TECHNICAL ARTICLE SHALLOW GEOTHERMAL · SURFACE-WATER HEAT

Seawater heat on the Baltic coast

How much heat the sea supplies – and where physics and water law set the limit

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ABSTRACT

Seawater is a virtually inexhaustible heat source – but in winter only at 0 to 4 °C. The article derives source capacity and flow rate of a seawater heat pump, shows with a study for a hotel resort on the Baltic coast why winter governs the design, and names the water-law and nature-conservation issues to settle before design.

KEYWORDS · Surface-water heat · Seawater heat pump · Baltic Sea · Flow rate · Water use · WHG

1 Background

Surface water is an open source: extracted heat is constantly replenished – unlike the same hotel's BHE field, which needed approx. 95 % recharge [6]. In Neustadt in Holstein, an approx. 700 kW seawater heat pump has fed a heat network since 2026 [3], [4].

2 Source capacity and flow rate

Heating capacity and COP give the extraction capacity, hence the flow rate:

$$\dot{Q}_Q = \dot{Q}_H \cdot (1 - 1/\mathrm{COP}) \qquad \dot{V} = \dot{Q}_Q / (\rho \cdot c_p \cdot \Delta T) \tag{1}$$

$\dot{Q}_H$ heating capacity · $\dot{Q}_Q$ extraction capacity · $\rho \cdot c_p \approx 4.1$–$4.2$ MJ/(m³·K) · ΔT seawater cooling

Halving the permissible cooling doubles the pumping rate; filters and pipe cross-section grow with it, pump power even more.

3 Winter governs the design

In February the water averages 2 °C, at minimum 0 °C. The outlet temperature governs: brackish water freezes at approx. −0.5 to −1 °C. With 2 to 3 K cooling, the outlet would at times reach 0 to −2 °C from December to March (Figure 1a); extraction must then be throttled or topped up by peak load. Half the cooling and 2.3 times the load give – with a slightly smaller source share – approx. four times the August flow rate in February; peak capacity occurs in December and January. The LAWA recommendations (above 3 °C, max. 5 K, 1 K/h) apply only to rivers and lakes [2]; for the Baltic Sea, the water authority decides.

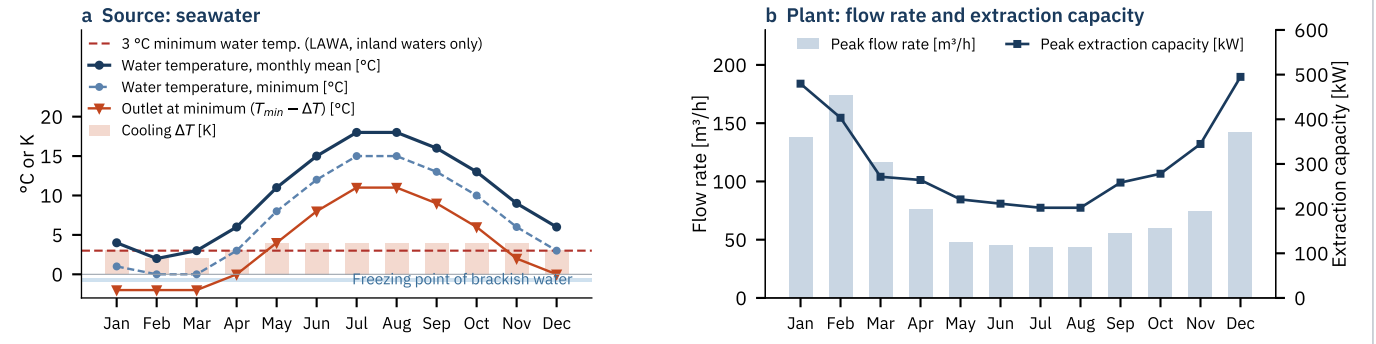


Figure 1. Seawater heat pump for a hotel resort on the Baltic coast, monthly study values (anonymised). a) Water temperature, cooling and outlet at the monthly minimum vs. the freezing point of brackish water; b) peak flow rate and extraction capacity. February governs flow rate and pipework, December and January the capacity.

4 Study results

Of the sources studied, only seawater carries the base load (Table 1), with peak load on cold days. With its higher SPF it supplies more source energy than the BHE field in [6] (1 410 MWh/a); the field could be charged with seawater in summer.

Table 1. Annual values of the seawater variant (total demand approx. 2 900 MWh/a)

Quantity	Value
Heat via heat pump	approx. 2 270 MWh/a
of which from the sea	approx. 1 620 MWh/a
Heat pump electricity	approx. 640 MWh/a
SPF without / with intake pumps	3.5 / approx. 3.3
COP February / August	3.0 / 4.5
Peak flow rate	approx. 175 m³/h (February)

5 Permitting and engineering

The return flow is a discharge under § 9(1) No. 4 WHG requiring a permit (§ 8); the water authority also assesses the abstraction from coastal waters [1]. Depending on location, the waterways office (§ 31 WaStrG), coastal protection and Natura 2000 are also involved. Schleswig-Holstein has a 150 m protection strip, with exceptions e.g. for installations permitted under water law [5].

- Design for winter: outlet well above freezing, throttle extraction below approx. 2 °C, provide peak load.
- Measure temperature and salinity for a year; titanium for corrosion, screens and pigging for fouling, glycol intermediate loop for frost.

STANDARDS AND REFERENCES

[1] **WHG** Wasserhaushaltsgesetz (Federal Water Act), §§ 3, 8, 9 · **WaStrG** § 31
[2] **LAWA (2025)** Leitfaden Gewässerthermie, Project O 5.23
[3] **stadt+werk (2026)** Energiequelle Ostsee. News item, 10 Sept. 2026
[4] **Stadtwerke Neustadt in Holstein** www.swnh.de, accessed 24 Sept. 2026
[5] **LNatSchG SH** § 35 Schutzstreifen an Gewässern
[6] **GeoStudys Technical articles 3 (2026)** BHE field and balance ratio over 25 years