NEST type TES compared to Molten Salt

Eskom CSP / Solar Augmentation Conference

Jarl Pedersen
26-27 August 2013
Johannesburg, South Africa
Agenda

- Company Summary
- Technology Development
- Market Focus
- Case Studies
- Main Applications
- Value Propositions
TES Integration into CSP project

NEST type TES solution is an alternative to Molten Salt storage tanks typically used in CSP plants.
Company Overview

- Office location – Billingstad, near Oslo, Norway.
- Innovation based on proprietary and patented technology for flexible thermal energy storage system.
- First patent has been awarded and additional patent applications have been filed and are pending.
- R&D agreement with leading cement company, to optimize NEST’s Heatcrete® storage medium.
Experienced Leadership

Chairman of the Board: Pål Bergan, Professor, Ph.D, Dr.h.c, Inventor, co-founder and NEST stock holder

Board Member: Odd Rune Austgulen, Master of Finance and Master of Law. Professional Investor

Board Member: Neil Kristian Samuelson, Investment Analyst, LANI Invest AS

Board Member: Vivian Hugh James Bennett, Former Trading Division Leader, Glencore. Professional Investor

Board Member: Adrian de Ferranti, Bank and Investment Industry Professional

CEO: Øivind Resch is an experienced entrepreneur having started numerous companies. Co-founder and NEST stock holder

Technical Director (also Chairman): Pål Bergan, Ph.D, Dr.h.c. Inventor, co-founder and NEST stock holder

VP Marketing & Sales, Global Market Development: Jarl Pedersen, M.Sc.

Project Manager & Senior Engineer: Christopher Greiner, Ph.D/M.Sc.

Market & Strategic Analysis: Jon E. Bergan, M.Sc./MA

Senior Engineer, Thermal Systems: Andreas Mørkved, M.Sc.
NEST Organization

Board of Directors

Research & Development

Quality Assurance

Sales & Licensing

Engineering & Procurement

Construction through consortia with local partners

Project Build & Management

NEST Head Office

Admin / Finance
Legal / IPR
HRM
Technology Development

- NEST Innovation: Proprietary and patented technology.
- Proof of principle: TNO – leading independent R&D organization.
- Heatcrete® development: Collaboration with global cement company.
- Heatcrete® performance: Third party testing to 600°C.
- NEST column integrity testing: DNV – global service provider for managing risks.
TNO is one of Europe’s largest research institutions, located in the Netherlands.

TNO, has conducted a comprehensive and detailed study, a “Proof of Principle” report, which included advanced numerical simulations and physical testing. The TNO report on NEST’s thermal energy storage resulted in a clear conclusion:

“[…] the versatile concrete thermal storage system with integrated heat exchangers based on the concept of NEST AS works.”
Technology Verification

- Third party proof of principle – TNO
- Verification of Heatcrete® performance
- Verification of NEST column integrity
- Pilot NEST project at CSP demo facility
- Small-scale NEST project at commercial CSP plant
- Large-scale NEST project at commercial CSP plant
NEST Project Roadmap: Path to commercialization

- 2013: Pilot NEST project at CSP demo facility
- 2014: Small-scale NEST project at commercial CSP plant
- 2015: Large-scale NEST project at commercial CSP plant
Main technical characteristics

- Proprietary and patented Thermal Energy Storage technology utilizing a special kind of concrete with superior thermal performance: Heatcrete®

- Efficient and flexible heat exchangers allow for effective heat transfer with a range of different Heat Transfer Fluids (Thermal Oil, Water/Steam, etc.)

- Can operate over a wide temperature range, from -50°C to >600°C

- Modular and scalable system from <1 MWh_t to >1000 MWh_t

- High round trip efficiency (>90%)

- High operational flexibility and availability

- Suitable for a wide range of applications, designed to project specifications

- Highly durable and safe, can be built in populated areas or within cities

- Inexpensive and readily available materials that can be obtained locally

- Simple and efficient manufacturing process using NEST modules that can be replicated (“Lego brick” concept)
NEST – Heat Storage Zone

The sequential piping arrangement and the division into storage zones with different temperature levels enables operational flexibility and efficiency.
Size of 1000 MWh$_t$ NEST solution
Total system integration – NEST storage facility
CSP and Thermal Energy Storage

Thermal Energy Storage adds significant value to CSP:
• Increased operational flexibility and availability
• Increased annual power generation and higher capacity factor
• Increased utilization of existing transmission infrastructure
• Allows higher amount of intermittent Wind and PV
• Reduces the LCOE (levelized cost of energy)
CSP with Thermal Energy Storage
Charge / discharge: NEST vs. Molten Salt

Inlet temperature (charge)

Outlet temperature (NEST)

Outlet temperature (two-tank Molten Salt)

Inlet temperature (discharge)
A Viable Alternative to Molten Salt

For a 1000 MWh_t TES system in a parabolic trough type CSP plant, NEST would cost <60% of Molten Salt, implying significant savings and increased competitiveness for CSP developers and operators.
Cost factors

NEST type TES systems use inexpensive and readily available input materials:

- Concrete, Aggregates, Carbon Steel, etc.

Molten salt systems require expensive materials and specialized equipment:

- Stainless steel materials
- Submerged molten salt pumps
- Molten salt heat exchangers
- Electrical heat tracing
Size and Temperature Range:

- NEST Temp Range
- NEST Size Range
- Molten Salt (270°~600°C)
RE-IPP Procurement Process

Evaluation Criteria:

- **Price weighting: 70 points**
  - Reduced Capex of NEST solution makes CSP projects more competitive
  - Reduced Opex of NEST solution makes CSP projects more competitive

- **Economic development weighting: 30 points**
  - Job creation 25%  
    NEST on-site manufacturing concept
  - Local content 25%  
    NEST raw materials: concrete & steel
  - Ownership 15%
  - Management control 5%
  - Preferential procurement 10%
  - Enterprise development 5%
  - Socio-economic development 15%
CSP and TES is being combined in new areas and emerging industries:

- Enhanced Oil Recovery
- Desalination of seawater
- Waste water treatment
- Remote mining operations
Target markets and applications

Electric Energy Storage (EES)

CSP Power Tower

CSP Parabolic Trough

Coal-fired Power Plants

Industrial waste heat recovery

Waste to energy via incineration
Other interesting application areas

- Combined Heat and Power (CHP), Municipal Waste to Energy
- Waste heat recovery in energy intensive industries
  - Pulp & paper
  - Chemical
  - Steel & metals production
  - Fertilizer
  - Petrochemical
- Electricity Energy Storage (PV/Wind) in Isolated grids, island communities, etc.
Wind / PV and Thermal Energy Storage

Intermittent Wind, Photo-Voltaic and other variable power generation technologies

TES adds value to grids with high penetration variable RE
- Storing of “zero value” intermittent Wind and PV
Comparative advantages

- **Modularity** – module-based, scaled-to-purpose (“customizable”), utility-scale long duration storage solution

- **Simplicity** – mass produced, pre-fabricated components, low-cost and readily available materials, solid state

- **Versatility** – multi-zone storage, multi-HTF, appropriate for multiple energy segments (solar, coal, CHP, waste incineration, wind/EES, energy intensive industries)

- **Applicability** – installed irrespective of locality, caters to high level of local content, relevant to power producers across globe

- **Longevity** – long-duration, response capabilities + contingency

- **Durable and safe** – comparable LTC and minimal O&M costs, can be built in populated areas or within cities
Value propositions

- A technology with tremendous potential: **interoperable** and **cross-industrial** TES solution that caters to nearly entire power industry

- Integral technology for achieving **power quality**, **system stability**, **grid reliability**, and **energy security** targets. Allows for better planning and more efficient electricity generation to match real time fluctuations in supply and demand

- Thermal Energy Storage is a highly cost effective way of achieving **increased firm capacity** combined with CSP while reducing needs for new coal and nuclear power plants and transmission infrastructure

- **TES is a key enabler** for facilitating high penetration and increased deployment of Variable Renewable Energy into national energy mixes:
  - ✓ direct impact on efforts to reduce dependence and consumption of fossils fuels
  - ✓ direct impact on reducing GHG and CO₂ emissions
  - ✓ TES is a core technology for building a more sustainable energy future
Contact

Jarl Pedersen
Vice President
jp@energy-nest.com
+1 713 408 9847

Øivind Resch
CEO & President
or@energy-nest.com
(+47) 90 89 93 11

Professor Pål G. Bergan
CTO and Chairman of the Board
Pal.Bergan@ntnu.no
(+47 9073 4770)

NEST AS
Olav Brunborgsvei 4
1396 Billingstad
Norway
www.energy-nest.com

Download our brochure at:
http://www.energy-nest.com/images/NEST.pdf
Thank you!

26-27 August 2013
Johannesburg, South Africa