MAL - Métalectrique

Aluminium-Air Power Technology

www.al-air.com

MAL - Green Power Solutions for the World !

MAL - Our Mission

Our Mission !

MAL - Our “Green” Mission !

MAL - Our Company and Founder

Our Company !

MAL - Who we are !

MAL Research & Development **limited**

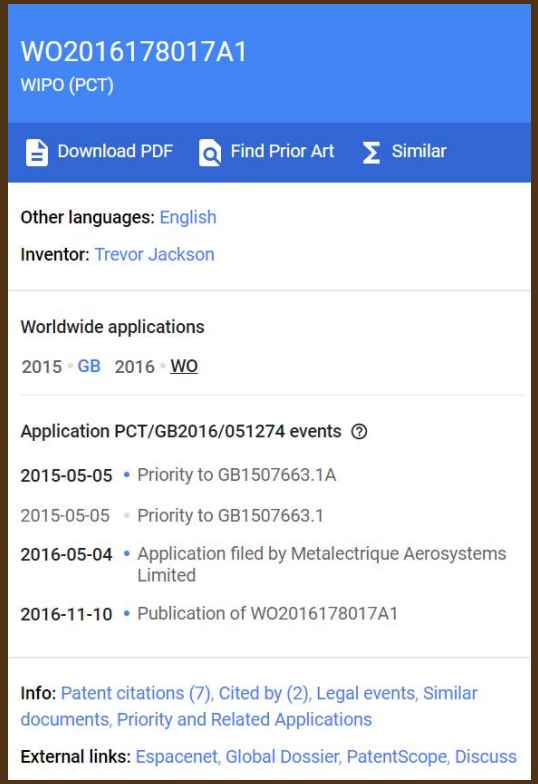
Métalectrique is a british engineering company that uses proprietary metal-air electric power technologies to provide green and cost effective mobile energy

MAL - The Inventor bio

Trevor Jackson has invented Aluminium - Air type battery which can run 1500 miles (Wed. 14th March 2018)

Trained as Rolls-Royce engineer Trevor Jackson from Tavistock has come up with the Aluminium-Air type of battery which he has invented already back in 2002 but has made industrial interest just recently. His works were first recognized by French State and marked as Strategic and the National Interest. He returned to UK by the request of HM Ambassador to France and was introduced to Formula 1 Team. This led to formation of MAL(R&D)Ltd where Trevor and his team developed and successfully tested and full size, zero CO2 battery technology to 1500 miles range with F1 partner Lotus Engineering. Lotus completed a successful Product Definition Workshop which provided guidance on designing for Electric Vehicles. This resulted in two designs; one for the Nissan Leaf and one for the ‘G-Wiz’. Although Nissan expressed a strong interest in this battery they were already committed to fitting LiON batteries to the ‘Leaf’. A three-month test programme concluded with seven repeat tests on the G-Wiz prototype cells and each test showed steady delivery of power for a range of 1500 miles. This battery will be demonstrated in a MEGA Multitruck in 2018. Trevor has a strong team and continues his works to enter to aviation and marine industries as well.

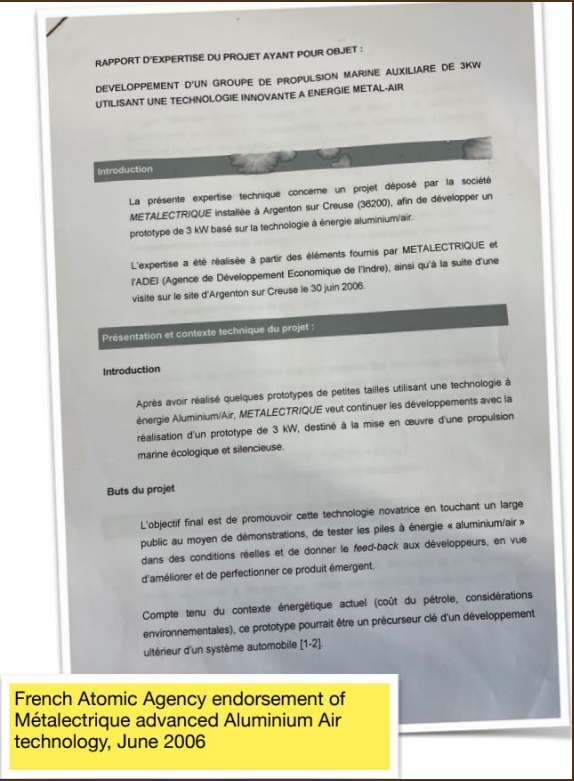
MAL - The Patent !



An aluminium-air cell, an aluminium-air battery and a motor unit comprising an electric motor and an aluminium-air battery

In a first aspect the present invention relates to an aluminium-air cell and to an aluminium-air battery comprising a plurality of the aluminium-air cells. In a second aspect the present invention relates to a motor unit which comprises the aluminium-air cell or the aluminium-air battery of the invention along with an electric motor. An aluminium-air cell (10) comprises: a casing (12) and within the casing: an air cathode (23); an electrode (27) of aluminium or aluminium alloy spaced from the air cathode; an electrolyte chamber (45) defined between the air cathode and the electrode; an electrolyte liquid; a reservoir cavity (36) separate from the electrolyte chamber for storing the electrolyte liquid; a rotatable shaft (15); a delivery conduit (37) connecting the reservoir cavity and the electrolyte chamber; and an impeller device (20) driven by the rotatable shaft to draw the electrolyte liquid out of the reservoir and pump the drawn electrolyte liquid through the delivery conduit into the electrolyte chamber.

MAL - Endorsements



RAPPORT D'EXPERTISE DU PROJET AYANT POUR OBJET :

DEVELOPPEMENT D'UN GROUPE DE PROPULSION MARINE AUXILIARE DE 3KW UTILISANT UNE TECHNOLOGIE INNOVANTE A ENERGIE METAL-AIR

Introduction

La présente expertise technique concerne un projet déposé par la société *METALECTRIQUE* installée à Argenton sur Creuse (36200), afin de développer un prototype de 3 kW basé sur la technologie à énergie aluminium/air.

L'expertise a été réalisée à partir des éléments fournis par METALECTRIQUE et l'ADEI (Agence de Développement Economique de l'Indre), ainsi qu'à la suite d'une visite sur le site d'Argenton sur Creuse le 30 juin 2006.

Présentation et contexte technique du projet :

Introduction

Après avoir réalisé quelques prototypes de petites tailles utilisant une technologie à énergie Aluminium/Air, *METALECTRIQUE* veut continuer les développements avec la réalisation d'un prototype de 3 kW, destiné à la mise en œuvre d'une propulsion marine écologique et silencieuse.

Buts du projet

L'objectif final est de promouvoir cette technologie novatrice en touchant un large public au moyen de démonstrations, de tester les piles à énergie « aluminium/air » dans des conditions réelles et de donner le *feed-back* aux développeurs, en vue d'améliorer et de perfectionner ce produit émergent.

Compte tenu du contexte énergétique actuel (coût du pétrole, considérations environnementales), ce prototype pourrait être un précurseur clé d'un développement ultérieur d'un système automobile [1-2].

French Atomic Agency endorsement of Métalectrique advanced Aluminium Air technology, June 2006

UK TRADE & INVESTMENT

10th March 2011

Trevor Jackson, Chief Executive Officer
Metalectrique Ltd.
Furzehill, Burraton Coombe, Saltash, Cornwall, PL12 4QF

Dear Mr. Jackson,

Re: Metalectrique

Further to your recent discussions with Eric van der Kleij, I am pleased to write to you to confirm our support for Metalectrique in developing and executing your UK and overseas growth strategy.

As discussed with you, our role is in attracting some of the most significant breakthrough technologies to the UK, in order to create the next generation of high growth, global technology companies.

We are pleased to confirm that we have reviewed your achievements to date, and following our initial technological and commercial evaluation we are pleased to formally "Greenlight" the Metalectrique Al Air Battery as a technology of exceptional global potential, being led by a professional management team.

We would be grateful if you would kindly confirm by signing below that you agree to seek our written consent prior to distributing any materials in which you may choose to reference publicly our support for your business.

We look forward to working with you and your team to help accelerate your global success from the UK.

Yours sincerely,

James Graham
Cleantech Dealmaker
Global Entrepreneurs Programme

UK Trade & Investment
Bay 813, Kingsgate House
66-74 Victoria Street
London SW1E 6SW

Signed on behalf of Metalectrique:
Signature:

Date: 10 March 2011
Name: Trevor Jackson
Position: Chief Executive Officer

UK government endorsement of Métalectrique advanced Aluminium Air technology, March 2011

IMN

Professor Thierry BROUSSE, PhD
Institut des Matériaux Jean Rouxel (UMR CNRS 6502) - Polytech'Nantes
Rue Christian Pauc – 44300 NANTES - FRANCE
thierry.brousse@univ-nantes.fr
Phone : +33 6 83 40 36 12

To who might be concerned

Nantes, August 4, 2016

Dear Sir or Madam,

This is to confirm that electrochemical tests presented by Trevor Jackson from Métalectrique Company were also independently verified in my team (former name of the team LGMPA - Laboratoire de Génie des Matériaux et Procédés Associés). They were conducted on Biologic potentiostat/galvanostat using EC-lab as acquisition and data analysis software. Both potentiostatic and galvanostatic techniques were used with the help of boosters when required.

The electrolyte that was used undoubtedly presents superior performance compared to standard NaCl electrolyte. Additionally, it allows the use of ordinary aluminium, it hinders side reactions, it limits the formation of gel as well as heat generation, and subsequently allows steady and long-duration power.

The use of such electrolyte combined with the technology of Métalectrique would be an asset for implementation in various stationary and transportation applications.

Thierry Brousse, distinguished Professor
Vice-Dean of the University of Nantes in charge of Technology Transfer
President of the evaluation committee for energy storage for French National Research Agency (ANR) 2010-2014
Associate Editor for the publications of the Electrochemical Society

Institut des Matériaux Jean Rouxel - UMR 6502
44306 Nantes cedex 03, France

French Scientific endorsement of Métalectrique advanced Aluminium Air technology, June 2016

MAL - Our Technology

Our Technology !

MAL - What Wikipedia says !

Aluminium–air batteries (Al–air batteries) produce electricity from the reaction of oxygen in the air with aluminium. They have one of the highest energy densities of all batteries, but they are not widely used because of problems with high anode cost and byproduct removal when using traditional electrolytes. This has restricted their use to mainly military applications. However, an electric vehicle with aluminium batteries has the potential for up to eight times the range of a lithium-ion battery with a significantly lower total weight.[1]

Aluminium–air batteries are primary cells, i.e., non-rechargeable. Once the aluminium anode is consumed by its reaction with atmospheric oxygen at a cathode immersed in a water-based electrolyte to form hydrated aluminium oxide, the battery will no longer produce electricity. However, it is possible to mechanically recharge the battery with new aluminium anodes made from recycling the hydrated aluminium oxide. Such recycling would be essential if aluminium–air batteries were to be widely adopted.

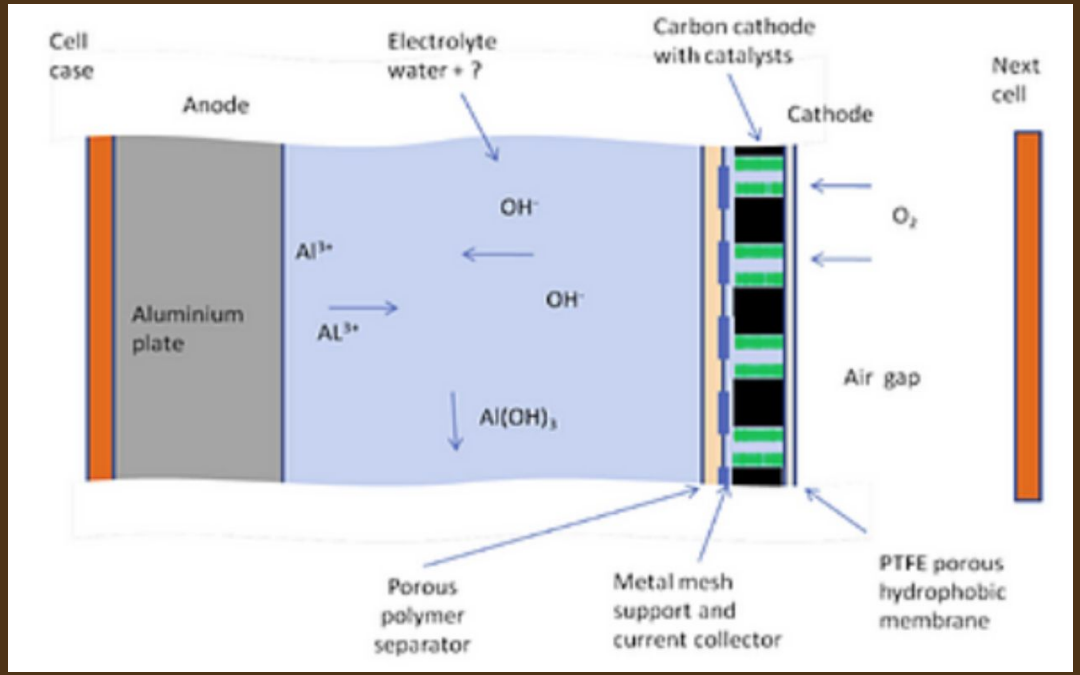
Aluminium-powered vehicles have been under discussion for some decades.[2] Hybridisation mitigates the costs, and in 1989 road tests of a hybridised aluminium–air/lead–acid battery in an electric vehicle were reported.[3] An aluminium-powered plug-in hybrid minivan was demonstrated in Ontario in 1990.[4]

MAL - How it works ?

Aluminium-Air technology has long attracted attention due to its cheap, lightweight and high-energy nature. Aluminium is the most abundant metal on Earth and is easy to handle, store and is safe as a way of storing electrical energy.

A Métalectrique power cell is actually quite simple. A piece of Aluminium is in contact with a special electrolyte. This electrolyte reacts with the metal on the negative end and on the positive end, air reacts with the electrolyte. When those two reactions are combined, aluminium is transformed into hydrated alumina and electrons are transferred from the second layer, through the conductor, ready to power a device. After use, the hydrated alumina can be reprocessed by smelting it, recovering the water and oxygen as it forms fresh aluminium. This cycle can be used over and over again.

MAL - How it works (Schema) !



The discharge reactions within the cell are as follows:

Anode:

$$Al \rightarrow Al + 3e^-$$

Cathode:

$$O_2 + 2\,H_2O + 4e^- \rightarrow 4\,OH^-$$

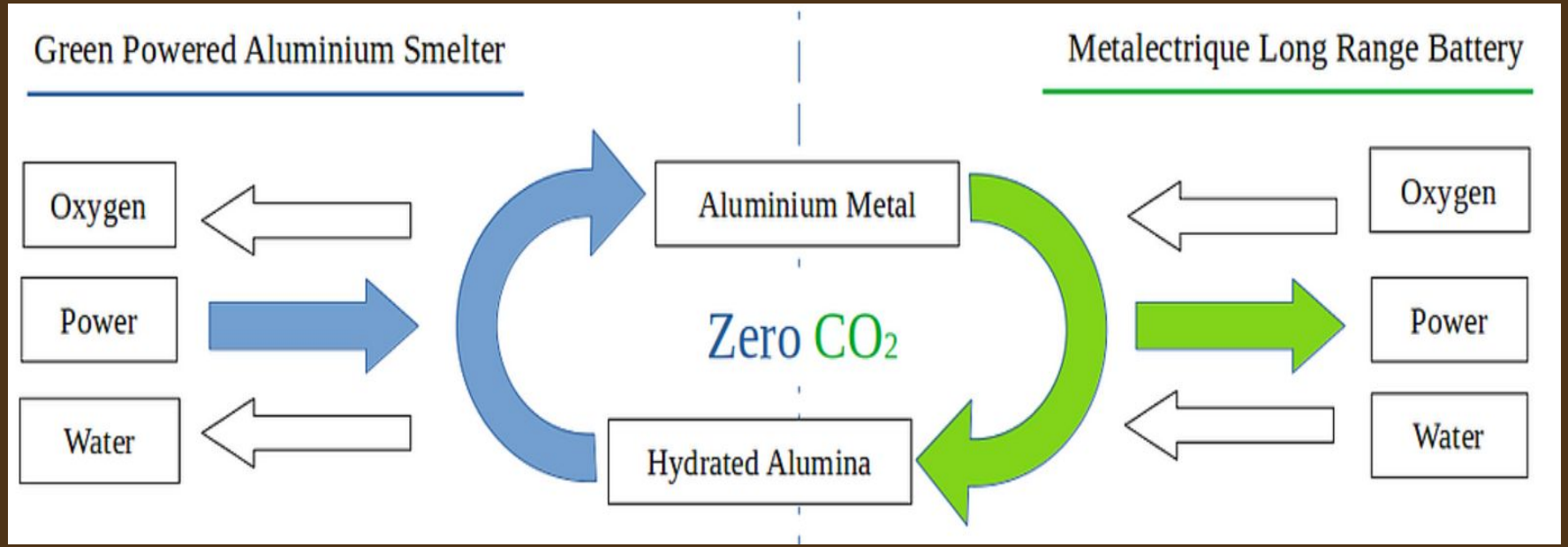
Overall:

$$4\,Al + 3\,O_2 + 6\,H_2O \rightarrow 4\,Al(OH)_3$$

The parasitic hydrogen–generating reaction is:

$$Al + 3\,H_2O \rightarrow Al(OH)_3 + 3/2\,H_2$$

MAL - How it works (Schema)



MAL - Why Metalectrique Power Technology ?

BS EN IEC 62840
Safety Standard

	. Fully Green & Recyclable Solution.
	. Team of engineer to adapt to your specific needs.
	. Extremely reduced maintenance. (No Engine needed)
	. Use of Low Cost & Easy to Process Regular Aluminium. (1000 Series Alloy) . It works also with **Recycled** Aluminium to reduce cost & ecological footprint.
	. Non Toxic Electrolyte based on Salt Water. (before & after chemical reaction)
	. Cost saving solution when properly recycled. (both Infrastructure & Consumables)

MAL - Cost !

Extremely Cost Saving Solution (including Recycling)

- Infrastructure Cost (One Shot / Including Electronics)

  From 30 € to 300 € per kWh

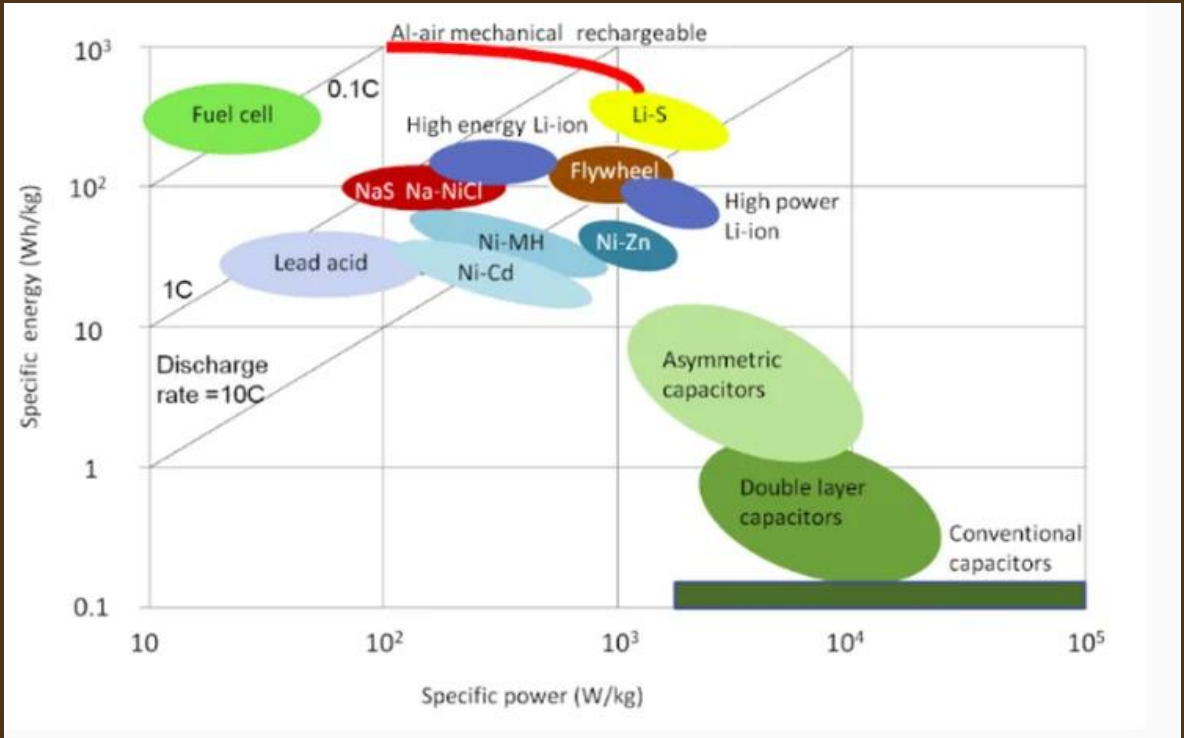
- Run Time cost (including Recycling) :

  From 0.1 to 0.60 € per kWh

MAL - The Power Solutions !

Where is the Competition !

MAL - How we Compare



The graph on the left can be used to visualise how aluminium air technology compares to competing power solutions on the market, both in specific power (W/kg) and specific energy (Wh/KG). In summary, although our technology retains and exceeds the energy advantage of past fuel cell technologies, our unique chemistry enables a power that is comparable to certain Lithium Ion batteries; and this is expected to improve in future Level B prototype development projects

MAL - Our Current Initiatives !

Our Current Initiatives !

MAL - Our Comparative Key Benefits !

. Long Life Duration (15 years) & Easy 100% Recycling

. Cos Savingt Solution (both Infrastructure & Consumables).

. 100% Halophile & “Green / Sustainable” Solution.

. **No Fire Risk** / No Heat Increase (Running Temperature 26°C).

. Operating Range : -40°C to 71°C (easy cooling) without loss of performance / without degradation.

. BS EN IEC 62840 Safety Standard. E-MARK in progress.

. **No Plug Recharge**. Depending on your version : **“Swap”** or **“Refuel”**. (And then “WE” Recycle).

. Excellent Ratio between Power vs. Energy :

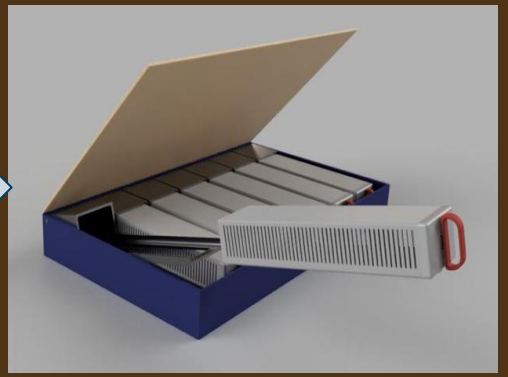
E/w = 1350 Wh / kg (validated) **E/v = 800 Wh / dm3** **P/w = 206 W / kg @ 26°C.**

E*/w = 2000 Wh / kg (“in labs”) **P/w = 355 W / kg @ 40°C.**

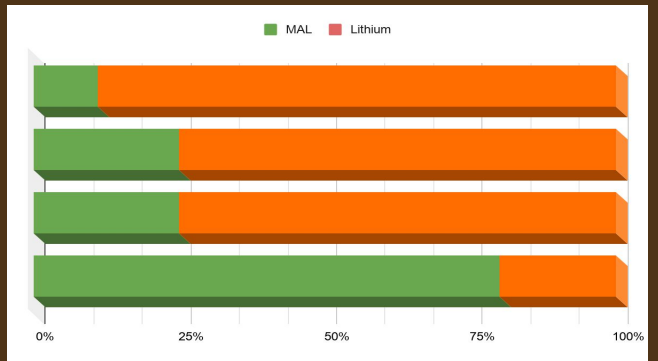
P*/w = 1800 W / kg (“coming”)

MAL - Compared to Lithium-Ion batteries

- Easy 100% Recycling.
- 100% Halophile Solution.
- No Fire Risk.
- No Heat Increase.
- No Complex BMS.
- 100 % Green Solution
- No Plug Recharge.



- Weight : 9 times lighter than Lithium batteries.
- Size : 4 times smaller than Lithium batteries.
- Cost : 4 times cheaper than Lithium batteries.
- Duration : 5 times longer than Lithium batteries.



MAL - Compared to Power Generator

. Almost no Maintenance (No moving pieces).

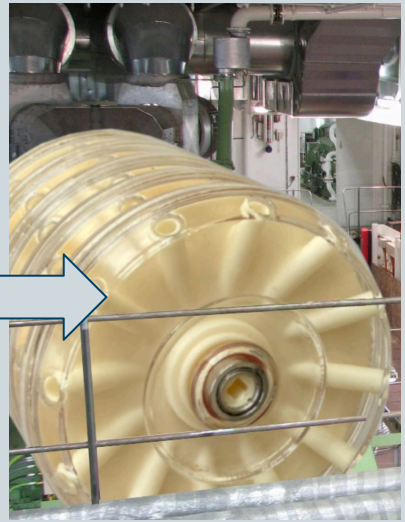
. No Fire risk / No Fume / No Noise.

. 100% Halophile Solution.

. 100 % Green Solution.

. No Plug Recharge / No Power Generator / No Fuel.

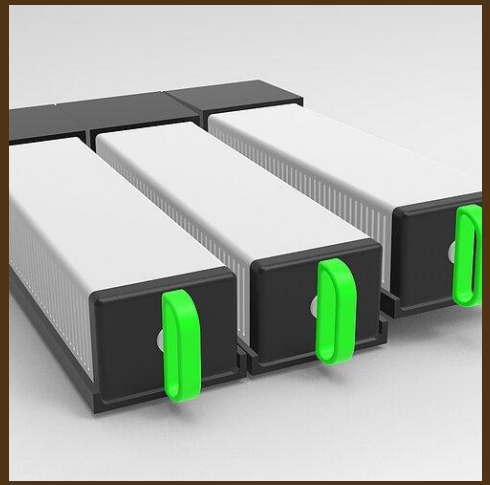
After



MAL - Automotive !

Light, Compact & Easy to “Swap” (cf. Vidéo)

- 4.5 kg / 6 kWh / 1 kW per module
- W8cm x D11cm x L44cm per module (3.8 dm^3)

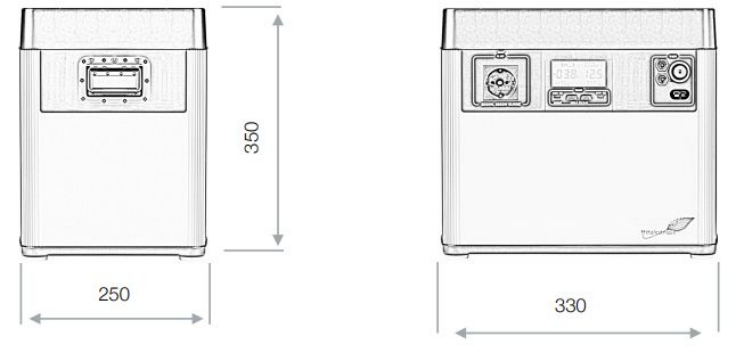


MAL - The “4wd” Universal Power Bank !

Light, Compact & Easy to “Swap” but a lot of energy.

- Energy : 23 kWh for only 21 kg.
- Power : 60W (12V) / 2 kW (230V) (3,5 kW Peak)
- Dim (mm) : W250 x L330 H350

More Power(s) on demand !



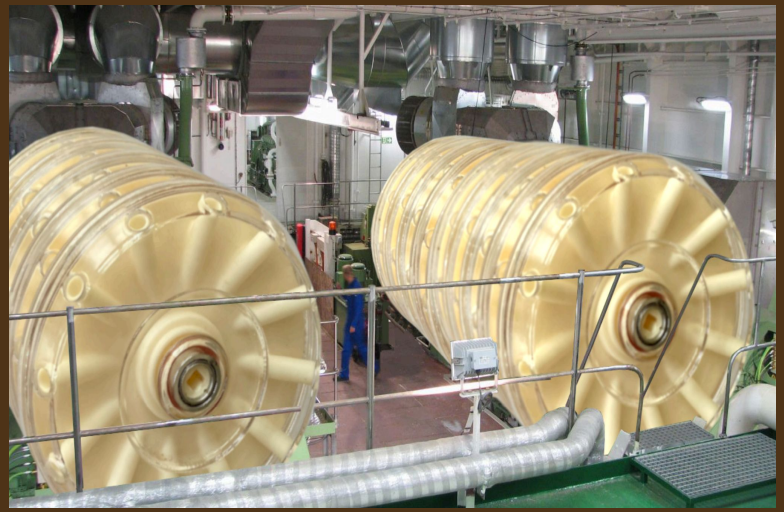
MAL - Next Steps !

Next Steps !

MAL - The (very) close Future !

. Powering Electric Engines for boats and planes,

. Illuminating isolated villages, etc...

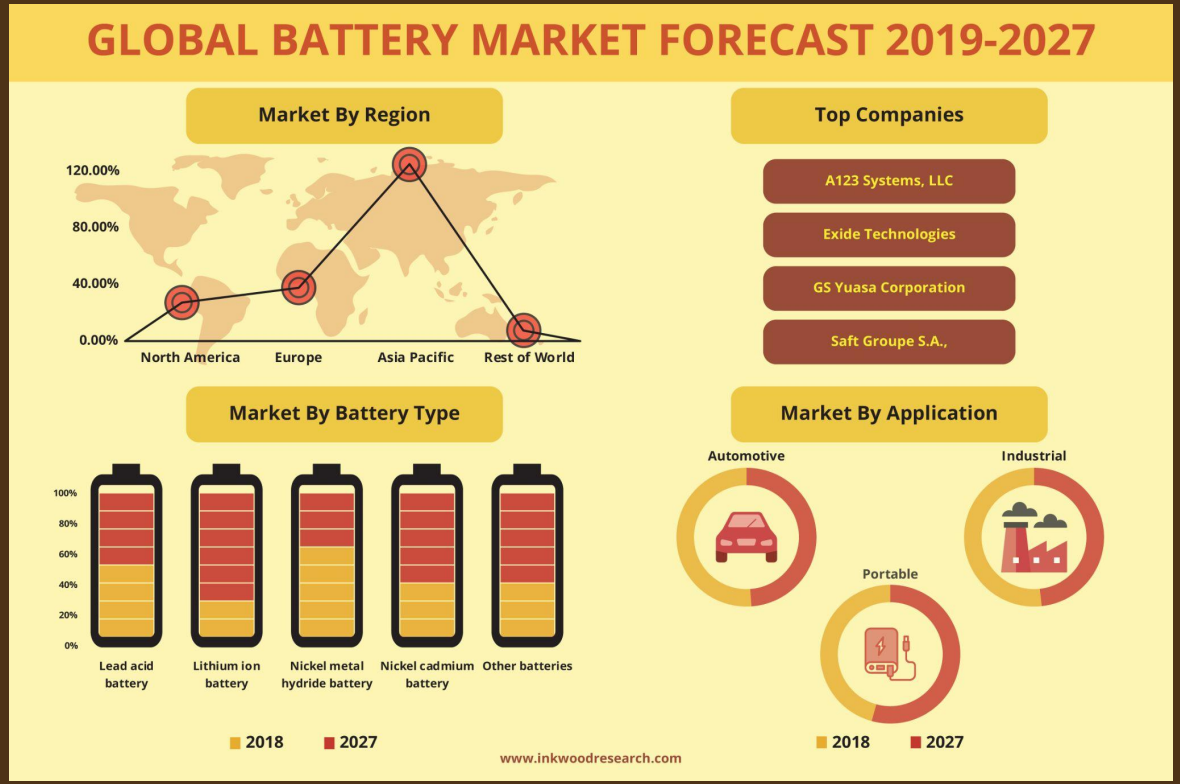


MAL - The WW Battery Market in Value !

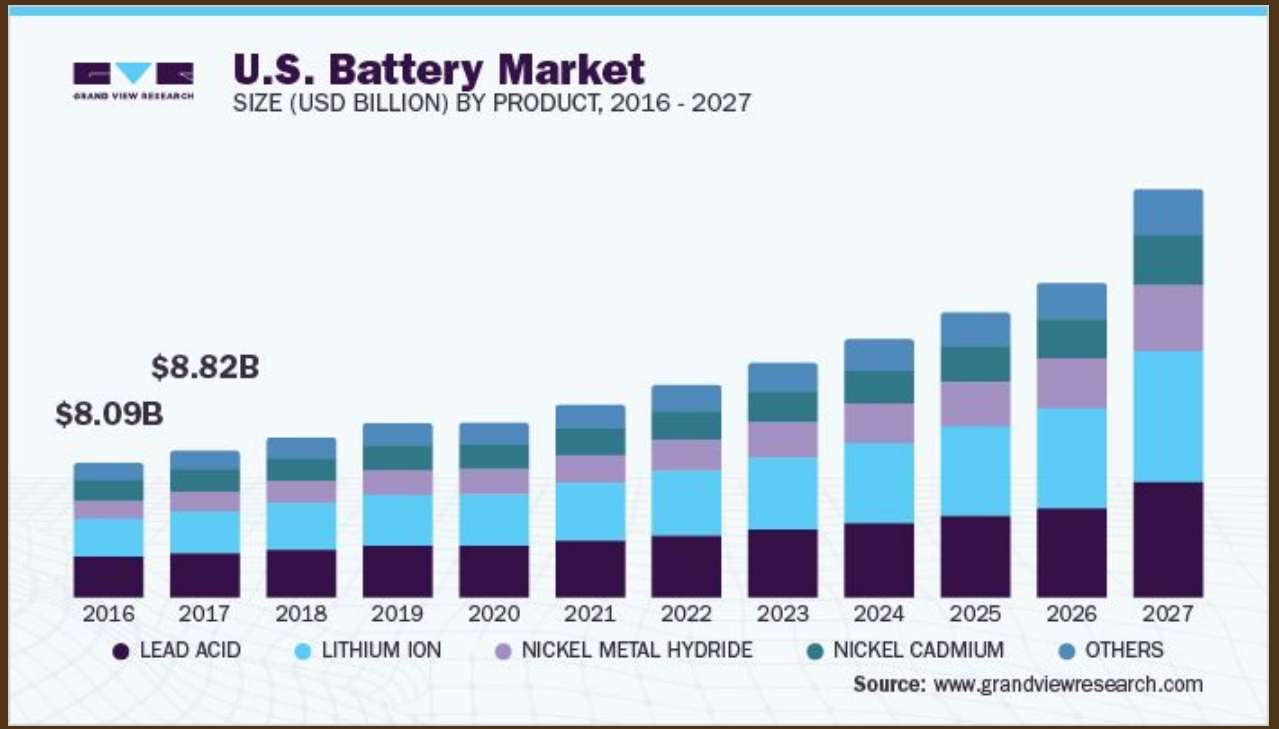
Global Battery Market to Reach $279.7 Billion by 2027

The global market for Battery estimated at US$120.4 Billion in the year 2020, is projected to reach a revised size of US$279.7 Billion by 2027, growing at a CAGR of 12.8% over the analysis period 2020-2027. Lead Acid, one of the segments analyzed in the report, is projected to record a 11.8% CAGR and reach US$76.6 Billion by the end of the analysis period. After an early analysis of the business implications of the pandemic and its induced economic crisis, growth in the Li-Ion segment is readjusted to a revised 14.1% CAGR for the next 7-year period.

MAL - The WW Battery Market in % !



MAL - The US Battery Market in $!



MAL - The WW Lithium Ion Battery Market !

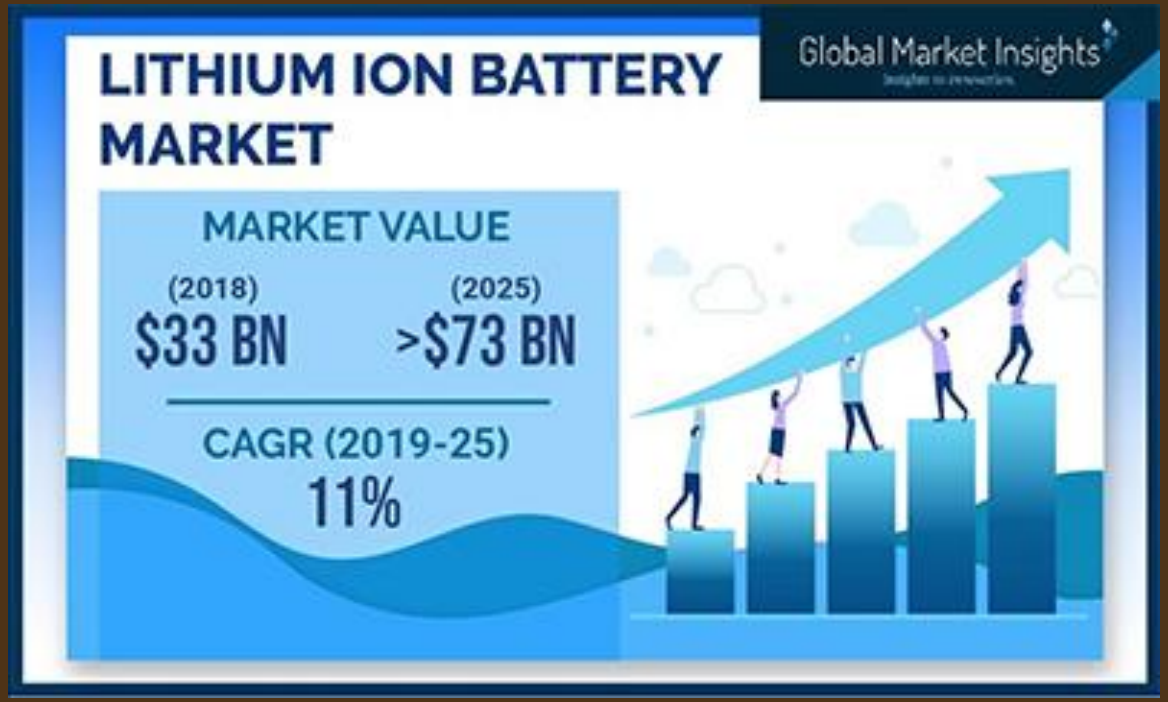


Image courtesy of Global Market Insights Inc.

MAL - What about Aluminium !

What about Aluminium !

MAL - 6 Aluminium Facts !

#1 It Weighs One-Third Less Than Steel

#2 It Doesn't Rust

#3 It's the World's Most Abundant Metal
Consisting of about 8.2% of the Earth's crust, it typically costs less than other, less-common metals.

#4 It's Recyclable
According to the "Aluminum Association", it's the "most recyclable of all materials." When aluminum is recycled, nearly all of the metal can be reused without creating any waste. Recycling just a single aluminum saves enough energy to power an MP3 player while listening to entire album of songs.

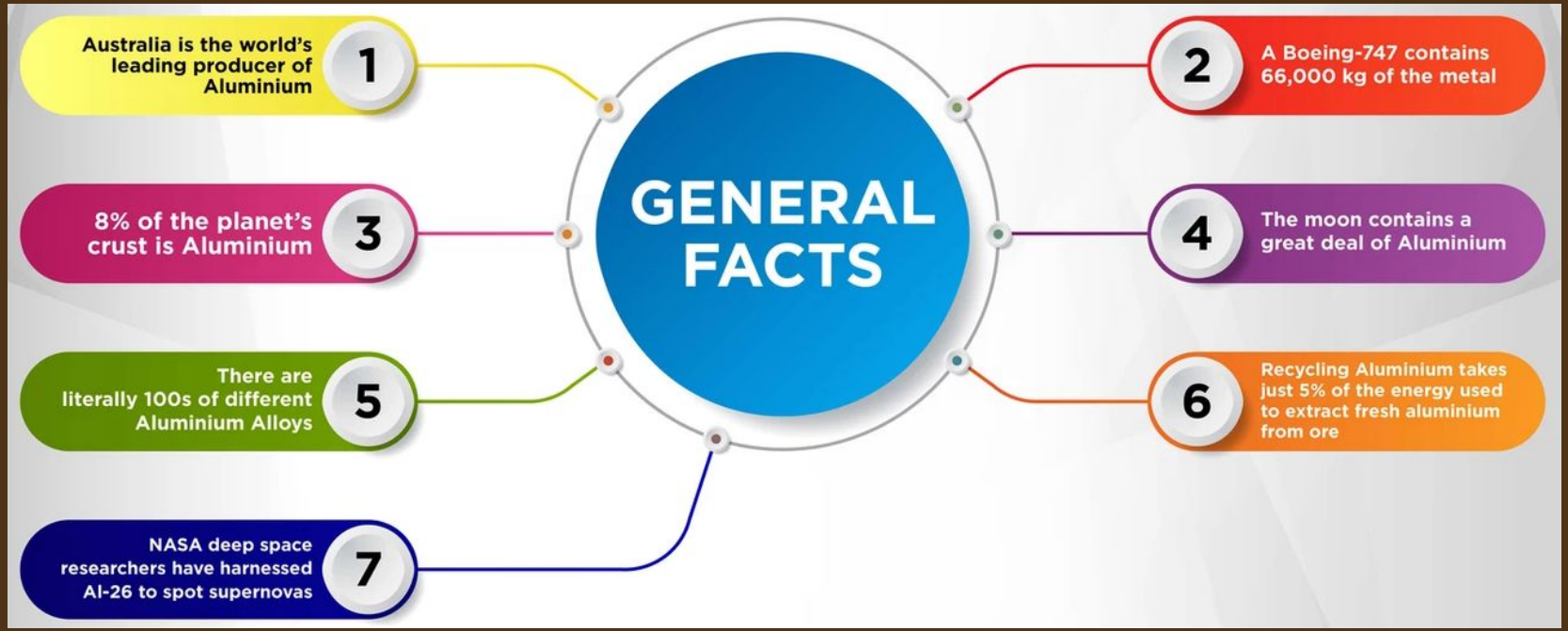
#5 It's Resistant to Heat
Aluminum is highly resistant to heat. It will still smelt from a solid to liquid state when exposed to temperatures in excess of 1,220 °F.

#6 It's Ductile
Aluminum is a ductile metal that is easy to bend and shape, sing basic tools and minimal pressure.

#7 Aluminum is non-toxic to humans.
In fact, aluminum hydroxide is used medicinally as an antacid. This aluminum compound can also be used to treat kidney failure and is found in some vaccines.

#8 Aluminum is highly reactive.
It even binds with oxygen, which is basically all around us.

MAL - Aluminium Facts 2 !



MAL - Aluminium Facts 3 !

#1) It Weighs One-Third Less Than Steel
One of the reasons aluminum has become such a widely used metal in the manufacturing industry is because of its lightweight characteristics.

#2) It Doesn't Rust
Since it doesn't contain iron, aluminum doesn't rust. Aluminum products can withstand rain, sleet, snow and humidity without rusting.

#3) It's the World's Most Abundant Metal
Consisting of about 8.2% of the Earth's crust, aluminum is the world's most abundant metal. Because there's so much aluminum readily available, it typically costs less than other, less-common metals.

#4) It's Recyclable
Aluminum is also recyclable, meaning aluminum products can be smelted down and reused in other applications. According to the Aluminum Association, it's the "most recyclable of all materials." When aluminum is recycled, nearly all of the metal can be reused without creating any waste. And the Aluminum Association notes that recycling just a single aluminum can saves enough energy to power an MP3 player while listening to entire album of songs.

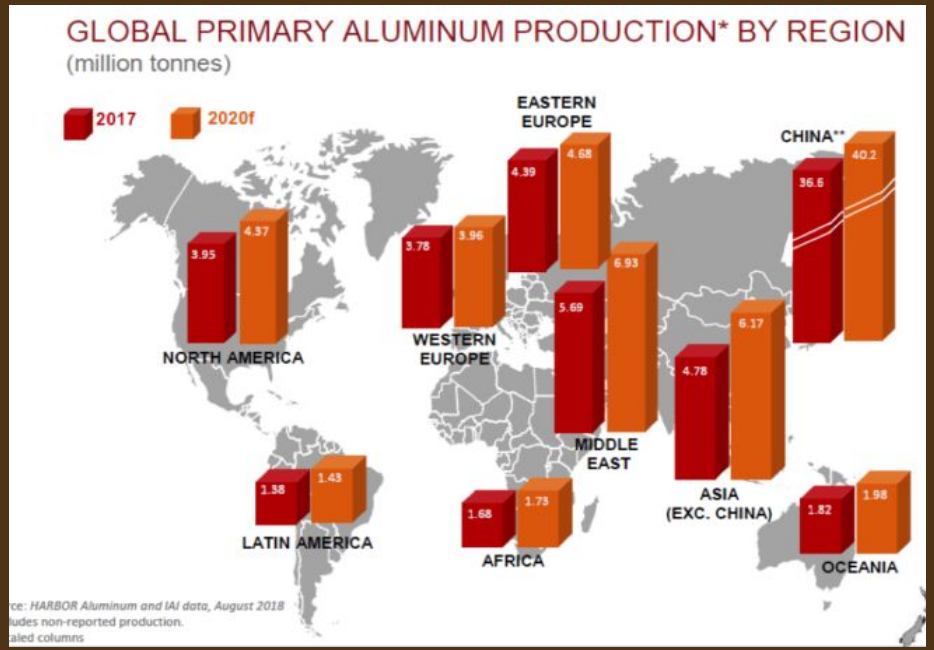
#5) It's Resistant to Heat
Aluminum is highly resistant to heat. It will still smelt from a solid to liquid state when exposed to enough heat, but it takes temperatures in excess of 1,220 degrees Fahrenheit to smelt aluminum.

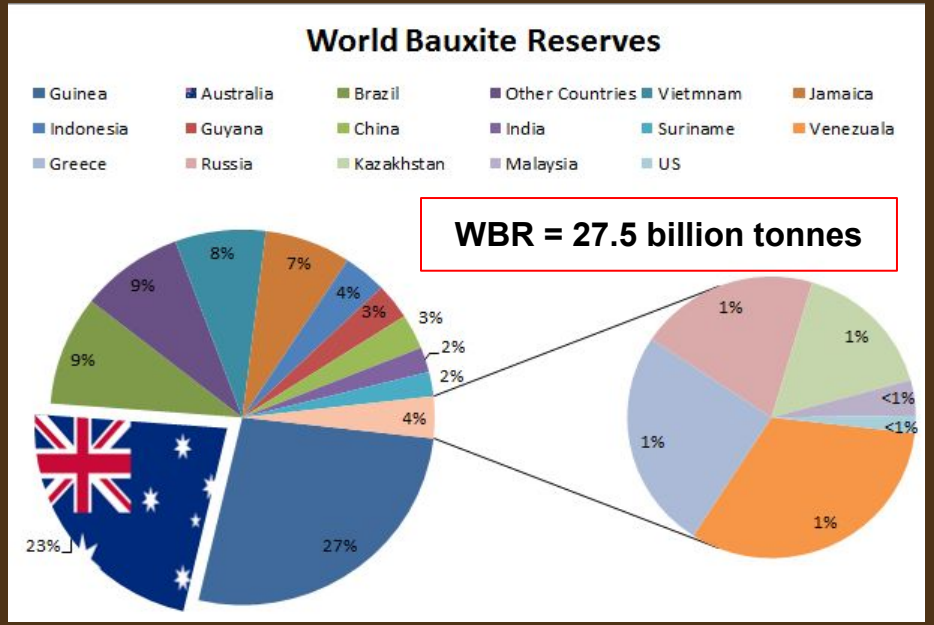
#6) It's Ductile
Aluminum is a ductile metal that is easy to bend and shape, sing basic tools and minimal pressure.

MAL - Aluminium Facts 4 !

AP= 0.84 € per kg

Reuters Base Metal Poll October 2019		
Aluminium price US$/t	2019	2020
Mean	1802.9	1812.1
Median	1796.8	1814
Highest	1900	2180
Lowest	1775	1600
Count	26	27





MAL - What the Press and Wikipedia says !

What the Press & Wikipedia says !

MAL - Somes Useful Links (1/2) !

Al-air: a better battery for EVs? By Richard Brown 03 February 2020	https://www.automotivelogistics.media/electric-vehicles/al-air-a-better-battery-for-evs/40079.article
BBC coverage of Métalectrique Technology	https://www.youtube.com/watch?v=38cKvIQzHG0&t=1s
Les promesses miraculeuses des batteries aluminium-air Repéré par Thomas Burgel sur TechCrunch 19/07/2019 à 6h49	https://korii.slate.fr/tech/promesses-miraculeuses-batteries-aluminium-air-tout-electrique

MAL - Somes Useful Links (2/2) !

By Steven Douglas October 23, 2019	Inventor Builds A Car Battery With A Range Of 1,500 Miles And Gains Investors
	Aluminium–air battery
	WO2016178017A1 - An aluminium-air cell, an aluminium-air battery and a motor unit comprising an electric motor and an aluminium-air battery
	https://www.inclusivecapitalism.com/news-insights/meet-the-council-a-qa-with-trevor-jackson/

MAL - Your Contacts

Stephane Collard

Senior Business Development Manager for Continental Europe

+33 660 662 650 - stephane@arcane-conseil.com

https://www.linkedin.com/in/scollard/

Visit Us : www.arcane-conseil.com

Jean-Pierre Chambon

Worldwide Marine Expert

+33 614 797 424 - jpc@arcane-conseil.com

SCAN ME

MAL - Your Questions !

Questions ?