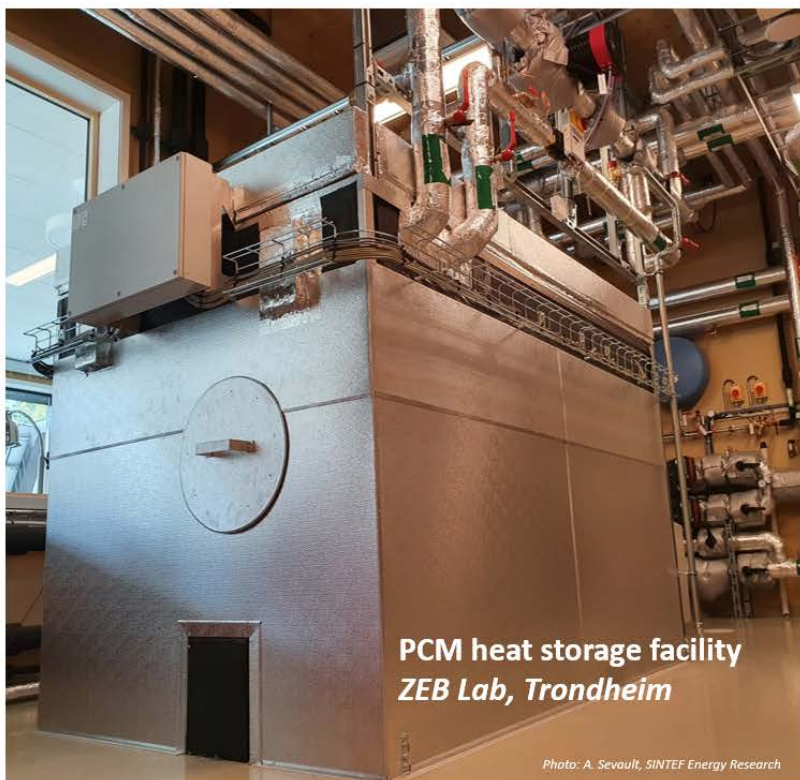




Workshop on Thermal Energy Storage for industry, buildings and marine applications

Friday 12th November 2021

SINTEF Headquarters, Strindveien 4, Trondheim // Teams (online)



PCM heat storage facility
ZEB Lab, Trondheim

Photo: A. Sevault, SINTEF Energy Research

- 08:30 *Welcome and check-in*
- 08:45 Introduction to TES workshop 2021
- 09:00 Part 1: Low-temperature TES in industry**
- 10:00 *Coffee break*
- 10:30 Part 2: Medium- and high-temperature TES**
- 11:40 Visit of PCM heat storage facilities at ZEB Lab**
- 12:30 *Lunch*
- 13:30 Part 3: TES in maritime sector**
- 14:30 Part 4: TES in a broader perspective**
- 15:15 *Wrap-up and conclusions*
- 15:30 *End of TES Workshop 2021*



PCM-STORE



CoolFish





SINTEF

A person wearing a bright yellow jacket and black pants is climbing a large, jagged ice formation. They are using two ice axes to ascend the ice. The background shows a clear blue sky and a snow-covered mountain peak.

Workshop on Thermal Energy Storage for industry, buildings and marine applications

Alexis SEVAULT, Hanne KAUKO, Kristina WIDELL, Cecilia GABRIELLI

2021-11-12 – Teams / SINTEF headquarters



SINTEF

SINTEF: One of Europe's largest independent research organisations

SALES



340

Million EUR

EMPLOYEES



2000

PROJECTS



6800

CLIENTS



3400

GLOBALLY

EUR 47 million

PUBLICATIONS

5100

NATIONALITIES

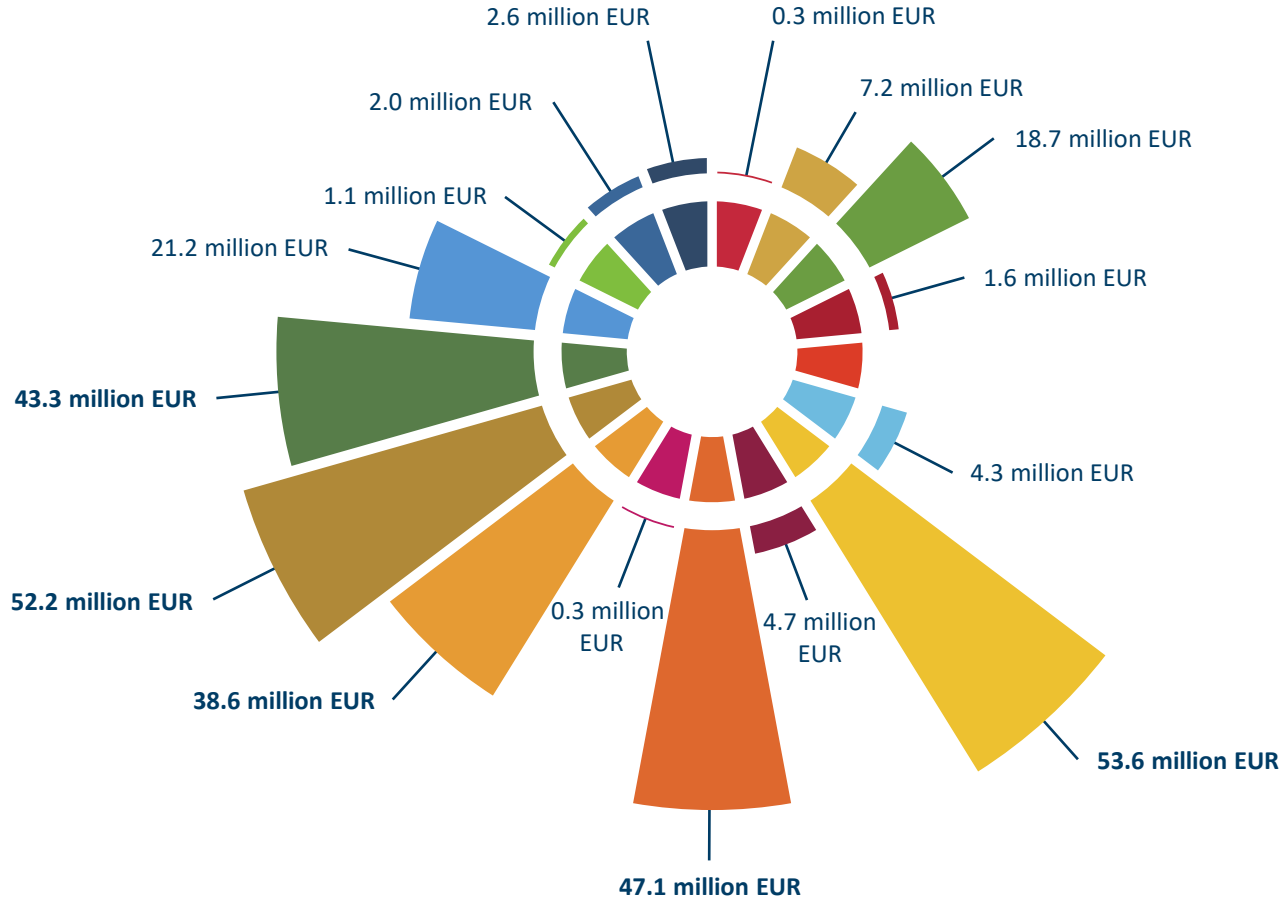
75

CLIENT SATISFACTION

4.6 out of 5



Our projects contribute to meeting the UN's Sustainable Development Goals



- 1. Zero poverty
- 2. No hunger
- 3. Good health and well-being
- 4. Quality education
- 5. Gender equality
- 6. Clean water and sanitation
- 7. Affordable and clean energy
- 8. Decent work and economic growth
- 9. Industry, innovation and infrastructure
- 10. Reduced inequalities
- 11. Sustainable cities and communities
- 12. Responsible consumption and production
- 13. Climate action
- 14. Life below the water
- 15. Life on land
- 16. Peace, justice and strong institutions
- 17. Partnerships for the goals

SINTEF's net turnover in 2019 sorted according to the Sustainable Development Goals

Hour-to-hour adjustments in power systems due to variability in demand, wind and solar

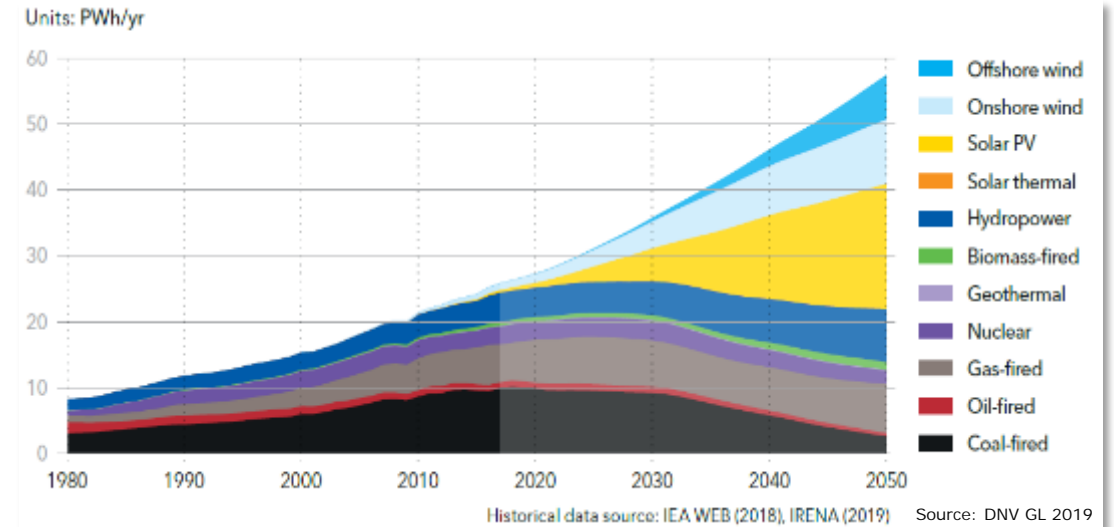




SINTEF

The world must succeed with energy storage

- Most likely 52-67 % renewable energy as global share of primary energy in 2050 in scenarios where global warming is limited to 1.5°C (IPCC)
- Wind and solar will dominate the global electricity mix by mid-century (DNV-GL)



“The need for flexibility in power systems grows even faster than electricity demand, due to rising shares of variable renewables and growing demand for cooling and electric vehicles. (...) demand-side response has huge potential (...) battery storage capacity rises 40-fold by 2040”

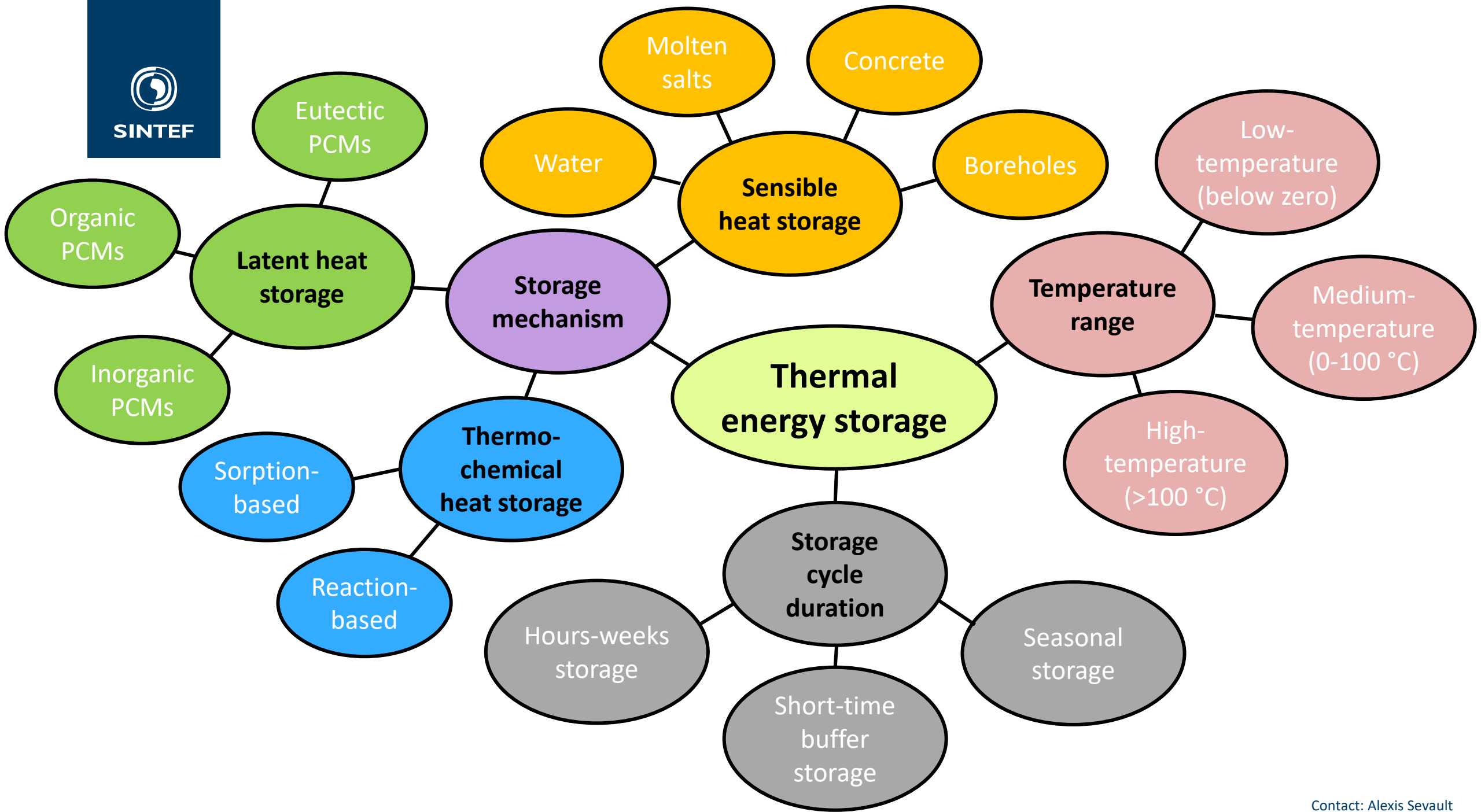
(IEA 2019)



Photos are licensed under CC BY-SA

Total global market for thermal energy storage: €300+ billion

Source: Infracapital, EnergyNest secures €110m investment from M&G-backed Infracapital; <https://bit.ly/3hVxP4U> (visited 2021-05-07)



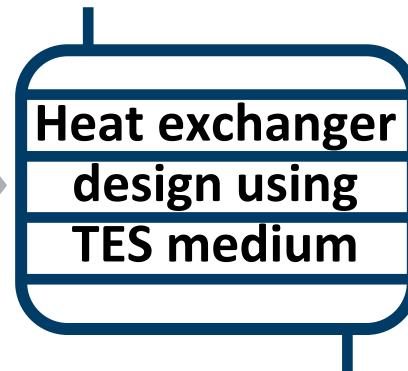
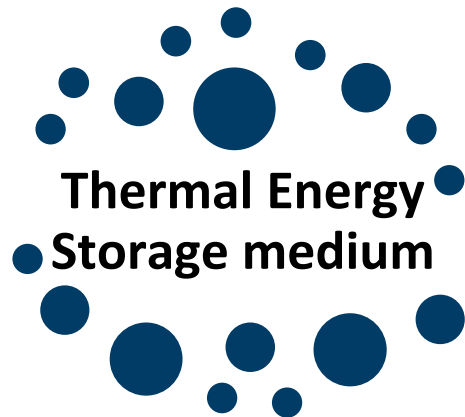


SINTEF

Our approach to Thermal Energy Storage systems

Analysis of energy sources, energy demands & temperature profiles

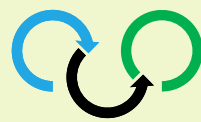
Evaluation of goals & opportunities for thermal energy storage



Process integration towards goals

Control & monitoring strategies

Production and implementation of thermal energy storage solution



WP1 – Fundamental models for PCM



Leader: *F. Vullum-Bruer*

WP2 – Design of novel PCM cold storage units



Leader: *A. Sevault*

WP3 – Integration in industry processes



Leader: *K. N. Widell*

WP4 – Pilot testing of PCM cold storage units

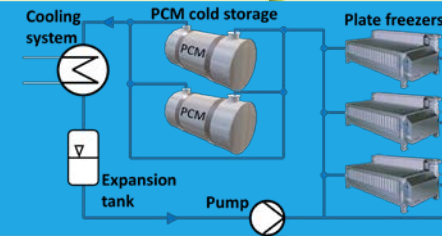


Leader: *A. Hafner*

CASE A: Industrial batch freezing processes

$-50\text{ °C} < T < -15\text{ °C}$

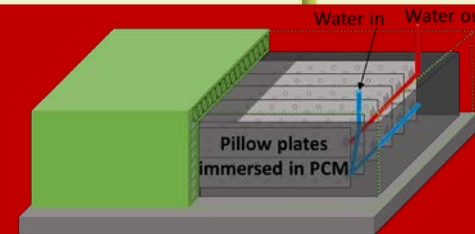
Expert Adviser:  *T. S. Nordtvedt*



CASE B: Cold food batch processes

$-5\text{ °C} < T < 5\text{ °C}$

Expert Adviser:  *S. Jensen*



CASE C: Refrigerated display cabinets

$-15\text{ °C} < T < 4\text{ °C}$

Expert Adviser:  *K. Banasiak*



WP5 – Management – Dissemination – Education – Technology Monitoring

Project Leader: *A. Sevault*

Demonstration projects, implementations in industry

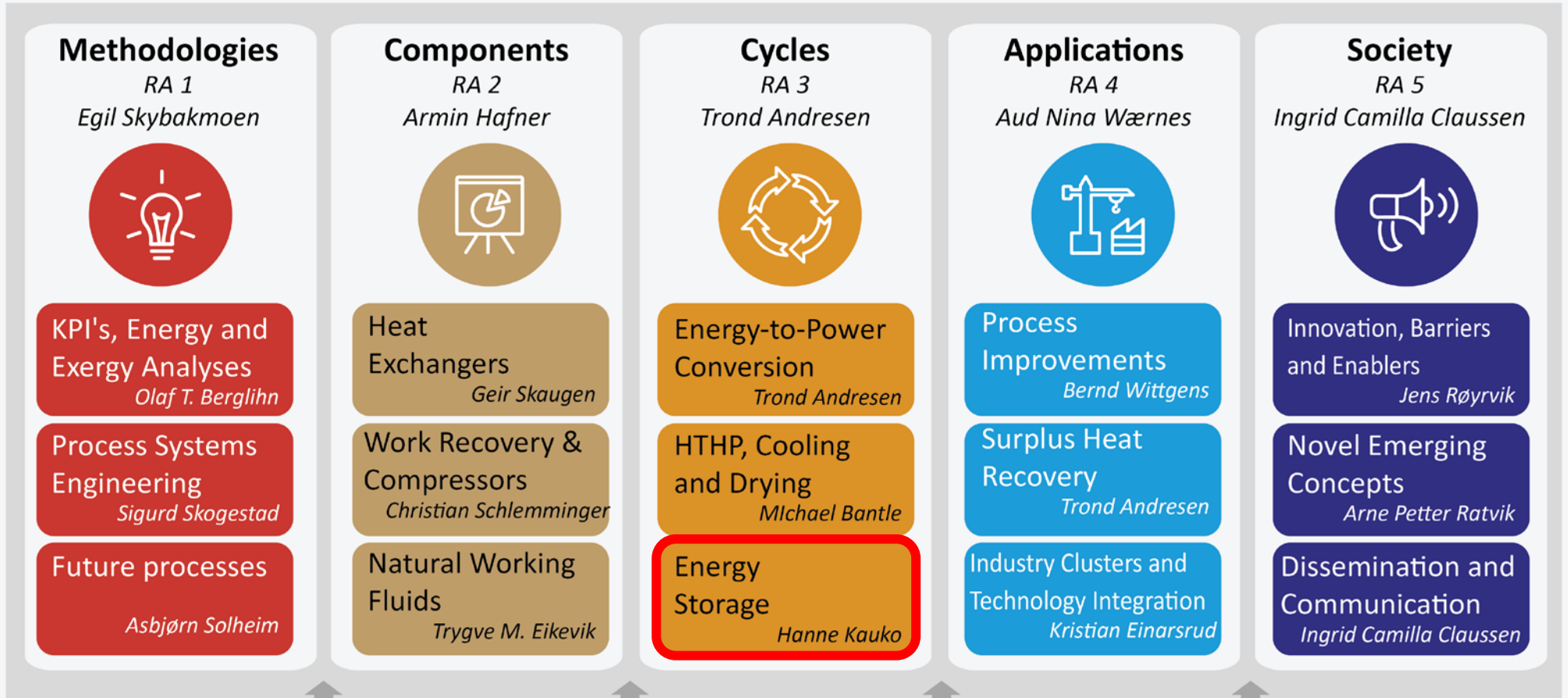


Making Norwegian industry the world's greenest

Education

Management

Centre Building



Case Studies
RA 6
Marit Mazzetti



- Metal, Material
Ida Teresia Kero
- Oil, Gas, Energy
Monika Nikolaisen
- Food, Chemical
Michael Bantle
- Industry Clusters
Kristian Einarsrud

Training of Experts

CruiZE



Cruising towards Zero Emissions

Background:

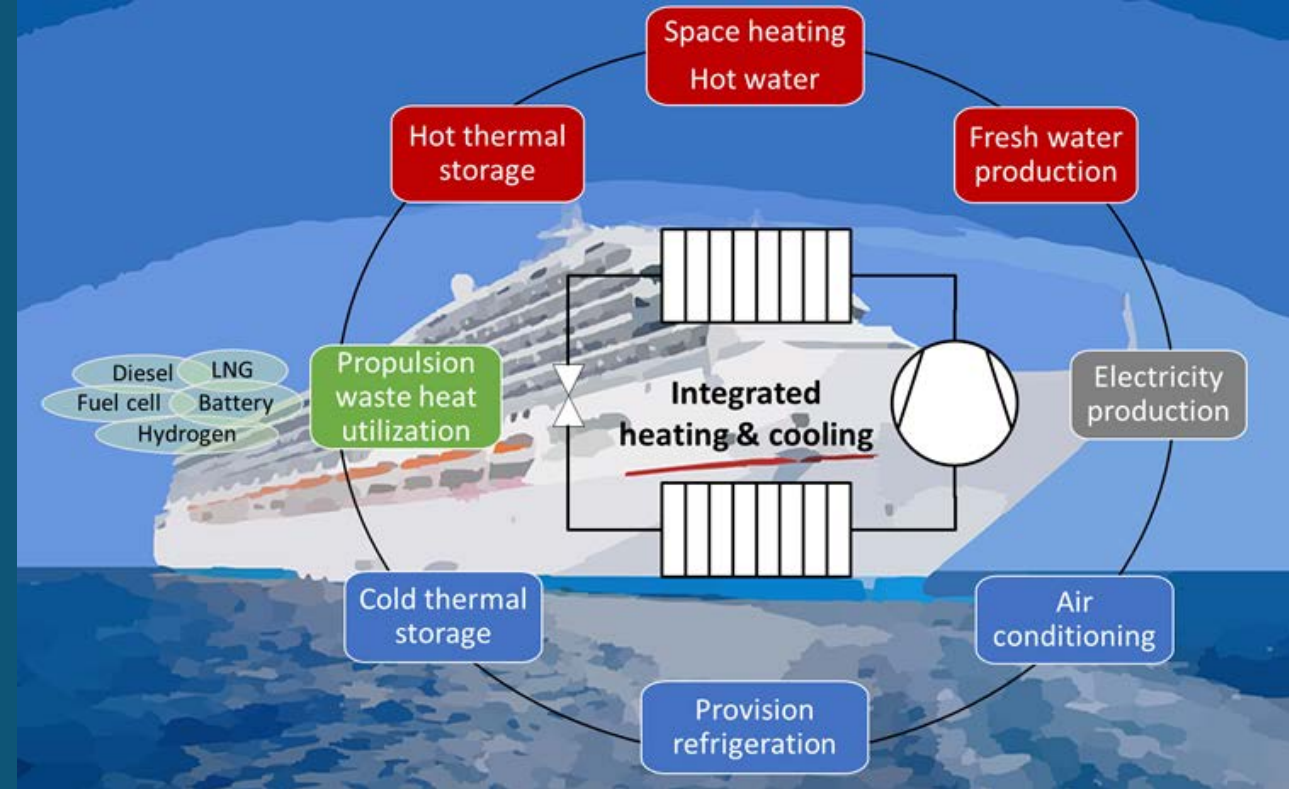
The energy use of hotel facilities onboard cruise ships can constitute up to 50% of the ship's total energy use.

The development of propulsion systems and fuels imply changes in the ship's energy system and waste heat characteristics.

Objectives and ambitions:

Develop innovative, integrated, energy-efficient and environment-friendly concepts for heating and cooling onboard cruise ships.

Suggest concepts, *optimized for the actual propulsion system and operating conditions*, aiming at zero emissions in ports, minimized emissions at sea and 10-20% reduction in total energy use.



KPN project: 2020 – 2024

Project manager: Cecilia Gabriellii, SINTEF Energi cecilia.gabriellii@sintef.no

Partners: Teknotherm Marine, Ulmatec Pyro, Kongsberg Digital, Vard Design, Carnival Corporation, NTNU

Budget: 24 MNOK

Webpage: <https://www.sintef.no/prosjekter/2020/cruize/>

CoolFish

Energy efficient and climate friendly cooling, freezing and heating onboard fishing vessels



- **KPN project**, financed by partners and  **Forskningsrådet**
- **Project period:** 2019 – 2023
- **Project manager:** Kristina N. Widell (SINTEF Ocean) kristina.widell@sintef.no
- **Partners:** MMC First process, Selvåg Senior, Øyangen, Bluewild, PTG, GASNOR, Danfoss, Isotherm Inc, NTNU, SINTEF Energi
- **More information:** www.sintef.no/en/projects/2019/coolfish



Workshop on TES for industry, buildings & maritime applications

Friday 12 November 2021

SINTEF (Trondheim) // Teams (online)



08:30 Welcome and check-in

08:45 Introduction to TES workshop 2021 – Alexis Sevault (SINTEF Energy Research)

09:00 Part 1: Low temperature TES in industry

- **Intro: How TES could benefit cold industrial processes** - Kristina Norne Widell (SINTEF Ocean)
- **Cold thermal energy storage for refrigeration systems: Current status and future perspectives** Håkon Selvnes (SINTEF Energy Research)
- **A new validated model of PCM-pillow-plate heat exchanger to show the benefits of TES in any thermal system** Sven Fösterling (TLK-Thermo)
- **Thermal energy storage in fish processing industry** - Jan Petter Urke (MMC First Process)

10:00 Coffee break

10:30 Part 2: Medium and high temperature TES

- **Intro: Thermal Energy Storage to enhance flexibility** - Hanne Kauko (SINTEF Energy Research)
- **Two current projects where TES in concrete will benefit the industry** – Christopher Greiner (EnergyNest)
- **Molten salt TES for the industry** – Christopher Kjølner (Kyoto Group)
- **Demo 200-kWh heat storage using bio-based PCM in ZEB Lab** – Alexis Sevault (SINTEF Energy Research)
- **EnergiHUB – Energy concept for the giant project NTNU Campussamling** - Eivind Selvig (Civitas/Statsbygg)

11:40 Visit of PCM heat storage facilities at ZEB Lab (Høgskoleringen, Trondheim)

12:30 Lunch (Hegstad & Blakstad, Nina-building)

13:30 Part 3: Low- and high temperature TES in maritime sector

- **Intro: Thermal storage – an enabler of zero-emission shipping?** - Cecilia Gabriellii (SINTEF Energy Research)
- **Opportunities for compact TES on board fishing vessels and cruiseships** – Erling Vingelsgård (SINTEF Ocean), Angel Pardiñas (SINTEF Energy Research) & Håkon Selvnes (SINTEF Energy Research)
- **Some reflections on the utilization of PCMs in thermal systems** - Chris-Andre Larsen & Bjørn Holo (Teknotherm)
- **Piloting Integrated HT/LT system on 600pax Ro-Pax vessel** – Bernt Aage Ulstein (Ulmatec Pyro)

14:30 Part 4: TES in a broader perspective

- **What is the best thermal energy storage?** - A Guideline to find out - Stefan Krimmel (Univ. Applied Sciences Lucerne / SINTEF Industry)
- **What type of PCM materials are available today?** - Ragnhild Sæterli (SINTEF Energy Research)
- **The role of TES in future fossil-free energy systems** - Hanne Kauko (SINTEF Energy Research)

15:15 Wrap-up

15:30 End of TES Workshop 2021