

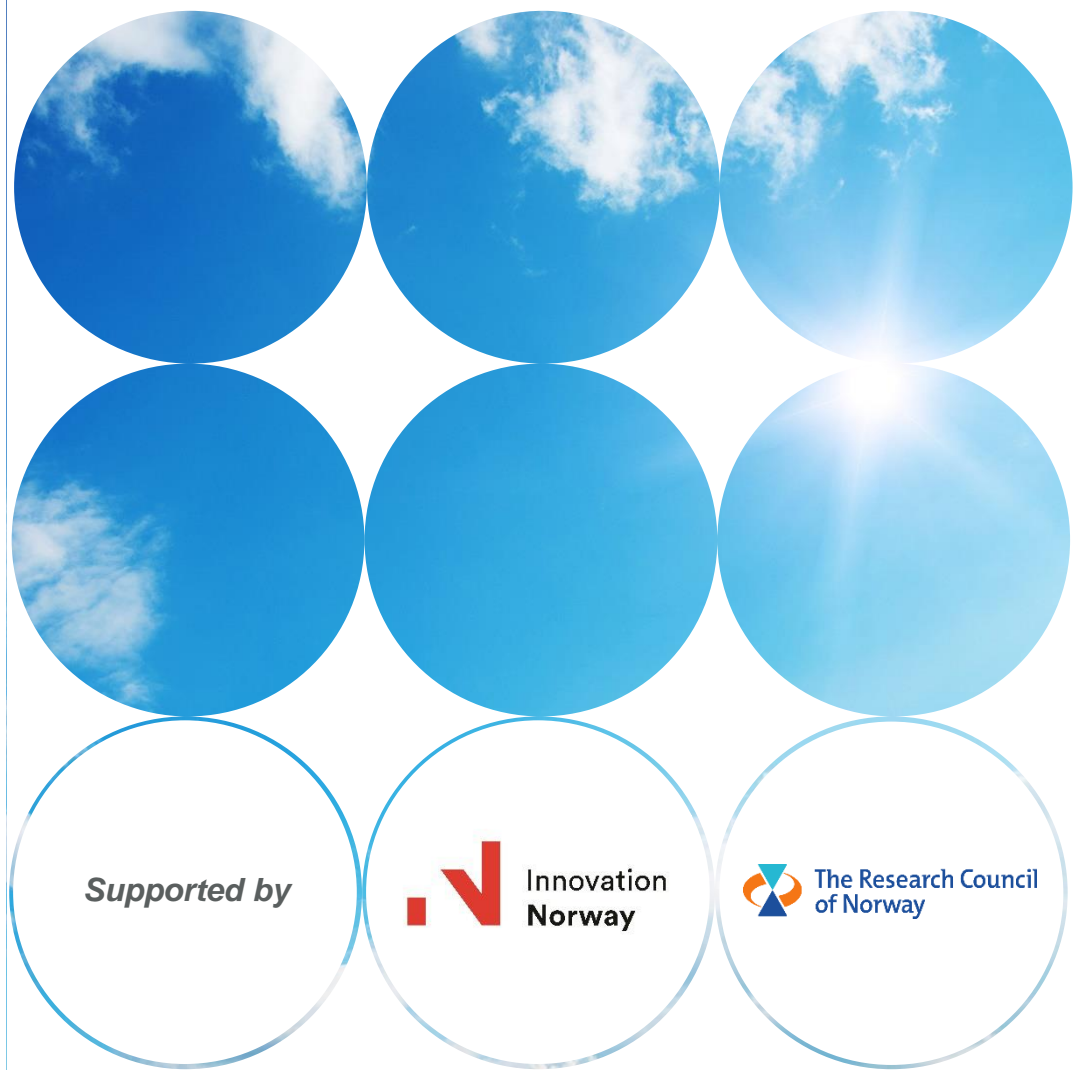


EnergyNest

Høy-Temperatur Termisk Energilager

Christopher J. Greiner, Ph.D.
Director Engineering

August 2016



Innhold

- Kort om selskapet
- Teknologi
- Markedsmuligheter
- Konkurransen

Vi er et norsk teknologiselskap basert i Oslo og Abu Dhabi

EnergyNest AS Headquarters, West Oslo, Norway



EnergyNest AS, Olav Brunborgsvei 6, 1396 Billingstad, Norway

Headquarters and International Sales Office.

EnergyNest AS Office, Masdar City, UAE



Masdar Institute of Science and Technology, Opposite of Presidential Flight/Opposite of Abu Dhabi Intl. Airport, Abu Dhabi, UAE.

Office 114 of the Masdar Incubator Building at Masdar City, UAE.

Med en høyt kvalifisert ledelse

Harald Norvik – Chairman

- ❖ Former CEO of Statoil
- ❖ Initiated privatization of Statoil as a company
- ❖ Significant experience in the energy sector as well as in company leadership



Prof. Pål G. Bergan – Chief Technology Officer

- ❖ Founder of EnergyNest, technology innovator & product architect
- ❖ Drove Research & Development as responsible SVP at DNV-GL
- ❖ Holds professorships at NTNU and KAIST



Dr. Christian Thiel – Chief Executive Officer

- ❖ Executive with focus on bringing new technologies to market
- ❖ Led market entry into India, Japan & Turkey for wind power OEM Servion
- ❖ Set up e-mobility development team at BMW Group (result: BMW i3)



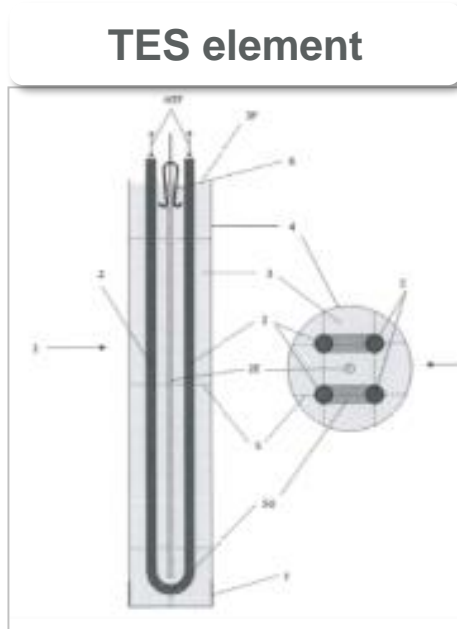
André Korn – Chief Financial Officer

- ❖ Finance professional in High-Tech
- ❖ Held leadership positions in Finance with Mubadala, McKinsey & Infineon
- ❖ Start-up team member (AMTC): from zero to \$60m revenue within 3 years; secured a \$120m syndicated loan



CEO, CTO & CFO with combined work experience of ~80 years

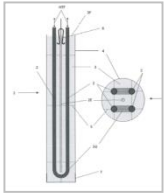
Modulært, skalerbart termisk energilager basert på spesialbetong



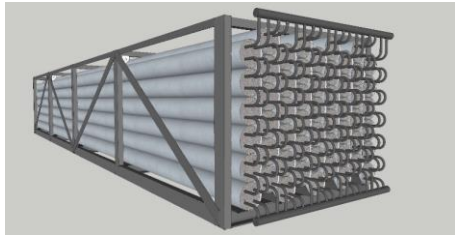
- Basis for EnergyNest's solution are advanced solid-state material modules that allow fully scalable energy storage
- Heatcrete®, the solid-state storage medium, has been developed in collaboration with HeidelbergCement AG
- EnergyNest together with its engineering partners will provide full design & engineering for the client and supervises project from sourcing, to module assembly through to final commissioning of the storage system

Modulært, skalerbart termisk energilager basert på spesialbetong

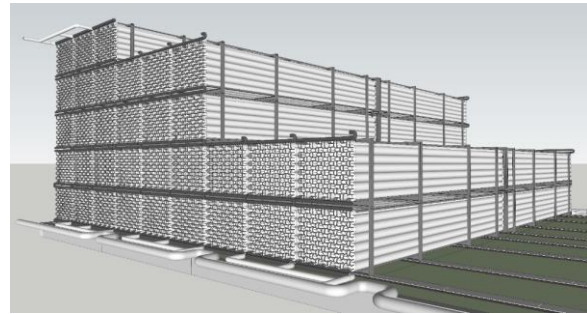
TES element



Heatcrete®



1 TES Module
(2 m x 2 m x 12 m)
up to 2 MWh_{th} energy capacity



- Basis for EnergyNest's solution are advanced solid-state material modules that allow fully scalable energy storage
- Heatcrete®, the solid-state storage medium, has been developed in collaboration with HeidelbergCement AG
- EnergyNest together with its engineering partners will provide full design & engineering for the client and supervises project from sourcing, to module assembly through to final commissioning of the storage system

Stor-skala energilagring for kraftsektoren og industrien

Eksempel:

800 MWh lagret termisk energi gir **270 MWh** elektrisk energi (via turbin-generator) samt **450 MWh** fjernvarme



Teknologien er testet og validert på Masdar Institute, Abu Dhabi

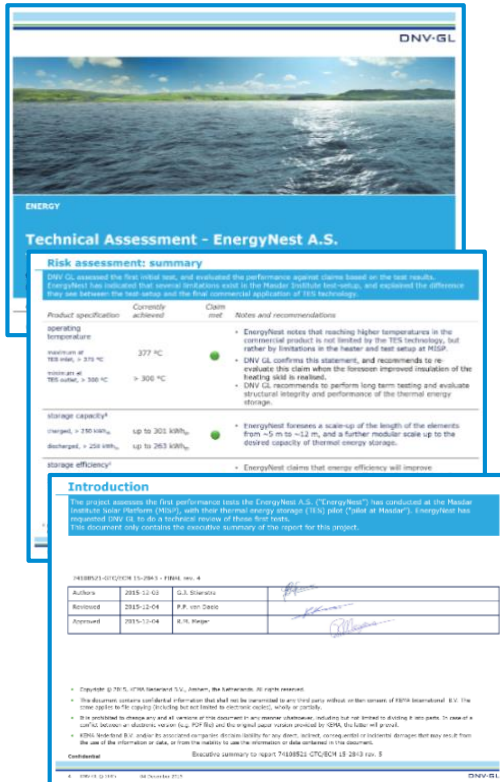


EnergyNest TES pilot installation in Masdar City, Abu Dhabi, UAE.

Key features are:

- ✓ **Fully scalable energy storage solution** – modular from 1 MWh_{th} to several GWh_{th}
- ✓ **Lowest total cost of ownership (TCO) of any storage technology** – system simplicity by design, low-cost materials with CAPEX of 20-25 USD/kWh_{th} (<20 USD/kWh_{th} for large-scale systems exceeding 1 GWh_{th}), very low maintenance required
- ✓ **Superior thermal efficiency** of >95%
- ✓ **Easily integrated** with different systems: Concentrated solar power (CSP) plants, other renewables, power grid and industrial plants
- ✓ **Long system life** of 50+ year lifecycle; no degradation
- ✓ **Fully recyclable**

DNV GL har validert oppsettet, utføringen og resultatene



Executive Summary

The project assesses the first performance tests conducted on the EnergyNest thermal energy storage (TES) pilot at Masdar Institute Solar Platform (MISP). EnergyNest has requested DNV GL to perform a technical review of these first tests.

DNV GL has reviewed the test setup, execution and results, and witnessed several of the first performance tests conducted at MISP. The assessment is limited to the technical aspects of the TES. Financial and legal components are excluded from the current project.

Technical performance

DNV GL has assessed the test results for the TES pilot at Masdar, and found all claims to be met, with respect to the following claims:

- Operating temperature:
 - maximum inlet temperature during charge of > 375 °C
 - minimum outlet temperature during discharge of > 300 °C
- Energy storage capacity:
 - energy charged of > 250 kWh_{th} per cassette
 - energy discharged of > 250 kWh_{th} per cassette
- Energy balance of charging and discharging cycles:
 - 1st law energy efficiency of > 85%

Notes and recommendations

- DNV GL confirms that with the current test set-up, reaching higher temperatures is limited by the heater, and by the test set-up of MISP. We recommend to retest on meeting the operating temperature claims for the commercial product, when the foreseen improved insulation of the heating skid is realized.
- EnergyNest foresees a scale-up of the length of the elements from ~5 m to ~12 m, and a further modular scale-up to the desired storage size, and expects larger installations to have a higher storage efficiency.
- EnergyNest evaluated the test data from the pilot at Masdar, including heat loss, and will use this for further improvement of design and performance of their commercial scale product.

Confidential

Executive summary to report 74108521-GTC/ECM 15-2843 rev. 5

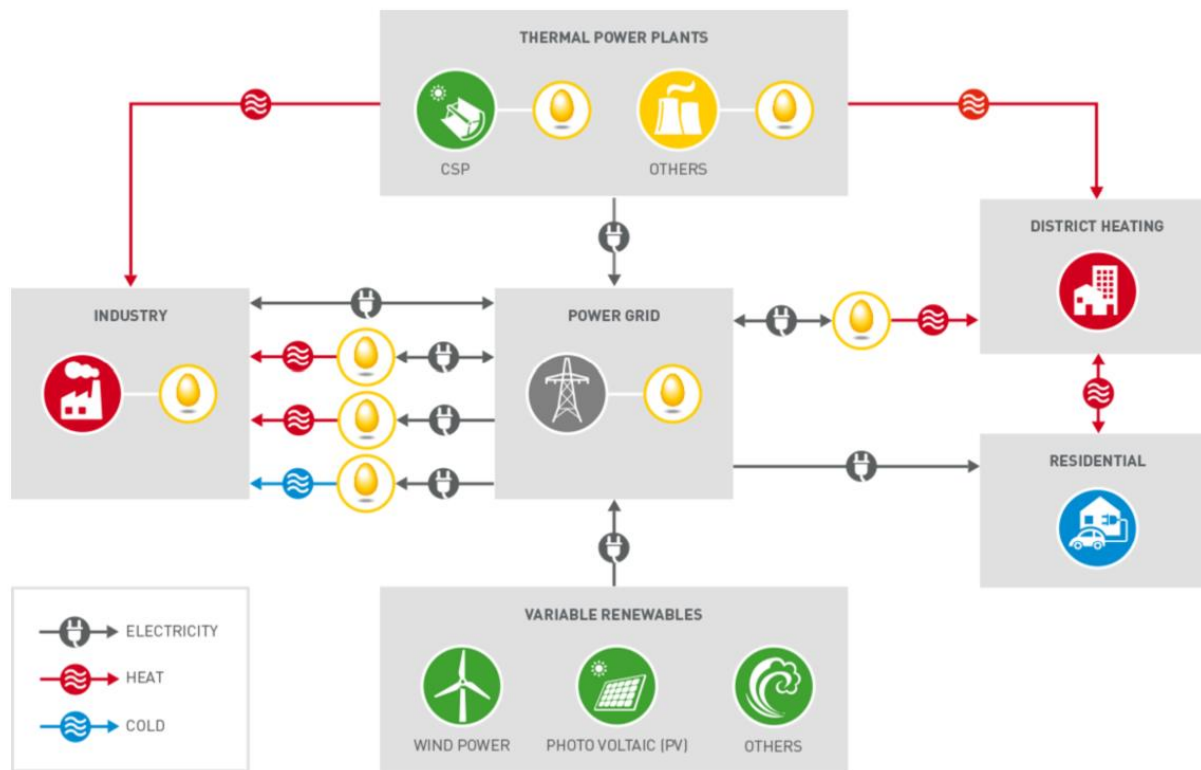
2 | DNV GL © 2015 04 December 2015

DNV-GL

Full report from DNV GL available upon request



Store markedsmuligheter



Termiske kraftverk

- Konsentrert solkraft (CSP)
- Open-cycle gassturbiner

Industri

- Stålverk
- Sement
- Kjemisk
- Papir
- Mat
- etc

Kraftnett

- Balansere fornybar energi

Eksempler på kommersielle prosjekter under utvikling

Beskrivelse:

Retrofit i eksisterende CSP anlegg, for økt utnyttelse av solenergi og mer effektiv drift av anlegget.

Kundens verdi:

Øke energieffektivitet og fornybar strømproduksjon

Lokasjon: Midtøsten

Kapasitet: 60 – 120 MWh



Beskrivelse:

Lagring av overskuddsenergi fra gassturbin-testanlegg, for bruk i strømproduksjon og fjernvarme.

Kundens verdi:

Øke energieffektivitet, redusere energiforbruk og CO₂ utslipp

Lokasjon: Nord-Europa

Kapasitet: 20 – 25 MWh



Beskrivelse:

Lagring av overskuddsvarme fra stålverk, for intern bruk i ulike høy-temperatur varmeprosesser.

Kundens verdi:

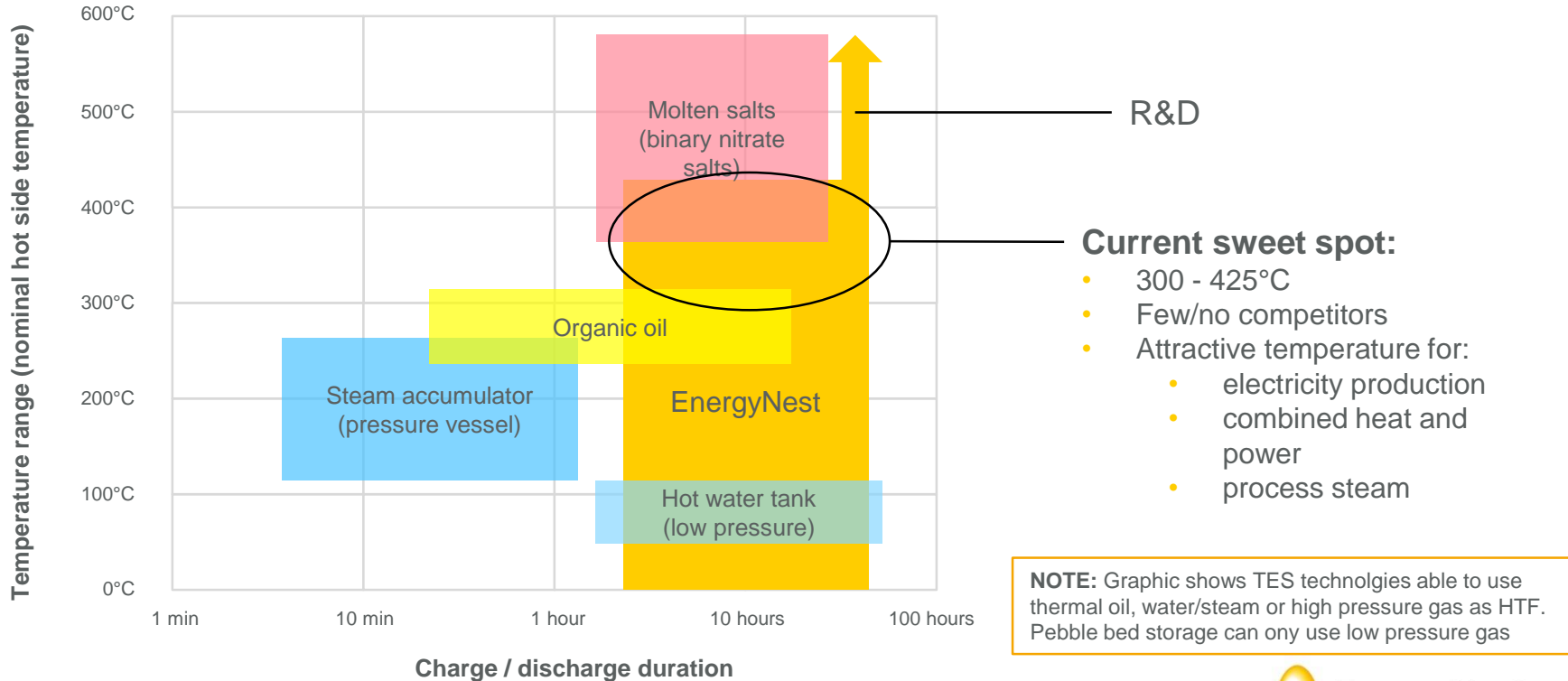
Redusere bruk av naturgass og CO₂ utslipp

Lokasjon: Nord-Europa

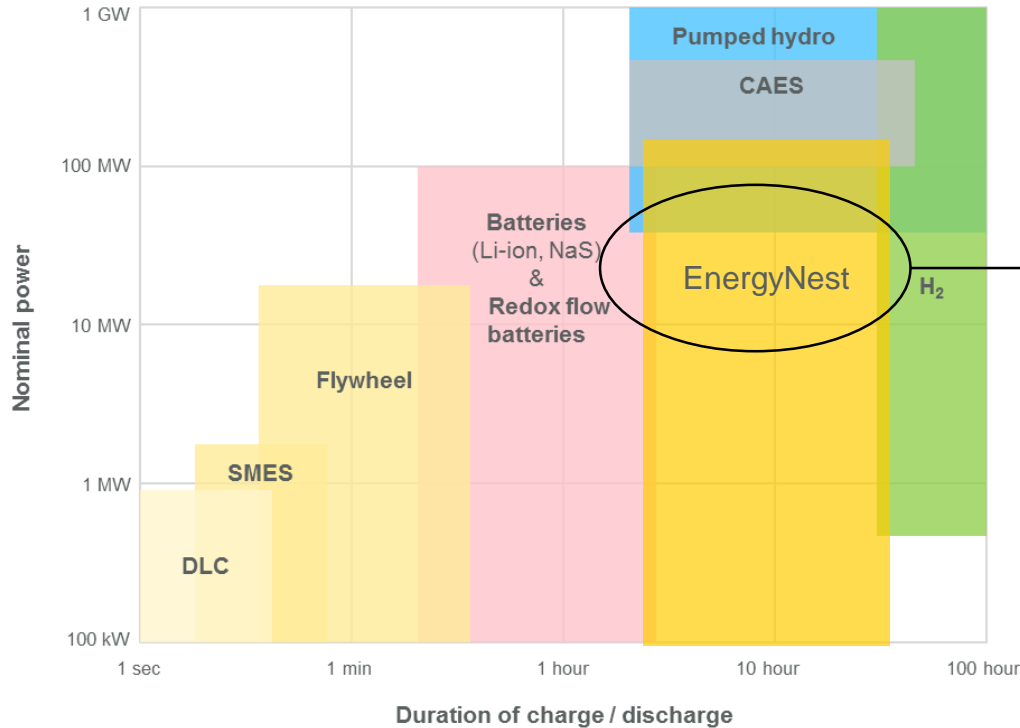
Kapasitet: 20 – 25 MWh



Konkurransen med andre termiske energilagre



Konkurransen innen elektrisk energilagring



Current sweet spot:

- 10 – 100 MW_{el}
- Few/no competitors
- Attractive temperature for:
 - electricity production
 - combined heat and power

Oppsummering/Konklusjon

EnergyNest

... is ABOUT

- Long-duration, stationary, large-scale energy storage
- Wide range of applications in power and industry sectors
- Low cost (CAPEX/OPEX) and long lifecycle
- Environmentally friendly
- Commodity materials
- No geographical limitations

... is NOT

- Suitable for household applications
- Applicable for mobile/transport applications



Teknologier:

- Fleksibel vannkraft med magasin
- Pumpekraft
- Svinghjul
- Batterier for nettilknytning
- Hydrogen og andre stoffer
- Trykkluft og flytende luft
- Hybride løsninger
- Høy-temperatur termisk energilager

“

**Simplicity
is the ultimate
sophistication** ”

Leonardo da Vinci