RepliCable and InnovaTive
Future Efficient Districts and cities

RepliCable and InnovaTive Future Efficient Districts and cities

D4.6: Implementation plan of the Swedish demonstrator

WP 4 , T 4.2

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[1] PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

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Versions

Version	Person	Partner	Date
00	Jeanette Green	IVL	5 September 2014
01	Collaborative work	KEAB, LKF,IVL	19 December 2014
02	Collaborative work	KEAB, LKF, IVL	3 February 2015
03	Collaborative work	KEAB, LKF, IVL	5 February 2015
04	Collaborative work	KEAB, LKF, IVL	3 March 2015
05	Ali Vasallo	CAR	5 March 2015
06	Collaborative work	IVL, LKF, KEAB	20 March 2015
07	Collaborative work	IVL, LKF, KEAB	30 March 2015

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Abbreviations and Acronyms

AMM	Automatic meter management system
AMR	Automatic meter reading system
A_{Temp}	Defines the floor area that is used in energy calculations and expressing the energy performance of a building according to Swedish building regulations.
BBR	Swedish Building Regulations
DSO	Distribution system operator
GM-FD	Grid monitoring and fault detection
HES	Head end system
PBL	Swedish Planning and Building Code
PLC	Power Line Communication
PQM	Power Quality meter
PV	Photovoltaic
RTU	Remote Terminal Unit
CCU	Central Control Unit

0 Abstract

The final retrofitting strategy of Linero is in line with the Swedish Building Regulation incentives to reduce bought energy consumption. It also meets the demand for ventilation according to Swedish regulation and is in line with the affordability demands for the tenants and presents an overall decreased environmental impact in regard to CO2 and primary energy.

In addition to the retrofitting strategy for the buildings, existing energy systems will become more efficient and innovative including new district heating substations, photovoltaics and a smart grid architecture.

KEAB as well as LKF are publicly owned companies and thereby regulated by the Swedish Public Procurement Act. The Retrofitting of the buildings as well as the installation of photovoltaics will fall under this process and be performed by “turnkey” contractors.

LKF set their rents according to a political model called the “lundamodellen”. The aim of “Lundamodellen” (The Lund model) is to set the rent on rented flats in Lund based on a valuation of each individual flat, so that differences in their utility value is reflected by reasonable differences in rent. In order for the property owner/landlord to undertake any retrofitting measures, a retrofitting agreement of each tenant is required. For the convenience of the tenants, LKF has therefore developed a process of communication with the tenants. The dialogue process of tenants and dialogue with The Swedish Union of Tenants runs parallel to the planning of the renovation project; inventories, planning, planning application and specifications.

During a retrofitting, there may be critical steps or milestones that must be met along the project. Some of these are already met before construction starts, while others must be met within the project. There is always a risk that LKF are not allowed to access to the apartment even though they have the tenant consent. With the help of extensive experience in the retrofitting and working with tenants, preventive efforts are in place to facilitate the process and reduce risk critical moments.

1 Introduction

The objective of this deliverable is to define and develop an implementation plan of the complete renovation for the Swedish demonstration. The implementation plan includes descriptions of the public procurement processes, from requests of licenses and permits to the procurement of equipment and installers.

The implementation plan also includes specifications for renovation of the district heating network, the retrofitting process and specifications for investments in the smart grid architecture.

Finally the implementation plan describes the milestones defined for the retrofitting process and the interventions in the smart grid architecture.

1.1 Relationship with other WPs

Deliverable	Task	Relation
D4.3	T4.1	Technical definition of the Swedish demo site
D2.1	T2.1	Retrofitting solution of building's envelope
D2.7	T2.2	CHP solution for thermal and electrical production.
D2.16	T2.3	Report on technologies for steering the buildings energy demand and minimising peak loads in the district heating system
D2.18	T2.3	Definition of renewable systems for district heating
D2.26	T2.3	Report on eliminating of disadvantages of conventional distribution systems
D2.27	T2.3	Report on new efficient heating and cooling systems to improve the efficiency of energy generation systems

Table 1.1: Relationship with other WPs

1.2 Contribution from partners

Participant short name	Contributions
LKF	Sections concerning the retrofitting of the building
IVL	Deliverable leader, general descriptions, overall reviewer
KEAB	Sections concerning the district heating, smart grid and electrical generation
CAR	Reviewer

Table 1.2: Contributions from partners

2 Technical definition of the Swedish demonstrator

The objective of this section is to summarize the information from D4.3: Technical definition of the Swedish demo Site in Lund [1], Sweden in order to establish the current situation and starting conditions of the demo site.

2.1 Description of the district.

Description of Linero

The district of Linero, created in 1969, is in the eastern part of Lund. Today it has a population of about 6,000 persons in detached houses, terraced houses and flats.

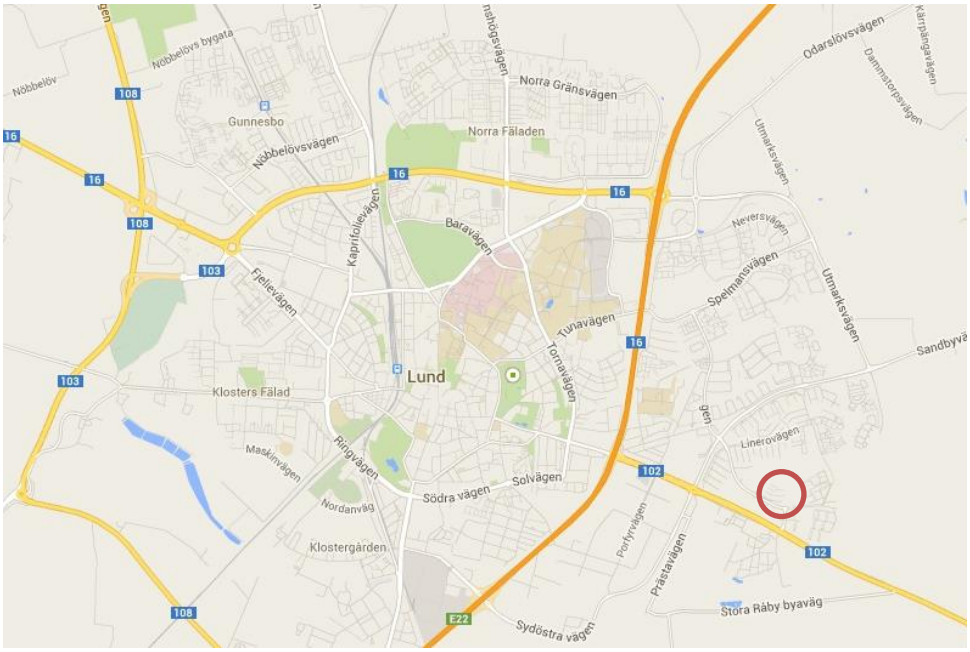


Figure 2.1: Map of Lund with Linero circled

(Source: Google Maps)

The district of Linero is found in the eastern part of Lund. Over the next few years the district is going to undergo major changes. Lunds kommunala fastighetsbolag, LKF is currently constructing six new tower blocks with 24 flats in each. At the same time the square in the centre of Linero is being refurbished, with new shops and offices, a supermarket and two new tower blocks with 94 flats. The final phase of the district refurbishment of Linero is the renovation of the Eddan and Havamal properties.

The district´s buildings have a consistent orientation within the residential area. The road Vikingavägen divides this residential area into two by a road, Havamal in the north and Eddan in the south.

The area consists of 28 three storey building with an area 71 258 m^2 $A_{temp.}$. Today there are approximately 2,000 tenants in the area, with 681 flats owned and managed by LKF.

Upprustning av kvarteret Eddan och Havamal is the Swedish name of the retrofitting of the housing areas of Linero. Of the 28 buildings in the area only 16, with an area of 40 400m^2 A_{temp}, are included in the CITyFiED project. This includes the urban block Eddan and two buildings in the urban block Havamal.

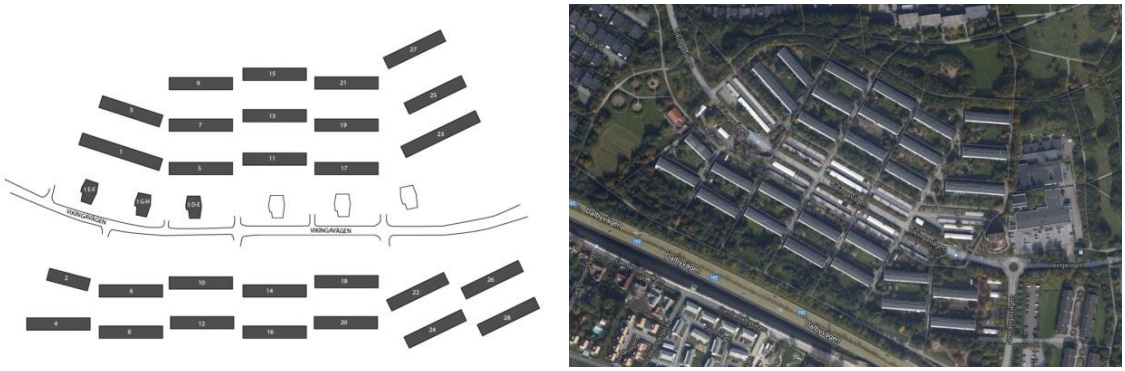


Figure 2.2. The road Vikingavägen divides Linero into two, Havamal in the north and Eddan in the south

2.2 Buildings description.

All buildings in the area are almost identical in appearance and design. They are all three-story buildings with a basement. The buildings and the whole residential area is characterized by concrete façades combined with metal components. In all buildings the entrances face north and the balconies south. Most of the buildings have three stairwells with the exception of a few having two or four stairwells.

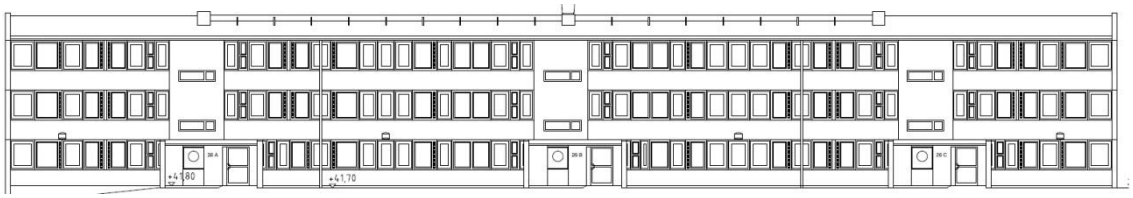


Figure 2.3: Drawing of the north façade with the stairwells.

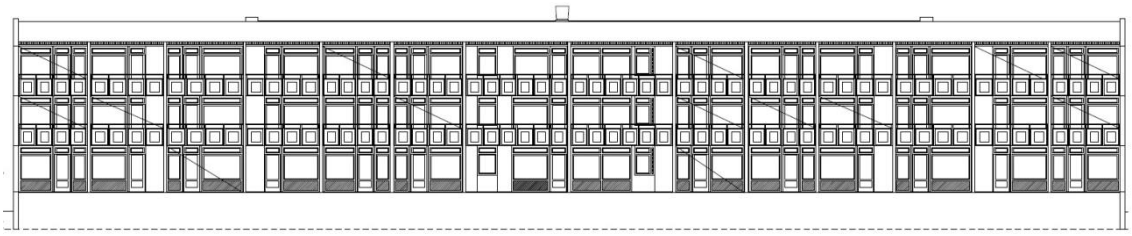


Figure 2.4: Drawing of the south façade with balconies

2.2.1 Building characteristics

2.2.1.1 Frame

Foundations are longitudinal footings under load-bearing concrete walls, see Figure 2.5.

The footings are based on 50 mm blinding concrete directly onto the floor of the excavation without an underlying drainage or capillary breaking layer. Footings under façade walls are perforated by 75 mm pipes, c/c 3.0 m, inclined out to an outside drainage line [2].

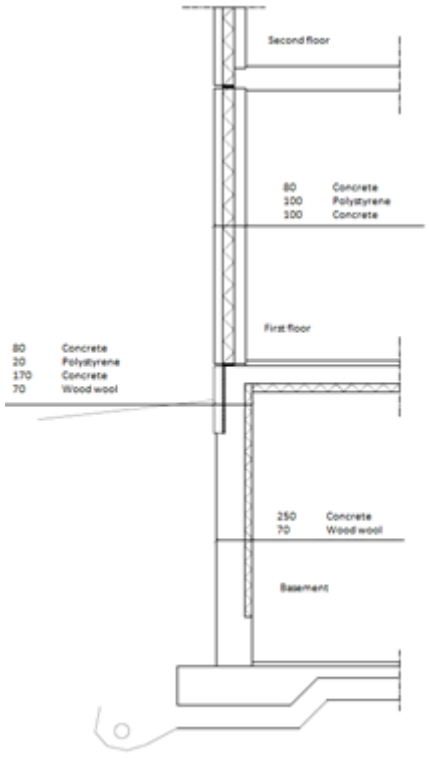
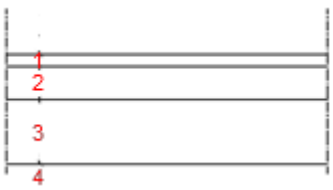
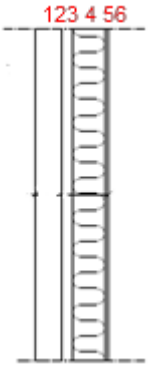
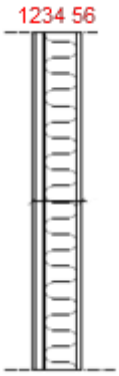
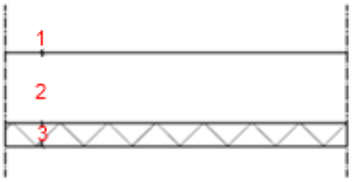
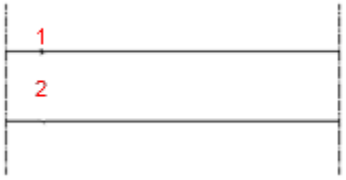
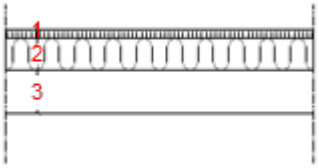


Figure 2.5: Cross section of gable

In Table **2.1** the walls are described from outside to inside and floors are from top to down.

Element	Detail	Picture
Basement floor	Basement floor structure 1. 40 mm concrete topping 2. 100 mm structural concrete 3. 200mm drainage aggregate 4. Excavated floor	

Element	Detail	Picture
Basement walls	<u>Structure of the outside basement walls</u> 1. 300 mm coarse drainage aggregate up to about 250 mm below ground level 2. 230 mm impermeable concrete 3. 70 mm wood wool insulation from the basement ceiling 2.0 m downwards 4. Plaster	
	<u>Structure of the load bearing internal basement walls</u> 1. 150 mm concrete	
Outside walls/façade walls	<u>Structure of the end façade up to the attic floor</u> 1. 80 mm concrete 2. 100 mm polystyrene 3. 100 mm concrete	
	<u>Structure of the end façade above the attic floor</u> 1. 80 mm concrete 2. 80 mm polystyrene 3. 100 mm concrete	
	<u>Structure of the entrance façade</u> 1. 80 mm concrete laid on concrete connections acting as brackets from the intermediate floor structure 2. 30 mm air 3. Windproof board 4. 95 mm wooden studs 2" x 4" c/c 600 mm + mineral wool 5. Vapour barrier 6. 13 mm plaster	

Element	Detail	Picture
	Structure of the façade wall with the balcony/patio 1. Board cladding 2. Batten 3. Windproof board 4. 95 mm wooden studs 2" x 4" c/c 600 + mineral wool 5. Vapour barrier 6. 13 mm plaster	
Partition walls	Load bearing partition walls 150 mm or 180 mm concrete.	
Intermediate floor	Structure of the floor above the basement 1. Floor covering 2. 210 mm structural concrete 3. 70 mm wood wool slab	
	Structure other intermediate floors 1. Floor covering 2. 210 mm structural concrete Thermal bridge insulation at the edge of the floor structure is 40 mm mineral wool.	
	Stairwell landing 1. Floor covering 2. 150 mm structural concrete 3. 50mm wood wool slab	
Roof/Attic floor The existing roof consists of concrete joists with a supported pitched roof.	Structure of the roof 1. Roofing felt 2. Tongue and groove 3. Supported wooden roof trusses c/c 1200	
	Structure attic floor 1. 30 mmm mineral wool matting with a wind barrier 2. 100 mm mineral wool 3. 140 mm structural concrete	

Element	Detail	Picture
	Thermal bridge insulation at the edge of the floor structure is 40 mm mineral wool against the balcony façade and 30 mm mineral wool against the entrance façade.	

Table 2.1: Structure of building elements.

2.2.1.2 Windows

Existing windows are from different periods and are in varying conditions. Window type 1- the majority of the north windows are 1+1 glass windows. The outside sash was replaced in 2005 with an aluminium sash with low emission glass. Window type 2- the minority of the north windows are 3 glass windows.

Figure 2.6: Picture of the north windows

Window type 3 -the south windows on the ground floor and first floor are: 1+1 glass windows. These windows are original windows. Window type 4- the south windows on the second floor are: 2 glass windows. These windows are from 1987.

Balcony slabs

Approximately 160 mm prefabricated concrete slab. The balconies are supported on transverse concrete walls or concrete beams. Connection to the inside intermediate floor structure is with 40 mm thermal bridge insulation. There are thermal bridges at the connections of concrete beams and the inside concrete partition walls.

Roofs over balconies

The roof over the balconies on the top floor is made of corrugated plastic or plastic flute board, resting on load-bearing wooden studs. The wooden studs are supported on transverse concrete walls or concrete beams by way of hangers.

Figure 2.7: Roofs over balconies

2.2.1.3 Ventilation

The ventilation system in these buildings is an extract air ventilation system with one central extract air fan on the roof of each building. The extract air ducts are extended above the roof linking the stairwells. Outdoor air is taken in through slot vents beside the windows in the living room and bedrooms. Extract air is taken out through the cooker hood in the kitchen and from the toilet. Extract air can also be taken from the wardrobe. There is no heat recovery of the extract air. The extract air fans are pressure controlled because the air flow varies when tenants open the damper on the cooker hood when cooking. The pre-study indicates that the ventilation is not working properly according to current requirements

The building has an exhaust air ventilation system with a pressure regulated fan from 2006. However, after a survey of the system it has been identified that the pressure sensor seems to be out of order. During the planning stage it has been discovered that the air flow in the apartments is insufficient. The average extract air flow in kitchens was 9.2 l/s, whereas Swedish Building Regulations (BBR) [3] stipulate 10 l/s as minimum. The air extraction units in the bathrooms were clogged with dirt, reducing the flow to 7.4 l/s in average. Building regulations calls for 10 l/s in bathrooms with opening windows. In total the ventilation is deficient and does not reach the requirements neither in Building regulations nor LKF's policy for renovations. The ventilation system is to be further investigated and restored during the renovation project, in order to reach the air flows stipulated by the authorities.

Minimum total air flow in the whole building will add up to 850 l/s, following the building regulations. Current total air flow is about 609 l/s, meaning that the heating demand will increase by 12 kWh/m². This value is added to the measured value for district heating and thus included in the baseline heating demand for the building.

2.3 Energy System description

This is a short explanation of the existing energy system in the Linero district. A more thoroughly description is found in report *D4.3: Technical definition of the Swedish demo site*.

2.3.1 District heating system in the district

The residential area of Linero in Lund is connected to the main district heating grid as shown in Figure 2.8.

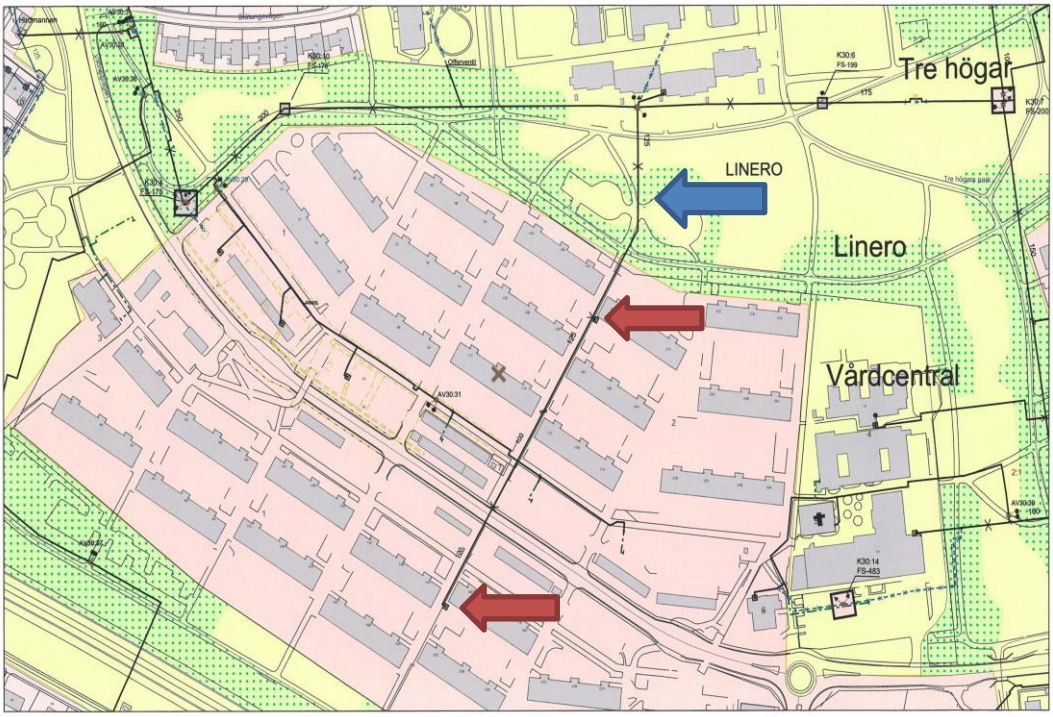


Figure 2.8: Existing district heating system in Linero. Blue arrow - primary distribution pipe of the main grid. Red arrows - two district heating substations feeding the Linero district.

In the Linero districts Eddan and Havamal a pipe of the main district heating grid (blue arrow in Figure 2.8) are feeding two substations (red arrows) feeding 28 buildings. Only the southern one of the two substations, located inside the building at Vikingavägen 18, is feeding the buildings included in the CITyFiED project.

2.3.2 Energy mix of the district heating production

The renewable share of the district heating has been reviewed and the baseline value of RES has increased from 68% to 74.8%. The update does not affect the ambition of the BEST-table.

As for the electricity use in heat pumps, the RES share in the Nordic electricity grid is assumed to be unchanged at 61% over the whole CITyFiED period [4].

District heat	Fuel (MWh)	Renewable fuel (MWh)
Heat for heat pumps (aquifer water, heat from WWTP, etc)	231 188	231 188
Electricity for heat pumps	115 106	70 215
Bio oil	195 655	195 655
Natural gas	71 394	0
Gas turbine	118 427	0
Recycled wood	59 466	59 466
Pellets	28 290	28 290
Waste heat (Sugar factory)	88 314	88 314
Externally acquired heat (wood chips)	23 705	23 705
Externally acquired heat (straw)	10 752	10 752
Biogas	3 950	3 950
Oil	365	0
Auxiliary electricity (approximated to 3%)	25 617	15 626
Total	**972 228**	**727 160**
Share renewables		**74,8%**

Table 2.2: District heating metadata for 2011,

2.3.3 District heating system in the buildings

The district heating pipe enters the building at Vikingavägen 18. This district heating pipe is owned by Kraftringen AB and its media is at a high temperature and pressure, approximately 95°C and 16 bar (Primary line). Heating water and hot tap water are produced centrally at the district heating substation for all fourteen buildings that comprise Eddan 1 and 2. The district heating water is exchanged with secondary circuits for heating water and hot tap water. The pipe systems within the buildings are owned by LKF.

There is one heat exchanger for heating water and one heat exchanger for hot tap water that serve all of the buildings. The district heating substation contains main pumps for heating water and hot tap water circulation.

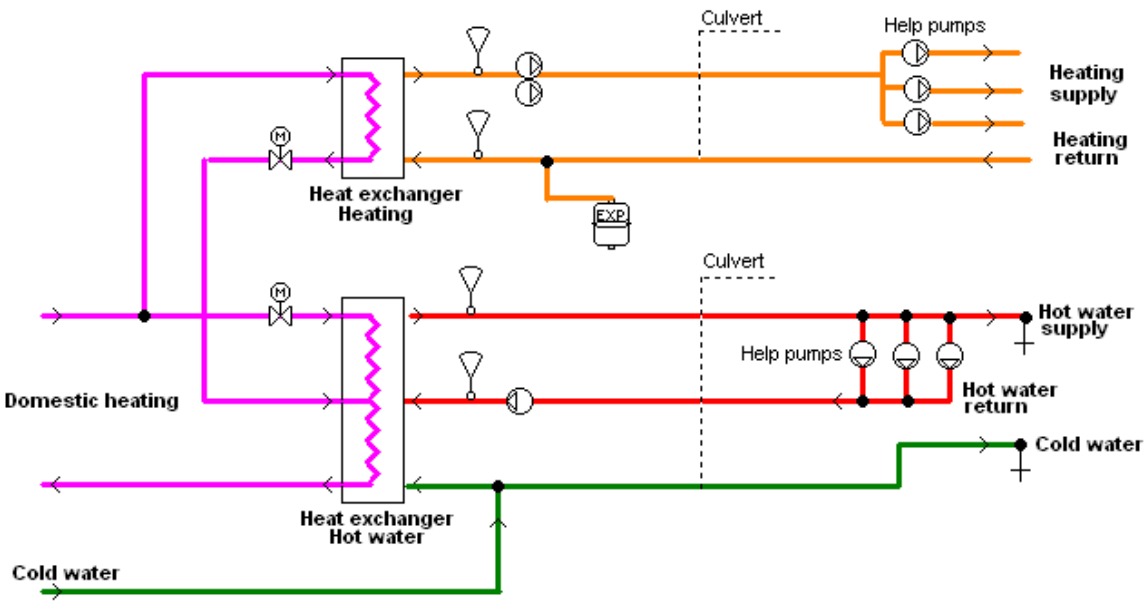


Figure 2.9: Shows a schematic diagram of the district heating substation in the Vikingavägen 18 building along with the culvert system.

The culvert network

The culvert network originates from the building at Vikingavägen 18 and serves all of the other buildings. The culvert network has pipes for supply and return heating water, hot tap water, hot tap water circulation and cold tap water. Inside the buildings the culvert pipes are suspended in the basement ceilings. Between the buildings they are buried underground. At Vikingavägen 6, 12 and 24 auxiliary pumps for heating water and hot tap water circulation are installed due to the long pipe runs.

The culvert network is from the 1970's when the area was built. There is quite a lot of energy loss from such a large and relatively poorly insulated pipe system. The total length of the culvert network is approximately 800 m.

Figure 2.10: Shows the routing of the culvert network with the secondary circuits that LKF owns

There are auxiliary pumps at Vikingavägen 6, 12 and 24 for heating water and hot tap water circulation. These auxiliary pumps are located in small service rooms.

Radiator system

Heating water for the radiator system is produced centrally, as mentioned above, in the district heating substation at Vikingavägen 18, and then circulates through the culvert network to the flats.

The flats have one or more radiators in every room to replace transmission and ventilation losses. The radiator system in the flats is constructed as a single pipe system with the radiators connected in series. This solution was common when these buildings were constructed at the beginning of the 1970's.

Hot tap water system

Hot tap water is also produced centrally in the district heating substation at Vikingavägen 18 and circulates out onto the culvert network. There is a supply pipe for the hot tap water to the taps and a return line to the district heating substation.

The reason for constructing a hot tap water system with a return line and circulation pump is to minimise the wait for hot water. Reducing the waiting time stops tepid water being wasted for extended periods and thereby reduces energy losses and water consumption.

On the other hand there are significant energy losses as hot tap water at 55-50°C is being circulated through 800 metres of poorly insulated culvert pipes all year round.

2.3.4 Electricity system in the district

The Lund grid has three 130/10 kV distribution stations connected by 130 kV lines; named VM, ÖM and SM. Two of these stations, VM and ÖM, are connected to the overlying 130 kV region grid. The three stations feed the 10 kV grid that contains more than 400 substations, connected in loops, with transformation 10/0.4 kV.

The buildings in the CITyFiED project are fed at low voltage, 400 V, from the substation, N188 (in blue circle in Figure 2.11). The substation is connected at 10 kV in a loop with a number of more substations. The 10 kV loop is fed from the distribution station SM (to the left in Figure 2.12.

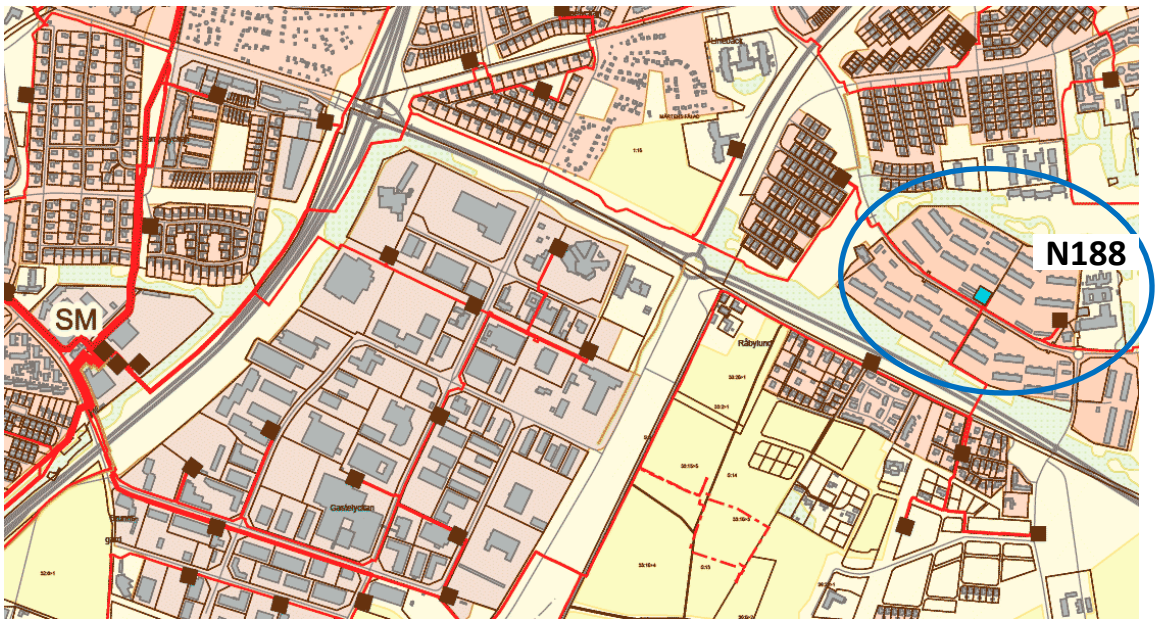


Figure 2.11: The distribution station (SM), 10 kV grid (red lines), substations (black squares) and the Linero substation N188 (blue square). (Source: Kraftringen)

Each building is separately connected to the grid at 400 V, green lines in Figure 2.12. The distribution system operator owns the grid to the connection point in the building. Inside the building the electricity consumption of each apartment is separately measured and also the building electricity (lighting, fans, common washing machines etc.) is separately measured. All electricity meters are located in the basement of the buildings.

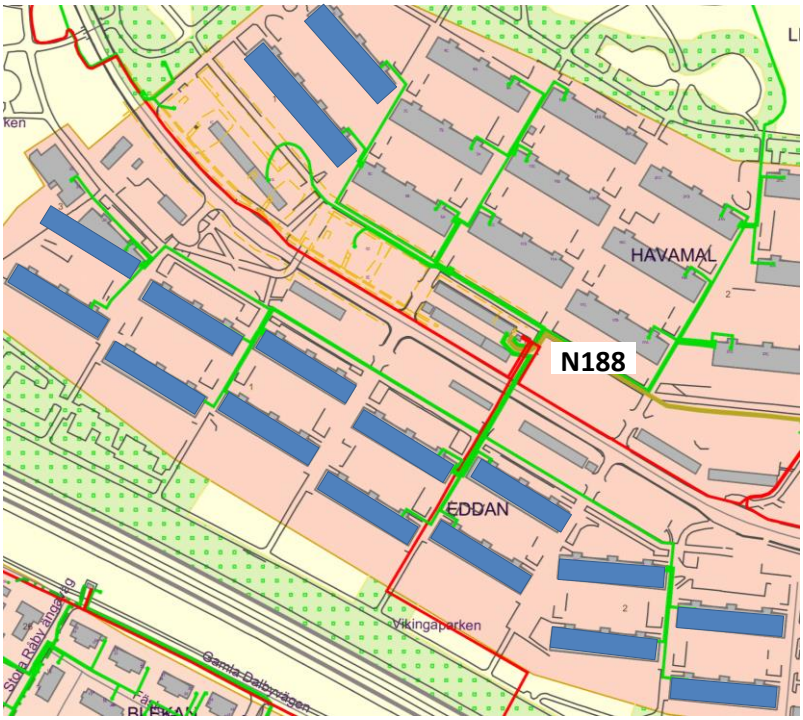


Figure 2.12: The 10 kV grid (red lines) and the 400 V grid (green lines) feeding the CITyFiED (blue) buildings (Source: Kraftringen).

2.4 Definition of the needs

The heat losses in the district where defined in D4.3 [1]. As can be seen in Figure 2.13 the major losses of energy are through ventilation and through the building envelope.

Façade renovations have not been deemed necessary as the structure and air sealing are of good quality. The results of the airtightness test indicate that the building envelope is largely of such a high standard as to be comparable with the standards for new buildings. Consequently, the renovations will be targeted at the elements in the building envelope that can be given an improved U-value. The building's windows currently vary in both quality and type. The analysis shows that replacing the least performing windows on the first and second floors of the buildings south facades is a cost effective way to reduce energy consumption.

The old curtain wall sections will be replaced with a new external wall with a lower U-value. The buildings envelope will be further improved by adding insulation to the roof.

The improvement of the building envelope makes it possible to reduce the indoor temperature without negative effects on the thermal comfort.

The existing lighting in the building does not work as it should. During the renovation, all the lighting in the building's communal areas will be changed to LEDs in order to reduce energy use. Furthermore, presence control will be installed in stairwells, cellars, entrances and gable ends. With presence control, use can be controlled so that no more energy is used than required by the tenants.

The 14 houses in the Eddan district currently receive district heat and hot water from a single substation. The area's existing culvert system has long sections of culvert between the buildings and the area's heat exchanger. The long culverts lead to external energy losses (13% of the total loss, Figure 2.13). Switching from one to six heat exchangers leads to a reduction of culvert size and with that a reduction of the energy loss.

The ventilation flow in the buildings does not work as it should and does not comply with Swedish building regulations or LKF's ventilation policy. The exhaust air system will be modernised with a pressure-controlled exhaust air fan being installed in the buildings. Furthermore, exhaust air heat pumps will be installed to recycle heat from exhaust air into the heating and hot water systems. The latter applies to the buildings in which heat exchangers will be installed. The heating will be further improved by upgrading the radiator system with new thermostats and valves.

Individual hot water metering and billing is introduced to increase the awareness of the tenants and promote energy saving.

Finally, monitoring systems for district heating and the electrical grid will be developed. The data will be gathered in a database to enable further energy efficient solutions.

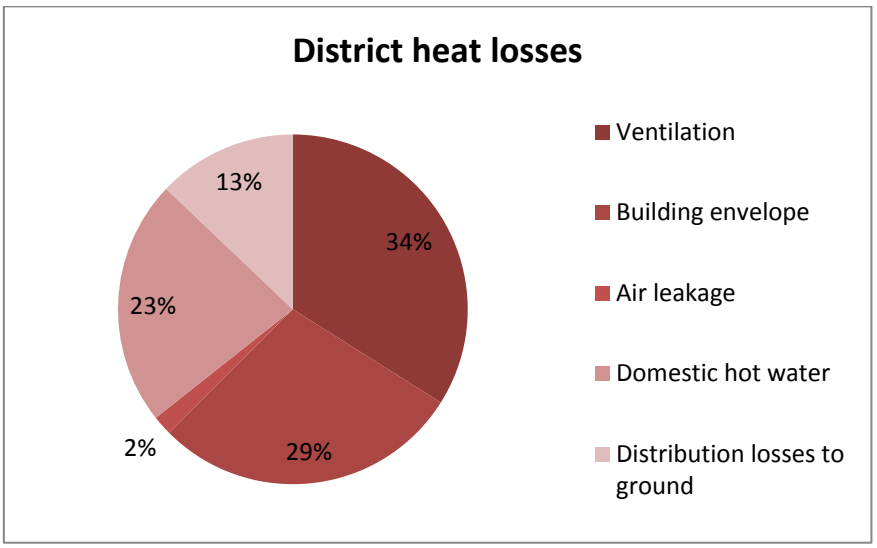


Figure 2.13: Distribution of heat losses in the district (Source D4.3, CITyFIED)

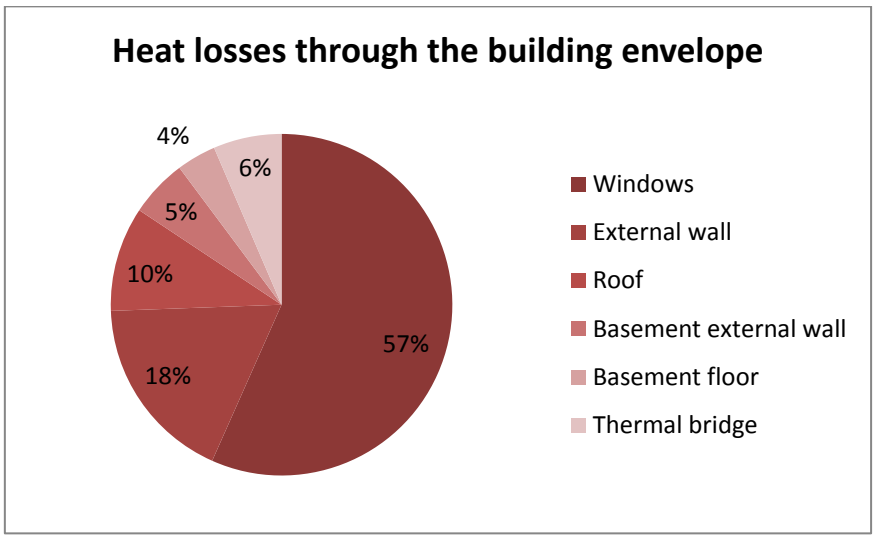


Figure 2.14: Distribution of heat losses through the building envelope (source D4.3, CITyFIED)

3 Building retrofitting technical solutions

The turnkey contractor is responsible for the detail planning of the technical solutions; this process is ongoing in the Linero project. To be able to make a good procurement LKF have a detail pre-projecting phase to establish some specifications of the retrofitting strategy. Presented in this chapter is the specification of the technical solution according to LKFs pre-projecting and the enquire document that was the framework at the procurement of the turn key contractor. There are no further specifications on the technical solutions at this moment.

3.1 Building envelope

3.1.1 Windows and balcony doors

During the renovations, the south-facing windows and balcony doors on first and second floor will be replaced with a more energy-efficient model. New windows and doors are made of wood with exterior aluminium cladding, manufacturers Nordanstad or equivalent. Opening windows should only be H-hinged, reversible. Exterior aluminium cladding shall be powder coated, RAL 9010 white. The interior wood must be painted white, gloss max 35, NCS 0500-N.

Category	Specifications
U-value	0.9.
Audio Class	Rw 34 dB / Rw + Ctr 29 dB.
Slit valves	Installed in the lintel at the ceiling. Soundproofing Dn, e, w less than 42 dB rel 10 m2. Type Leif Arvid Andersson AL-dB 800th
Glass	3 glazing. Insulate windows must be P-labelled and mounted according MTK regulations. Hinges may not be done in aluminium.
Tightness Class	D

Table 3.1 Specifications of windows

Windows should be provided with ventilation fittings with integral brake and child safety measures. Windows shall be marked with the date of manufacture and type of glass and 10 year warranty on the glass.

Balcony doors should open outwards. Doors at the balcony should be fitted with a cylinder and a handle on the inside and a pull handle on the outside.

Balcony doors to patio should be equipped with a cylinder and a door handle on the inside and outside. Cylinders for windows doors shall be included in the locking system and adapted for the apartment keys.

Caulking is performed with mineral wool strip with interior air and damp proof or environmentally certified sealing foam type Essve 199 or equivalent.

Mounting holes are covered with wooden dowels treated as surrounding surfaces. 13

Window sills shall be constructed of painted aluminium in the same colour as the window, white RAL 9010, and fastened at the bottom with continuous cleats. Lacquer must be PVF second. Outer cover profiles and drip plate is performed in material and colour as exterior aluminium cladding, supplied from the window supplier.

New balcony doors must be the width 10M and be equipped with adapted thresholds for better availability. Dimension of the wall opening needs to be adjusted if necessary; measurements will be taken during the detail planning phase. Other windows shall have the same parapet and basically the same classification as existing but with some solid parts. The outline of the windows is showed in the figures below [5].

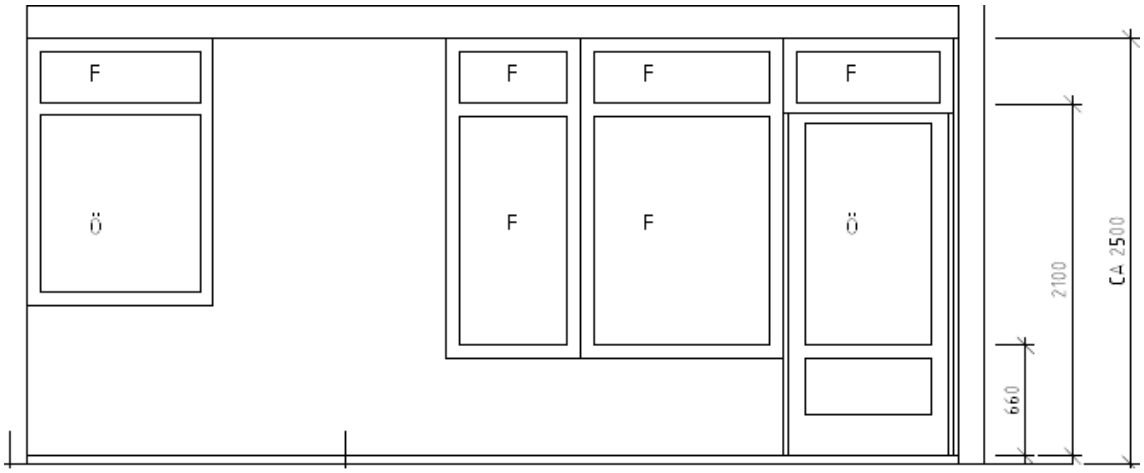


Figure 3.1: The outline of the windows on the south side first and second floor.

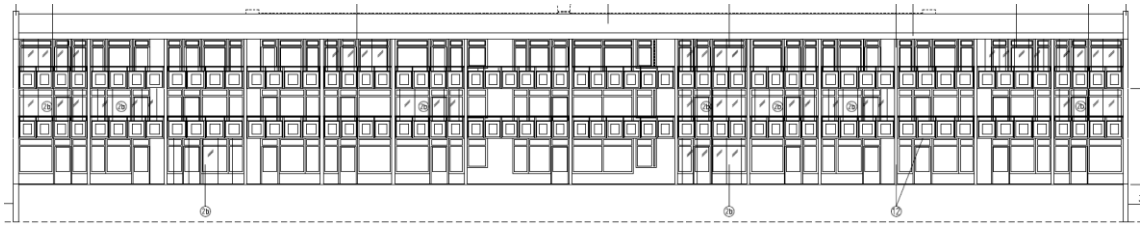


Figure 3.2: Facade drawing to see the outline of the windows

3.1.2 Glazing of balconies

The balcony glazing on third floor plan will be removed and replaced with new once in the retrofitting. Since this intervention has an impact on the rent, tenants can choose whether they want to have their balcony glazed or not.

The new glazing will be frameless with sliding and folding glass section that will be set from balcony platform to balcony platform. First floor will be set from ground to balcony platform and third floor will be set from balcony platform to the ceiling. The glazing will be assembling free from existing front railing. To be able to clean and polish between glaze and railing front the glazing must be adjustable for sliding and folding.

Example on the fabric is Windoor, system 300 alt 410, frameless or similar

The final detail is a collaborated work between the manufacturer, LKF and the constructor/designer[6].

Figure 3.3: Reference picture of the new balcony glazing [5]

3.1.3 Additional wall insulation

A new external wall with a lower U-value will be built along the southern long side of the ground and first floor. Existing external wall (curtain wall) on first floor and second floor will be demolished and replaced with a new wall with a U-value of max 0.19.

Proposal for construction:

- 13 plaster
- 0.2 plastic foil (PE-foil)
- 95 studs / mineral wool. Crosstie performed steel.
- Wind deflector minerit board.
- 100mm rockwool or equivalent.
- 25 mm steel battens, corrosivity C4.
- 8 mm cement fibre board, white, dyed.
- Tin plate at the bottom edge to prevent snow, mice, leaves, etc. to put in a pocket formed between the supplement and the concrete slab and the current gap. Air gap at the bottom for ventilation of the cement fibre board [5].

3.1.4 Additional roof insulation

Existing attic will be additionally insulated with loose wool, 280mm. To get an even distribution and good filling the loose wool will be injected through new work openings. The total insulations shall measure up to the existing insulation plus 280mm loose wool. The existing insulation that either are missing or needs to be removed shall be replaced with new insulation so the total thickness is achieved. An air gap will be secured in the lower part of the roof slope by placing gap forming hard boards between the roof truss [5].

3.2 Ventilation

3.2.1 Balanced ventilation

The exhaust air system will be modernised with a pressure-controlled exhaust air fan being installed in the buildings. This applies to buildings that were not built with heat exchangers for use with district heating. In these, the duct will be built in the attic. There is already forcing potential in the kitchen ventilation hood. The total ventilation flow increases from 609 litres/s to 850 litres/s (basal flow).

3.2.2 Exhaust air heat pump

As part of the renovation, an exhaust air heat pump will be installed to recycle heat from exhaust air into the heating and hot water systems. This applies to the buildings in which heat exchangers will be installed.

- A heat pump takes heat from the building's exhaust air. This is used to heat water for the radiators and hot water system in two–three buildings.
- Completion of the fan room
- Completion of the ducting between the fan room/plant room and heat pump
- Total ventilation flow increases from 609 liters/s to 850 liters/s (basal flow)

Exhaust air from a building is replenished with an exhaust air pump (exhaust air flow as per the building regulations/LKF standards). Heat is provided to the heating system for radiators and the hot water system of two–three buildings. The available heat in the exhaust air from one building that can be used is 155,000 kWh/year.

3.3 Thermostats and balancing valves

3.3.1 Reduction of interior temperature

The interior temperature will be reduced by 1°C, the estimated energy reduction is 5 kWh/(m²·year). Changing the windows and adding additional façade insulation may mean that the interior temperature can be reduced by 1–2°C without the residents perceiving a reduction in thermal comfort.

3.3.2 Replacement of radiator thermostats

The radiator system in the buildings consists of a single-pipe system, which will be retained. The radiator thermostats, adjustment valves and shut-off valves will be replaced during the renovation. These interventions are judged to result in an energy reduction of 5%.

Technical specifications

Radiator valves, serving radiators in:

- Apartments and rooms are provided with thermostatic valves set to 21°C.
- Bath and WC equipped with hand wheel.
- Entrance and basement (except in the premises) valves are provided with actuators for loose key.

The maximum limited temperature of the thermostatic valve shall be two degrees above the dimensioned room temperature. Maximum limit temperature must be easily changed without the thermostat needing to be parted or dismantled. The conversion shall be hidden from the uninitiated (tenant) and special tools are required for changing the alignment, respectively, maximum limit shall be to be delivered in three rounds [1].

3.4 Lighting in the building

The stairwells, existing light fixtures is replaced with new type **Karl H Ström Sensorarmature**

RS Pro LED S1. Supplementation fixture will be placed in the ceiling at the new post office boxes. General lighting in stairwells must be at least 100lux.

On the gable facades shall be mounted wall luminaires, see Figure 3.4.

Luminaire type: **Ateljé Lyktan Tall Lite vägg 205385-236** complete for surface wiring.

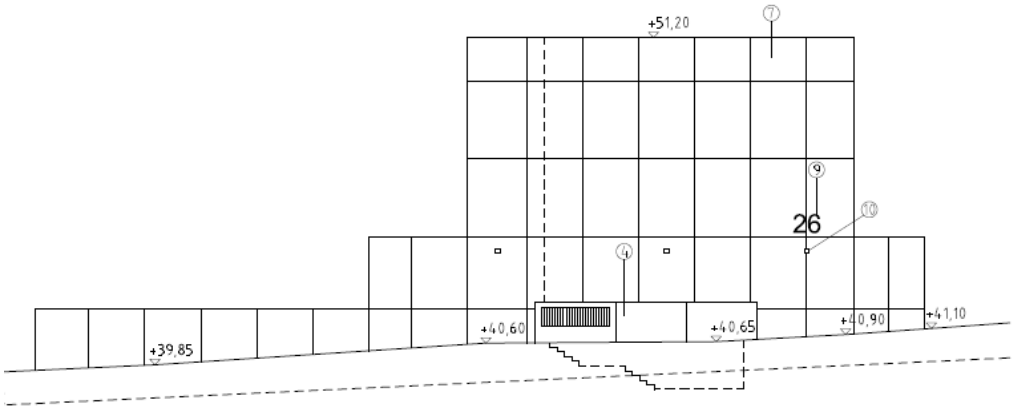


Figure 3.4: The location of the new wall luminaire on the façade gable, described with number 10 in the drawing. (Source: LKF)

New entrances to stairwells will be provided with new lighting implemented outdoors. The luminaire shall consist of LED strip.

Luminaire type: **Wario LED Flex Phobos television IP67 - W824 10W / m 360lm / m**. Luminaire dimensions adapted and needs to be control measurement before ordering.

In the basement corridors, storerooms, electrical / equipment rooms, garbage rooms, bicycle storage and laundry area shall mounted sealed luminaire IP 44, reflector, with opal diffuser. Fixtures will be with built in motion detector possible that the slave switch for optimum performance. Basement corridors and storage room must be zoned. Fixtures will be with LED light source.

In the basement direction signs, with built-in batteries, will be mounted in extent according to fire protection description [7].

3.5 Domestic hot water

3.5.1 Individual measuring and billing

Individual hot water metering and billing will be introduced in conjunction with the renovation. The tenants will thus have to pay for the hot water they use. The hot water meters will be checked on a monthly basis and the figure reported on the rental statement the following month.

The hot water meter will be installed on the hot water pipe entering the apartment and will start metering hot water usage when the water temperature is over 45°C. The tenant will not be billed for the water they use that is below 45 °C. The tenants can see how much hot water they are using by logging into their account on LKF's website [8].

Technical specifications

A conduit runs from the water manifold cabinet in the apartment to broadband RTU in the basement. A CAT6 cable (PC cable) is placed in the conduit and runs from the water manifold cabinet to broadband RTU. The meter for hot water is placed in the manifold cabinet in the apartment and report values on to the broadband RTU that communicates with CCU at LKF office.

3.5.2 Replace bathtubs with showers

The renovation will involve bathtubs being replaced with showers. As the majority of tenants now have a bathtubs, it is their choice whether they want to replace their bathtub with a shower. Our assessment is that 30% of tenants will choose to change to a shower. Introducing hot water metering also results in a reduction in the use of water and the use of bathtubs decreases when the tenants themselves have to pay for their hot water usage.

4 District heating technical solutions

The KEAB part of the district heating renovation consists of new pipes in the ground from a connection point in the existing grid to the buildings, six new substations in the buildings and the interior primary connection of the substations.

4.1 Energy mix of the district heating production

The renewable share of the district heating has been reviewed and an updated prognosis for 2018 has been made by KEAB. This new prognosis includes the import of district heat from the district heating grid of the neighbouring cities Landskrona and Helsingborg. The Lund, Landskrona and Helsingborg district heating grids will be interconnected by a new pipe during 2015. District heat from Landskrona and Helsingborg is in Table 4.1 defined as "Imported district heat". The import represents an uncertainty in the prognosis since the nature of the imported district heating is decided by another energy company.

According to the current prognosis the 2018 value has increased from 91% to 93.4%. The update does not affect the ambition of the BEST-table.

As defined in the Technical definition, what fuels that are considered to be renewable is defined according to the national trade organisation standard "Agreement in the Heat market committee in 2013 on the perception on environmental accounting for buildings heated by district heating" [17]. This standard includes peat as a renewable fuel. Peat is included in "Bio fuel, CHP Örtofta" in Table 4.1.

As for the electricity use in heat pumps, the RES share in the Nordic electricity grid is assumed to be unchanged at 61% over the whole CITyFiED period.

Metadata for 2018, prognosis

District heating	Fuel (MWh)	Renewable fuel (MWh)
Heat for heat pumps (aquifer water, heat from WWTP, etc)	160 404	160 404
Electricity for heat pumps	65 435	39 915
Bio oil	22 481	22 481
Natural gas	247	0
Gas turbine	0	0
Bio fuel, CHP Örtofta	356 311	356 311
Recycled wood	37 431	37 431
Pellets	5 176	5 176
Max IV input electricity	7 192	4 387

Max IV waste heat	17 607	17 607
Waste heat (Sugar factory)	0	0
Externally acquired heat (wood chips)	13 773	13 773
Externally acquired heat (straw)	6 280	6 280
Biogas	5 152	5 152
Oil	0	0
Imported district heat	151 082	138 794
Auxiliary electricity (approximated to 3%)	26 608	16 231
Total	**875 180**	**823 943**
Share renewables		**94,1%**

Table 4.1: Prognoses district heating metadata for 2018.

4.2 Exterior piping

Five of the buildings will be connected by new piping in the ground. Today all buildings are connected on the secondary side of one common substation. The exterior piping is not included in the CITyFiED project and thereby not further described. However for the overall picture the location of the new pipes are shown in red in Figure 4.1.

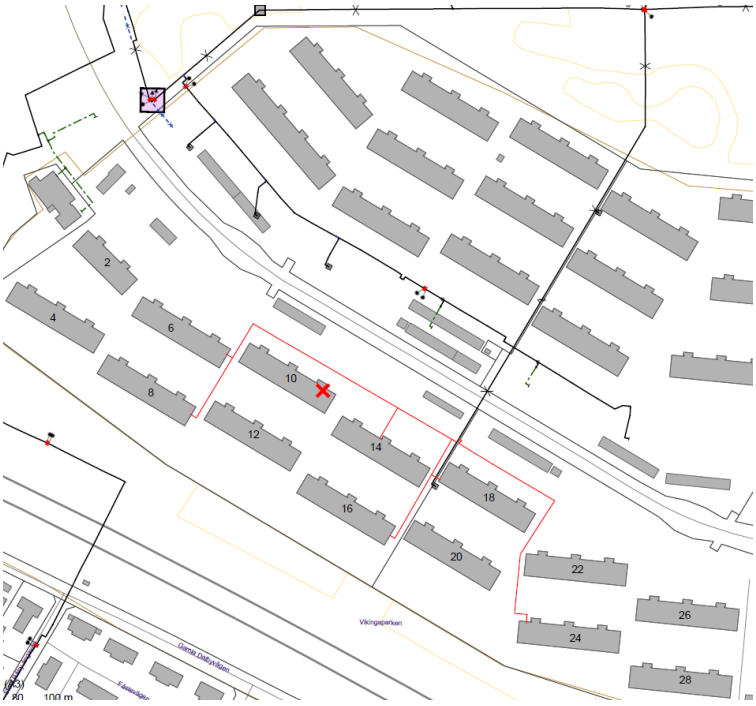


Figure 4.1: New pipes (red lines) for the six new substations. (Source: Kraftringen)

4.3 Substations

There will be a change from one substation serving the CITyFiED buildings to six new substations. The new substations will be placed in the buildings on the addresses Vikingavägen 6, 8, 14, 16, 18 and 24. The substations will be equipped with two different sizes of heat exchangers depending on the number of apartments served. Alfa-Laval will be the supplier of the substations and the type “Maxi” will be used, see Figure 4.2.

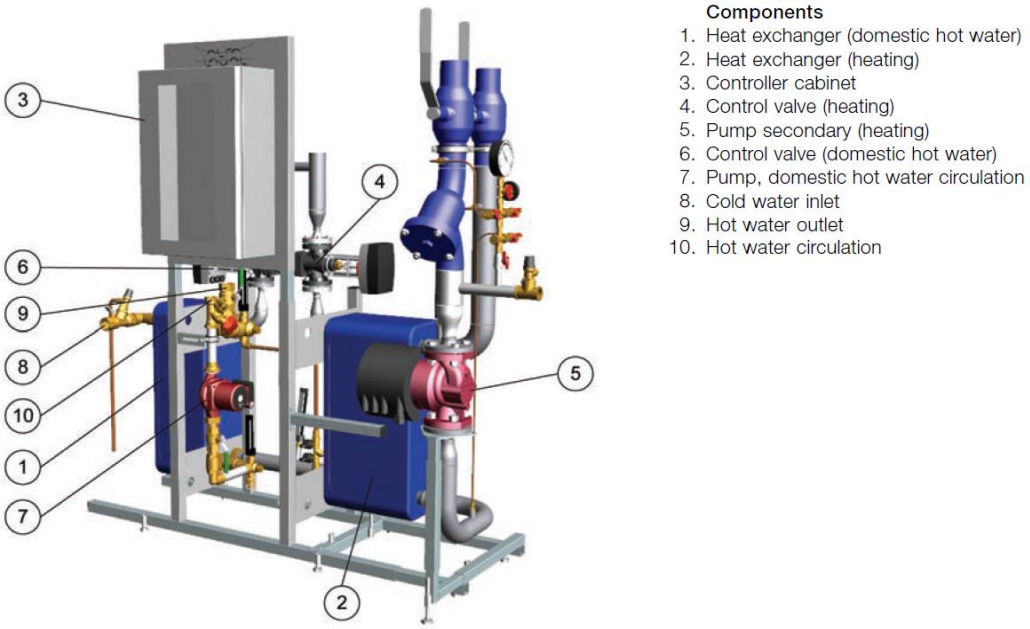


Figure 4.2: Substation from Alfa Laval, type Maxi.

Maxi can be ordered with a number of different specifications on heat exchangers. Each substation will consist of two heat exchangers, one for the heating and one for the hot water. The specifications for the two different sizes of heat exchangers for heating respectively for the hot water that will be used in the substations are listed in Table 4.2 and Table 4.3. Remaining specifications of the substation are mainly defined by the secondary connection and the control system that is LKF´s part.

Parameter	Value
Available difference pressure	150kPa
Pressure class	PN16
Hot Water	**CB60-64L:2**
Effective output	169kW
Temperature intervals	65-20.5 / 10-55 °C
Flow	0.93 / 0.90 l/s
Pressure drop	18 / 19 kPa
Heat 1	**CB110-80H 6C-HES**
Effective output	300kW
Temperature intervals	100-61.9 / 60-80 °C
Flow	1.96 / 3.65 l/s
Pressure drop	4 / 13 kPa

Table 4.2: Specifications of heat exchanger, type 1. Installed in Vikingavägen 6, 8, 14 and 16.

Parameter	Value
Available difference pressure	150kPa
Pressure class	PN16
Hot Water	**CB60-100L:2**
Effective output	226 kW
Temperature intervals	65-19.3 / 10-55 °C
Flow	1.21 / 1.20 l/s
Pressure drop	14 / 15 kPa
Heat 1	**CB110-120H 4C-HES**
Effective output	450 kW
Temperature intervals	100-61.8 / 60-80 °C
Flow	2.94 / 5.48 l/s
Pressure drop	4 / 15 kPa

Table 4.3: Specifications of heat exchanger, type 2. Installed in Vikingavägen 18 and 24.

The substations are connected to the exterior pipes by shut-off valves on the inside of the building wall.

The equipment included in the substation is shown in Figure 4.2. Figure 4.3 shows a schematic diagram of the substation with the district heating circuit, the building heating circuit and the domestic hot water circuit.

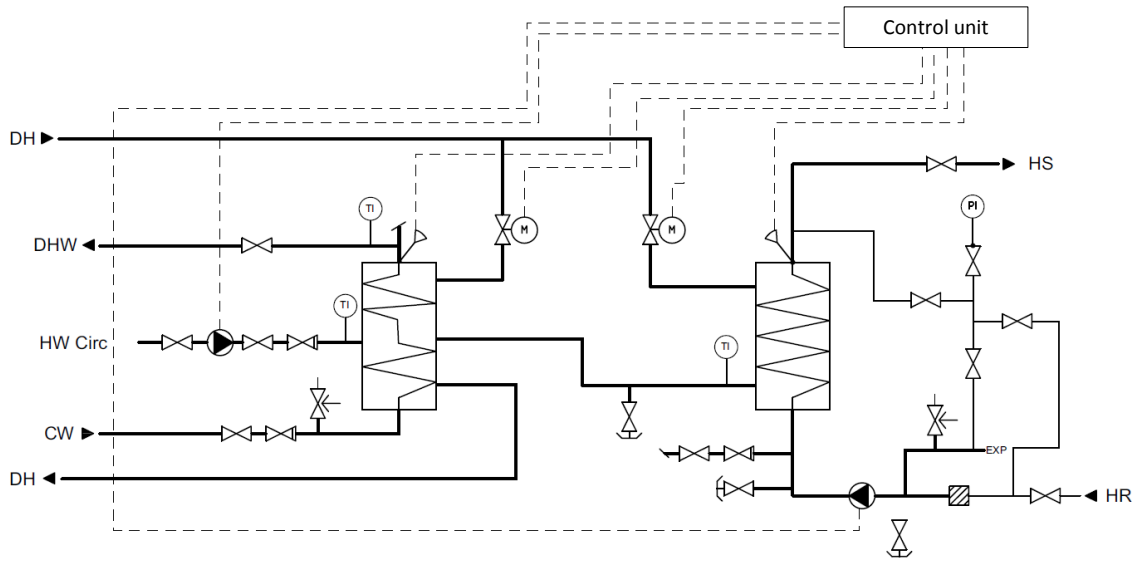


Figure 4.3: Schematic diagram of a substation. DH – district heating circuit, DHW/CW – hot water circuit and HS/HR – heating circuit (Source: Alfa-Laval).

The responsibility of KEAB ranges to the valves on the secondary side of the heat exchangers, in the DHW/CW circuit and in the HS/HR-circuit in Figure 4.3. After these valves LKF is responsible for the material and installation.

Individual energy meters for charging will be installed on each of the six substations. The energy measurements will be remotely collected by the KEAB automatically metering reading infrastructure. Hourly readings will be collected to the measurement database once per day.

4.4 Smart district heating

The district heating in the CITyFiED buildings will be controlled by a smart heat building system for example the one developed by “Noda – Intelligent Systems” as described below. The system takes the control signal from the outdoor temperature sensor and adjusts it by considering the indoor temperature in relation to the outdoor temperature, the heating on the primary side (the grid) and the secondary side (the building) of the substation. This adapted temperature signal, instead of the direct outdoor temperature signal, is then used to control the heating distributed from the substation.

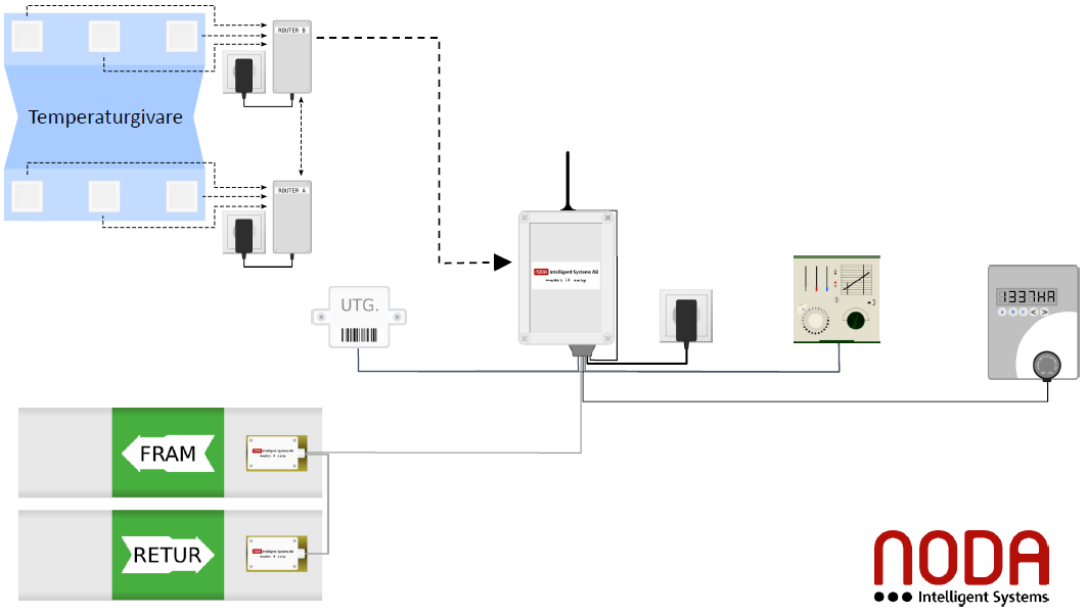


Figure 4.4: The smart heat building system from Noda (Source www.noda.se)

By this, the system takes into consideration the thermal behaviour of the building, which is affected by the heating system, sun insolation, social behaviour etc. [9].

The smart heating building system therefore minimizes the temperature variations in the building to optimise the heating and enables energy savings.

One Noda system is needed for each substation, this means six systems is needed for the CITyFiED buildings. Wireless indoor temperature sensors on strategic places in at least 10% of the buildings are needed to control the heating system. The system also gives the possibility of real time monitoring of the indoor temperature of the apartments.

The Noda equipment is installed adjacent to the substation and uses the existing outdoor temperature sensor of the substation. The only additional equipment needed is a number of wireless indoor temperature sensors, connected to the system by radio communication. In this case about 40 sensors will be installed, in about 6-7 apartments per Noda-system. If there are already existing indoor temperature sensors, these normally can be used instead of installing new sensors.

The Noda-solution also includes a web interface for monitoring the energy use, historical data and real-time, see Figure 4.5. The interface also provides reports, analyses and support for decisions.

Figure 4.5: The Noda web interface (Source Noda)

5 Smart grid interventions and ICT

The smart grid interventions include new electricity generation from photovoltaics and new electricity use by an EV charger. The other interventions concerns monitoring of energy flow, power quality and fault analysis in the demo site. The purpose of the enhanced monitoring is to increase the energy awareness of the people living in the area in order to reduce the electricity consumption. The purpose is also for the distribution system operator to get a better control of the electricity quality in the grid in order to enable a high penetration of further local electrical generation in the area.

5.1 Photovoltaics

Al least 70 kWp roof mounted photovoltaics will be installed in the project, divided on at least two of the buildings.

The size of the PV plant for a building is normally limited by the main fuse for the building electricity. With a bigger plant the main fuse have to be enlarged and that gives a raised subscription fee to the network company.

The design of the PV-plant suggested by KEAB is a plant evenly distributed on three building roofs with about 23 kW per building. 23 kW correspond to 34 A which fits within the existing main fuse for all buildings which are either 35 A or 50 A.

The final design of the PV-plant depends on the LKF retrofitting process. For example the number of buildings with PV´s is finally decided in LKF´s detailed planning of the large retrofitting stage, during 2016. No PV´s will be installed on the pilot building. Thereby the procurement of the PV-plant will be coordinated with the LKF large retrofitting process and the exact specifications for the procurement will be defined then.

For each building with a PV-plant there will be a DC/AC-converter, an electricity meter measuring the electricity production and a display at least showing instantaneous power and total energy produced included in the PV-plant, see Figure 5.1.

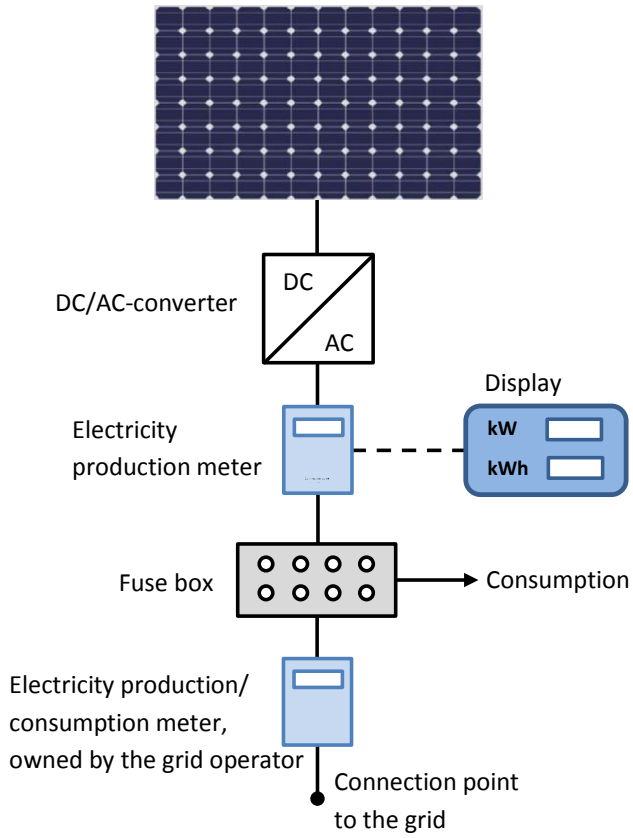


Figure 5.1: The PV-plant consists of PV, DC/AC-converter, electricity production meter and a display. The plant is connected to the electricity building system.

The installation of photovoltaics will be connected to the electricity system of the building and the electricity production will primarily feed the building and reduce the need of bought electricity. In cases when the production exceeds the consumption of the building the excess electricity is fed to the grid and sold to the chosen electricity trading company.

The produced electricity will primarily feed the building and reduce the need of bought electricity. In cases when the production exceeds the consumption of the building the excess electricity is fed to the grid and sold to the chosen electricity trading company.

In the procurement process following questions will be addressed:

- Performance data – Peak power of the system, tilted angle of the modules, angle towards south and the resulting estimated energy production.
- Equipment data – Type, size and number of PV-modules and converters. Technical description and warranty of the PV-modules, converters and other equipment.
- Mechanical installation – Support structure design for attaching the PV´s on the roof, solution for wall and roof penetration.
- Electrical installation – Electrical circuit diagram showing the string connections of modules, wiring, grounding, security breakers etc.

The display showing the solar production data will be combined with the visualisation tools for showing the energy use in the buildings and in the district. Combining display of energy use and local energy production is intended to increase the awareness of the energy flow in the district for the people living in the area.

5.2 EV charger

An EV charger will be installed in the demo area in order to give the tenants easy access to quick and well-functioning charging infrastructure that fits their needs, both now and in the future.

The charger will be configured in order to host one car for car-sharing and one other private car at the same time. In order to facilitate well-functioning car-sharing-functionality, the charger will be configured to enable full charging within one hour.

Category	Specification
General description	2 * 32 A, 1- and 3 phases
Power	22 kW
Charging time at 32 A, 3 phases	1 h
Type	Type 1 & 2 (Type 2 EU-standard)
Mode	Mode 3 (EU-standard)
Payment method	RFID/App/SMS (different for car sharing and private solution). Will be ready for future roaming technology.
Connection	Ethernet/3G
Other	Empty conduit pipes will be installed in order to secure increased future demand for charging infrastructure.

Table 5.1: Specifications for the EV charger.

Connection and location

The EV charger will be connected to the 400 V grid (green lines in the picture below, marked with black arrow). The location will be easily accessed by the tenants.

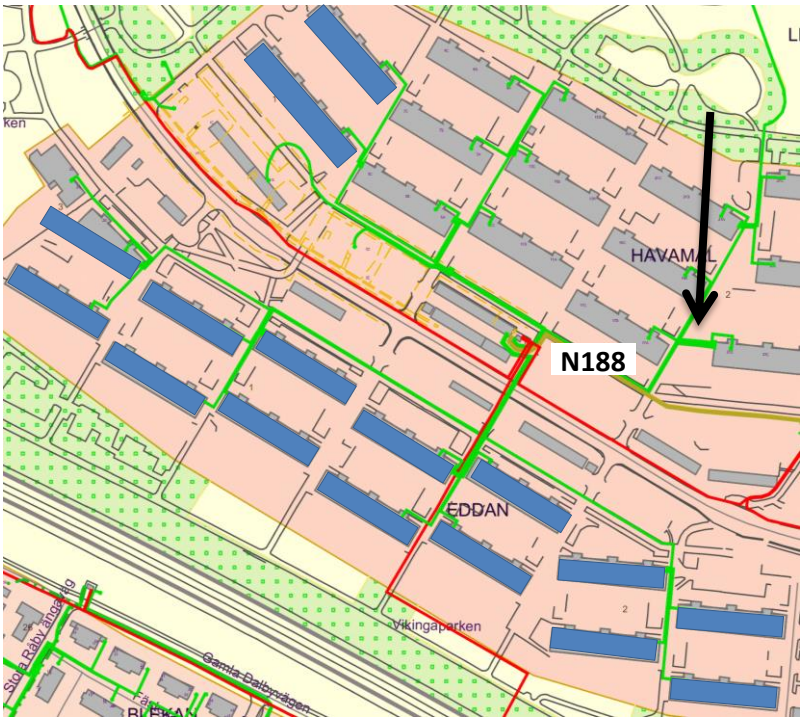


Figure 5.2: The location of the EV charger marked with black arrow. (Source: Kraftringen)

5.3 Visualization

Visualization will be implemented on three levels; district, building and home level. Home level will focus on household electricity use, since that is the parameter that the tenant has the ability and the incitement to influence on the Swedish demo site. Building level will include electricity, heating, and local solar PV production. On district level aggregated use of energy will be visualized in order to evaluate the energy use of the demo site as a whole.

5.3.1 Home

A solution giving the tenant real-time visualization of the household electricity consumption will be implemented. The implemented solution will be set up in order to collect the individual household electricity use according to the picture below. In the first step, the consumer data can also be collected by attaching a clip to the fuse box.

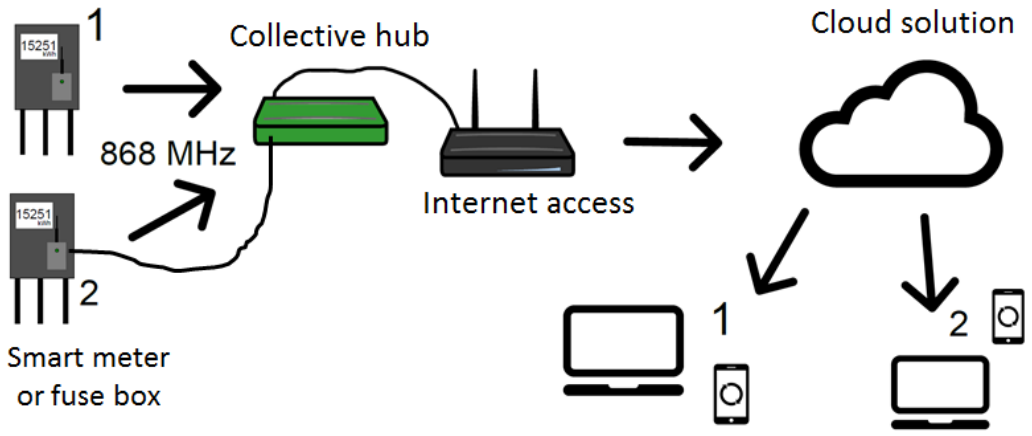


Figure 5.3: Schematic description of home level visualization at the Swedish demo site. (Source: Kraftringen)

The solution will be made available to the tenant through mobile devices such as tablets and smart phones.

5.3.2 Building

The solution for visualization on building level has a similar set-up as the home level visualization. Data from all meters with information to be visualized will be collected according to the picture below.

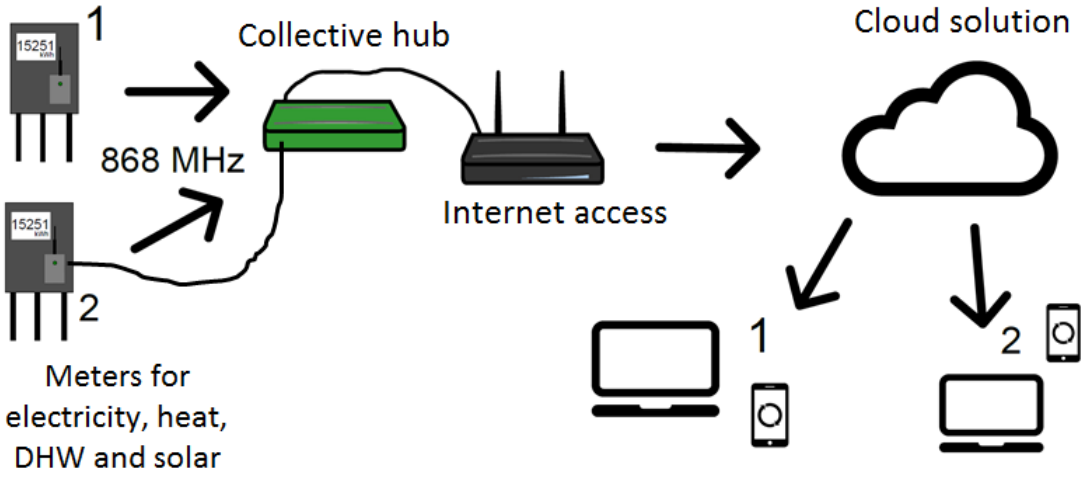


Figure 5.4: Schematic description of building level visualization at the Swedish demo site. (Source: Kraftringen)

The solution will be made available to the tenant through stationary screens in the buildings. The energy use of the buildings in the demo site area will be intercomparable, as is exemplified in the picture below.

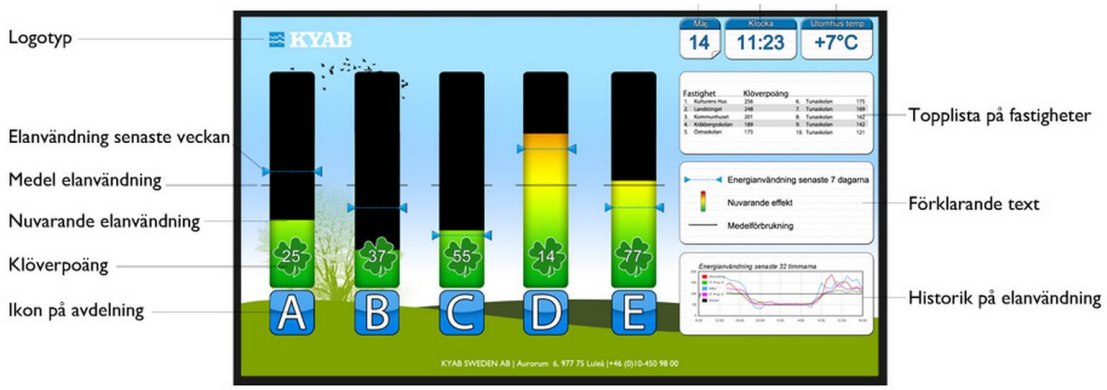


Figure 5.5: Example of building level visualization at the Swedish demo site. (Source: Kraftringen)

5.3.3 District

The district level visualization will use the same set up as the building level. On district level aggregated use of energy will be visualized in order to evaluate the energy use of the demo site as a whole.

District level visualization will be made available to the tenants on the most suitable common areas synced with the renovation process.

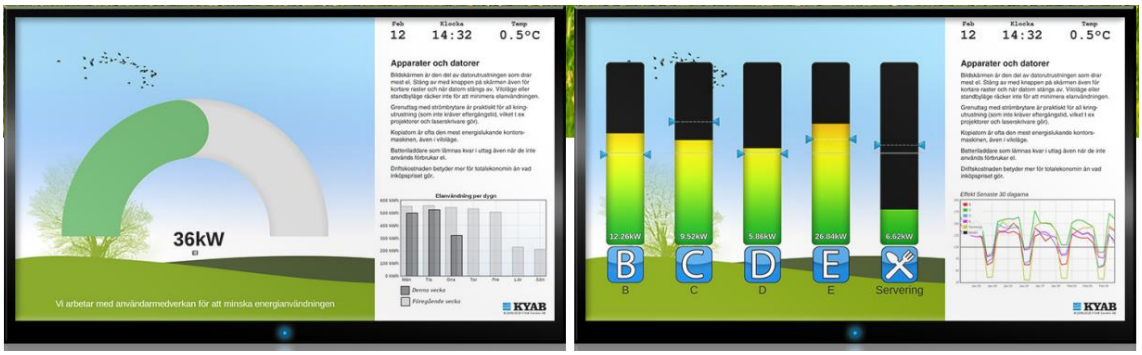


Figure 5.6: Example of district level visualization at the Swedish demo site. (Source: Kraftringen)

5.4 Demand response

In the application for energy visualisation of the apartment, possibilities for controlling loads are integrated. From the application loads can be remotely turned on and off. Also more advanced control is possible, for example schemes for loads can be introduced and some selected loads can be turned off when the total power reaches a defined level.

5.5 Smart meters

The smart meters to be installed are supplied by Sagemcom, type CX2000-9, Figure 5.7. This smart meter is also compatible with the new power line communication, third generation (G3-PLC) that will be applied in the CITyFiED area.

For the moment there is only one supplier that has electricity meters compatible with G3-PLC. Several companies have been consulted and within one or two years there will probably be several G3-PLC compatible products on the market.

Figure 5.7: The new smart meter with enhanced power quality functions and next generation (G3-PLC) power line communication (PLC). (Source: Sagemcom)

The CX2000-9 smart meter performs the following measurements:

- Imported and exported active energy measurement (in compliance with the standard IEC 62053-21 Class 1 and EN 50470-3 Class B)
- Imported and exported reactive energy on four quadrants (in compliance with the standard IEC 62053-23 Class 2)
- Instantaneous voltage
- Instantaneous current
- Instantaneous active imported power
- Instantaneous power
- Instantaneous apparent power
- Instantaneous reactive power.

All of these data are displayed on the front LCD-panel but are also remotely available via the G3-PLC. Also a number of calculated values from these measured values can be made available.

The meter also supports different smart grid functionalities. For example time of use functionalities like tariff management, automatic billing period system and generation of load profiles. Furthermore there are functionalities for remote customer power disconnection by one latching relay per phase and management of maximum demand. There is also an optical interface for local communication of energy measurements to third party equipment.

Power quality functions are for example registration and remote collection of quality parameters like power failure, voltage sags and voltage swells. There is also a possibility of defining allowed intervals for quality parameters where if a parameter is outside an allowed interval an alarm signal is tripped and pushed to the system operator.

The electricity meters in the CITyFiED buildings are located in the basement of each building. Each apartment and the building electricity are separately measured. All meters, about 410 pieces, will be exchanged.

5.6 Power line communication

Measurements from the existing electricity meters in the CITyFiED area are collected on the power lines by power line communication (PLC). However noise on the power lines, originated from for example electronic devices connected to the power grid, sometimes interfere the communication. With an increase in photovoltaics and other local electricity production sources connected to the grid by power electronic converters these problems are assumed to increase.

In order to handle this communication problem the new generation power line communication, G3-PLC, will be tested in CITyFiED. This is a more robust and accessible technology.

Figure 5.8 shows the existing complete measurement system with the automatic reading system (AMR) and the automatic meter management system (AMM), Metrima MActor.

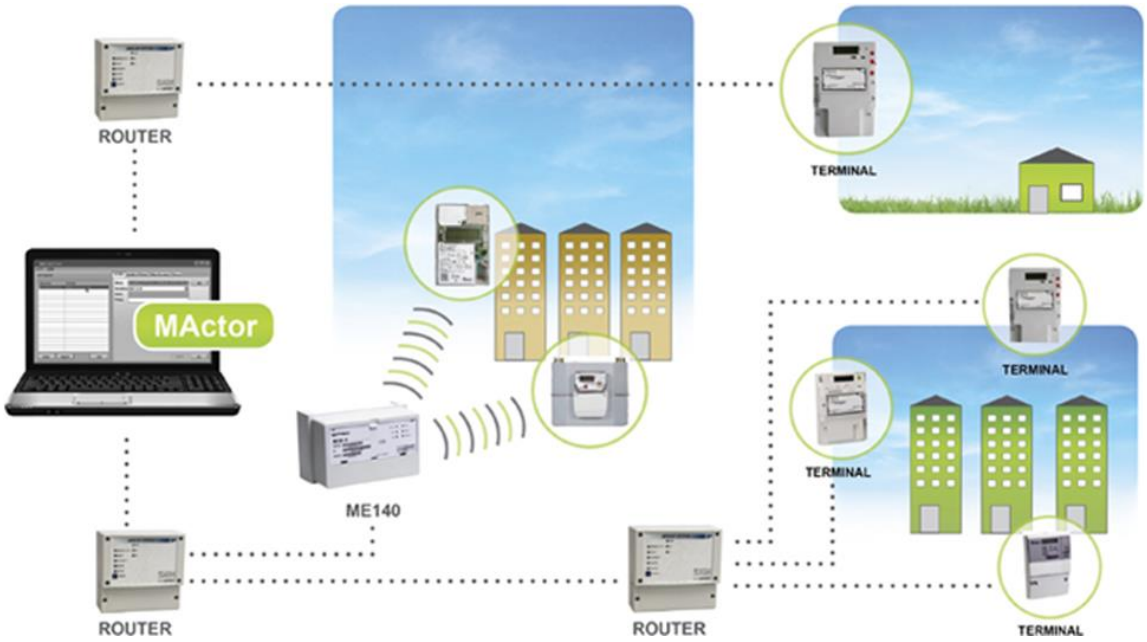


Figure 5.8: Existing solution of AMR (Automatic Meter Reading) with an AMM (Automatic Meter Management) system MActor from the Swedish supplier Metrima AB www.metrima.com/en/. (Source: Metrima)

Figure 5.9 shows the new solution still using the existing MActor system. A new router/concentrator will be installed in the substation N188 in parallel with the existing router/concentrator. These two have to be able to coexist in order to be able to handle both the new G3-PLC and the existing PLC technology for meters in non-CITyFiED buildings.

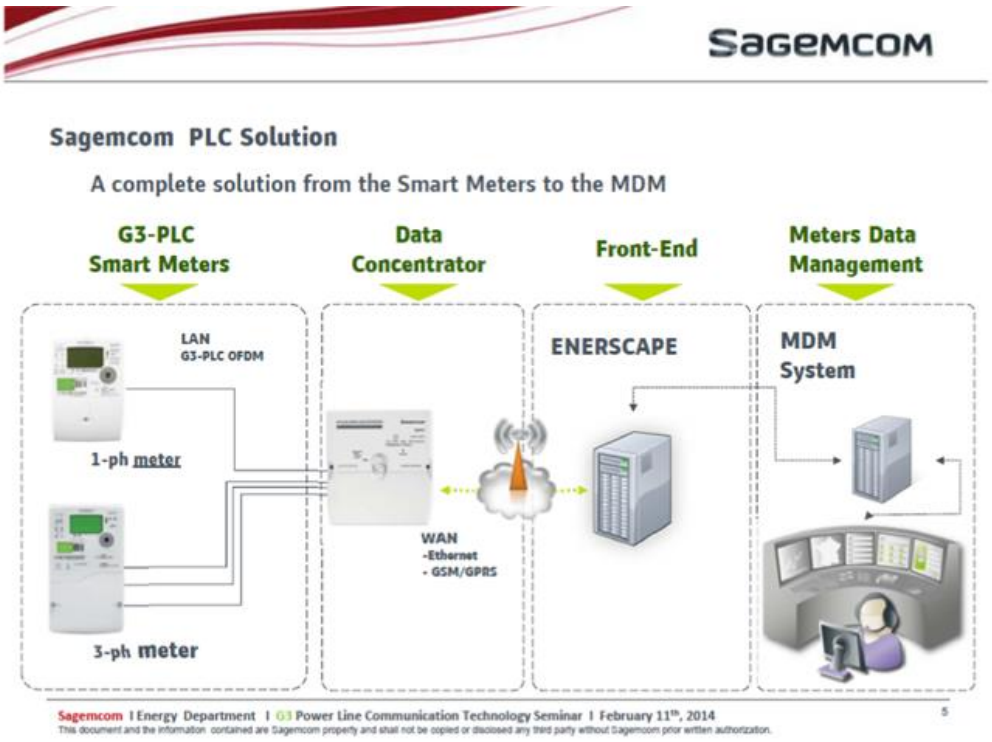


Figure 5.9: The new solution with G3-PLC. The MDM system is the existing MActor system, AMR and AMM system. (Source: Sagemcom).

For the G3-PLC a system from Sagemcom is chosen, consisting of a data concentrator, type XP4000, and a head end system (interface to the existing MActor system), Comserver Meterscape. The concentrator will be installed in substation N188.

The chosen solution for power line communication enables to extend the existing measurement system to also handle G3-PLC. It will also be possible to connect different types of smart meters from different suppliers when they are available on the market.

5.7 Power quality meters

Nine identical power quality meters will be installed in the substations N067, N194, N188, N481, N185, N2379, N189,N187, and N199. An additional power quality meter will be installed in N188, the substation directly feeding the CITyFiED area. This is to be able to evaluate the different types of meters.

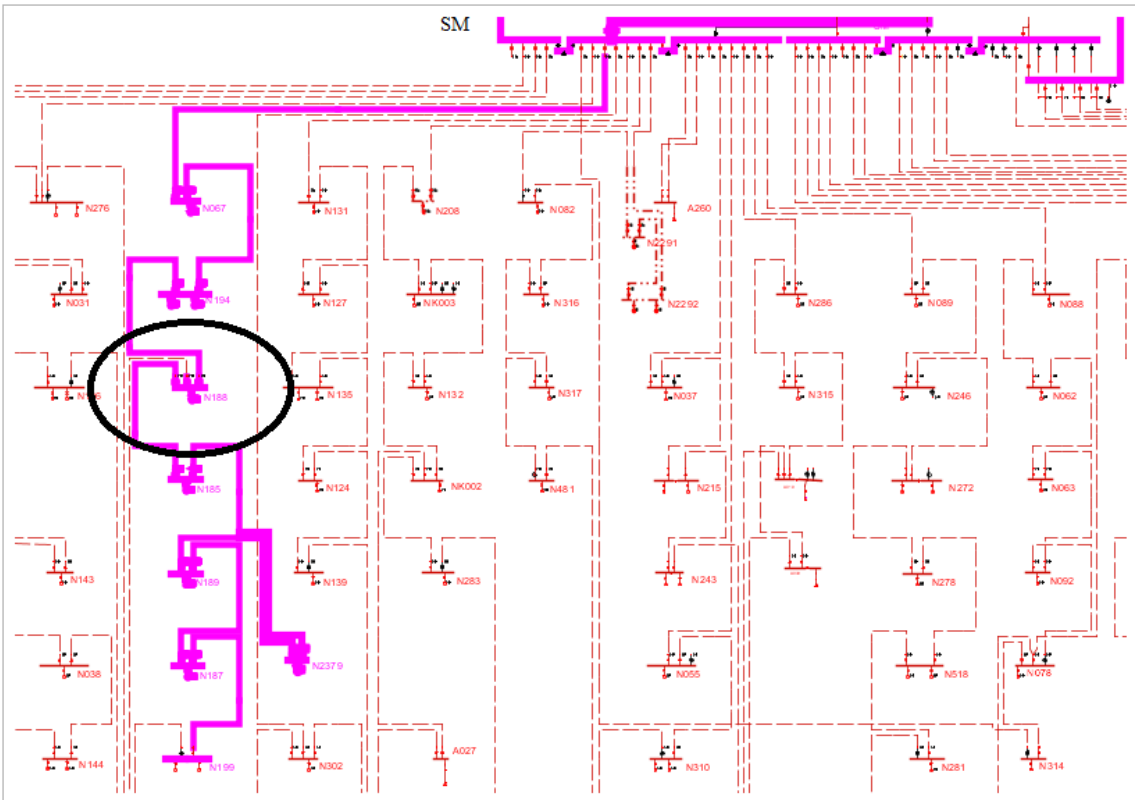


Figure 5.10: Single line schematic over the Linero electrical grid. (Source: Kraftringen)

The quality standard that will be confirmed by the power quality measurement is the European standard EN 50160. The standard regulates requirements of the following parameters that will be monitored by the quality meters:

- Frequency
- slow voltage changes
- rapid voltage changes

- flicker
- voltage dips
- short interruptions of supply
- random long supply interruptions
- temporary power frequency overvoltage
- transient overvoltage
- transient unbalance
- harmonic voltage
- between harmonic voltage and
- signal voltages.

In station N188, the one closest to the demo site, an additional quality meter that can measure noise will be installed. The noise will be measured in the frequency spectrum of 3-150 kHz, the same as the communication of the PLC. This is to ensure that problematic existing noise that interferes with the automatic meter reading system (AMR) can be investigated. All equipment will be installed on the secondary side of the transformer located in the nine substations.

The products that will be used are from the supplier Swemet, type PQA 400 (1 piece) [10] and Metrum, type SC [11] (9 pieces), see Figure 5.11.

Figure 5.11: Left: PQ meter from Swemet (Swemet PQA 400) meter with possibility to analyse frequency spectrum in area of PLC communication 3-150 kHz www.swemet.se. (Source: Swemet). Right: PQ meter from Metrum (Metrum SC) www.metrum.se. (Source: Metrum)

The data from the measurements will be collected through a 3G wireless system and can be analysed by the grid operator by a provided database viewer and analyser.

5.8 Grid monitoring

Equipment for grid monitoring will be installed in the 130/10 kV distribution station feeding Linero (SM). The product that will be used is called dBox, supplied by dLaboratory Sweden AB.

Figure 5.12: The measurement unit of the dBox from dLaboratory

The equipment continuously monitors all feeders in the distribution station and automatically analyses detected faults and disturbances. The analysed disturbances are saved in a searchable database and made available through a web interface.

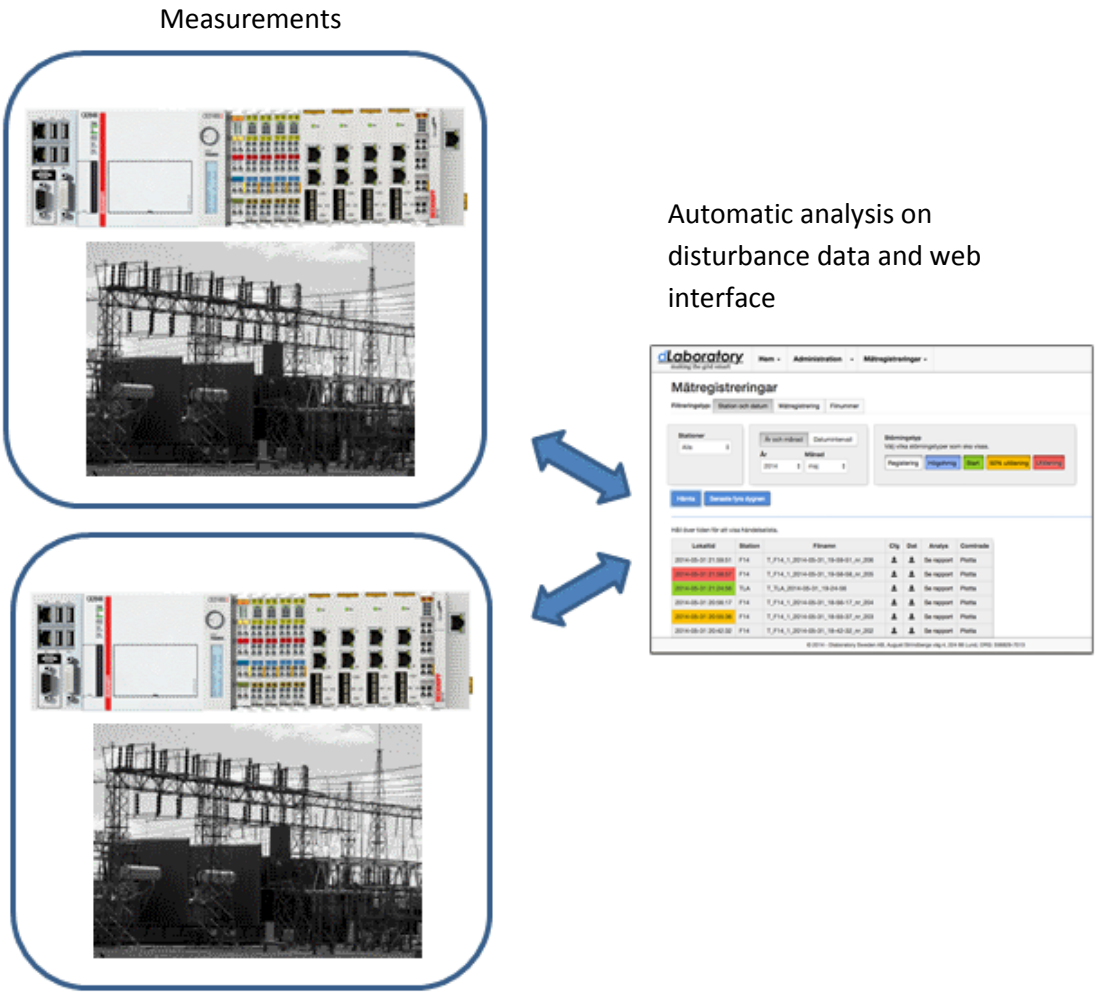


Figure 5.13: The measured data is collected, analysed and presented on a web interface

The high quality measurements enable new analysing possibilities, which make it easier to find the cause for interruptions. From the analyses it is possible to get information of the probable cause and location of the fault and enables to prevent more severe faults. The automatic analysis also sends immediate warnings by email about disturbances and initial stage errors to selected persons.

The disturbance information is sent to the grid operator by wireless communication (3G). The analyses help the grid operator to find out the cause of a fault and thereby to improve the recovery time.

The measurement input for the system are collected by a voltage transducer on the secondary side of the existing voltage transformer on the rail and current transducers on the secondary side of the current transformers in each feeder of the station. In addition to that only 400 V voltage supply and a communication channel, in this case 3G, is needed.

6 Tenants (End-users) acceptance

LKF is required, by law, to collect redevelopment agreement from all tenants to be able to begin the retrofitting, see Annex A and [13]. During the years of retrofitting, LKF has identified that information to tenants is of great importance for a successful progress of a project. The section below describes how the tenant process is controlled by policies and law in Sweden and how it is dealt with within LKF.

6.1 The Swedish Union of Tenants

The Swedish Union of Tenants [12] is a democratic membership organisation for tenants. The Swedish Union of Tenants promotes the right of everyone to good, affordable housing. Their vision is secure housing that promotes human and social development. Over half a million households in Sweden are members of the Union of Tenants.

The Swedish Union of Tenants

- has no party political affiliation.
- negotiates with landlords concerning rents and terms and conditions of housing.
- answers questions from members and provides support in dealings with landlords.
- works with opinion-shaping and lobbying policymakers to improve conditions for tenants.
- helps members to personally make a difference in their housing.

LKF has a negotiating agreement with the Union of Tenants. This means that as a landlord LKF is required to negotiate on rents. For the Union of Tenants this means a right to request negotiations. Both sides can also bring up other terms and conditions related to rents, for example the condition of flats, laundry rooms, parking and other matters affecting tenants collectively.

6.1.1 Tenant influence through the local tenant union

The goal of tenant influence is to give tenants increased involvement in their domestic environment and to improve solidarity and engagement in their own residential area. Tenant influence is regulated in an agreement between LKF and the Union of Tenants.

Work on tenant influence takes place through the local tenants union. The local tenants union represents the tenants in the area. Members – often three to nine of them - are selected at a housing meeting. Housing meetings are for all tenants. They are held often enough to deal with current and important issues. Tenants can make their voices heard on a variety of different proposals.

The local tenants union appoints two representatives to the housing council. The housing council meets twice a year. LKF informs the tenants about administrative issues and other important issues. For example, information about maintenance measures, janitorial issues and issues related to the outdoor environment.

LKF and the Union of Tenants have agreed on an approach on tenant influence to the refurbishment of 1960's and 1970's areas. LKF and the Union of Tenants appoint representatives to the Tenant Influence Committee, a superordinate body. The Tenant Influence Committee meets four times a year. At every meeting LKF reports on planned and ongoing construction projects. This provides the local tenants union with information about planned refurbishment projects.

6.2 "Lundamodellen" - a method for fair rent

LKF set their rents according to a political model called the "lundamodellen" [13]. The aim of "Lundamodellen" (The Lund model) is to set the rent on rented flats in Lund based on a valuation of each individual flat, so that differences in their utility value is reflected by reasonable differences in rent.

6.2.1 Attributes that affect rents

In the "Lundamodellen" the rent is influenced by four main groups of attributes. Based on these attributes each flat receives a certain number of points. After calculation, the number of points determines how high the rent will be.

The most important attributes when setting points are the **size and type of flat**. Size means the floor area of the flat. Type indicates how many rooms and what type of kitchen the flat has. Points also depend on the type of building in which the flat is located, for example high rise buildings (higher than two floors), low-rise buildings or terraced houses.

A third category of attributes relates to the **flat's modernity and standard**. Modernity is determined by the year in which it was built. Newer properties have a higher standard and thus a higher degree of modernity than older ones. Modernisation and refurbishment also result in a higher value. The standard is influenced by the property's equipment and technical standard, accessibility, outdoor environment and access to broadband and cable television. The standard is also influenced by whether the flat has a balcony or patio, extra toilet, parquet floor, storeroom or parking space.

The property's geographical location, i.e. where it is situated, makes up the fourth main attribute.

Tenants can see the attributes on which their rents are based. This information is always available on the tenant's page on the internet.

6.2.2 The Lundamodellen in relation to refurbishment

When homes are renovated, they become more modern, which has an impact on their utility value. The tenant must approve the intervention in advance if the landlord is to be permitted to increase the rent. The rent increase then depends on how much the modernisation affects the utility value. Modernisation measures that have the greatest impact on utility value are those that affect the bathroom and kitchen. In these cases, the age/standard of the spaces and what is replaced/ modernised is significant. The older the space being renovated, and the greater the impact on utility value of the fittings and equipment being replaced, the higher the degree of modernisation and thus the higher the rent increase.

6.3 Retrofitting agreements

According to Swedish tenancy legislation [14], a tenant has some influence over the retrofitting of their flat and the common parts of a property. This influence relates to significant measures to raise the standard of the flat's utility value (and thus the rent on the flat) and significant measures to retrofit the flat or common areas in the property. In order for the property owner/landlord to undertake such measures, a retrofitting agreement of each tenant is required. If measures cover the common areas of the property, the approval of at least half of the affected tenants is required. Pure maintenance and repair procedures do not require approval.

Approval must be preceded by written information about the measures and is generally formalized in a written agreement between the landlord and tenant. This is called a retrofitting agreement or a tenant approval.

An approval is required for measures that raise the standard of a flat and that affect the rent. Rents are determined following a negotiation and an agreement between the landlord and the Union of Tenants. It is desirable to complete these negotiations before the individual tenants are asked to take a position on the implementation of the measures.

Tenant influence does not mean an absolute veto on the landlord's wish to refurbish the property. If the parties do not agree, a court – The Rent Tribunal – can assess the case and decide on whether refurbishment can take place or not. In such an assessment the interests of the landlord are weighed, in the first instance, against the interests of the tenants in not having the retrofitting undertaken. The Rent Tribunal's decision can be reviewed by one higher court.

Obviously the above process can make the planning of the retrofitting somewhat problematic. However, intensive communication and collaboration with the tenants are often effective measures to ensure a smooth implementation.

6.4 Retrofitting information process of LKF

By informing tenants in good time, they can process the information and get used to the idea that their apartment will be improved and that there will be construction works performed in their apartment for a short period of time.

For the convenience of the tenants, LKF has developed a process of communication. The dialogue process of tenants and dialogue with The Swedish Union of Tenants runs parallel to the planning of the renovation project; inventories, planning, planning application and specifications. This means that tenants feel involved and receive information about the ongoing project.

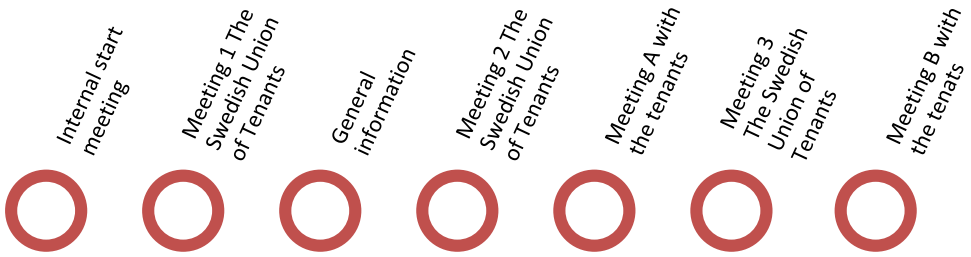


Figure 6.1 The process of different meeting with the tenant and Union of Tenants

When the most basic frame work of the project is internally mapped LKF have a meeting with the Union of Tenants and the local Union of Tenants. The aim of this meeting is to provide the Union of Tenants with a background to the planned refurbishment project, its estimated scope and a timetable. This meeting takes place before information is given to the tenants.

After the meeting with the Union of Tenants a general information letter is sent to all tenants in the area. This letter informs about the plans for an upcoming renovation project in the residential area. In general this information is send to tenants about a year before the construction starts in the area.

Two months after the general information letter there is a seconds meeting with the Union of Tenants. Information about the current state of the project and the rough plans of the renovation strategy is shared at this meeting

After the second meeting with the Union of Tenants, the tenants gets a notice to attend meeting A to get more information on the retrofitting project. A notice to attend to a meeting is sent out one month before the meeting takes place so that the tenants have the opportunity to submit comments and questions at forehand. A reminder is sent to the tenants a week before the information meeting will take place. The reminder is sent as a part to remind tenants about the meeting but also to encourage more tenants to attend. At the meeting, the tenants have the opportunity to get answers to their questions regarding the project. In order to assure that all tenants in the residential area receive the same information about the renovation project a written information letter is sent after the meeting to all tenants.

When the retrofitting strategy is more established it is time for the third meeting with the Union of Tenants to present the retrofitting strategy and discuss the proposals on an increase of rent according to the “Lundamodellen”. The rent must be preliminarily negotiated with the Union of Tenants before retrofitting agreement where the expected rent shall be stated, are sent out to tenants.

When the retrofitting strategy is defined and retrofitting agreement is settled the tenants are invited to meeting B. At this meeting LKF present the final retrofitting strategy for the retrofitting project, all increase in rent and how the retrofitting will affect each individual tenant. During the meeting the retrofitting agreements is explained in detail so that tenants can get answers to their questions during the meeting. The retrofitting agreements are handed out during the meeting or sent to each tenant. Some weeks after that all tenants received their retrofitting agreements, they are invited to open house where representatives from LKF can answer their questions about retrofitting agreements individually face to face. Those who haven’t sent in their retrofitting agreements will receive a reminder a week before the deadline runs out. In order to solve any problems we keep contact with the tenants who did not submit their retrofitting agreements when the deadline expired to investigate why they did not submit the contract. The missing approvals often depends on lack of information about the project and can be solved by a private meeting to learn more about the project before signing the agreement. If the tenant does not want to sign despite the above dialogue, the matter may be forced to move to the Rent Tribunal, a process that can take up to 3 months before the case is heard and a decision can be provided.

When the tenants have signed the retrofitting agreements, the procurement phase is over and the project has a turnkey constructer, a last meeting is held with the tenants. At the meeting the turnkey contractor will have the opportunity to introduce themselves and provide information about the work that they will perform in the tenant's home. When the tenants have the opportunity to meet with contractors before construction it creates a sense of security. They have a name and a face to the people responsible that will perform the work in the tenant's home.

All tenants of residential Linero have received the same general information. The tenants of pilot house, Vikingavägen 26, have also received more detailed information because this house is the first in the retrofitting. Certain steps in the communication process is repeated when we go into the different stages and the current tenants will receive more detailed information on the measures, renovation contracts and increase in rent.

Process of communication for Eddan & Havamal	
Meeting 1 with the Union of Tenants	January 2014
Letter containing general information	January 2014
Meeting 2 with the Union of Tenants	February 2014
Invite to the meeting A with the tenants at Vikingavägen 26 & 28	February 2014
Reminder for the information meeting A	Mars 2014

Process of communication for Eddan & Havamal	
Meeting A for the tenants living at: Vikingavägen 26 & 28	Mars 2014
Information folder after the meeting for Vikingavägen 26 & 28	Mars 2014
Invite to information meeting A and a workshop for Eddan & Havamal	September 2014
Reminder for the information meeting A	October 2014
The information meeting A and workshop for Eddan & Havamal	Oktober2014
Information folder	November 2014
Meeting 3 with the Union of Tenants	November/December 2014
Invite to information meeting B regarding the retrofitting agreements - Vikingavägen 26	December 2014
Reminder	January 2015
The information meeting B regarding the retrofitting agreements - Vikingavägen 26	January 2015
Retrofitting agreements - Vikingavägen 26	January 2015
Information folder - Vikingavägen 26	January 2015
Deadline for Tenant approval - Vikingavägen 26	February 2015
Newsletter for all tenants	February 2015
Invite to information meeting C, with the contractor - Vikingavägen 26	February/March 2015
Reminder	March 2015
information meeting C, with the contractor - Vikingavägen 26	March 2015

Table 6.1: Information process for the tenants at Eddan and Havamal to the present date.

6.5 Privacy protection law

When dealing with the tenants individual electrical consumption patterns, these have to be protected according to the privacy protection law [Personuppgiftslag (1998:204)]. This means that no individual consumption can be distributed freely, without the acceptance and allowance of the tenant.

7 Procurement processes

The sections below describe all the licences and permits that are needed for a retrofitting process in Sweden. KEAB as well as LKF are publicly owned companies and thereby regulated by the Swedish Public Procurement Act. This process is therefore further described below.

7.1 Licences and permits for the retrofitting measures

The retrofitting of the buildings and the installation of photovoltaics requires a building permit.

For the district heating renovation there is instead a need of a permit for excavation in public land for the pipes in areas owned by the municipality. For the pipes in areas owned by LKF an agreement between KEAB and LKF instead has been negotiated.

The smart grid applications that include installation on the electricity grid has to follow the distribution system operator's grid connection guidelines.

Permission to install the EV charger must be granted by the land owner. In the Linero area LKF and the municipality of Lund owns the land and permission will be ensured by the Lund site project group.

7.1.1 Building permit

The Planning and Building Act [15] indicates when a building consent is required to erect or modify a building. Normally building consent is required for new build, extension and modification, although there are some exceptions. Application for building consent is made to and granted by the municipality. Municipal public servants administer the process and a politically appointed planning and building committee makes the decision. In straightforward cases the decision can be delegated to public servants employed in the municipality's administration.

The construction client employs an architect to design buildings that meet the requirements of the construction client and of the detailed development plan. After that an application for building consent is submitted to the municipality. The application shall include, in addition to an application form filled in and signed by the construction client, information about the responsible inspector appointed, drawings and other documents showing that the building fulfils both the requirements of the detailed development plan and building legislation as a whole.

Recently, requirements related to the documentation to be enclosed have been raised. This is because in the past many building permits were issued without it being possible to ensure that the building would fulfil all the requirements. Normally today the application must be supplemented by drawings, illustrations, a parking study, accessibility certificate, noise study etc.

When the building consent officer considers that the documentary basis for assessment is complete, the stipulated processing time (maximum) 10 weeks starts to run. If there are special circumstances, the processing time may be extended for another 10 weeks. So building consent can take almost six months.

When the planning and building committee or delegated case officer has made a decision about building consent, this can be appealed to the County Administrative Board. The appeal period is three weeks. The appeal is submitted to the municipality, which in turn submits it to the County Administrative Board (together with the documentation supporting the decision regarding building consent) which must assess whether the decision is correct.

If no appeal is made, or when a review has taken place, the building consent decision enters into force. After that it can no longer be appealed.

A building can also be started before building consent enters into force, on condition that the construction client has obtained a start certificate. A start certificate can be granted if the municipality deems that all requirements will be met. In order for the planning and building committee to take a view as to whether the requirements will be fulfilled, the construction client must submit proposals for an inspection plan as well as the technical documents which are required, in addition to the application documents. However, any construction before building consent has entered into force legal force, takes place at the construction client's own risk.

It could be said that the building consent process is completed when the end certificate has been issued. The end certificate is issued by the municipality when all of the requirements in the building consent and inspection plan etc., have been fulfilled.

Start-up and final clearance

The conditions regarding start-up and final clearance are regulated in the Swedish planning and building code (PBL) [15]

An action that requires a building permit shall not commence before the Planning Committee has granted a so-called start-up notification. If the action starts without a start-up notification it is classed as unauthorized construction and a fine may be imposed. However, in some simple cases, the construction can commence when the building permit is granted since the start-up notification is included in the building permit decision.

A start-up notification is granted when the developer can demonstrate that the building measure complies with current building regulations in the planning and building act and related regulations. In order to make a decision, it is required that the developer submits proposals for an inspection plan and relevant technical documentation concerning the case to the board.

The start-up clearance shall indicate the conditions required to commence work. Furthermore, it shall list which documents the developer and the controller shall submit to the committee prior to a decision on final clearance and if staking is needed. Construction staking means that the proposed action is marked on the plot by survey stakes. The start-up clearance shall also

state whether there are other requirements in other legislation that must be fulfilled. E.g. it could concern a notification or application for an individual sewage treatment system.

Building measures that requires a start-up clearance also requires a final clearance. The final clearance is given if the developer has complied with the requirements and conditions applicable to the measure and if the board has not found reason to intervene with supervision. If the developer does not meet the requirements that apply to the final clearance, the board may, under certain circumstances, provide a temporary clearance, a so-called interim final clearance pending a final clearance. Normally it is not allowed to take the construction into service without a final or interim final clearance. The board can however, make an exception and in the startup clearance specify whether the construction in whole or in part can be utilized without a final clearance.

The inspector

For actions that require a building permit, demolition permit, ground permit or notification, the developer must appoint one or more inspectors (KA), according to the Planning and building act [15]. The controller´s main task is to ensure that the building project meets the requirements of the PBL (Planning and Building Act). However, in some simple cases, a controller is not required if the developer can be expected to fulfil his responsibilities without support. The control manager shall be certified and have an independent position, which in practice means that he or she cannot work at the same company that builds or orders the construction.

By law the inspector shall ensure that the inspections plan and the rules and conditions for the measures are followed. The developer, however, is solely responsible for ensuring that the requirements of the PBL are met and that inspections are carried out sufficiently.

The inspector shall also attend technical consultations, inspections and other controls such as "on site" inspection by the Building committee. Furthermore, the inspector shall document his or her visits and observations. The developer should be informed of any deviations from the regulations or conditions. If necessary, the planning and building committee should also be informed. Finally, the inspection officer should also write a statement to the developer and the planning and building committee as a basis for the final clearance.

The inspection and test plan

The inspection and test plan is put together to ensure that the construction project fulfills the regulatory requirements and the provisions of the PBL (Planning and Building Act).The inspection plan is a document specifying which inspections that must be carried out and the subject of these inspections. It should also clearly state who is to carry out the inspections. Each plan is object specific. Critical control points can be: technical fire documentation, acoustic measurements and concerns during measures in historically valuable buildings.

The inspection plan should also state which notifications that need to be reported to the planning and building committee as well as which site visits the committee should carry out and when they should be done. Furthermore, the plan must contain information about any

hazardous waste the measures can result in and how this and other waste will be taken care of.

Technical consultation

In some cases, there must be a technical consultation with the building committee. A consultation must be held if the building measure requires a controller or if the developer has requested a technical consultation. The developer and the Inspector or inspectors must be present at the consultation.

The consultation includes a review of how the work should be planned and organized and of the control plan and other technical documents submitted to the planning and building committee. If the measure concerns a demolition, a discussion regarding how to inventory potentially hazardous waste should be included in the technical consultation. The consultation ensures that all involved has an overview of what will be done, in what order it will be done and who does what in the process.

At the consultation it is also decided whether the committee shall conduct visits at the building site or if other enforcement actions are needed. It is not necessary to have a site visit, but in most cases there is at least one. For large and / or complex construction projects there will always be at least one site visit

Normally, when building measures require a technical consultation there should also be a final consultation before the final clearance is issued. The planning and building committee assesses if there is a need.

7.1.2 Excavation permit

Before excavation and pipeline work in public land may take place a permit has to be issued by the Technical administration of the municipality "Excavation Regulations for public land in the Lund Municipality". (Grävningsbestämmelser för allmän platsmark i Lunds Kommun) [16]. An application for permit shall be made at least four weeks prior to the work to begin.

The application must include drawings showing the location of the pipes, location depth, and excavation width and pipe dimensions. In the drawing the bound of public land must be clearly stated. Also the soil conditions for the location of the pipes must be presented, such as vegetation, sidewalks, pedestrian and bicycle paths, etc. In the application also the contractor of the excavation shall be stated.

7.1.3 Grid approval and electric grid regulations

All new electrical installations on the distribution grid must be approved by the distribution system operator (DSO) and be performed in line with the grid principals.

For grid approval the installation must be in compliance with the DSO´s guidelines "General guidelines for electricity connection and metering within Kraftringen" ("Generella anvisningar

för servisanslutning och mätning inom Kraftringen) [17]. This guideline states the obligation to report new and changed installations connected to the grid and some technical demands on the installation.

The reporting procedure for grid approval starts with an advance registration from the electricity installer to the DSO, the DSO checks the ability of the grid to handle the connection and returns to the installer with an approval of connection. When the installation is completed the installer submits a ready registration to the DSO and the DSO returns with an approval for commissioning. The reporting procedure between the installer and the DSO is handled by a web interface, Elsmart.

In the case with a new PV installation the DSO perform some additional work, before approval, in order to verify that the electricity fed into the grid not affects the electricity security and power quality in a harmful way. This verification needs some data from the supplier.

In order to get the necessary data the distribution system operator normally uses a form (in Swedish: MIKRO-blankett) produced by the Swedish energy company association Swedenergy (Svensk Energi). The installer submits data including manufacturer and type, nominal power, number of phases, protection settings (according to SS-EN50438), and power quality data on flicker (according to EN 61000-3-3).

7.2 Public procurement of equipment and installers

KEAB as well as LKF are publicly owned companies and thereby regulated by the Swedish Public Procurement Act as described below. The Retrofitting of the buildings as well as the installation of photovoltaics will exceed threshold levels for public procurement and fall under this process.

The rest of the works at KEAB in the different areas in the CITyFiED project are separate installations and consequently separately purchased.

The retrofitting as well as the installation of photovoltaics will be performed by turnkey contractors as described below. The interior primary connection of the substations for the district heating renovation as well as the rest of installations on the smart grid will be performed by KEAB personnel.

7.2.1 The Public Procurement Act

The Swedish Public Procurement Act regulates purchases made by public authorities and certain other organizations financed with public funds. In addition to municipalities, county councils and state authorities, this includes publicly owned companies, and certain other organizations close to these. The Act is based on the EU directive 2004/18/EG, and is thus an adaptation of Swedish practice to the EU [18].

The Act regulates in detail how those responsible for following the Public Procurement Act should act when purchasing goods, services and contracts. The key rule is that all purchases of

goods and services required by a contracting authority must undergo a procurement process. A contracting authority may not go directly to only one supplier except in a few, specific situations. Procurement and negotiations are to be advertised so that all interested companies are able to submit tenders.

The requirements set must also be specified in a contract specification. Authorities must provide contract specifications and evaluate all tenders. Evaluation is to take place on an objective basis, and must not deviate from the evaluation method announced in the contract specification. The result of the evaluation is to determine the winner of the contract, and this is to be announced in an award decision. An entity that has submitted a tender and which has objections to the objectivity of the management of the procurement process by the authority can address these to the Administrative Court in the county in which the procurement was carried out with an application for a review.

The rules, that are common to the entire EU internal market, only apply to purchases above a certain value, the threshold value. The process stipulated for all purchases above the threshold value are relatively detailed. Direct procurement may be only be used if the value of the procurement is low or when there are exceptional circumstances. The Public Procurement Act gives the threshold for the direct procurement of goods and services as a maximum of approximately SEK 290,000, and for construction contracts of approximately SEK 48,000,000.

For procurement above the threshold, undertaken in accordance with the Public Procurement Act, the contracting authority can choose between using an open or a restricted procedure.

An *open procedure* is where all suppliers can submit tenders (Chapter 2, Section 22 of the Public Procurement Act).

A *restricted procedure* is where all suppliers can apply to participate, but only tenderers that are invited by the contracting authority or entity to participate, following a selection process, may submit a tender (Chapter 2, Section 16 of the Public Procurement Act). Selection must take place according to the fundamental principles of public procurement.

In an open procedure the minimum time for submitting a tender is 52 days. In a restricted procedure the time is normally 37 days to apply to participate in the procurement process, and a further 40 days to submit a tender.

The winner of the procurement is selected on the basis of price and the fulfilment of requirements. Because of the difficulty in evaluating quality requirements there have often been problems where poor quality suppliers have been selected. The practice has been that public authorities must more or less prove that quality will be poor in order to deselect the lowest tender. After a supplier has been awarded the tender, a 10 day contract block starts (or 15 days if communication cannot take place digitally) before the agreement can be signed. This is so that other parties can submit appeals.

The procurement process, including publication, tender calculation, evaluation and time limits can take several months, in addition to this time is needed to draw up a contract specification

7.2.2 Turnkey contracting

There are three different types of construction contract forms between the client and the constructor; shared construction, general contractor and a turnkey contract. Generally LKF only procures a turnkey contract for the execution of construction projects and renovation projects. In the procurement of a turnkey contract, the client will only write the contract with one main contractor. This turnkey contractor is then responsible for planning and carrying out construction work according to the functional requirements that the client has presented in the specification documents. The construction consists of many different parts that require different skills for example, plumbing, ventilation, electrical, etc. If the turnkey contract does not hold all the expertise within their company they can hire additional contractors to perform the work, known as subcontractor. The turnkey contractor prepares individual contracts with its subcontractors and these are not affected by the agreement between the client and the turnkey contractor. In some cases, the client may approve subcontractors even though it lies within the responsibility of the turn key contractor to add these.

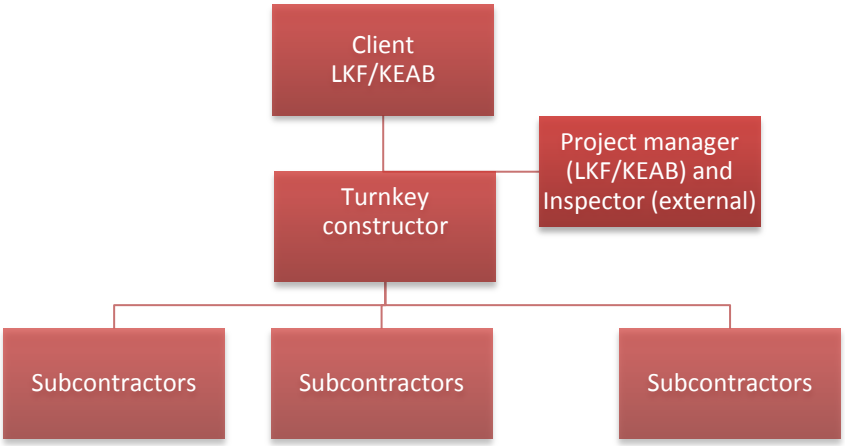


Figure 7.1 Schematic organization of a turnkey contract

A turnkey contract requests the overall responsibility for the retrofitting project. It is important that the client is clear and well-spoken with their functional requirements in the efficiency and indoor environments. The detailed planning starts from what is described in the enquiry, otherwise there is a risk of free interpretation of the turnkey contract [19].

Detailed planning

When a turnkey contractor is procured they will develop the detailed documents for the project. The detailed project plans includes studies, planning and costs for the work of the contractor. However, the technical systems must be reviewed to ensure that they fulfill the client's and the authorities' requirements for functionality, energy efficiency and indoor environments. The detailed planning starts from the enquiry documents and develops into a detailed level of planning the work, times periods, materials, features, etc. Reviewing documents are drawn up and will include features, dimensions and execution. After the

documents are approved by the client they will be seen as final instruction documents. In order to begin construction there has to be approved construction documents detailing the work to be performed.

7.2.3 Turnkey contracting framework for KEAB (Photovoltaics)

The photovoltaics delivery is purchased as a turnkey contract. The contract includes inspection of the existing building, projecting, delivery, installation, commissioning and testing of the complete ready to run photovoltaics installation. The material included consists of: solar panels, stand and attachment for roof mounting, DC to AC-converter and meter for the energy production.

The contractor also provides the necessary documents for the building permit application, see chapter 7.

The KEAB inquiry for tenders includes:

- Framework specification – technical specifications for the PV-plant; electrical and mechanical installation, testing and documentation
- Administrative regulations – regulations regarding procurement and turnkey contract, protection and safety regulations, permits and notifications, organisation, quality assurance, schedule, insurance and warranty
- KEAB´s code of conduct for purchase and procurement – guideline for suppliers and entrepreneurs regarding bribes and benefits, human rights, environment, health and safety, inspections
- Environmental audit of supplier / entrepreneur – questionnaire for completion by suppliers and entrepreneurs regarding environmental management system and certifications, environmental impact and demands
- Tender form – form for completion in order to facilitate comparison; price, brand on PV and converter etc.

8 Planning

8.1 Milestones for the retrofitting intervention in Linero

During a retrofitting, there may be critical steps or milestones that must be met along the project. In this report, as well as the technical definition of the demo site following different steps that may affect the project have been identified and elaborated.

- Procurement
- Board decision
- Retrofitting agreement approved from tenant
- Building permits
- Start Notification
- Timetable
- Inspection
- End Notification

The progress of these milestones is a part of the whole project process. Some of these are already met before construction starts, while others must be met within the project. For the pilot house, milestones such as procurement, retrofitting agreements and the Board's decision are met and work on the next milestone is in progress. Despite the milestone as, for example, retrofitting agreements are completed; situations once work on site begins may still occur. There is always a risk that LKF are not allowed to access to the apartment even though they have the tenant consent. It is difficult to predict the critical steps that may occur during the project. With the help of extensive experience in the retrofitting and working with tenants, preventive efforts are in place to facilitate the process and reduce risk critical moments.

Phase	Time period
Planning	April 2014- April 2015
Construction	April 2015-April 2018
Measurements	April 2018- April 2019

Table 8.1 General Time schedule for all Buildings included in CITyFiED

Phase	Time period
Internal process	Dec 2013 - March2014
Investigation phase	March - July 2014
Pre-planning (Pilot house)	Aug- Oct 2014.
Procurement (Pilot house)	Nov 2014- Jan 2015
Board Decision	28 Jan 2015.
Planning	March- April 2015
Construction (Pilot house)	April - Sep 2015.

Table 8.2. The detailed planning of the Pilot houses

8.2 Milestones for the district heating renovation

The KEAB district heating delivery ranges to the valves on the secondary side of the heat exchanger. After these valves LKF is responsible for the material and installation. The commissioning of the system thereby is determined by the LKF retrofitting process.

Project	Activity	Time period
Exterior piping	Not within the project	---
Substations	Installation start	Q2 2015
	Installation complete	Q2 2015
Smart district heating	Installation start	Q3 2015
	Installation complete	Q3 2015

Table 8.3: Timetable for the district heating renovation.

8.3 Milestones for the Smart Grid interventions

The final specifications for the photovoltaics procurement partly depends on the LKF retrofitting project. No PV will be installed on the pilot building. The procurement of the PV-plant will be coordinated with the LKF large retrofitting process and can be performed earliest after the detailed planning of the large retrofitting part.

The visualization solution is developed within subtask 2.2.2 e in the project, where the final specifications for the solution are set. Thereby the schedule for the technical solution to be installed is coordinated with the schedule of 2.2.2.e. The excavation work for the cable of the EV charger must be coordinated with the ongoing work in the Linero area performed by LKF and in line with that time plan.

Project	Activity	**Time period**
Photovoltaics	Procurement	Q3-Q4 2015
	Turnkey contractor handover	Q1 2016
	Final inspection	Q2 2016
EV charger	Definition of location and technical prerequisites	Q1 2015
	Installation on site	Q1 2016
	Fully operational	Q2 2016
Visualisation	Specification of requirements	Q1 2015
	Test on site	Q2-Q3 2016
	Fully operational	Q4 2016
Smart meters	Acceptance test	Q2 2015
	Fully operational	Q3 2015
Power line communication	Installation of HES in test system	Q1 2015
	Acceptance test	Q2 2015
	Fully operational	Q2 2015
Power quality meters	Procurement	Q2 2015
	Installation on site	Q3 2015
	Fully operational	Q4 2015
Grid monitoring	Installation on site	Q3 2015
	Fully operational	Q4 2015

Table 8.4: Timetable for the smart grid applications.

9 Conclusions

The final retrofitting strategy included in CITyFiED is in line with the Swedish Building Regulation incentives to reduce bought energy consumption and exceeds the goal for energy efficiency measures and renewables set up in the Best table of the CITyFiED project. It also meets the demand for ventilation according to Swedish regulation. It is in line with the affordability demands for the tenants and presents an overall decreased environmental impact in regard to CO_2 and Primary energy.

The chosen renovation strategy balance environmental impact, energy savings and affordable housing in the best way for the Linero demonstration case according to best available technology, legislation and practice.The retrofitting strategy includes following measures:

- Replacing windows on the south side floor 1 and 2
- Replacing balcony doors on the south side floor 1 and 2
- Additional wall insulation on the southern long side of floor 1 and 2
- Additional roof insulation
- Reduction of the interior temperature
- Replacement of radiator thermostat
- Glazing of balconies
- Change stairwell lighting to LED and install presence control
- Change the lighting in the cellar to LED and install presence control
- Change the lighting at the entrance and gable ends to LED
- New culvert solution
- Upgrading of the ventilation system
- Exhaust air heat pump
- Individual metering and billing
- Replace bathtubs with shower

In addition to the retrofitting strategy for the buildings existing energy systems will become more efficient and innovative, and concept solutions will be tested in in full size. This includes the following:

- Develop existing monitoring sub stations system from the three current levels Building, District and the Grid /system as well as a fourth level that transmit data reports from Lund site to a comprehensive CITyFiED database
- Replacement of the one existing district heating substations to 6 new custom and prefabricated efficient modulars.
- Installing solar cells,

- Installing an electrical vehicle fast charging station
- An electrical smart grid architecture consisting of the following:.
  - Visualization.
  - Demand response.
  - Smart meters.
  - Power line communication (PLC).
  - Power quality meters (PQM).
  - Grid monitoring and fault detection (GM-FD).

Procurement and regulations

KEAB as well as LKF are publicly owned companies and thereby regulated by the Swedish Public Procurement Act. The Retrofitting of the buildings as well as the installation of photovoltaics will exceed threshold levels for public procurement and fall under this process.

The rest of the works at KEAB in the different areas in the CITyFiED project are separate installations and consequently separately purchased.

The retrofitting as well as the installation of photovoltaics will be performed by turnkey contractors. The interior primary connection of the substations for the district heating renovation as well as the rest of installations on the smart grid will be performed by KEAB personnel.

The retrofitting of the buildings and the installation of photovoltaics requires a building permit For the district heating renovation there is instead a need of a permit for excavation in public land. For the pipes in areas owned by LKF an agreement between KEAB and LKF has instead been negotiated.

The smart grid application that includes installation on the electricity grid has to follow the distribution system operator's grid connection guidelines for grid approval. Permission to install the EV charger must be granted by the land owner. In the Linero area LKF and the municipality of Lund owns the land and permission will be ensured by the Lund site project group.

Tenant acceptance

LKF set their rents according to a political model called the "lundamodellen". The aim of "Lundamodellen" (The Lund model) is to set the rent on rented flats in Lund based on a valuation of each individual flat, so that differences in their utility value is reflected by reasonable differences in rent.

According to Swedish tenancy legislation, a tenant has some influence over the retrofitting of their flat and the common parts of a property. This influence relates to significant measures to raise the standard of the flat's utility value (and thus the rent on the flat) and significant measures to retrofit the flat or common areas in the property. In order for the property

owner/landlord to undertake such measures, a retrofitting agreement of each tenant is required.

The above process can make the planning of the retrofitting challenging. However, intensive communication and collaboration with the tenants are often effective measures to ensure a smooth implementation. During the years of retrofitting, LKF has identified that information to tenants is of great importance for a successful progress of a project. By informing tenants in good time, they can process the information and get used to the idea that their apartment will be improved and that there will be construction works performed in their apartment for a short period of time.

For the convenience of the tenants, LKF has therefore developed a process of communication with the tenants. The dialogue process of tenants and dialogue with The Swedish Union of Tenants runs parallel to the planning of the renovation project; inventories, planning, planning application and specifications. This means that tenants feel involved and receive information about the ongoing project.

Milestones and critical steps

During a retrofitting, there may be critical steps or milestones that must be met along the project such as:

- Procurement
- Board decision
- Retrofitting agreement approved from tenant
- Building permits
- Start Notification
- Timetable
- Inspection
- End Notification

The progress of these milestones is a part of the whole project process. Some of these are already met before construction starts, while others must be met within the project. For the pilot house, milestones such as procurement, retrofitting agreements and the Board's decision are already met and work on the next milestone is in progress. Despite the milestone as, for example, retrofitting agreements are completed; situations once work on site begins may still occur. There is always a risk that LKF are not allowed to access to the apartment even though they have the tenant consent. With the help of extensive experience in the retrofitting and working with tenants, preventive efforts are in place to facilitate the process and reduce risk critical moments.

10 Annex A

Retrofitting agreement for the pilot house, Vikingavägen 26

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Lund 2015-01-13

Ombyggnadsavtal för pilotprojekt 2015 Vikingavägen 26

gällande lägenheter om 2 rum och kokvrå samt 2- 4 rum och kök

Lägenhetsnummer: Tele: .....
Adress:
Hyresgäst/er: Tele: .....

LKF har lämnat information om planerade moderniserings-, förbättrings- och underhållsarbeten i ovannämnda fastighet och dess lägenheter, vid möten med hyresgästerna. Efter synpunkter från hyresgäster, har viss anpassning av initialt framlagda förslag gjorts.

De arbeten och åtgärder som ska genomföras framgår av bilaga 1 till detta avtal.

Med hänvisning till ovanstående, träffar hyresgästen och LKF följande

ÖVERENSKOMMELSE

1. Ombyggnadsarbetena genomförs med kvarboende hyresgäster. LKF kommer också att ställa en lokal till förfogande för hyresgästerna att vistas i under dagtid då arbeten pågår i huset.

2. Hyresgästen godkänner att de aktuella arbetena enligt bilaga 1 genomförs och medger att LKF och av LKF anlitad entreprenör erhåller tillträde till lägenheten för att utföra dessa. Hyresgästen kommer att få anvisningar om vilka ytor i lägenheten som måste hållas fria från inredning och lösöre. T ex kommer dragning av elledningar att beröra lägenhetens samtliga utrymmen.

3. Arbetena beräknas starta i mars/april 2015. Beräknad tid i respektive lägenhet är totalt ca 4 veckor. Utöver arbeten i lägenheterna kommer utvändiga arbeten samt vissa injusteringsarbeten pågå efter att arbetena avslutats i lägenheterna. LKF ska lämna en mer exakt tid för arbetenas genomförande så snart entreprenörens tidplan är klar. Därefter ska LKF regelbundet informera hyresgästen om planeringen av arbetena. Inför påbörjande av arbete i respektive lägenhet, skall hyresgästen erhålla särskild information om start för påbörjande av arbete, ungefärlig tidsåtgång och om vad hyresgästen ska medverka till att utföra. Sådan information kan även lämnas direkt av byggnadsentreprenören.

4. Som kompensation för de hinder och men som hyresgästen drabbas av under ombyggnadstiden, medger LKF hyresgästen en hyresnedsättning med en månadshyra. Kompensationen utbetalas i form av avdrag på månadshyran månaden efter det att samtliga arbeten i huset är besiktigade.

5. Hyresgästen är underrättad om att en hyreshöjning kommer att ske som en följd av planerade moderniseringsåtgärder, vilka presenterats i bilaga 1. Enligt LKFs beräkning kommer hyran att höjas med ca 11 till 13 procent. Hyresnivån har preliminärt accepterats av Hyresgästföreningen och kommer slutligen att fastställas efter förhandling då projektet avslutats. Hyreshöjning kommer att fasas in. Det innebär att en första höjning sker med 500kr och eventuellt återstående höjning per den 1 juni 2016. Hyran höjs samtidigt som kompensationen enligt punkt 4 erhålls.

6. Individuell varmvattenmätning och debitering kommer att införas. Kostnaden för varmvatten, vilken för närvarande ingår i hyran, kommer att sänkas med ett schablonbelopp. Hyresgästen betalar sedan efter uppmätt förbrukning. LKF återkommer med tidpunkt för när debitering av varmvatten ska börja. (Se vidare bifogad broschyr "Varmvattenmätning".)

Var god vänd →

Retrofitting agreement for the pilot house, Vikingavägen 26

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7. LKF ska tillse att entreprenören tecknar en så kallad ROT-försäkring, som ska gälla för omhändertagen fast och lös egendom (=hyresgästens lösöre).

8. Detta avtal har med en bilaga upprättats i två likalydande exemplar, varav hyresgästen och hyresvärden efter undertecknande tagit var sitt.

Ort och datum: .....

.....	.....
Underskrift hyresgäst	Underskrift hyresgäst
.....	.....
Namnförtydligande	Namnförtydligande

Ort och datum: .....

Lunds Kommuns Fastighets AB

.....	.....
Underskrift hyresvärd	Underskrift hyresvärd
.....	.....
Namnförtydligande	Namnförtydligande

Vi ser gärna att samtliga exemplar av denna överenskommelse (inklusive bilagan) undertecknas och återlämnas till oss så snart som möjligt, **dock senast 27 januari**.

Undertecknade exemplar kan lämnas på LKFs områdesexpedition, Vikingavägen 29, eller i postlådan vid LKFs huvudkontor på adress Lilla Tvärgatan 21 eller skickas till LKF, Box 1675, 221 01 LUND.

Bilaga: Ombyggnadsåtgärder 2015

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