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Opportunities for compact TES on board fishing vessels and cruise ships

Erling Vingelsgård (SINTEF Ocean), Ángel Á. Pardiñas & Håkon Selvnes (SINTEF Energy Research)





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Energy demand on fishing vessels

- Cooling
 - Refrigerated sea water (RSW)
 - Brine cooling
 - Chilling tank
- Freezing
 - Plate and blast freezers
 - Air cooling
- Processing of rest raw materials
- Heating, tap water

 High**EFF**

PCM-STORE 

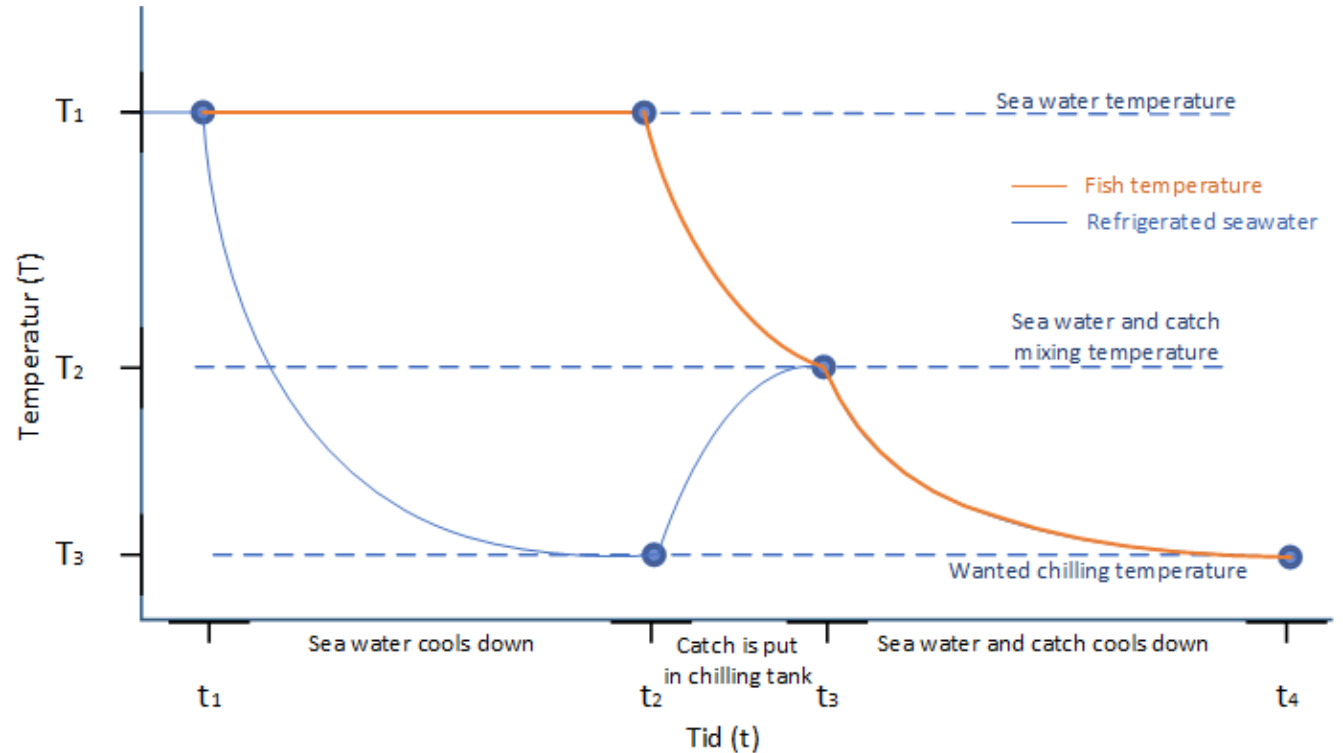
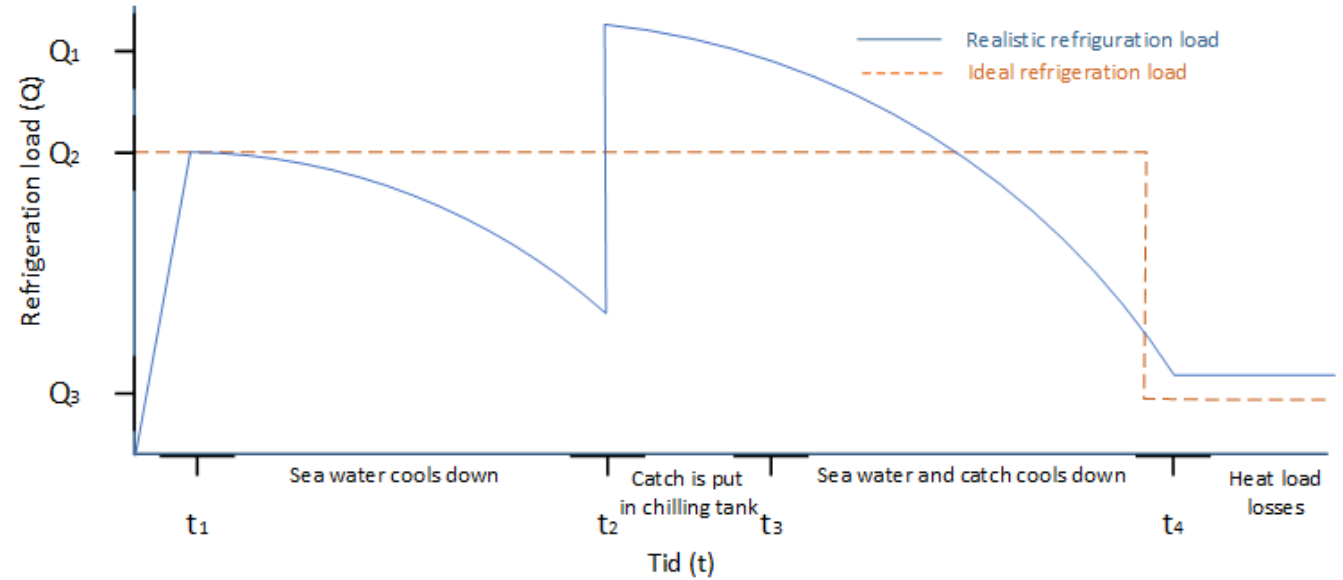
CoolFish 



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Refrigerated sea water

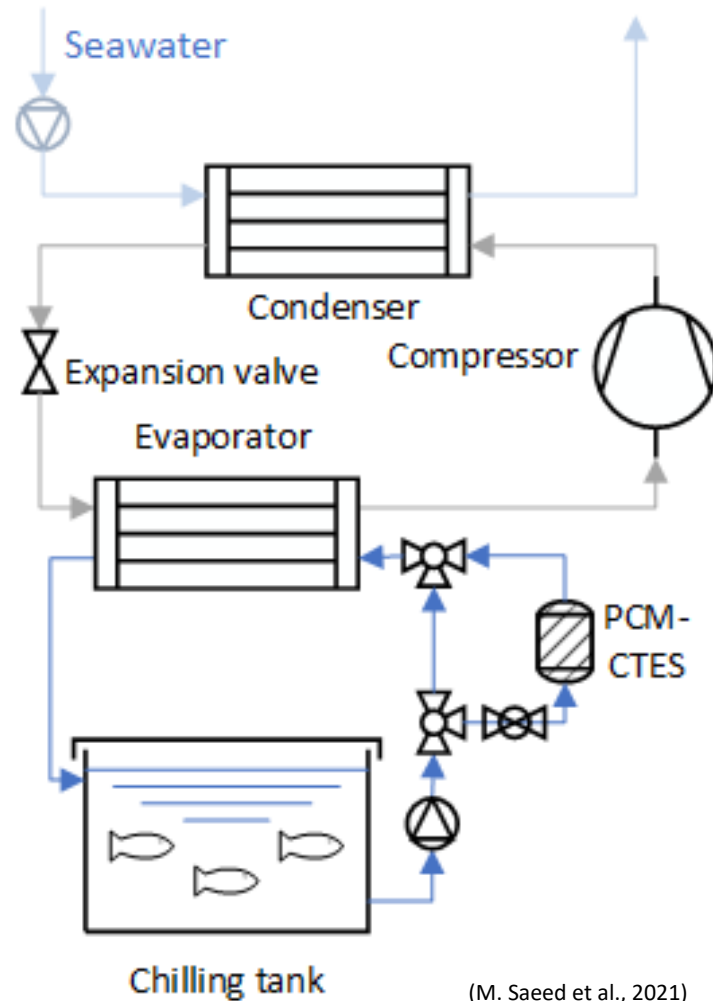
- Seawater chilled
 - Travel out to fishing ground
 - Not time sensitive
- Large catch brought on board
 - Time sensitive



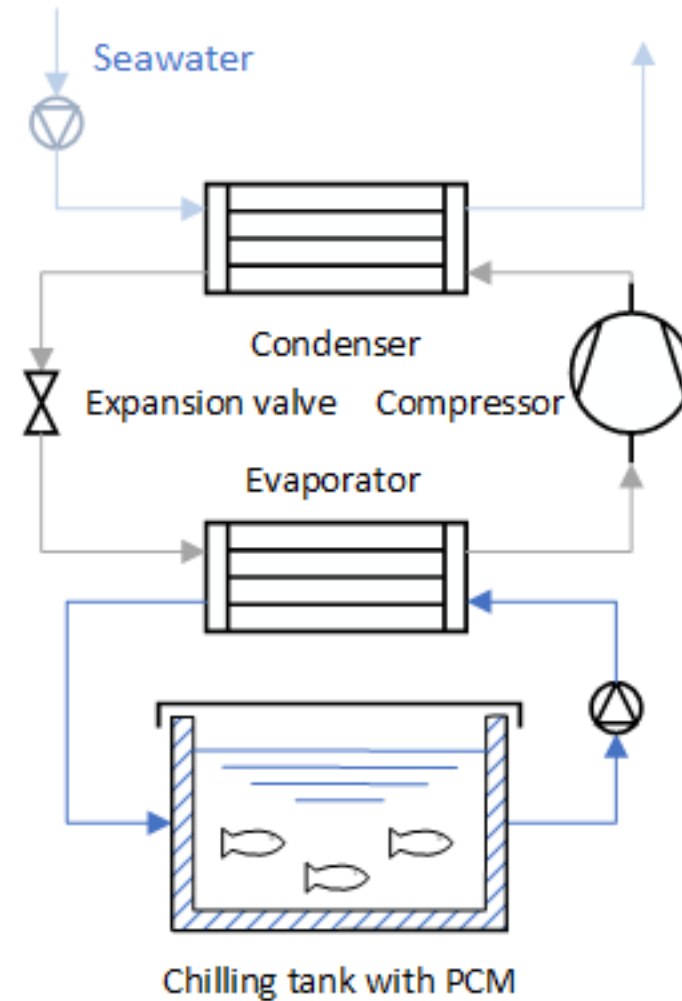


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PCM-CTES in RSW systems



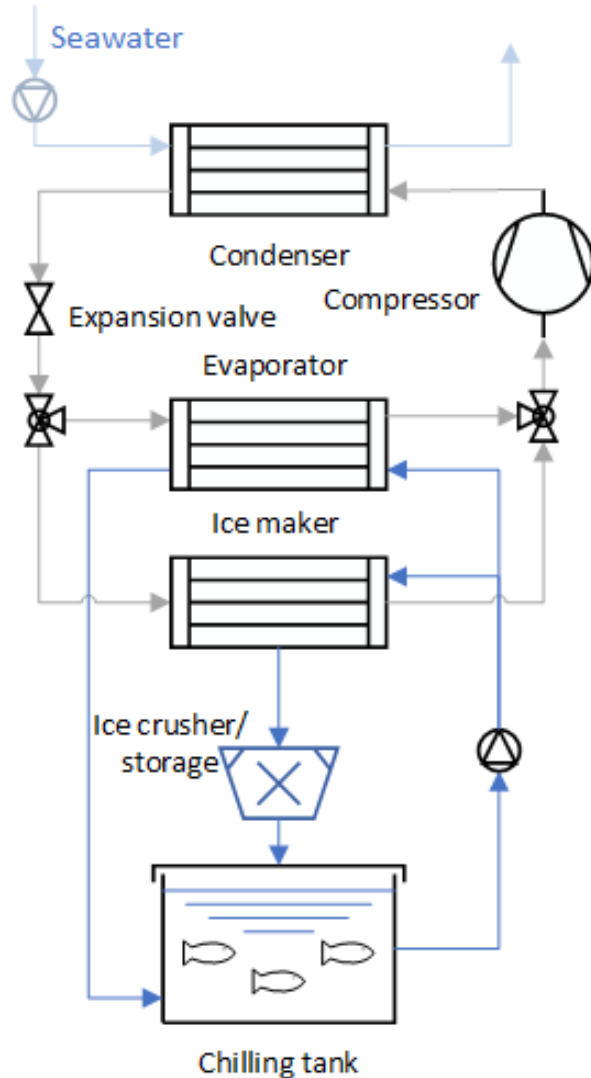
(M. Saeed et al., 2021)





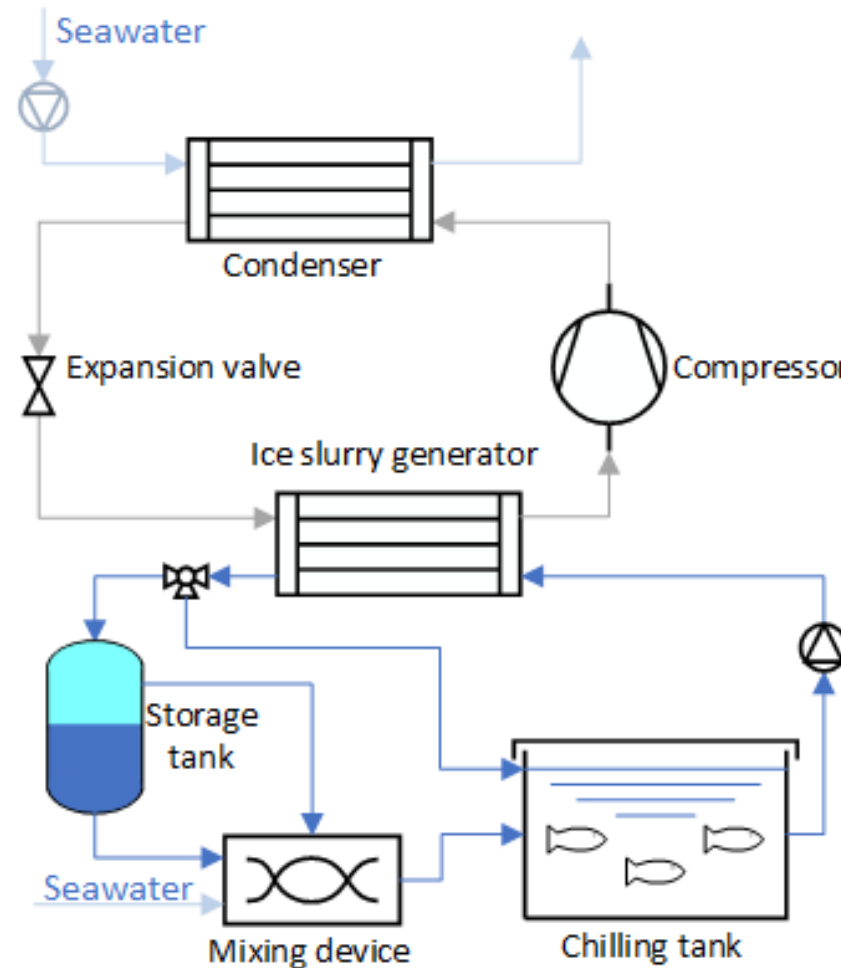
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Ice vs. ice slurry



ICE

- High latent heat
- Manual handling
- Rough ice
 - Damage product



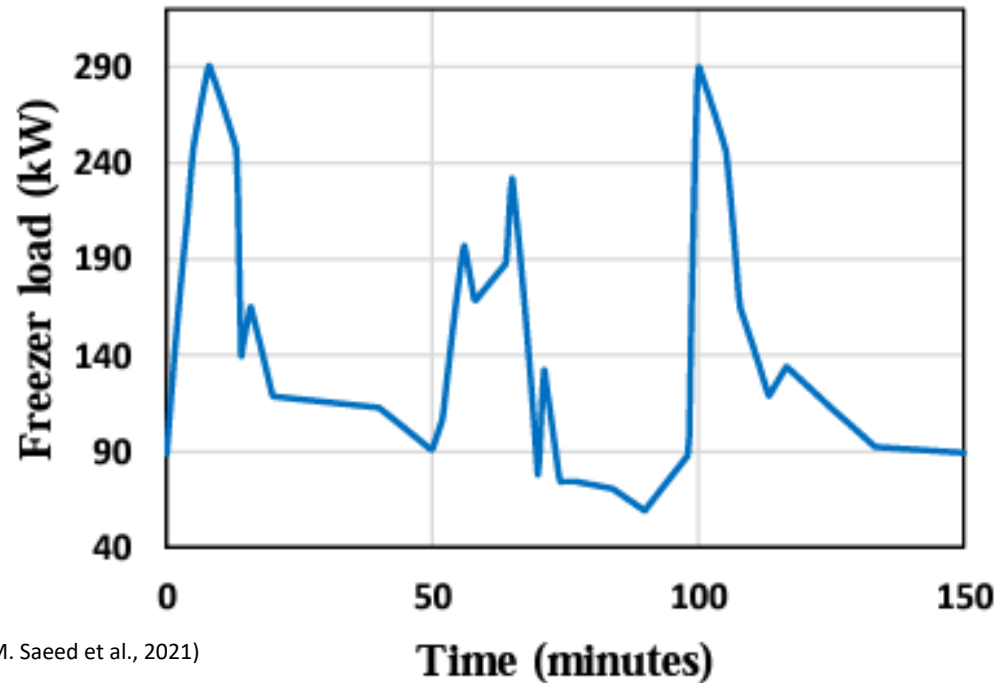
ICE SLURRY

- High latent heat
- Pumpable
- Small ice crystals
 - Gentle to product
- Increased heat transfer

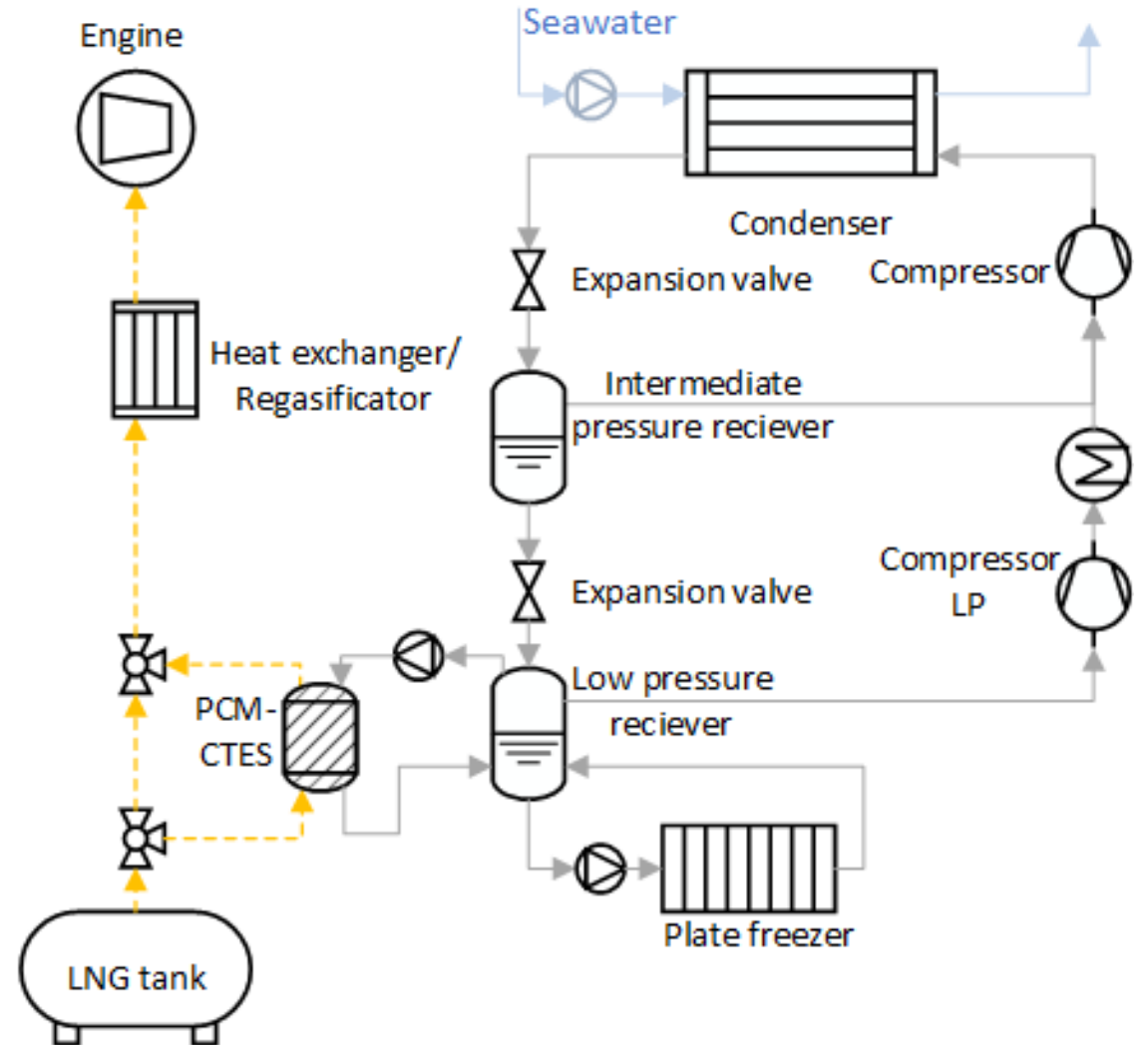


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PCM-CTES in on board freezing systems



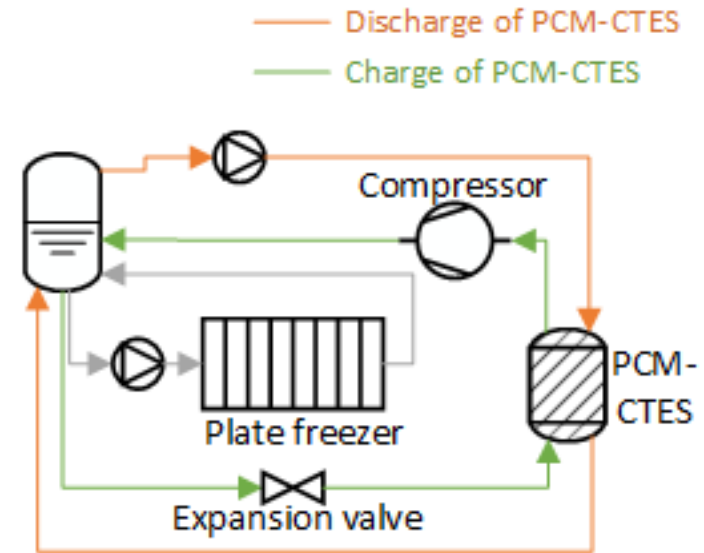
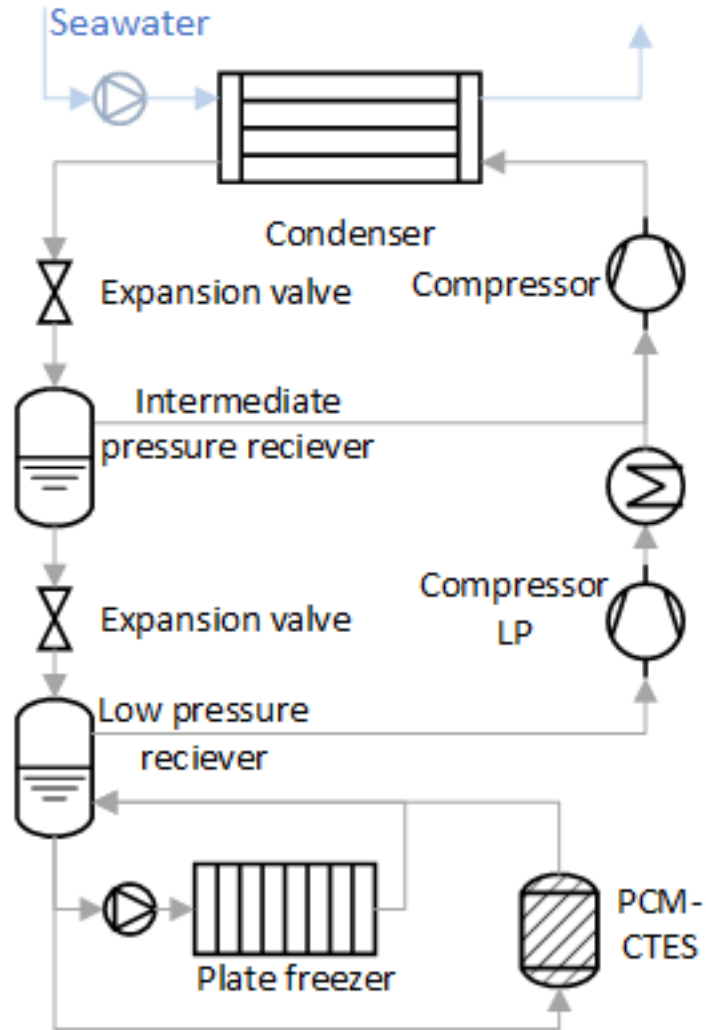
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PCM-CTES in on board freezing systems

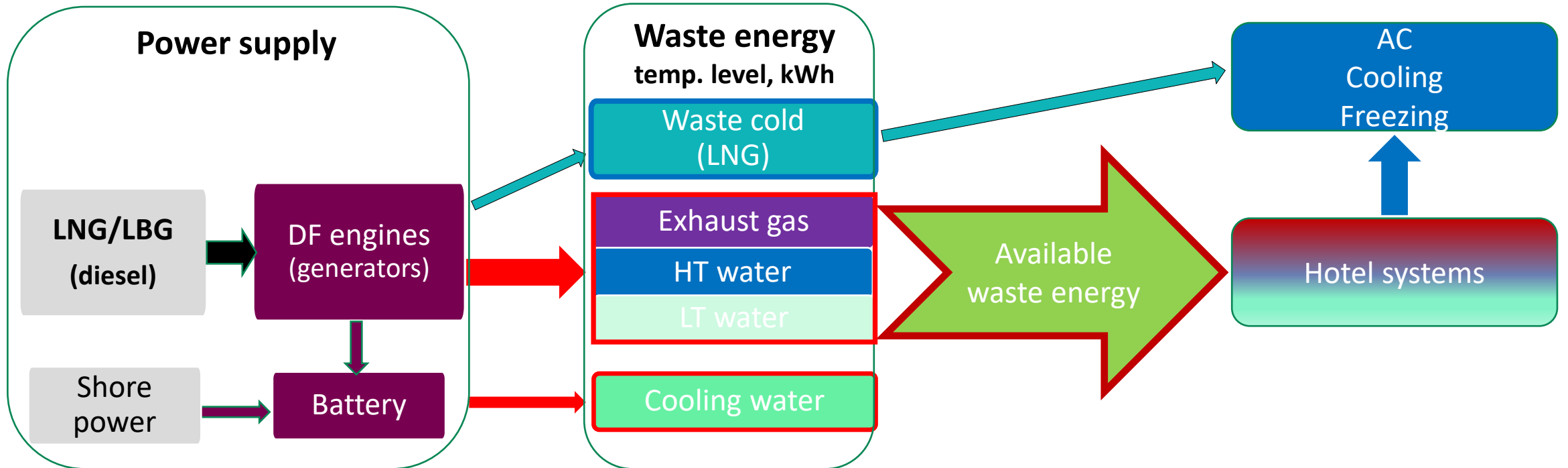




Cruise ships and TES



PCM-STORE

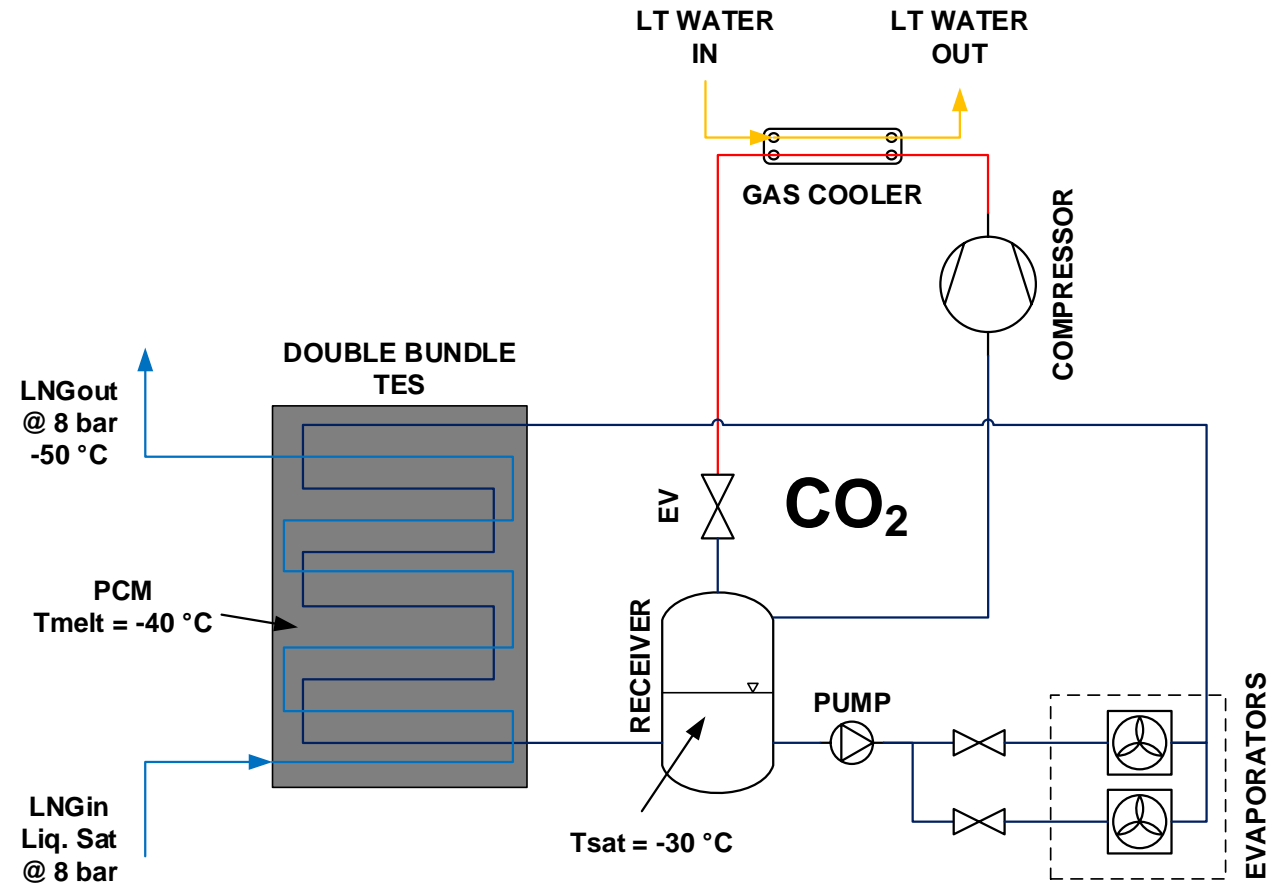


LNG use and PCM for cruise ships

- Maximize LNG use as cold sink.
- Concerns for stability due to:
 - Variability of loads.
 - Variability of temperatures.



PCMs?

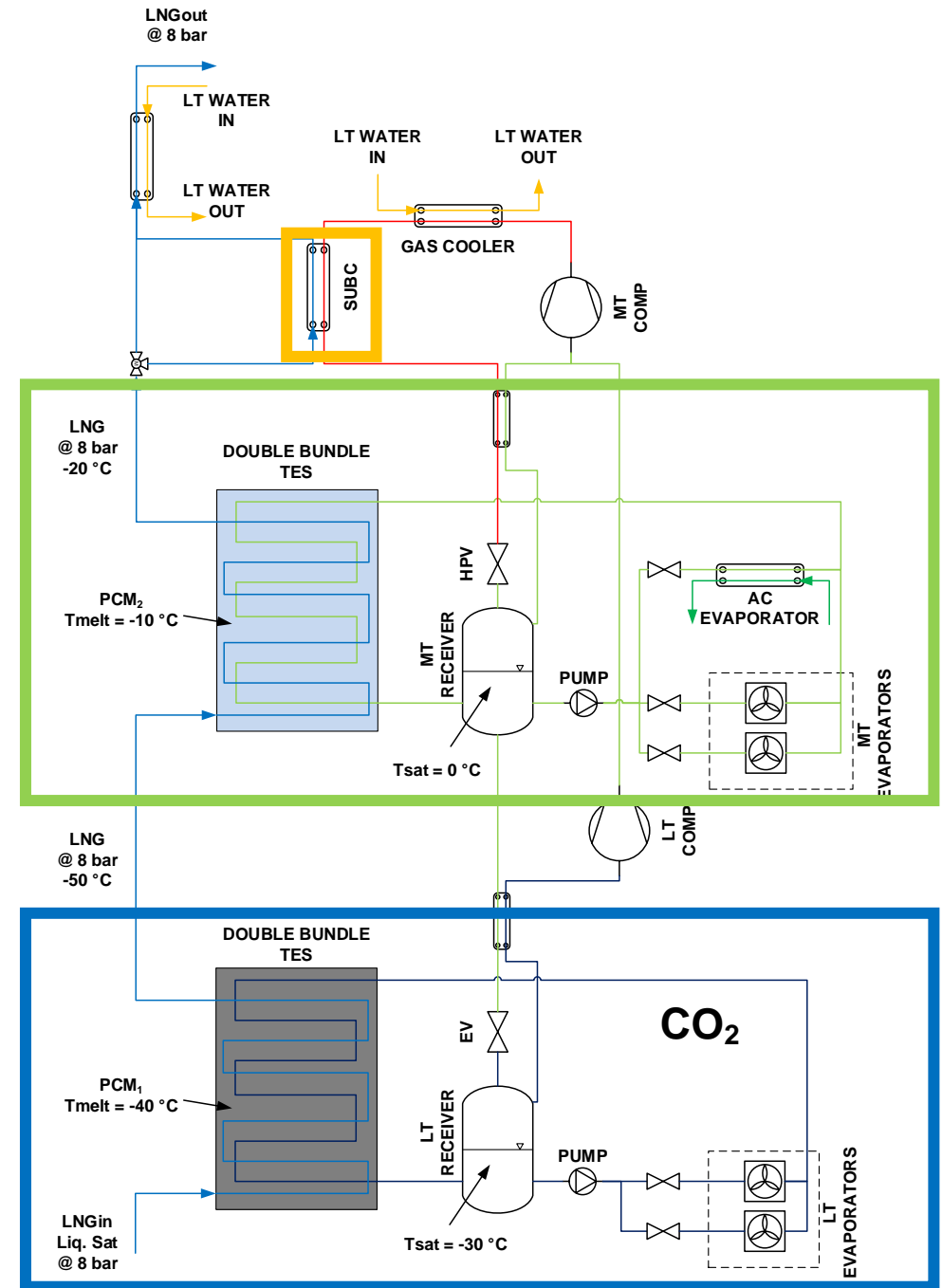


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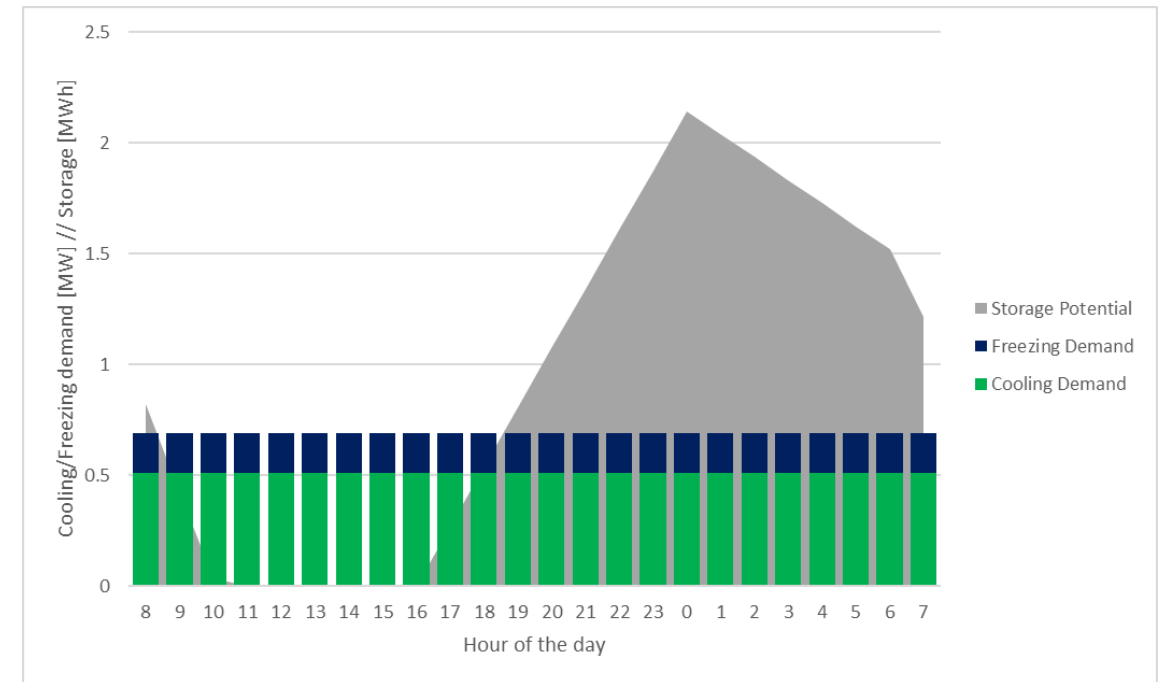
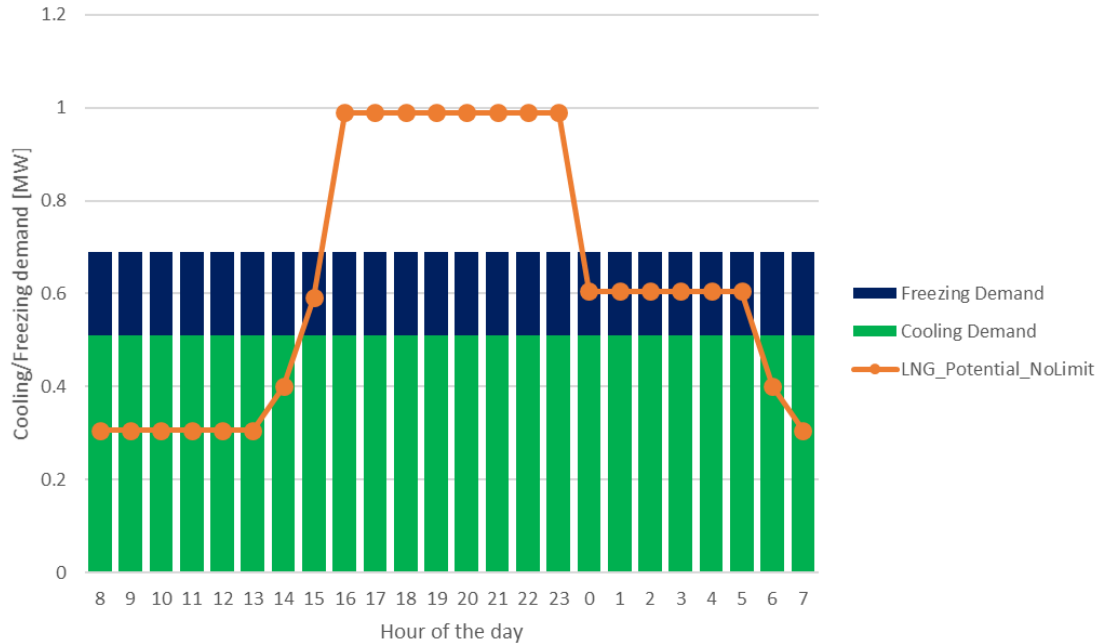
PCMs?





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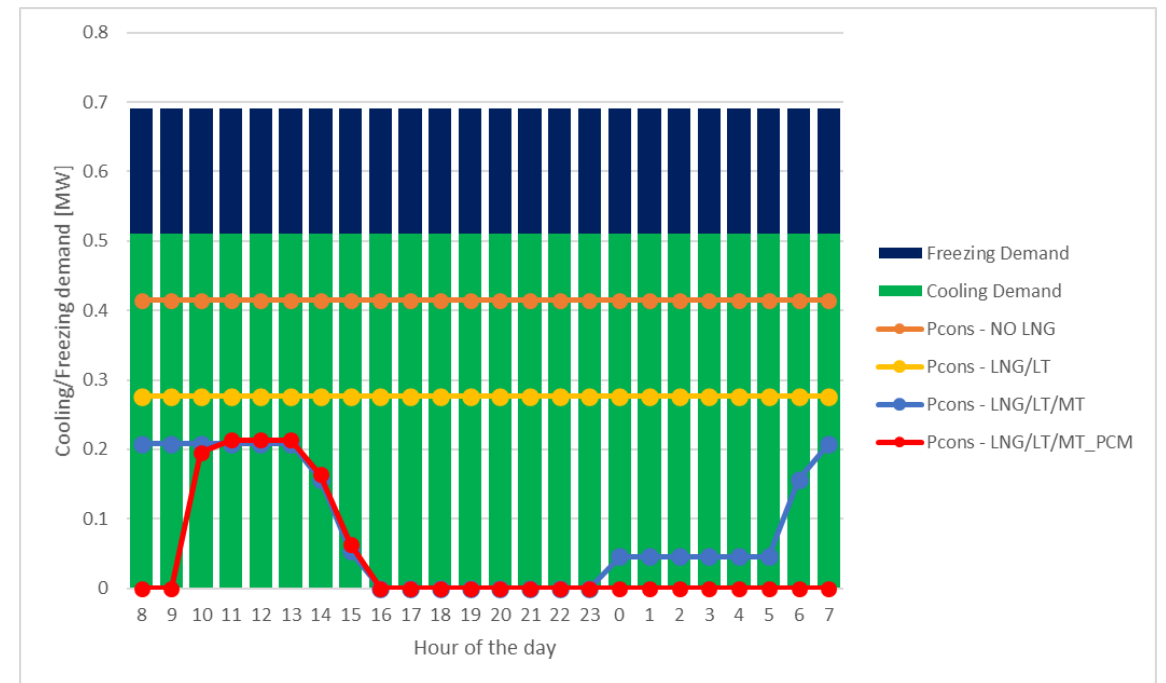
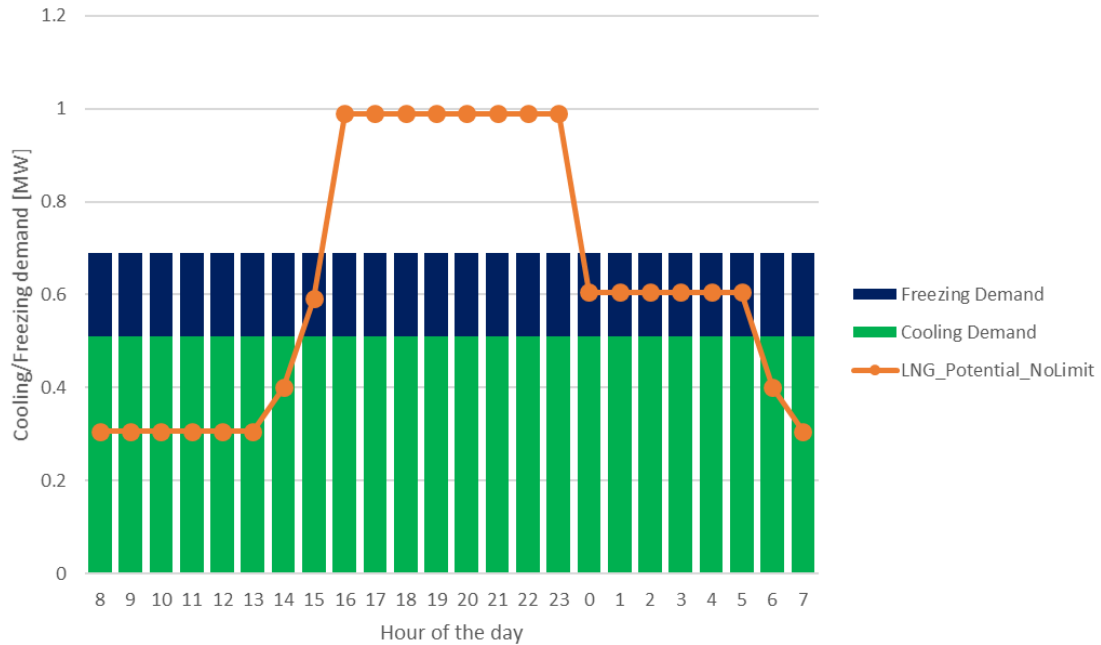
LNG use and PCM for cruise ships





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LNG use and PCM for cruise ships





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LNG use and PCM for cruise ships

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PCMs?

Data sheet
ATS -12

AKO-THERM PCMs are designed to absorb and release large quantities of thermal energy at constant temperatures. Over 30 organic (O-TX) and inorganic (I-TX) high-performance PCMs in a temperature range between -80 °C to 180 °C are available in special micro-encapsulated form with an optimized surface-to-volume ratio for better energy exchange and improved performance in practical applications. Standardized solutions such as our HeatStable and HeatStable are available for water and air-based applications and can be adapted to your specific requirements.

Key features of the AKO-THERM PCM are:

- High heat storage capacities
- Consistent, repeatable performance over thousands of thermal cycles
- Simple and safe handling
- Also based on renewable raw materials, carbonic and biodegradable



Typical Values	
Melting temperature	°C -14 to -11
Composting temperature	°C -41 to -17
Heat storage capacity* temperature range of -11 - -6°C	kJ/kg 300
Specific heat capacity	kJ/m ³ 3
Density (liquid)	kg/m ³ 1.1
Heat conductivity	W/m°C 0.5
Volume expansion	% -6%
Max. operating temperature	°C 48
Flash point	°C Non-flammable
Corrosion	Corrosive effect on metals

Data sheet
ATS -40

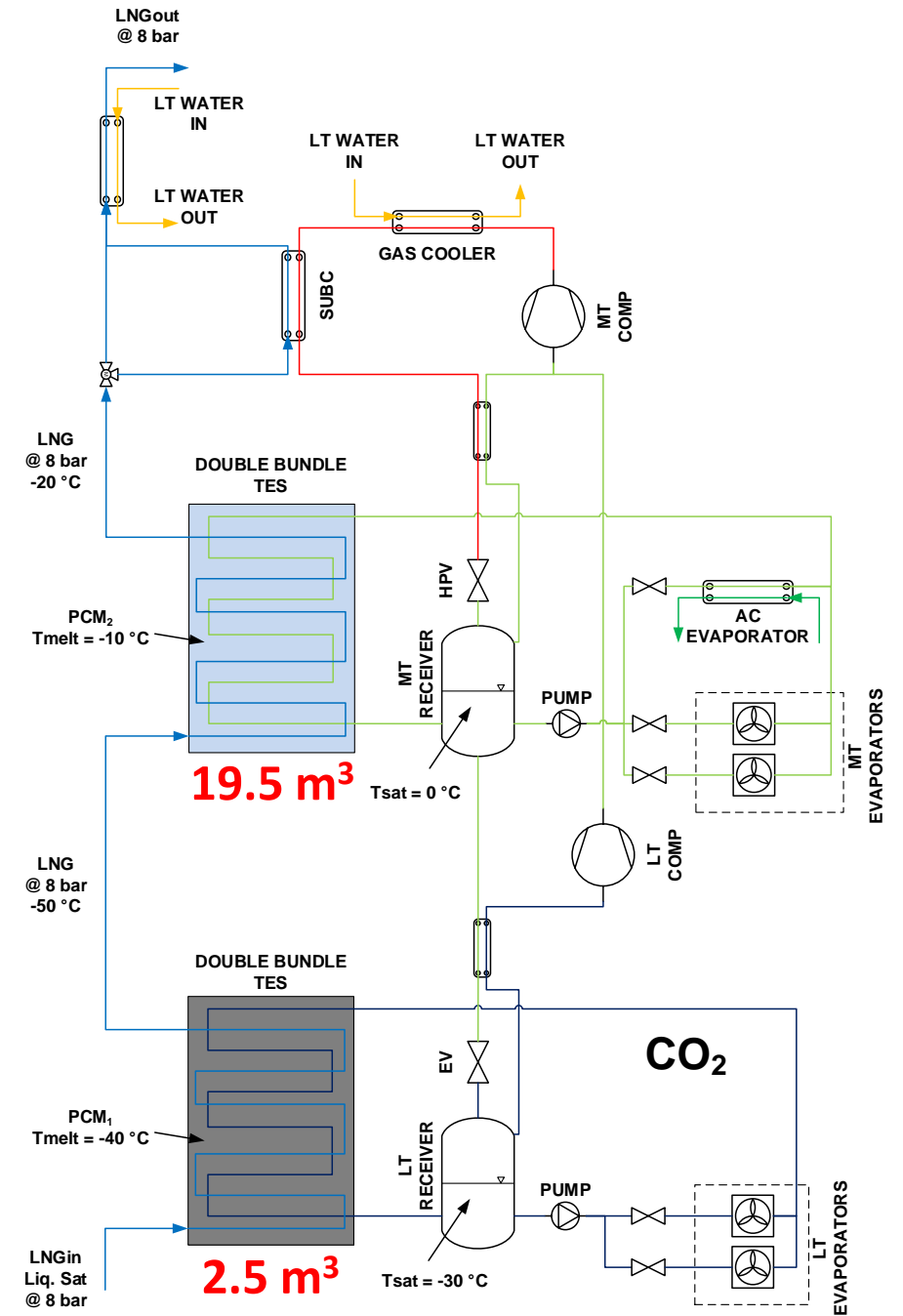
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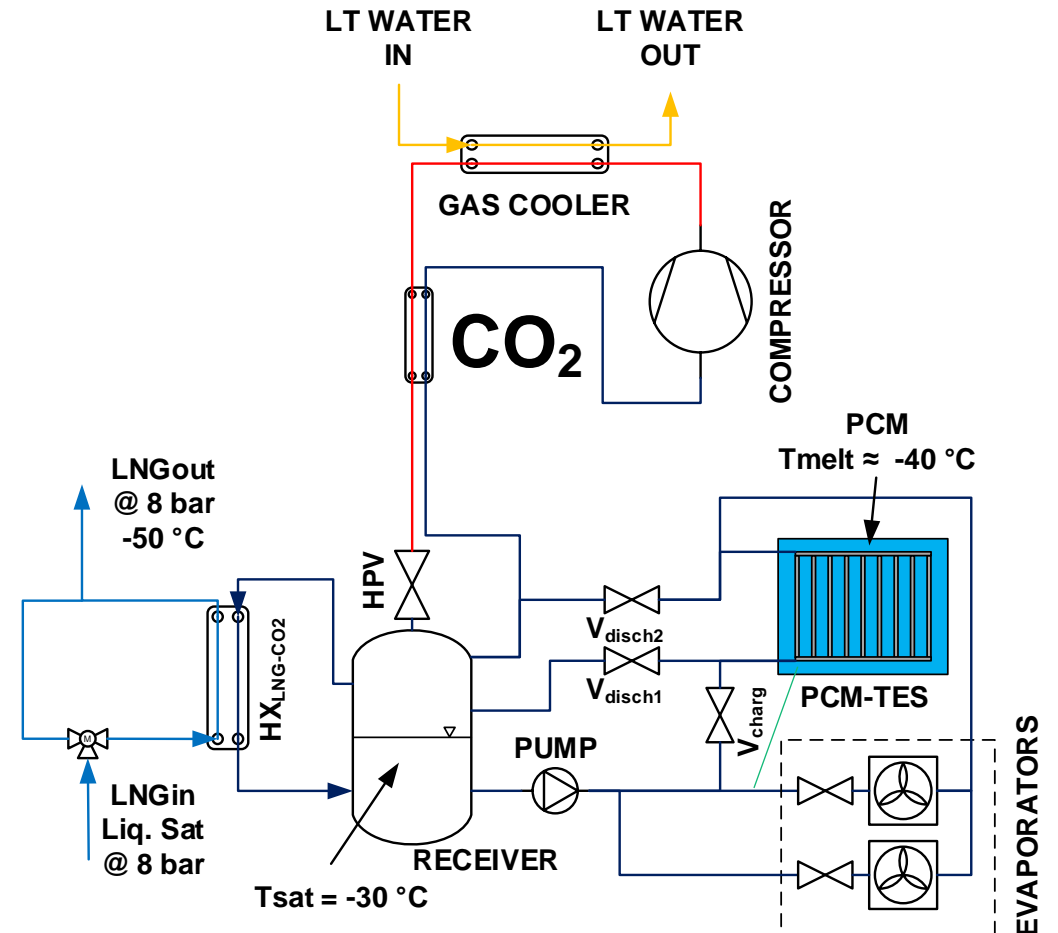


Typical Values	
Melting temperature	°C -40 to -38
Composting temperature	°C -42 to -20
Heat storage capacity* temperature range of -40 - -31°C	kJ/kg 100
Specific heat capacity	kJ/m ³ 3
Density (liquid)	kg/m ³ 1.1
Heat conductivity	W/m°C 0.5
Volume expansion	% -6%
Max. operating temperature	°C 48
Flash point	°C Non-flammable
Corrosion	Corrosive effect on metals



LNG use and PCM more general

- Concern about feasibility of three-fluid HX-TES (double bundle TES)
- Alternative with more conventional PCM-TES approach (CO₂ and PCM)
- Self-circulated CO₂ in HX with LNG.
- Potential for "booster" applications → LT, MT, AC.

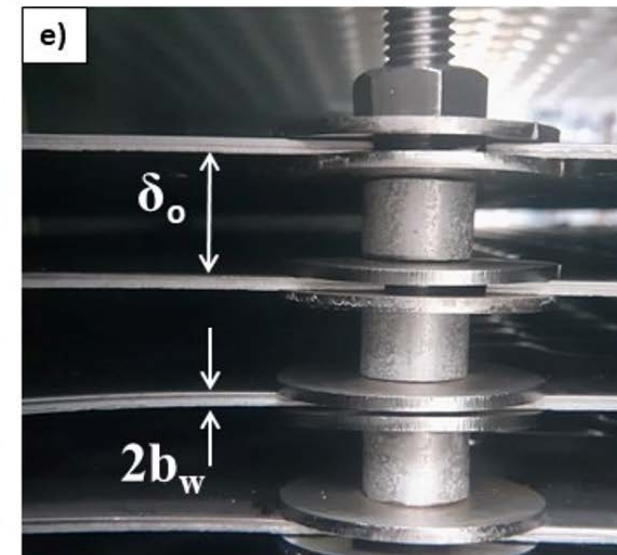
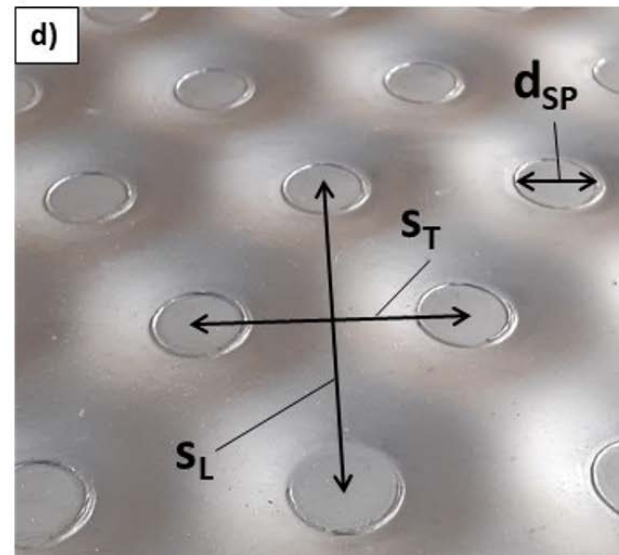
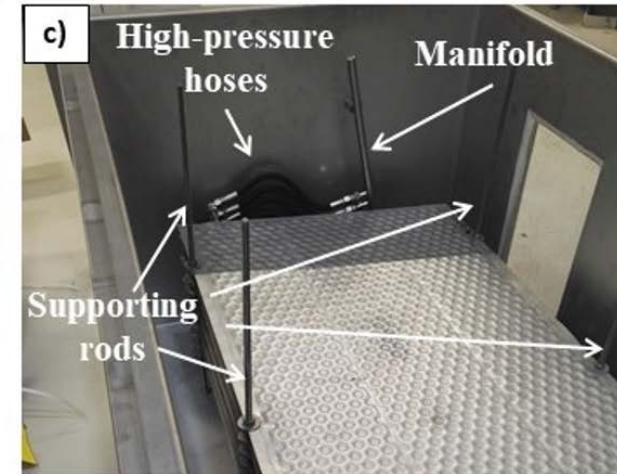
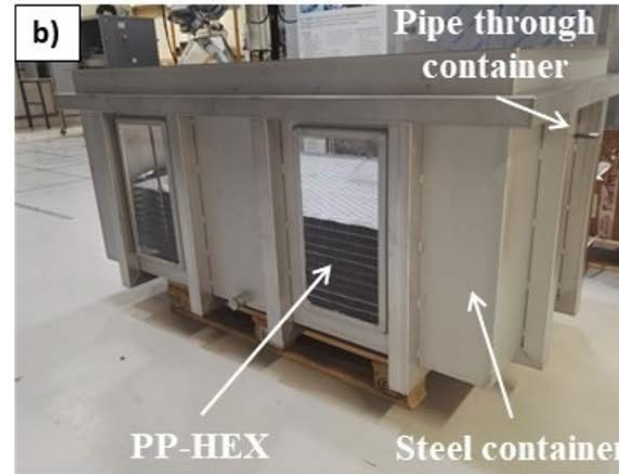




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Alternative HX-TES concept – CO₂ & PCM

- Simplifying the hardware by limiting to two mediums
- Already tested at lab-scale for PCMs at subzero temperatures
- Availability of commercial PCM in -40 °C range is limited
 - Alternative for LT – TES: Using dry ice (solid CO₂) as PCM in a pressurised tank.
 - Will be investigated further





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THANK YOU FOR YOUR ATTENTION

