

# FREE TECH<sup>®</sup>

 EMMANUELLE  
MOORS  
consulting

## THE VACUUM CAPACITOR

THE ULTIMATE  
ENERGY STORAGE  
TECHNOLOGY



# MASSIVE ENERGY STORAGE IS ESSENTIAL TO THE ENERGY TRANSITION

## YESTERDAY



Energy mix led by fossil fuels



Reliable electricity production



Few electricity producers and suppliers



Low sensitivity for energy saving and environmental and social aspects



0.03 TWh of energy storage capacity in 2020



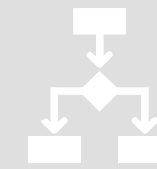
## TOMORROW



Rise of Distributed Energy Resources (DER)



Increased intermittent production



Increased number of independent producers & liberalized market



Energy storage to bridge the gap to a 24/7 optimized renewable energy production and supply



1 TWh LDES capacity forecast by 2025  
5-10 TWh LDES capacity forecast by 2030  
~ 100 TWh of LDES required for grid net zero by 2040



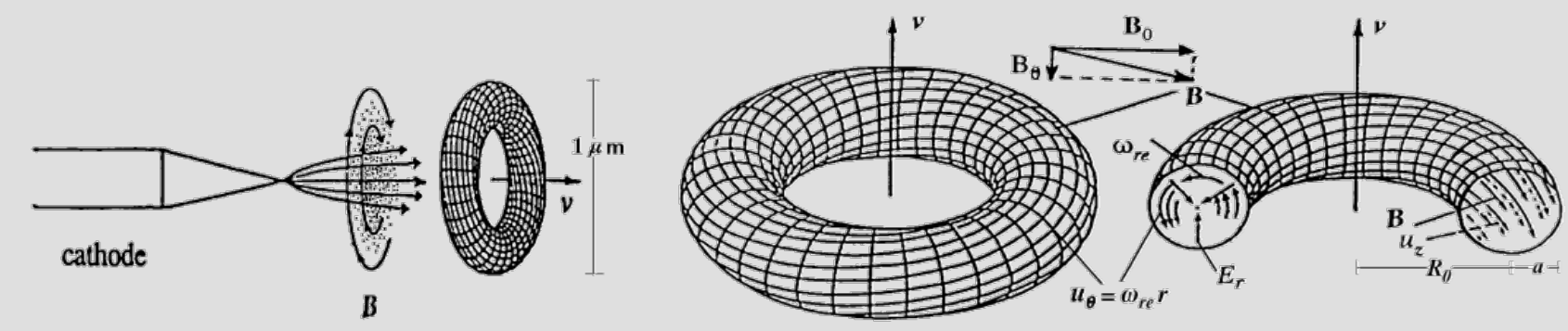
**MARKET TREND FAVORABLE TO THE SURGE OF COMPETITIVE ENERGY STORAGE SOLUTIONS**

**OUR MISSION : TO PROVIDE COMPETITIVE LARGE-SCALE ENERGY STORAGE SOLUTIONS FOR FIXED STATIONARY APPLICATIONS**

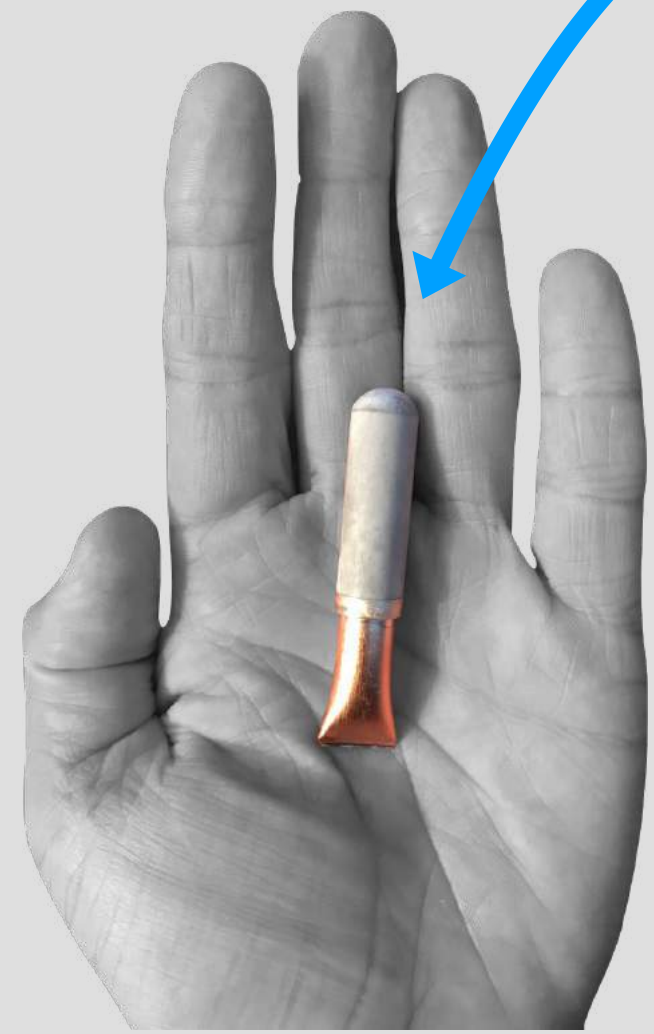


# OUR SOLUTION : VACUUM CAPACITORS, INTEGRATED IN BEST-IN-CLASS ENERGY STORAGE SOLUTIONS

The Vacuum Capacitor can roughly be compared to a **supercapacitor**. Electrons are packed under a high-voltage electrical field into very dense, **3- D plasmoids** (High Density Charge Clusters, or “HDCC”), to fit into a small volume under controlled atmosphere.

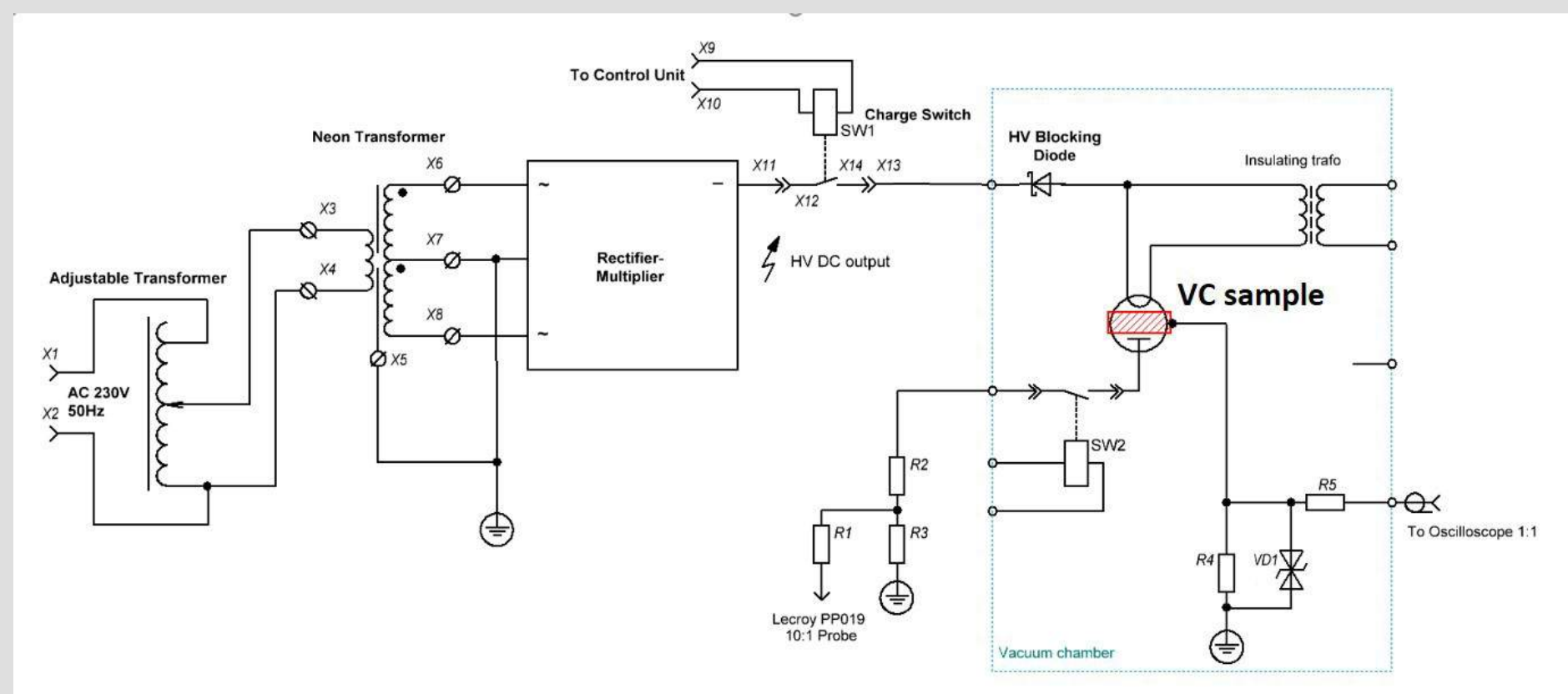


Experimental proof of concept (TRL 3) was reached in 2009 with an energy density equivalent to around 7 500 Wh / kg.



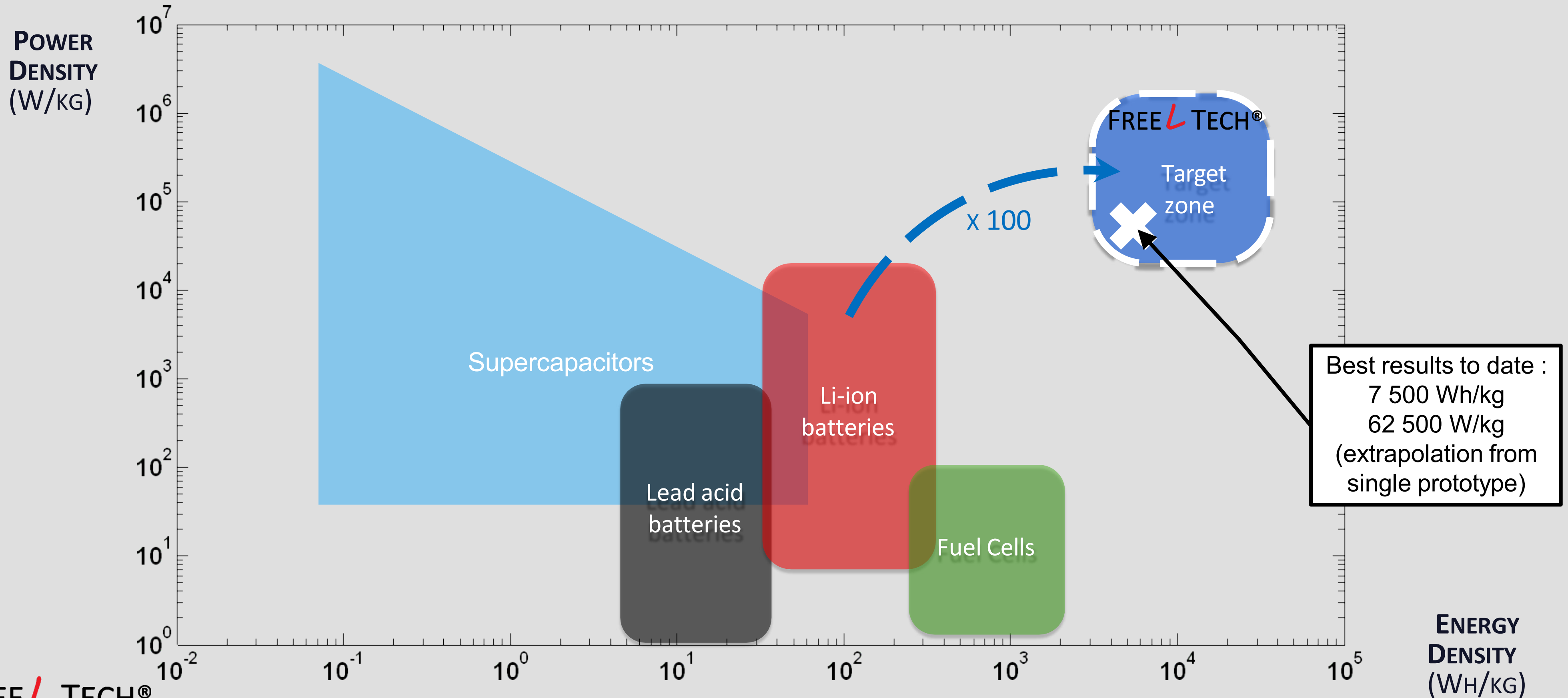
EARLY PROTOTYPE (2018)  
Built with non-precious material, each encapsulated VC targets (at TRL 6) an energy density of at least 5 000 Wh / kg.

## EXAMPLE OF CHARGING SCHEME (HVDC)



# THE VACUUM CAPACITOR : AN UNMATCHED ENERGY AND POWER DENSITY

Ragone plot of Vacuum Capacitor performance *versus* selected energy storage technologies



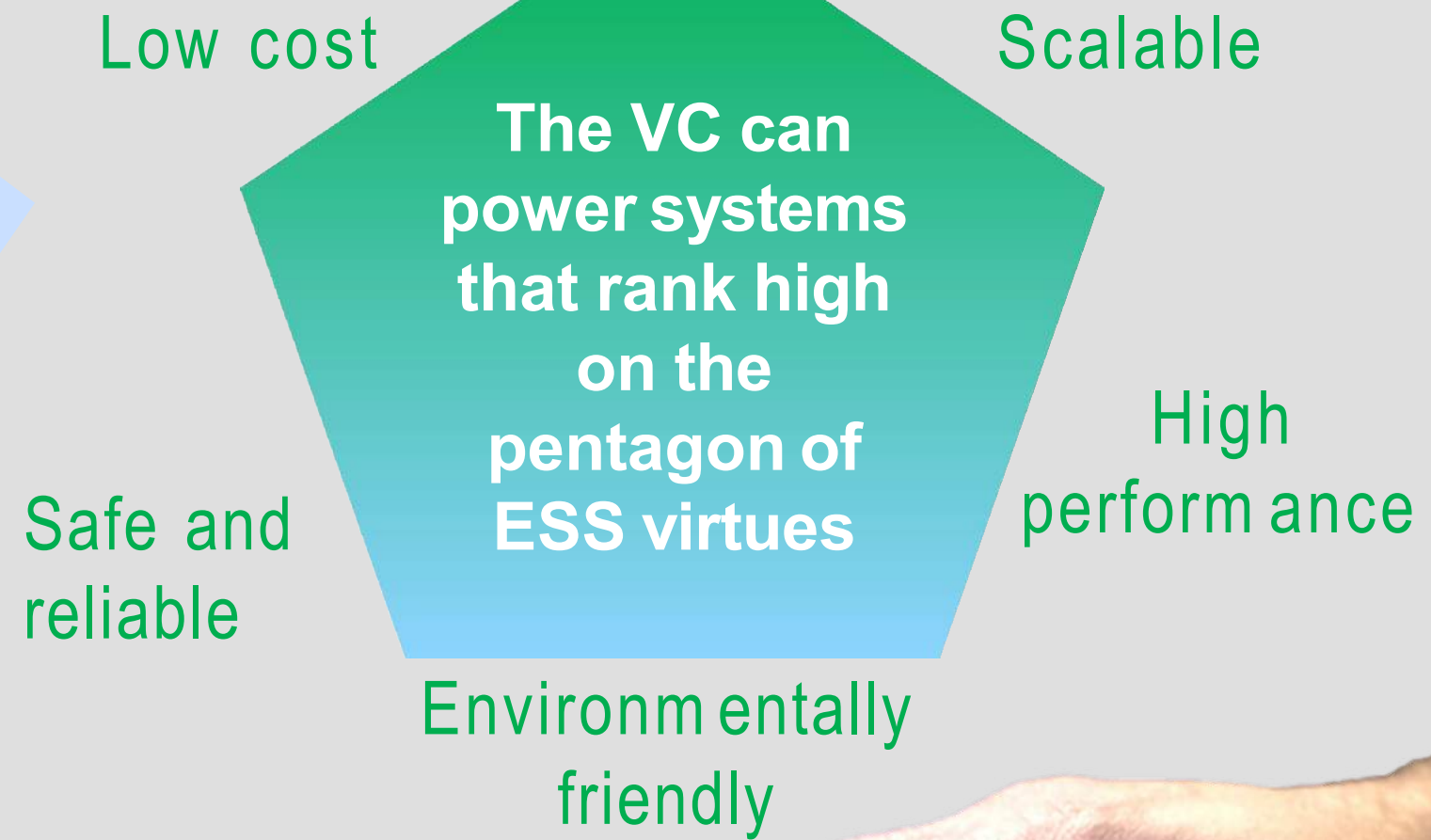
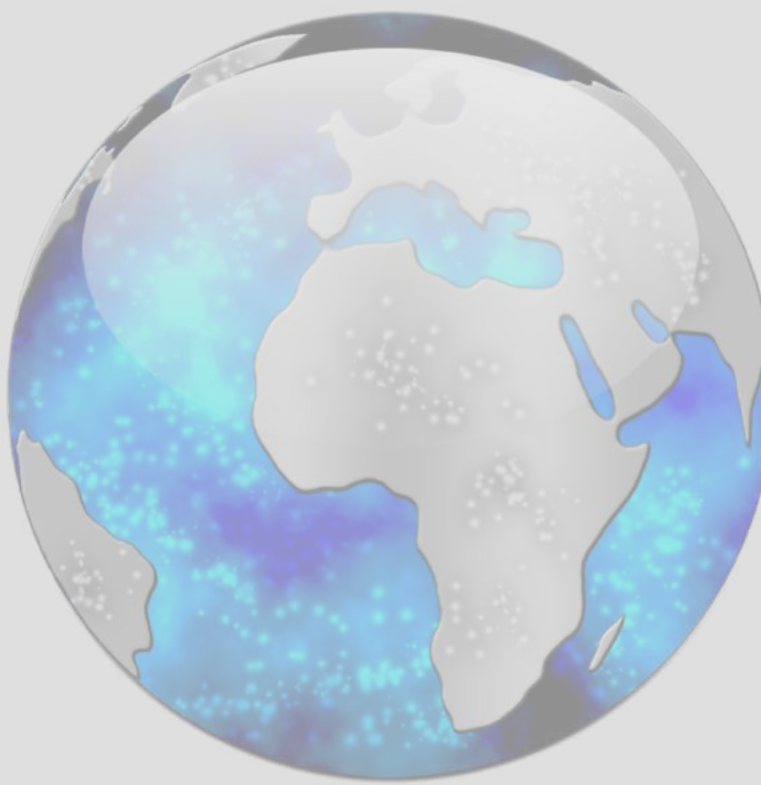
# SHORTCOMINGS OF COMPETITION ON KEY ENERGY STORAGE FACTORS

**Lead-acid** batteries have low energy density and a limited cycle lifetime

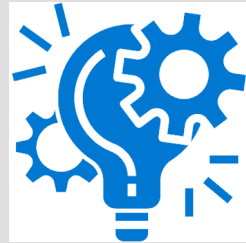
**Fuel cells** and hydrogen electrolysis have a mediocre R/T energy efficiency and limited scalability

**Vanadium redox flow** batteries are expensive, have a low volumetric storage and contain toxic components

**Li-ion** batteries rely on ESG onerous, expensive and fragile supply chains



# FREEL TECH IN A SNAPSHOT



**INCORPORATED IN LUXEMBOURG IN 2017**



**CO-FOUNDERS OWNS MAJORITY OF SHARES**



**INDUSTRIAL PARTNERSHIPS TO CO-DEVELOP ENERGY STORAGE SOLUTIONS**



**AUG.2020**



**TECHNOLOGY PATENTED IN EUROPE, US, CANADA, INDIA AND OTHER KEY COUNTRIES**

# FREEL TECH CORE TECHNICAL AND MANAGEMENT TEAM

Co-Founders joined by senior managers bringing key energy storage, R&D and project management experience



**Michael IRGANG**  
Executive Director &  
Co-Founder

Over 25 years in business development (France and Russia) in the nuclear energy sector. Graduated from Mines ParisTech



**Roman KHOLOSHENKO**  
Technology Director  
Co-Founder

Military career, then engineer & business owner in Russia. Expert in electronics and magnetic fields. Led the Russian team who invented the "Vacuum Capacitor"



**Jean-Philippe GINESTET**  
R&D Director

Over 30 years as consultant and team leader in innovation management and R&D (design, implementation) in various high-tech fields (supercapacitors, electromechanics, optical, semiconductors...)



**William WEBER**  
Strategic Marketing  
Director

10 years in technical studies and development of renewable energy production and storage systems. Graduated from Griffith's School of Engineering (Australia)



**Julien PLAN**  
Business Development  
Director

Project management experience in the nuclear energy sector. Master in nuclear physics and engineering from Université Grenoble Alpes. Executive-MBA from EM Lyon BS.

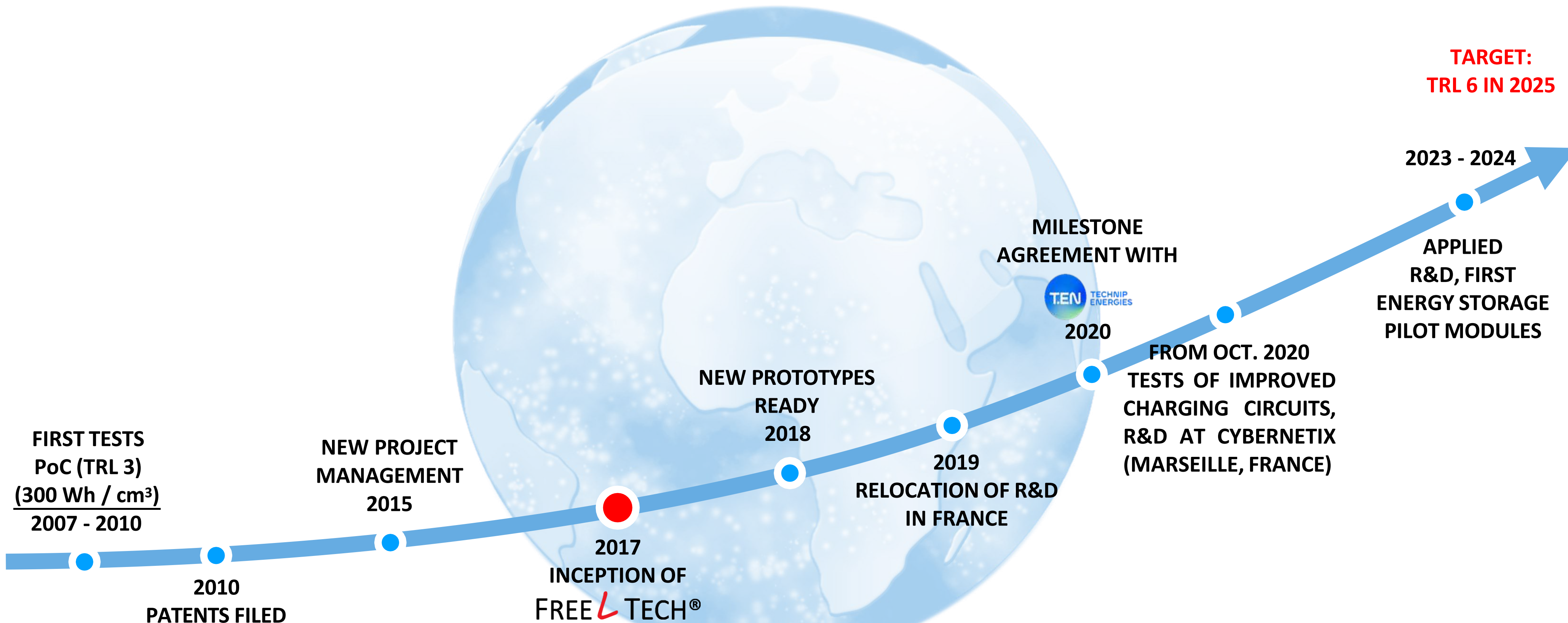


**Roland IRGANG**  
Finance and Administration  
Director

25 years in banking, financial advisory, fundraising and investment, in the transport and energy sectors. Post-graduate degree in banking & finance from Université Panthéon Sorbonne.

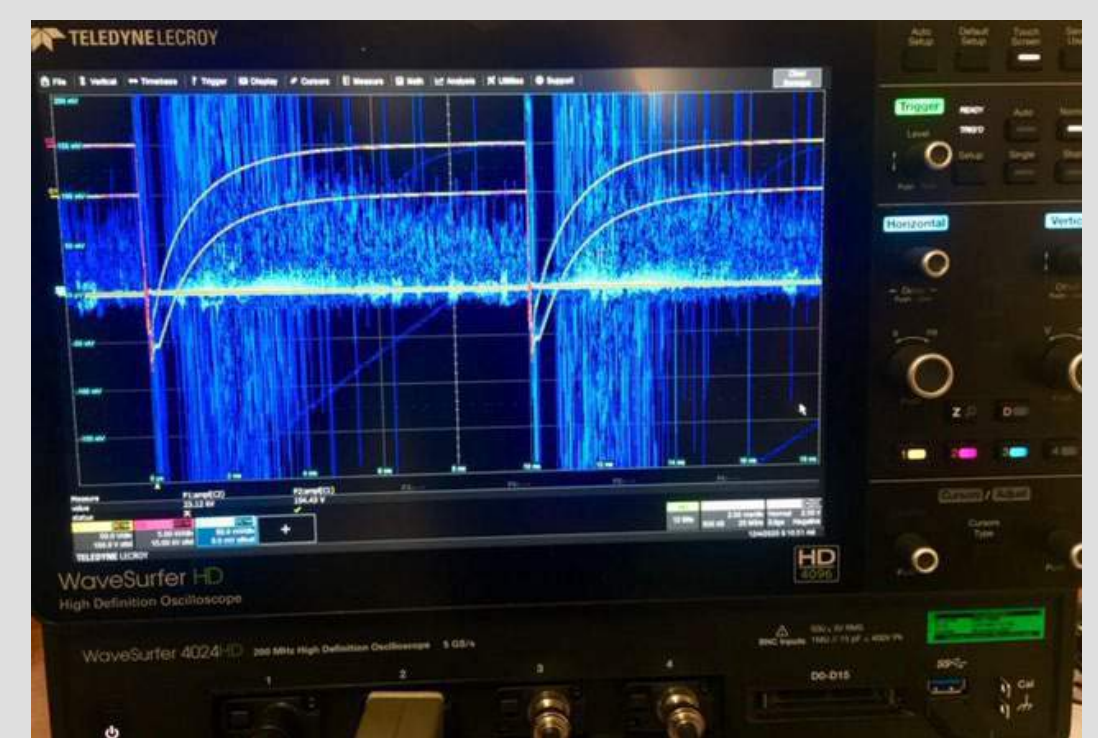
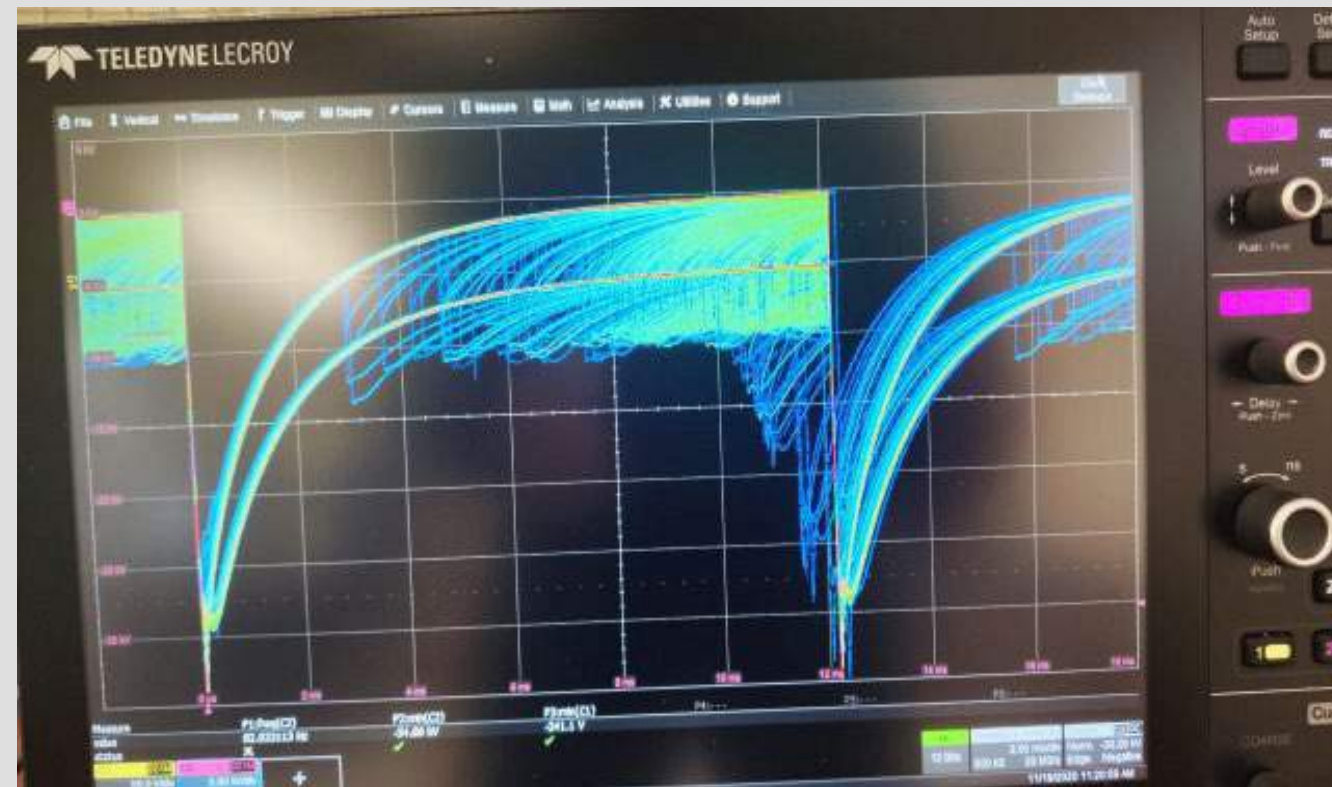


# PROJECT'S TIMELINE



# LABORATORY EXPERIMENTS (FRANCE)

SNAPSHOTS OF FREEL TECH'S EXPERIMENTS IN MARSEILLE (SINCE OCTOBER 2020)





# Thank you



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