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D 2.2

Energy retrofit summary report



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0 Publishable Summary

The objective of this deliverable is to summarize the list of energy retrofitting projects expected to be included in the HAPPI project, based on the evaluation of energy audit reports for the six participating housing associations in HAPPI.

The energy audits of 56 departments took place in the period 01.04.2018 – 30.01.2019 by an expert team from Danish Energy Management A/S in cooperation with officials from the six involved housing associations.

The goal was to identify energy retrofitting projects for an investment amount of 15.2 million Euro.

The energy audits focused on insulation of the envelope of the buildings, the technical equipment, ventilation systems, heat recovery etc, but also on more innovative energy measures as heat pumps, solar cells and battery storage solutions.

The result of the 56 energy audit reports showed, that there was a basis for energy retrofitting projects with an estimated investment sum of 15.03 mio. Euro.

The estimated energy savings were calculated to 5.5 GWh/year in heating plus renewable energy supply of 2.0 GWh/year.

The next phase was to present and discuss the proposed energy retrofitting measures with the involved housing associations and their management staff

in order to prioritize the projects and continue planning of implementation.

This process took place in the period February – August 2019, where each of the proposed measures were presented and evaluated. During the process it was concluded, that some of the measures were not sufficiently profitable, and that the tenants probably would not approve to continue with all proposed retrofitting measures.

Therefore, alternative retrofitting measures were discussed, and a few more housing departments were audited.

The result of this evaluation process is, that the housing associations now propose energy retrofitting measures for an investment amount of 15.9 mio. Euro.

This include 67 housing departments and 3534 homes.

It is anticipated that the investment will lead to energy savings of 5.0 GWh/year in heating plus renewable energy supply of 2.6 GWh/year.

The next phase in the project is to get approval from the tenants and to start the detailed planning, tendering and implementation phase including prepare bundling of relevant projects from the different departments and housing associations.



Table of content:

0	Publishable Summary	3
0.1	Overall result of the energy retrofit summary report.....	5
1	Energy Retrofit Summary Process.	12
2	Energy retrofitting measures	13
2.1	Renewable energy	13
3	Bundling af relevant retrofitting projects.....	14

Table of table

Tabel 1	summarizing the planned retrofitting measures for each housing associations.	5
Tabel 2	summarizes the result for each of the 67 involved departments.....	6



1 Introduction

The overall objective for this work is to prepare a basis for energy retrofitting projects for the six participating housing associations in the HAPPI project.

The first step was to prepare energy audits of 56 departments in the six associations. This work was done in the period 01.04.2018 to 30.01.2019, and the work is presented in "D2.1: Energy Audits".

The next step was to present and discuss the proposed energy retrofitting measures from the energy audits with the involved housing associations and their management staff in order to prioritize the projects and continue planning of implementation.

This work took place in the period February to August 2019.

The result of the evaluation process is, that the housing associations now propose energy retrofitting measures for an investment amount of 15.9 mio. Euro.

This include 67 housing departments and 3534 homes.

It is anticipated that the investment will lead to energy savings of 5.0 GWh/year in heating plus renewable energy supply of 2.6 GWh/year.

The goal was to prepare energy retrofitting projects for an amount of minimum 15.2 mio. Euro in the six housing associations.

The investment launched by HAPPI was anticipated to lead to energy savings of 11.5 GWh/year and the generation of 1.6 GWh/year of renewable energy.

1.1 Overall result of the energy retrofit summary report.

<u>Part. No.</u>	<u>Name</u>	<u>Num. dept</u>	<u>Homes</u>	<u>Energy saving</u>	<u>Investment</u>
3	SAB	12	1370	2.3 GW	6.8 mio. Euro
4	NAB	7	366	1.2 GWh	2.6 mio. Euro
5	Danbo	6	132	0.4 GWh	0.6 mio. Euro
6	B42	33	1010	2.0 GWh	2.9 mio. Euro
7	SOBO	9	380	1.0 GWh	1.8 mio. Euro
8	GAB	11	276	<u>0.7 GWh</u>	<u>1.2 mio. Euro</u>
		67	3534	7.6 GWh	15.9 mio. Euro

Table 1 summarizing the planned retrofitting measures for each housing associations.



1.2 Summary of Energy Retrofit Reports for each of the 67 departments.

Housing Association department	Homes F=Flats T=Terrace houses	Type of energy retrofitting	Energy savings kWh/year	Renewable energy kWh/year	Energy invested costs (DKK)	Energy invested costs (€)
SAB Dept. 03	51 (F)	New windows, circulation pumps	45.000		725.000	96.663
SAB Dept. 09	70 (F)	New district heating units, new outer doors, radiator thermostats, insulation pipes.	81.150		1.088.000	145.062
SAB Dept. 10	67 (T)	New district heating units	85.000		675.000	89.997
SAB Dept. 13	93 (F)	New windows and doors, solar cells with batteries.	39.000	100.000	4.300.000	573.314
SAB Dept. 15	105 (F)	Insulation walls, radiator thermostats, solar cells with batteries	168.000	108000	9.800.000	1.306.622
SAB Dept. 18	114 (F)	Solar cells with batteries		118000	4.000.000	533.315
SAB Dept. 20	94 (F)	Hot water tanks, new windows on backside facade, radiator thermostats, pipe insulation, solar cells with batteries	380.000	96000	6.975.000	929.968
SAB Dept. 21	72 (F)	New district heating pipes	85.000		500.000	66.664
SAB Dept. 24	324 (F)	Solar cells with batteries, pipe insulation	75000	340.000	9.225.000	1.229.958
SAB Dept. 27	52 (F)	New hot water tanks, solar cells with battery	65.000	53500	2.175.000	289.990

SAB Dept. 30	232 (F)	Solar cells with batteries, circulation pumps	35.000	240.000	7.500.000	999.966
SAB Dept. 50	96 (F)	Heating automatic, solar cells with batteries	55.000	100000	3.750.000	499.983
						-
NAB Dept. 06	39 (T)	New roof windows, radiator thermostats, floor insulation	125.000		1.000.000	133.329
NAB Dept. 07	96 (T)	Insulation of roofs	94.000		1.600.000	213.326
NAB Dept. 08 + 09	122 (T)	Windows and doors, insulation of roofs, radiator thermostats	571.400		5.615.000	748.641
NAB Dept. 12	28 (T)	Insulation of roofs, facades and floors, windows and doors, heating automatic, ventilation recovery, solar cells with batteries	115.000	85000	4.650.000	619.979
NAB Dept. 13	54 (T)	Insulation of roofs, facades and floors, windows and doors, circulation pumps, heating automatic, ventilation recovery	200.000		5.400.000	719.975
NAB Dept. 18	26 (T)	New windows and doors	45.000		975.000	129.996
NAB Dept. 28	1 (T)	Solar cells with battery		1.700	55.000	7.333
						-
Danbo Dept. 19	9 (T)	Insulation roof, new windows, solar cells with batteries	19.800	67.500	1.380.000	183.994
Danbo Dept. 22	28 (T)	New district heating units	35.000		280.000	37.332
Danbo Dept. 26	26 (T)	New district heating units, heating automatic	54.000		312.000	41.599
Danbo Dept. 27	45 (T)	Radiator thermostats, air-to-air heat pumps	22.600	187500	1.970.000	262.658

Danbo Dept. 34	10 (T)	New district heating units	12.500		120.000	15.999
Danbo Dept. 36	14 (T)	District heating units, radiator thermostats	26.500		235.000	31.332
						-
B42 Dept. 01	32 (T)	Radiator thermostats, floor insulation over a period	85.000		375.000	49.998
B42 Dept. 03	40 (T)	Heat exchangers over a period, radiator thermostats			220.000	29.332
B42 Dept. 05	44 (T)	Heat exchangers over a period, radiator thermostats, floor insulation over a period, water saving.	95.000		500.000	66.664
B42 Dept. 06	41 (T)	Heat exchangers over a period, floor insulation over a period, radiator thermostats, water saving.	295.000		2.693.560	359.129
B42 Dept. 09	32 (T)	Roof insulation, heat exchangers over a period, floor insulation over a period, radiator thermostats, new ventilation systems	210.000		1.200.000	159.995
B42 Dept. 11	80 (F)	New windows and doors against outdoor rooms, insulation of roofs	11.000		335.000	44.665
B42 Dept. 13	48 (F) + 122 (T)	New ventilation systems, heat exchanges over a period, radiator thermostats, solar cells + batteries for 48 apartments	340.000	45000	4.500.000	599.980
B42 Dept. 15	72 (T)	Radiator thermostats, water saving	41.000		314.000	41.865
B42 Dept. 16	40 (T)	Radiator thermostats, water saving	3.500		64.400	8.586
B42 Dept. 18	19 (F)	Solar cells with batteries		18.000	525.000	

						69.998
B42 Dept. 24	24 (T)	New ventilation system with heat recovery and new heating system	125.000		1.950.000	259.991
B42 Dept. 29	16 (F)	Solar cells with batteries		15000	433.000	57.731
B42 Dept. 30	30 (F)	Radiator thermostats, pumps, water saving.	55.400		168.800	22.506
B42 Dept. 35	28 (F)	New pump, water saving,	6.000		25.000	3.333
B42 Dept. 35A	9 (T)	Insulation, heating automatic.	40.500		473.000	63.065
B42 Dept. 36	37 (F)	Solar cells with batteries		35000	1.000.000	133.329
B42 Dept. 37	72 (F)	Solar cells with batteries for B42, insulation of walls and water tanks	27.000	68000	2.170.000	289.323
B42 Dept. 41	12 (T)	Insulation of floor, wall and roof, warm water tank, heating automatic, water saving.	14.000		162.000	21.599
B42 Dept. 42	26 (T)	Radiator thermostats, new ventilation systems, water saving.	173.100		787.800	105.036
B42 Dept. 44	106 (T)	Battery solution to solar cells		210.000	2.000.000	266.658
B42 Dept. 73	48 (T)	Solar cells on ground with battery solution		45.000	1.300.000	173.327
B42 Dept. 77	32 (F)	Solar cells with batteries		27.000	785.000	104.663
						-
SØBO Dept. 02	32 (T)	District heating units, insulation walls, roof	51.100		987.000	131.596
SØBO Dept. 08	33 (T)	District heating units, insulation walls, floor	172.640		1.900.000	253.325

SØBO Dept. 12	72 (F)	Solar cells with batteries.		174.000	4.200.000	559.981
SØBO Dept. 21	49 (F)	Solar cells with batteries.		65.000	1.600.000	213.326
SØBO Dept. 23	36 (T)	District heating units, insulation floors	80.000		1.540.000	205.326
SØBO Dept. 102	70 (F)	Insulation floors	86.500		1.147.000	152.928
SØBO Dept. 110	32 (T)	Heat pumps, pipe insulation, doors	2.000	220.000	1.000.000	133.329
SØBO Dept. 128	24 (T)	Heat pumps, pipe insulation, circulate. pumps	5.600	130000	539.000	71.864
SØBO Dept. 130	32 (T)	Insulation roof, circulation pumps	66.000		403.500	53.798
						-
GAB Dept. 01	20 (T)	Radiator thermostats, pipe insulation, new hot water tanks	36.500		323.000	43.065
GAB Dept. 06	26 (F)	Insulation roof, outer walls, new pumps, radiator thermostats, LED lights, solar cells and batteries	56.000	27000	1.475.000	196.660
GAB Dept. 07	72 (F)	Insulation roof, hot water heat exchanger, pumps, LED, solar cells and batteries	39.000	75000	3.240.000	431.985
GAB Dept. 10	23 (T)	Insulation roof, pumps, new gas boilers, windows	185.000		2.200.000	293.323
GAB Dept. 12	56 (T)	Rad. thermostats, insulation pipes, new hot water tanks	103.000		710.000	94.663
GAB Dept. 16	6 (F)	New windows, insulation roof	10.000		100.000	13.333
GAB Dept. 18	18 (T)	Pumps, new gas boilers, pipe insulation	63.000		600.000	79.997

GAB Dept. 23	12 (F)	Insulation roof, radiator thermostats	11.500		98.000	13.066
GAB Dept. 31	12 (F)	Insulation roof, rad. thermostats, district heating units, timer ventilation, LED lights	35.000		331.000	44.132
GAB Dept. 33	15 (T)	Rad. thermostats, pumps, vent. motors, LED	16.000		118.000	15.733
GAB Dept. 43	16 (T)	Radiator thermostats, pipe insulation	11.500		96.000	12.800
67	0	0	4985790	2651200	118894060	15.852.000

Table 2 summarizes the result for each of the 67 involved departments

2 Energy Retrofit Summary Process.

The energy audits of 56 departments took place in the period 01.04.2018 – 30.01.2019.

Based on the energy audits DEM-ESB prepared a report for each of the 56 departments describing the current energy status of the buildings including a scheme with proposed energy retrofitting measures, the estimated investment, the estimated energy savings and the pay-back time for each of the proposed measures.

The next phase was to present and discuss the proposed energy retrofitting measures with the involved housing associations and their management staff

in order to prioritize the projects and continue planning of implementation.

This process took place in the period February – August 2019, where each of the proposed measures were presented and evaluated. During the process it was concluded, that some of the measures were not sufficiently profitable, and that the tenants probably would not approve to continue with all proposed retrofitting measures.

Therefore, alternative retrofitting measures were discussed, and a few more housing departments were audited.

3 Energy retrofitting measures

The following energy measures have been proposed in the summary report:

- Insulation of roofs, facades and basements.
- New low-energy windows and outer doors.
- New ventilation systems with heat recovery.
- New individual heat exchangers for district heating.
- Heating automatic equipment.
- New radiator thermostats
- New energy efficient circulation pumps.
- Water saving measures in baths and kitchens.

3.1 Renewable energy

For a number of departments renewable energy measures are suggested:

Heat pumps (air/air, air/water, water/water) instead of existing natural gas boilers, both individual heat pumps as well as central heat pumps installations for a group of buildings in combination with an internal district heating system. Heat pumps are only suggested in areas, where public CO₂-neutral district heating plants are not available.

Solar cell systems in combination with battery solutions.

In some bigger housing departments with several floors, solar cell plants are suggested in combination with battery solutions. This combination allows a much higher utilization of solar energy compared with solar cells connected to the public grid.



4 Bundling of relevant retrofitting projects.

The next phase in the project is to get approval from the tenants and to start the detailed planning, tendering and implementation phase including prepare bundling of relevant projects from the different departments and housing associations.

