Summary of technology

Large Heat Pumps (LHP) are utility-scale heating plants that allow to transfer large quantities of heat from a colder source to a higher temperature heat user. Turboden LHP technology – based on closed cycle - takes advantage of 40+ years’ experience with custom made products operated by means of high temperature thermodynamic cycles.

Turboden’s LHP systems are designed application specific, selecting the proper cycle layout, working fluid and designing the main components based on the specific project need. LHP technology summary:

- Highly efficient: Electrically driven system based on turbo compressor technology.
- Large scale: Thermal power output from 3 MWth to 30 MWth per single unit.
- High lift: Up to more than 100 °C, possible thanks to custom design.
- High temperature: Output up to 200 °C with the possibility to generate steam.
- Environment-friendly: Experience with 10+ different working fluids with low GWP and low ODP.
- Main application: Large scale heat user with required temperature up to 200 °C with possibility to generate steam – mainly district heating network (DHN) and industrial user with possibility to generate steam.
- Base solution with:
  - Heat source side: Liquid form heat carrier. Possibility to evaluate different streams such as process mixture, etc.
  - Heat user: Heat carriers could be either liquid (water, thermal oil, etc.) or vapour (saturated steam, superheated steam, etc.)
Additional information:
- Application specific design.
- Possible combination with storage system (not part of Turboden scope of supply).
- Heat exchangers are typically shell & tube type with the possibility to select proper materials depending on the specific application.
- Flexible operation and with fast start-up and shut down.

**Table 1: Estimated performance for selected conditions**

<table>
<thead>
<tr>
<th>$T_{\text{source,in}}$</th>
<th>$T_{\text{source,out}}$</th>
<th>$T_{\text{sink,in}}$</th>
<th>$T_{\text{sink,out}}$</th>
<th>COP$_{\text{heating}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>[°C]</td>
<td>[°C]</td>
<td>[°C]</td>
<td>[°C]</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>60</td>
<td>90 (hot water)</td>
<td>2.75</td>
</tr>
<tr>
<td>95</td>
<td>80</td>
<td>90</td>
<td>150 (sat. steam)</td>
<td>3.1</td>
</tr>
</tbody>
</table>

**Project example – HEATLEAP project**

The HEATLEAP project aims to demonstrate the environmental and economic benefits of waste heat recovery systems in energy intensive industries by testing these technologies at real scale. The project is partially funded under the LIFE program (EU’s funding instrument for the environment and climate action).

The ultimate goals of this project are the valorization of waste heat streams from the cooling of the steelmaking process can be upgraded through a large-scale heat pump and used for district heating instead of being wasted, i.e. dissipated through cooling towers.

Here below the main technical features of LHP:
- LHP size: 6 MWth design heat output.
- Operative temperature: Design case 95°C with possibility to have output temperatures up to 120 °C.
- Flexibility: LHP output temperature adjustable depending on district heating network needs (requiring a variable temperature between 85 °C and 120 °C).
- Full integration with DH network. Control system designed to be highly flexible depending on DH network operating temperature.
- High flexibility with 2 compression stages and variable frequency driver (due to a very variable process)

**FACTS ABOUT THE TECHNOLOGY**

- **Heat supply capacity:** 3 MW to 30 MW per single unit
- **Temperature range:** Up to 200 °C or 12 bar steam, with maximum lift exceeding 100 °C
- **Working fluid:** Turboden already experienced with more than 10 different fluid between refrigerants, hydrocarbons and siloxanes.
- **Compressor technology:** Turbo compressor
- **Specific investment cost for installed system without integration:** 700 - 300 €/kW (thermal supply capacity) depending on the LHP unit size and temperature
- **TRL level:** 7 – 9
- **Expected lifetime:** 20+ years
- **Size:** Custom made - depending on specific size and application
  - High speed centrifugal compressor
  - Working fluid: Low GWP HFO, R1233ZD

**Table 2: Design case performance in HEATLEAP**

<table>
<thead>
<tr>
<th>$T_{\text{source,in}}$</th>
<th>$T_{\text{source,out}}$</th>
<th>$T_{\text{sink,in}}$</th>
<th>$T_{\text{sink,out}}$</th>
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<tbody>
<tr>
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<td>[°C]</td>
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<tr>
<td>75</td>
<td>70</td>
<td>65</td>
<td>95</td>
<td>8.2</td>
</tr>
</tbody>
</table>

**Contact information**

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All information were provided by the supplier without third-party validation. The information was provided as an indicative basis and may be different in final installations depending on application specific parameters.