Danish Energy Agency

Technology Brief

Updated chapters on large heat pumps, electric boilers, geothermal plants and new chapter on oil boilers for district heating

The Danish Energy Agency has published an updated Technology Catalogue for the Generation of Electricity and District Heat. The revision aims to deal with the discrepancy between the technology delivered to the Danish market and the types of units described in the chapters, while also representing recent cost and technology developments.

In this updated edition, the chapters on geothermal absorption heat pumps have been removed. These heat pumps are no longer being installed, and there is little to no quantitative data about them.

Lastly, a new chapter on oil boilers was added to the catalogue for comparison and modelling purposes.

The following technologies have been updated in this iteration:

Compression heat pumps:

- 1 MW Compression heat pumps using ambient air
- 3 MW Compression heat pumps using ambient air
- 10 MW Compression heat pumps using ambient air
- 1 MW Compression heat pumps using waste heat
- 3 MW Compression heat pumps using waste heat
- 10 MW Compression heat pumps using waste heat
- 20 MW Compression heat pumps using seawater
- 65 MW Compression heat pumps using seawater

Electric boilers:

- Electric boilers with heat capacity lower than or equal to 10 MW
- Electric boilers with heat capacity higher than 10 MW

Geothermal heating plants:

- Medium-scale, 1200m well, with DH temperature 80/40°C
- Medium-scale, 2000m well, with DH temperature 80/40°C
- Medium-scale, 1200m well, with DH temperature 70/35°C
- Medium-scale, 2000m well, with DH temperature 70/35°C
- Large-scale, 2000m well, with DH temperature 80/40°C

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Major changes in updated Technology Catalogue

Based on the latest publicly available data and newest projects, the updated chapters give an up-to-date perspective on technical and economic assumptions behind the expected future development of the technologies. This section summarises the changes.

Compression heat pumps for district heating

The chapters were last updated in 2020, except the seawater heat pumps, which were updated in 2022. The investment costs for the 20MW seawater heat pumps are now double as high, compared to the previous iteration of the catalogue. The significant change is due to the fact, that the technology was new when the catalogue was last updated, and that the old data was unreliable. On the other hand, the investment costs for the larger seawater heat pumps are similar to the previous edition. In Figure 1, it is shown that the LCOH for the 20MW heat pumps is approximately 20% higher in the new iteration of the chapter.

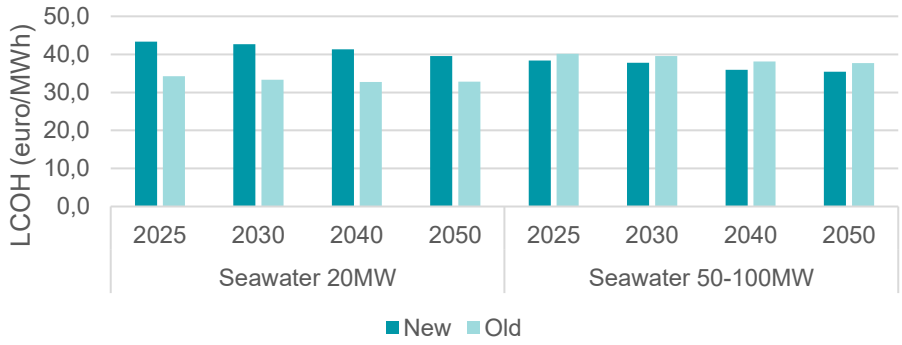


Figure 1: LCOH for seawater heat pumps. Assumptions for the LCOH analysis are found in footnote [1]

Notable differences in LCOH also occur for the larger 10MW air source heat pumps, and despite their modular setup (where smaller 1-3 MW units make up for the entire capacity), it is the lower COP and higher O&M costs that push the cost of produced heat up. The LCOH differences for the 10MW heat pump size and the smaller capacities of the air sources heat pumps can be seen in Figure 2.

[1] Interest rate 3,5%, Inflation from 2020€ to 2025€: 16,8%, Electricity price is based on an average of 6000 hours in the heating season from Klimastatus og fremskrivning 2025 in year 2030.

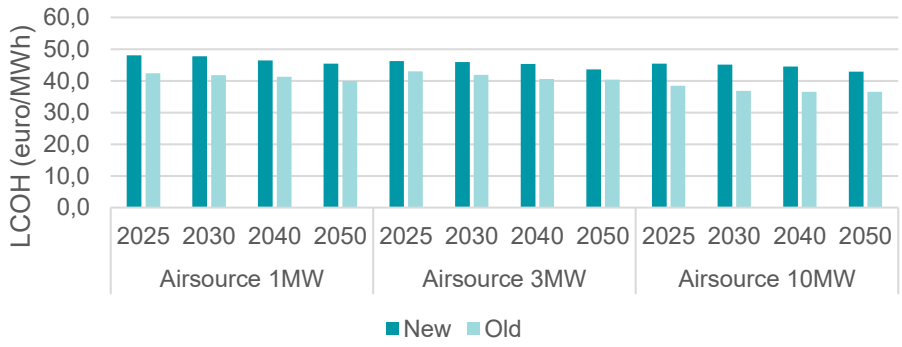


Figure 2: LCOH for air source heat pumps using the same assumptions in footnote [1]

Geothermal heating plants

The chapter on geothermal plants was last updated in 2020. Large-scale geothermal plants were added in 2022; however, this is also where the largest LCOH differences occur, primarily because at the time of writing the chapter, the technology data was unreliable, as in the case for seawater heat pumps. Overall, the LCOH is 14-18% higher in the new chapter, and the difference is primarily due to the doubling of the overall O&M costs. The largest change is for the fixed O&M, which are now 2-3 times larger than in the old chapter.

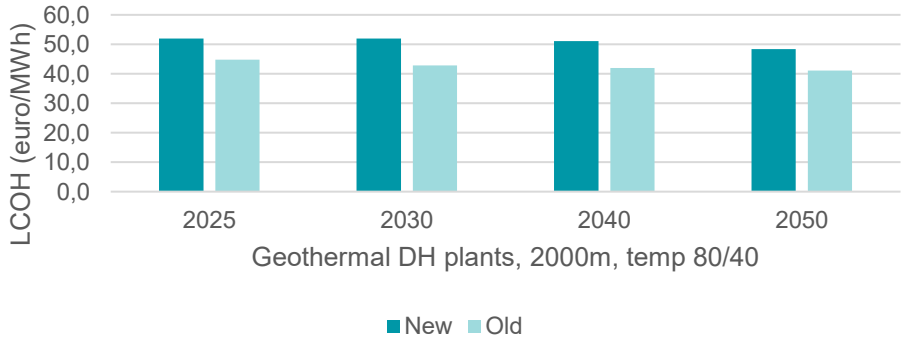


Figure 3: LCOH for geothermal DH plants, 2000m, with DH temperature 80/40°C. Same assumptions as in footnote [1]

It also worth noting that geothermal plants can be designed so that part of the heat from the boreholes is supplied directly to the district heating system without further heating, while the rest is further heated using an electric heat pump. The ratio between the amount of energy supplied directly and the amount supplied via a heat pump is crucial to the plant's overall efficiency. These figures were reassessed in the update, meaning that the efficiency of some of the plants has changed significantly. This applies primarily to geothermal plants with injection wells at 2000m, with the previous COP between 8,5 and 12,5, while in the new chapter this is estimated to 4 - 4,5 for the same heat pumps. The difference in COP is however offset by the lower investment costs, reduced by 50-100% in the new catalogue.

Table 1: Key technical and cost data for Geothermal plants, 2000m injection well, with DH temp. 70/35 in the new and old catalogue, using assumptions on footnote [1]

	2025		2030		2040		2050	
	New	Old	New	Old	New	Old	New	Old
Annual Investment (euro/year)	1,8	3,5	1,8	3,0	1,8	2,9	1,6	2,8
COP	4,6	12,0	4,6	12,1	4,7	12,3	4,7	12,4
Overall O&M (euro/year)	1,3	1,0	1,3	1,0	1,2	1,0	1,1	0,9

Finally, there are also differences in the size of the units. The assumption in the new chapter is that large-scale geothermal plants have 60MW of capacity, while in the old catalogue this was approximately 120MW.

Perspectives for Denmark

The updated chapters for district heating heat pumps show a slightly higher cost of heating compared to the previous iteration. However, large heat pumps of various types are still expected to be primary means of decarbonising the Danish district heating sector and reducing biomass consumption.

Seawater heat pumps and geothermal plants offer the benefits described in the chapters and may provide a lower LCOH than alternative supply options. As both technologies are constrained by location and resource potential, they should be considered where appropriate. This principle has not changed in the updated chapters. However, absorption heat pumps are no longer considered relevant in a Danish context.

The addition of oil boilers is important for Danish planners, district heating owners and authorities, as it provides a benchmark for the cost of existing oil boilers used as reserve and backup capacity.