gTET

Hot Wire

The Heat Transformers

ISSUE 5 Q1 2021

News & Updates from green Thermal Energy Technologies

gTET remains open for business during COVID19

IN THIS ISSUE...

- Project: Jeffries Group SA, Green Waste
- Technical Brief: Thermal Battery

Turn-key solutions to transform waste into useful energy, delivering economic and climate change benefits

gTET

gTET specialises in innovative solutions at industrial scale for thermal energy management, in particular redeploying waste or renewable streams to reduce opex and carbon footprint.

gTET's revolutionary ORC generators enable thermal energy to be effectively converted into electrical power where this is the most efficient and effective use of the energy.

As we like to say here "*WASTE* is the new *OIL*"

www.g-tet.com

gTET
2/12 Mosrael Place Rowville Victoria 3178 Australia
Phone: +61 413 884 231 email: enquiries@g-tet.com

1. Projects:

Jeffries Group SA, Green Waste

Jeffries is a fourth-generation, wholly South Australian company focused on receiving, processing and marketing recyclable organic resources. Their story began in the 1930s, when Fred Jeffries loaded and carted horse manure from Mallala to nurseries in and around Adelaide. His son, also Fred, sourced and delivered soils to the home gardens of Adelaide and the emerging landscape trade.

Jeffries Group now employs more than 70 people and recycles over 150,000 tonnes of green organics each year, receiving the majority of kerbside-collected green organics from Adelaide metropolitan councils. The company supplies quality compost, soil and mulch products to resellers across metropolitan Adelaide, and supplies product to many leading South Australian vineyards and vegetable growers.

In 2019, after identifying a demand across South Australian agricultural industry for biochar, Jeffries embarked on Australia's first green waste pyrolysis processing plant producing biochar and power from the green waste. gTET was contracted to design and supply a 300kWe ORC generator recovering exhausted heat from the pyrolysis equipment via a Heat Recovery Steam Generator (HRSG).

The new installation receives saturated steam at a nominal 195°C/3.74Tph which is condensed to 90°C in the ORC generator before returning to the HRSG. This generates a nominal 300kWe depending upon the cooling water temperature from the cooling tower.

The ORC generator deploys three of gTET's high speed turbo-alternators with mating regenerative electronic drive and AS4777 certified grid inverter.

ORC Generator ready for shipment from gTET

Jeffries executed a connection agreement with South Australia Power Networks (SAPN) with provision for export since the site cannot consume all of the power generated. This requirement necessitated additional electrical protection and commissioning requirements from SAPN.

gTET ORC Generator in position. Pyrolysis equipment in the background.

Commissioning of the new installation is anticipated in Q1, 2021, delayed due to COVID 19 restrictions, demonstrating Jeffries commitment to reducing carbon emissions.

Jeffries site, prior to the pyrolysis and power station installation, showing the biomass fuel storage.

2. Technical Brief:
Thermal Battery

The Australian Governments Integrated Systems Plan 2020 has called for 6-18GW of despatchable resources, most of which is storage, to set up the National Electricity Market for transition to clean energy.

The government's roadmap applies a stretch target of electricity storage below AUD$100/MWh.

There are many technologies that can be used for storing energy all with varying advantages and disadvantages, but it is important to note that electricity itself cannot be stored; it must be transformed into another form of energy.

The optimal electricity storage solution will depend upon the application. The optimal metrics will vary for the various application including transportation systems, portable systems, grid stabilisation systems, grid peaking systems and micro grids systems and no single technology is optimal in all key metrics.

The key metrics for electricity storage are:

1. $/kWh (cost per kWh of storage)
2. Life and Maximum cycles
3. kWh/kg/l (Energy density or size and weight)
4. Portability (how easily the technology is located and transported)
5. η_{rt} (round trip efficiency or losses in charging and discharging)
6. Response time (Discharge and charging time)
7. kWh (Storage capacity)

	Max Power Rating (MW)	Discharge Time	Max Cycles or Lifetime	Energy Density (Watt-hour per litre)	Efficiency
Li-ion Battery	100	1 min - 8h	1000 - 10000	200 - 400	85 - 95%
Lead-Acid Battery	100	1 min - 8h	6 - 40 years	50 - 80	80 - 90%
Flow Battery	100	hours	12000 - 14000	20 - 70	60 - 85%
Pumped Hydro	3000	4h - 16h	30 - 60 years	0.2 - 2	70 - 85%
Compressed Air	1000	2h - 30h	20 - 40 years	2 - 6	40 - 70%
Hydrogen	100	mins - week	5 - 30 years	600 (at 200 bar)	25 - 45%
Flywheel	20	secs - mins	20000 - 100000	20 - 80	70 - 95%
Molten Salt (Thermal)	150	hours	30 years	70 - 210	80 - 90%

Characteristics of selected energy storage systems (source: The World Energy Council)

1. Li-ion Battery

Lithium Ion batteries are the most common form of batteries today controlling more than 90% of the global grid battery storage market. Bloomberg predicts that Li Ion will achieve <US$100/MWh by 2025.

Advantages include high energy density, round trip efficiency, fast response time, transportable and flexibility to locate where needed.

Disadvantages include very limited Life and kWh capacity (also restricted by low depth of discharge) and $/kWh. They also need to be carefully managed to avoid fire in fast discharge situations.

2. Lead Acid Battery

Lead acid batteries are a robust and well proven technology amongst some of the earliest battery storage technologies available.

Advantages include round trip efficiency and discharge time (not charge time), $/kWh and flexibility to locate where needed.

Disadvantages include energy density and very short life.

3. Flow Battery

Flow batteries are less popular than Li Ion due to their lower energy density and high cost but are well suited to longer duration storage applications.

Advantages include long life, large storage capacity and flexibility to locate where needed.

Disadvantages include $/kWh, low round trip efficiency, low energy density and long discharge time.

4. Pumped Hydro

Pumped hydro storage is the process of pumping water to a high elevation to charge the system and flowing water from the high elevation through a turbine generator during discharge of the system. The technology is well proven having been a key part of the Australian NEM for decades providing both generation and storage.

Advantages include long life, large storage capacity, excellent $/kWh, and providing stabilising inertia to the power grid by the large synchronous generators.

Disadvantages are the very low energy density and the limited locations that they can be situated which are typically long distances from the main power grid, thereby driving significant connection costs.

5. Compressed Air

Compressed Air storage is typically achieved by compressing air into an underground cavern where it is also heated during charging and releasing the compressed air though a turbo-generator above ground during discharging. The technology is not very common and achieves low round trip efficiency of 40-50% unless the cavern includes natural gas whereby efficiencies of up to 70% are achieved.

Advantages are the long life, large storage capacity and $/kWh.

Disadvantages are low energy density, few suitable locations and low round trip efficiency.

6. Hydrogen

Hydrogen fuel cells are rapidly growing in popularity with significant global investment. Electrolysis fuel cells which operate at easily manageable temperatures are being deployed as electricity generators in mobile applications and also being used in storage (apply electricity to reverse the process in charging) but suffer from low round trip efficiencies. Significant investment is occurring in Solid Oxide Fuel Cells (SOFC) globally that has much higher round trip efficiencies but have very high operating temperatures requiring materials and structures that can cope. There are few manufacturers that can offer reliable SOFC products.

Advantages in electrolysis fuel cells are energy density, life and portability/locate-ability.

Disadvantages are $/kWh and round trip efficiency.

7. Fly Wheel

Fly Wheels are not suitable for long-term energy storage, but are very effective for load-levelling and load-shifting applications. They are a packaged unit comprising a high speed permanent magnet motor/alternator coupled to an IGBT inverter and drive. They charge by driving the flywheel as a motor and discharge by electrically retarding the PM alternator.

Advantages of flywheels are long-life cycle, high round trip efficiency, low maintenance costs, and quick response speeds.

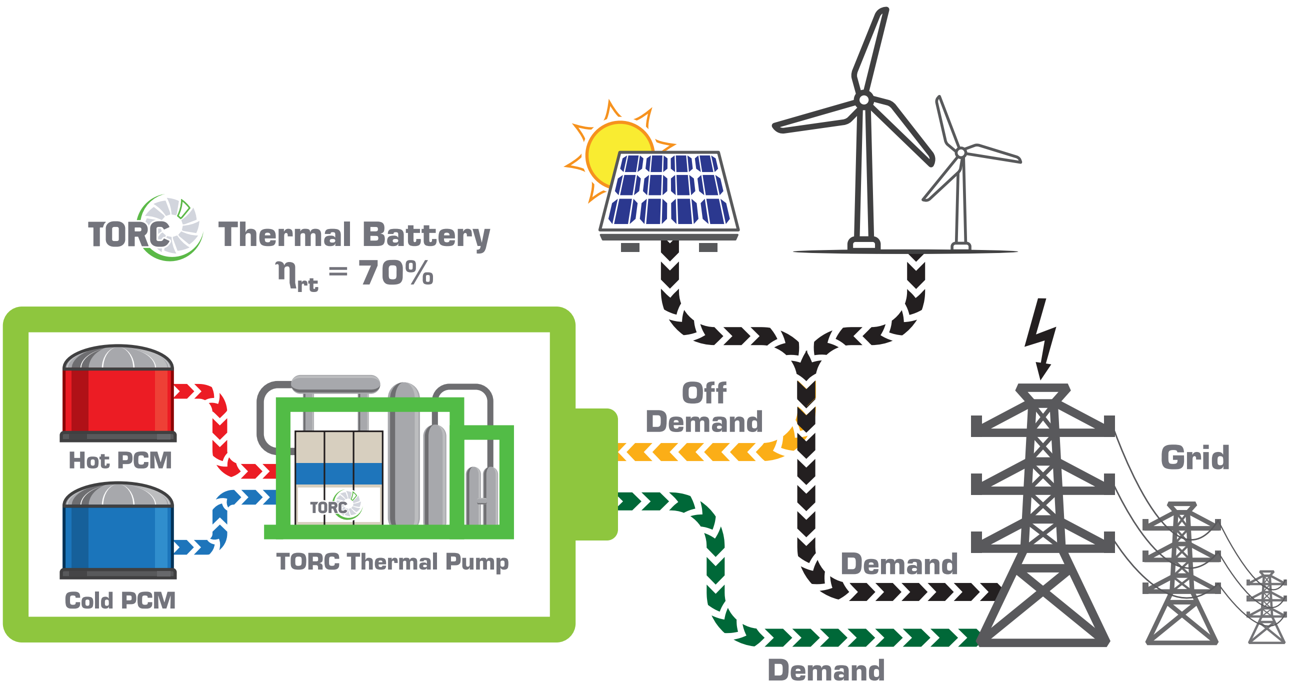
Disadvantages are very low storage capacity and low energy density. They are generally used for ride through applications.

8. Thermal Storage

High Temperature Thermal Storage stores electrical energy in the form of heat. Charging occurs either by direct heating, i.e using heat as the input not electricity, or heating the thermal battery from electric to heating devices e.g electric elements or heat pumps. Discharging the Thermal Battery is achieved using a heat engine e.g Rankine Cycle system. The highest energy density is achieved when the storage media undergoes phase change thereby applying the latent heat as opposed to the simple heat in the media.
Molten salts have been used in various applications melting salts typically comprising a combination of sodium and potassium nitrate. The phase change temperatures exceed 500°C suitable for steam turbine generators during discharge. Consequently the service life is very long and the energy density is high. The round trip efficiency of this high temperature molten salts is at rankine cycle efficiencies of <30%.

Low Temperature Thermal Battery

gTET, through its partner operation TORC pl, has developed patented low temperature Thermal Battery technology that deploys patented phase change materials customised for the optimal operating point of a novel thermal pump that enables round trip efficiencies of 70%. The system is designed to provide base load grid or micro grid storage, as opposed to peaking, at leading $/kWh and energy densities >100kWh/m3. The design life of the system is 25years minimum and provides in excess of 90% depth of discharge. The technology is scalable and readily deployable at optimal locations on the grid in order to levelise Variable Renewable Energy (VRE) power and provide grid stability without incurring major grid connection costs. The high energy density results in a minimal footprint.



The Thermal Battery is charged using a heat pump to efficiently produce heat from electrical energy at temperatures suitable to melt the specialised phase change material with resultant thermal energy of 4-5 times the input electrical energy (COP=4-5x). The heat material is stored in insulated vessels that ensure the heat is retained for long periods.

The Thermal Battery is then discharged using gTET's ORC generator, with asynchronous high speed turbine and inverter, converting the heat stored in the PCM as it solidifies to produce electrical power at 15% efficiency.

Our Thermal Battery is an effective commercial solution to overcome the fact that VRE power connected to the grid is unavailable on demand.

Be sure to follow gTET on

LinkedIn

to stay up-to-date on news, updates, past and present project info