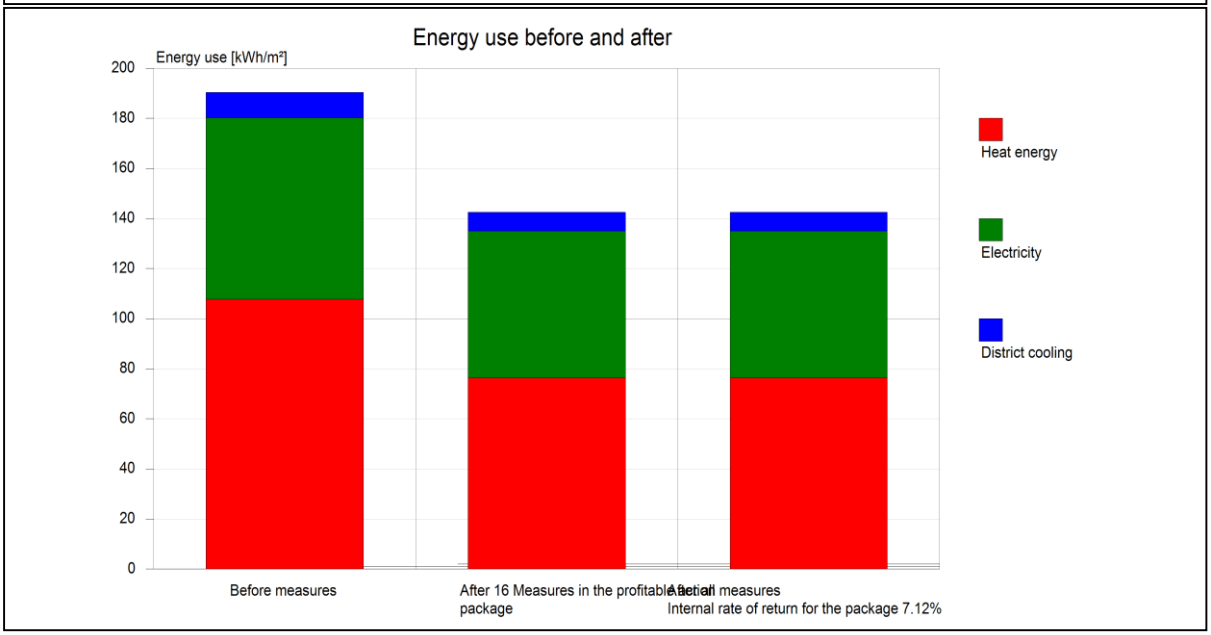
The solar panels were an important part of the package as they help Tampere Hall in the transition towards renewable energy which reduces the energy bill. The panels also fit in the image of the building and were put forward by the building's management.

The most significant savings potential lies in the ventilation equipment, because of the 119 ventilation units in the Tampere Hall only 5 currently have heat recovery. In addition, most of the units have come to the end of their lifetime. The savings potential of the chosen ventilation units was found to be significant regardless of the challenges related to the structures of the building. Implementation of such changes is however hindered by the continuous use of the building. Due to this reason it is likely that only some of these measures will be implemented during the renovation.

Summary of the measures in the action package

Measure		Invesment cost keuro	Cost saving keuro/year	Energy saving MWh/year
1	9.3 More efficient HRU Museo & Soolo	21	9	172
2	9.1 HRU iso sali (TK31+32)	180	29	520
3	9.4 HRU to pieni sali (TK72)	69	8	161
4	6. LEDs in rest of the areas	81	9	80
5	9.5 HRU Restaurant (TK74)	45	5	93
6	8. Motion sensors + LED in WC & cloakrooms	5	0	4
8	9.6 HRU Keittiö (TK75)	58	4	72
9	4b 1000m2 solar electricity	139	8	90
10	9.2 HRU to Lämpiöt (TK41)	67	2	50
11	7. Electronic faucets	18	0	4
12	1. Window wall in hallway to virtual wall in extension	21	0	7
13	3. Southern façade windows	145	2	37
14	2 North class hallway new windows	128	0	15
15	5. LED in concert halls	176	5	42
16	9.7 More efficient roof ventilators	52	0	8
-	Sum	1205	88	1357





Results

The Total Concept analysis indicated that there is a significant potential in reducing the building's energy consumption in a profitable manner. Tampere hall is ready to go forward into the next step, that is to carry out the measures in the package, during the planned construction of the extension.

Limitations to carrying out the measures in the action package are however created by the fact that most of the building will be used during the renovation. Due to this reason the package cannot be implemented at once but those measures which can be carried out wihtout disturbing the use of the building will be implemented during the renovation. The rest of the measures will be divided between the upcoming years.