Module 4
District cooling

Part of the SHaKE Educational Package on District Heating and Cooling Systems

CASE STUDIES

Case-study activities for applied analysis and classroom discussion

Developing institution: Universitat Jaume I de Castellón
Erasmus+ KA220-HED Cooperation Partnerships in Higher Education
Version: 1.1
Date: May 2026

https://www.shakeproject-dhc.eu/

Select only one section of your choice to do the assignment (one case study is mandatory)

1. District Cooling Systems and Heat Pumps

Case Study Title: Helsinki (Finland) – Seawater-Based SHC with Heat Pumps

Climate: Cold-temperate

Project Reference: Helen Ltd. District Cooling System (source: Energy Cities)

Assignment:

1. Study the district cooling network in Helsinki that uses seawater, heat pumps, and data center waste heat.
2. Tasks:
3. Describe how the system operates across three modes: free cooling, heat pump operation, and waste heat integration.
4. Analyze the seasonal variation in performance (e.g., COP of the system in summer vs winter).
5. Discuss the role of simultaneous heating and cooling (SHC) in improving system efficiency.
6. Estimate the carbon savings using available data (around 60,000 tons of CO_2 avoided per year).
7. Design a simplified schematic diagram of the system.

Deliverable:

Technical report (4–6 pages) with system diagram and energy balance estimation.

2. Cooling Technologies and Absorption Systems

Case Study Title: Riyadh (Saudi Arabia) – Solar-Driven Absorption Chiller Integration

Climate: Hot and arid

Project Reference: Franchini et al., "Solar-powered district cooling systems in arid regions" (2018)

Assignment:

Analyze a district cooling project in Riyadh using solar-assisted absorption chillers.

Tasks:

1. Compare two solar technologies: parabolic trough collectors (PTC) vs evacuated tube collectors (ETC), based on system COP.
2. Evaluate energy performance differences (e.g., COP of 1.39 for PTC, 0.723 for ETC).
3. Calculate the potential CO_2 emissions reduction based on solar fraction (up to 70%).
4. Propose improvements or modifications to reduce fossil fuel reliance.
5. Suggest maintenance strategies for desert environments.

Deliverable:

4–5 pages analysis report including energy flows, solar contribution, and schematic diagram.

3. Refrigerants

Case Study Title: Tokyo (Japan) – Low-GWP Refrigerant Transition in District Cooling

Climate: Humid subtropical

Project Basis: Real refrigerant transitions in Tokyo's cooling systems (e.g., R-134a phase-down)

Assignment:

Evaluate the retrofit of a district cooling system from R-134a to low-GWP refrigerants (e.g., R-1234ze or CO_2).

Tasks:

1. Compare environmental metrics (GWP, TEWI, LCCP) before and after refrigerant transition.
2. Identify challenges related to safety, compressor compatibility, and oil/lubricant miscibility.
3. Review Japanese F-Gas regulations and how they influence refrigerant selection.
4. Discuss PFAS and TFA risks associated with HFO refrigerants.
5. Propose suitable alternatives for tropical climates with low environmental impact.

Deliverable:

Technical dossier (max. 5 pages) with comparative tables, regulatory context, and retrofit analysis.

4. Heat Pump Integration and Configurations

Case Study Title: Drammen (Norway) – Ammonia Heat Pump Using Fjord Water

Climate: Cold-maritime

Project Reference: Drammen Heat Pump (Norway) – One of the world's largest seawater heat pumps

Assignment:

Analyze the Drammen heat pump system, which extracts heat from fjord water at ~8–9 °C and delivers district heating at 90 °C using ammonia (NH_3) refrigerant.

Tasks:

1. Describe the vapor compression cycle used with NH_3 and explain the system's configuration.
2. Calculate seasonal performance variations (COP ≈ 3) considering outdoor temperatures.
3. Evaluate economic benefits versus fossil boilers in similar climates.
4. Analyze risks and advantages of using ammonia as refrigerant.
5. Discuss the replicability of this project in other European port cities.

Deliverable:

Detailed technical report (5–6 pages) including simplified energy balance and cost comparison.

5. Thermal Energy Storage and Hybrid Systems

Case Study Title: Singapore – Phase Change Material (PCM) TES in District Cooling

Climate: Tropical

Project Reference: Keppel DHCS + NUS pilot project (2024), news.nus.edu.sg

Assignment:

Explore the integration of PCM-based thermal energy storage in Singapore's district cooling system at Changi Business Park.

Tasks:

1. Explain how PCM tanks work and how they integrate into district cooling systems.
2. Simulate daily charge/discharge cycles and peak load reduction.
3. Evaluate economic benefits (cost savings >10%) and reliability improvements.
4. Compare this system to chilled water TES and ice storage systems.
5. Discuss scalability and applicability in other equatorial regions.

Deliverable:

Report (4–5 pages) + visual diagrams of TES cycles and energy savings estimation.