EBC
Energy in Buildings and Communities Programme

Kildeparken, Aalborg (Denmark)

Country: **Denmark**

Name of city/municipality: **Aalborg**

Title of case study: Kildeparken

Year and duration of the renovation: 2014 – 2020 (ongoing)

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Link(s) to further project related information / publications, etc.:

Project homepage: www.kildeparken2020.dk (in Danish)

Schematic figure or aerial overview

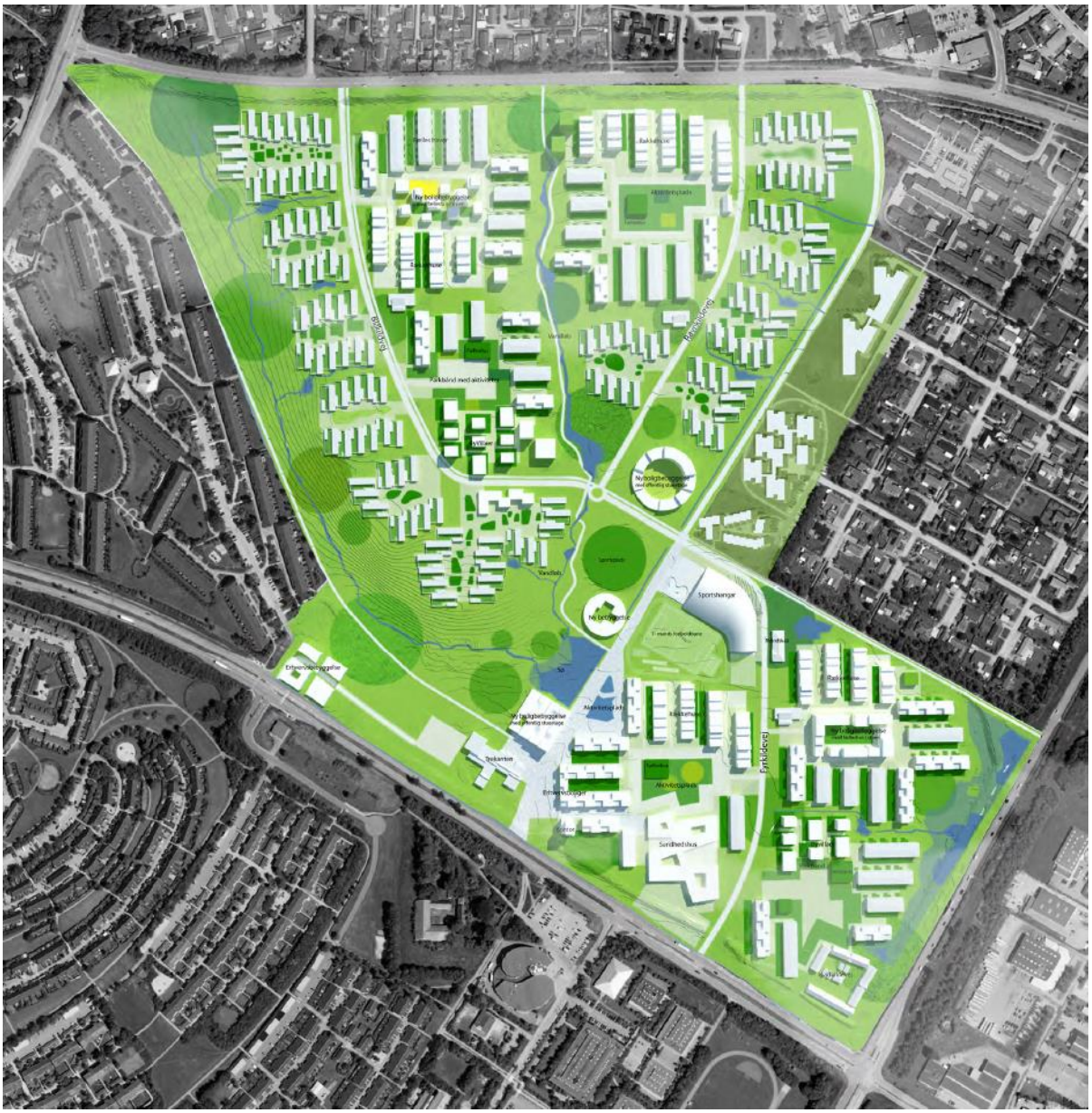

Figure 1. Schematic/aerial view of Kildeparken after renovation (Source: "Kildeparken. Foreløbig helhedsplan" from www.kildeparken2020.dk).

Table 1. Main characteristics of the intervention.

	Before		After	
Number of dwellings, total	942	[-]	1,228	[-]
- Apartment blocks	792	[-]	594	[-]
- Detached houses	150	[-]	183	[-]
- Tower blocks	0	[-]	149	[-]
- Terraced houses	0	[-]	186	[-]
- Roof apartments	0	[-]	67	[-]
- Other	0	[-]	49	[-]
Heated floor area, total	96,446	[m^2]	119,886	[m^2]
- Renovated	96,446	[m^2]	97,274	[m^2]
- New construction	0	[m^2]	22,612	[m^2]

Introduction and description of the situation before the renovation

Kildeparken is a built up area from 1970s in Eastern Aalborg that consists of three clusters of buildings; Blåkildevej, Fyrkildevej and Ravnkildevej. Before the renovation Kildeparken consists of 792 apartment blocks and 150 detached houses (see Figure 1). One of the key features of the renovation is to transform some of the apartment blocks into different types of dwellings, i.e. terraced houses (Figure 2), and add roof apartments to some of the blocks. This will make the whole area less monotone and more attractive while offering a wider range of types of dwellings will increase diversity of inhabitants. The new buildings, i.e. the tower blocks, have different number of stories to create variation in the skyline.

Figure 2. Apartment block (left) and detached house (right) before renovation.

Kildeparken used to be on the so-called “Ghetto-list”, meaning a neighborhood struggling with problems like high unemployment rate, high crime rate etc. Therefore, the overarching aim of the renovation is to transform Kildeparken into an attractive and sustainable district and an integral and exciting part of Aalborg city.

Initially Housing Association Himmerland’s purpose was to develop a cooperation model for an energy partnership with Aalborg Municipality and Aalborg District Heating. The purpose of the energy partnership was to create synergy between energy optimization at building level and on energy system level towards the ideas behind “Smart Grid” systems. The energy partnership should point to concrete energy solutions, so that Kildeparken would comply with the Building Regulation 2020 (BR20) standards after the renovation, while at the same time contributing to the sustainable conversion of the entire Aalborg East.

Unfortunately, it has not been possible to establish a binding energy partnership with energy supply and municipality in spite of several workshops and positive results of cooperation. Both Aalborg Municipality and Aalborg District heating have contributed with relevant knowledge, and Aalborg District Heating promoted the renovation of the district heating pipes in Kildeparken as a result of the dialogue. However, a truly committed energy partnership where the parties co-operate, analyze and decide common actions for overall optimization of the energy system in Aalborg East was not achieved.

Description of the renovation goal

As already mentioned, the overarching aim of the renovation is to transform Kildeparken into an attractive and sustainable district and an integral and exciting part of Aalborg city.

Regarding energy, the goal of the renovation is to achieve an energy label corresponding to Renovation Class 2 according to the Danish building Regulations (BR18). This will result in a primary energy consumption of approximately 71 kWh/m^2. It could be argued that this is not a very ambitious target. However, detailed calculations were performed showing that if the housing association had taken one-step further, i.e. Renovation Class 1 (primary energy consumption of approximately 53 kWh/m^2), the distribution losses in the district heating network would account for more than 50% even if the temperature is lowered to 50 °C (temperature is typically 70-80 °C in Danish district heating systems). Therefore, the conclusion was to settle for Renovation Class 2 and try to put focus on the distribution system instead.

Figure 3. Block of flats has been converted into terraced houses.

The primary focus is on insulating the building envelope, i.e. heating and ventilation installations are replaced, but not significantly improved. However, analyses show that reducing the energy consumption further (i.e. to renovation class 1) is possible if the combined exhaust/natural ventilation is replaced by mechanical ventilation with heat recovery. This is a possibility if further energy reductions are needed in the future.

Figure 4. Vision for Ravnkildevej (Source: D/K2 Building Consultants).

Description of the renovation concept

Before the renovation, Kildeparken consists of 150 detached houses and 792 apartments in two-story apartment buildings. In order to diversify the area making it more attractive to both existing and new residents, a number of new types of dwellings is being added.

The detached houses are so-called atrium-houses and 33 of these will be split into two, transforming them into smaller double-houses. The apartment buildings will be transformed in a number of different ways. Some buildings will be extended with new roof-apartments (67 apartments will be added), some of the smaller apartments will be turned into youth-apartments (37 apartments) and offices (12 apartments) and finally, some apartments will be joined to form two-story terraced houses (186 houses). The three neighborhoods will also have six new tower blocks with a total of 149 apartments. The tower blocks will have different heights to create a diverse and interesting skyline.

The new buildings will (naturally) comply with the present Danish Building Regulations (BR18), meaning that the primary energy demand for heating, domestic hot water and electricity for building operations will be less than 30 kWh/m^2. The existing buildings will be renovated to reach 70 kWh/m^2, which corresponds to approximately 50% of the energy use before renovation. Table 2 lists the U-values before/after for the renovated buildings.

Table 2. U-values in W/m^{2}K before and after renovation.

Terraced houses and apartments	U-value before	U-value after
Slab on ground (wood / tiles)	0.28 / 0.50	0.28 / 0.50
Slab above basement (wood / tiles)	0.46 / 1.50	0.46 / 1.50
Façade (wall / balcony)	0.69	0.12 / 0.18
Gable	0.68	0.20
Roof, apartments	0.20	0.13
Roof, terraced houses (1st floor / 2nd floor)	0.20	0.11 / 0.20
Windows	2.60	0.70 – 1.00
Detached houses		
Slab on ground (wood / tiles)	0.31	0.09 / 0.12
Heavy wall, brick-brick / brick-light façade	0.44	0.16 / 0.17
Light wall	0.42	0.17
Roof	0.19	0.12
Windows	2.60	0.70 – 1.00

Ventilation with heat recovery was not installed in the existing buildings but can be added later, whereby the buildings will improve one level in the energy labelling system (A2010, renovation class 1). For now, demand-controlled exhaust ventilation is used in combination with natural ventilation.

The district heating supply to Kildeparken was not energy efficient and therefore the local system was renovated. The sustainable future scenario for the energy system in North Jutland is low temperature district heating and renewable energy. Therefore, all radiators will be replaced with high capacity versions so that they can supply adequate heating when the district heating temperature is lowered.

No renewable energy was installed. The thought is that renewable energy should be supplied through the district heating network to avoid sub-optimization.

Project Fact Box (I)

General information

Parameter	unit	before renovation	after renovation
Urban scale of area:	m²	540,000	540,000
Population in the area:	-	2,450	2,950
Number of buildings in the area	-	942	1,228
Heated floor area of all buildings	m²	96,446	119,886
Building mix in the area:			
Single family homes (SFH)	% of heated floor area of all buildings	15.9	30.1
Multi-family homes (MFH) - up to three stories and/or 8 flats		84.1	56.8
Apartment blocks (AB) - more than 8 flats		0	12.1
Schools		0	0
Office buildings		0	1.0
Production hall, industrial building		0	0
other (please specify)		0	0
Consumer mix in the area:			
Small consumers: SFH + MFH – < 80 MWh/a	in % of annual heat demand	100	100
Medium consumers: AB, schools, etc. – 80-800 MWh/a		0	0
Large consumers: industrial consumers, hospitals, etc. > 800 MWh/a		0	0
Property situation of buildings:			
private	% of heated floor area	0	0
Public		100	100
Property situation of energy supply system (district heating):			
Private	% of heated floor area	0	0
Public		100	100

Project Fact Box (II)

Specific information on energy demand and supply:

Parameter	unit	before renovation	after renovation
Energy use (primary energy) Apartment blocks Detached houses Tower blocks Terraced houses Roof apartments	kWh/m²a	 140 140 - - -	 70 70 30 70 30
heating demand (calculated)	kWh/m²a	Not available	Not available
domestic hot water demand (calculated)	kWh/m²a	Not available	Not available
cooling demand (calculated)	kWh/m²a	Not available	Not available
electricity demand (calculated)	kWh/m²a	Not available	Not available
heating consumption (measured)	kWh/m²a	133 [1]	68 [2]
domestic hot water consumption (measured?)	kWh/m²a	52 [1]	23 [2]
cooling consumption (measured)	kWh/m²a	0	0
electricity consumption (measured)	kWh/m²a	Not available	Not available
(Thermal) energy supply technologies:			
decentralized oil or gas boilers	% of heated floor area	-	-
decentralized biomass boilers		-	-
decentralized heat pumps		-	-
centralized (district heating)		100	100
other *(please specify)*		-	-
renewable energy generation on-site:			
solar thermal collector area	m²	0	0
photovoltaics	kWp	0	0
other (please specify)	kW	0	0

[1] Measured average consumption for all buildings
[2] Measured average consumption for first buildings renovated

Financial issues:

Parameter	unit	before renovation	after renovation
total investment costs of the renovation	Euro/m^2	-	to be updated
- building envelope renovation costs	Euro/m^2	-	to be updated
- heating/cooling supply costs	Euro/m^2	-	to be updated
- renewable energy production costs	Euro/m^2	-	0.00
LCC available	yes/no		no

Description of the technical highlights and innovative approaches

The overarching goal for the housing association was to develop a collaboration model for an energy partnership between housing organizations, municipality and an energy company. The purpose of the energy partnership was to create synergy between energy optimization at building level and on energy system level towards the ideas behind “Smart Grid” systems. The energy partnership should also point to concrete energy solutions, so that Kildeparken as a residential area could achieve compliance with BR20 regulations, while contributing to an overall sustainable conversion of Aalborg East.

When Himmerland and the Danish Building Research Institute formulated the original pilot project in 2012, the goal was to establish an energy partnership with both municipality and district heating company and achieving BR20 requirements in the renovation of the Kildeparken under the heading "Smart Grid 2020". At the end of the pilot project in 2016, no committing partnership has been established with the district heating company, Kildeparken is being renovated to a lower standard, and the Smart Grid perspective is dimmed. The reasons for these changes are explained throughout this study and shows an example on how focus and goals can change and shift during a projects lifetime.

The partnership was not a total success, but it has helped to make complex issues more tangible and created concrete positive results in the renovation case. Himmerland Housing Association and partners have:

1. analyzed questions about the development of the energy system and the role of the buildings in a future sustainable energy system
2. analyzed the balance between energy efficiency targets in buildings and in the energy system in Aalborg East, in order to identify an appropriate renovation goal in balance with the energy system
3. formulated a holistic energy renovation strategy for Kildeparken based on analysis and collection of knowledge about all sub-elements of an energy renovation
4. inspired Himmerland's work to strengthen its role as city developer in Aalborg East, and create synergy between the renovation of Kildeparken and the sustainable transition of the entire Aalborg East
5. given operational input to Himmerland's work on formulating a new sustainability policy in the organization in dialogue with the resident’s democracy
6. provided sparring to Himmerland's analysis of the energy saving potential in the housing association's building stock that has formulated a roadmap for realizing this savings potential in the period up to 2030

The original goal for Kildeparken of achieving the BR20 standard is not fulfilled and instead the buildings will achieve renovation class 2 as explained earlier. From a holistic perspective, this is the optimal solution since losses in the district heating system should match losses at the building level first, i.e. the district heating system should supply lower temperature heating with less system losses. Therefore, the goal of finding an energy renovation level in reasonable balance with the heating system has succeeded.

Decision and design process

Knowledge partnership / Stakeholder involvement

As already described, the goal for the housing association was to develop a collaboration model for an energy partnership between housing association, municipality and energy company. The purpose of this energy partnership would have been to involve all the different stakeholders in order to ensure synergy between energy optimization at building level and on energy system level. The thought was that the energy partnership would thereby benefit all the stakeholders.

More than energy

Himmerland Housing Association is not just focused on energy savings. They want to achieve three overarching sustainability goals:

1. Social sustainability: Himmerland creates quality of life and space for everyone
2. Environmental sustainability: Himmerland is at the forefront of the sustainable transition of the built environment
3. Economic sustainability: Himmerland creates contemporary housing with a fine balance between price and quality

These goals have been defined further in the company sustainability policy.

Sustainability policy

Himmerland Housing Association has formulated a new sustainability policy as a result of the knowledge partnership and work on the "smart solutions" in Aalborg East. The foundation of the sustainability policy is a strategy for energy renovation, where the total energy consumption in 2030 - heating and building-related electricity – is reduced by 30% of the measured consumption in 2014. The year 2030 was chosen to harmonize goals with the national goals regarding energy consumption and CO_2 emissions.

The goal will be achieved by the following measures:

- energy savings are regularly carried out in the daily operation with measures that have a payback time of 5 years or less
- most of the housing organization's dwellings are renovated within the period
- measures are implemented that affect the residents' energy behavior in a positive direction
- energy initiatives are largely implemented in cooperation/partnership with the municipality of Aalborg and the energy companies
- annual evaluation of the development and a following revision of strategy and continuous development of "smart solutions", that can lead to the ultimate goal being achieved
- energy initiatives are assessed on the basis of Himmerland's sustainability policy, where they basically must have a positive or neutral effect in relation to a broad definition of sustainability

The content of the policy is formulated and developed further in the knowledge partnership, but also in workshops with employees in the housing association and in dialogue with the occupant democracies.

Figure 5. Picture from the master plan Kildeparken 2020 (Source: Himmerland Housing Association).

Himmerland's sustainability policy covers all three branches in the broad sustainability concept. Therefore, an initiative that aims to improve energy efficiency of a dwelling must at the same time be socially and economically balanced.

The sustainability policy consists of visions, strategic benchmarks and a project catalog. All concrete measures must be assessed on the basis of the three branches in the policy: social sustainability, environmental sustainability and economic sustainability.

Screening process

As already described, it is an important element in Himmerland sustainability policy, that the measured building-related energy consumption in the total housing stock is reduced by 30% from the baseline in 2014 until 2030. Therefore, the housing association has made a complete screening of all their buildings in order to be able to establish the individual savings potential of the different types of dwellings. The initial step was to determine the baseline, i.e. the total energy consumption, in order to determine the total necessary savings in order to achieve an overall 30% savings. Table 3 shows the total savings necessary to achieve the goal, i.e. 12,312 MWh primary energy.

Table 3. Measured total energy consumption for Himmerland Housing Associations complete building portfolio and necessary reduction to achieve the overarching goal.

Baseline – 2014					
Area (m^2)	Measured heating consumption (kWh/m^2)	Measured electricity consumption (kWh/m^2)	Corrected total energy consumption (kWh/m^2)		
460,758	108.6	8.3	86.7		
Goal – 2030					
Area (m^2)	Measured heating consumption (kWh/m^2)	Measured electricity consumption (kWh/m^2)	Corrected total energy consumption (kWh/m^2)	Savings in %	Savings (MWh)
460,758	74.9	6.2	60.7	30.0	12,312

The corrected total energy consumption (in table 3) has been corrected for heating degree-days and heating and electricity is multiplied by the primary energy factors (i.e. 0.6 for district heating and 1.8 for electricity according to BR15).

Table 4 shows an example for a specific building type (prefabricated concrete buildings erected from 1965-1980 – see figure 6). These types of buildings constitute 28.3 % of the housing associations total building portfolio and a large part of Kildeparken.

Figure 6. Typical prefabricated concrete building.

Table 4. Measured total energy consumption for Himmerland Housing Associations prefabricated concrete buildings and necessary reduction to achieve the overarching goal.

Baseline – 2014					
Area (m^2)	Measured heating consumption (kWh/m^2)	Measured electricity consumption (kWh/m^2)	Corrected total energy consumption (kWh/m^2)		
460,758	140.2	6.4	104.1		
Goal – 2030					
Area (m^2)	Measured heating consumption (kWh/m^2)	Measured electricity consumption (kWh/m^2)	Corrected total energy consumption (kWh/m^2)	Savings in %	Savings in MWh
460,758	65.0	4.0	50.1	51.9	7,046

As shown in the Table 4, these types of buildings have a large saving potential of approx. 52%.

Further analysis

In addition to the energy savings screening process, Himmerland has also initiated several analyses in order to determine the best possible way to move forward. The analyses cover a wide range of aspects including the possibilities of:

1. islanding as an alternative to integrating in existing energy system
2. including renewable energy systems as part of the renovation
3. moving towards low temperature district heating

In addition to this, the renovation of Kildeparken naturally covers a wide range of non-energy related measures regarding e.g. traffic, mobility, roads, landscaping, rain water use and climate change adaptation etc.

The renovation of Kildeparken is divided into the three separate projects corresponding to the three clusters of buildings, Blåkildevej, Fyrkildevej and Ravnkildevej. This means that three different consortiums will deliver different solutions to the total renovation, which in turn will make Kildeparken a more diverse and interesting area.

Stakeholders' role and motivation

Main stakeholder	**Specify which organization(s) was (were) involved**	**Role (decision maker, influencer, technical advisor, delivery)**	**Driver/motivation**
Policy actors (municipality department, government body, innovation agency, etc.)	Aalborg Municipality		Integration of Kildeparken in Aalborg East
Users/investors (individual owner, housing association, building managers, asset manager, project developer)	Himmerland Housing Association	Owner (decision maker)	Improved dwellings and surroundings, increase quality of life for tenants
District-related actors (Community/occupants organizations, etc.)	Tenants democracy	Tenants (influencers)	Improved dwellings and surroundings at a reasonable increase in rent
Energy network solution suppliers (Distributor system operator, energy supply company, energy agency, ESCO, renewable energy companies)	Aalborg District Heating	Energy supplier (delivery)	Integration of Kildeparken in existing energy supply network
Renovation solution suppliers (Planning and construction parties, urban planners, architects, design team general contractors, products suppliers, ESCO, contractor, energy monitoring, facility manager, installation provider, one-stop-shop, etc.)	Three consortiums. See list below	Architects and consultants, landscape, traffic etc. (technical advisors)	No special motivation
Other intermediaries (public bodies, trade organizations, NGO's, consultancies, research institutes)	Aalborg University, Danish Building Research institute, COWI, Kuben Management	Advisors, consultants etc. (technical advisors)	No special motivation

Three different consortiums were chosen to perform the renovation of the three neighborhoods (Fyrkildevej, Blaakildevej and Ravnkildevej):

Fyrkildevej:
Architect: Aarhus Arkitekterne A/S
Architect: Arkitekterne Bjørk & Maigård ApS
Consultant: Brix & Kamp Rådgivende Ingeniører A/S

Blaakildevej:
Architect: KPF Arkitekter A/S (now ERIK Arkitekter A/S)
Landscape architect: Preben Skaarup
Consultant: Viggo Madsen A/S
Traffic consultant: Via Trafik Rådgivning A/S

Ravnkildevej:
Architect/Consultant: Kærsgaard & Andersen A/S
Architect: EFFEKT Arkitekter ApS
Urban development/Consultant: SLA A/S

Financing issues
To be updated.

Lessons learned/interesting findings

Balancing energy efficiency targets in buildings with the energy system

It is a central energy policy goal that Denmark's energy supply is fossil-free in 2050. Housing Association Himmerland's first question was therefore: is it smart to seek to integrate the building renovation into the existing energy structure, or can we get closer to the goal by choosing an independent supply system in the end. For example, should the housing organization set up a wind turbine combined with other renewable energy sources in an attempt to become completely self-sufficient and disconnected from the local energy system?

The answer is “no”, the analysis made for Denmark shows that it is not socio-economic rational to have "island operations" (self-sufficiency based on renewable energy) everywhere. Doing this leads to an over-investment in infrastructure. Energy systems must be connected and local VE production must be integrated into the existing energy system. For Aalborg East, which is located in an efficient district heating area, the premise is that the long-term 2050 scenario is a low-temperature district heating solution plus supplementary renewable energy sources. Energy saving measures in buildings, in order to work positively together with a future energy supply system (based on 100% renewable energy by 2050), should reduce the energy requirement in these buildings by 50% on average in the period 2030 - 2050.

Therefore, Kildeparken should not be disconnected from the energy system with its own renewable energy sources, but integrated with the existing district heating system.

The district heating supply to Kildeparken was, as a starting point (in 2013) not energy efficient. There were only two "plugs" into the area, and the remaining distribution was handled by the housing association. As a consequence of the dialogue in the energy partnership, the modernization of the district heating network in Kildeparken was advanced, and the system is today renovated.

The sustainable future scenario for the energy system in North Jutland is low-temperature district heating and renewable energy. Therefore, as part of the refurbishment of Kildeparken, Himmerland has chosen to install radiators with a capacity that takes into account a future low-temperature model. The district heating system in Aalborg East cannot immediately be converted to a low temperature solution, i.e. parts of the system is dependent on high temperature. These issues are expected to be addressed in a future trial project. In the project, it will be investigated how smaller local areas can be converted to low-temperature areas using mixing loops when moving from the large system to the individual areas. Unfortunately, Himmerland's original ambition to establish a binding partnership with Aalborg District Heating Association for joint analysis and development of the housing role in a more integrated energy system has not been realized. One explanation may be that the central investments must take place in the district heating system (low temperature VE future). The primary role of the general housing in such a transition is to reduce total energy consumption by 50% by 2050.

References

The information given in this case study description is based on two primary sources:

1. *"Kildeparken. Foreløbig helhedsplan" from www.kildeparken2020.dk*
2. *Engberg, L. A. and Buch, S., "Bæredygtighed og Smarte Løsninger i Aalborg Øst – Himmerland Boligforenings Erfaringer med Bæredygtighed i Praksis", SBi 2016:28, Danish Building Research Institute, Aalborg University, 2016.*