Vapor Compression as Flexibility Enablers

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HVAC-R industry: a major energy consumer with high saving potential

- 95% of all systems only utilise 50% of the compressor work
- Compressors use 17% of all electricity
- Cooling capacity increase year over year

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Total energy store:

- Heat recovery with CO2 as refrigerant
- Use refrigeration compressors for heat pump purposes where cooling load is low and heating load is high (winter).
- Install heat/cooling storage units (to store energy where electricity price is low and/or COP is high).
- Sell excessive heat from refrigeration system into the district heating system.
- Combine Photovoltaic (PV) and refrigeration/heating into a local “micro-grid power system”
Thermal networks: expand the perception of smart systems and the scope for Vapor Compression Systems

District heating and cooling networks are perfect for thermal energy storage – but limited in temperature range.

Vapor Compression can upgrade temperature levels to grid demands.

In some application areas thermal storage can provide flexibility in electricity consumption.
Overview of selected opportunities

Opportunity

- Heat Recovery (HR)
- Use of idle compressor capacity (HP)
- Ice storage (ICE)
- Demand Response (DR)
- PV panels and Battery
Energy cost overview based on auxiliary type

- **A higher degree** of variable electricity pricing can be foreseen.
- Basic case stores will likely experience an **increase in energy costs**.
- There is an **overall advantage** (win-win) to invest in advanced technology solutions.

### Yearly Cost

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Yearly Cost [DKK per KW installed refrigeration capacity]</th>
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</thead>
<tbody>
<tr>
<td>Base</td>
<td>0</td>
</tr>
<tr>
<td>Base + HR</td>
<td>500</td>
</tr>
<tr>
<td>Base+HR+HP</td>
<td>1000</td>
</tr>
<tr>
<td>B+HR+HP+ICE</td>
<td>1500</td>
</tr>
<tr>
<td>DR</td>
<td>2000</td>
</tr>
<tr>
<td>PV+Battery</td>
<td>2500</td>
</tr>
</tbody>
</table>

- Scenario 1 (constant electricity price)
- Scenario 2 (Variable electricity price)
Vapor compression systems are huge energy consumers and that will increase with growing urbanization.

- Most systems only utilise 50% of the compressor work
- Most systems do not use their full capacity
- Systems are suited to connect to grids
- Systems can store energy – Hot / Cold

- Marginal investments to become ‘smart’ are small

Volatile electricity price structures can lead to:

- Increase in electricity cost if no flexibility and storage opportunities are disregarded
- Significant energy cost reductions if the electricity consumption is flexible and planned.
  → investments in advanced technology solutions