Energy Forum - Storage 15.06.2015

Dan Sagie Capital Nature and Rotem Industries

Chakratec Kinetic Battery

- Applications : Renewable integration , Time shift , Back-up , Peak shaving
- Equivalent cost to Li-ion batteries systems
- Superior economics for applications with 2 cycles per day or more
- Green, No Chemicals, No fire hazards
- Kinetic energy storage in a flywheel
- Long life and Unlimited Number of Charge/Discharge Cycles
- Depth Of Discharge close to 100% over full lifetime
- Accurate Capacity Reading
- Wide Operating Temperature range



12 kWh / 6 kW system 180X120X60cm

Chakratec - The Economic Advantage



ThermaSphera Process Flow Diagram

Schematic Piston/Booster Discharge



ThermaSphera

- Low cost and readily available
- non-flammable and non-toxic
- chemically stable
- high latent heat of fusion
- high thermal conductivity
- low changes in volume due during phase change
- low vapour pressure
- Thermal stability
- non corrosive
- High volumetric storage density and High specific heat capacity
- Smaller temperature change between storing and releasing energy









ThermaSphera

4.5X4.5m land area Packed in a standard container Up to 50KW_e charge and discharge

Connoo 3



Energy storage by :

- 1. Single phase Hydride synthesis
- 2. Molten electrolysis transition metal recovery
- High conversion rate
- Energy efficient process
- Scalable to MW scale
- Flexible energy input
- Standard metallurgy industry modules

Energy Generation by :

- 1. Stable, ambient, non flammable liquid fuel
- 2. Active and resilient catalyst
- Absolute safety non flammable, non explosive, ambient
- On demand hydrogen generation
- Scalable to MW scale
- Active and resilient catalyst synthesis method
- Multiple consumption options (on site, remote delivery, mobile fuel)
- Simple distribution and consumption infrastructure



TerraGenic Superiority

- 1. Scalable to MW
- 2. Multiple consumption/revenue streams
- 3. Competitive LCOE
- 4. Absolute safety

Grid Energy Storage



Estimated Market Size:

600 b \$

	Terragenic	H2 Electrolysis	LAES	Flow- Batteries
Round-trip efficiency	39-41%	35%	60%*	85%
Discharge cycles	Unlimited	Unlimited	Unlimited	Limited
Energy Density Wh/Kg	High	High	Medium	Low
Power Density W/Kg	High	High	Medium	Low
Safety	Absolute Safety	Flammable, Explosive	Acceptable	Dangerous reactants
Utilization	Multiple revenue streams	Back to grid	Back to grid	Back to grid
LCOE (C/KWh)	24	28	24	80-100

Integrated Receiver – Novel Innovative Concept





Major reduction compared to conventional TES cost

Tamuz Energy Proprietary information

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Rational for Buffer Storage



Buffer TES can reduce up to 15% of system IRR !

Sensible heat Ceramic thermal storage unit

HTF – air, thermal oil, etc.



Less than 6% Thermal Loss

Temperature Profiles during charging and discharging Temperature Profile vs. Time within a Cycle

Charge mode



Discharge mode







APPLYING PCM STORAGE TO DSG

The problem Heat transfer restricted by PCM solid layers

The solution schematic

High pressure steam is flowing in the pipes while the PCM fills the shell around



5-8 bar tank



30KW_{th}h Pilot at Rotem





Solidification with star insert - Thermal Oil





640+01

6.14+05

14040

830+01

5.17a-01

4850-01

450e05

420-01

300+01

3,556-01

323+01

281+01

250+0

220e-01

1340-01

14De-Dt

125e-01

870-02

6470-02

323+07

0.00+00













Insert effect on rate of Solidification (Discharge)



* Factor of 12 presented for the more critical solidification rate

