

ELICiT

Environmentally
Low Impact
Cooling
Technology



**MAGNETIC COOLING ENGINE FOR
DOMESTIC REFRIGERATION APPLIANCES
VICTORIA, BC CANADA**

ELICiT WORKSHOP
THERMAG VI,
SEPTEMBER 9TH 2014

Camfridge

- Camfridge is a world-wide leader in **energy-efficient** , **gas-free** , **low cost** magnetic refrigeration technology.
- Camfridge develops a **low-cost** and **rare-earth free** solution.
- Camfridge started operation in 2005, as a spin-off from the University of Cambridge
- Camfridge is the key partner of many EU Research projects (SSEEC, DRREAM, FRISBEE and ELICiT).



EUROPEAN VENTURE CONTEST
BERLIN | 6 & 7 December 2012

**Overall Cleantech
Winner**



**“Top technology for a cleaner
planet” global list.**



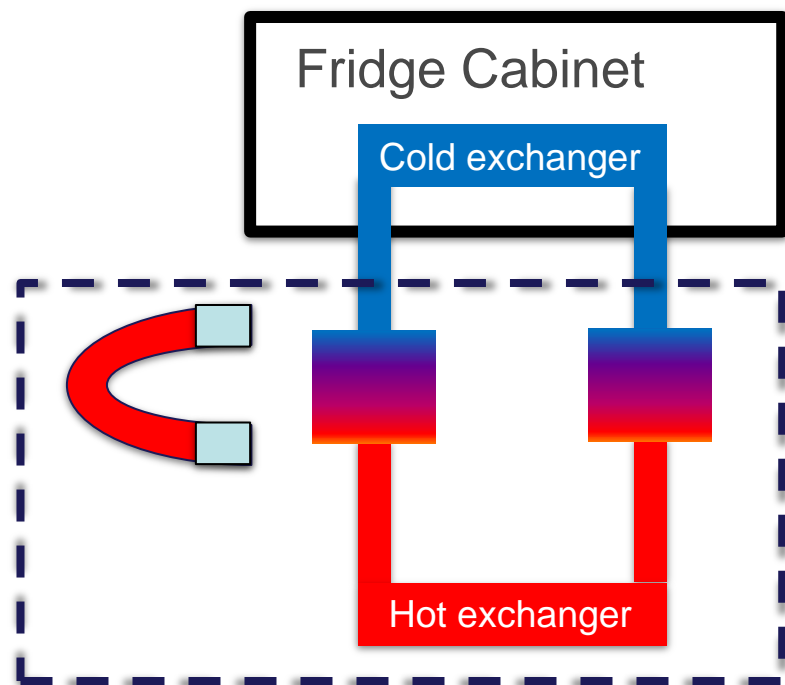
**Top 30 UK clean
technology start-ups**

Featured on: Financial Times / Daily Telegraph / Guardian / Chemistry Technology Review /
Zeitschrift / Professional Engineer / BBC /



MAGNETIC COOLING ENGINE FUNCTIONAL VIEW

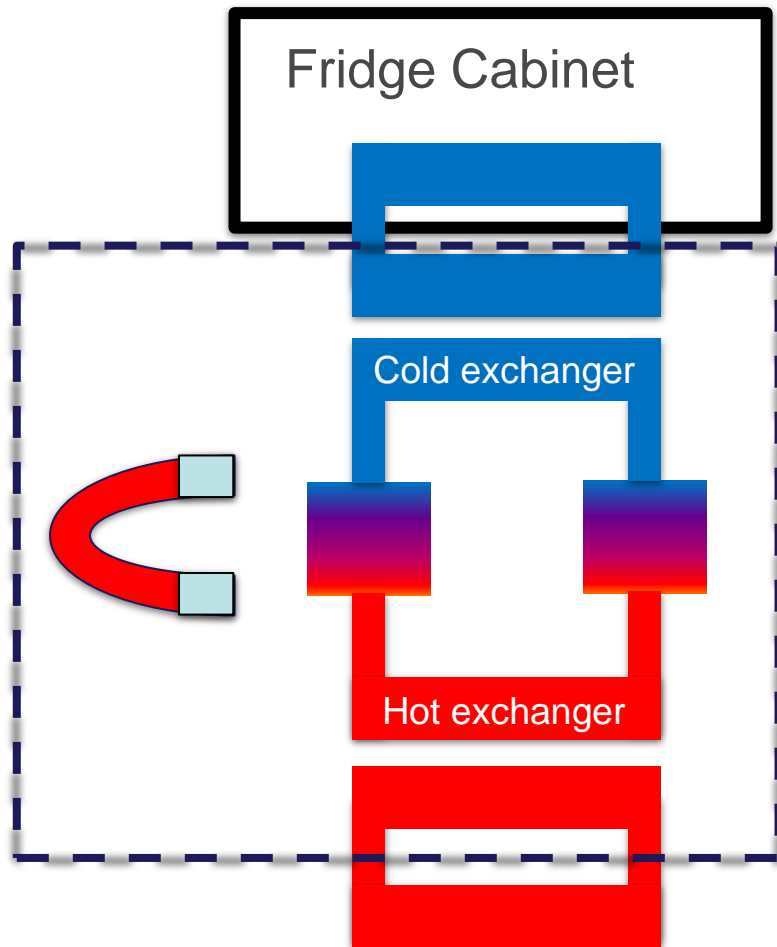
Cambridge



Cooling engine components:

- Permanent magnet
- Magnetocaloric material
- 1 Electric engine
- 1 pump
- Fluid handling system

OTHER POSSIBLE MAGNETIC COOLING ENGINE DESIGN: MORE EXPENSIVE AND BIGGER!



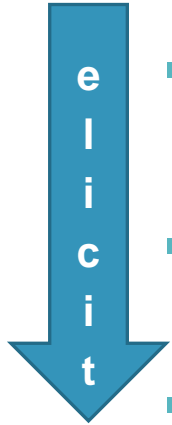
Cooling engine components:

- Permanent magnet
- Magnetocaloric material
- 1 Electric engine
- 3 pumps
- Fluid handling system
- 2 Secondary loops

EU H2020 TECHNOLOGY READINESS LEVELS (TRL)

DEFINITION

- TRL 1 – BASIC PRINCIPLES OBSERVED
- TRL 2 – TECHNOLOGY CONCEPT FORMULATED
- TRL 3 – EXPERIMENTAL PROOF OF CONCEPT
- TRL 4 – TECHNOLOGY VALIDATED IN LAB
- TRL 5 – TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT (INDUSTRIALLY RELEVANT ENVIRONMENT IN THE CASE OF KEY ENABLING TECHNOLOGIES)
- TRL 6 – TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT (INDUSTRIALLY RELEVANT ENVIRONMENT IN THE CASE OF KEY ENABLING TECHNOLOGIES)
- TRL 7 – SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT
- TRL 8 – SYSTEM COMPLETE AND QUALIFIED
- TRL 9 – ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT (COMPETITIVE MANUFACTURING IN THE CASE OF KEY ENABLING TECHNOLOGIES; OR IN SPACE)



CAMBRIDGE: WORLD'S SMALLEST MAGNETIC COOLING ENGINE

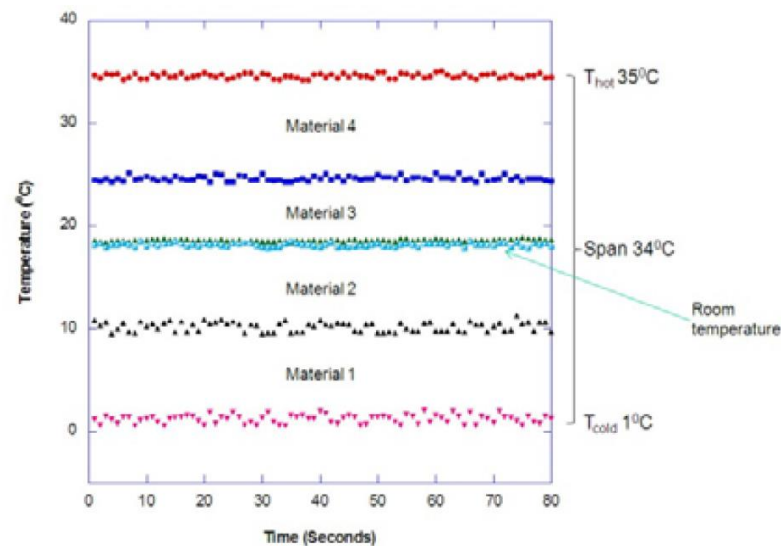
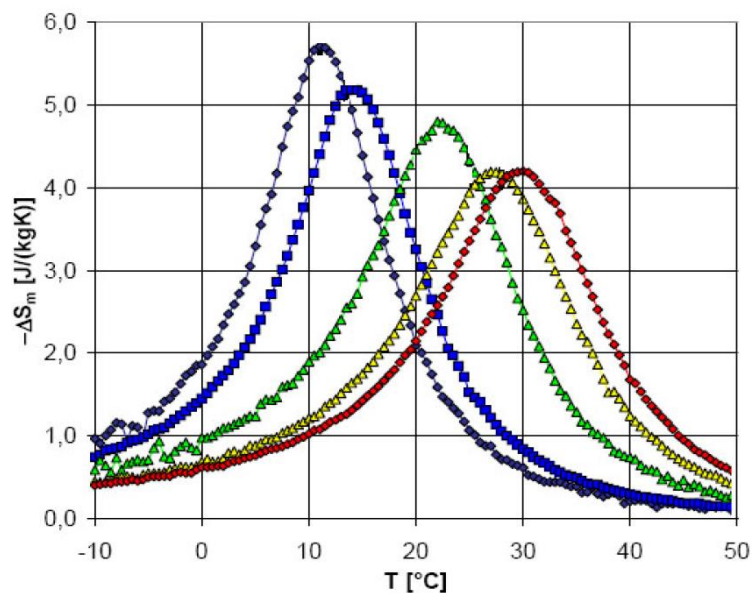
Cambridge



Same size and weight as a gas compressor

The starting point of ELICiT project is the Cambridge's TLR4 machine

OPERATING CONDITIONS IN 4 MATERIAL REGENERATOR MACHINE



DOMESTIC REFRIGERATION REFERENCE SPECS*: THE RELEVANT ENVIRONMENT FOR MAGNETIC COOLING ENGINE

T span: 34K (fridge)/ 54 K (freezer)

T_{cold}: 274 K (fridge) / 254 K (freezer)

T_{hot}: 308 K

Cooling power: 30W – 180W

Cooling engine weight : max 10 Kg

Efficiency appliance: EEI < 22

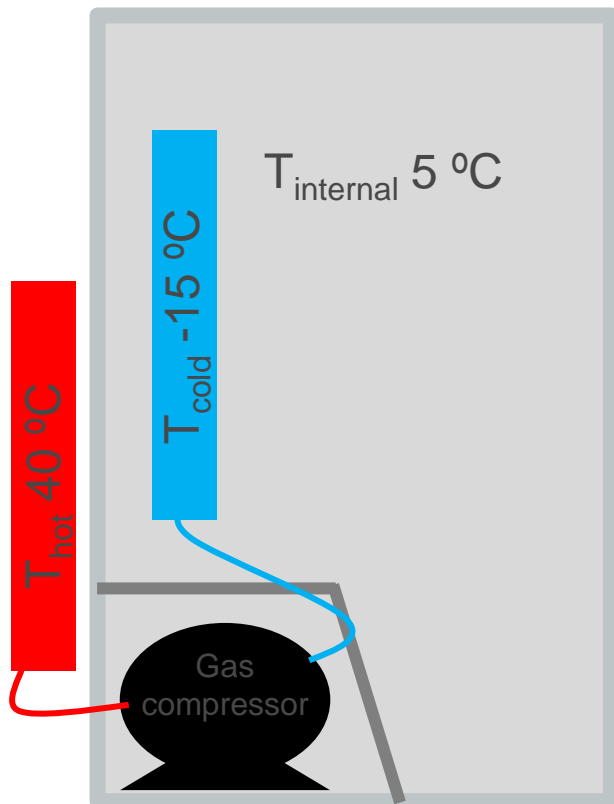
Life cycle: 10-15 years

Noise appliance: <40 dB



A GAS COMPRESSOR BASED DOMESTIC FRIDGE IS ONLY NOMINALLY 14% EFFICIENT

Cambridge



Ideal Carnot COP: 14

Gas compressor based domestic fridge COP : 2

Magnetic cooling engine based domestic fridge COP : 4

The Magnetic cooling engine based domestic fridge can double the appliance efficiency

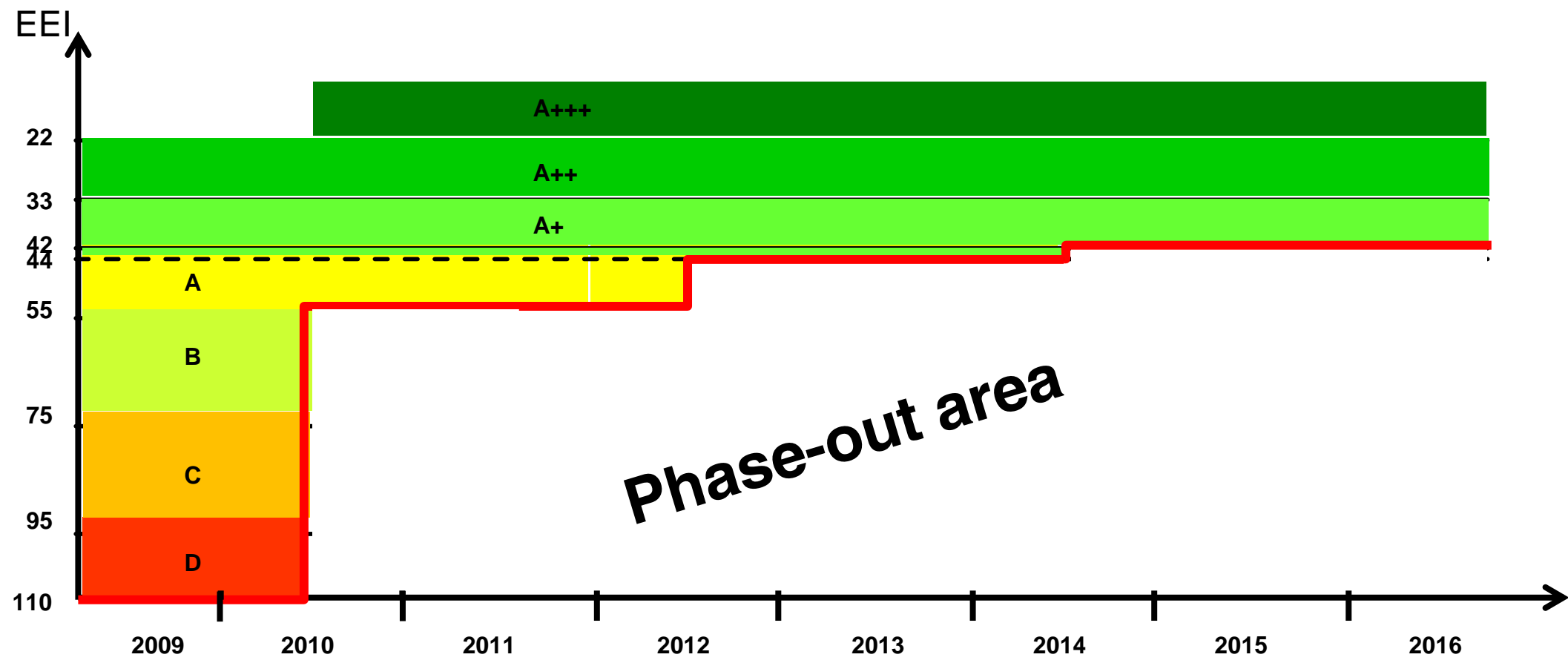
THE MAGNETIC COOLING ENGINE BASED DOMESTIC FRIDGE CAN DOUBLE THE APPLIANCE EFFICIENCY

Cambridge

	Thermodynamic Ideal	Current Solution (Butane)	Magnetic Solution
Target Cooling Power (W)	30	30	30
$T_{hot}(^{\circ}C)$	25	40	35
$T_{cold}(^{\circ}C)$	5	-15	0
Cooling Engine Power (W)	30	150	30
Technology Efficiency (%)	100%	43%	50%
Running Time (%)	100%	20%	100%
COP	14	2	4
Relative Efficiency	100%	14%	28%
Energy Consumption (W)	2.2	15	7.5

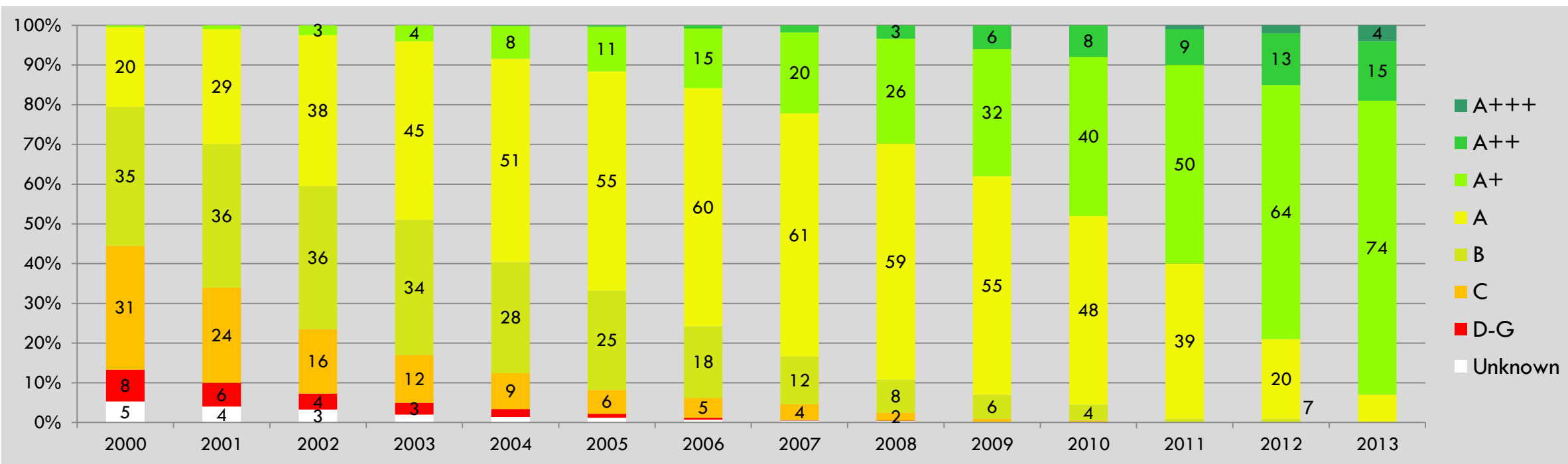
Analysis based on a typical high efficient domestic fridge working parameters

THE LEGISLATIVE DOMESTIC REFRIGERATION MARKET DRIVER: THE EU CASE



MOST EFFICIENT REFRIGERATOR WINS MARKET

elicit - project - eu



New efficient fridges experience strong growth in the 15M* units p/a

Source: GfK Panelmarket 10 countries Western Europe (AT, BE, DE, ES, FR, BG, IT, NL, PT, SE)



- **Magnetic Cooling is an environmental technology that meets a real market need.**
- **Camfridge's solution is compact and low cost for high-efficiency domestic appliances.**
- **Camfridge is working with suppliers and producers to optimise and scale production of key components.**
- **We are hiring!**



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#MagneticCooling