



**FREE<sup>L</sup>TECH<sup>®</sup>**

**THE “VACUUM CAPACITOR”:  
THE ULTIMATE ENERGY  
STORAGE TECHNOLOGY**

**2019**

**STORAGE IS KEY FOR THE GROWTH OF CLEAN ENERGY,  
AND CURRENT TECHNOLOGIES CANNOT ADDRESS  
THE MASSIVE STORAGE REQUIREMENTS**

The world will increasingly rely upon fast growing **clean energy**,  
in particular **electricity**.

To accommodate clean, but intermittent and renewable energy sources, and to  
create a genuinely clean mobility, the world will need  
**huge energy storage capacities (hundreds of TWh)**.

Today, total energy storage capacity installed worldwide  
represent only **5 TWh** (mostly Pumped Hydro Storage).  
Battery and other energy storage represent only **0,16 TWh** (4 %).

Expectations for 2030 ? Total installed storage capacity worldwide in 2030 is  
estimate to reach **12 - 15 TWh, which still remains insufficient**.

## CURRENT TECHNOLOGIES RAISE MAJOR ISSUES

Available energy storage technologies (especially electrochemical) :

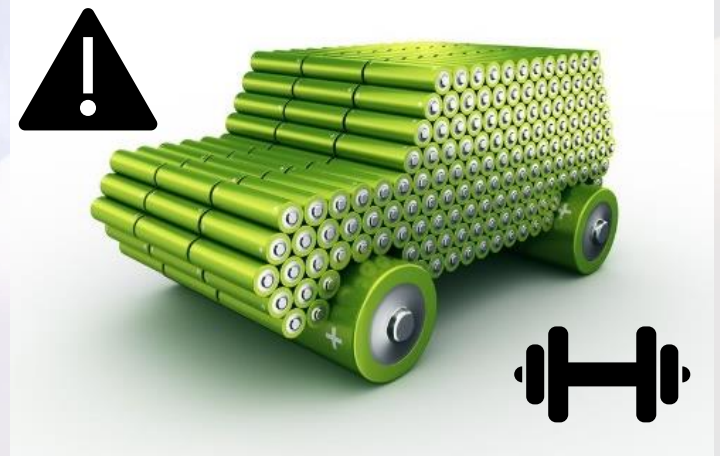
- are expensive
- remain heavy for mobile application (insufficient energy density)
- are dependent upon limited resources of raw materials, located in a limited number of countries (supply & geopolitical risks)
- cause environmental harm (supply chain, recycling electrochemical batteries, etc ...)
- incur incidents including fire hazards (Li-Ion)
- depend upon outside temperature
- have limited service life, number of cycles

**FREEL TECH'S TECHNOLOGY ADDRESSES THESE ISSUES.**

## SPECIFIC CHALLENGES FOR GLOBAL CLEAN MOBILITY



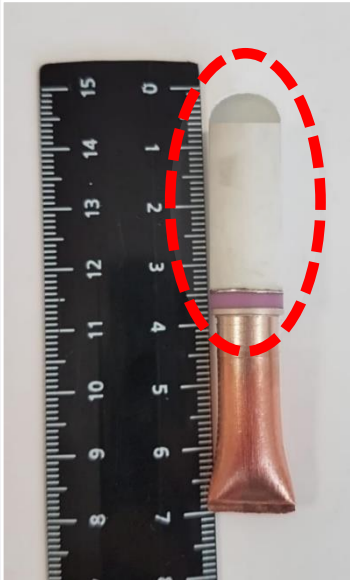
- **Insufficient energy density** and **high cost** of current technologies are barriers to power global electrical mobility at affordable price and with sufficient autonomy
- High cost of replacement of EV battery pack
- Fire hazard
- Recycling of discarded EV batteries (environmental impact)





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## OUR SOLUTION - THE VACUUM CAPACITOR



### Our solution, the “Vacuum Capacitor”

#### A technological revolution :

We manage to store charges (electrons) directly inside a small device, which we called “**Vacuum Capacitor**”, creating the proper conditions for the formation of very high-density “clusters” of charges inside a small bulb under vacuum.

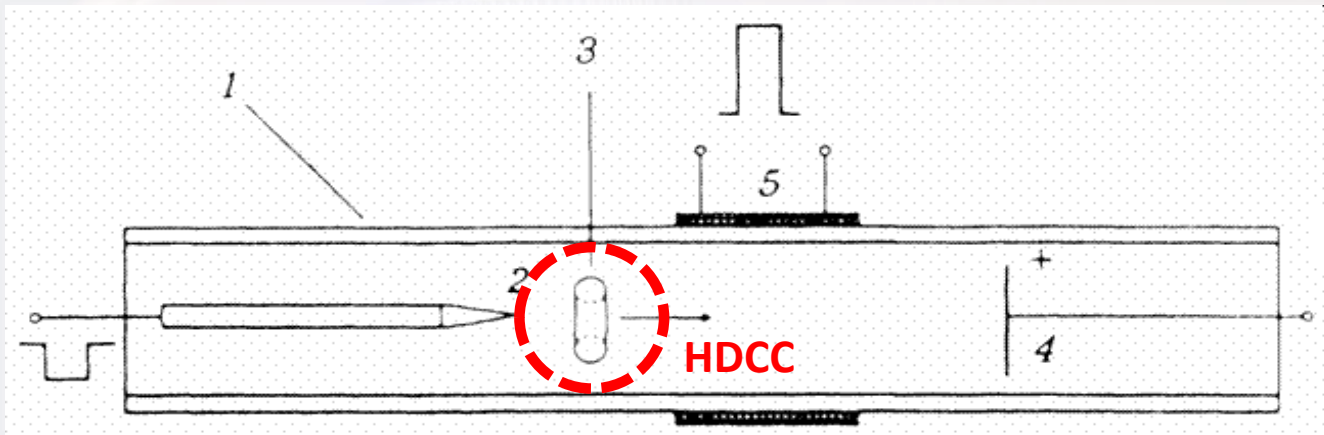


- up to 100 times **more energy density** than Li-Ion
- significantly lower cost (in USD / kWh of capacity)
- long life duration, high number of cycles (target)
- high round-cycle efficiency, very low level of energy losses when charged (target)
- no rare or expensive raw materials required
- simple recycling, no environmental impact



## THE PHYSICS BEHIND THE VACUUM CAPACITOR

HDCCs are known structures, studied in particular by US scientists Ken Shoulders.



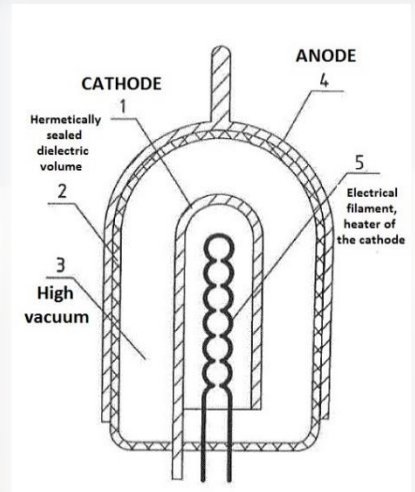
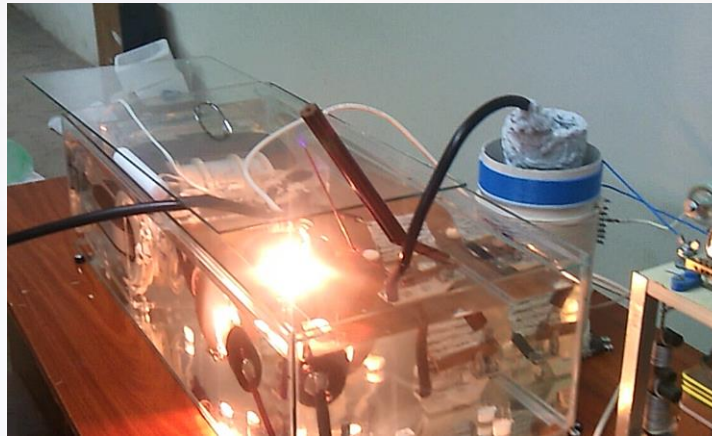
One of Ken Shoulders' experimental systems to produce and observe the properties of high-density charge clusters (HDCC)

*HDCCs are « ... highly organized, micron-sized clusters of electrons, having soliton behavior, with electron populations on the order of Avogadro's number... » (K. Shoulders)*

For more information : <http://www.rexresearch.com/ev/ev.htm>

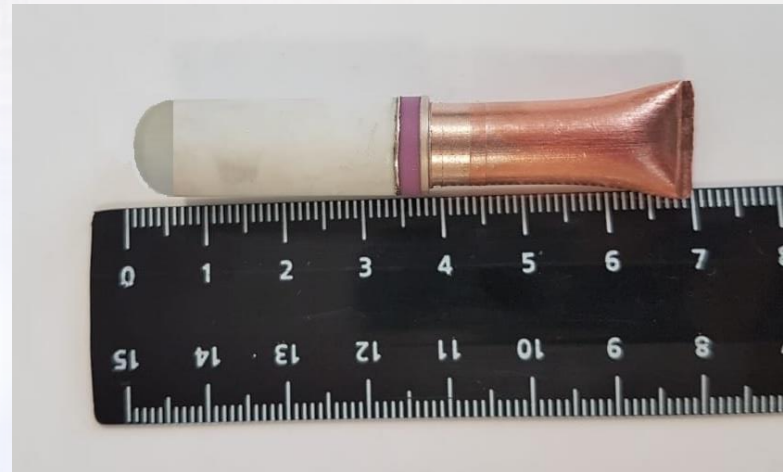
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## THE VACUUM CAPACITOR : HOW IT ALL STARTED 15 YEARS AGO



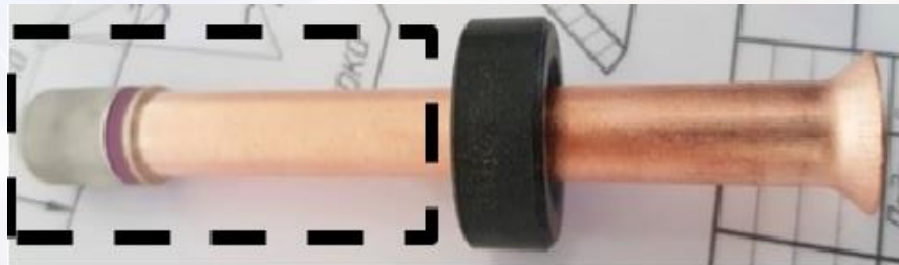
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## THE FREEL TECH TECHNOLOGY AS OF TODAY : OPTIMIZED PROTOTYPES OF THE VACUUM CAPACITOR



**TARGET : to reach  
1 KWH PER DEVICE**

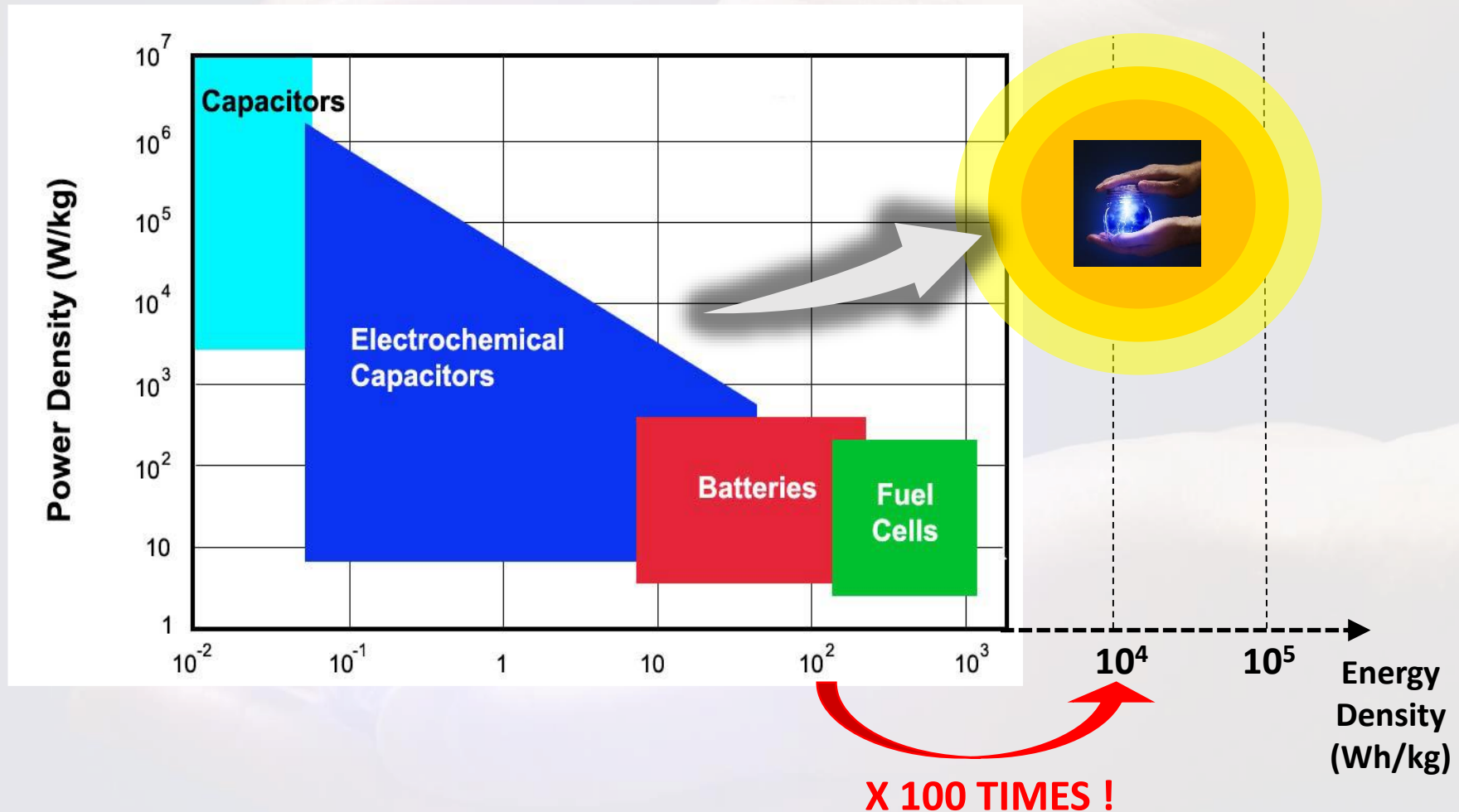
**(current weight < 100 g) !**





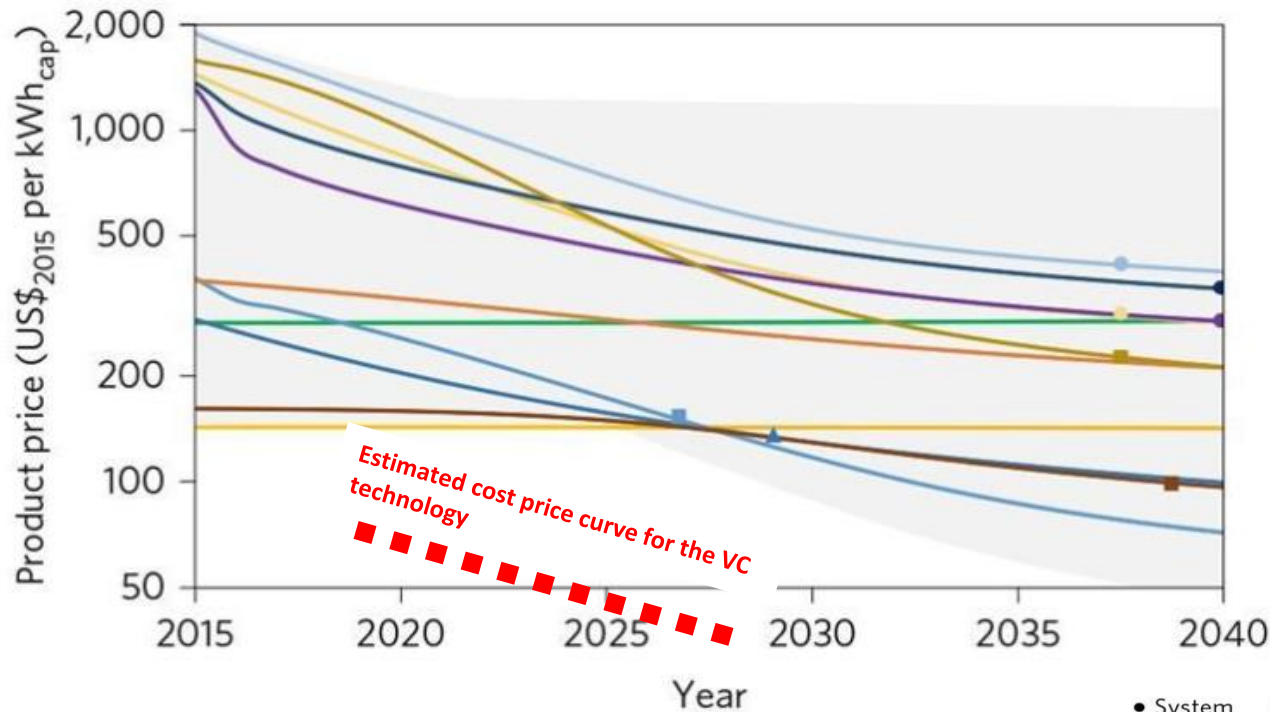
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## COMPETITIVE ADVANTAGE VS OTHER TECHNOLOGIES: 1 - UNMATCHED ENERGY DENSITY



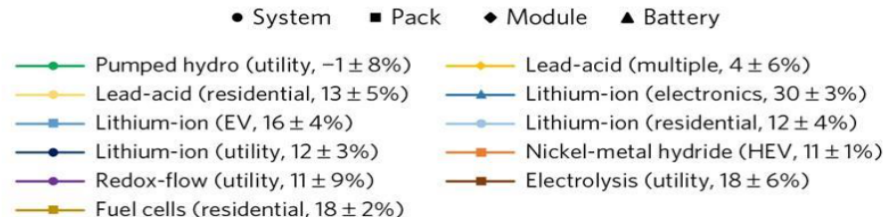
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## COMPETITIVE ADVANTAGE VS OTHER TECHNOLOGIES: 2 - LOWER PRICE



**Our technology is –  
and will remain –  
significantly less  
expensive than  
other technologies  
(under 100 USD /  
kWh).**

Source : ChemistryWorld.com, July 2017



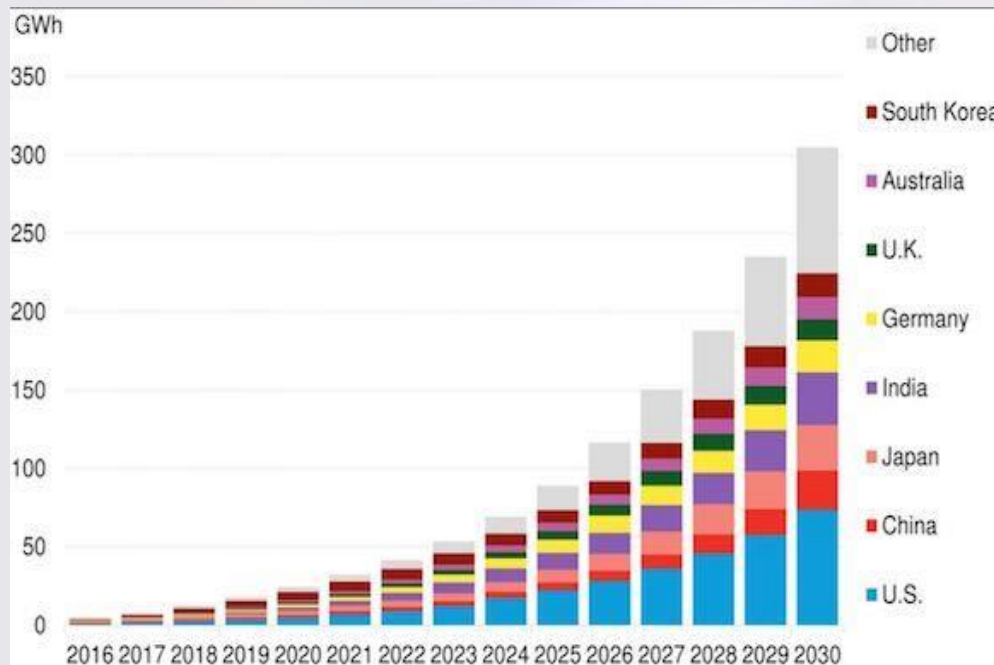
Source: Springer Nature

Costs are projected to fall rapidly for many energy storage technologies

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## MARKET SIZE : HUGE OPPORTUNITIES

The energy storage market is anticipated to grow at a rapid pace. New energy storage capacities (without Pumped Hydro Storage) represented 15 GWh in 2017, with Li-Ion representing a growing share of new additions over the last years (> 90 % of total).



Source : BNEF \*

According to BNEF analysts, more than \$600 bln. may be invested in energy storage between now and 2040.

Global Market Insights sees the Li-Ion market exceeding \$ 60 bln. in 2024.

“We see energy storage growing to a point where it is equivalent to 7% of the total installed power capacity globally in 2040. The majority of storage capacity will be utility-scale until the mid-2030s, when behind the meter applications overtake.”

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## MARKET ASSESSMENT FOR OUR TECHNOLOGY : TARGET



With production cost expected to be **significantly lower than 100 \$ / kWh** from the beginning, our technology can capture a significant share of new energy storage capacities, especially replacing Li-Ion and other, more expensive technologies (redox flow, adiabatic CAES, TES, gravitic, mechanical, ...).

Worldwide target markets and applications for the Vacuum Capacitor:

- stationary grid scale storage, smart grids
- industrial & commercial (I&C)
- behind the meter residential

**Our objective is to capture at least 30 % of global storage capacities between the early 2020's and 2040, which represents a market opportunity of up to € 150 bn .**



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## CORPORATE REVIEW

- FREEL TECH was created and incorporated in Luxembourg in 2017
- Its shareholders structure is majority owned by its management and by a minority financial investor
- FREEL TECH owns multiple patents in Europe, Northern America, Eurasia, Brasil, India, for the VACUUM CAPACITOR technology
- FREEL TECH is preselected as one of the TOP 30 most innovative energy companies in 2019 (InnoEnergy contest) :

<http://www.innoenergy.com/>



- We are a member of the « World Alliance for Efficient Solutions », created by the **Solar Impulse** Foundation :

<https://solarimpulse.com/companies/freel-tech>

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[www.freel.tech](http://www.freel.tech)



<https://youtu.be/Qke1ITu8VR4>