Backing visionary entrepreneurs

The European Innovation Council

Programme Managers Office, Unit 01

European Commission

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The EIC and the energetic transition: How to drive the innovation of cleantech technologies

Backing visionary entrepreneurs

Paolo Bondavalli
Programme Manager
Advanced Materials for Energy

Short Bio Dr HdR Paolo Bondavalli

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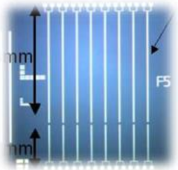


Education

2011 HDR (Habilitation à Diriger des Recherche)
STIC (Science et Technique de l'Information et Communication)

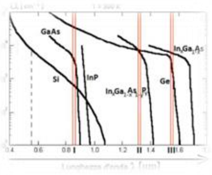
université PARIS-SACLAY

2000 PhD, specialisation « Integrated electronics devices »
Laboratoire de Physique de la Matière (LPM)

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

1995 Graduated on « Solid State Physics »

UNIVERSITÀ DI PARMA



Working experience

2019-24 PEPR SPIN Leader, Scientific officer, Evaluation committee president, Strategic Expert M-ERA net

anr agence nationale de la recherche

2015-24 In Charge of the Transverse topic on nanomaterials ,
Thales Research & Technology.

THALES

2009-15 *Head of the Nanomaterials Topic team*,
UMR137 Thales Research &Technology/CNRS

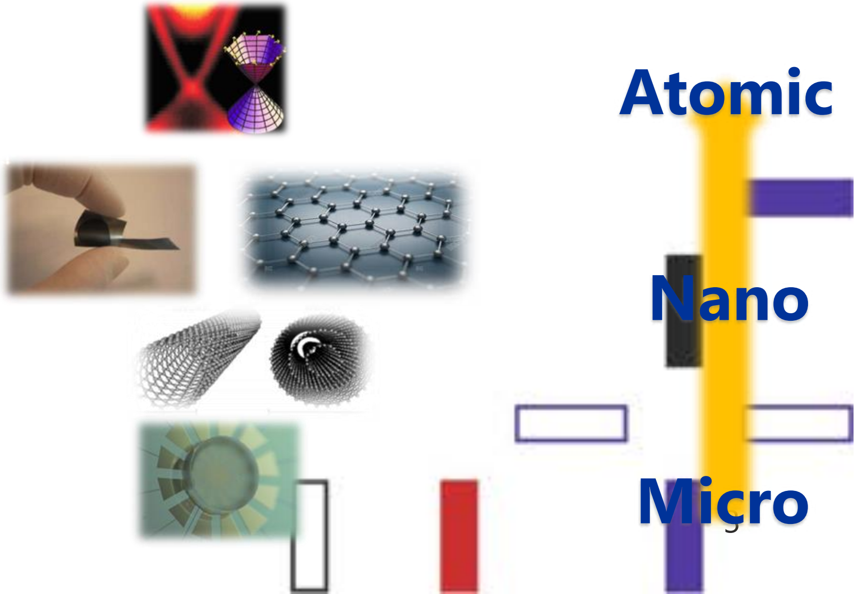
THALES

2004-08 Project Leader — Nanotechnologies,
NANOCARB lab (joint unit Ecole Polytechnique/THALES)

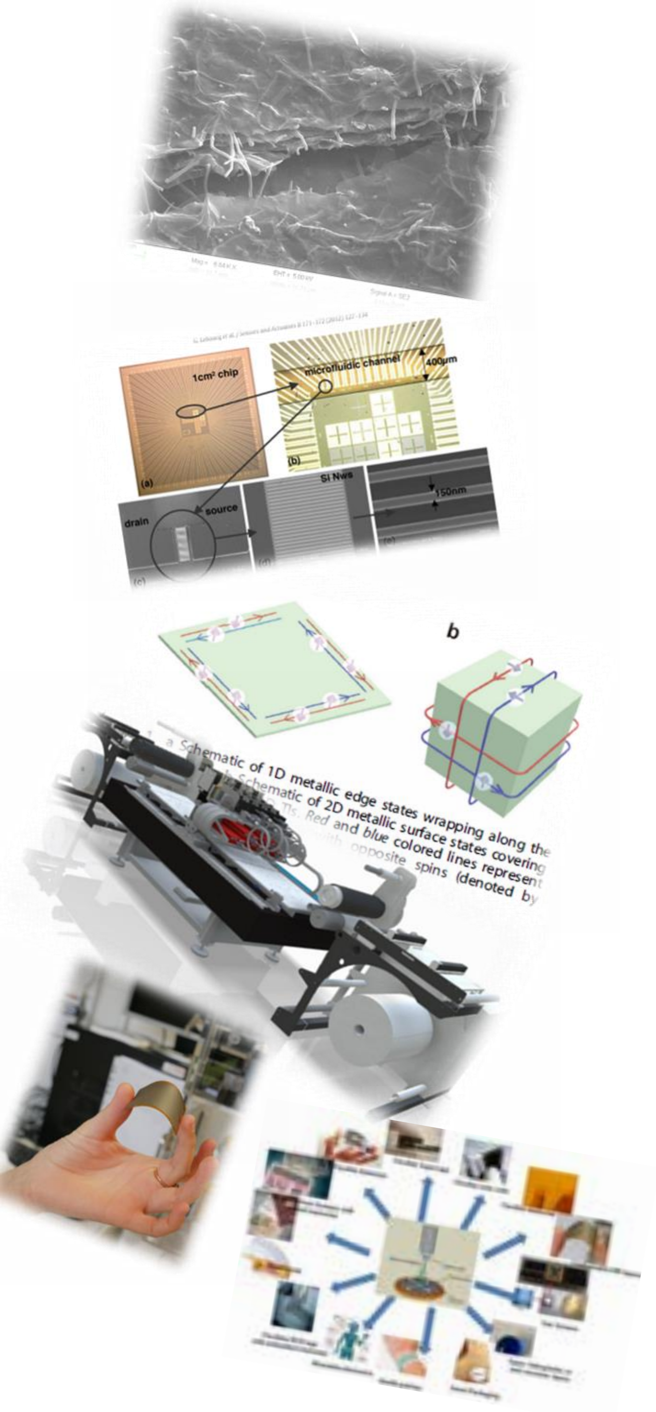
THALES

2001-04 Project Leader —MEMS technology,
Microtec 3D lab

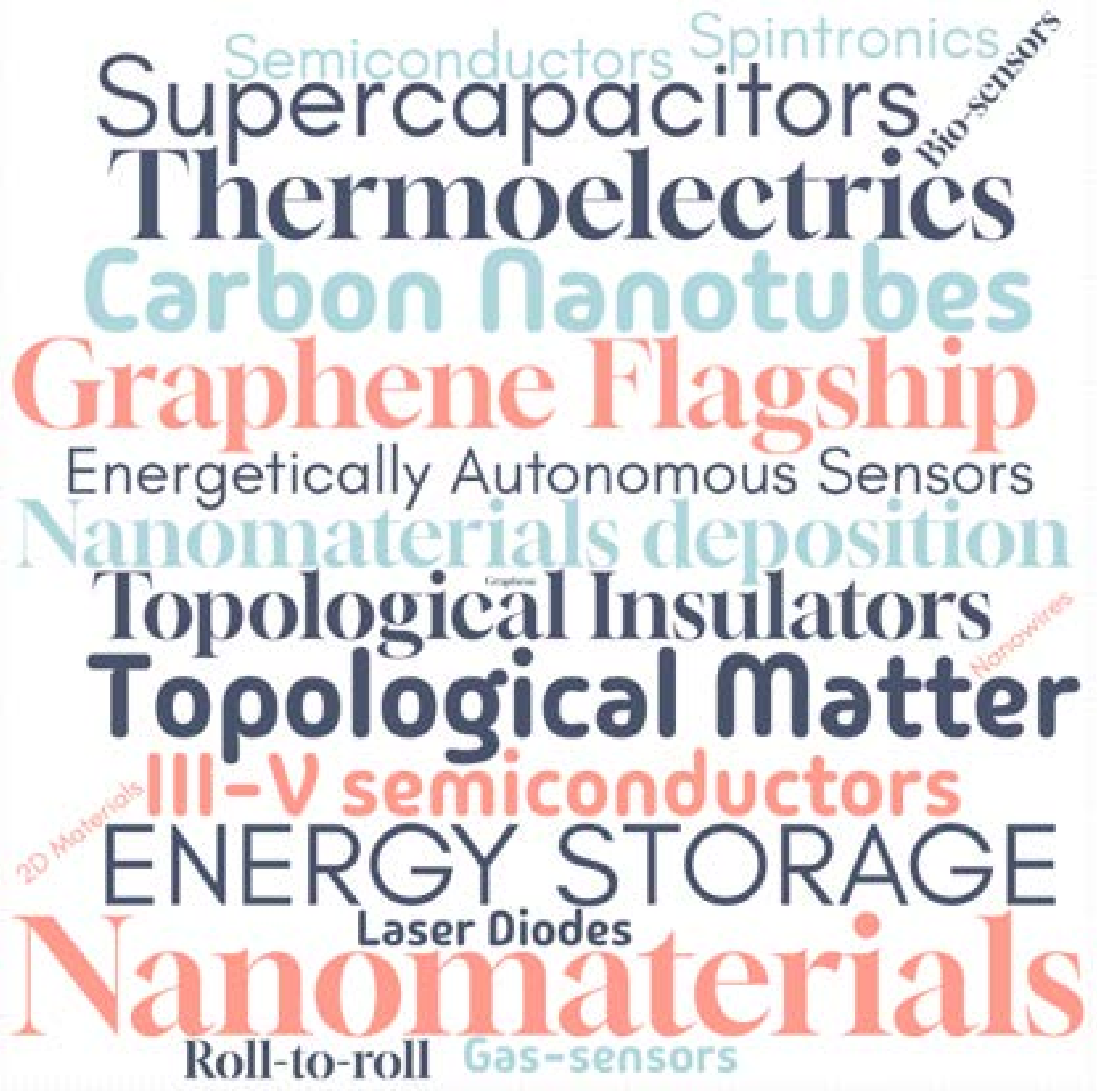
THALES



Background



1cm² chip
microfluidic channel
400µm
Si Nws
150nm
drain
source
b
Schematic of 1D metallic edge states wrapping along the
Schematic of 2D metallic surface states covering
Red and blue colored lines represent
opposite spins (denoted by



Semiconductors
Spintronics
Supercapacitors
Bio-sensors
Thermoelectrics
Carbon Nanotubes
Graphene Flagship
Energetically Autonomous Sensors
Nanomaterials deposition
Topological Insulators
Nanowires
Topological Matter
2D Materials
III-V semiconductors
ENERGY STORAGE
Laser Diodes
Nanomaterials
Roll-to-roll
Gas-sensors

GRAPHENE AND RELATED NANOMATERIALS
Properties and Applications
Paolo Bondavalli
DE GRUYTER
STEM
Paolo Bondavalli
2D MATERIALS
AND THEIR EXOTIC PROPERTIES
Carbon nanotubes based transistors as gas sensors: State of the art and critical review
Pierre Legagneux, Didier Pribat
PERSPECTIVE · OPEN ACCESS
Sequencing one-dimensional Majorana materials for topological quantum computing
Marco Minissale, Paolo Bondavalli, M S Figueira and Guy Le Lay
Published 25 June 2024 • © 2024 The Author(s). Published by IOP Publishing Ltd
Journal of Physics: Materials, Volume 7, Number 3
Citation Marco Minissale et al 2024 J. Phys. Mater. 7 031001
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- EIC presentation: what is our rôle?
- What are advanced materials? A definition
- CRM materials and the energetic transition: main points
- Energy storage for electric grid: a perspective on the different technologies and the portfolio approach
- Market analysis
- Conclusions

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The EIC in a nutshell

The European Innovation Council is Europe's flagship innovation programme to identify, develop and scale up breakthrough technologies and game changing innovations.

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- **Major novelty** introduced in Horizon Europe (following a pilot 2018-20 under Horizon Europe) with budget of over €10 billion as part of HE
- **Objective to identify, develop and scale up breakthrough technologies and disruptive innovations** in Europe and focused on Deeptech
- **Covers full innovation journey** from foundational research on breakthrough technologies, to commercialisation, deployment and scale up (to drive the research to innovation)
- **EIC Board** to advise Commission on strategy and implementation, with full time President (Michiel Sheffer) and 20 members (entrepreneurs, investors, research/ tech transfer, innovation experts)
- **EIC Programme Managers** to develop visions for technology breakthroughs and manage portfolios of projects to achieve breakthroughs (drawing on experience of US DARPA, ARPA-E, etc). To identify and develop challenges with strategic economic/societal impact.
- **EISMEA (**European Innovation Council and SMEs Executive Agency (EISMEA)**)** delegated implementation of calls and grant management, coordination with equity, BAS (Business Accelerator Services)
- **Dedicated EIC Fund** established to implement investments (EIB as investment advisor)

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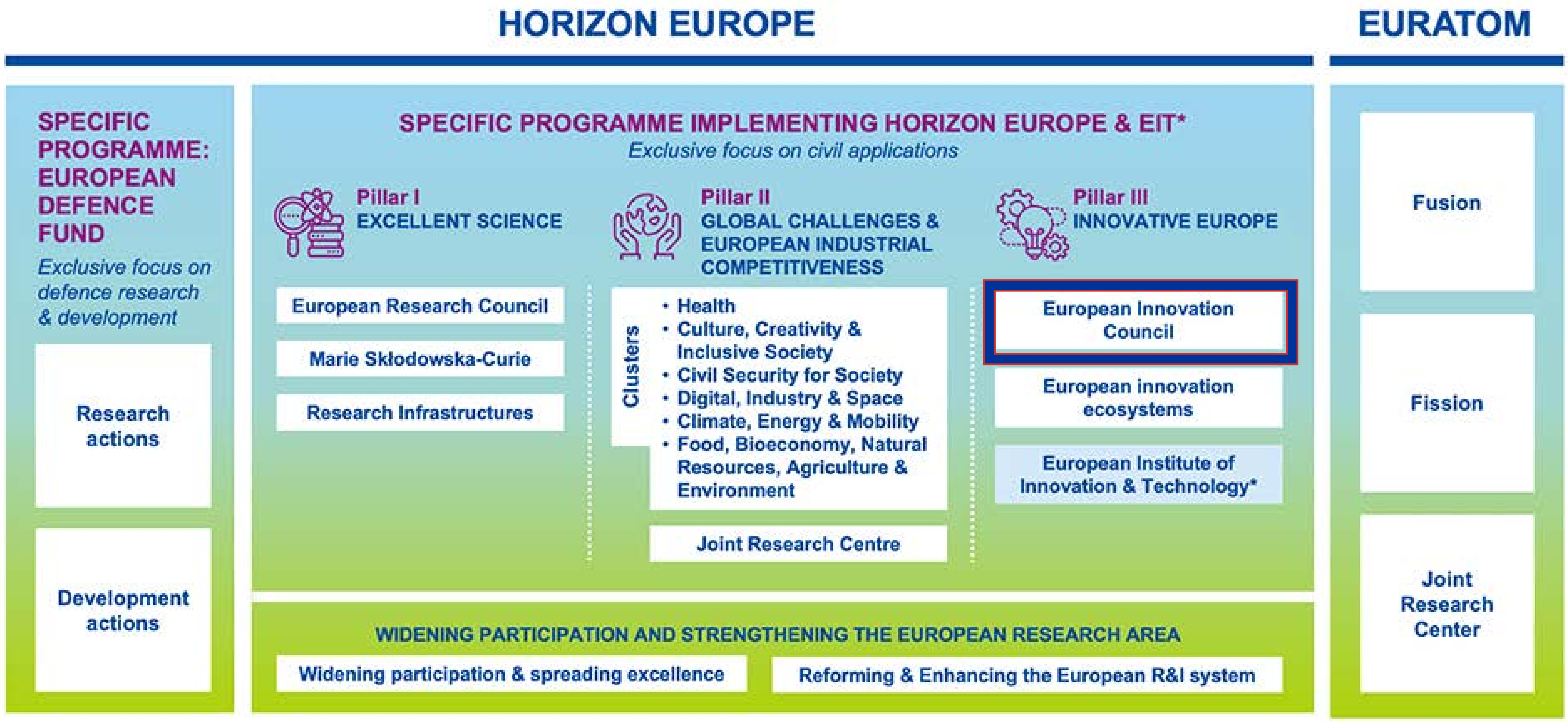
EIC is trendy!

The future of European competitiveness: Report by Mario Draghi

Horizon Europe Structure



* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

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EIC deals with Deep Tech

Definition of Deep Tech

Deep tech is technology that is based on cutting-edge scientific advances and discoveries and is characterized by the need to stay at the technological forefront by constant interaction with new ideas and results from the lab.

EIC definition (Glossary page 16) https://eic.ec.europa.eu/document/download/5e1eb75f-e437-477f-9ee9-ef54ff6387fd_en?filename=EIC%20Work%20Programme%202025.pdf

EIC meanly deals with Deeptech

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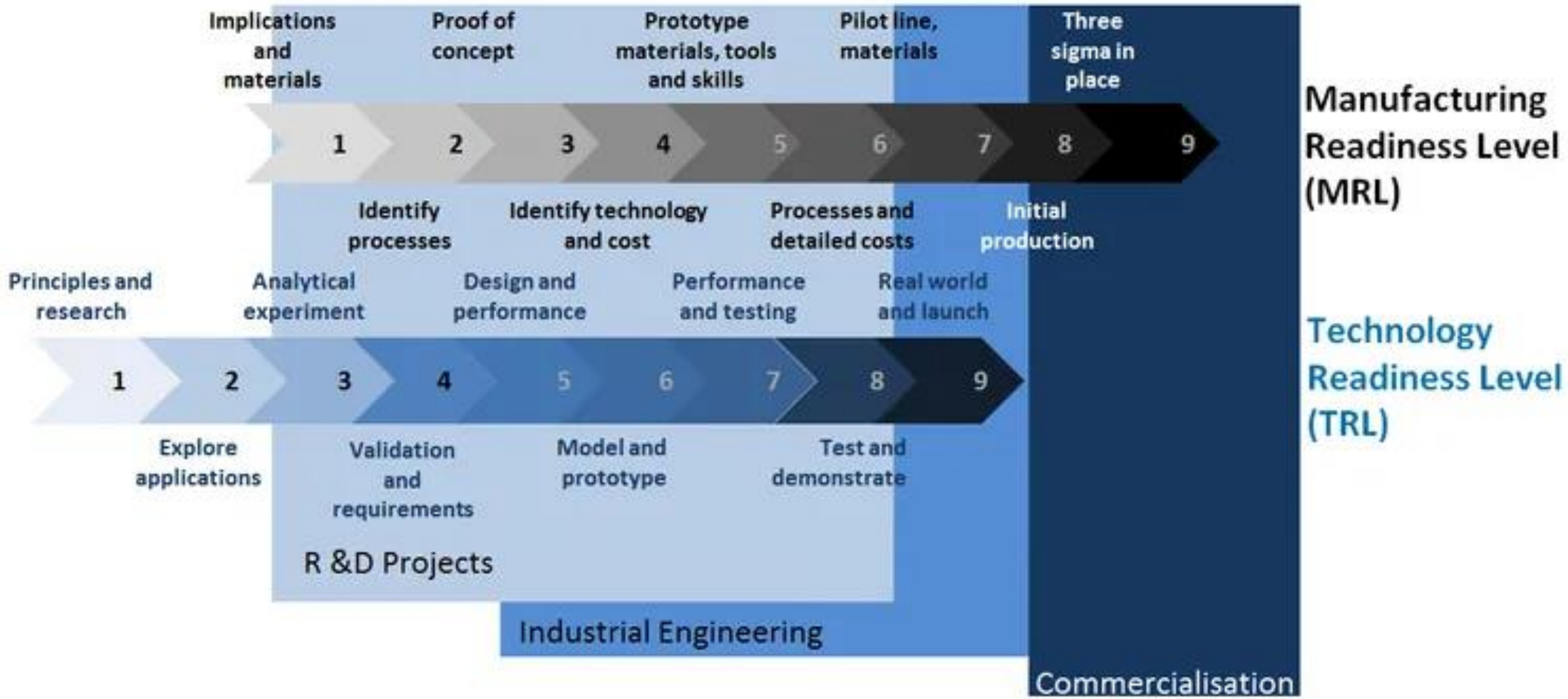
A deep tech innovator, i.e., is an innovator providing technology solutions based on substantial scientific or engineering challenges. Deep tech is characterized by a **much longer time horizon** from the earliest stages of technological development from prototyping in a research lab (private or public) to demonstration in a real-life environment and then scaling to impact.

- **Problem and Hardware oriented**
- **Multidisciplinary**
- **High risk, high fund needed (Disruptive research)**
- **Open innovation approach (ecosystem of innovation)**

investments include private investments, minority stakes, initial public offerings and M&A

EIC definition (Glossary page 16) https://eic.ec.europa.eu/document/download/5e1eb75f-e437-477f-9ee9-ef54ff6387fd_en?filename=EIC%20Work%20Programme%202025.pdf

How to classify the technology readiness of the projects? Technological readiness level and Manufacturing readiness level



EIC main instruments and characteristics

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Pathfinder

- **Early stage research** on breakthrough technologies
- Grants up to €3/4 million
- Successor of FET (Open & Proactive)
- **TRL 1-3/4**

Transition

- **Technology maturation** from proof of concept to validation
- **Business & market readiness**
- Grants up to €2.5 million
- **TRL 4-5/6**

Accelerator

- **Development & scale up** of deep-tech/ disruptive innovations by startups/ SMEs
- Blended finance (grants up to €2.5 million; equity investment up to €10 million)
- Successor of SME instrument
- **TRL 6-9**

- Focus on **breakthrough, market-creating, deep-tech innovations**
- Steered by **EIC Board** of leading innovators (entrepreneurs, investors, researchers, ecosystem)
- **Business Acceleration Services** (coaches/ mentors, corporates, investors, ecosystem)
- **Pro-active management by EIC Programme Managers**
- **Follow up funding for results from Horizon** (ERC, EIT, collaborative) & national programmes

Hands on approach to drive the trip from research to innovation

EIC BAS (Business Acceleration Service)

- Access to advice/skills
- Access to business partners
- Access to innovation ecosystem & peers

Explore — EIC Pathfinder

Exploit — EIC Transition activities

Scale up — EIC Accelerator & equity

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Orsolya Symmons
Health and Biotechnology

Hedi Karray
Artificial Intelligence

Paolo Bondavalli
Advanced materials for energy

Stella Tkatchova
Space systems & technologies

Samira Nik
Quantum tech & electronics

Franc Mouwen
Architecture engineering construction technologies

Federica Zanca
Medical imaging and AI in healthcare

Ivan Stefanic
Food chain technologies, novel & sustainable food

Isabel Obieta
Sustainable Semiconductors

Carina Faber
Renewable energy conversion & alternative resource exploitation

EIC PROGRAMME MANAGERS Oversee projects

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EIC Programme Manager Priorities

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Identify candidate challenges and select portfolios of projects

Science and innovation intelligence activity

Outreach and community building

Guiding panel members to select portfolio of projects for Pathfinder, and active observers for Transition and Accelerator

Pro-active management of selected portfolios and projects

Technology

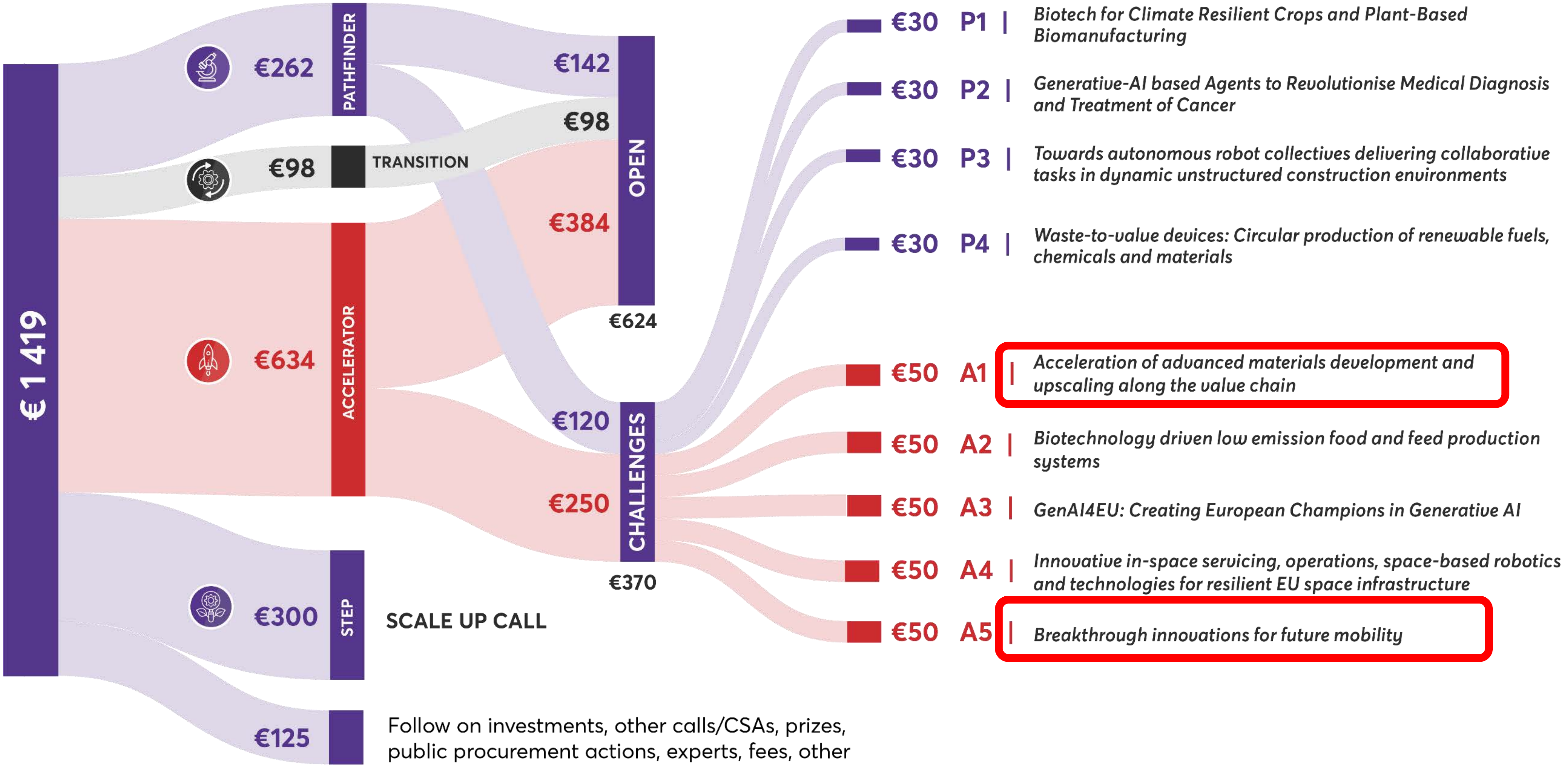
Regulation

Transition to innovation

Communication and dissemination

EIC Programme Management (per sector)

Creating together a nucleus of expertise and capabilities; the core of the innovation ecosystems of the future


€ 1 419
€262
PATHFINDER
€98
TRANSITION
€634
ACCELERATOR
€300
STEP
SCALE UP CALL
€125
Follow on investments, other calls/CSAs, prizes, public procurement actions, experts, fees, other
€142
€98
€384
OPEN
€624
€120
€250
CHALLENGES
€370
€30 P1 | Biotech for Climate Resilient Crops and Plant-Based Biomanufacturing
€30 P2 | Generative-AI based Agents to Revolutionise Medical Diagnosis and Treatment of Cancer
€30 P3 | Towards autonomous robot collectives delivering collaborative tasks in dynamic unstructured construction environments
€30 P4 | Waste-to-value devices: Circular production of renewable fuels, chemicals and materials
€50 A1 | Acceleration of advanced materials development and upscaling along the value chain
€50 A2 | Biotechnology driven low emission food and feed production systems
€50 A3 | GenAI4EU: Creating European Champions in Generative AI
€50 A4 | Innovative in-space servicing, operations, space-based robotics and technologies for resilient EU space infrastructure
€50 A5 | Breakthrough innovations for future mobility

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Advanced materials: definition

Advanced Materials are defined as materials that are engineered with a view to enhancing functional performances above and beyond that of existing materials.

They are **key enablers for the development of game-changing products and innovative solutions** in many industrial sectors, such as **energy, mobility, electronics, and construction.**

70% of all technical innovations are directly or indirectly attributed to advanced materials

Advanced materials: definition

- Advanced materials include both:

➢ **new emerging materials from innovative manufacturing processes (high tech materials)**

➢ **materials that are manufactured from traditional materials (low tech materials)**

https://one.oecd.org/document/ENV/CBC/MONO(2022)29/en/pdf

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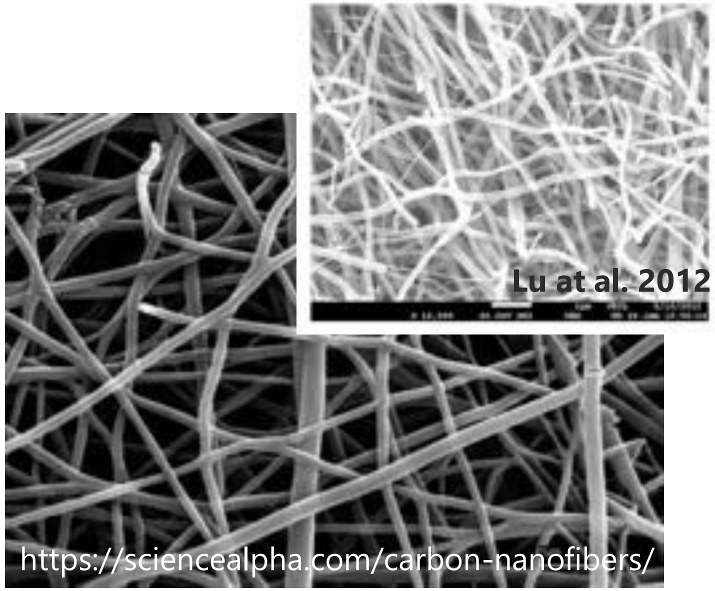
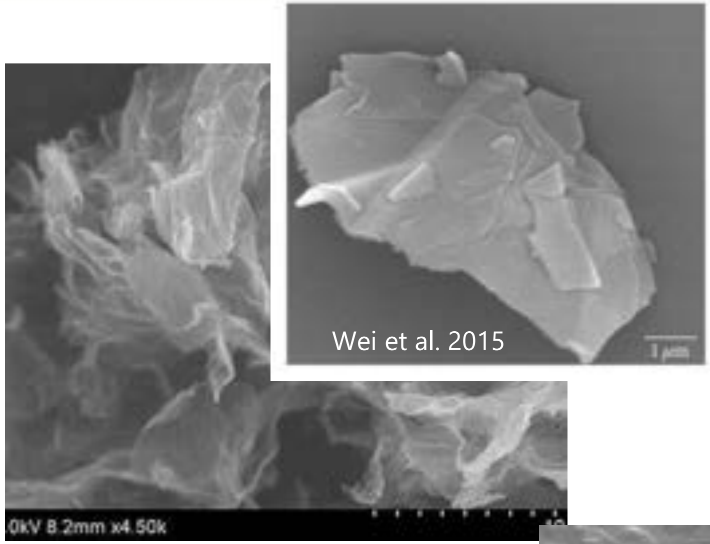
Some example of advanced materials (high tech)

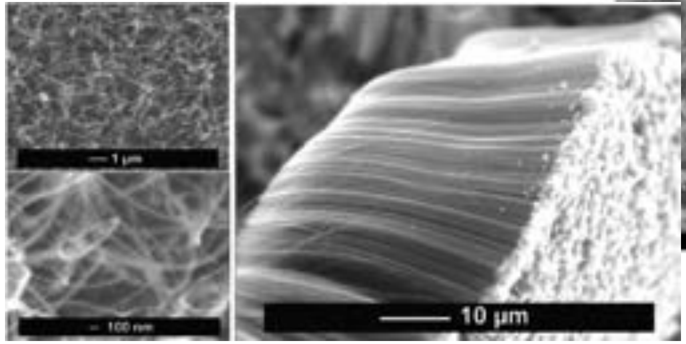

Lu at al. 2012

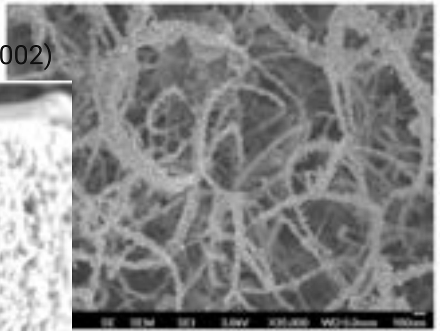
https://sciencealpha.com/carbon-nanofibers/

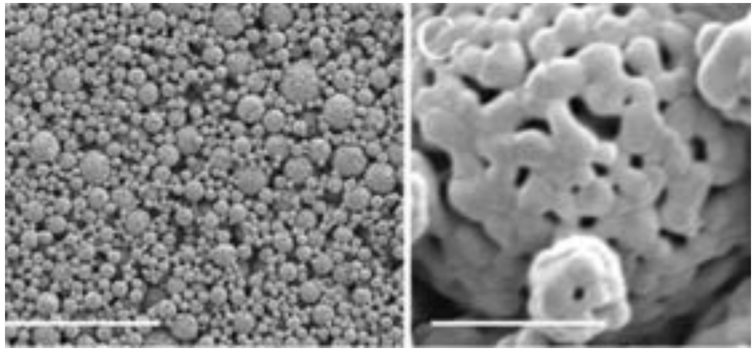

Wei et al. 2015

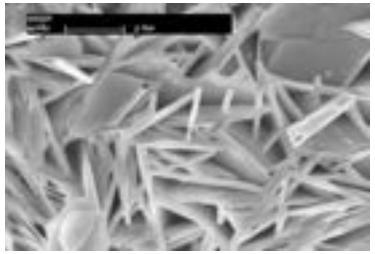
https://yaavikmaterials.com/product/ya
ik-monolayer-layer-graphene/

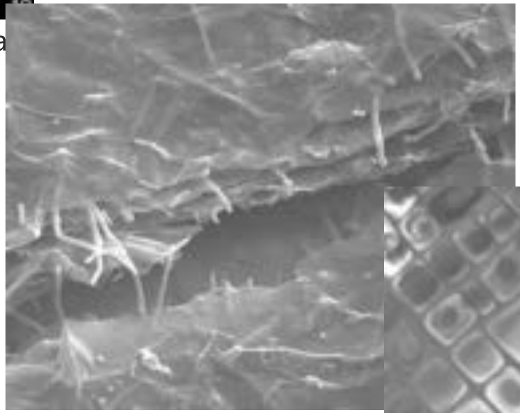
F. Rohmund et al. J. Vac. Sci. Technol. B 20 , 802 (2002)

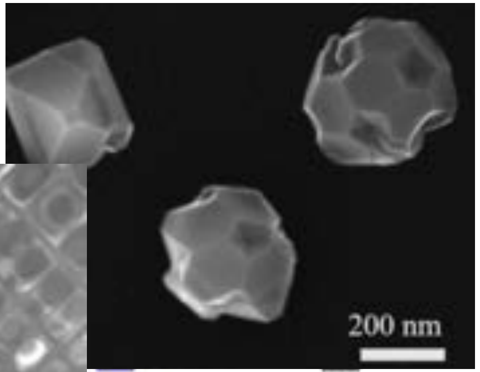



Gomez et al. Adv.Mat.Eng. 201

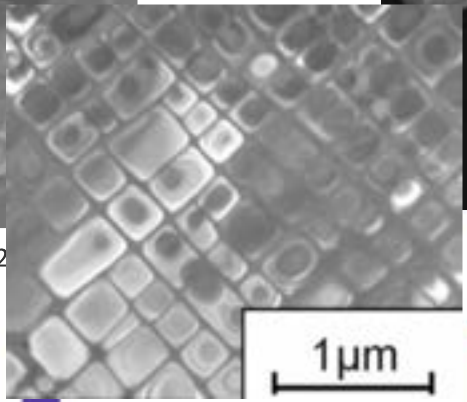

Gariboldi at al. 2019


Gazda et al., 2004


Bondavalli *et al* 2019 *J. Phys. Mater.* **2** 032002



Grudinkin et al. 2021



Neumeir at al. 2008

Advanced materials are in our everyday life in all sectors

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The four foundamental pillars that generate the basis for the development of advanced materials

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- **Safeguarding Europe's technology leadership**
- **Reducing the environmental footprint by using advanced materials**
- **Securing strategic autonomy**
- **Targeting advanced materials innovation markets**

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The Green Deal

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The European Commission has adopted a set of proposals to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

It set in stone Europe's goals to become climate-neutral by 2050.

The paradox of the Green Deal and the enhancement of the Renewable Energy Sources (RES)

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The Green Deal is pushing to the development of cleantech that will reduce dramatically the CO_2 emissions.

However, the EU's demand for base metals, battery materials, rare earths and more is set to increase exponentially as <u>the EU divests from fossil fuels</u> and turns to clean energy systems <u>which necessitate more minerals.</u>

<u>The Critical Raw Materials are at the base of the implementation of the Green Deal Objectives.</u>

Definitions

- **Critical Raw Material**

  Critical Raw Materials (CRMs) are raw materials that are **economically and strategically important** for the European economy but have a high-risk associated with their supply.

- **Strategic Raw Materials**

  Strategic raw materials are raw materials that are important to an **individual's or organization's strategic plan** and supply chain management.

EU Critical Raw Materials Act

Critical Raw Materials Marked with Color

★ Strategic Raw Material

Transition metals
Metals
Halogens
Alkali metals
Metalloid
Lanthanide
Alkaline earth metals
Nonmetal
Actinide
Noble gas

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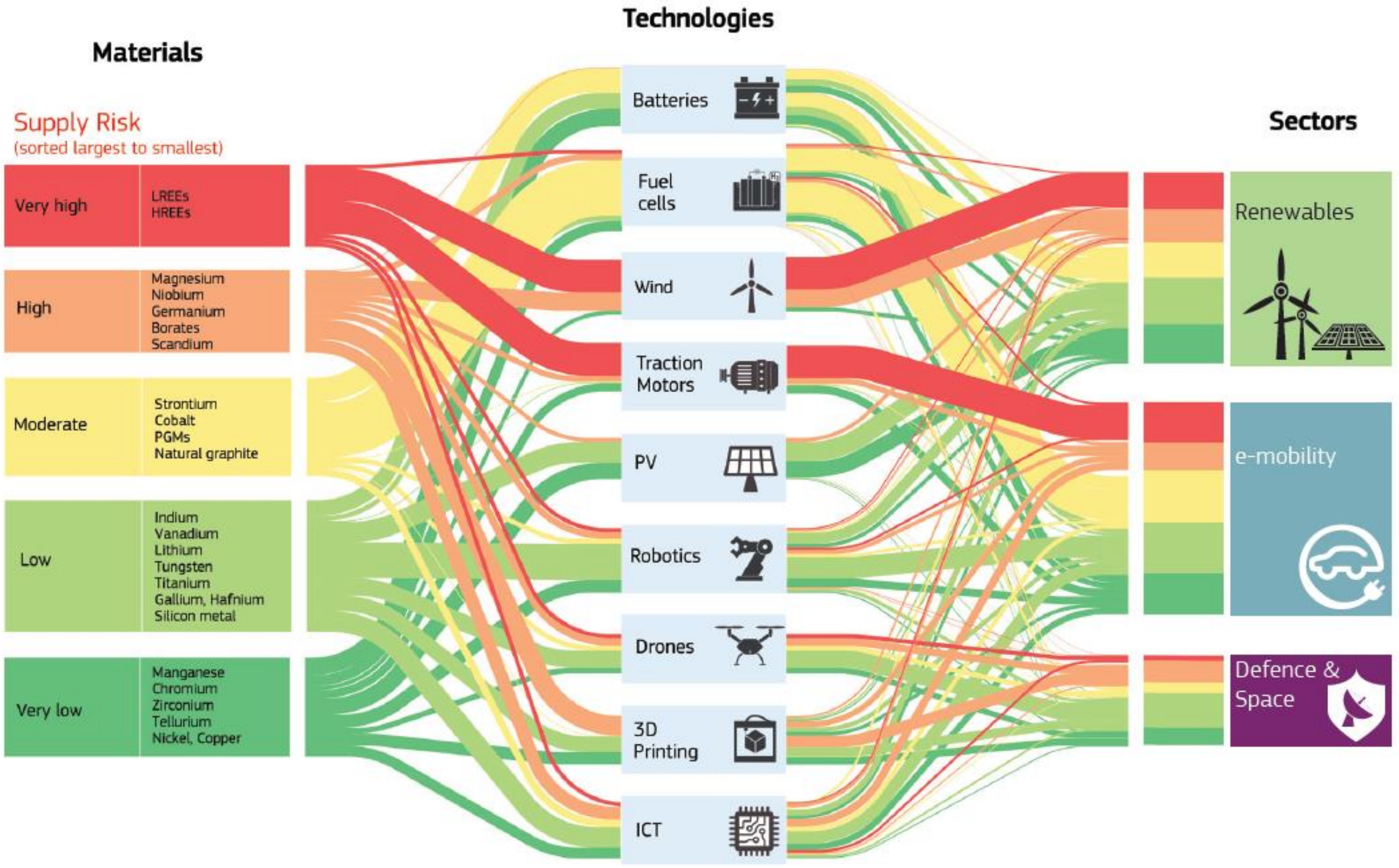
Technologies
Materials
Supply Risk
(sorted largest to smallest)
Very high
LREEs
HREEs
High
Magnesium
Niobium
Germanium
Borates
Scandium
Moderate
Strontium
Cobalt
PGMs
Natural graphite
Low
Indium
Vanadium
Lithium
Tungsten
Titanium
Gallium, Hafnium
Silicon metal
Very low
Manganese
Chromium
Zirconium
Tellurium
Nickel, Copper
Batteries
Fuel cells
Wind
Traction Motors
PV
Robotics
Drones
3D Printing
ICT
Sectors
Renewables
e-mobility
Defence & Space

Critical Raw Materials in Wind turbins: how are they used in Wind Turbins?

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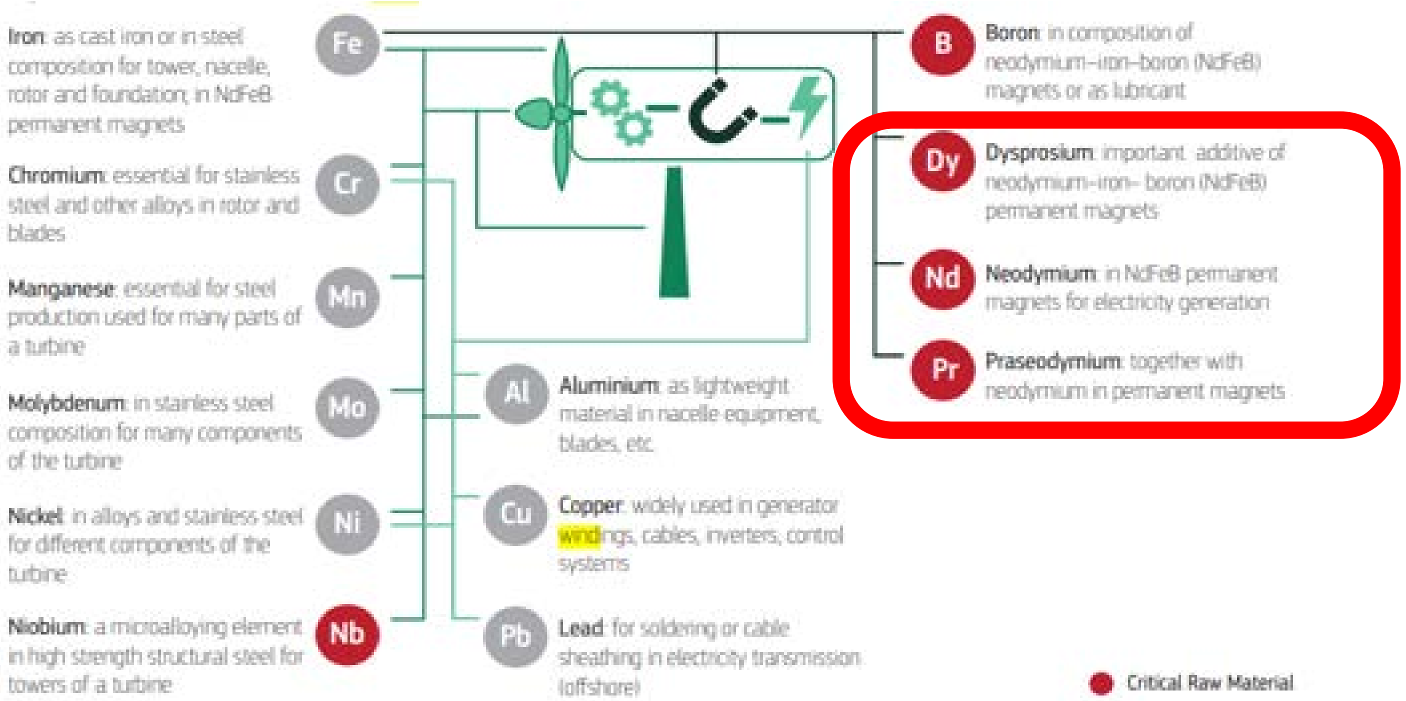
Permanent magnets

https://manuallibraryrecourse.z21.web.core.windows.net/materials-for-wind-turbi

There is a strong needs of rare earth elements that are used for magnets fabrications.



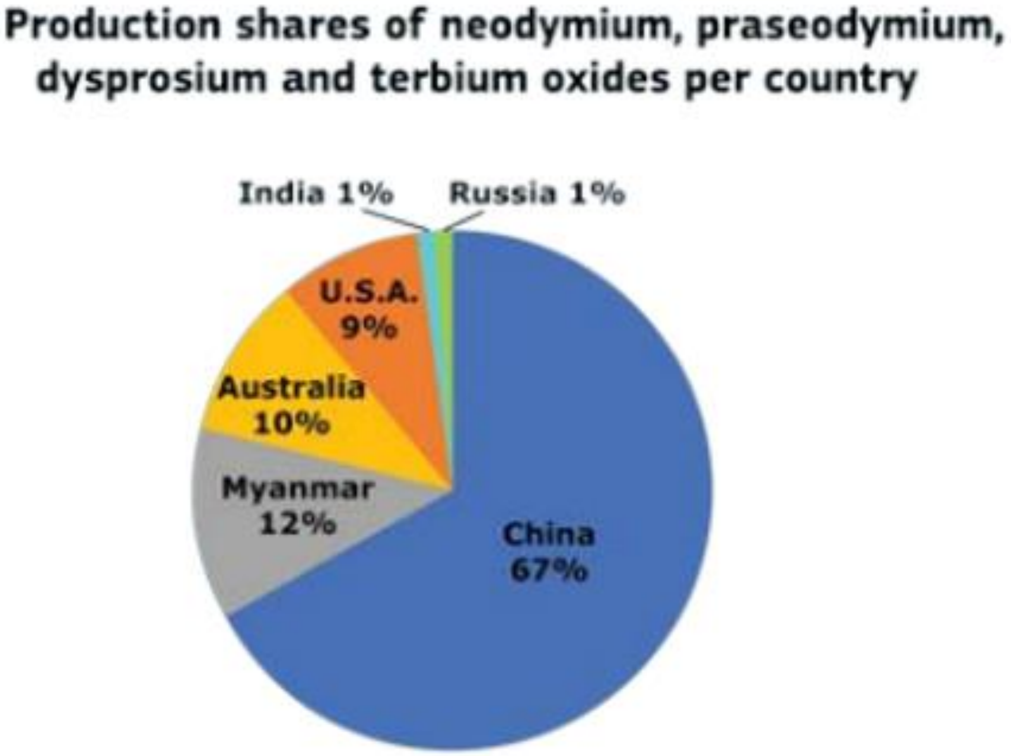
European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Bobba, S., Carrara, S., Huisman, J., Mathieux, F., et al., Critical raw materials for strategic technologies and sectors in the EU : a foresight study, Publications Office, 2020, https://data.europa.eu/doi/10.2873/58081

Critical Raw Materials in Wind turbins: how are they used in Wind Turbins?

Permanent magnets

https://manuallibraryrecourse.z21.web.core.windows.net/materials-for-wind-turbines.html

China control the production of rare earth used and has 90% control on the fabrication of magnets.



Sources: (A), USGS (2020); (B) and (C), JRC (see Annex 1 for further information).

Critical Raw Materials in Wind turbins: we have a marginal rôle…

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- Within the supply chain for wind generators, the highest risks exist at the raw materials stage. **The EU only provides 1% of the raw materials for wind energy.** Major concerns exist about the supply of rare earths for the production of permanent magnets — key components for the wind turbine generator — for which China plays a quasi-monopolistic role. **However, EU plays a major role only in the assembly stage, where its share is above 50%.**

- **Rare earths and borates** contained in permanent magnets are crucial raw materials. The supply risks related to extraction and processing of rare earths are the main concern: **China increasingly dominates the supply of these raw materials.**

Solar Cells and Critical Raw Materials: how are they used in solar cells?

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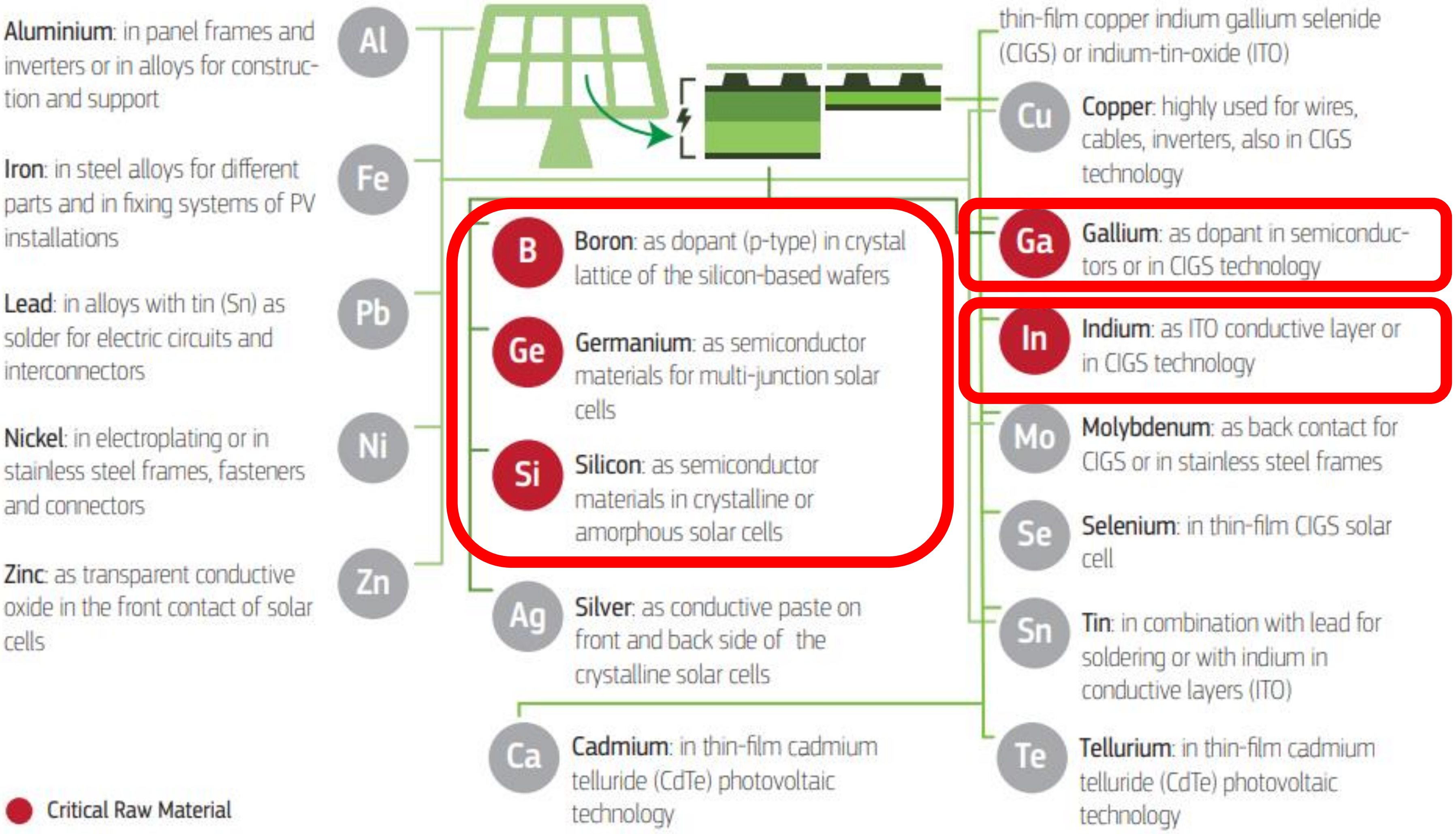
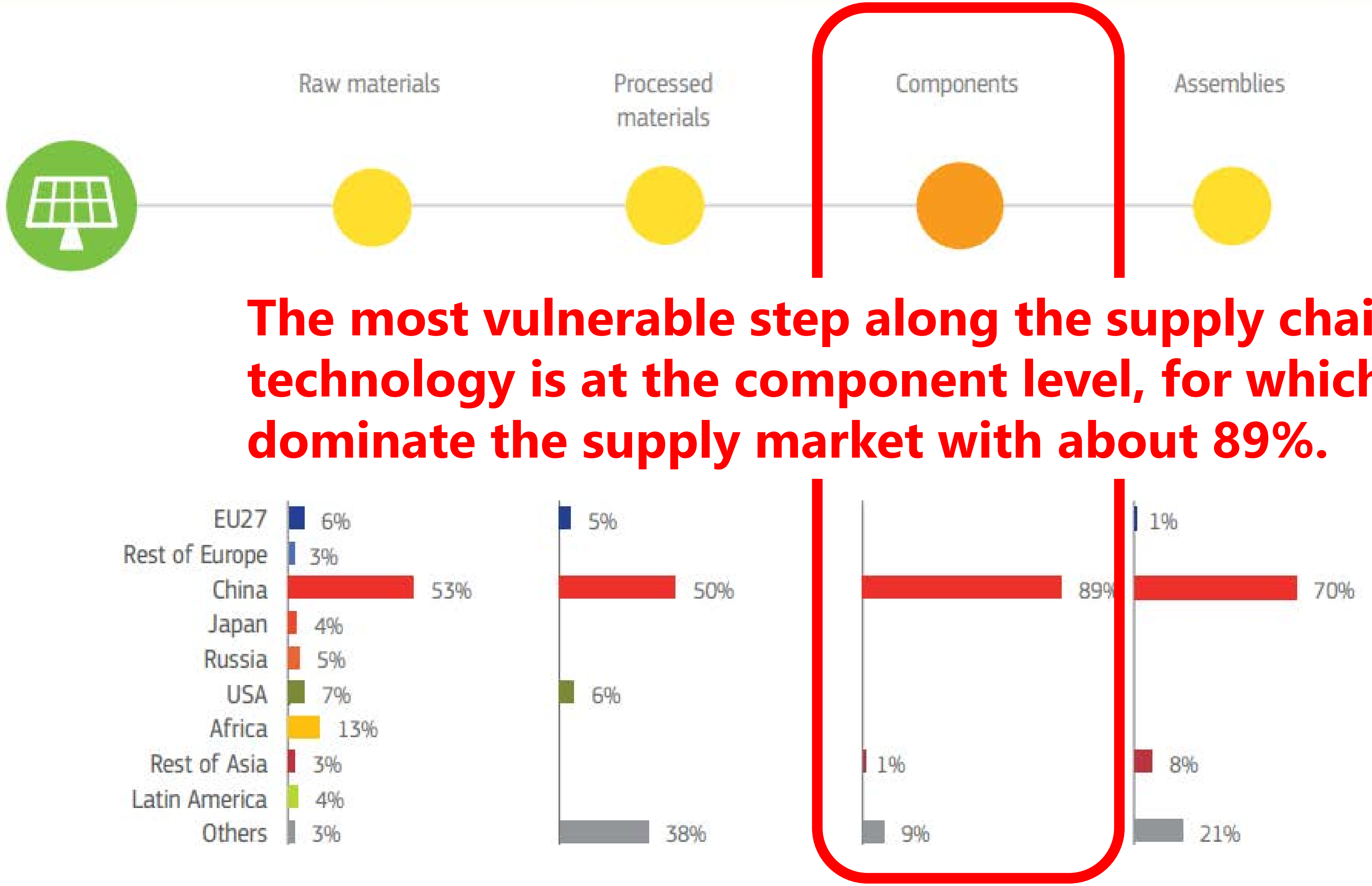




The most vulnerable step along the supply chain of PV technology is at the component level, for which China dominate the supply market with about 89%.

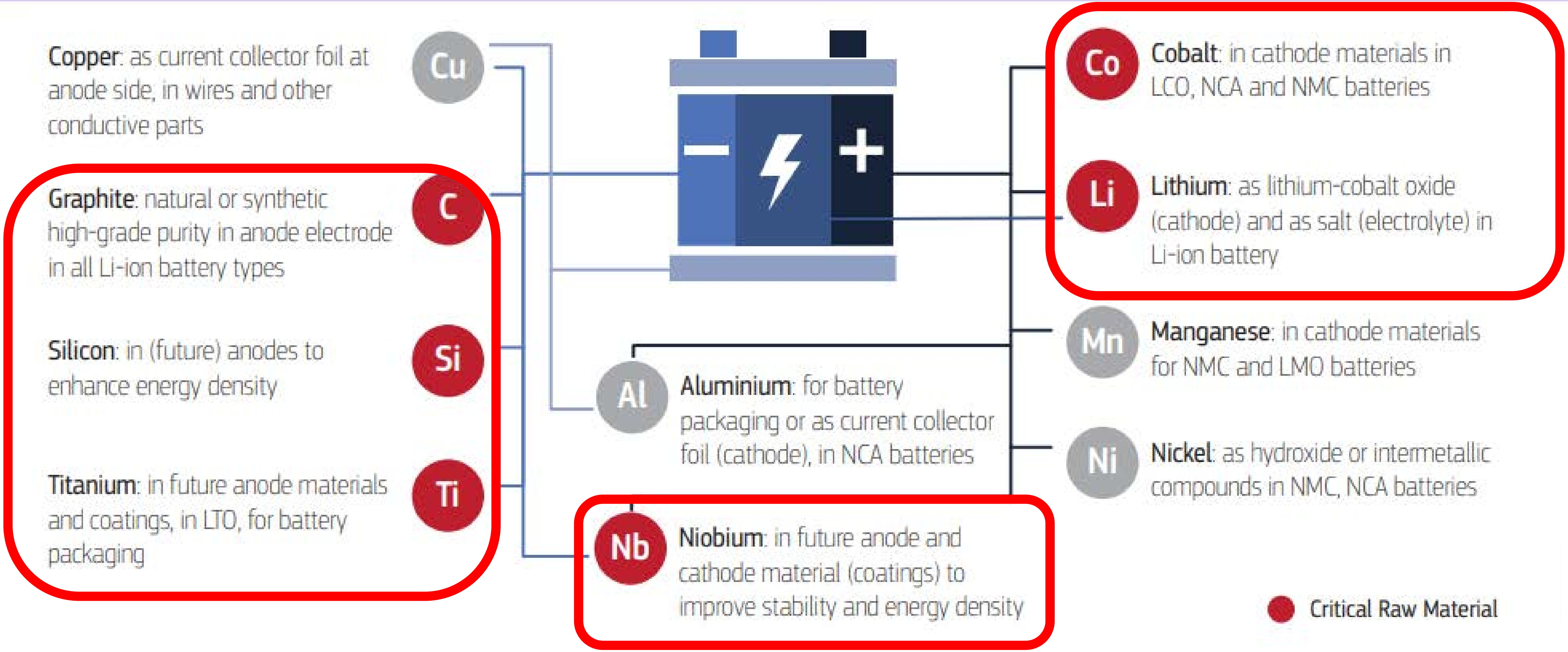
Short history on how we have lost the leadership in Solar Cells Production

- **China dominates nearly all aspects of solar PV manufacturing and use**. This dominance started ironically in the late 1990s as response to the increasing demand for solar panel generated by at nearly all aspects of solar PV manufacturing and use. **This dominance started in the late 1990s as response to the increasing demand for solar panel generated by Germany incentive programme to promote rooftop solar cells.**

- China's solar manufacturing capacity grew further in the years following the 2008 economic crisis when the Chinese g the 2008 economic crisis when **the Chinese introduced in 2011 the feed-in tariffs for solar cells ("dumping"). The China technique has been to reduce the price internally and to reduce exportation of rare earths.** At the same time, they reduce internally the price of rare earth and they push some Chinese companies with subsidies. The push foreign companies to move to China to reduce the production prices. As a consequence, the low price in China became a standard killing all the companies developed outside China.

- In 2019, the list of **top 10 companies in terms of crystalline silicon cells include eight from China, one from South Korea (Hanwha Q Cells) and one from Canada (Canadian Solar).**
- According to Bloomberg, the EU manufacturing capacity for crystalline silicon cells in accounted **for only 0.3% in 2019**, particularly in Italy, Germany and France (BloombergNEF, 2020)

Batteries Critical Raw Materials: how are they used in batteries?



European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Bobba, S., Carrara, S., Huisman, J., Mathieux, F., et al., Critical raw materials for strategic technologies and sectors in the EU : a foresight study, Publications Office, 2020, https://data.europa.eu/doi/10.2873/58081

Batteries Critical Raw Materials: a strategic issue

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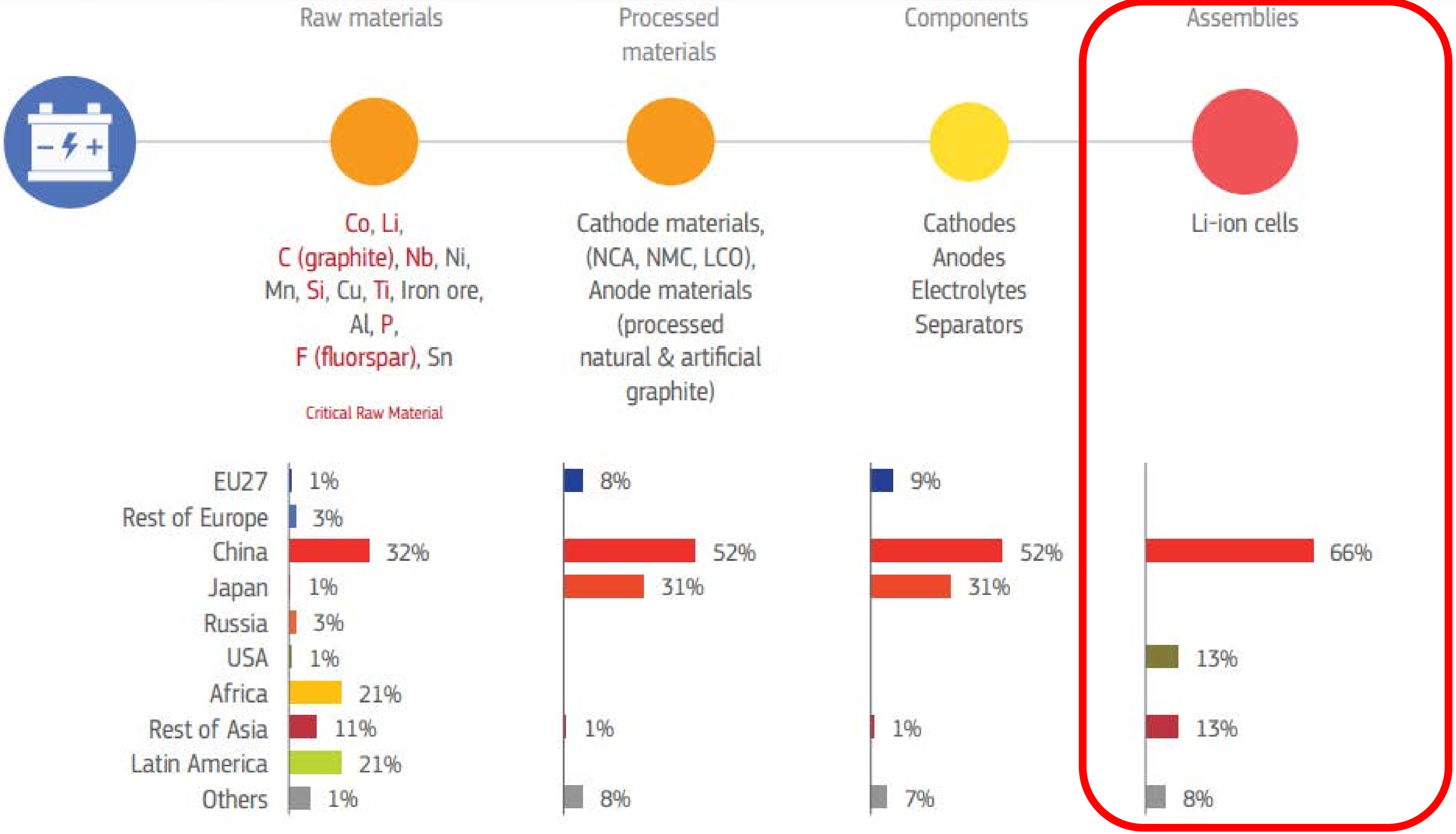

Batteries Critical Raw Materials: where are they produced?

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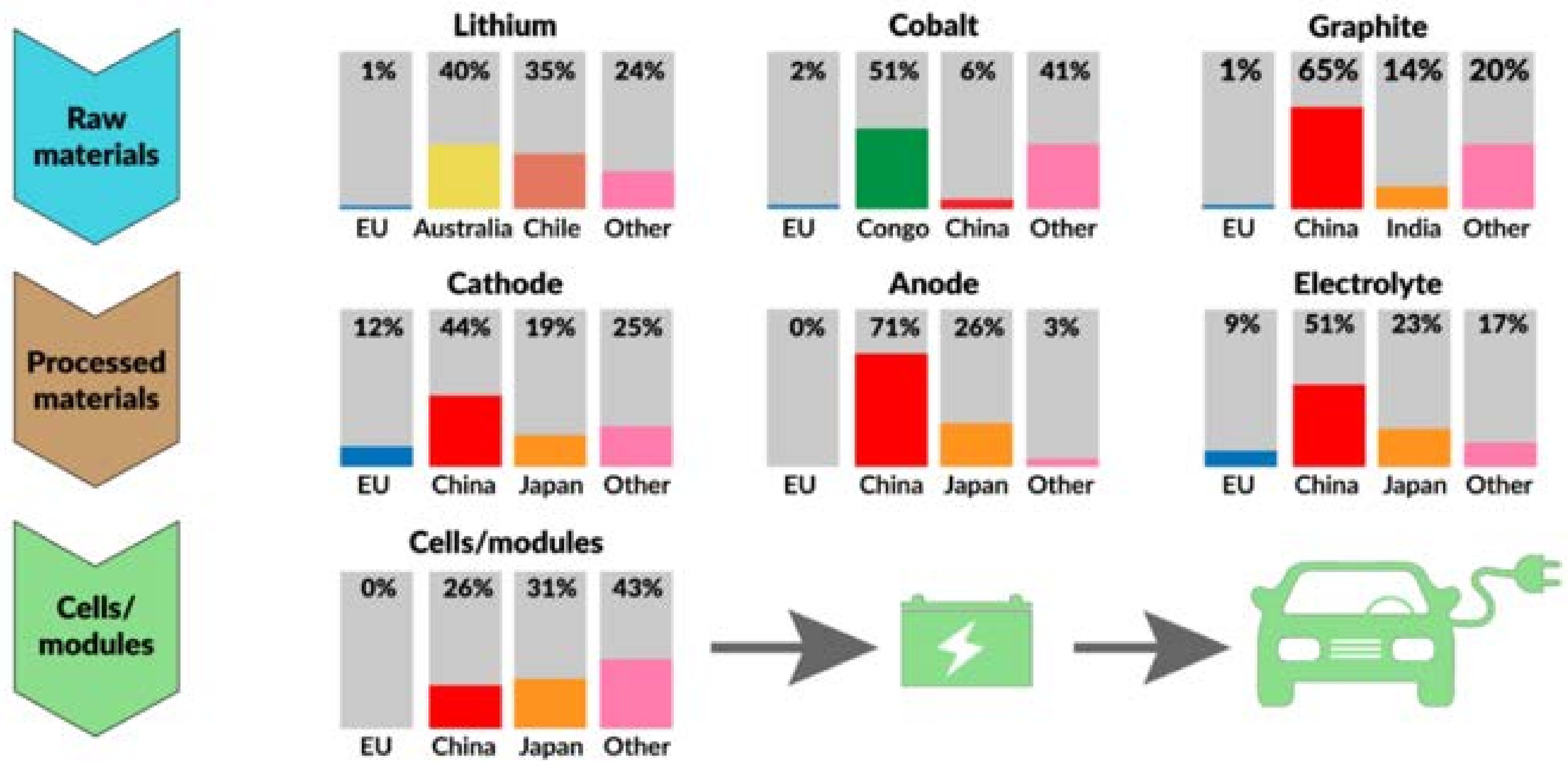
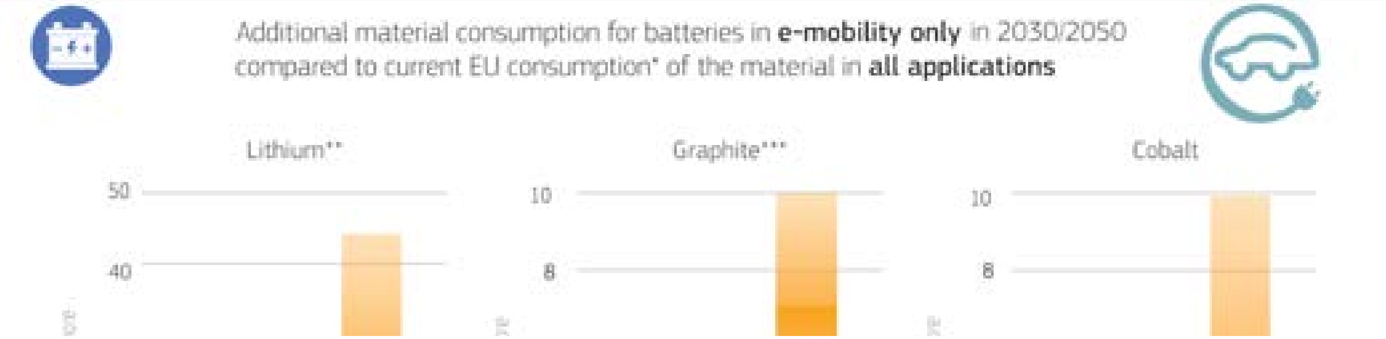
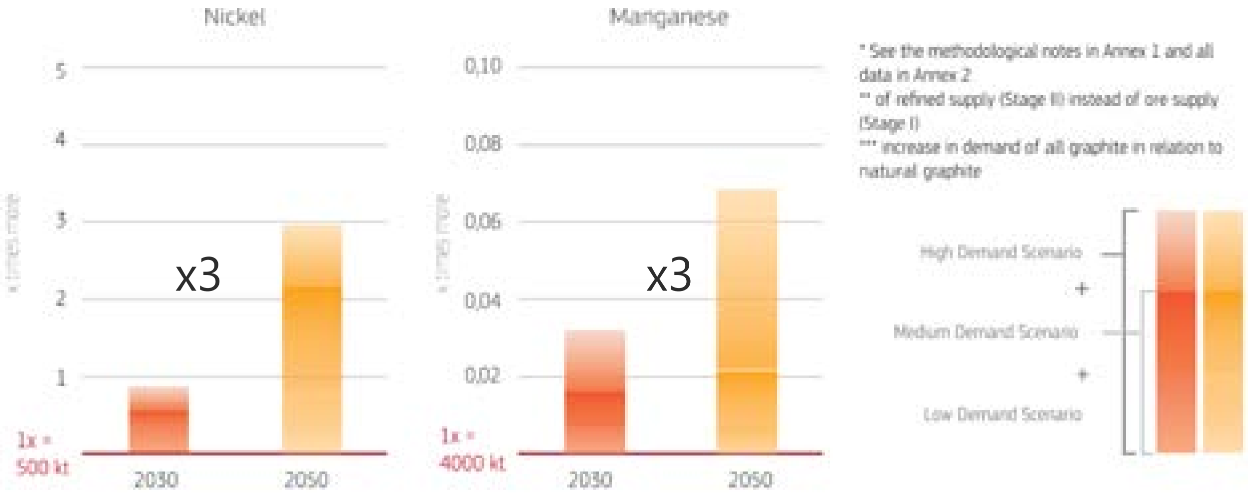


The EU is particularly dependent on other countries when it comes to the supply chain of electric vehicle batteries. © macpixxel for GIS

Batteries Critical Raw Materials: what is the impact on e-mobility in the next years?



Considering the monopoly of China in the field of Rare Earths, they were able to develop a market for cars with a lower price, it is the same tactics used for Solar Cells



Batteries Critical Raw Materials: which are the main bottlenecks?

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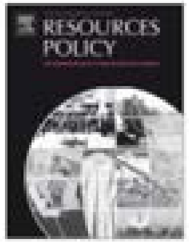
- Bottlenecks for the EU are in the raw materials stages and the Li-ion cells production: **China, together with Africa and Latin America, provides 74% of all battery raw materials**.
- By itself **China supplies 66% of finished Li–batteries**.
- Currently, the EU provides **less than 1% of Li-batteries**.

Some conclusion about energy transition, cleantech and the link with CRMs and SRMs

Resources Policy
Volume 46, Part 2, December 2015, Pages 272-280



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The development of the market for rare earth elements: Insights from economic theory

Dominik Schlinkert [a], Karl Gerald van den Boogaart [a b]

Show more

The law of van den Boogaart

Phase	Model	Real market
1: Penetration of the market	One producer is able to fulfill the market demand at a lower price and gains market share.	Between the late 1980s to the 1990s China's market share increased due to a low price strategy.
2: Exploiting market power	Only one significant producer is left in the market who can use this power to maximize the profit (i.e. control supply).	With the shutdown of the Mountain Pass mine in 2002, the Chinese production is the only significant supplier. In the following, actions, such as the export quota, are imposed that control supply.
3: Losing market power	Due to increasing marginal costs with increasing production, prices rise to a level that attracts competitors.	The price peak in 2011 and a predicted further growing demand results in the launch of several REE projects around the globe. The market is currently in this phase.
4: Transformation of the market	The growing demand in the market lead to the entering of enough competitors to transform the market from a	This scenario is yet to come but is the comprehensive final stage of the previous three phases.

Not arrived at this phase

China is simply realizing a precise strategy

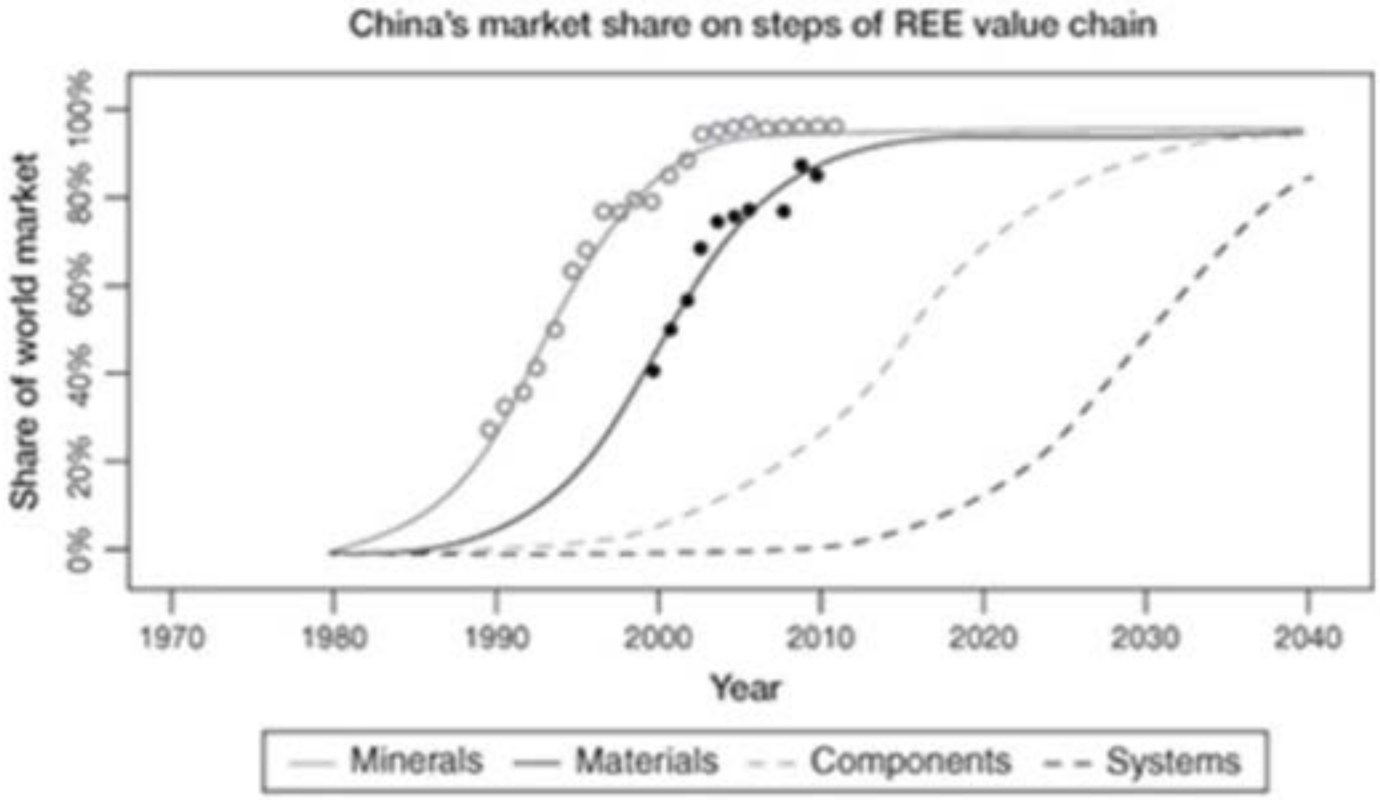


Figure 2. China's market share of global production of various rare earth elements (REE) of increasing value.

Source: Karl Gerald van den Boogaart, Polina Klossek, and Andreas Klossek, "How Forward Integration along the Rare Earth Value Chain Threatens the Global Economy,"

Rare Earth mines

Materials

Components

Systems

Critical Raw Materials: European policy

European Innovation Council

- For cleantech technologies, **increasing EU raw materials production** and processing and assembly capacities will require investments to reduce the dependency on the Asian market. Establishing privilegied relationship (agreement with Congo, Australia has been just signed).

- **To move in the direction of developing new technologies based on other materials (e.g. sodium based for batteries)** even if they require initial strong investments.

- To improve **the capacity in recycling CRM materials** and to develop a virtuous **circular-by-design approach** (recyclability taken into account form the very beginning).

- To develop **ad hoc regulations to push the market and to protect Europe** from aggressive competitors such as US and China.

To summarize

- To be **creative**
- To be **patient**
- To **strongly invest** on specific new technologies
- To protect from competitors with **strong policies on regulations**

The question is: is it too late?

Let's talk about fundamantal research

Do Scientists deal with CRMs from the very beginning of their research?

Is it a real concern for researcher?

Scientists often forget CRMs' related issues
an example: Supercapacitors and Ruthenium

European Innovation Council

Communication

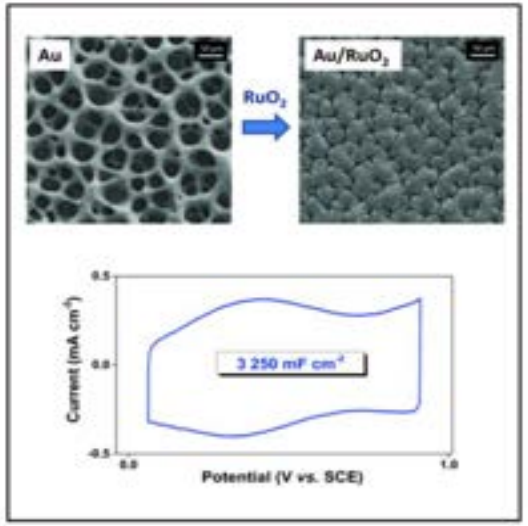
3D RuO_2 Microsupercapacitors with Remarkable Areal Energy

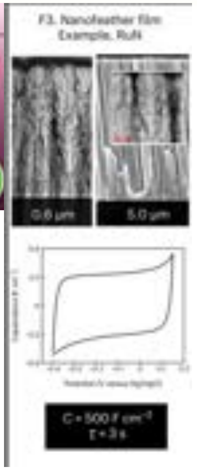
Anaïs Ferris, Sébastien Garbarino, Daniel Guay, David Pech

First published: 30 September 2015 | https://doi.org/10.1002/adma.201503054 | Citations: 213

Graphical Abstract

Large areal capacitance electrodes made of ruthenium oxide on highly porous gold current collectors are realized by an attractive approach. The hybrid structure exhibits a capacitance in excess of 3 F cm^{-2} and an areal energy density for all-solid-state microsupercapacitors that is comparable to those of microbatteries.





Article | Published: 27 February 2024

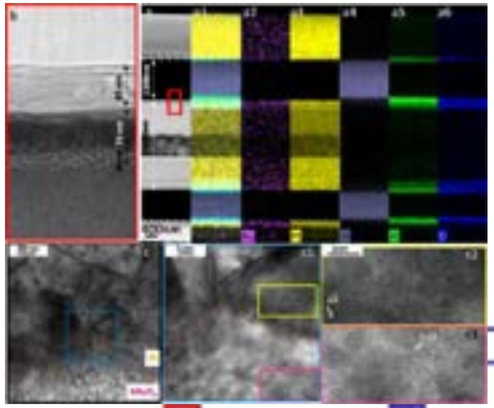
Nanofeather ruthenium nitride electrodes for electrochemical capacitors

Dinh Khac, H., Whang, G., Iadecola, A. et al. Nanofeather ruthenium nitride electrodes for electrochemical capacitors. Nat. Mater. 23, 670–679 (2024). https://doi.org/10.1038/s41563-024-01816-

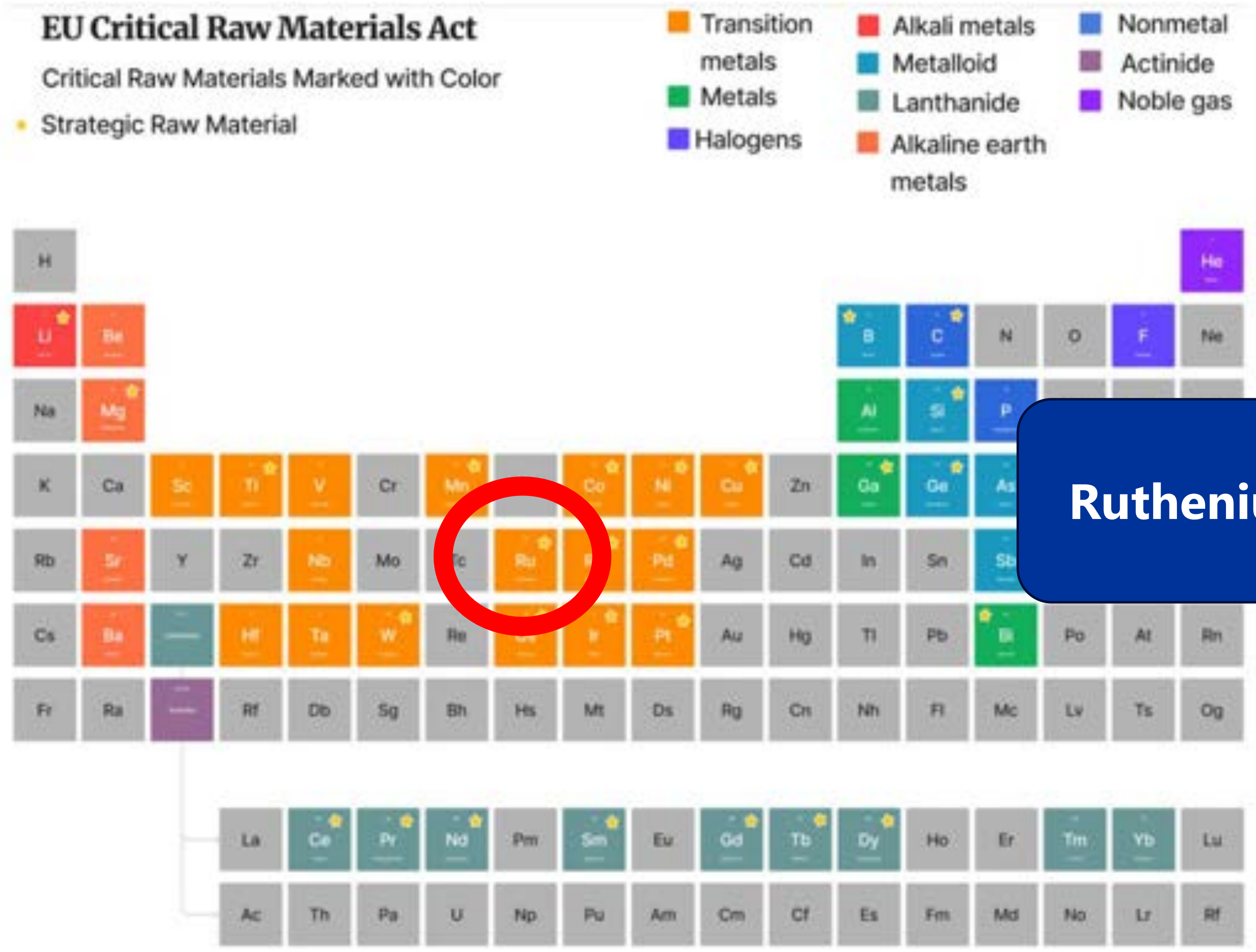
ELSEVIER
Energy Storage Materials
Volume 42, November 2021, Pages 259-267

Ultra-high areal capacitance and high rate capability RuO_2 thin film electrodes for 3D micro-supercapacitors

Bouchra Asbani [a b], Gaetan Buvat [a b], Jeremy Freixas [a b c], Marielle Huvé [d], David Troadec [a], Pascal Roussel [d], Thierry Brousse [b c], Christophe Lethien [a b e]



Scientists often forget CRMs' related issues an example: Supercapacitors and Ruthenium

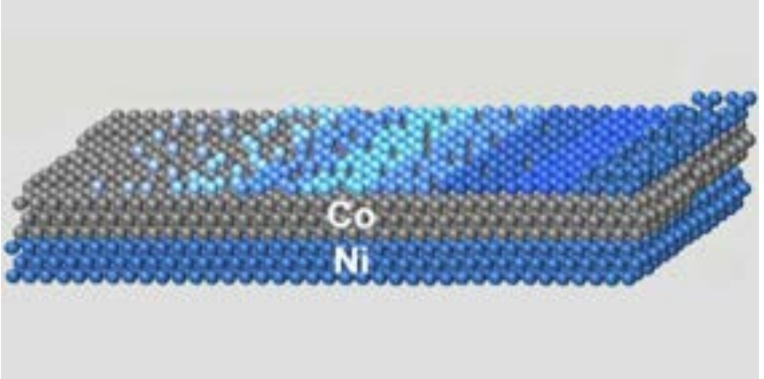


Source: *mobilitynotes.com*

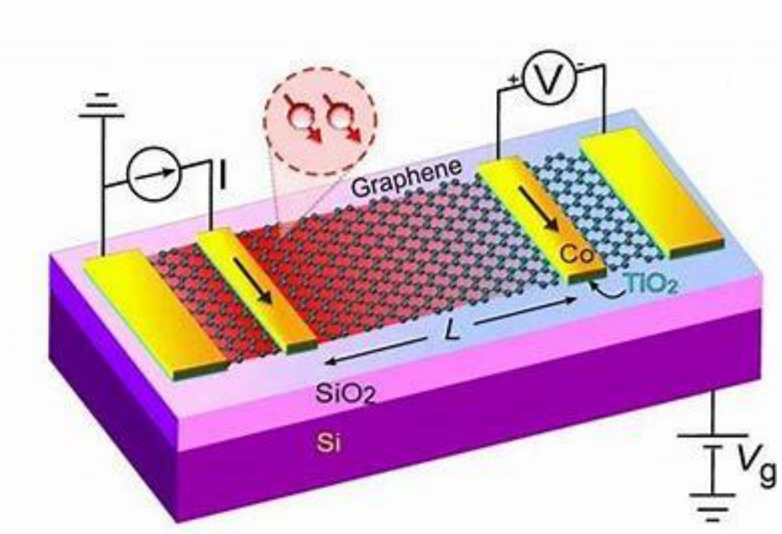
Ruthenium is a CRMs and a strategic material

Scientists often forget CRMs' related issues an example: Spintronics

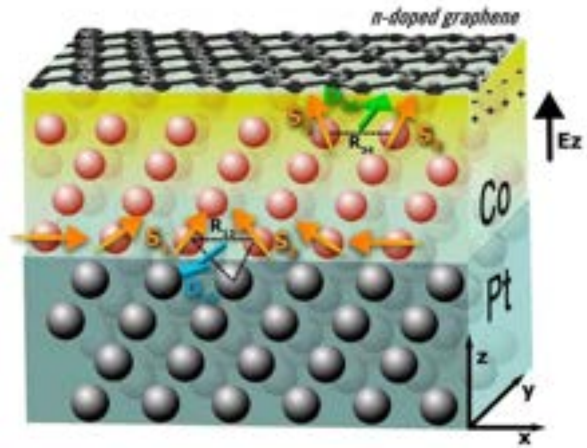
SPINTRONICS is the main candidate for Beyond CMOS technology



S. Andrieu et al, Phys. Rev. Materials (2018)



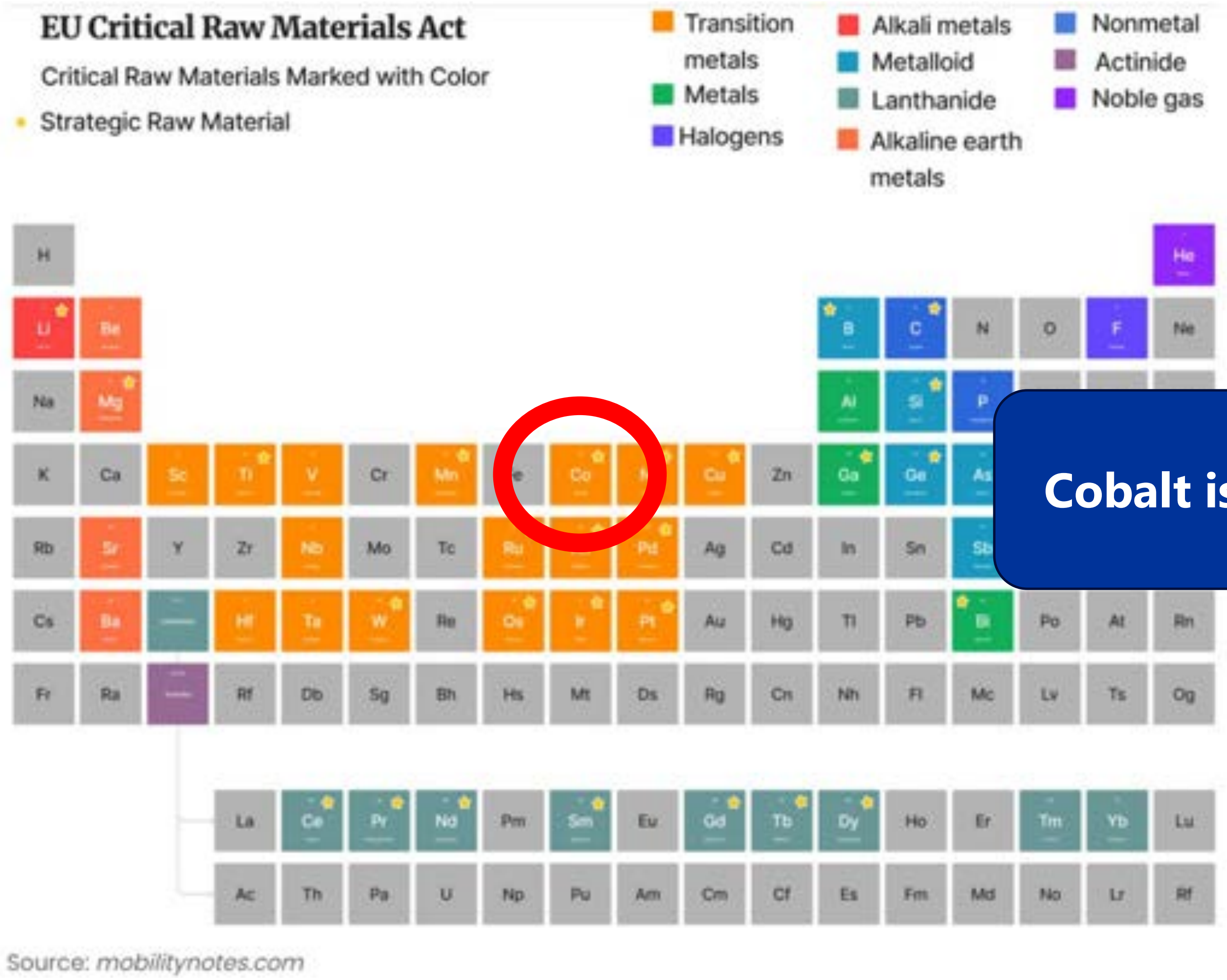
https://phys.org/news/2015-04-graphene-future-spintronic-devices.html



https://lightsources.org/2018/09/27/towards-oxide-integrated-epitaxial-graphene-based-spin-orbitronics/

All the potential new devices are based on junctions exploiting Cobalt

Scientists often forget CRMs' related issues an example: Spintronics



Cobalt is a CRMs and a strategic material

CRM issues need to be taken into account from the very beginning

Developing new systems/devices based on advanced materials

First question to be answered!!!

Do we have to deal with CRMs?

This has to be an implied question to take into account from the very beginning of the project

53

Takeaway messages

- **The researchers' mind-set has to change**: CRMs issues have to be pointed out from the early stage of the research. If not, the research will lead to extremely costly devices with a strong dependence from suppliers (Strategic autonomy).

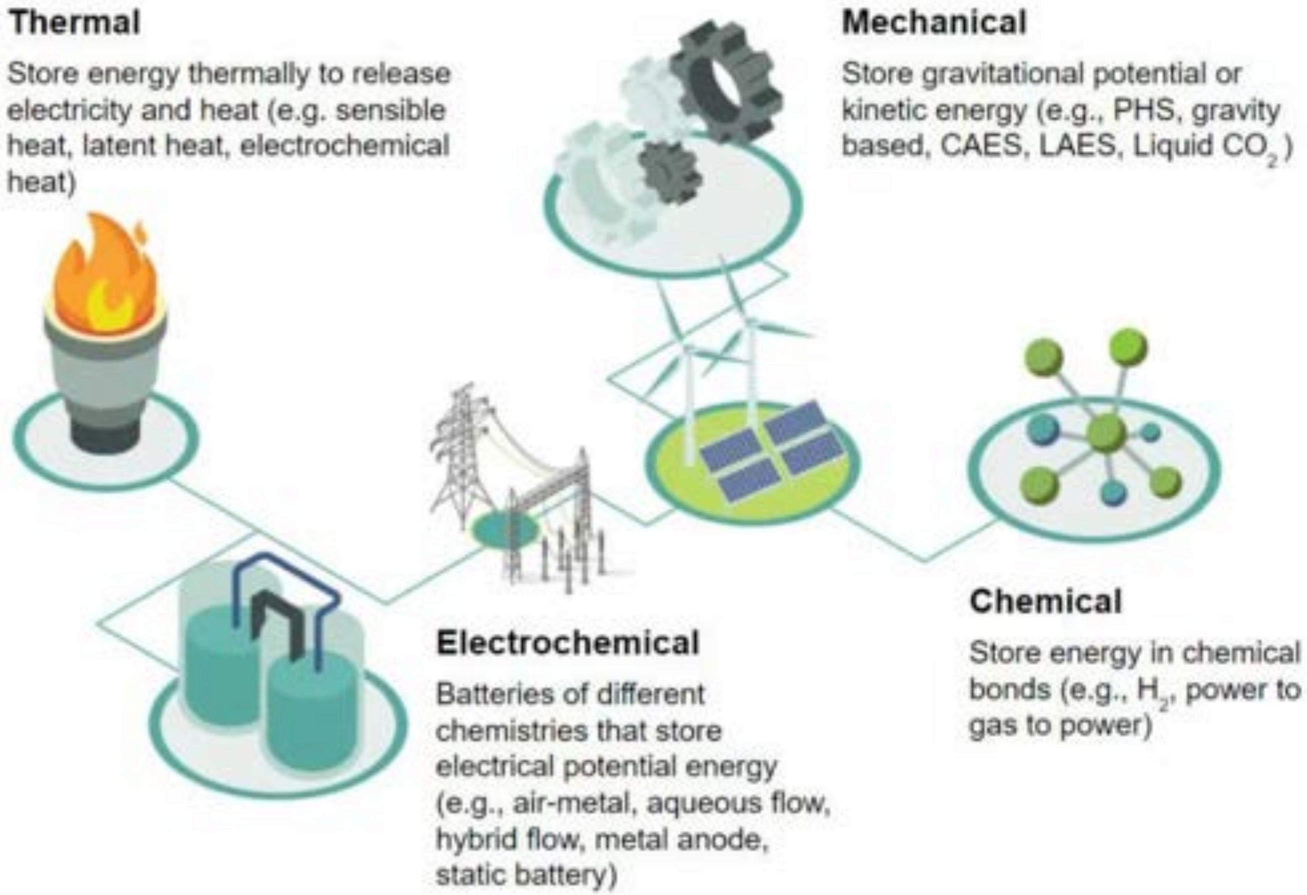
- **Alternative materials** that can take the place of the CRMs (backup solutions) **have to be identified from the very beginning in research.**

European Innovation Council

- EIC presentation: what is our rôle?
- What are advanced materials? A definition
- CRM materials and the energetic transition: main points
- Energy storage for electric grid: a perspective on the different technologies and the portfolio approach
- Market analysis
- Conclusions

Context: The motivation for the challenge

European Innovation Council



Mid-long-term energy storage can bridge the intermittency of renewable energy sources (RES)
The challenge will implement this vision

European Innovation Council

THE BASICS & THE GAPS

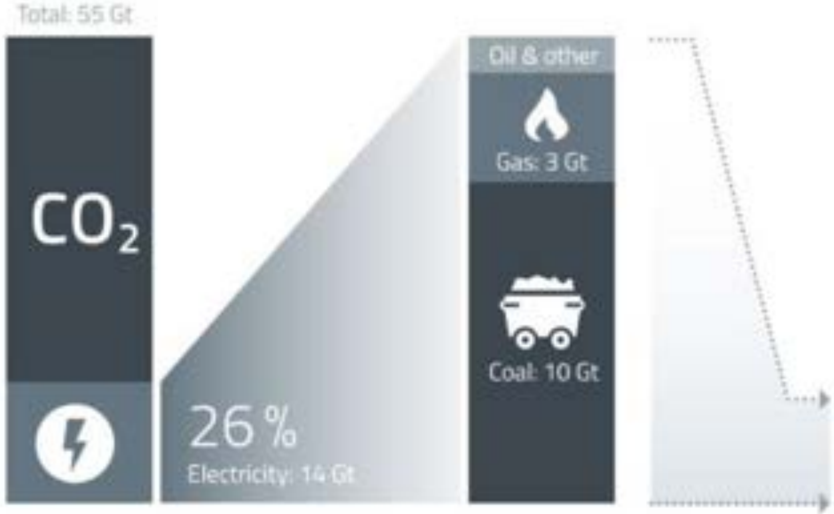
Climate Innovation Factsheet Series #3/2023

Long Duration Energy Storage for the Power System **LDES**

THE CLEAN ELECTRICITY CHALLENGE: SOLAR AND WIND FLUCTUATE

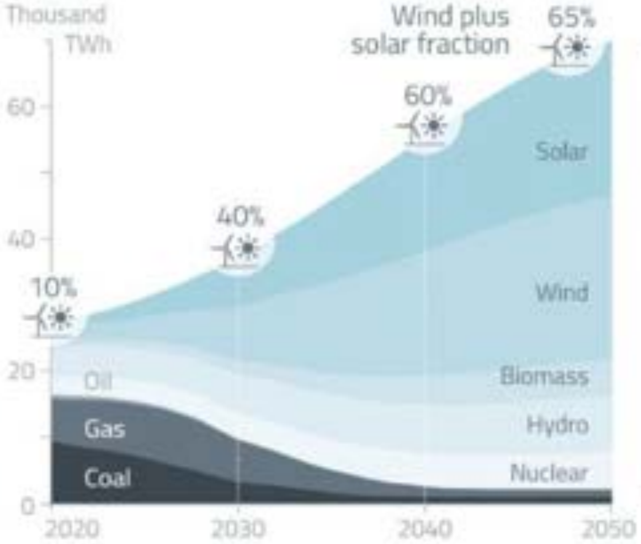
Electricity generation is responsible for over a quarter of global greenhouse gas emissions.

Global emissions (Gt CO_{2eq}/year)



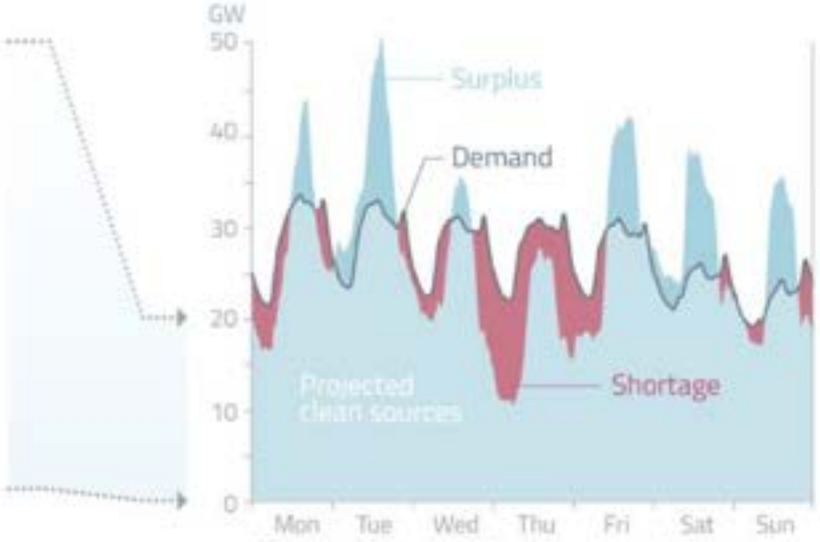
Solar and wind energy are key to quickly decarbonizing the power system.

Global electricity generation under a net-zero scenario (thousand TWh/year)



Since solar and wind are intermittent, this results in an increasing mismatch between supply and demand.

Projected generation in a developed economy* (GW)



*Example of fluctuations shown over one week.
See our website for fluctuations shown over one year.

Classification for energy storage
Mid Long Term Energy Storage MDLES

European Innovation Council

	Short duration	Inter-day LDES	Multi-day / week LDES	Seasonal Shifting
Duration of dispatch	0-4 hours	10–36 hours	36–160 hours	160+ hours
Storage technologies	· Batteries · Flywheels · Some mechanical technologies	· Most mechanical technologies · Some electrochemical technologies	· Many thermal technologies · Many electrochemical technologies	· Chemical storage (e.g., hydrogen)
Primary end-use	· Intra-day energy shifting (e.g., day to night) · Frequency regulation	· Inter-day energy shifting (e.g., one point in a day to another point the next day)	· Resilience for extended shortfall of power	· Shifting energy over months (e.g., summer to winter)

Portfolio Composition (Pathfinder challenge)

Project	Start/end date	Input	Output
PUSH-CCC Large-scale energy storage via optimized combined cycle CAES	01/10/2023 30/09/2027	Electricity	Electricity
SULPHURREAL Solid sulphur chemical looping with high T solar heat input for long	01/10/2023 30/09/2026	Heat	Energy carrier, electricity
AELECTRA Mid- to long-term storage of electrical energy via ammonia	01/10/2023 30/09/2027	Electricity, Water, atmospheric air	Energy carriers (ammonia)
HIPERZAB Electrically rechargeable zinc-air	01/10/2023 30/09/2027	Electricity	Electricity
ReZilient Redox-mediated hybrid zinc-air flow Batteries	01/10/2023 30/09/2027	Electricity	Electricity
VanillaFlow Artificial Intelligence Guided Development of Vanillin-based Flow	01/09/2023 31/08/2026	Electricity, vanillin	Electricity
MeBattery Mediated Biphasic Battery	01/05/2022 30/04/2025	Electricity	Electricity
M-TES Metallic phase change material composites for Thermal Energy	01/10/2023 30/09/2026	Heat	Heat
Muspell Medium to long duration thermal energy storage with embedded heat pumping capability	01/10/2023 30/09/2027	Heat, Electricity	Heat, Electricity

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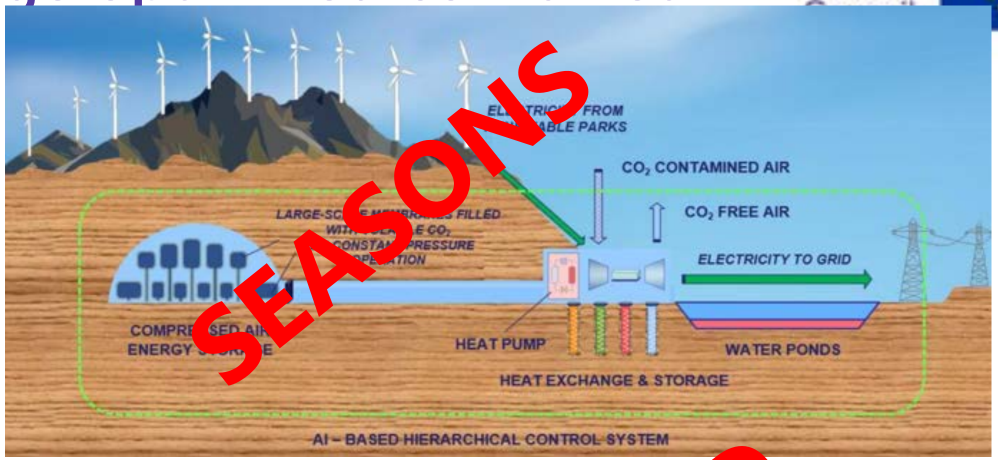
LONG TERM STORAGE

RIEGOSUR, S.A, Spain

Pushing the limits of large-scale energy storage optimized combined cycle CAES



PUSH-CCC aims to solve the key existing limits of **large-scale Compressed Air Energy Storage (CAES)**
Energy can be stored for months.

DLR, Germany

An innovative thermochemical cycle based on solid sulphur for integrated long-term storage of solar thermal energy

Direct conversion of solar energy into chemicals storable for a **virtually unlimited time**, via an integrated solar-aided thermochemical cycle.

Aarhus University, Denmark

A new Electrochemical concept for Mid- to Long-term storage of EleCTrical energy in green liquid Ammonia

Ammonia as energy carrier can transport stored electrical energy in a "safe and cost competitive way" and will be a key enabler for a fully decarbonized energy system.

RIEGOSUR, S.A, Spain

Pushing the limits of large-scale energy storage optimized combined cycle CAES

European Innovation Council

- **PUSH-CCC** aims to solve the key existing limits of **large-scale Compressed Air Energy Storage (CAES)** scalability, replicability, efficiency, and energy density

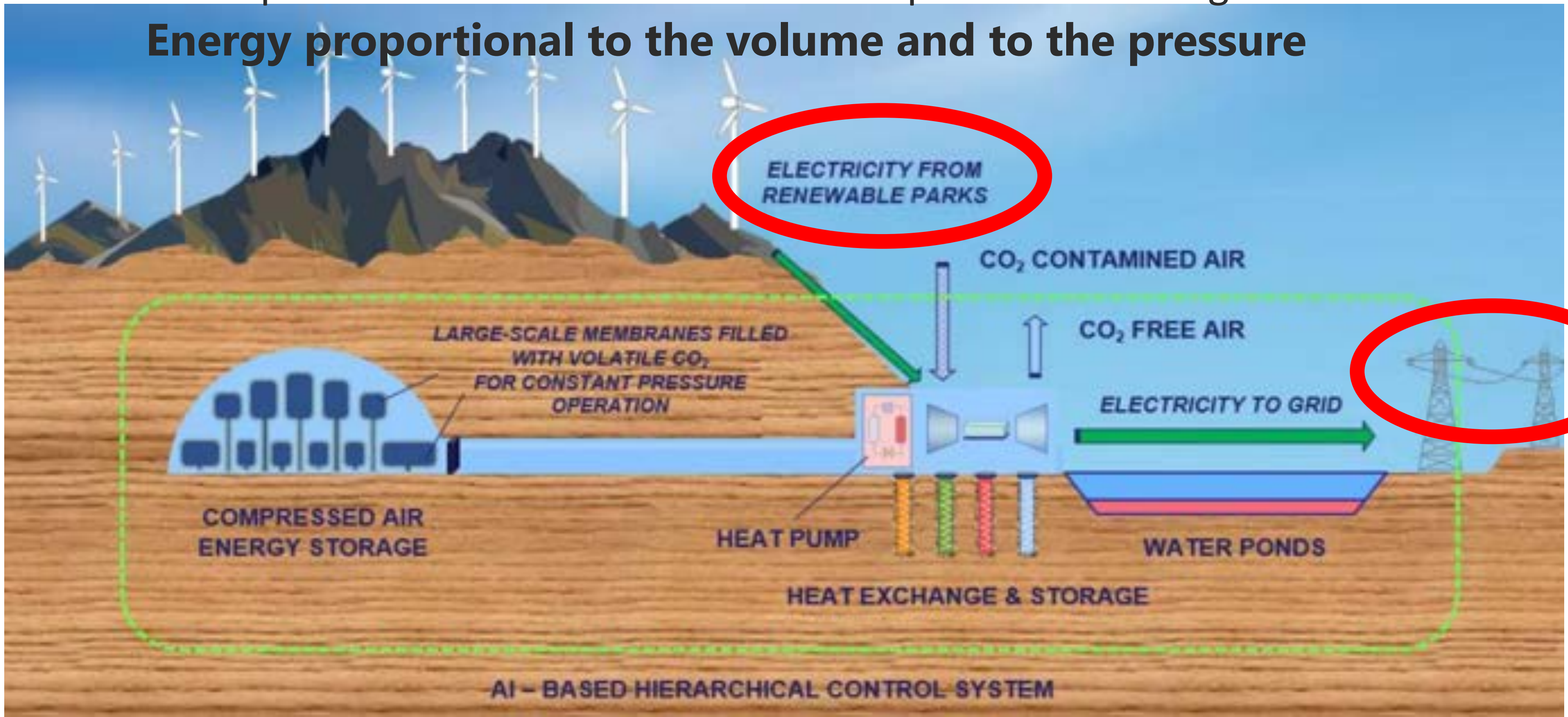
Main Breakthrough

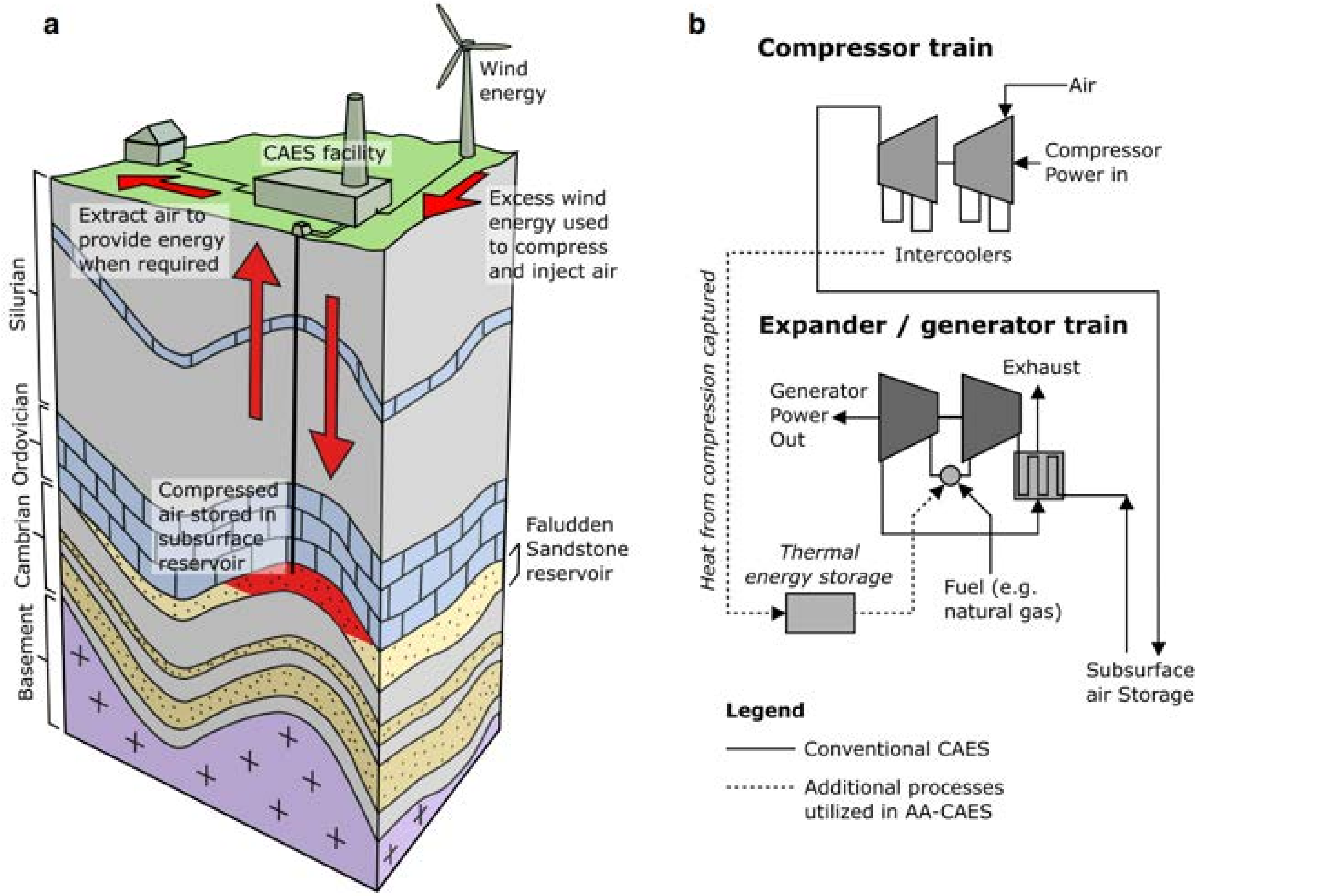
-**To perform energy storage through compressing air and capturing CO2 at the same time.**

-To capture **10 kTn of CO2/**year for a standard **500 MW plant** (**efficiency at 80%** for each cycle).

- Storage for weeks

-Potential recuperation of the heat related to compressed air is targeted too.





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Gotland Island Sweden

Sulphurreal DLR, Germany

European Innovation Council

An innovative thermochemical cycle based on solid sulphur for integrated long-term storage of solar thermal energy

Main Breakthrough

The valuable outcome of this Solid-Sulphur (SoSu) cycle is not a chemical product, but the **high-quality sulphur-combustion heat at temperatures in excess of 1200 °C, suitable for combustion in gas turbines and allowing hence efficient combined cycle power generation.**

		Reaction	Temperature (°C)
Sulphuric acid splitting	1a	$3H_2SO_4(aq) \rightarrow 3H_2O(g) + 3SO_3(g)$	450 – 500
	1b	$3SO_3(g) \rightarrow 3/2\ O_2\ (g) + 3SO_2(g)$	650 – 1000
Disproportionation	2	$3SO_2(g) + 2H_2O(l) \rightarrow 2H_2SO_4(aq) + S(s)$	50 – 200
Sulphur combustion	3	$S(l) + O_2(g) \rightarrow SO_2(g)$	500 – 1500
Contact process	4	$SO_2(g) + 1/2\ O_2\ (g) \rightarrow SO_3(g)$	
Absorption	5	$SO_3(g) + H_2O(g) \rightarrow H_2SO_4(aq)$	

Sulphuric acid decomposition (SAD) **Sulphur trioxide splitting (STS)**

Portfolio Composition (Pathfinder challenge)

European Innovation

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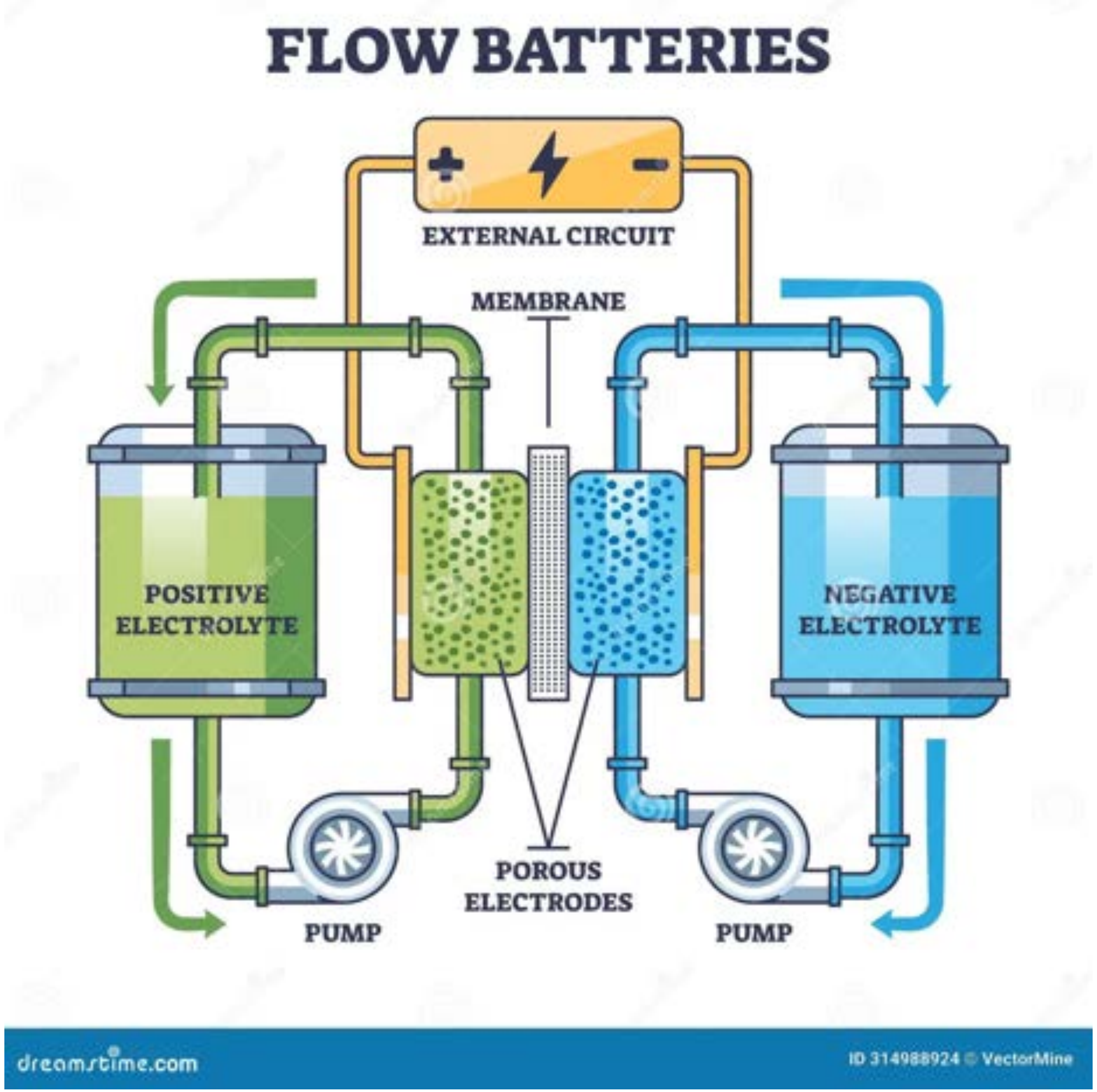
MID TERM STORAGE



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Larger Tanks
Larger energy stored

The energy is stored in the tanks and the power in the electrodes

SINTEF Energi AS, Norway

Redox-mediated hybrid zinc-air flow batteries for more resilient integrated power systems

European Innovation Council

Days

enhanced charge transfer processes and **eliminating the electroplating process to improve battery lifetime**.

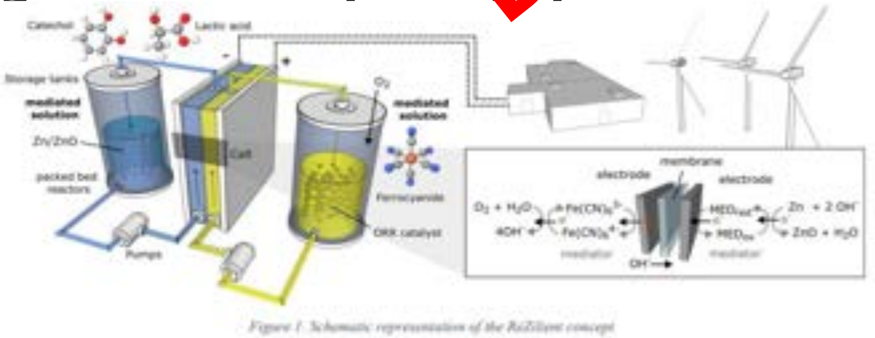


Figure 1. Schematic representation of the ReZilient concept

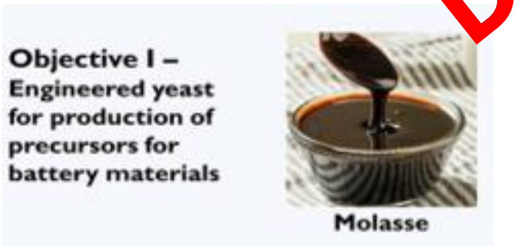
TU Graz, Austria

Artificial Intelligence Guided Development of Vanillin-based Flow batteries

Days

Production of sustainable Redox couple, via novel biotechnological processes.

New sustainable membranes based on non-toxic and recyclable materials.

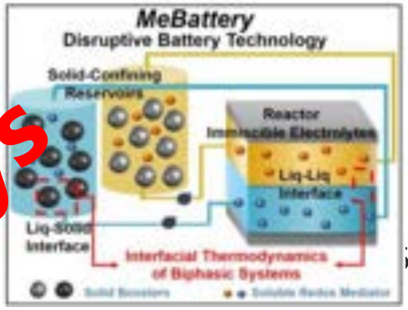


UBU - Universidad de Burgos

High performing electrically rechargeable zinc-air batteries for sustainable mid-term energy storage

Days

Immiscible liquids, carrying "redox mediators", eliminating the possibility of crossover.



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MID TERM STORAGE

Politecnico di Milano, Italy

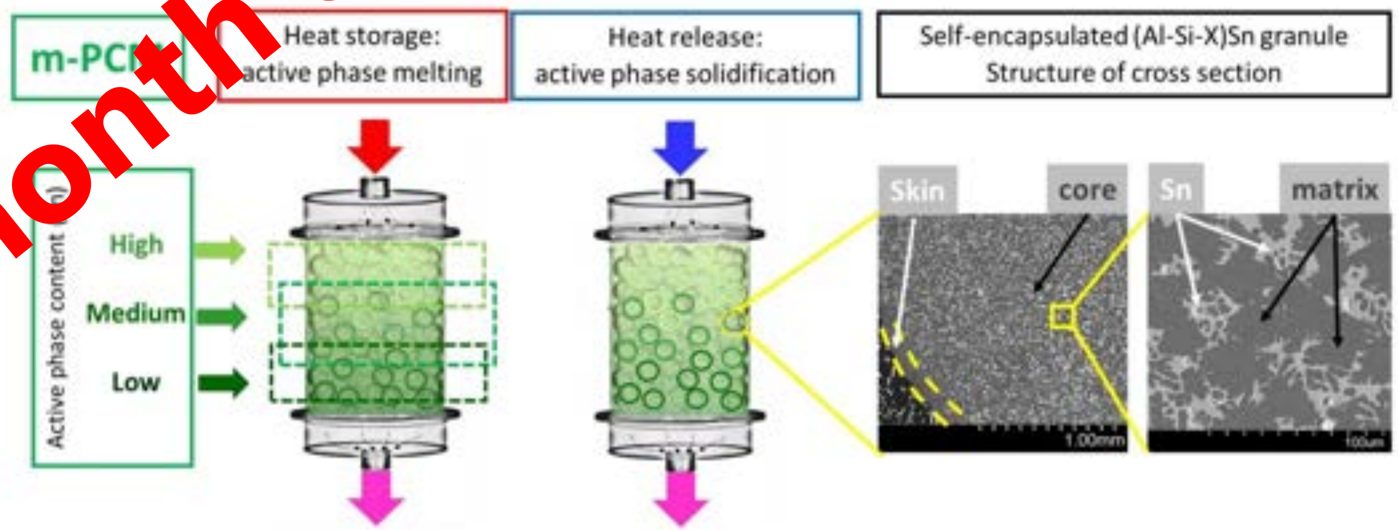
Metallic phase change material-composites for Thermal Energy management

- **M-TES aims to ad-hoc design, produce, test and deliver in the form of self-encapsulated granules, form-stable metallic Phase Change Materials (m-PCMs).** As PCMs, a particular class of alloys will be considered: immiscible alloys, also known as Miscibility Gap Alloys (MGAs).

Main Breakthrough

The main breakthrough is the possibility to achieve encapsulated m-PCM :

- **to isolate the granulate** from the external environment avoiding environmental interaction through leakage
- **to preserve the energy stored** during the phase-change and modulate through composition the thermal release to the vector fluid



Other projects in the thematic area : Thermal Storage

European Innovation Council

AMADEUS - Next GenerAtion MateriAls and Solid State DevicEs for Ultra High Temperature Energy Storage and Conversion
FET Open 01/01/2017-31/12/2019

↓

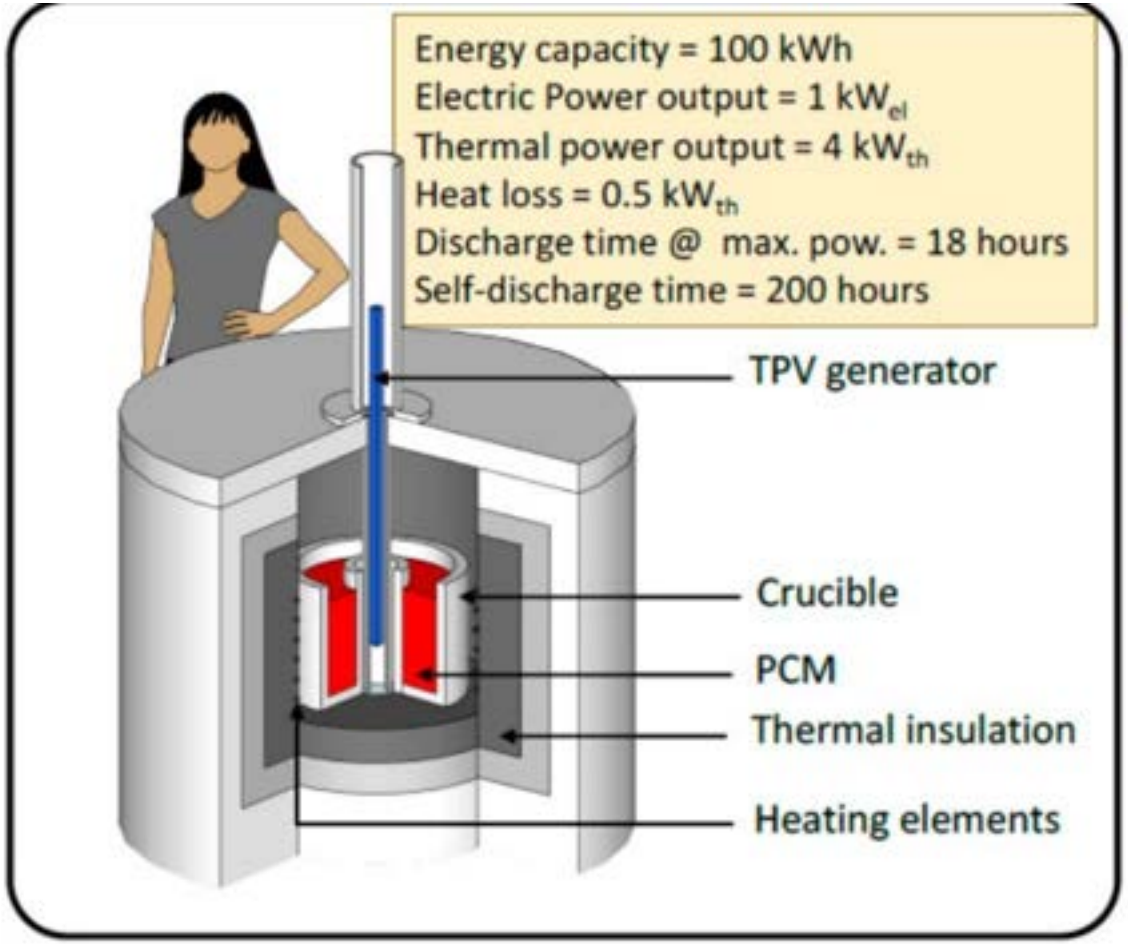
NATHALIE - New markets technological positioning for ultra-high temperature latent heat energy storage
FET Open 01/09/2020-28/02/2022

↓

THERMOBAT - A high-performance thermophotovoltaic battery for storing excess renewable energy
EIC Transistion 01/06/2022-31/05/2026

THERMOBAT

A high-performance thermophotovoltaic battery for storing excess renewable energy

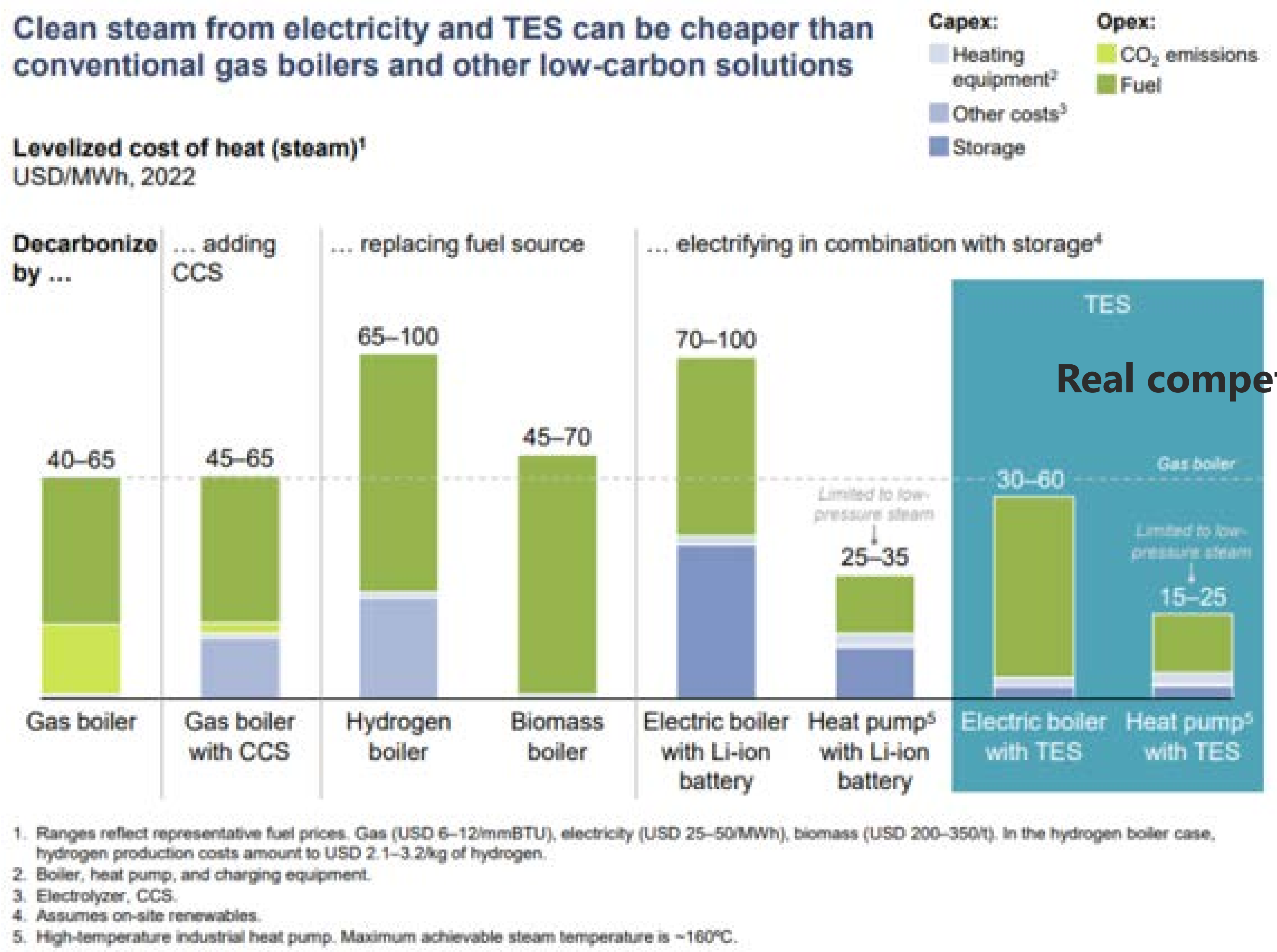


▪ High Capacity ▪ Cost Efficient ▪ Durable

- up to 85% is made from upcycled materials such as steel slag
- tested for 15,000 cycles with no degradation discovered. This is 50% longer than the maximum of battery storages
- Kraftblock material has a lifetime of over 40 years.

materials Solutions trip-efficiency

KRAFT BLOCK



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Real competitive advantage

Clean steam generation with different technologies. Source: LDES Council/Roland Berger/McKinsey & Company.

Projects running

European Innovation Council

Cooperant

Concentrated Solar Power (CSP) · Research & Development (R&D)

CSP on 1000°C with hybrid storage material

Volt with Eneco and PepsiCo.

Food, Beverages, Pharma · Energy Supplier

Kraftblock replaces a 25 MW gas boiler with Net-Zero Heat System.

Comet.

Glass & Ceramics · Waste Heat Utilization

Recovering and reusing waste heat in the ceramic industry with Kraftblock.

Buhck.

Waste Heat Utilization · Energy Supplier

Moving Waste Heat over the Streets.

Hall-A.

Steel Industry · Waste Heat Utilization

Recycling flare gas from the Steel Industry.

Newcline.

Concentrated Solar Power (CSP) · Research & Development (R&D)

Developing CSP Storages with Kraftblock material.

FlexKWK.

District Heating · Electricity Generation

Retrofitting Coal Power Plant Sites with Kraftblock.

Hercules.

Research & Development (R&D) · Renewable Energy

Developing storage vessels for new storage material.

- EIC presentation: what is our rôle?
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Top 10 Investors in the field of Energy Storage for electric grid in the World

pfnexus

European Innovation Council

NEXTera ENERGY RESOURCES

9/10 are in Europe !!!

ENGIE

Gresham House Specialist investment

RP GLOBAL RENEWABLE POWER

ecotricity

voltalia

fortum

akuo Entrepreneurs par nature

It is the right time to take the leadership in this field or at less to be more competitive

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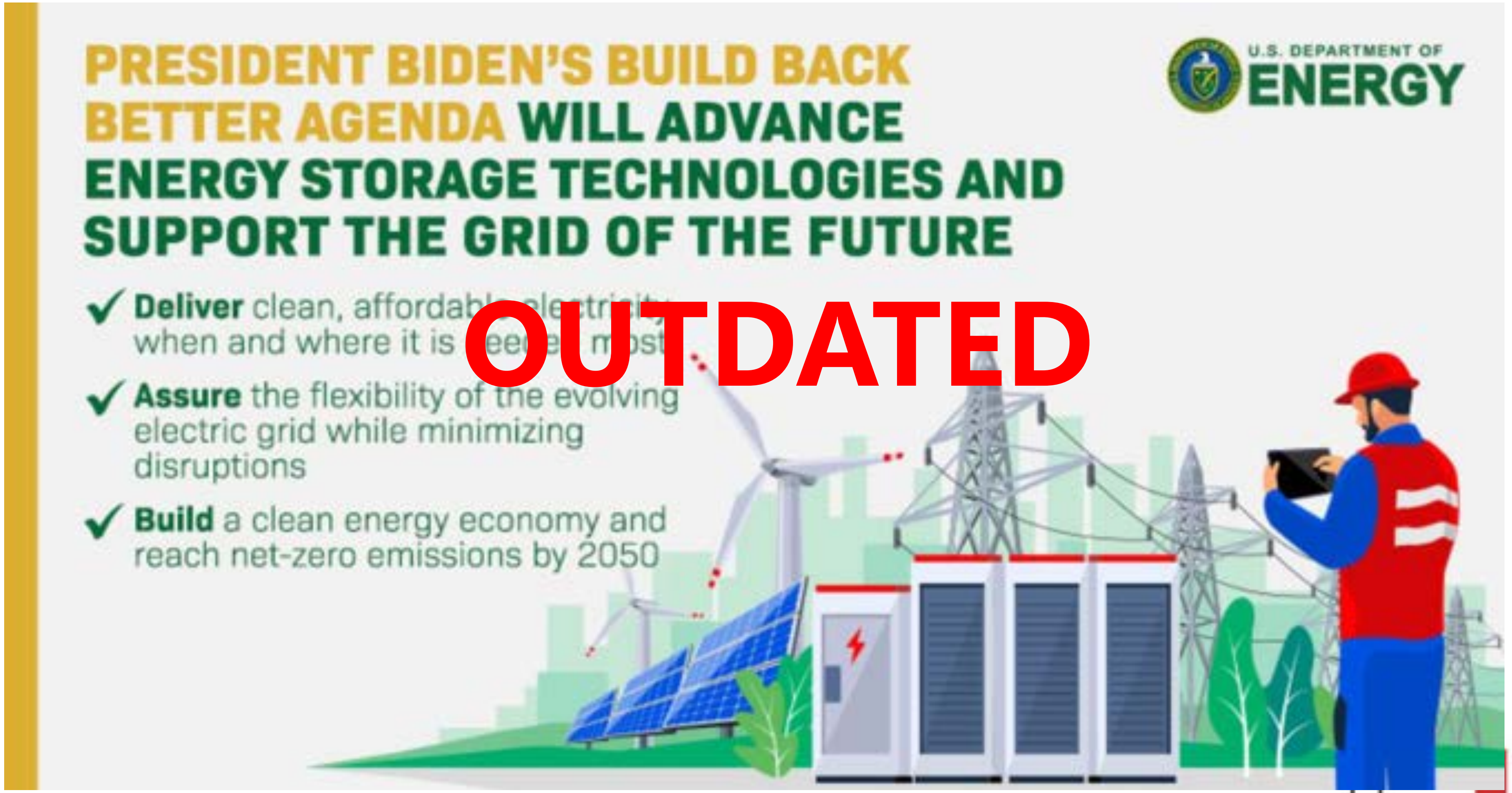
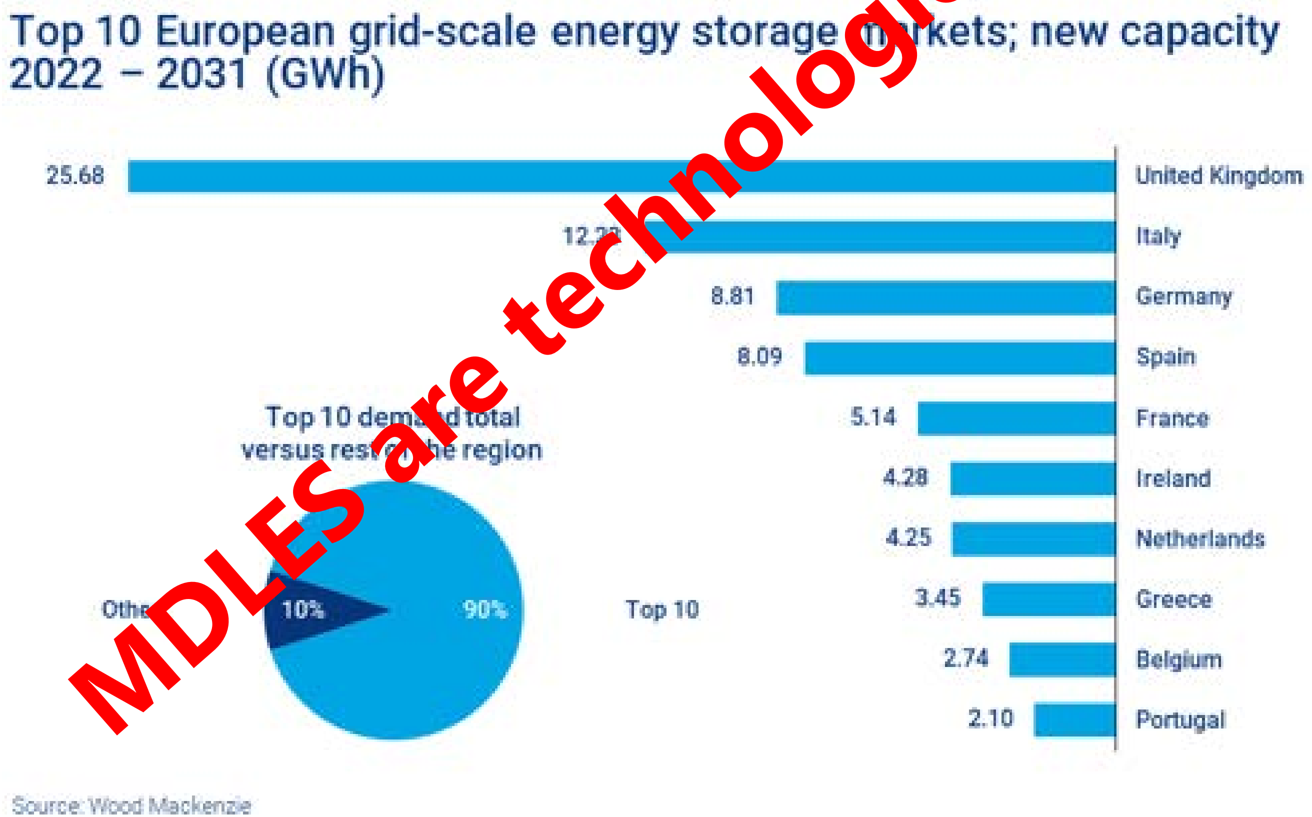


The context is extremely favorable

European Innovation Council

Europe’s grid-scale energy storage capacity will expand 20-fold by 2031 (from 2.8GW/3.3GWh in 2022 to 45 GW/89 GWh in 2031).
RePowerEu plan to cut Europe energy dependency on Russian gas well before 2030.
The proposed plan will double the share of variable renewables in power generation, passing 60% by 2030 and so the necessity of highly effective energy storage for grid.

MDLES are technologies are timely



Regulations barrier to unlock the EU potential

European Innovation Council

There are policy obstacles that need to be addressed for energy storage to fully realize its potential. In nearly all European countries, the three primary challenges for grid-scale storage assets are:

- **Outdated or absent definitions of energy storage** have led to its classification as both a consumer and a generator of electricity, resulting **in double taxation or unnecessary grid fees for importing and exporting power.**
- **Policies and requirements initially designed for traditional power sources can limit access to flexibility and balancing markets**, thereby restricting opportunities for energy storage to optimize its value across Europe.
- **The absence of revenue-generation mechanisms to support the business cases for energy storage** acts as an additional constraint.

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- Energy transition is a priority for Europe.
- To avoid loosing the leadership in new market, **regulations need to support the funding efforts.** The other competitors do not play the same game
- Mid-long term energy storage are a field of innovation for Europe considering the emergency of Renewable Energy Sources (60% in 2030). **We can be leader in this field if we learn from the previous experiences.**
- The Green Deal is an important tool but we have to keep the direction. **Patience** is important and to go back will not be beneficial. The Green Deal has been approved in 2020, the Chinese started to fabricate massively electric car ten years before…

LAST WORDS

The research of tomorrow will be funded by the innovation that we will be able to promote and bring to concrete results with strong economic/societal impacts. Moreover, innovation is the only way to dress the fight for competitiveness.

All the scientific community has to understand that the innovation is not in opposition to research but that **innovation can bring a strong added value to research and this is also true for fundamental one.**

European Innovation Council

Thank you!

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