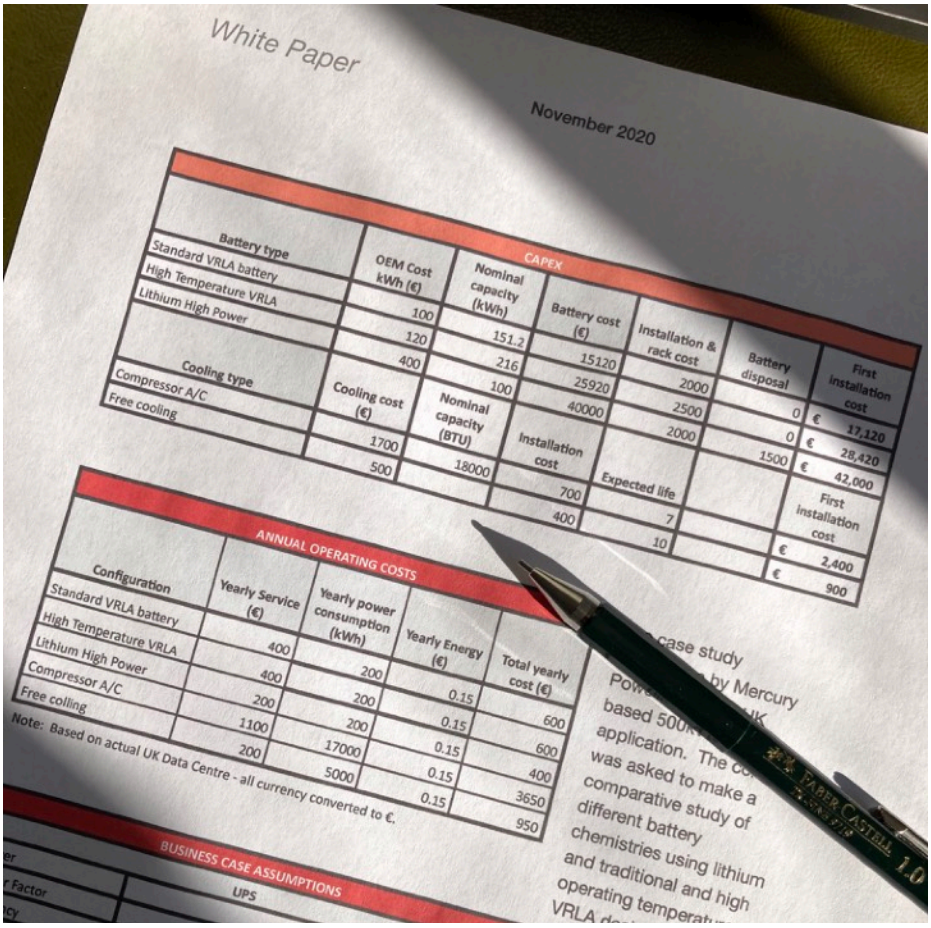
FIAMM
Your World, Our Energy

Determining the correct power backup solution in today's data centres



This paper is the result of an independent study undertaken by Mercury Power, UK to determine the best cost of ownership solution regarding batteries in a recent UK based data centre.

Owner operators of Data Centres are under pressure to reduce energy cost. This pressure is not just to defend and improve margins but to reduce CO2 footprint.

Batteries play an important part in the backup power solution. Whilst there is a growing debate arguing for the long term value of lithium chemistry batteries, this study showed that solutions need to be evaluated on a case by case basis and that new design lead acid batteries together with free-air cooling system design can provide a strong overall TCO business case.

Please note all UK pounds sterling figures have been converted to Euro's

Executive Summary

With the ever progressing data centre industry and forever changing efficiency goal posts it is a very hard task to produce critical power solutions which are resilient, cost effective and meet requirements whilst trying to improve overall running costs. This combined with the popularity of power rooms located in bespoke modular housings means equipment operating temperatures and design life are more important than they have ever been.

Due to these changes many customers are now looking towards Lithium Ion batteries as a preferred solution as these batteries are able to operate in high temperatures, able to produce multiple discharges, with claimed operational lives of 10 - 15 years design life and decrease the footprint required and overall weight.

With this shift in battery technology Mercury Power Ltd, a UK based Energy Solution company, using their many years experience and multiple Lithium battery installations, investigated Lithium Ion batteries in detail with surprising results.

Their investigation was based on an evaluation for a new UK based data centre and in which they were asked to evaluate the alternative battery backup solutions together with cooling. The results showed that over a 16 year period (which is the average life of today's data centre, the lithium solution would cost 44% more than a VRLA batteries designed to operate at higher temperatures.

Evaluating and selecting the correct battery solution

The demand for improved operating costs in data centres places a greater emphasis on suppliers of components and services to provide the best overall value. This value calculation adds up to complete total cost of ownership (TCO).

Batteries play a critical role in a modern data centre. They provide instant power in the event of a mains failure, providing energy that can be as short as a millisecond or as long as five to 10 minutes.

Power quality varies across the world. In most western countries, power outages are infrequent and may only last a few seconds. In other parts of the world power outages can occur regularly each day. The data centre management need to plan for this variant. Every situation is different.

Batteries are complex. They are governed and operate under the rules of physics. All batteries are a set of chemical reactions that allow electrons to move from a negative to positive state and supply stored energy on demand. There are many different chemistries for batteries and all have different characteristics that includes voltage, number of charge and discharge cycles, operating temperature range. There are over seventeen different factors that need to be taken into account when selecting the right battery solution.

Mercury Power, a UK based company, supplies critical power and cooling services to many major data centres operators. The company has been in operation for more than eight years, with their team made up of professionals that have working and and around the industry.

The Mercury Power team install and maintain many different battery chemistries, most recently lithium. In general their work involves the traditional industry standard of lead acid chemistry batteries and in the last few years, lithium.

As already indicated, all batteries have a place and it is important to choose the correct solution. However it was in recently working with lithium solutions that the company began to evaluate the overall factors that need to be considered to provide best customer value. This objective of this paper is not to discredit lithium systems. However, in the light of such media strong discussion relating to lithium, it prompted the case to evaluate the chemistry again improved new design lead-acid valve regulated batteries.

Lithium-ion batteries have become a major topic around the world. The chemistry, developed in the 1980's but began to emerge commercially as secondary or rechargeable battery solution in the late 1990's. Since that time the chemistry has made strong strides in commercialising and proving the chemistry. Furthermore, as the industry learning curve increase, coupled with production knowledge, commercial prices have dropped. Today, Lithium is the gold standard in the trade-off of price vs stored energy in electric mobility applications. These major strides in the industry and the increasing legislative pressures to to reduce carbon levels are enable the global transition from internal combustion engines to electrically power vehicles. Lithium chemistry batteries are currently enabling this whole new need to transition the way vehicles will move in the future.

Industrial batteries serve a number of critical applications that support the modern world. These include telecommunication and data centre backup power. There are many more but these are not the topic of this paper.

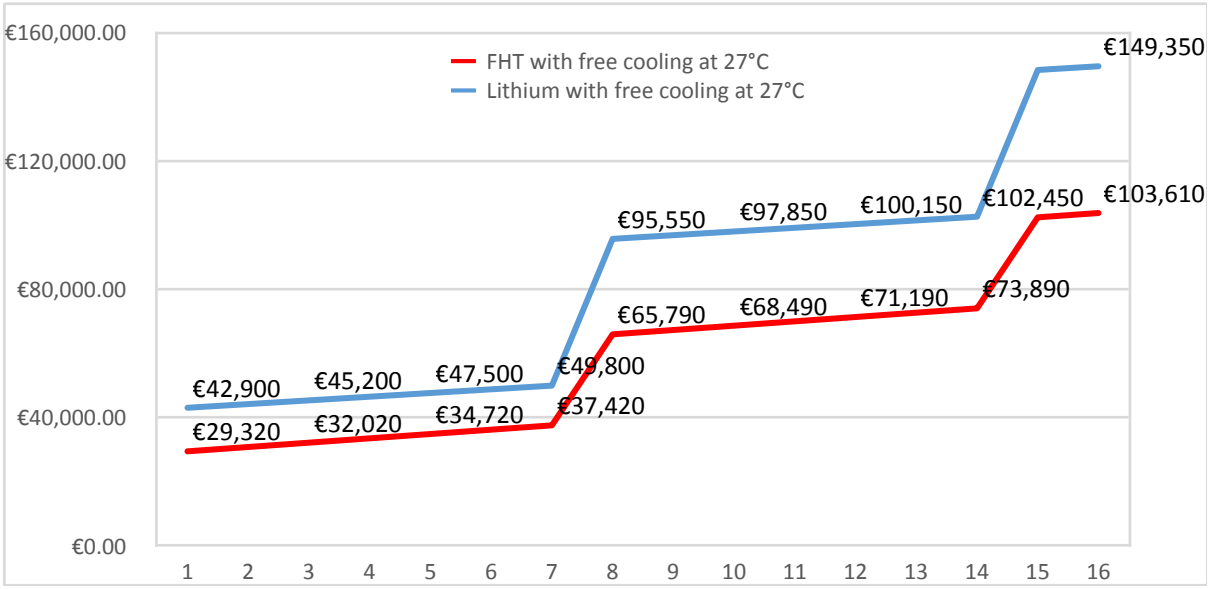
In most industrial battery applications lead acid batteries are the preferred solution to power back up in data centres today. Until the advent of digitisation and therefore the vital need to store and safeguard data the industry was largely referred to as the UPS market (Uninterruptible Power). The battery industry supply several billion of batteries for this sector globally.

Mercury Power, working with both battery chemistry system wanted to make a comparison between the systems. The company through working with lithium applications found there were many factors that needed to be considered and understood. They came to the following conclusions regarding working with lithium system in Data Centre applications.

Lithium - read the warranty conditions carefully

- **Warranty**: one major supplier of lithium for a UPS application offered 3 year full warranty from the date of manufacture. These batteries, which had to be shipped from Asia and then installed and finally accepting power load, the warranty was reduced to 2 years. Temperature is a major factor for all batteries.
- **Temperature**: As temperatures increase the life of all battery systems is reduced or in colder temperatures the efficiency of the battery decreases. (This is why starting the car in freezing conditions, the power may seem slower). This is a factor of the science and does not change. In the instance of this particular case a +/-3C of 24C invalidated the warranty.
- **Discharge Temperatures**: When batteries discharge high loads the battery can overheat. In a lithium system which has its own battery management system (BMS) this information is recorded. If the battery is charged before the overheated and discharged battery is discharged then then the warranty is invalidated.
- **Life Claims**: Lithium claims long life: in general 10 year and more. To achieve the 10-year end of life claim the battery system must be oversized by 20% and for 15 years by 30%
- **Fire Suppression**: It is well known that lithium batteries, due to their higher power and chemical characteristics have safety issues that must be considered. Because of this special systems must be installed. Furthermore, thermal runaway is an issue and must be considered. In some areas of the US, where there have been fire issues involving lithium in building new fire regulations have be imposed that stipulate the layout of rooms where lithium batteries are installed. Part of these new rules stipulate that lithium batteries should not be installed above 6 floors with strict stipulations on cabinet spacing and layout
- **Battery Management Systems (BMS)**: All lithium batteries have a battery management system. This system is the brain of the batteries and monitors and controls the performance of the batteries. On a plus side a BMS creates a communication link to operators and allows real time information to be given. However part of the purpose of a BMS system in a lithium battery is to control the operating parameters and make sure that the chemistry does not exceed parameters which could either damage the battery or lead to a safety issue. This mean that the system could turn off in the middle of a discharge.
- **Disposal and transportation:** Early issues in moving lithium batteries have led to legislative rules for moving batteries by road, sea or air. These rules are covered in UN3480. These rules can lead to long details and extra cost in installing but also disposing batteries

The need to re-evaluate the solution on a case-by-case basis



TCO Comparison - Standard VRLA / Fiamm FHT High Temperature with FAC / Lithium with FAC

The above financial summary calculation shows that based on the UK business case studied by Mercury and use new generation high temperatures VRLA batteries free-air cooling system will provide excellent value to the customer. In the instance show above the initial capital outlay on the two comparative systems showed that using a well known lithium brand solution and the Fiamm FHT high-temperature design. The calculations, can be seen in more detail on page 6, and were for a 500kVA application. Based on this requirement a comparison was made between the two chemistries.

The capital outlay for the lithium and high temperature VRLA including racks and installation were €42,000 and €28,420 respectively. A disposal cost of €1500 was added to the end of life calculation for lithium but a residual disposal credit cost for lead acid was not added. It's important to note that all lead acid batteries are fully recyclable and have a reclaim value to the customer.

A major part of the consideration was based on free-air cooling. Energy costs are the major OPEX costs in data centres. Therefore any solution to reduce these costs has a major impact of the financial return of the centre. Mercury examined the impact of having a battery that could operate at a higher ambient temperature combined with the designing the battery solution around free air cooling. This led to results that showed that over an operational period of 16 years the advanced lead acid battery cost 44% less.

The Fiamm FHT High Operating Temperature Battery

The Fiamm Energy Technology High Temperature battery, and used as the basis for the study was developed using the combined knowledge of over 70 years experience of designing and supplying batteries across the world and major customers.

- The FHT range operates at a standard operating temperature of 27°C but with peaks of up to 60°C.
- The battery can provide 50 full discharges a year without affecting the 10 year design life.
- The battery doesn't require any supplementary fire suppression equipment.
- The battery has a very low operational maintenance cost
- Battery monitoring systems can be installed if required.
- Like all lead acid batteries the battery is 95% recycle-able (Lead is smelter and can be reused without any detrimental performance in the battery.
- Plastics are also reclaimed and reused, often for further batteries.
- At the end of life of any lead acid battery, such as the Fiamm FHT, batteries can be easily disposed through established networks and can have some residual value to customers.

How the calculations were made

The case study undertaken by Mercury Power was for a UK based 500kVA application. The company was asked to make a comparative study of different battery chemistries using lithium and traditional and high operating temperature VRLA designs.

CAPEX						
Battery type	**OEM Cost kWh (€)**	**Nominal capacity (kWh)**	**Battery cost (€)**	**Installation & rack cost**	**Battery disposal**	**First installation cost**
Standard VRLA battery	100	151.2	15120	2000	0	**€ 17,120**
High Temperature VRLA	120	216	25920	2500	0	**€ 28,420**
Lithium High Power	400	100	40000	2000	1500	**€ 42,000**
Cooling type	**Cooling cost (€)**	**Nominal capacity (BTU)**	**Installation cost**	**Expected life**		**First installation cost**
Compressor A/C	1700	18000	700	7		**€ 2,400**
Free cooling	500		400	10		**€ 900**

ANNUAL OPERATING COSTS				
Configuration	**Yearly Service (€)**	**Yearly power consumption (kWh)**	**Yearly Energy (€)**	**Total yearly cost (€)**
Standard VRLA battery	400	200	0.15	600
High Temperature VRLA	400	200	0.15	600
Lithium High Power	200	200	0.15	400
Compressor A/C	1100	17000	0.15	3650
Free colling	200	5000	0.15	950

Note: Based on actual UK Data Centre - all currency converted to €.

BUSINESS CASE ASSUMPTIONS	
UPS	
Power	500kVA
Power Factor	1
Efficiency	0.965
BUT	5'

BATTERY	
No. Elements	240
Sizing temperature	25°C
End Voltage	1.67Vpc

COOLING		
Standard	Compressor AC	Temperature set point at 22°C
High Temperature	Free cooling	Temperature set point at 27°C

About Mercury Power UK Ltd

Mercury Power is in its eighth year of trading, having grown year on year with an extremely high client retention. The company works with many new clients from recommendation and word of mouth. The business philosophy is to ensure that it delivers the projects that are undertaken in a well-managed and structured way. The company has a dedicated team of project managers and employs all its own staff to carry out the installation works.

Critical Power and Cooling Specialists, the company is predominantly focused on Data Centre and Critical Services arena. The company has high-end client base and delivering to a very high standard to ensure that they exceed our client's expectations. Some of the long-standing clients include Bloomberg (sites across EMEA), BNY Mellon Bank (Sites Across EMEA) and Visa to name but a few. They also work with many Data Centre's in the UK and EMEA carrying out new build, refurbishments, and battery replacements.

About Fiamm Energy Technology

FIAMM Reserve Power Solutions is an internationally recognised leader in the development and supply of industrial batteries and energy storage systems. We design and manufacture proven backup power solutions to support critical applications operating when main generated power fails. As result of our reputation, we are proud to supply many of the world's leading companies in markets that include telecommunications, data centres, rail, power, oil, gas and renewable energy storage.

Fiamm has a worldwide network. The company is headquartered in Montecchio Maggiore in the Veneto Region of Northern Italy and has a manufacturing site based in Avezzano in central Italy.

Mercury Power Ltd. Hanger 9, Redhill Aerodrome, Kings mill Lane, Redhill, Surrey RH1 5JY Telephone 44 (0) 1737 821 215
sales@mercurypower.net www.mercurypower.net. Registration No: 8590503