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D 2.2

Energy Retrofit Planning Process Summary Report



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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 original energy audits of 56 selected departments took place in the period 01.04.2018 – 30.01.2019 by an expert team from DEM-ESB 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.

In the discussion with the management of the housing associations it turned out, that the 56 selected departments were not enough to reach the goal of investments for more than 15 million Euro

Therefore another 11 departments were selected to be audited.

The result of this process was, that the housing associations now proposed energy retrofitting measures for an investment amount of 15.9 million Euro.

This includes 67 housing departments and 3,534 homes.

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.

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 it was decided, that the housing associations and DEM-ESB in the following periods of the project should continue to examine further retrofitting measures in order to reach the investment goal of the project.

The identification of potential extra retrofitting measures was based on overall auditing of more departments to find feasible energy measures, which then during the project period were presented and approved by the tenants.

This work took place during the whole project period, and the result was, that in total 116 departments in the six housing associations decided to invest in energy retrofitting measures.



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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 selected 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.

In the discussion with the management of the housing associations it turned out, that the 56 chosen departments were not enough to reach the goal of investments for more than 15 mio. Euro

Therefore another 11 departments were selected to be audited.

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

This includes 67 housing departments and 3,534 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 original planned energy retrofitting process.

| <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 |

Tabel 1 Summarizing the planned retrofitting measures for each housing association.



2. Planned Energy Retrofit Summary Process.

Based on the energy audits DEM-ESB prepared a report for each of the 67 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.

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 it was decided, that the housing associations and DEM-ESB also in the following periods of the project should examine further retrofitting measures in order to reach the investment goal of the project.

These potential extra retrofitting measures were based on overall auditing of more departments to find feasible energy measures, which then during the project period were presented and approved by the tenants.

This work took place during the whole project period, and the result was, that in total 116 departments in the six housing associations decided to invest in energy retrofitting measures.



3. Overview of the 116 involved departments in the HAPPI project.

The original 67 departments, which received a deep audit report, are listed in Table 2 in this report.

In addition to the 67 departments, 49 extra departments decided to invest in energy retrofitting measures:

Total number of departments involved:

SAB: $12 + 11 = 23$

NAB: $7 + 10 = 17$

Danbo: $6 + 15 = 21$

B42: $22 - 5 = 17$

SOBO: $9 + 4 = 13$

GAB: $11 + 14 = 25$

In total 67 + 49 extra = 116 departments involved.

The 116 departments and their individual investments are listed in deliverable D2.7



4. Summary of Energy Audit 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

5. 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.
- New energy saving electrical equipment in apartments.
- LED lighting.

5.1 Renewable energy

For a number of departments renewable energy measures are suggested:

Heat pumps (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.



6. 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.

