European Innovation Council

Backing visionary entrepreneurs

Antonio Marco Pantaleo
Program manager, European Innovation Council

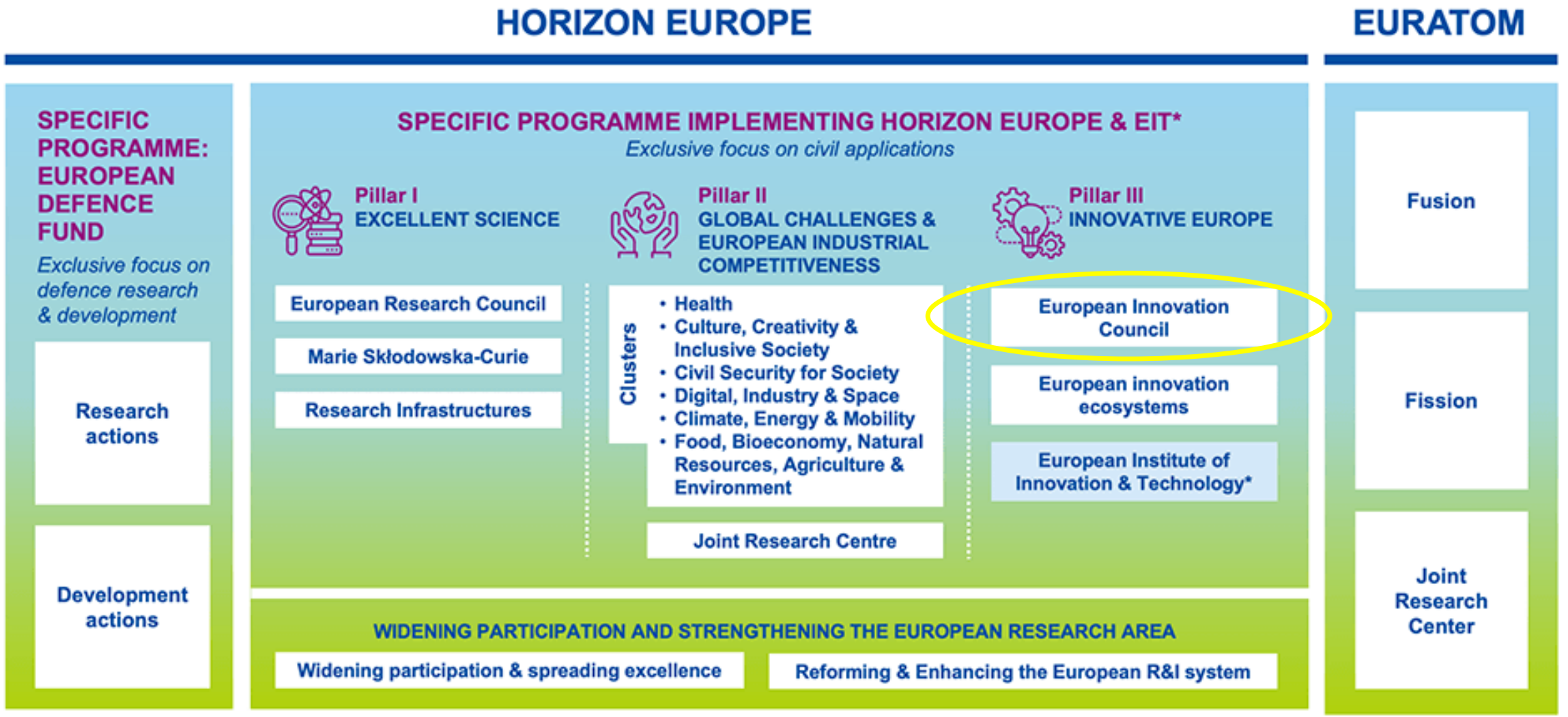
11th Swiss Symposium on Thermal Energy Storage
Lucerne, 26-01-2024

Outline

- Horizon EU and European Innovation Council
- Research and innovation priorities for energy transition
- Innovation trends in thermal energy storage and lessons learnt
- Funding opportunities: EIC pathfinder and accelerator

The Horizon Europe framework programme

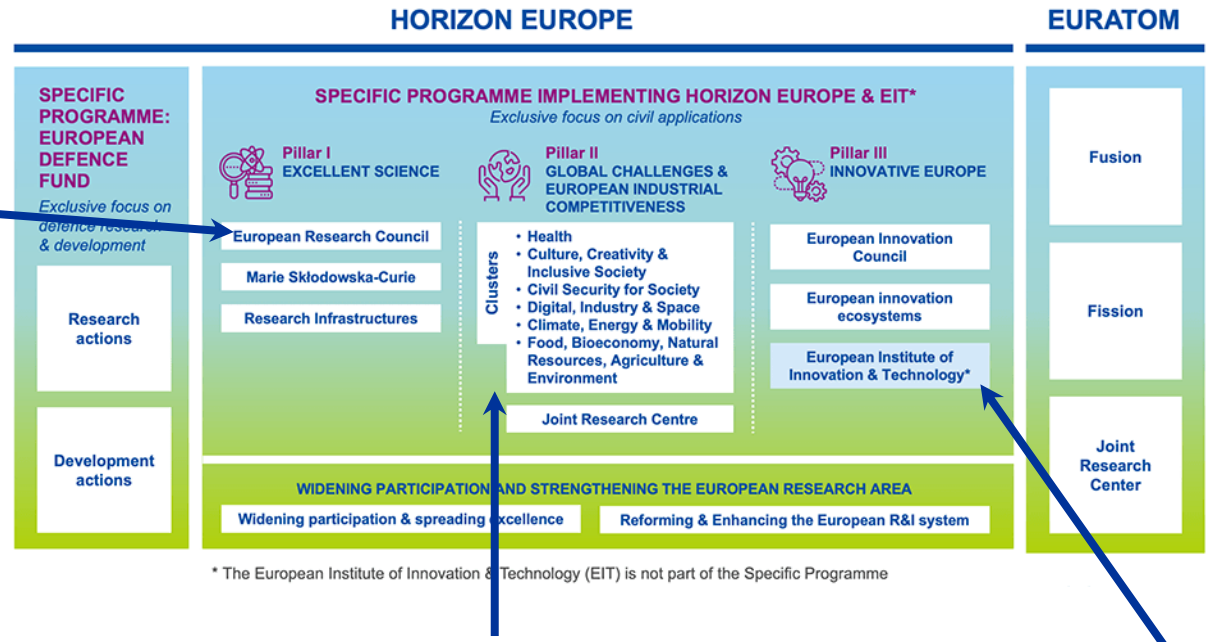
European Innovation Council



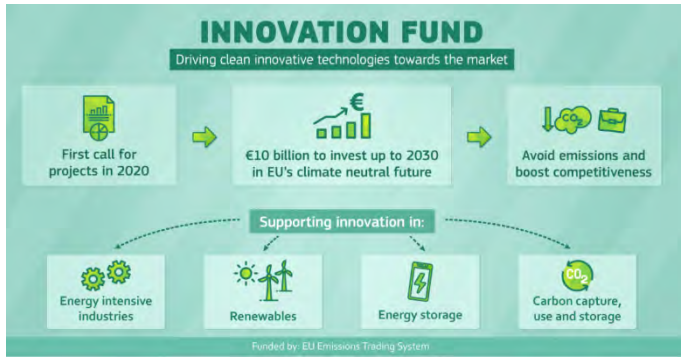
* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

EU instruments to support R&I in energy storage

European Innovation Council



Other EU public funding options



IPCEI BATTERIES

European Investment Bank The EU bank

Pillar 2 – HEU Clusters and Partnerships

Clean Hydrogen Partnership

CSP The Clean Steel Partnership

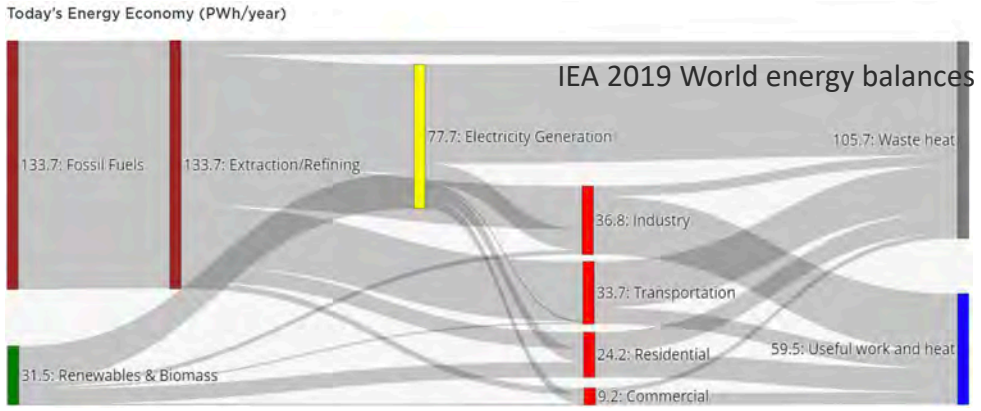
2ZERO

HEU Cluster 5: TES, transport, grids, industrial decarbonization, buildings..

HEU Cluster 4: EU Raw Materials Alliance, EIP raw materials; Manufacturing; automation AI and robotics; Key Digital Technologies

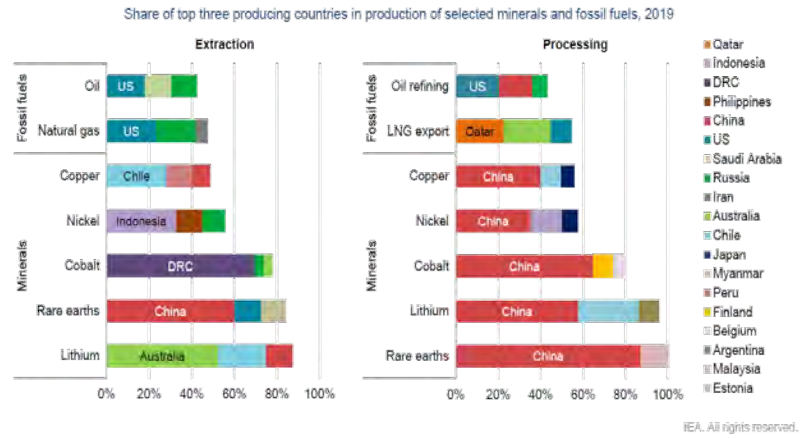
eit European Institute of Innovation & Technology

Priorities for the energy transition



64% of primary energy is lost

Final uses (energy efficiency, digital transition..)



EU is 75-100% reliant on import for metals

Circularity and security (reuse, recycle, critical materials, domestic resources)

Emissions from materials production

Systems integration (sectors coupling, industrial symbiosis, H2 in steel etc)

Nature Climate Change
Vol 13, April 2023

CO2 is only part of the problem

Nature based solutions – biodiversity
Combine engineering and bio: synthetic biology

Broader views (food-water-energy)

European Innovation Council

Circular Economy Action Plan

The European Green Deal

- Fit for 55%
- RepowerEU, RefuelEU
- Green deal industrial plan
- Net zero industry act
- Critical raw materials act
- Electricity market design
- Chips act
- Economic security

EIC main instruments and characteristics

European Innovation Council

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

Transition
- **Technology maturation** from proof of concept to validation
- **Business & market readiness**
- Grants up to €2.5 million

Accelerator
- **Development & scale up** of deep-tech/ disruptive innovations by startups/ SMEs
- Blended finance (grants up to €2.5 million; equity investment up to €15 million)
- Successor of SME instrument

- 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

EIC Programme Manager Priorities

Identify candidate challenges and select portfolios of projects

Science and innovation intelligence activity

Outreach and community building

Steering 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

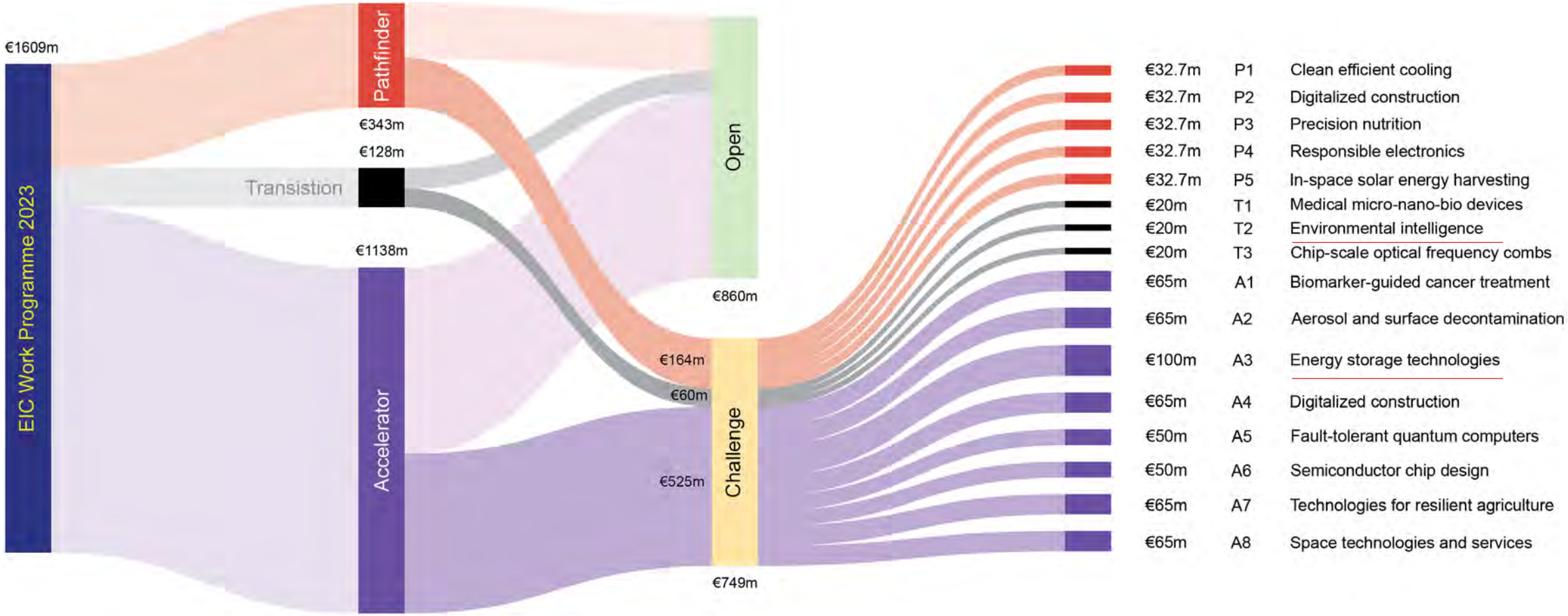
EIC Programme Management (per sector)

Bridging policy and implementation

Temporary role: scientific and innovation expert to bring vision, technical knowledge, networking to EC policy and implementation

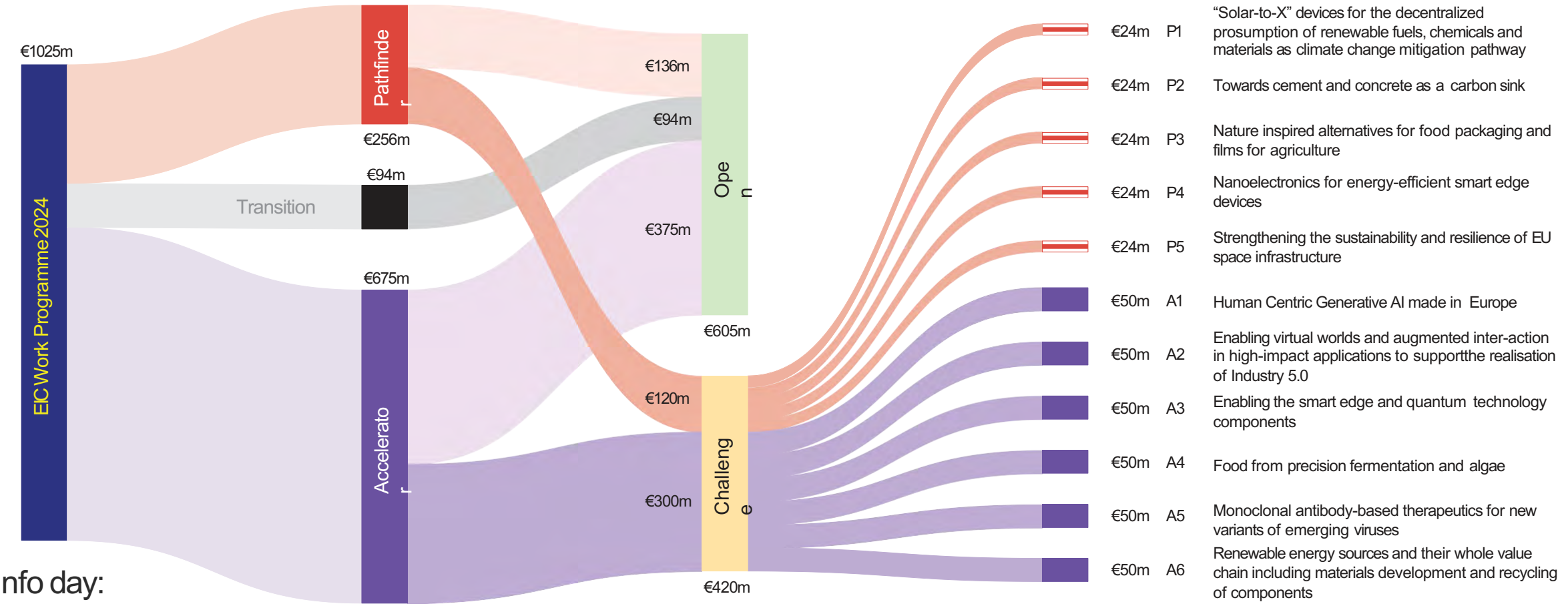
3 PM positions open until 26-01-24

In 2023 EIC allocates ~€1.6bn to Open and Challenge calls by its Pathfinder, Transition, Accelerator programs



European Innovation Council

2024 EIC WP ~€1 bn



Info day:

15 January (General)

16 January (Accelerator Challenges)

20 March (tbc) Pathfinder Challenges

European Innovation Council

Tools and actions of PMs

- **Chair evaluation panel (PF)**: implement vision and strategies of the challenge guide
- **Package of BAS to beneficiaries:** booster grant (ad hoc grant 50 kEur), fast track to innovation (access to accelerator step 2), coaching and mentoring support
- **Scientific experts support**: assessment of innovation/market uptake potential, high level report on state of art of research and innovation, patenting assessment, etc

https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/work-as-an-expert

- Launching **innovation deals** to address regulatory, legislative and standardization issues to mobilize market uptake and innovation potential of specific technologies
- Support to technical due diligence for the equity component of EIC accelerator (EIC Fund)

EIC Cleantech challenges

European Innovation Council

EIC Challenges 2021			
	Pathfinder	**Transition**	**Accelerator**
Cleantech	• Novel routes to green hydrogen production (Portfolio kick off meeting October 2022)	• Energy harvesting and storage technologies	• Green Deal innovations for the economic recovery

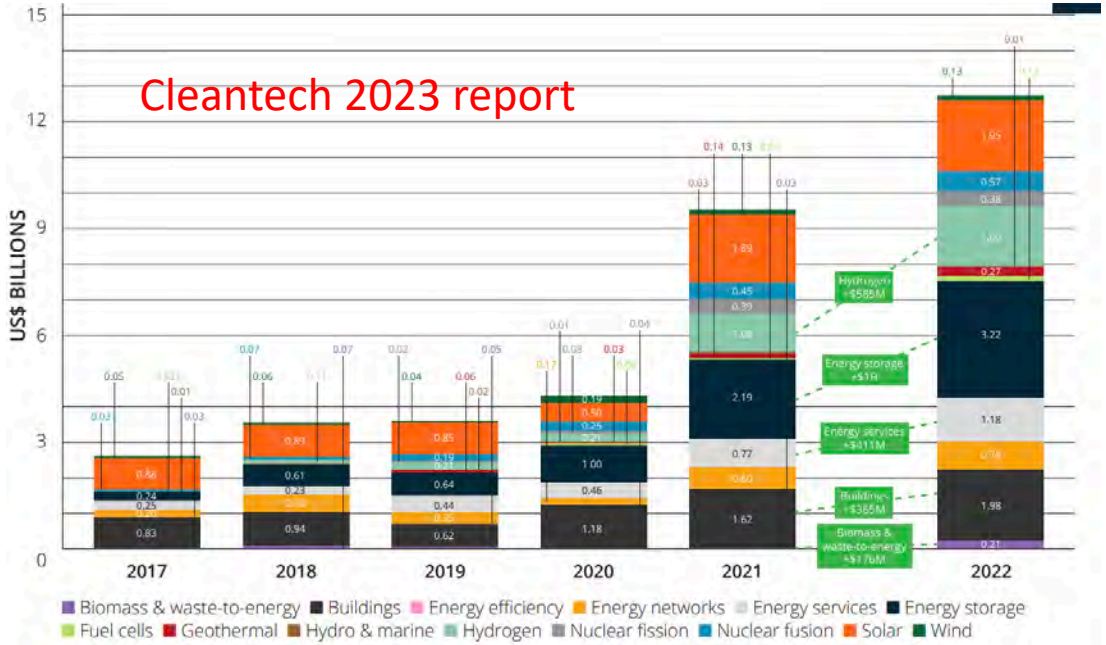
EIC Challenges 2022			
	Pathfinder	**Transition**	**Accelerator**
Cleantech	• Carbon dioxide & Nitrogen management and valorisation (final retained list end March 2023) • Mid-long term, systems-integrated energy storage (final retained list end March 2023)	• Process and system integration of clean energy technologies • Green digital devices for the future	• Technologies for 'Fit for 55'

EIC Challenges 2023			
	Pathfinder (32.7mln Euro)	**Transition (20mln Euro)**	**Accelerator (100mln Euro)**
Cleantech	• Clean and efficient cooling (submission deadline 18th October 2023)	• Environmental Intelligence (submission deadline 12th April and 27th September 2023)	• Energy Storage (submission deadline 22nd March, 7th June, 4th October 2023)

Portfolios of projects managed at EIC in cleantech

European Innovation Council

- Green hydrogen generation and uses
- Energy storage and systems integration
- CO2 and N management valorization
- Energy harvesting and conversion
- Clean cooling and cold chains
- Energy services and digital solutions

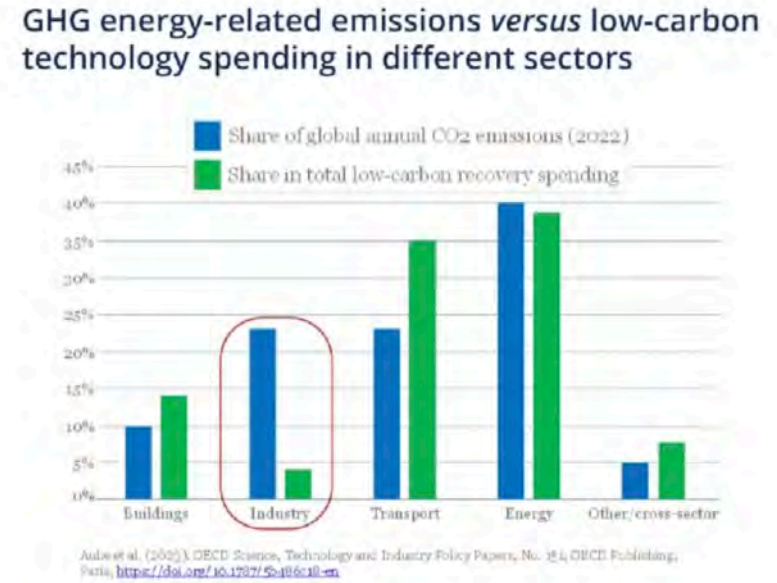


Future research and innovation trends

Modular Nuclear Reactors, georeactors and deep geothermal, sustainable mining/sea mining, materials substitution, solar chemistry, click chemistry, synthetic biology

Strategic EU research and innovation priorities 2024

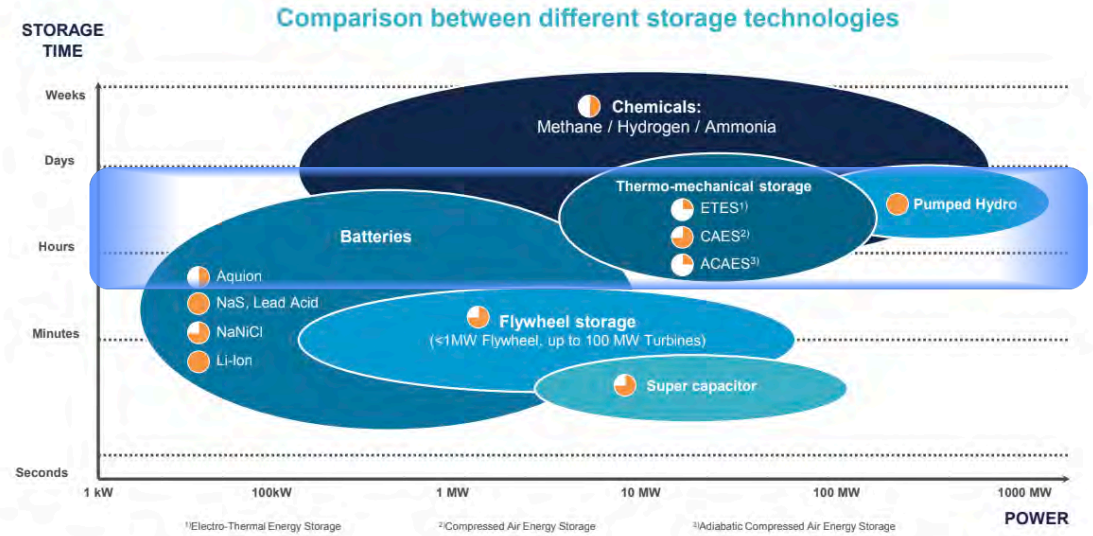
Chips and AI – Cleantech – Biotech and biomanufacturing – advanced materials



Medium-long duration energy storage (10-100 hours capacity)

European Innovation Council

Electricity storage need mainly driven by the intermittency of wind/PV (temporal mismatch)



Source: U.S. Department of Energy Fuel Cell Technologies Office

Maturity
- Concept phase
- Demonstration
- Early commercial
- Commercial

Technology
- Chemical
- Thermal
- Electrochemical
- Mechanical
- Electrical

Energy systems flexibility, a COMBINATION of:
- Dispatchable generation (embedded storage)
- Grid infrastructure and synthetic inertia
- Demand response and fast load control
- Sectors coupling
- Storage assets

Fully renewable EU power system by 2050:
+240% grid transmission (+ 140 GW)

+

flexible zero carbon firm capacity (programmable RES, seasonal storage) Applied Energy 233–234 (2019)

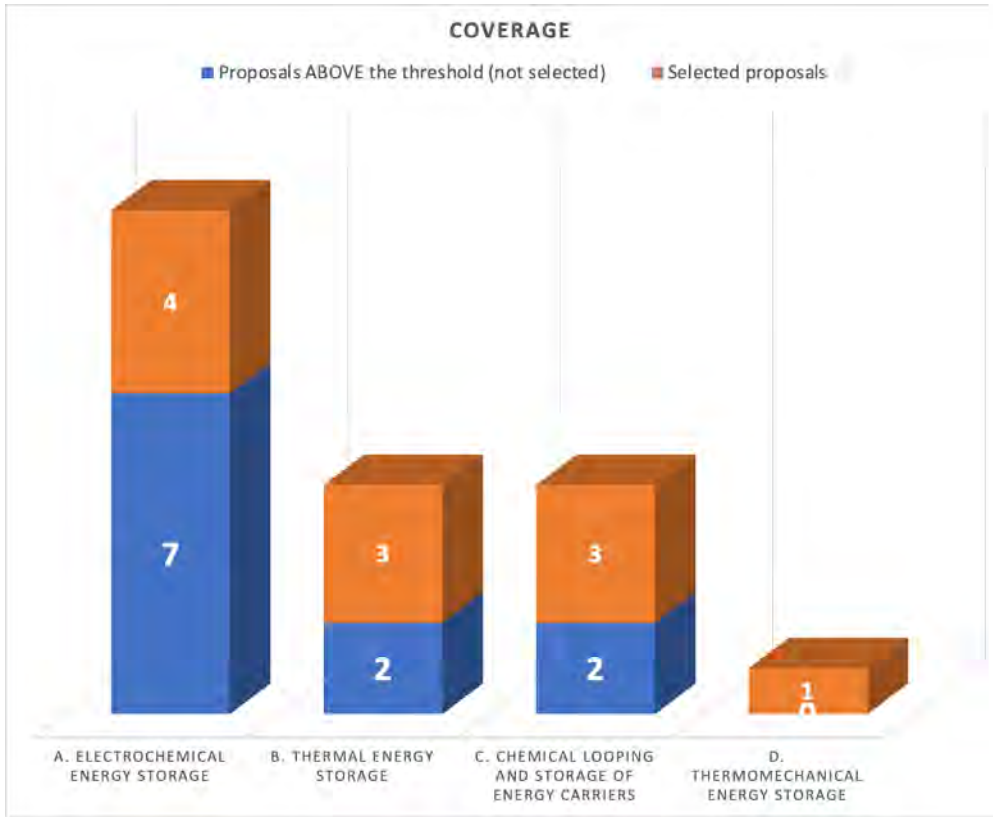
Spatial mismatch: generation vs transmission trade offs

The scale of intermittent RES balancing is critical: continental-scale balancing leads to low-cost electricity with higher transmission costs. supply scale vs infrastructure requirements (Trondle et al., Joule 4, Sept 16, 2020https://doi.org/10.1016/j.joule.2020.07.018

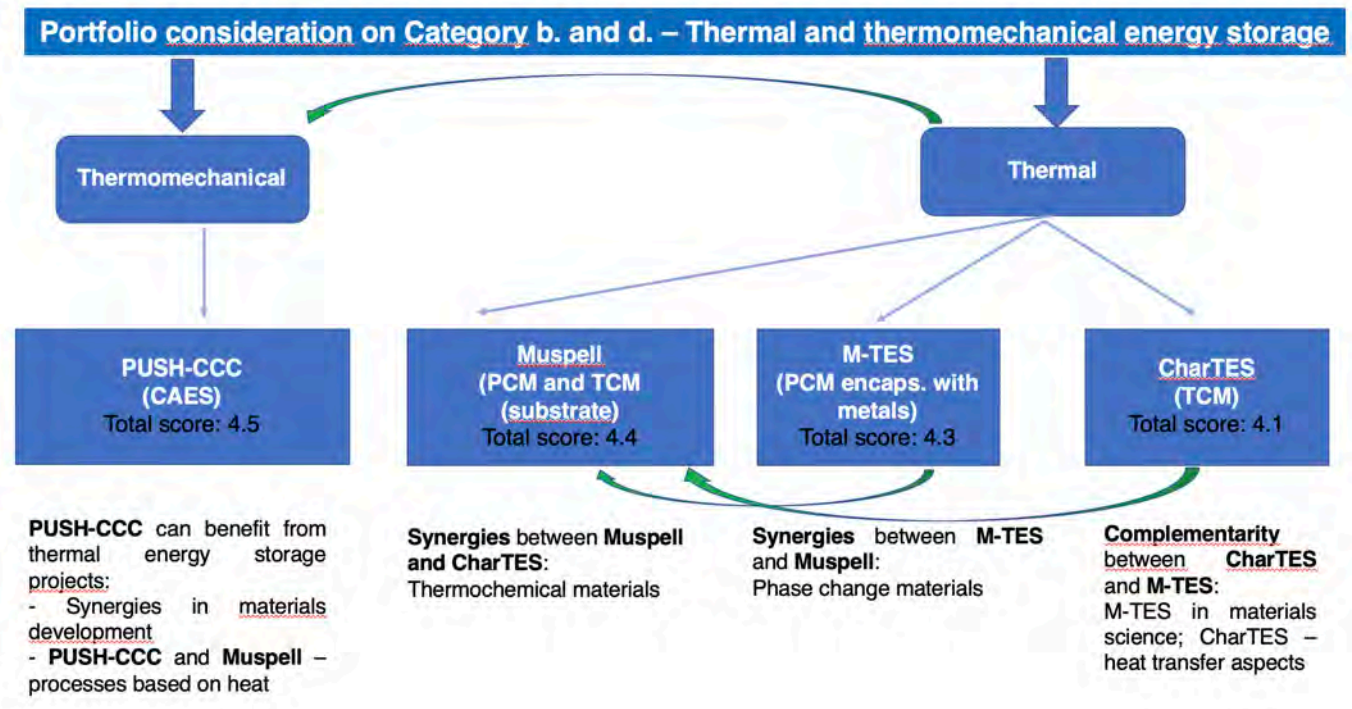
Cross border capacity needed at high NG cost:
64 GW by 2030, 88 GW 2040 (75% of 2025) + 41 GW storage ENTSO-E TYNDP 2022 · System Needs Study | July 2022

Portfolio composition for pathfinder challenge on energy storage

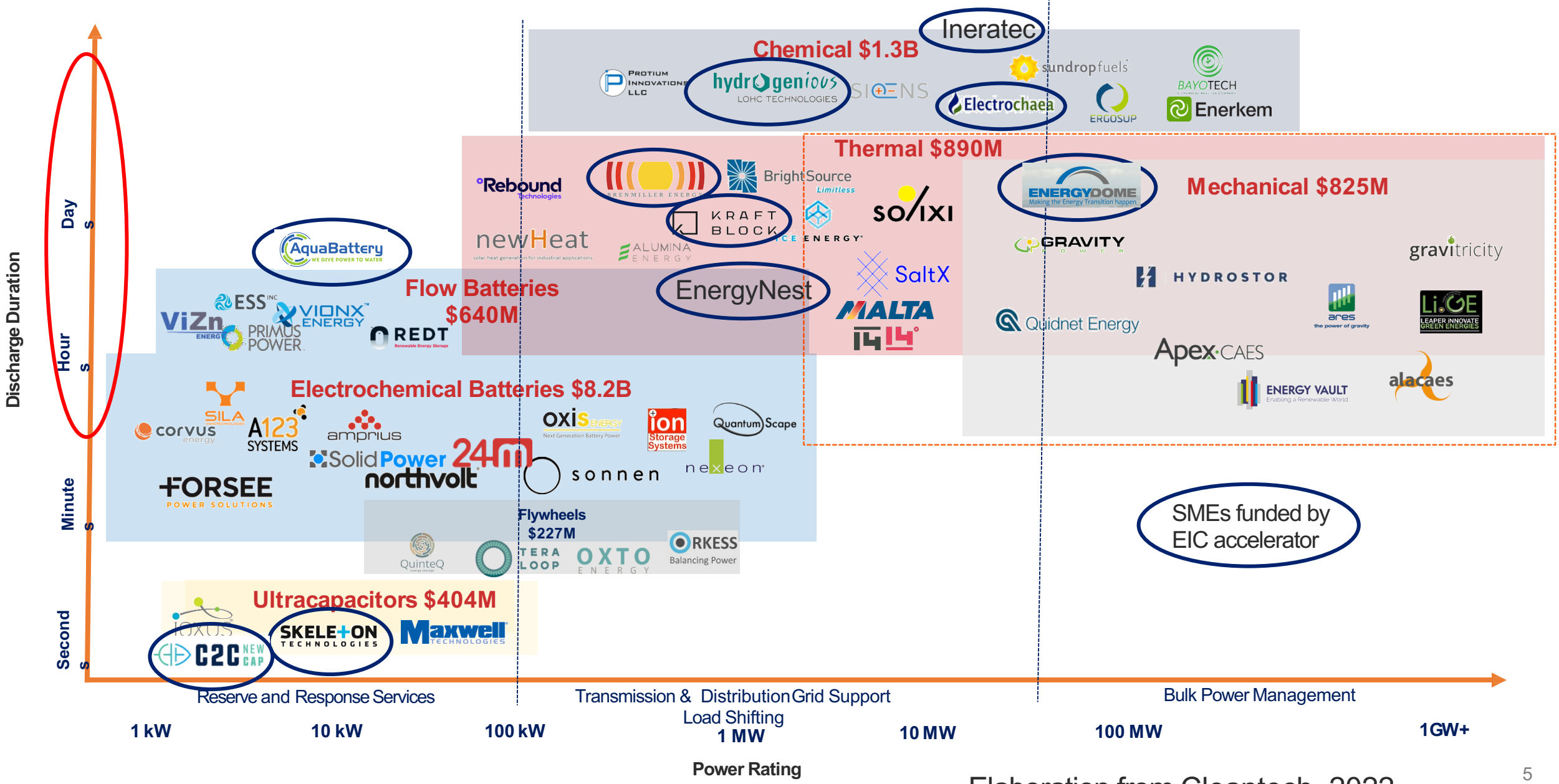
European Innovation Council



- Electrochemical storage
- Thermal storage
- Chemical storage in energy carriers
- Thermomechanical storage



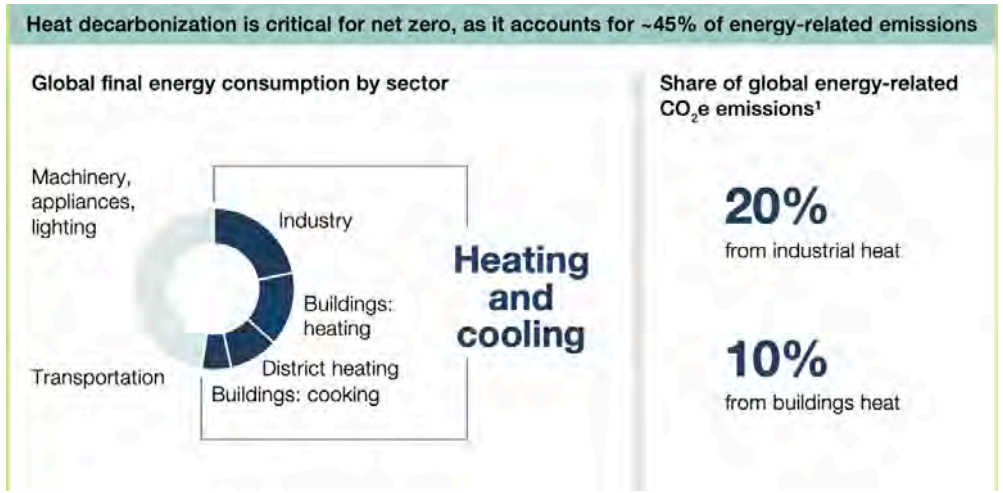
Energy Storage: market trends



Elaboration from Cleantech, 2022

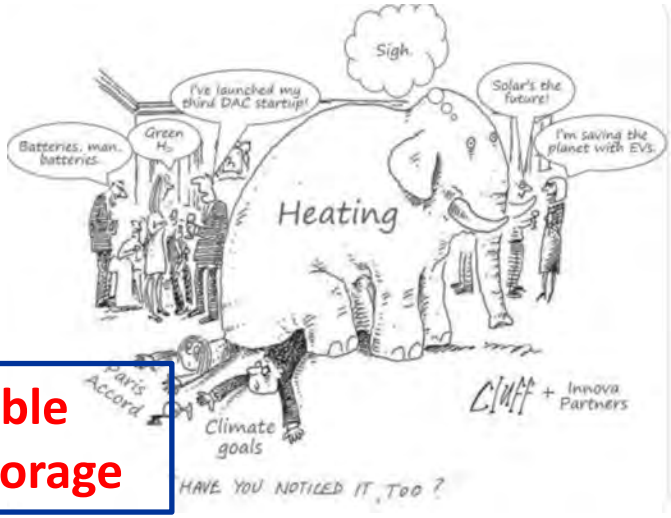
Storage and heat decarbonization

- Heat is the largest energy end-use: around 50% of total energy consumption
- Industries are responsible for 51% of the energy consumed for heat (mid to high T heat)

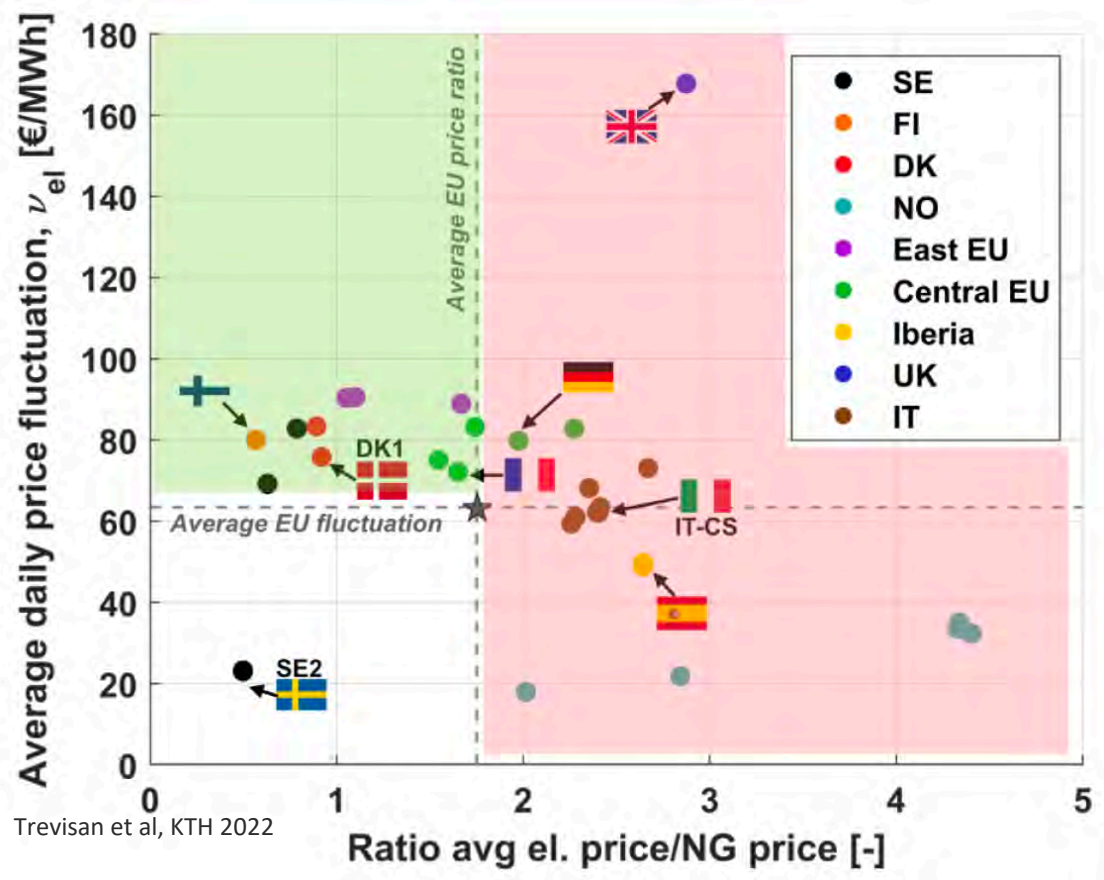


Net-zero heat: Long Duration Energy Storage to accelerate energy system decarbonization LDES Council, McKinsey

Key drivers for power to heat
High natural gas price
High electricity price fluctuations



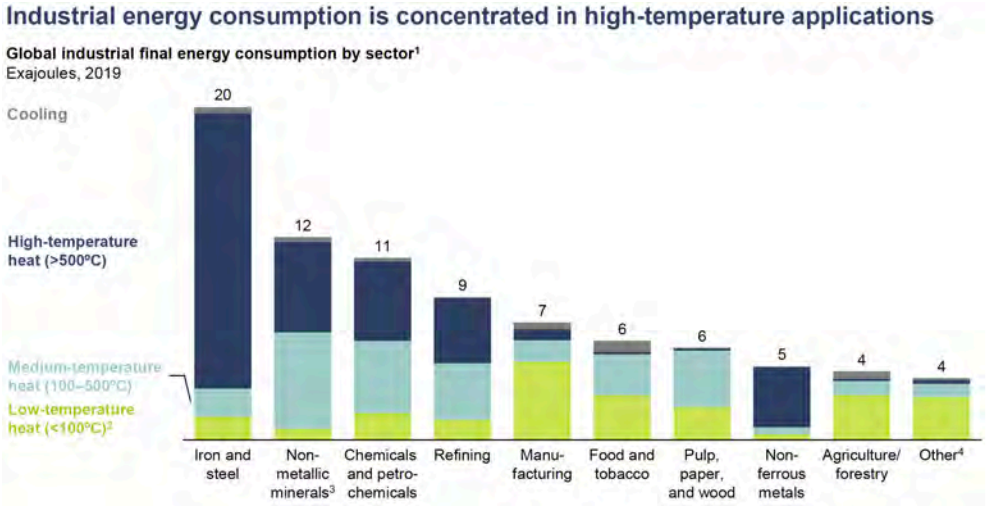
Electricity to heat can be sustainable and competitive – if coupled to storage

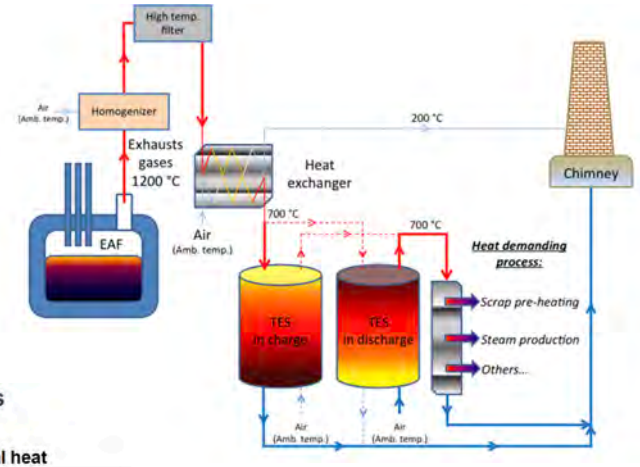


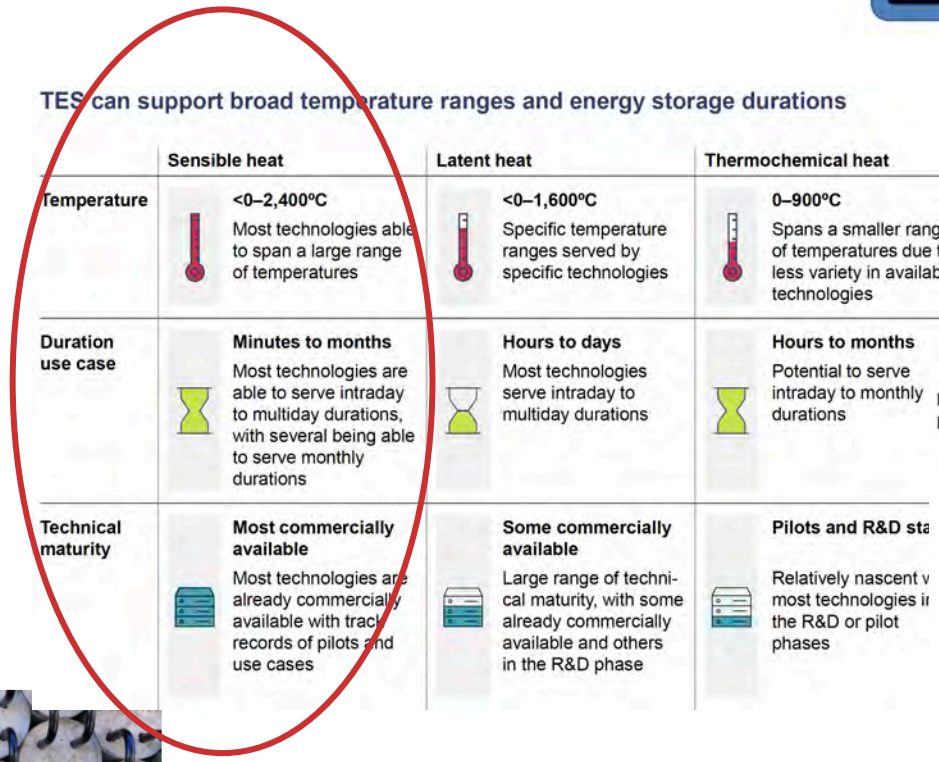
Trevisan et al, KTH 2022

Thermal Energy Storage for hard to abate industrial sector

Industrial batch processes: intermittent waste heat storage
Steel decarbonization: electric air furnaces + high T heat recovery
Cement and limestone (SaltX)

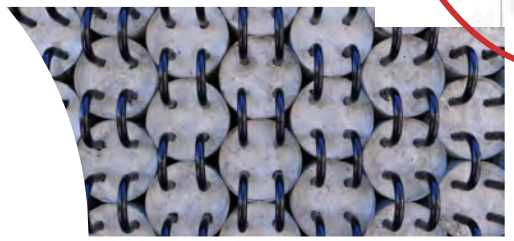


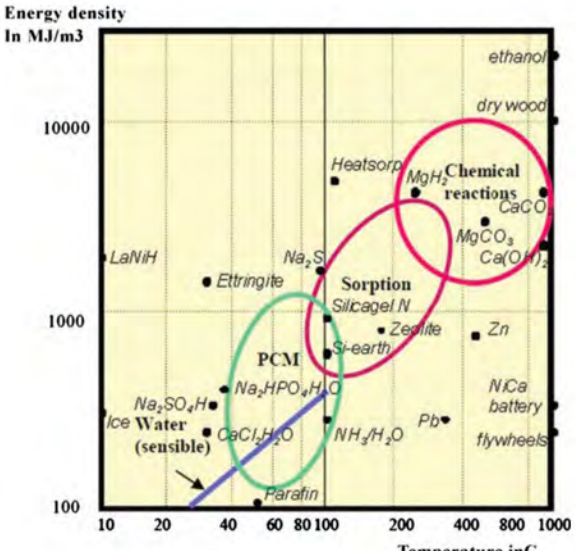




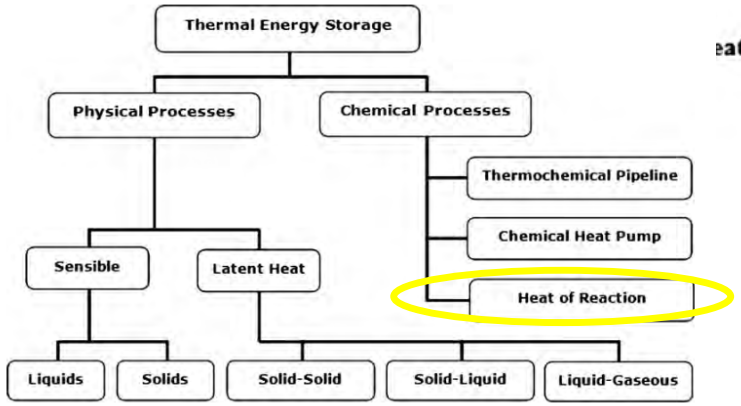
s://doi.org/10.1016/j.apenergy.2019.01.007

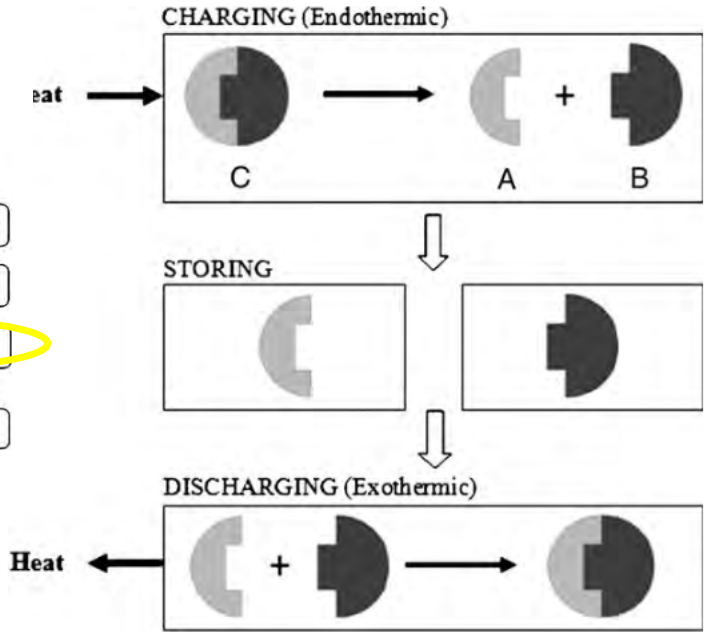
Waste heat or power to heat solution
Sensible heat storage (HEATCRETE®)
EnergyNest EIC accelerator





Thermochemical and molecular energy storage



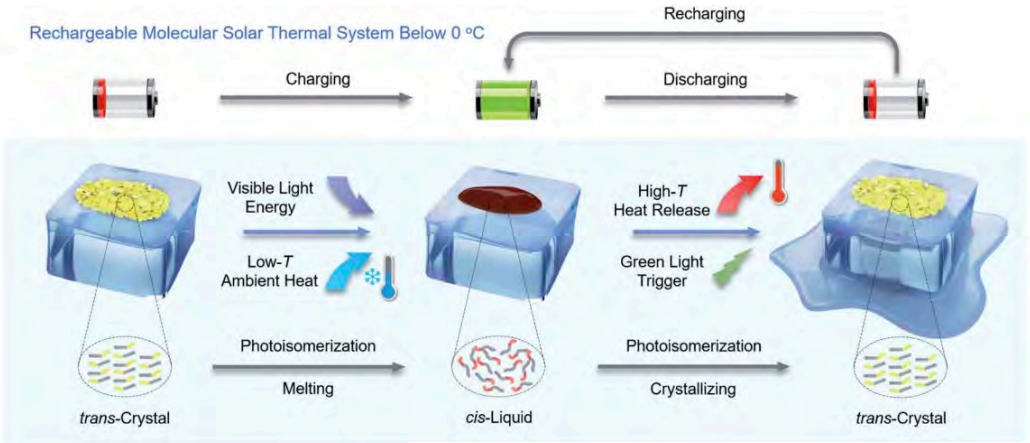


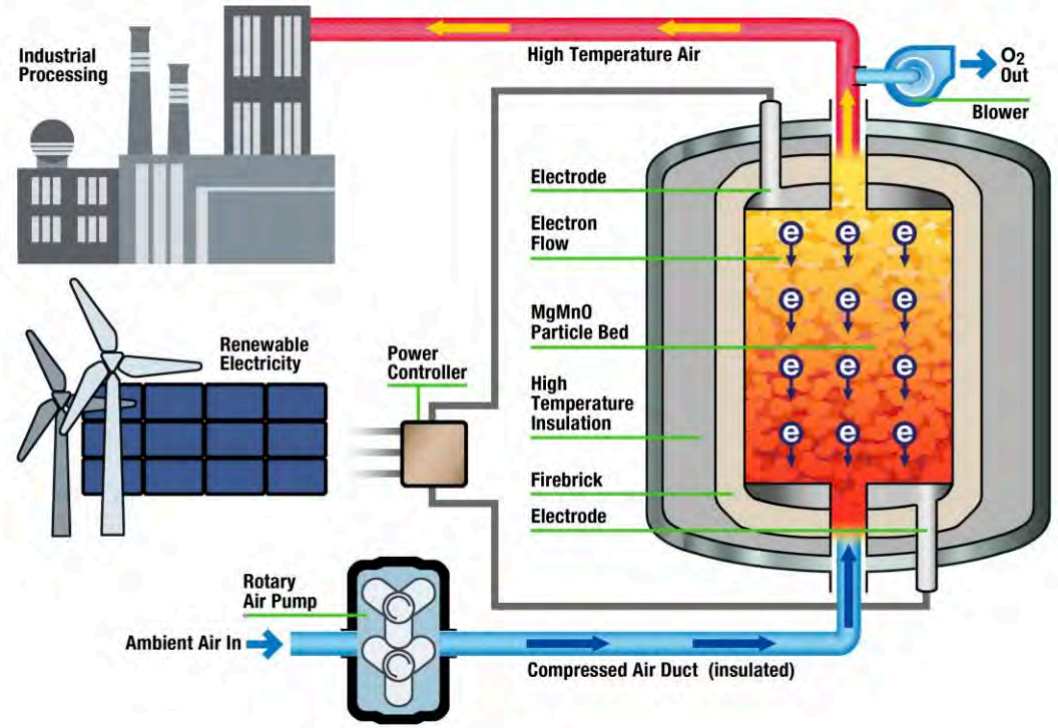
RedoxBox

Packed bed of magnesium manganese oxide pellets

Reduction (charge): $MgMnO_3(s) + \text{heat} \rightarrow MgMnO_2(s) + \frac{1}{2}O_2(g)$

Oxidation (discharge): $MgMnO_2(s) + \frac{1}{2}O_2(\text{in air}) \rightarrow MgMnO_3(s) + \text{heat}$





MOST, ESIM

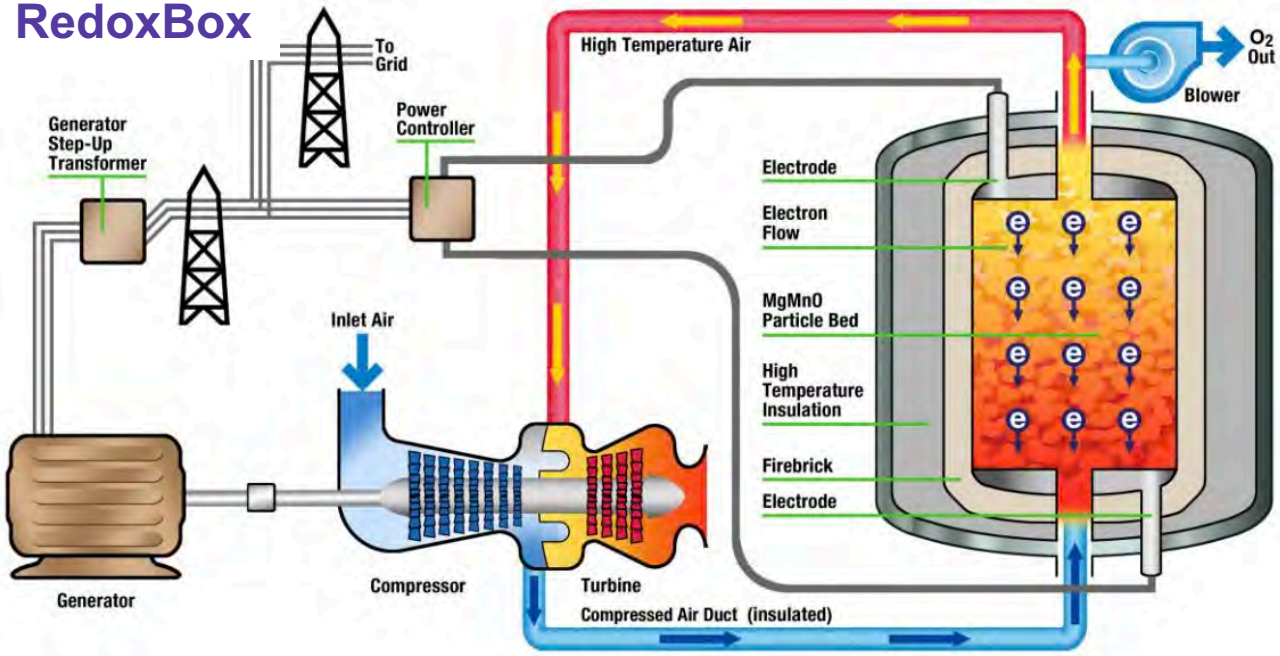
Molecular photoswitching + PCM

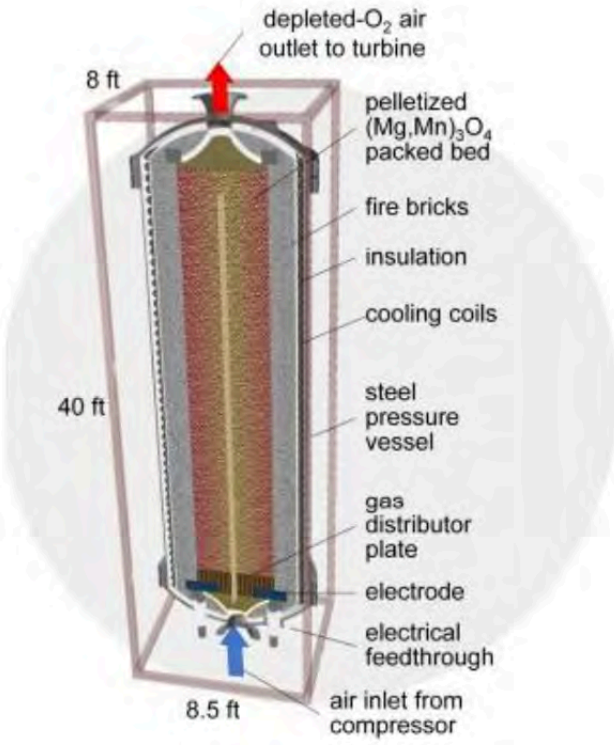
Heat harvesting + storage in chemical bonds

DOI: 10.1039/d2sc01873j

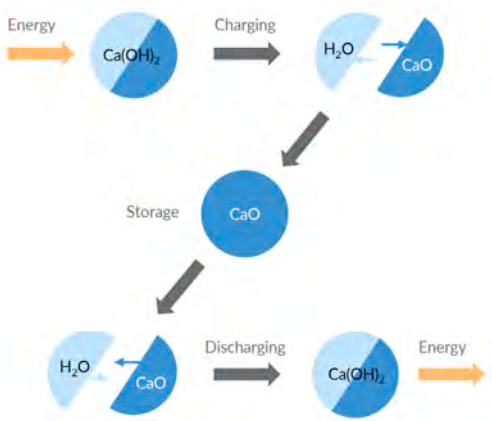
Thermochemical storage integration in power cycles

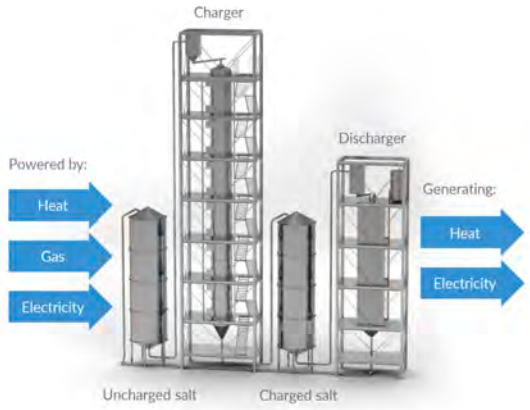
RedoxBox



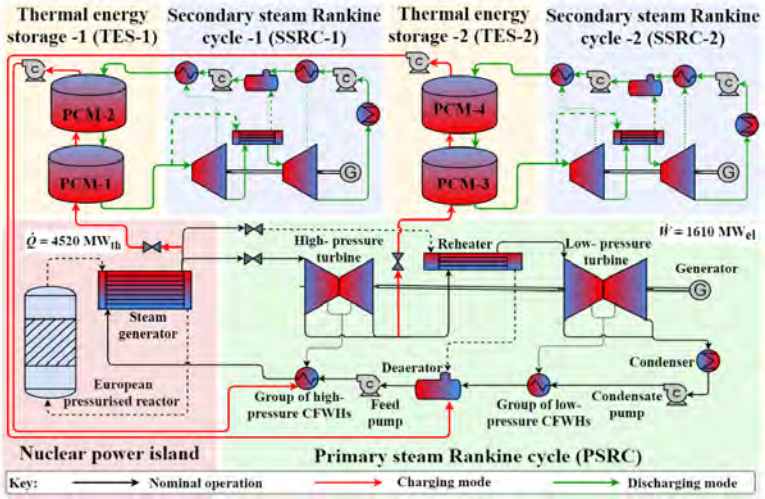


SaltX

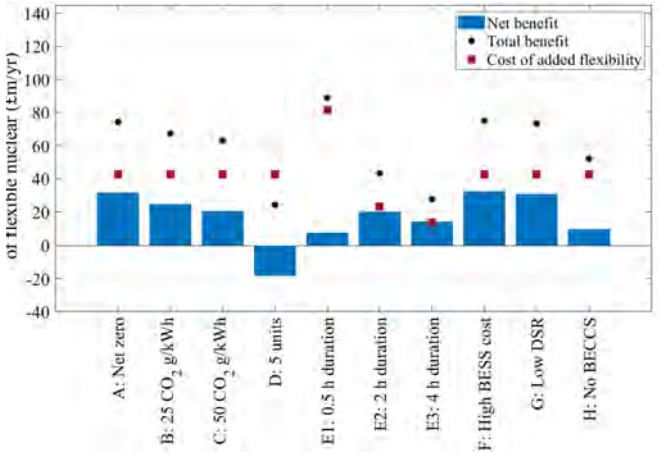




Energy storage integration in the generation mix



1.Nuclear flexibility upgrade is cost-efficient



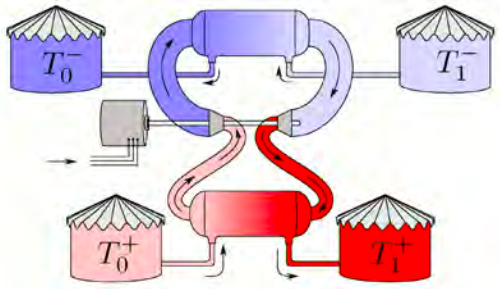
Sites of nuclear power stations in the UK

benefit from **£60.1–63.1m/yr** (50 gCO_2/kWh) to **£67.4–74.3m/yr** for a net-zero carbon system

Al Kindi A.A., Aunedi M., Pantaleo A.M., Strbac G., Markides C.N. (2022) Energy Conversion and Management

2.Coal power plants refurbishment to storage: the Bryton Energy concept (Arpa-e)

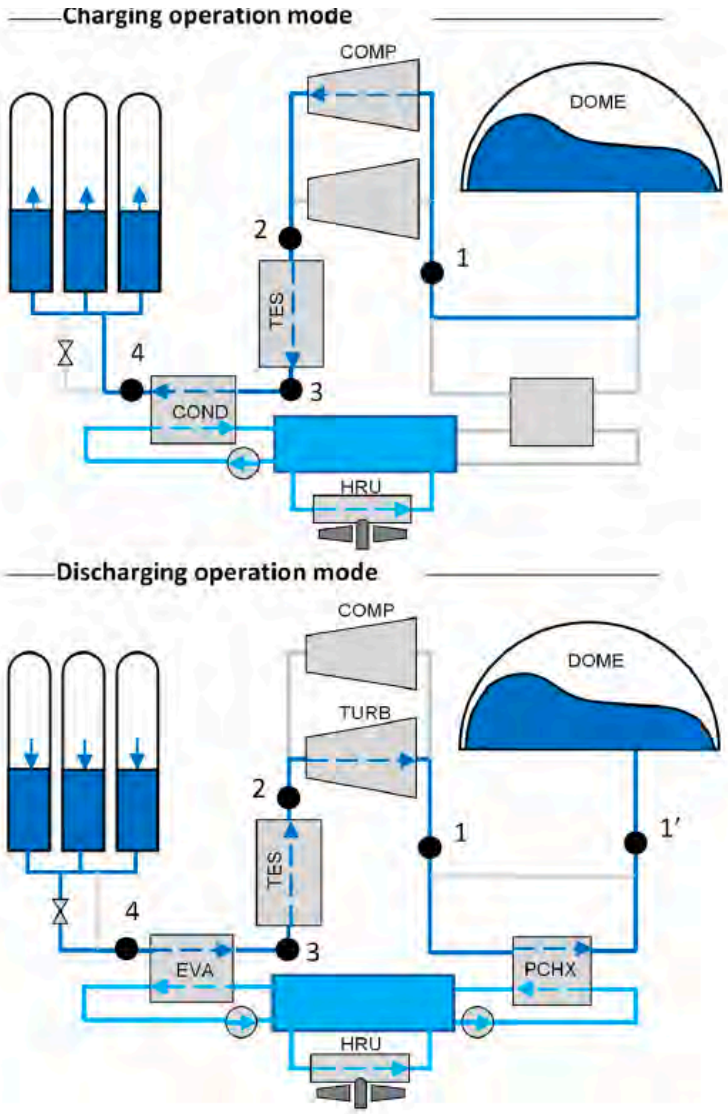
Nobel Laureate R. Laughlin: '*energy storage is a problem of 19th century science. No future laboratory breakthroughs or discoveries are required for solving it. All that is needed is* ***fine engineering*** *and* ***assiduous attention to detail****..'*

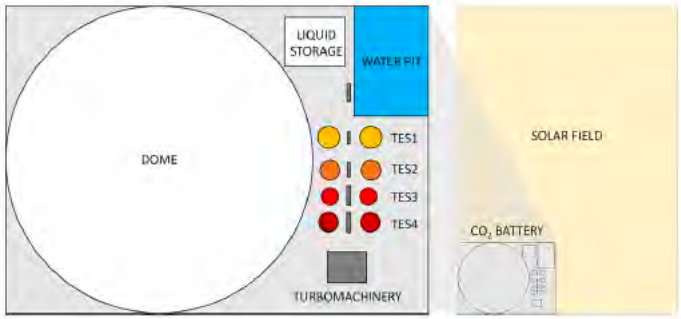


'..the storage capacity of months becomes feasible once the engine and HX exists as a product one can purchase at a **known cost**, particularly if the **heat is further transferred into cheaper media** for longer-term storage. Thus, pumped thermal storage with HX is not a niche solution to the energy storage problem but a global one...'

Pumped thermal grid storage with heat exchange," by R. B. Laughlin, *Journal of Ren and Sustain Energy* (2017)

EIC accelerator: EnergyDome

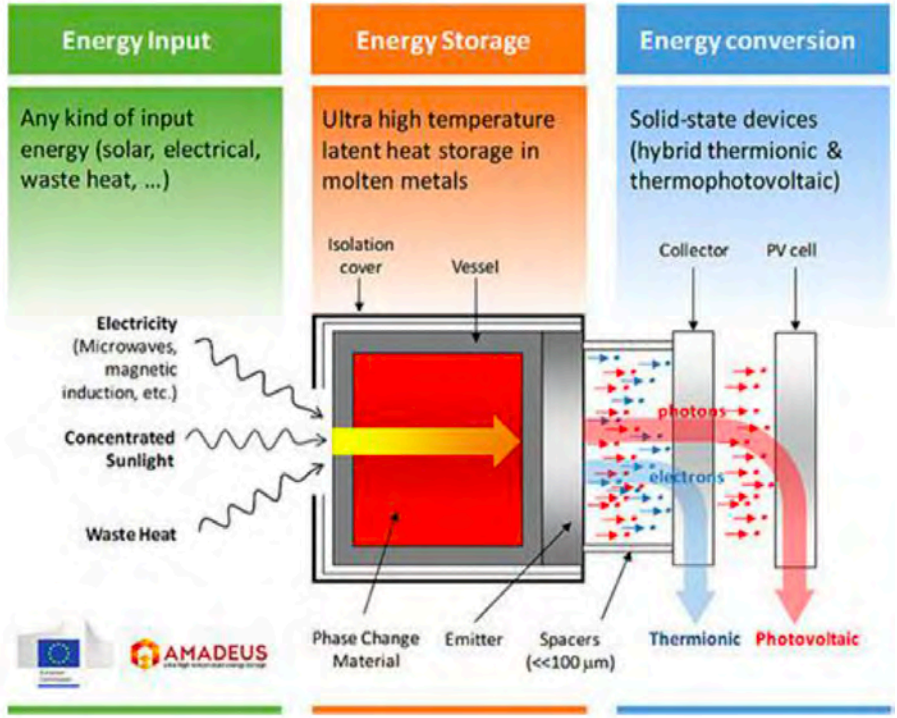


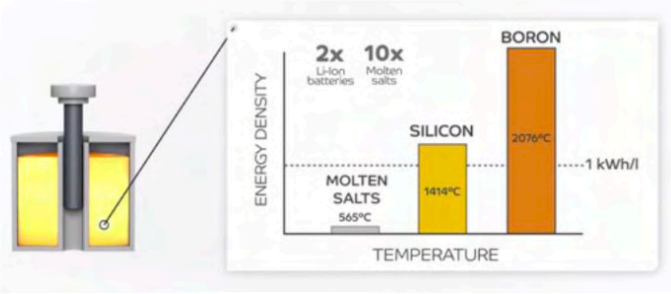


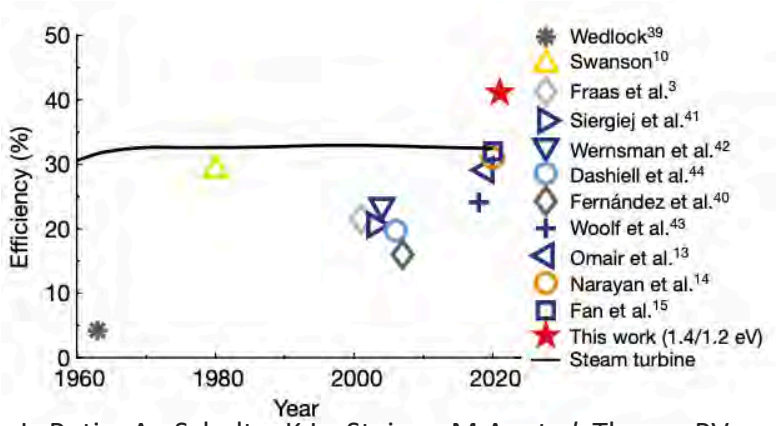
	CO_2 Battery	PHS + CAES	GRAVITATIONAL	Iron Flow Battery
Company	ENERGYDOME	HYDROSTOR	ENERGY VAULT	ESS INC
RTE (%)	75 – 80+	60	75 – 80+	65 - 70
CAPEX (€/kWh)	150-200 for First of a Kind*	Competitive only on very large scale	300	>200 under strong cost reduction hypothesis**
Lifetime (years)	30+	30+	30+	20 - 25 (not proven)
Working demo plant at scale	Yes	Yes	No	Yes
Commercialization date	2022	Commercial	>2024	Commercial
Dependency on raw material	Low	Low	High due to the large amounts of materials needed.	Iron, salt, and H2O but dependant on liquid electrolyte production
Typical capacity and duration	20MW; 4-24h	50MW; >10h	Unknown, but expected to be moderate	kW scale; 4 to 12 hours
Footprint (kWh/m2)	4-5	15 - 20	<5	2 - 4
Site dependency	None	High	Moderate	None
Others	No dependency on ambient temperature; No supply chain constraints; Potential visual impact concerns depending on location;	Long development time; high geological risk.	Very high visual impact, not proven technology	100% Depth of discharge; Non-hazardous electrolyte; Supply chain constraint on electrolyte availability

Journal of Engin. for Gas Turbines and Power AUGUST 2022, Vol. 144 / 081012-1

Power to heat to power: perspectives of thermoPV and the EIC transition instrument



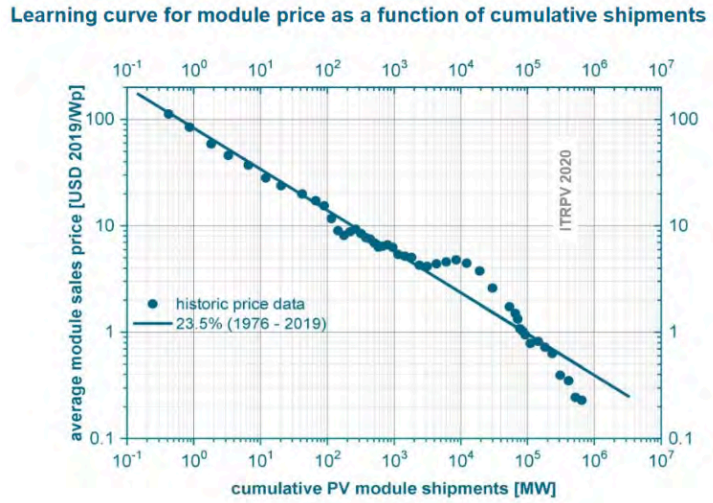




LaPotin, A., Schulte, K.L., Steiner, M.A. *et al.* ThermoPV efficiency of 40%. *Nature* **604**, 287–291 (2022).

ThermoPV: cost reduction similar to PV
Electric efficiency 40% lab scale

Antora Energy (Arpa-e), Amadeus/Thermobat (EIC), Nano-TEC (ERC CoG)
Trade offs cost vs efficiency: thermoeconomic comparison in different market segments

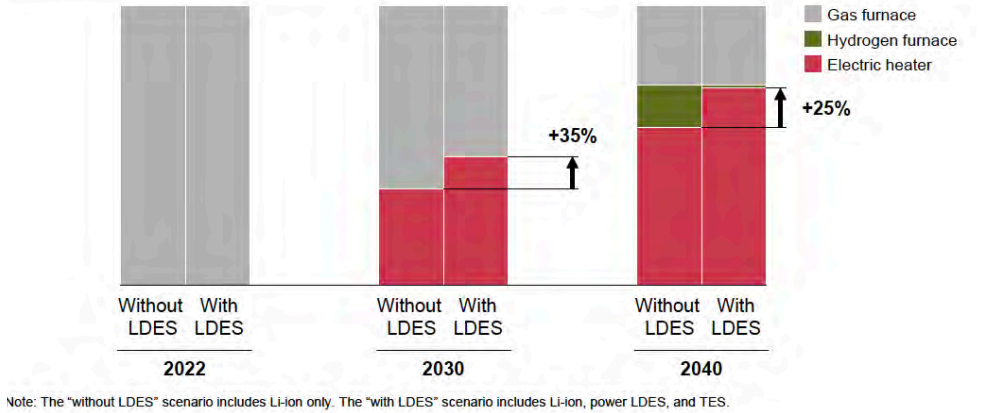


Technologies integration: heat pumps and storage

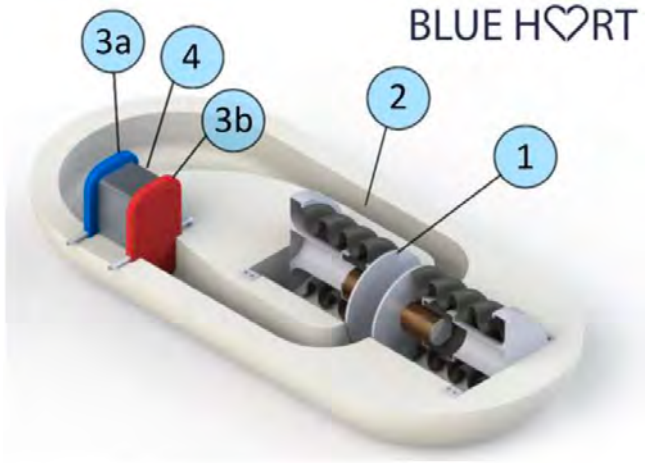
European Innovation Council

LDES can significantly improve the economics of electrified high-temperature heat

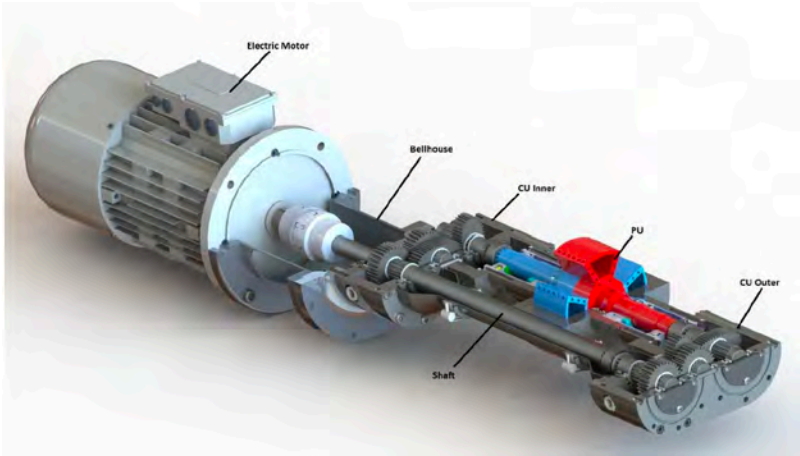
High-temperature heat supply mix development over time
Share in percent



Note: The "without LDES" scenario includes Li-ion only. The "with LDES" scenario includes Li-ion, power LDES, and TES.

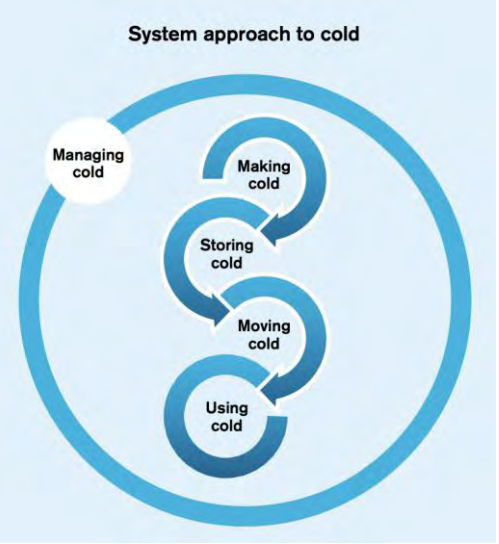


Key R&I needs for heat pumps
achieve high COP at higher temperature lift
To extend the application to existing building stock
Hybrid adsorption- vapour compression HP



The challenge on clean cooling

- **Dirty process**: 10% of CO2 emissions come from cooling (3 times more than aviation and shipping)
- **Fast increasing**: demand of air conditioning will cover 50% of global electricity demand by 2100
- **Data centres**: around **half of their energy consumption** goes on cooling (up to 100 GW by 2030)
- Current/future **energy carriers** (H_2, NH_3, CH_4) are small molecules : need cooling/ compression
- **Developing countries**: two million **vaccine** preventable deaths each year, and the **loss of 0.2 billion tonnes of food** (and 3.3 billion tonnes of CO2 emissions, third biggest emitter after US and China).
- Clean cold requires a **fully integrated 'cold economy',** with novel clean cold technologies, the integration of waste and under-exploited energy resources (i.e. wasted cold from LNG)



Need for:

- **transformational research** - displace existing technologies
- **Integration of renewable energy** for cooling (i.e. passive cooling, radiative and solar cooling, absorption and hybrid heat pumps)
- **Components**: new compression-expander mechanisms (scroll, electrochemical compression), mixed refrigerants, novel cycles configurations
- **store and move cold** (decoupling demand/generation) and system level integration
- **End uses**: management of cold consumption, diagnostics and soft fault detection

Portfolio composition and proactive management

Preliminary portfolio composition approach:

Cooling generation

Cooling transport and storage

Operation, control and demand management

Combination of diversity and complementarities

Portfolio activities

- Identification of shared components and potential synergies
- Definition of potential common activities and use of same metrics to compare technologies
- Stakeholder mapping and engagement with the innovation ecosystem,
- Development of common exploitation plans and communication activities
- Synergies with other EU funding instruments
- Policy, standards, regulatory bottlenecks to innovation

Key factors to increase success rate

- **Knowledge of policy background**: connection of proposals to EU strategies, SET plan
- **Alignment with topic guide**: full understanding of scope of call (for top down calls)
- **Write up of proposal**: support from grant offices to submit proposal without technical shortcomings and complete in all sections
- **Multidisciplinariety, communication plan, dissemination, exploitation, IP management**:
- **Interaction with POs and PMs**: not ’last minute’; experience as evaluator to submit successful proposals (high quality experts and evaluators needed!)
- **EIC accelerator**: gender parity, team expertise (CEO, CTO, CFO), market assessment and competitors, pilot ready (technical maturity), try several times!

EU paradox: excellent research not transferred into market creating innovation

European Innovation Council

- Empowerment of **innovation ecosystem** for start ups, networking and tech transfer
- Increase investment readiness of applicants: poor financial literacy, lack of private investors on board, family-owned companies not interested in equity
- Most Accelerator winners are already generating revenues with solid organizational structure and team, ready to scale-up. This is rare in Italian startups.
- Improve Pitching, project idea selling, IP management, awareness of position in the global market and trends
- **Venture studios**: a fast spreading phenomen, to scout in the research/academic field for entrepreneurial projects
- Role of academia:

'**scientist entrepreuners**', innovation management in PhD programmes

outreach of private investors by startups to learn how to pitch and receive valuable feedback, pitch events and competitions to stimulate entrepreneurial attitude

Key considerations on thermal energy storage

- Economics: Electricity price fluctuations and cost of fossil fuels
- Heat electrification and heat pumps: opportunity for TES
- Industrial decarbonization: TES in batch processes
- Need for regulatory framework amendments (prosumers and storage)
- Future trends: thermal fuels, seasonal storage, storage as a service/digital

The energy transition in the EU: lessons learn

European Innovation Council

- Need to lower the costs of energy transition: permitting, standard, regulations
- Scale up innovation and connect to industries
- Attract private investments
- Global market thinking
- Better metrics to advice investment decisions
- Better macroeconomic data to build robust scenarios for industrial investments

European Innovation Council

Thank you!

Antonio.pantaleo@ec.Europa.eu

EIC Accelerator – The evaluation process

European Innovation Council

We will help **you** to prepare your **business plan** and draft a **proposal** with AI tool and coaching

You submit your full **proposal** which will be **assessed** by Remote evaluators

You have a disruptive / deep tech **idea** with a potential to **scale up** and you need **financial support**

Tell us your story in 5 pages

You will **pitch** your innovation in front of EIC Jury Members

If selected, you will sign the **contract**

A four-steps process

European Innovation Council

Investment component

- minimum EUR 0.5 million and maximum EUR 15 million,

-usually in the form of direct equity or quasi-equity,

- maximum 25% of the voting shares of the company,

-“patient capital” principle (7-10 years perspective on average).

Grant component

- maximum EUR 2.5 million,

-eligible costs are reimbursed up to a maximum of 70%,

-innovation activities supported should be completed within 24 months,

-small mid-caps are not eligible for grant (but can apply for investment only).

Overview of the EIC Fund

European Innovation Council

EIC Fund invests in and supports early-stage companies to scale-up!

A **€4 billion Agnostic VC fund,** established in June 2020, with a "sweet spot" for Deep Tech

Nearly €1 billion of investments in deep tech companies have been approved by the EIC Fund since the Fund started its operations in **September 2022**.

EIB - Investment Advisor performs due diligence

EISMEA hires high quality independent experts for Tech DD

Ticket size between €0.5 to €15 million (current average €5.3 million)

726 companies selected for support (164 investment agreements signed - direct equity investment or convertible loans)

Current multiplier effect for equity investments is **3.14x average of the EIC money**

35

Key Strategic Goals

European Innovation Council

Our strategic goals reflect our ambition to create a strong European VC ecosystem

Strategic goals as defined in EIC's Work Program for 2023

Be the investor of choice for those with visionary ideas

Crowd in €30-50 billion investment into European deep tech

Support the most promising innovations for society

Increase number of European unicorns and scale ups

Catalyze innovation impacts from European public sector

Achieve operational excellence

36

Financial & Non-financial support

European Innovation Council

All the EIC Awardees receive both financial & non-financial support

Financial Support

- Financial support includes investing up to €2.5m in grants and €15m in equity

Coaching and mentoring

- Business experts with entrepreneurial and fund-raising background to provide companies with crucial insights and guidance

Business Acceleration Services

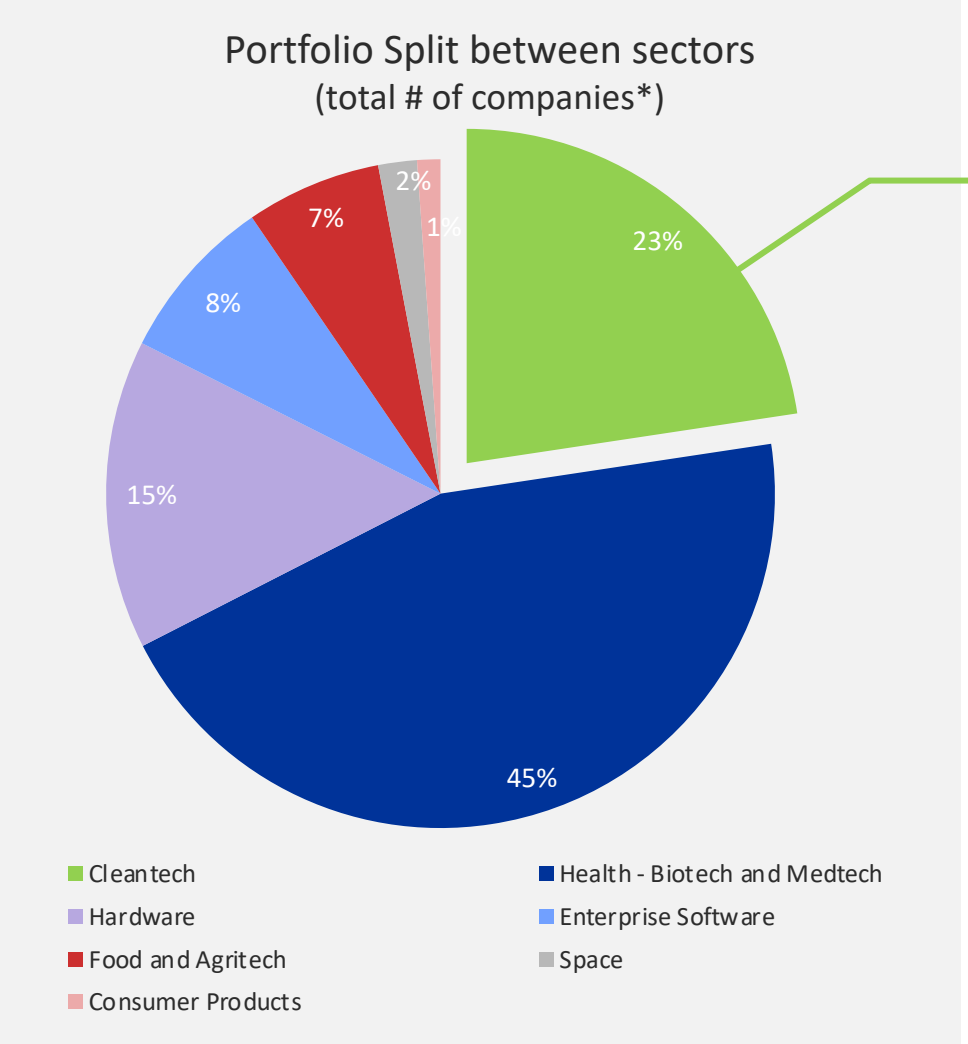
Direct introduction to investors, partners (corporates, procurers etc), participation in overseas trade-fairs

37

EIC Fund companies split across sectors

European Innovation Council

Total of 726 companies selected, 535 selected for equity investment and 164 with signed investment agreements



Cleantech

- **121 companies (23% of the total)**

Environment & Energy

- 61 companies (11% of the total)

New Materials & Construction

- 34 companies (6% of the total)

Transport & Mobility

- 26 companies (5% of the total)

Health - Biotech & Medtech

- 240 companies (45% of the total)

Hardware

- 80 companies (15% of the total)

Enterprise Software

- 43 companies (8% of the total)

Space

- 10 companies (2% of the total)

Food and Agri Tech

- 35 companies (7% of the total)

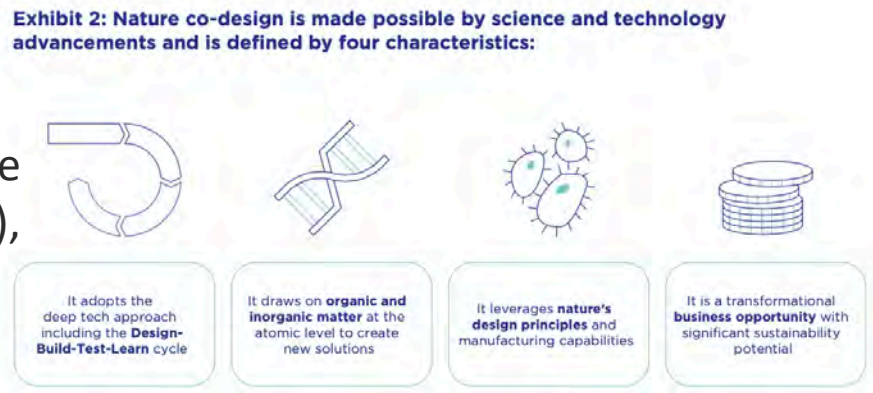
Customer Products and Services

- 6 companies (1% of the total)

*Excluding Grant-Only Portfolio companies

Emerging research trends in sustainability: nature based materials

- Engineering of yeast into a molecular assembly line to produce medicinal molecules (Antheia), plant-based milk and cultivated meat (Perfect Day, Memphis Meats), and programmable materials based on spider silk and cow leather (Bolt Threads, Spiber, Modern Meadow), or vaccinating plants against viruses
- Recycling and upcycling waste streams from industrial processes to "brew" fuel (LanzaTech), proteins (Kiverdi, NovoNutrients), fibers and materials (Mango Materials, Polybion)
- Modeling of living systems with computer-aided design tools to advance therapeutic applications (Asimov), improve protein design (Arzeda), create novel sensors (Koniku), and solve the 50-year-old challenge to predict protein folding (AlphaFold2)
- Leveraging of AI and automation for the discovery of advanced chemicals and materials (Kebotix, IBM RoboRXN, Citrine) as well as the reduction of the **development time for advanced materials** from 20 years to less than 2 years
- Engineering and manufacturing of advanced materials drawing lessons from nature and applying them to electronic films (Zymergen), construction (Biomason, Ecovativ), advanced materials (Niron Magnetics and Sila Nanotechnologies), advanced manufacturing (Terapore), and even luxury (Heyaru).



Instead of exploiting natural resources, nature co-design works with natural laws to manufacture new products and solutions. **Nature becomes humanity's primary partner.**

Synergies with programmes/institutions: some examples

European Innovation Council

- **fast track** to **Life CET** and Innovation Fund: specific extra bonus for SME beneficiaries of EIC accelerator to access other support instruments (potential topics: hard to abate industrial sectors, biomaterials, CCU, renewables, H2) and alignment to Life CET WP2024
- **ERC workshop** on energy storage (thermal, chemical and electrochemical): engagement with scientific community and key stakeholders (corporates, start ups), scientific complementarities Francesco/Marco to address broader scientific areas
- **Missions**: list of projects/beneficiaries aligned to Missions and definition of 2023 challenges with policy priorities (tech autonomy, climate, security and dependencies, health)
- **Task force H2 valleys** (reconcile research and deployment / production and final use)
- **OITB:** opportunities for start ups to test their technologies, share research infrastructures
- **Co-creation groups** (Pillar II)
- **ESA white paper** on circularity (food sector)
- **Internationalization**: collaboration with ARPA-e, Mena Countries and India (solar, biomass)

Institutionalised European Partnerships in the portfolio

PILLAR II - Global challenges & European industrial competitiveness

CLUSTER 1: Health

- Innovative Health Initiative
- Global Health Partnership
- Transformation of health systems
- Chemicals risk assessment
- ERA for Health
- Rare diseases*
- One-Health Anti Microbial Resistance*
- Personalised Medicine*
- Pandemic Preparedness* *Co-funded or co-programmed*

CLUSTER 4: Digital, Industry & Space

- Key Digital Technologies
- Smart Networks & Services
- High Performance Computing
- European Metrology (Art. 185)
- AI-Data-Robotics
- Photonics
- Made in Europe
- Clean steel – low-carbon steelmaking
- Processes4Planet
- Global competitive space systems**

CLUSTER 5: Climate, Energy & Mobility

- Clean Hydrogen
- Clean Aviation
- Single European Sky ATM Research 3
- Europe's Rail
- Connected and Automated Mobility (CCAM)
- Batteries
- Zero-emission waterborne transport
- Zero-emission road transport
- Built4People
- Clean Energy Transition
- Driving Urban Transitions

CLUSTER 6: Food, Bioeconomy, Agriculture, …

- Circular Bio-based Europe
- Rescuing Biodiversity to Safeguard Life on Earth
- Climate Neutral, Sustainable & Productive Blue Economy
- Water4All
- Animal Health & Welfare*
- Accelerating Farming Systems Transitions*
- Agriculture of Data*
- Safe & Sustainable Food System*

PILLAR III - Innovative Europe

EIT

- InnoEnergy
- Climate
- Digital
- Food
- Health
- Raw Materials
- Manufacturing
- Urban Mobility
- Cultural and Creative Industries

SUPPORT TO INNOVATION ECOSYSTEMS

- Innovative SMEs

CROSS-PILLARS II AND III

- European Open Science Cloud

Institutionalised Partnerships (Art 185/7)
Institutionaised partnerships / EIT KICs
Co-Programmed
Co-Funded

** Calls with opening dates in 2023-24*
*** Calls with opening dates not before 2022*

European Commission