European Innovation Council

Backing visionary entrepreneurs

Ann-Marie Sassen
Head of unit, EIC Programme Manager

Marco Antonio Pantaleo
EIC Programme Manager for Energy Systems and Green Technologies

15/03/2023

Agenda

- Overview of the EIC funding programmes
- The rationale for clean cooling
- The EIC pathfinder challenge: scope of the call
- Examples and innovation needs
- Evaluation process and portfolio composition
- Portfolio management
- Pitches for matchmaking

WELCOME!

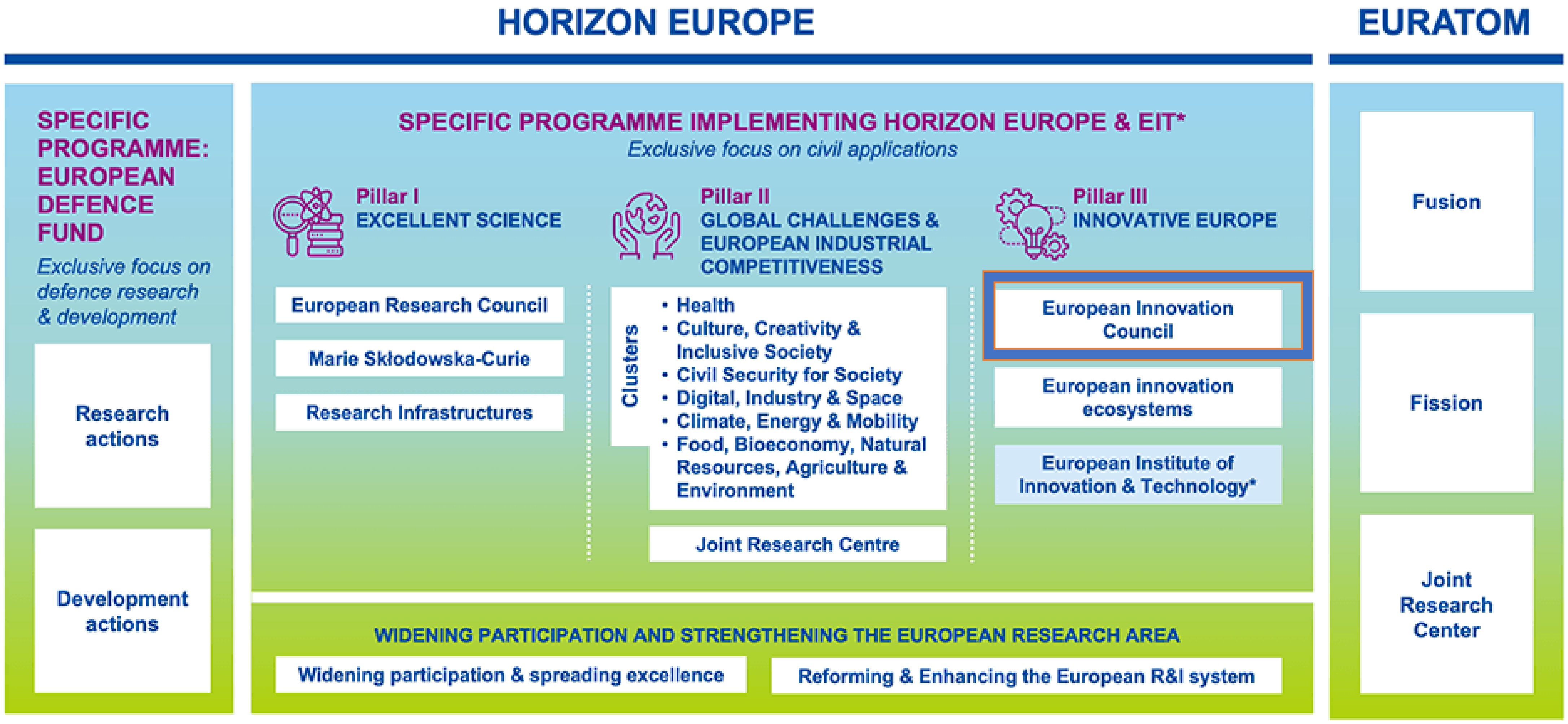
- Be aware that **this meeting is recorded**
- **Recording and slides** of the event will be available very soon **on the event page**
- Please submit **your question as Anonymous** in Sli.do if you do not want your name to appear in the recording.

Join at **Sli.do**

With the event code **#Challenges**

Horizon Europe Structure

European Innovation Council



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

European Innovation Council

EIC Programs

Pathfinder (TRL1-4)

- **For consortia (open and challenge calls) and single entities (challenge call)**
- Early stage research on breakthrough technologies
- **Grants up to €3/4 million**

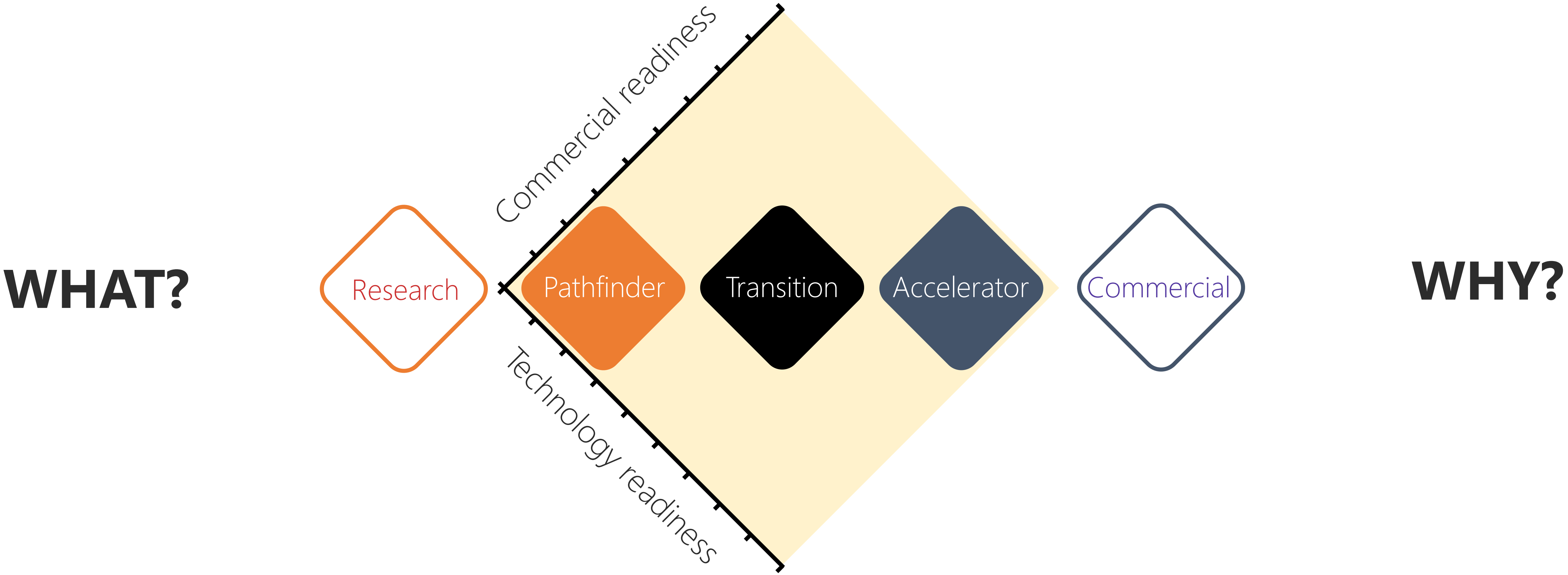
Transition (TRL 4-6)

- **For consortia and single entities**
- Technology maturation from proof of concept to validation
- Business & market readiness
- **Grants up to €2.5 million**

Accelerator (TRL 6-9)

- **For individual SMEs**
- 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 or above**)

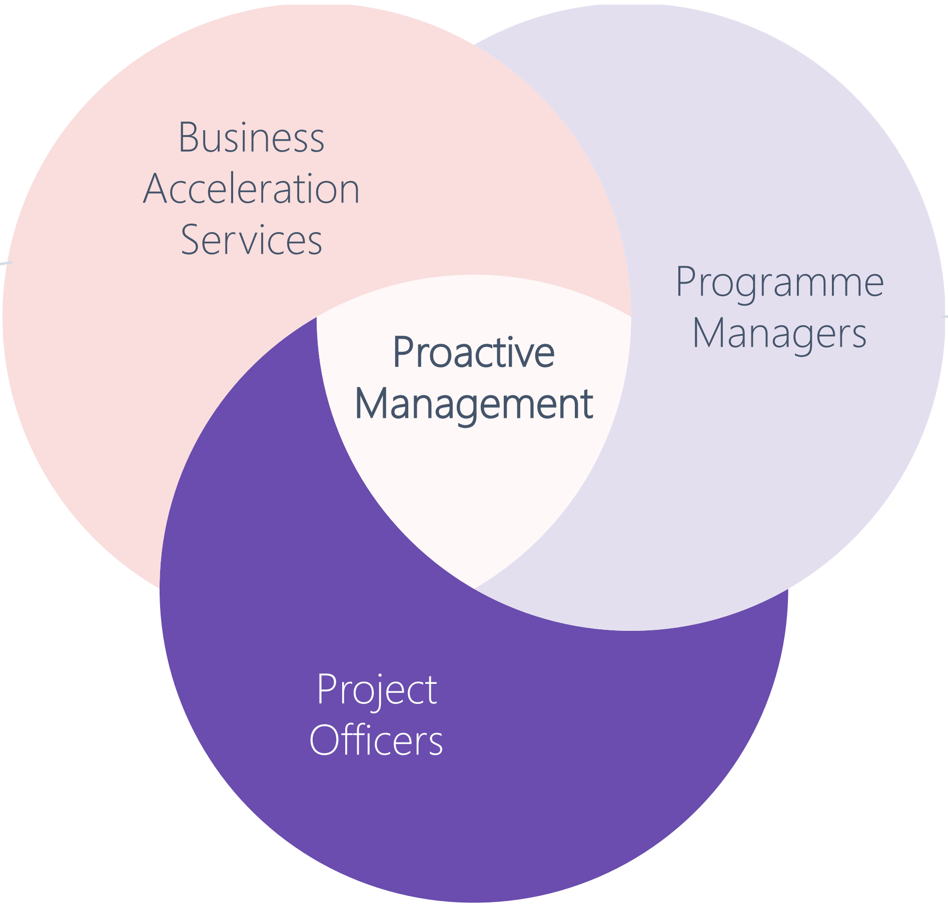
EIC stages the entrepreneurial journey as pathfinder, transition, accelerator with increasing readiness levels



European Innovation Council

With proactive management the EIC aims to maximize its support to success of the entrepreneurial journey

- Access to entrepreneurs
- Access to mentoring
- Access to ecosystems
- Access to partners, peers
- Access to trainings
- Access to workshops
- Access to expert advice
- Access to recruitment
- Access to industry

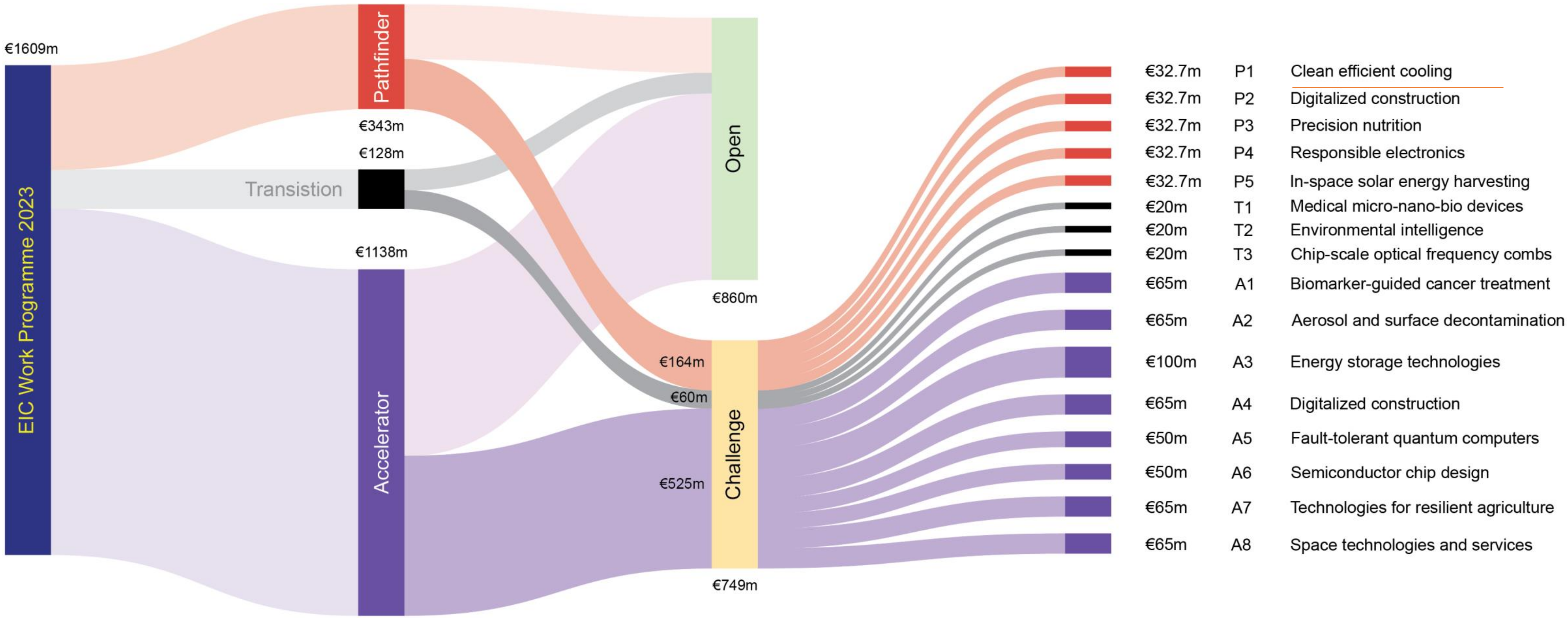


- Health, Biotech
- MedTech
- SpaceTech
- Quantum, electronics
- Greentech materials
- Greentech
- AEC
- Agri-food
- Responsible electronics
- Bio-fuels, E-fuels

Challenges
Portfolios
Outreach

European Innovation Council

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



European Innovation Council

Cut-off dates of the various calls

Cut-off dates:	Pathfinder	Transition	Accelerator
Open	7 March 2023	12 April 2023 27 September 2023	11 January 2023 22 March 2023 7 June 2023 4 October 2023
Challenge	18 October 2023	12 April 2023 27 September 2023	22 March 2023 7 June 2023 4 October 2023

European Innovation Council

EIC Pathfinder

Clean cooling technologies

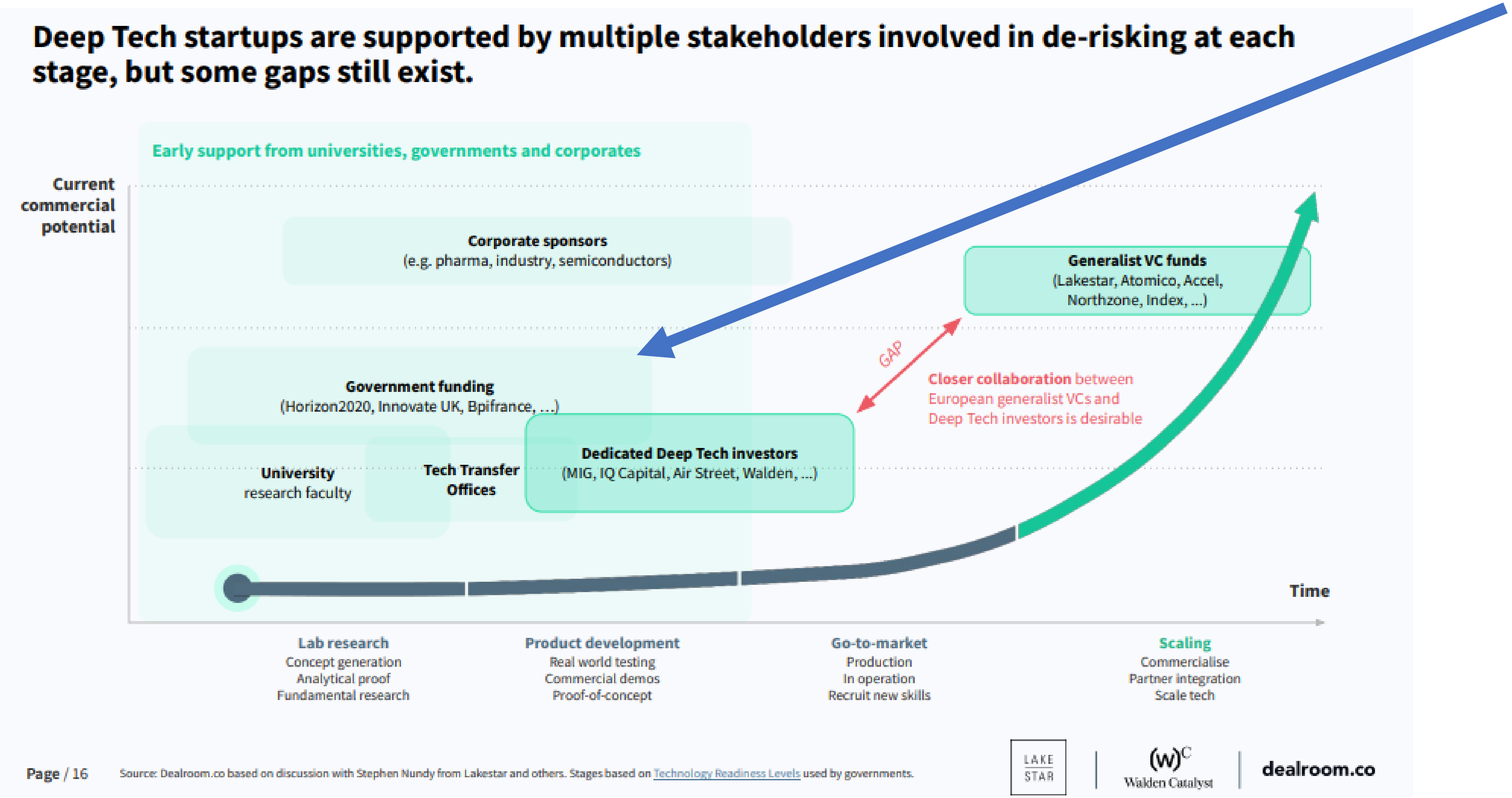
Positioning of EIC accelerator in deep tech

European Innovation Council

Turning innovation into solid economic success requires patience

Nobel Laureate J. Goodenough developed the Li-ion battery in the 1970s, but it wasn't until 1991 that Sony first commercialised it with its camcorders

High risk emerging Deep Tech



The research priorities for the energy transition

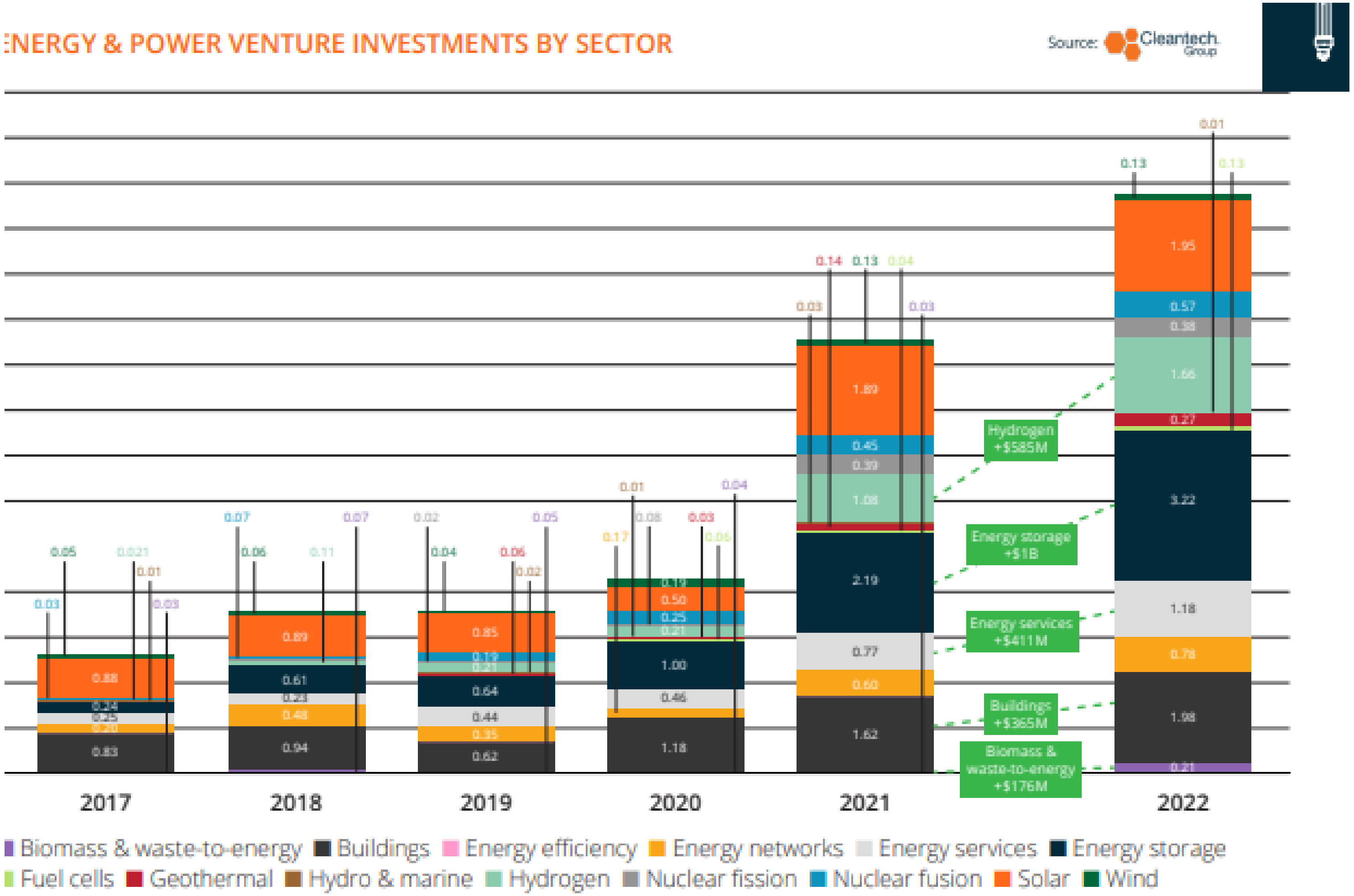
- green energy and circular economy (renewables, energy saving and efficiency, reuse and recycle)
- security of supply and open strategic autonomy (diversification, dependencies from imported fuels, critical materials)
- competitiveness and costs reduction (digital transition, energy communities, industrial symbiosis)

Key needs and opportunities for R&I

1. Systems integration and broader picture view
2. Circularity and Critical Raw Materials
3. Heating/cooling decarbonization
4. Complexity reduction act for innovation: speed, simplicity, scale

- Fit for 55%
- RepowerEU
- **Green deal industrial plan**
- **Net zero industry act**
- Critical raw materials act
- Electricity market design

PRIVATE INVESTORS SIGNALS



Cooling technologies are strategic for **several sectors** with high venture investments (hydrogen, energy storage, buildings etc) but also for digital, food, industrial processes etc

Fundamental and transformational research for clean cooling technologies has not been properly supported with dedicated EU programs so far

Scope/Specific objectives of the call

European Innovation Council

Potential applications

1) **data centres**, electronics, batteries and superconductors
2) **built environment**, building health and comfort, interoperable urban energy systems
3) **food production** (i.e. vertical farming), processing, storage and refrigerated transport,
4) **cold energy carriers production**, transport and network integration (liquid H2, LNG, ammonia, etc)
5) chemical, metallurgical and **hard to abate industries**

Research and innovation needs:

1) computational modelling, optimization and validation of heat transfer processes, working fluids, components;
2) unconventional refrigeration principles (i.e. thermoelectric, magnetocaloric, electrocaloric, elastomeric or barocaloric, photonic cooling).
3) net zero cooling technologies for industrial/residential sector (solar and geothermal, hybrid pumped heat and heat transformers, interoperability of district networks, etc);
4) ultra-energy efficient operations and logistics along the cold supply chain;

European Innovation Council

Objectives and expected outcomes

New devices, processes, components and materials for cooling, in order to:

- reduce investment/operational costs
- increase efficiency, operational reliability and interoperability
- avoid the use of critical raw materials or harmful refrigerants and pursue circularity by design approaches

The proposals should refer the expected COP to the **max theoretical COP** of the inverse Carnot cycle and describe how the proposed solution can be **competitive with the state of art at the proposed operating range**. The solutions should aim to achieve **single stage temperature gradients higher than 5 °C** at a competitive COP.

Alignment with EU Policies and synergies

European Innovation Council

Relevance to EU policies and initiatives

RepowerEU, Fit for 55, Chips Act, net zero industry act, critical raw materials act, Quantum energy initiative
Clean heating and cooling act
Digital EU, Food security, Farm to Fork, Health (post pandemic need built environment)
Mission innovation (affordable heating and cooling) Sustainable cooling pledge COP 28

Synergy/ complementarity with other EU programmes

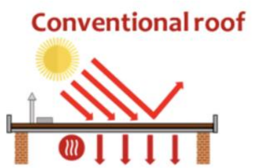
HEU missions (Cities, Climate Adaptation), Cluster 5 HEU, Cluster 4 HEU, BEPA,
Partnerships: Built4people, Clean Energy Transition, BEPA + Renewable heating and Cooling Alliance
Related topics in Cluster 5, WP 2023-24:

- flagships on 'Demonstration of innovative, large-scale, seasonal heat and/or cooling storage technologies for decarbonization and security of supply' (30 MEur)
- flagship ' Building stocks for REpowerEU: innovative solutions for cost-effective decarbonization of buildings via energy efficiency and electrification' (25 MEur)
- innovative components and configurations for heat pump systems (7 MEur)
- advanced manufacturing of PV and solar thermal components and systems (27 MEur)

Examples (I)

- **Heat transfer and heat exchangers:** materials and topology of heat exchangers

dropwise condensation, additive manufacturing or 3D extrusion for HX, solid state cooling, innovative coolants for electronics or batteries, with optimal rheological and thermal properties, integrated suction-gas heat exchanger to improve evaporation and minimize space needs

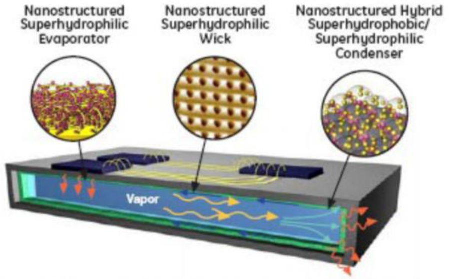


- **Component**s: wet compression for HP, PCM substrates for electronics and batteries and related thermal management, electrodynamic acceleration of dielectric media for air flow
- **Light as a refrigerant**: combination of the latest innovations in lighting, photovoltaics and nanotechnologies.

Electroluminescent cooling to develop **thermophotonic coolers** (from cryogenic coolers to domestic heat pumps) Nature Photonics, 2020 https://www.nature.com/articles/s41566-020-0600-6.pdf

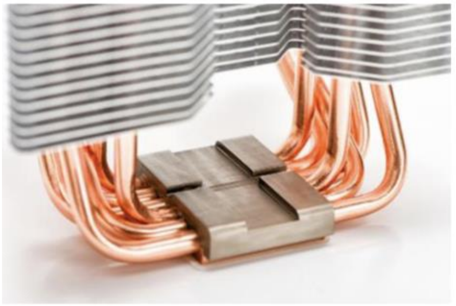
Optical refrigeration via anti-Stokes fluorescence: Monocromatic light absorbed and re-emitted at higher wavelength with high purity materials Optical refrigeration. *Nature Photon* 1, 693–699 (2007)

- **Radiative cooling:** materials that exhibits radiative cooling properties or thermal photonics to boost radiative cooling Nature Photonics (2022) https://doi.org/10.1038/s41566-021-00921-9



A diagram of GE's advanced thermal material system. Leveraging unique surface engineered coatings that both repel and attract water, GE's system achieves twice the heat conducting properties of copper and can function under extreme forces of gravity. The improved heat properties will enable a wide range of better electronics applications, ranging from faster laptops and more advanced radar systems to better aviation and naval electronic control systems.

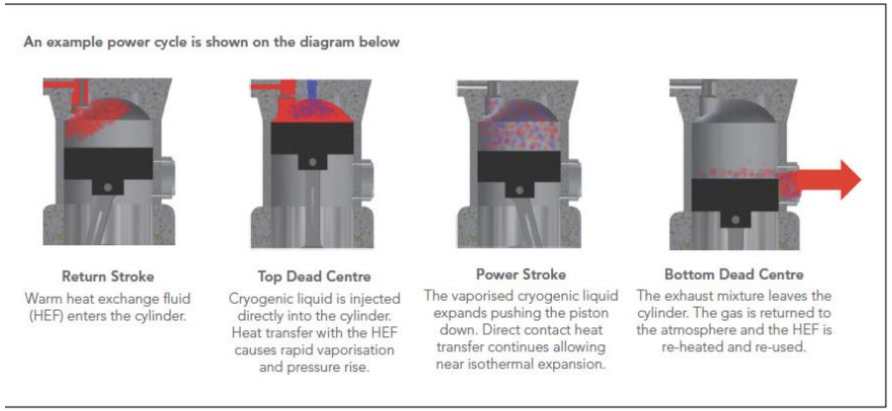
Heat pipes for electronics



Examples (II)

European Innovation Council

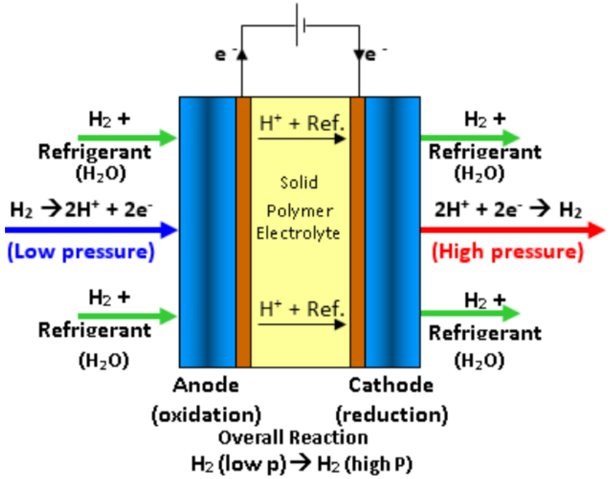
Refrigerated transport: refrigerated truck cooled by a liquid N



Cryogenic expansion engines: heat exchange fluid (made of water and glycol – just like conventional radiator fluid) to promote rapid and efficient re-gasification inside the engine cylinder.

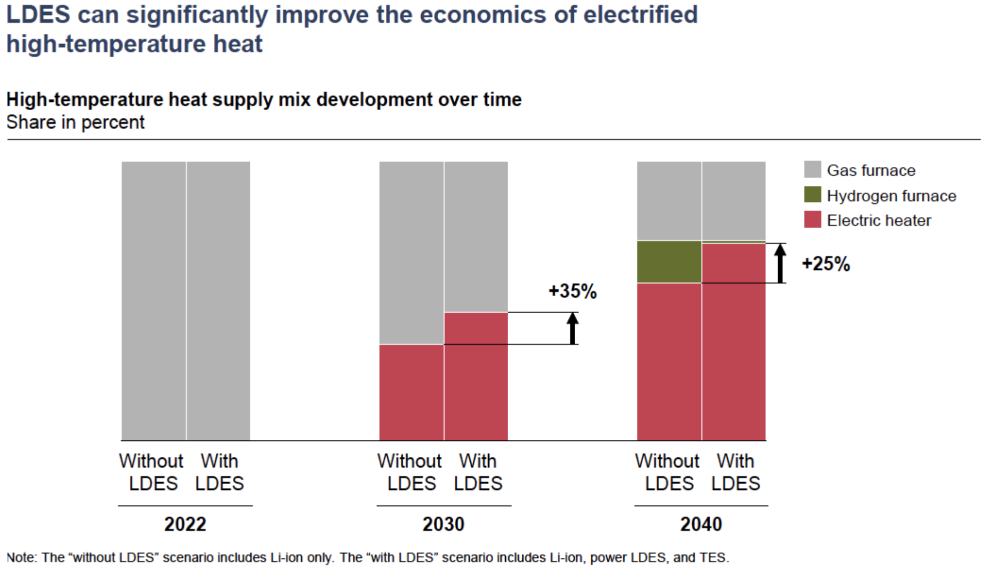
Waste heat recovery: energy recovery from lower pressure evaporator through ejectors, similar to how a turbocharger recycles exhaust gases in an engine to increase performance

Innovative compressors: Use of external voltage to pump hydrogen, water or other refrigerants. The electric potential gradient governed by Nernst equation and Ohm's law is the driving force



Examples (III): heat pumps, T lift and energy storage

European Innovation Council



Long Duration Energy Storage Council, 2022

Thermoacustic heat pump, BHE

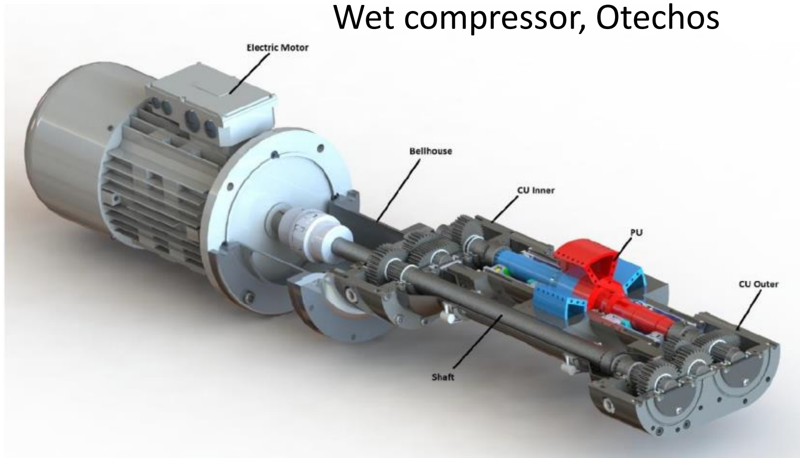
Key R&I needs for heat pumps

high COP at higher temperature lift

To extend the application to existing building stock

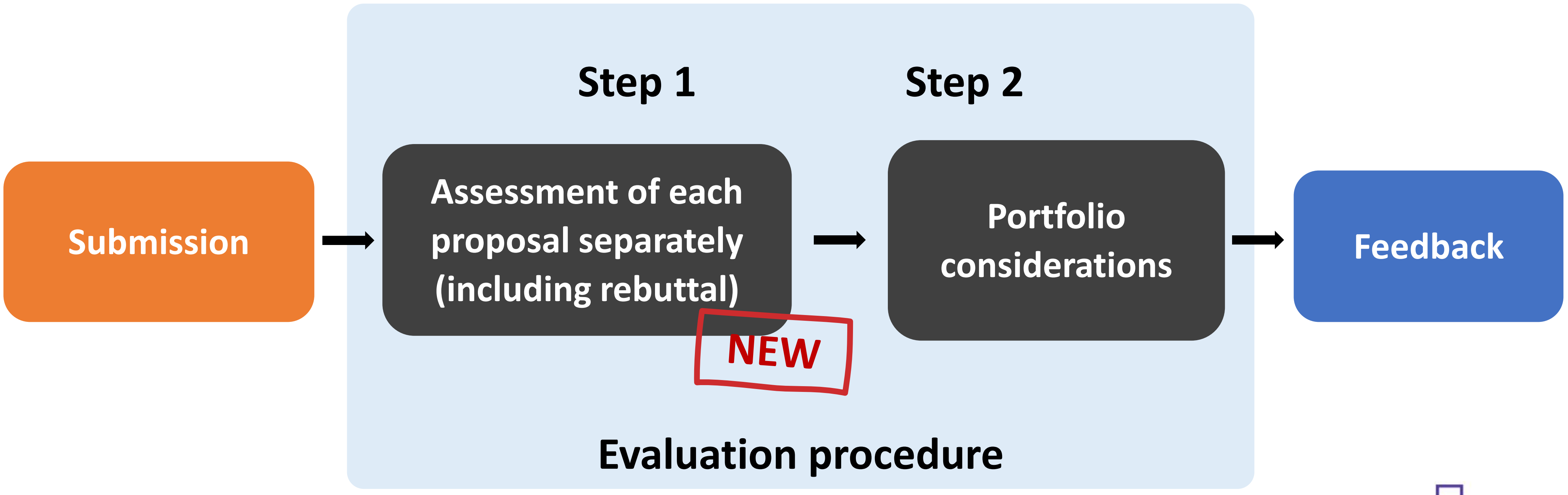
Hybrid adsorption- vapor compression HP

Wet compressor, Otechos



How does the EIC decide if your proposal will be funded?

European Innovation Council



European Innovation Council

Award criteria Pathfinder Challenge (and Open)

- Excellence (threshold 4/5, weight 60%)
- Impact (threshold 3.5/5, weight 20%)
- Quality implementation (threshold 3/5, weight 20%)

Step 2: portfolio considerations

The Challenge Guide describes the Portfolio Considerations:

[Clean and efficient cooling (europa.eu)]

Step 2: Portfolio considerations

NEW

European Innovation Council

- All proposals that meet the thresholds defined in the award criteria will be considered in step 2
- **Mapping of proposals in categories** stemming from overall goal and specific objectives of the Challenge (e.g., building blocks or subsystems, technical areas and/or competing technologies, platforms, applications areas, risk level and stage of technology readiness level, size)
- A **suitable portfolio of proposals** to be selected by evaluation committee by applying **portfolio considerations** in order to propose for funding a coherent set of projects to achieve expected outcomes and impacts of Challenge (in all cases the overall balance and composition of the portfolio will be taken into consideration)

Portfolio composition

European Innovation Council

	Elements for portfolio building	
Categories	**Complementarities**	**Shared components**
1. Cold energy generation 2. Storage/transport 3. Cold management, end-uses, monitoring/fault evaluation	Application range Temperature level Processes and technology proposed	Materials selected Components and devices integration Cold chain integration

Starting from the highest ranked proposal, a portfolio of proposals will be selected based on shared components/complementarities, while ensuring diversity among the selected proposals and coverage of the three categories.

Challenge guide – Activities within a portfolio

European Innovation Council

In your proposal add a dedicated WP for portfolio activities with at least ***10 person months.*** Example activities are:

- understand better/improve the current regulatory framework
- communicate of any key outcome of the research work of the portfolio members collectively and/or an individual project, to early stage private and corporate investors focused on the same field.
- Market analysis
- Discussions on IP, licensing and business models and commercialisation strategy
- Providing access to Open Innovation Test Beds and other research infrastructure
- Standardisation activities
- Providing access to new markets through multipliers like Enterprise Europe Network

Further information and questions

- **EIC 2023 WP**: EIC 2023 work programme (europa.eu)
- **Recording general info day**: European Innovation Council online Info Day - Work Programme 2023 - 13 December 2022 (europa.eu)
- **Your National Contact Point**
- **Marco Pantaleo**: https://www.linkedin.com/in/antonio-marco-pantaleo-1602622/

Pitches for matchmaking

European Innovation Council

- 1. Leon Stile – SolarICE
- 2. Martin Buchholz – Watergy
- 3. Virginie Ponsinet – METACOOL
- 4. Lorenzo Pattelli from INRIM
- 5. Alessandro Pastore – Camfridge
- 6. Albert Castell – RCE project
- 7. Gian-Marco Rignanese – Matgenix
- 8. Ioannis Papakonstantinou – RadCool Fundamentals
- 9. Lovisa Högberg – z.trusion® battery pack
- 10. Paul Motzki – Elastocalorics
- 11. Yair Suued – Sphere.

Thank you!

Q&A

Expected impacts

development of proof of concepts of technologies that could be scaled up towards technological innovations to reinforce the EU technological autonomy and its positioning in the global scenario, and be broadly implemented to:

i. increase the EU competitiveness, carbon footprint and security in strategic productive sectors (such as food production/processing/transport/delivery)

ii. give broad access to building comfort and **health** in living environment (**Mission Cities**),

iii. increase operational security of server and computing facilities (**Chips Act**)

iv. address climate change adaptation (in particular in semi-desertic areas) and **food security**, including possibilities of **international outreach** (EU-Africa cooperation on renewables, Mission innovation and AU-EU Science and Innovation Partnership on Climate Science and Sustainable Energy)

Pathfinder P3	Clean cold technologies

European Innovation Council

Relevance to EU policies and initiatives

Green Deal, RepowerEU (Hydrogen Accelerator, EU-Africa cooperation on renewables), Fit for 55, Chips Act, Digital EU, Food security, Farm to Fork, Health (post-pandemic need for health in built environment), Mission innovation (hard to abate industrial sectors + renewable energy)

Synergy/ complementarity with other EU programmes

HEU missions (Cities, Climate Adaptation), Cluster 5 HEU, Cluster 4 HEU, BEPA,
Partnerships: Built4people, Clean Energy Transition, BEPA + Renewable heating and Cooling Alliance
Related topics in Cluster 5, draft WP 2023-24:

- flagships on 'Demonstration of innovative, large-scale, seasonal heat and/or cooling storage technologies for decarbonization and security of supply' (30 MEur)
- flagship ' Building stocks for REpowerEU: innovative solutions for cost-effective decarbonization of buildings via energy efficiency and electrification' (25 MEur)
- innovative components and configurations for heat pump systems (7 MEur)
- advanced manufacturing of PV and solar thermal components and systems (27 MEur)

Underpinning evidence

Cooling and HVAC trends: https://www.cleancoolingcollaborative.org/wp-content/uploads/2022/02/Technology-review-report_MGM-Innova_K-CEP_ENG.pdf
Growth of the cold chain in China: https://www.chinadaily.com.cn/a/202112/14/WS61b7f011a310cdd39bc7b232.html
Growth of refrigeration whitegoods sales in France https://www.gifam.fr/2022/02/14/communique-de-presse-bilan-2021-du-gifam/
Clean cold chains and sustainability goals https://www.birmingham.ac.uk/documents/college-eps/energy/publications/clean-cold-and-the-global-goals.pdf
Coal coalition: Status of the global food-cold chain: https://coolcoalition.org/status-of-the-global-food-cold-chain-summary-briefing
IEA report: the future of cooling https://iea.blob.core.windows.net/assets/0bb45525-277f-4c9c-8d0c-9c0cb5e7d525/The_Future_of_Cooling.pdf
Clean cold and the global goals https://www.birmingham.ac.uk/documents/college-eps/energy/publications/clean-cold-and-the-global-goals.pdf
https://iea.blob.core.windows.net/assets/0bb45525-277f-4c9c-8d0c-9c0cb5e7d525/The_Future_of_Cooling.pdf
https://www.mordorintelligence.com/industry-reports/europe-data-center-cooling-market-industry
https://www.iea.org/reports/tracking-heat-pumps-2020
https://www.youtube.com/watch?v=X9vpgQNxX-E&t=33s
https://www.bechtel.com/blog/innovation/december-2020/disrupting-cooling-technology-accelerating-path/
https://www.energy.gov/sites/prod/files/2019/05/f62/bto-peer-2019-xergy-hydrogen-metal-hydride-based-heat-pump.pdf
https://doi.org/10.1016/j.applthermaleng.2022.118635
https://patents.google.com/patent/WO2018167773A1/en

Clean Cooling – possible area of investigations

Recovery of waste (or potentially waste) thermal energy (hot or cold)

- Only limited amount of cold released from LNG regasification is recovered.
- With proper recovery of cold energy, up to 38% energy can be saved in a district with mixed cold energy use.
- Such trend is expected to continue with liquid hydrogen potentially as one of the main transportation methods in hydrogen economy.
- ***Applications integrating waste cold and heat source*** can be identified, including Organic Rankine Cycles, Absorption cooling, Allam cycle with air separations, usage in data centers needs be investigated to maximize energy savings and minimize carbon emissions.
- ***Cascade utilization of ultra-cold energy from LNG or LH2*** needs to be investigated for higher exergy efficiency. Cold energy can be distributed to multiple users, from lowest temperature (such as air separation or liquefaction) to medium temperature (such as dry ice production) and highest temperature (freezing, space cooling or CCGT inlet cooling). Temperature mismatch always result in much lower exergy efficiency.

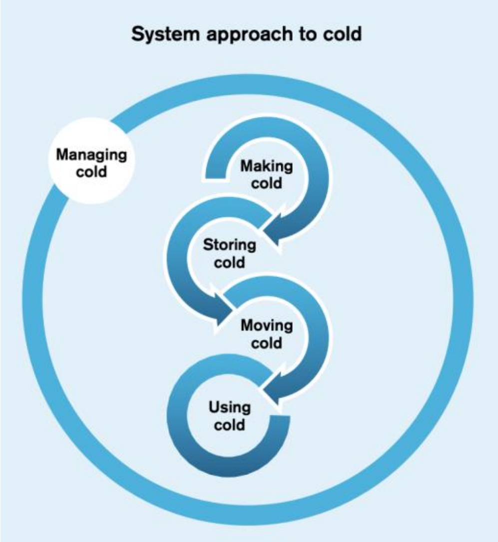
Storage of extra cold energy using thermal energy storages

- Storage of cold energy is important to bridge the distance and time-of-use between cold energy supply and demand.
- There are limited materials with good properties under cold condition, especially subzero temperature.
- ***Development of suitable materials***, especially phase change materials, need to be developed to suit the operational temperature of both cold energy supply and demand, as well as achieving good thermophysical properties such as no supercooling, high energy density and high thermal conductivity.
- ***Improvement on storage system design*** needs to be properly done to enhance the storage efficiency (e.g. maximize heat transfer area) and minimize thermal losses to the environment or mixing due to thermal stratification.
- ***Cascaded latent thermal energy storages*** (system consists of phase change materials with different phase change temperature) may also be required for cold storages from cold source with ultra low temperature such as LNG or LH2.

Clean cooling: background

- **Cooling is vital** for food, medicine, data, industry, urbanization, and almost every aspect of civilization
- **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 current 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**: the lack of adequate cold storage and refrigerated transport causes 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, making it the third biggest emitter after the 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) and system-level analysis



Need for:

- **transformational research** - displace existing technologies (i.e. functionalized PCM, laser cooling, reversible combustion etc)
- **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